Fort Peck Pallid Sturgeon Study

by

Anne Tews and Pat Clancey
Fisheries Biologists
Montana Department of Fish, Wildlife, and Parks

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Mark Harberg
Corps of Engineers
Project Coordinator

ABSTRACT

The 1992 field season was the fourth year of the Fort Peck Pallid Sturgeon Study. We completed 323 drifts totalling 38.0 hours and captured 35 pallid and 402 shovelnose sturgeon. Two of these pallids were recaptures. Pallids represented 8.7 % of the sturgeon netted. One pallid was captured 2 miles up the Yellowstone River. The rest were captured below the confluence of the Missouri and Yellowstone. Twenty-five "new" pallids were pulled from one pool/run, located 8 miles downstream of the confluence. Trammel netting appeared to be more effective in capturing pallids than gill netting. In September and October we concentrated trammel netting effort in known pallid habitat, which resulted in pallid catch rates of 3.8 pallids/hour in October of 1992. This compares with overall pallid catch rates of 0.9 pallids/hour in 1992 and <0.1 pallid/hour in 1991. This was the first year that no pallids were observed during winter SCUBA surveys in the Fort Peck tailrace. In 1992, pallids ranged in weight from 6.8 kg (15 lbs) - 24.5 kg (54 lbs). Morphometric measurements were taken from all pallids and from most shovelnose.

One internal and 8 external radio transmitters with battery lives of 100 days to 2.5 years were attached to 9 pallid sturgeon. Three of these pallids also had 4 year sonic transmitters. We collected extensive location and microhabitat data from these fish. Pallids were usually found in narrow channels along sandbars. Pallid nose velocity and depth measurements were variable but averaged 0.5 m/s and 3.1 m deep during September and October 1992.

Nine shovelnose implanted with transmitters in 1991 and the 9 shovelnose implanted in 1992 were relocated at least once during 1992 and most were monitored several times throughout the 1992 field season.

A character index, based on morphological measurements, divided pallid and shovelnose sturgeon into two separate groups. Based on this index, and field observation, no suspected pallid/shovelnose hybrids were captured in 1992.

DISCLAIMER

Mention of commercial products in this report does not imply endorsement by the Montana Department of Fish, Wildlife, and Parks.

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INTRODUCTION

This report summarizes the fourth field season of the Fort Peck Pallid Sturgeon Study, which began on April 1, 1989, with a contract between the U.S. Army Corps of Engineers (Corps) and the Montana Department of Fish, Wildlife, and Parks (MDFWP). Clancey (1990, 1991, 1992) reports the findings of the first three years of this study. In 1992, Bob Bramblett, a graduate student from the Montana Cooperative Fish Research Unit assisted with fieldwork by collecting extensive summer habitat information.

The goals of this study are to identify abundance, seasonal habitat use, migration patterns and potential spawning areas of pallid and/or shovelnose sturgeon and to evaluate pallid/shovelnose hybridization throughout the study area.

MDFWP is conducting two other pallid sturgeon studies, one on the Missouri River between Fort Peck Reservoir and Fort Benton (Gardner 1990, 1991, 1992), and one in cooperation with the Bureau of Reclamation, on the Yellowstone River, between Intake Diversion Dam near Glendive and Cartersville Diversion Dam near Forsyth (Watson and Stewart, 1991, Backes et al, 1992).

STUDY AREA

The study area is the approximately 230 miles of the Missouri River from Fort Peck Dam, Montana downstream to Lake Sakakawea, North Dakota, and the 70 miles of the Yellowstone River from its mouth to Intake diversion dam (Figure 1). In 1992 most fieldwork was concentrated on the Yellowstone River and the Missouri River below the confluence (Figures 2 and 3).

Discharge of the Missouri River averages 10,570 cubic feet per second (cfs) annually at Culbertson (USGS) and is regulated downstream of Fort Peck Dam. Flow regime (Figure 4), turbidity and temperature, have all been dramatically altered from natural conditions. In the Fort Peck tailrace, the river is up to 45 feet deep, current velocity is slow, bed load movement is minimal and the channel is free of obstructions. Downstream, accelerated streambank erosion and channel downcutting occur due to the fluctuating water levels in the river and to the "clean, hungry" hypolimnial water releases from Fort Peck Reservoir.

In 1992, powerhouse repairs and drought resulted in reduced flows from Fort Peck Reservoir. During 1992 instantaneous releases from Fort Peck Dam were from 2000 to 13000 cfs. Daily flow fluctuation varied from less than 50 cfs to more than 10,000 cfs.

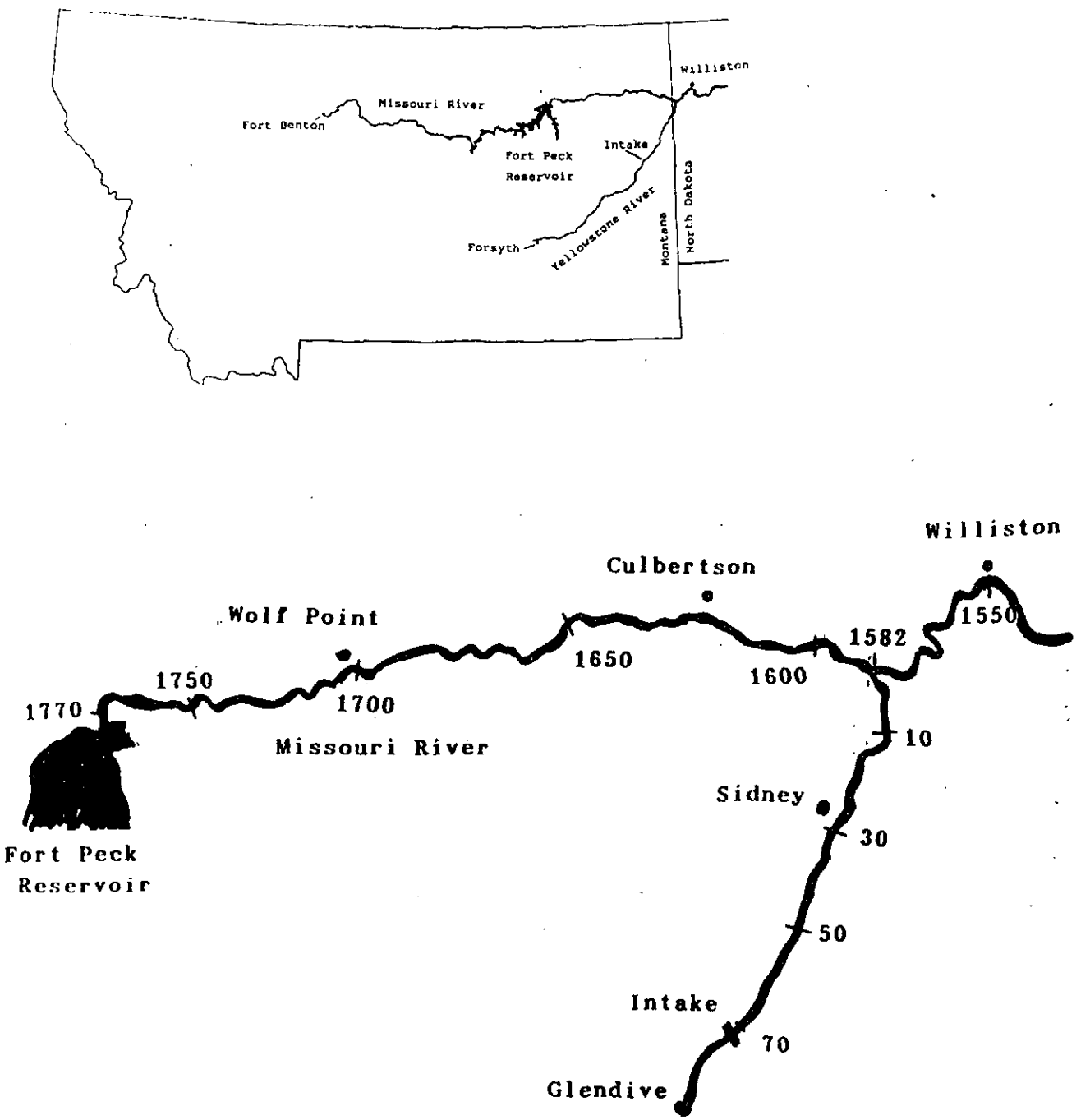


Figure 1. Map of Fort Peck pallid sturgeon study area with river miles.

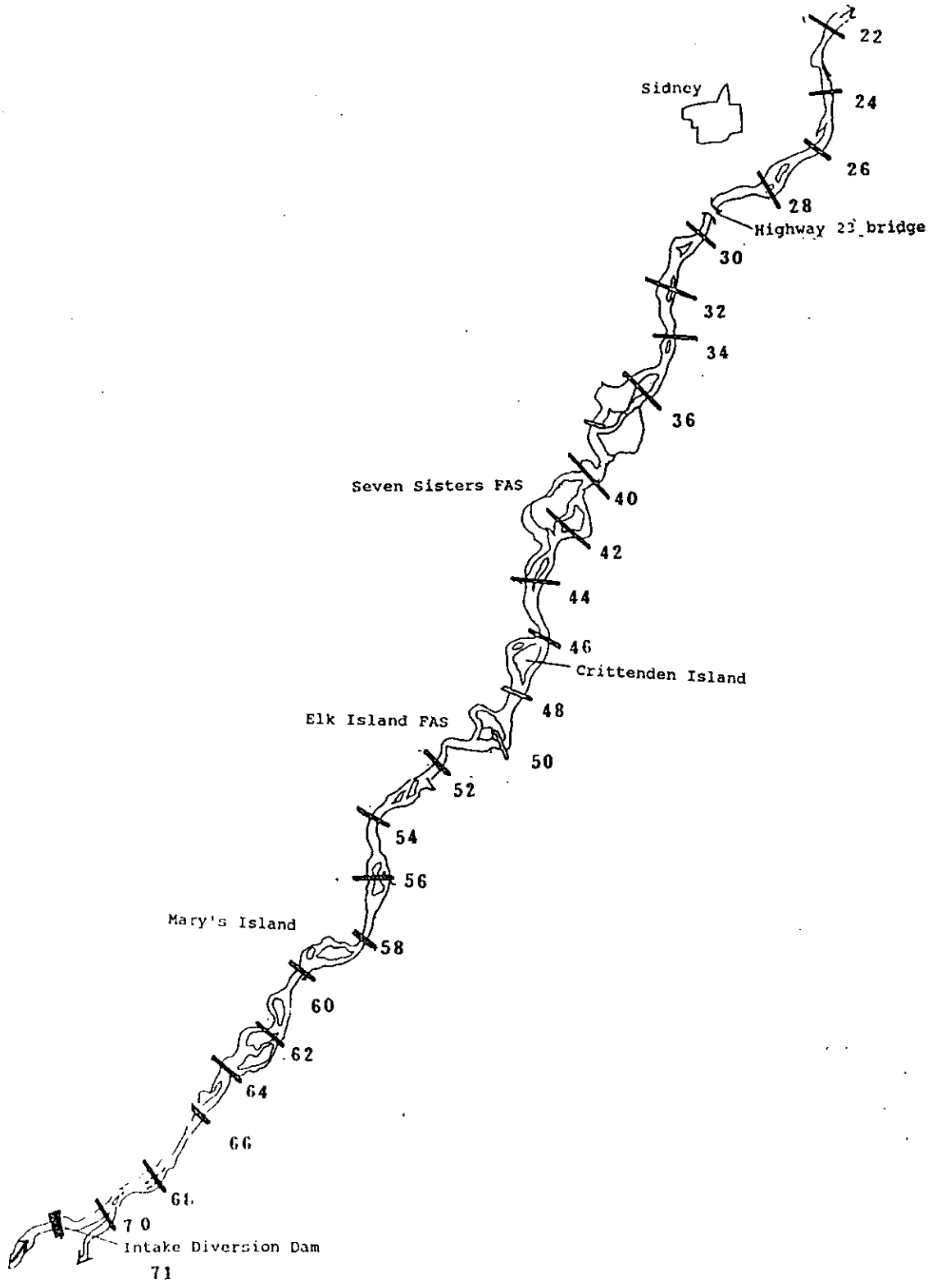


Figure 2. Yellowstone River from Sidney to Intake with river miles from the confluence Missouri.

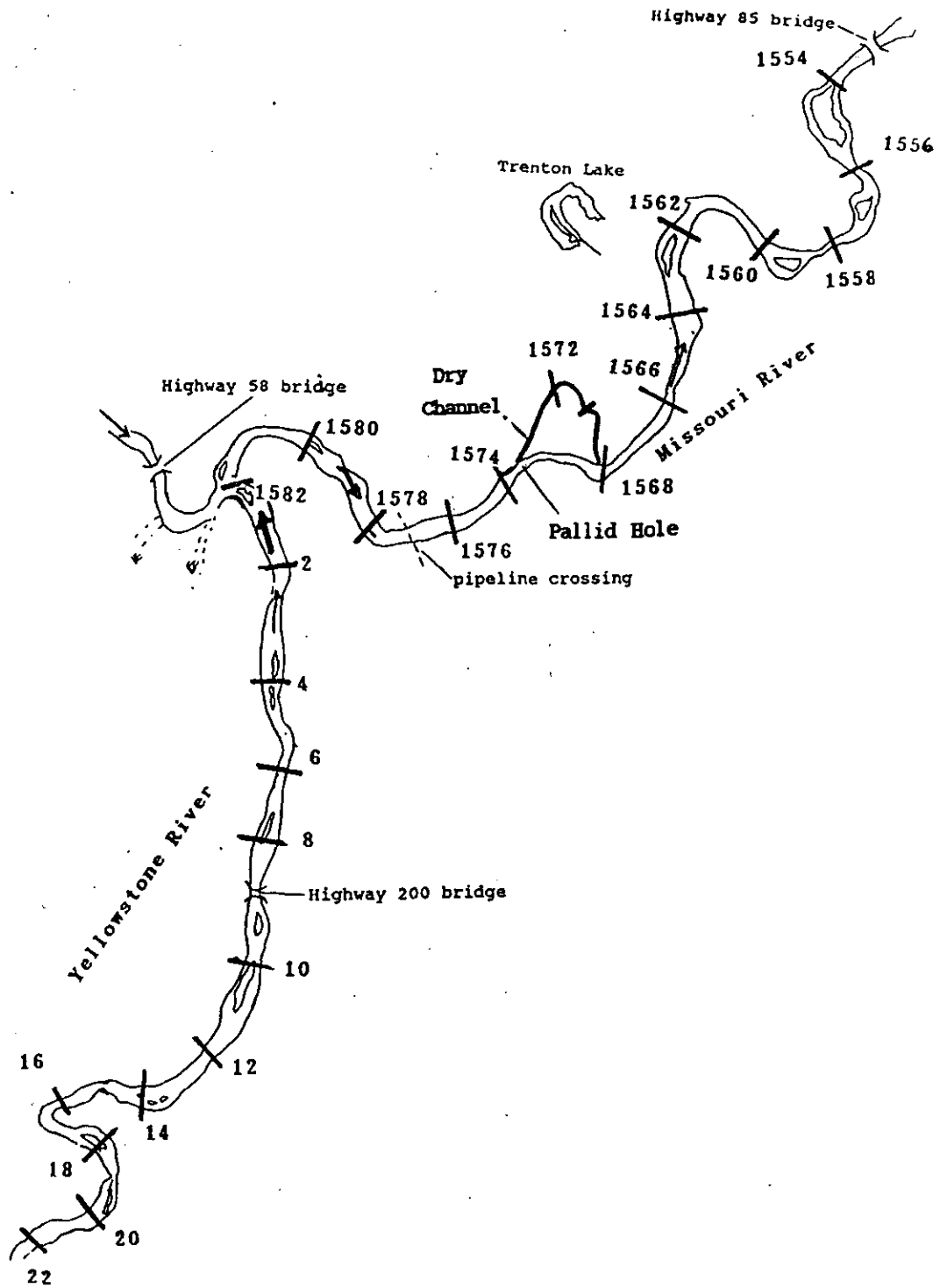


Figure 3. Missouri and Yellowstone Rivers from the Highway 85 Bridge to river mile 22 on the Yellowstone with Missouri river miles from mouth the of the Mississippi and Yellowstone miles from the confluence with the Missouri.

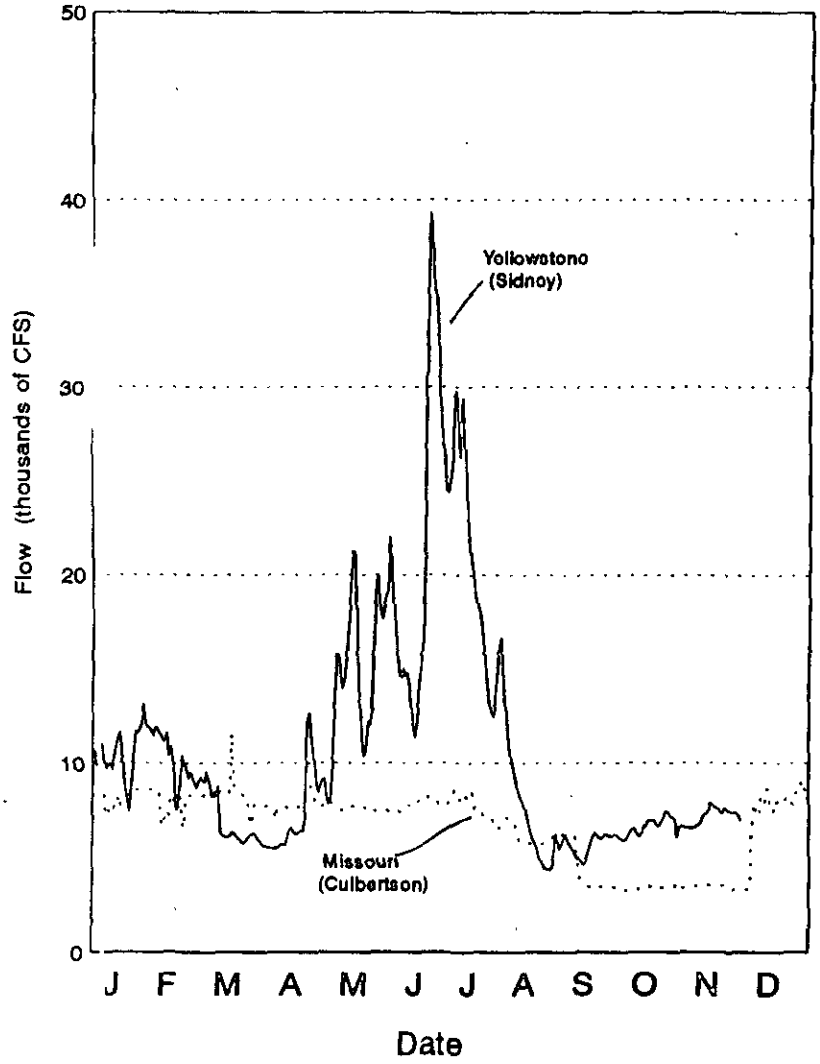


Figure 4. Hydrographs of the Missouri River below Fort Peck Dam and the Yellowstone River at Sidney from preliminary USGS data.

As in past years, fluctuations were moderated downstream (USGS, Gardner and Stewart 1987). In August 1992, daily flow fluctuation was reduced from an average 2000 cfs at Fort Peck Dam to 800 cfs at Wolf Point (70 miles downstream of Fort Peck) and to 200 cfs at Culbertson (151 miles downstream of Fort Peck). From September 1, 1992 through late November, discharge from Fort Peck Reservoir was reduced to a steady 3000 cfs, much lower than any sustained discharges of the past few years (USGS).

Like flow fluctuation, turbidity returns to near normal conditions around Wolf Point, however temperature is likely about 6 F colder at Culbertson than would be found in natural conditions (Gardner and Stewart 1987). In Montana, the Missouri River gradient varies from 0.6 feet/mile near the Milk River to 1.5 feet/mile near the Redwater River. The river becomes depositional near Wolf Point and is characterized by shifting sandbars near Culbertson (Gardner and Stewart 1987). The confluence of the Missouri and the Yellowstone Rivers is one mile downstream of the Montana border. Below this confluence, the Missouri is up to 35 feet deep, has shifting sand bars, moderate to fast current and numerous snags. When Lake Sakakawea is at full pool (1850 feet) there are only about 15 miles of river between the confluence and the headwaters of Lake Sakakawea (Power et al, 1992). However, throughout this study there have been about 40 - 50 miles of free flowing river downstream of the Yellowstone confluence.

Average annual discharge of the Yellowstone is 12,400 cfs, which is slightly higher than the Missouri at Culbertson (USGS). In contrast to the Missouri, the Yellowstone River is unimpeded for its entire course, except for run-of-the-river irrigation dams. However, inflow from two major tributaries, the Tongue and the Bighorn Rivers, is regulated by dams. Despite these alterations, the Yellowstone exhibits a near natural hydrograph (Figure 4) and water quality characteristics. The Yellowstone River below Intake is characterized by shifting gravel beds and numerous islands (Koch et al, 1977). Depth is generally less than 15 feet and current velocity is high. Gradient varies from 1 - 3 feet per mile from Intake to the confluence, and averages 2.8 feet per mile downstream of the Bighorn River (Haddix and Estes, 1976).

METHODS

Field methods were generally similar to those used in previous years (Clancey 1990, 1991, 1992). Flows were obtained from the Fort Peck field office of the USGS and the Corps. Missouri River mileages are miles upstream from the confluence of the Missouri and Mississippi Rivers and were obtained from the Corps 1983 aerial photos. Yellowstone River mileages were obtained from the River Mile index of the Yellowstone River (1976). All river miles less than 1500 referred to in this report are Yellowstone river miles.

Sturgeon were caught by drifting sinking gill nets and trammel nets from a 21 foot Wooldridge inboard jet boat. Depth and temperature were recorded. Several types of nets, all with 6 foot high panels were used. Multifilament 100-foot 3-inch gill nets, 100-foot monofilament experimental gill nets and 125-foot experimental multifilament gill nets were used for most of the field season. In September 1992 we started using 150-foot trammel nets with a 2-inch inner and 10-inch outer mesh. One end of the net was attached to the boat while the other end was attached by 10 - 20 feet of rope to 2 floats. Nets were set perpendicular to the current and were drifted from 1 - 41 minutes. Drift time averaged 7 minutes. A drift began when we started setting the net and ended as we began retrieving the net. We started attaching a small (1 pound) weight to the lead line in mid-September 1992, to insure this lead line was dragging on the river bottom.

The study area was subjectively divided into sections for comparison of effort and fish abundance (Table 1). Hourly catch was tabulated as catch per unit effort (CPUE). However, our effort was intensified in areas of known pallid habitat, so CPUE does not reflect abundance of various species for the entire study area or even sections of the study area.

Table 1. Study area sections (river miles in parenthesis):

1 Fort Peck Dam to the mouth of Milk River (1761.5 - 1770)
2 Milk River to Wolf Point (filtration plant) (1708 - 1761.5)
3 Wolf Point to mouth of Redwater River (1683.1 - 1708)
4 Mouth of the Redwater River to the mouth of Big Muddy Creek (1630.4 - 1683.1)
5 Big Muddy Creek to the confluence of the Missouri and Yellowstone rivers (1582 - 1630.4)
6 Missouri/Yellowstone confluence to Highway 85 Bridge (1553 - 1582)
7 Highway 85 Bridge to Lake Sakakawea (approx 1530 - 1553)
8 Yellowstone River from Intake to Highway 200 Bridge (9.0 - 71.1) (29)
9 Yellowstone River from Highway 200 Bridge to the Missouri/Yellowstone confluence (0.0 - 9.0)

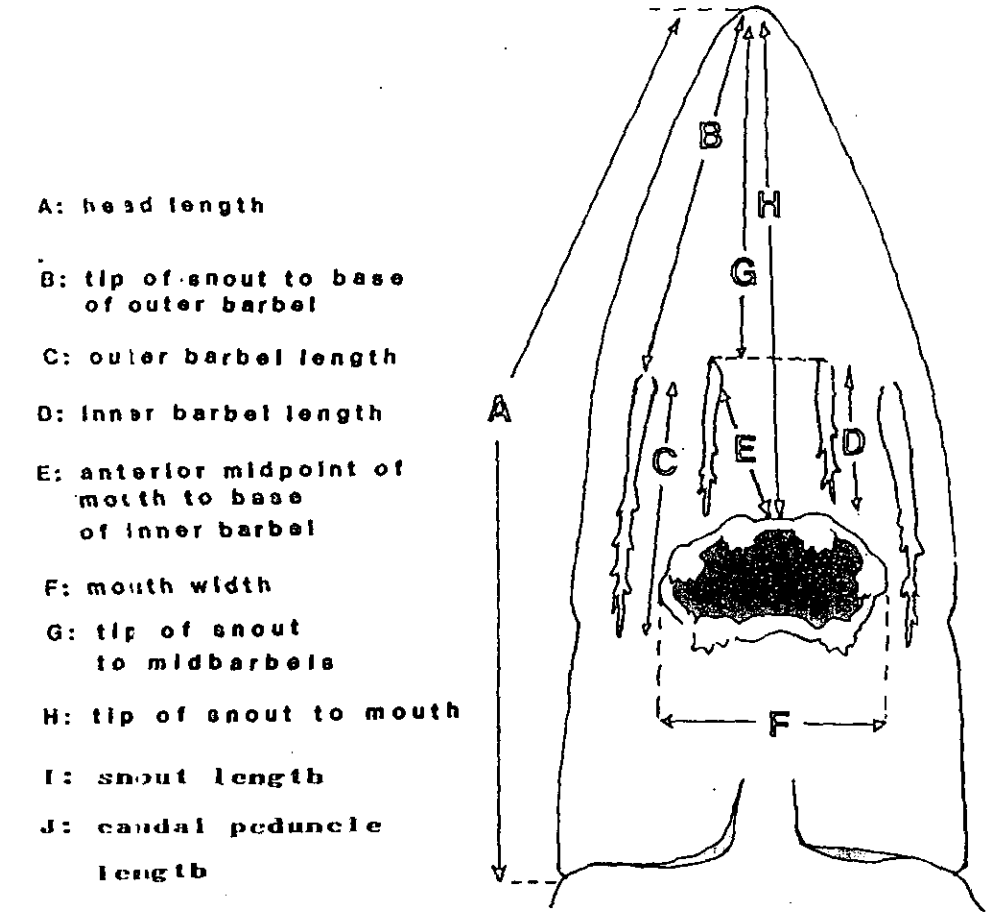
Figure 5 illustrates the characteristics measured on all pallid sturgeon and on most shovelnose sturgeon caught during the 1992 field season. Measurements were taken in inches or feet and converted to millimeters (mm). Percent of standard length was calculated from these measurements. Weights were taken from pallid sturgeon and from several shovelnose sturgeon.

To evaluate hybridization between pallid and shovelnose sturgeon, percent standard length of head length, inner barbel length, outer barbel length, snout to outer barbel length, mouth to inner barbel length and mouth width were transformed into a character index as done by Gardner (1992). This character index is similar to the one developed by Carlson and Pflieger (1981). The smallest numbers reflect the most shovelnose-like characteristics and the largest numbers the most pallid-like characteristics. The six numbers are added for a character index value between 0 and 600. See Appendix 1 for calculations.

Pallid sturgeon were injected with 400 kilohertz (Khz) passive integrated transponder (PIT) tags at the base of the dorsal fin. Yellow dangler tags were also attached to all pallids. Green disc tags were attached to some shovelnose including all transmittered shovelnose. After August 31, 1992 spaghetti tags were attached to the posterior of the dorsal fin of all shovelnose sturgeon of adequate size. Genetic samples from 11 pallids and 36 shovelnose were taken for Genetic Analysis of Smithville Texas. Blood samples were taken and placed in 7.5 mls of lysis buffer. A tissue sample cut from the tail and a muscle plug taken from the body of the fish were placed in 75% ethanol. Gloves were worn and tools were wiped with alcohol and flamed prior to use. Fish tissues were also wiped with alcohol prior to removal.

Several types of transmitters were used this year (Table 2). All radios were 3 volt high output transmitters, however four external pallid transmitters were modified for slightly reduced output which extended battery life. All sonic transmitters were made by Sonotronics of Tucson, Arizona, set at 74 Khz and were uniquely coded. The radio transmitters are all within the 48.000 - 49.999 Megahertz (Mhz) range, with a unique frequency to allow individual fish to be identified. Three pallids were outfitted with both sonic and radio components, one of which was implanted with internal transmitters using the catheter technique (Clancey 1992). Six pallids had small external radio transmitters. External transmitter placement differed from earlier years. In 1992 transmitters were attached to the base of the dorsal fin as in Apperson and Anders (1991) (Figure 6).

In 1992 all transmittered shovelnose were implanted with internal radios. Most internal radio implants were done by us or Bob Bramblett, MSU (Bramblett and White 1992), using the catheter



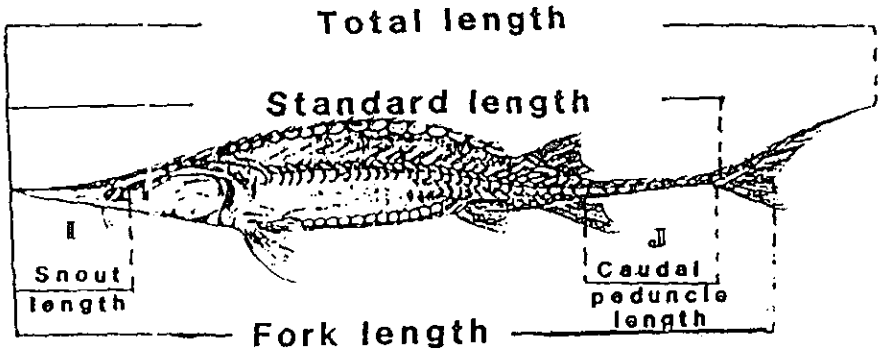


Figure 5. Morphological measurements taken from pallid and shovelnose sturgeon.

Table 2. Statistics of transmitters used on sturgeon relocated in 1992.

	Transmitter type	Battery life (days)	# of fish	Weight (g) in air
A.	Internal ATS radio External antenna (model 5A) Sonic (coded)	275 420	5 shovelnose	45 28
B.[1]	Internal ATS radio External antenna (model 5A) Sonic (coded)	360 420	7 shovelnose	40 24
C.	Internal ATS radio External antenna Sonic (coded)	900 1500	1 pallid	160 28
D.	Internal ATS radio (model 2) Sonic (coded)	100	2 shovelnose	11 28
E.	Internal Smith Root Internal antenna No sonic	80	2 shovelnose	40
F.	External ATS radio Sonic (coded)	700 1500	2 pallids	144 (total weight)
G.	External ATS radio (model 2) No sonic	100	2 pallids	14
H.	External ATS radio (model 2A) (reduced output) No sonic	150	4 pallids	14
I.	Coded sonic	420	2 shovelnose	28

[1] Transmitter data from Bramblett and White 1992.

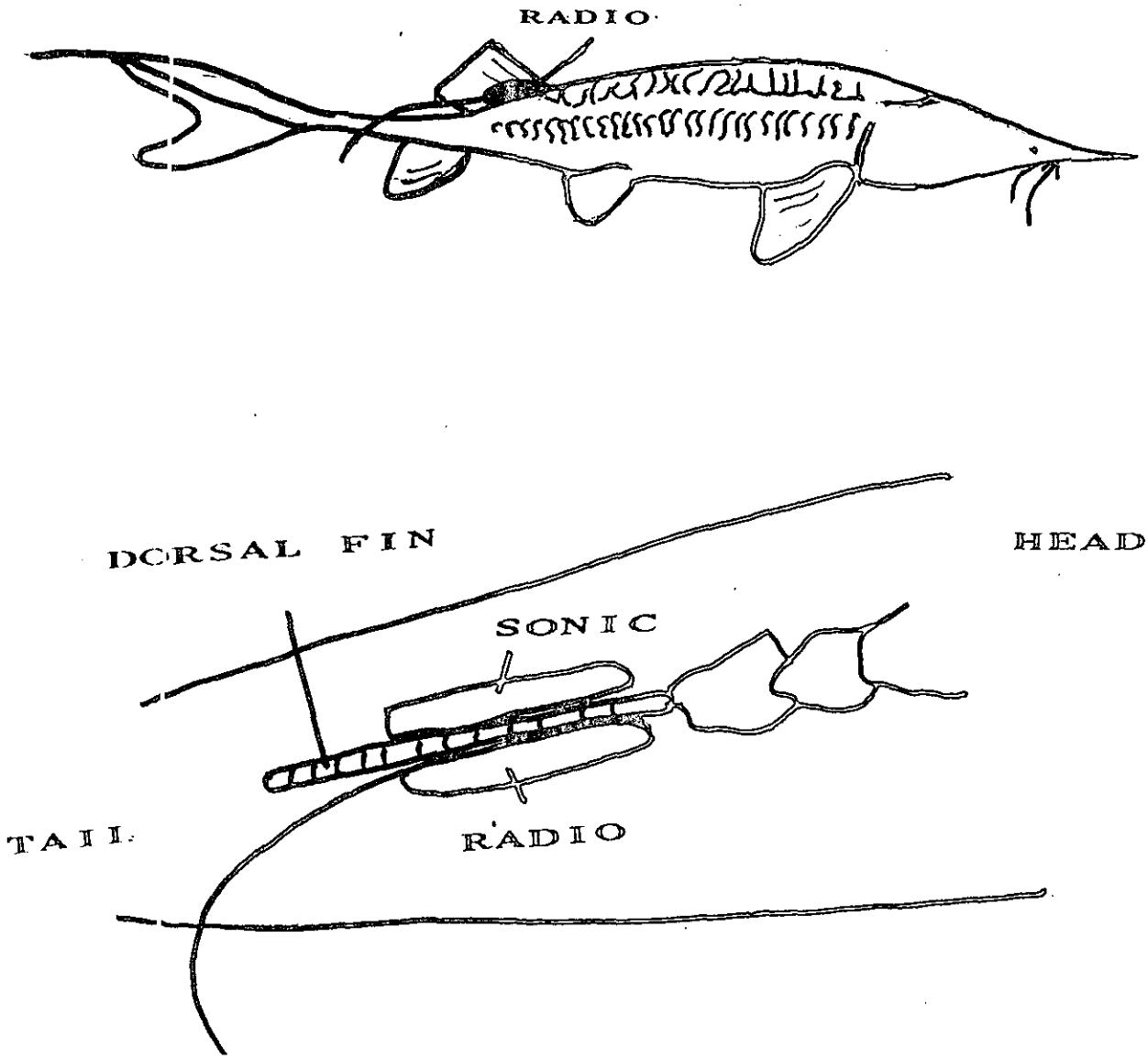


Figure 6. Schematic diagram of attachment of sonic and radio transmitters to the dorsal fin of pallid sturgeon.

technique (Clancey 1992) and included sonic implants. Two additional radios with internal antennae were implanted in shovelnose. These transmitters were inserted into a 3-inch belly incision. The transmitters and all surgical equipment were disinfected with Nolvasan disinfectant, which was diluted three ounces per gallon of water. The fish's gills were irrigated with river water during implantation by pumping the water into the fish's mouth using a small bilge pump and surgical tubing.

A programmable scanning radio telemetry receiver (ATS Challenger) with a whip or loop antenna was used to locate sturgeon from a Cessna 172 plane and inboard jet boats. Flights were completed at least twice monthly from May - September, and approximately every 6 weeks from November - April. A hydrophone and sonic receiver (Sonotronics Model USR-5) were also used to track sturgeon from a boat. Microhabitat measurements were taken once fish were located and at many sites where pallids were netted. Radio telemetry was used to initially find the fish and then the sonic signal was used to precisely determine its location. Radio triangulation was used for those fish without sonic transmitters.

Depth, conductivity, temperature, bottom (nose) velocity, substrate type, and turbidity were usually determined when sturgeon were relocated. Depth was measured with an Impulse 2800 plus fish finder. Conductivity and temperature were taken in the field with a Yellow Springs Model 33M S-C-T meter and conductivity was corrected to 25 C using a conversion factor of 2.5% per degree (Lind 1979). In past years a conversion factor of 2.0% was used. Velocity was recorded with a General Oceanics Model 2035-MK III meter. A weight was attached to the velocity meter and lowered to the river bottom. Substrate was determined by dragging a weight on the bottom of the channel. Surface water was sampled in the field and turbidities read in the lab with a Cole Palmer model 8391-35 turbidimeter.

Microhabitat measurements were also taken by Bob Bramblett of MSU. He measured depth with an Eagle Mach 2 recording depth finder, cross section width with a Ranging MK5 range finder, velocity at several depths with a Marsh-McBirney Model 201 portable water current meter, and water clarity with a secchi disk. Location was determined with a Magellan Global Positioning System navigator. Most water chemistry variables were determined near shore close to the fish's location. Dissolved Oxygen was measured with an Otterbine Sentry III meter and conductivity with an automatic temperature compensated VWR digital conductivity meter (Bramblett and White, 1992).

Larval fish were sampled in the Yellowstone on three dates from the right bank, left bank, and midchannel with 0.75 m diameter nets. Nets were made of 750 micron Nitex netting and had a 5:1 length to diameter ratio to reduce potential back-flushing. A single surface and bottom sample were taken simultaneously. A General Oceanics flow meter, placed in the mouth of each net, was used to estimate the water volume filtered for each sample.

RESULTS AND DISCUSSION

Pallid sturgeon

Thirty-three new pallid sturgeon and 2 recaptures were caught in 1992, which is more than twice the number found in the previous 3 years of this study. All pallids were caught with gill or trammel nets. A 12.7 kg pallid was captured in June, 2 miles up the Yellowstone River (river section 9). The rest of these fish were netted in river section 6 below the confluence of the Yellowstone and Missouri Rivers (Tables 3 and 4). One pallid was taken in April, one in June and the remaining 33 were captured in September and October (Table 4, and Appendix 2).

In July, anglers recaptured an additional pallid near Culbertson, MT. This fish had been transmittered in February, 1990 in the Fort Peck tailrace and had lost its transmitters. It had moved downstream about 150 miles since last observed. Two other verified reports of angler caught pallids occurred this year, one from below the confluence, and one from Intake (Backes et al, 1992). This is the first year that no pallids were observed during winter dives in the Fort Peck tailrace near Park Grove and the powerhouse (the same two dive locations as in previous years). During 14 dive dates, 30 man-dives were completed, resulting in 12 hours of bottom time.

Netting effort was focused in areas frequented by pallids and varied from 0 drifts in river sections 1 and 4, to 187 drifts in section 6 (Table 3). Of the 33 new pallids, 25 were pulled from one pool/run 8 miles downstream of the confluence at river mile 1573 (Table 4). In the fall of 1992 the maximum depth of this pool varied from 4.5 - 5.3 m. Two pallids were recaptured from this pool 2 weeks after they were initially tagged. Five other pallids were caught in other pool/runs 4 - 5 m deep. All of these pools were located in narrow river sections along sandbars, which is similar to pallid locations reported by Sandvol (U. S. Fish and Wildlife Service, 1992).

During 38 hours of netting, 35 pallids were caught for an average annual CPUE of 0.92 pallids/hour. Catch rates averaged 1.59 pallids/hour in river section 6 (Table 3). These numbers greatly exceed last years catch rate of 0.03 pallid/hour for the entire study area 0.08 pallid/hour in river section 6 (Clancey 1992).

Table 3. Catch per unit effort (CPUE) of shovelnose and pallid sturgeon by section, month and net type.

Section	Month	Net type	Hours	# Drifts	Shovelnose #	Shovelnose #/hr	Shovelnose #/drift	Pallid #	Pallid #/hr	Pallid #/drift
2	June	exp-50'	1.77	12	7	4.0	0.58	0	0.0	0.00
3	July	exp-100'	0.50	5	1	2.0	0.20	0	0.0	0.00
3	Aug	exp-100'	0.87	6	10	11.5	1.67	0	0.0	0.00
3	Aug	exp-125'	0.25	1	10	40.0	10.00	0	0.0	0.00
3	Sept	exp-100'	1.05	14	12	11.4	0.86	0	0.0	0.00
3	Sept	tram-150'	0.22	3	0			0	0.0	0.00
3	Total/Mean		2.90	29	33	11.4	1.14	0	0.0	0.00
5	Aug	exp-50'	0.07	1	0	0.0	0.00	0	0.0	0.00
5	Aug	exp-125'	0.92	14	3	3.3	0.21	0	0.0	0.00
5	Sept	exp-100'	0.85	7	4	4.7	0.57	0	0.0	0.00
5	Sept	exp-125'	0.88	8	3	3.4	0.38	0	0.0	0.00
5	Total/Mean		2.72	30	10	3.7	0.33	0	0.0	0.00
6	Apr	exp-100'	0.35	5	0	0.0	0.00	0	0.0	0.00
6	Apr	exp-125'	2.35	15	12	5.1	0.80	1	0.4	0.07
6	Apr	3"-100'	1.25	15	3	2.4	0.20	0	0.0	0.00
6	May	exp-100'	0.45	2	1	2.2	0.50	0	0.0	0.00
6	May	3"-100'	0.62	7	0	0.0	0.00	0	0.0	0.00
6	June	exp-100'	0.62	4	10	16.1	2.50	0	0.0	0.00
6	July	exp-100'	2.53	9	11	4.3	1.22	0	0.0	0.00
6	July	exp-50'	0.23	2	0	0.0	0.00	0	0.0	0.00
6	July	exp-125'	2.45	11	11	4.5	1.00	0	0.0	0.00
6	Aug	exp-100'	0.02	1	6	300.0	6.00	0	0.0	0.00
6	Sept	exp-100'	0.92	7	11	12.0	1.57	0	0.0	0.00
6	Sept	tram-150'	3.30	37	97	29.4	2.62	9	2.73	0.24
6	Oct	tram-150'	6.32	65	87	13.8	1.34	24	3.80	0.37
6	Total/Mean		21.40	187	249	11.6	1.33	34	1.59	0.18
7	July	exp-100'	2.06	7	0	0.0	0.00	0	0.00	0.00
8	May	exp-100'	1.07	10	4	3.7	0.40	0	0.00	0.00
8	Jun	exp-125'	1.58	15	65	41.1	4.33	0	0.00	0.00
8	Sep	exp-100'	0.08	2	10	125.0	5.00	0	0.00	0.00
8	Total/Mean		2.73	27	79	28.9	2.92	0	0.00	0.00
9	May	3"-100'	1.07	13	0	0.0	0.00	0	0.00	0.00
9	June	exp-100'	3.32	18	24	7.2	1.33	1	0.30	0.05
9	Total/Mean		4.39	31	24	5.47	0.77	1	0.22	0.03
All sections			37.97	323	402	10.6	1.24	35	0.92	0.11

Table 4. Statistics from pallid sturgeon captured in 1992, weights in kg and length in mm.

Date	River Mile	PIT Tag# (7F7)	Yellow Dangler #	Weight	Total	Fork	STD	Head	Mouth Width	Snout to outer Barbel	Mouth to inner Barbel	inner Barbel	outer Barbel	Snout	Caudal Ped.	Snout to Mouth	Snout to Midbarbs	Girth	Radio #	Radio type
4/10	1574	F065A4E	1360	22.2	1651	1567	1478	488	137	213	61	58	112	274	183	254	198	610	49.682	C
6/17	2Y	F06627E	1388	12.7	1435	1336	1275	424	124	188	46	53	124	229	198	218	168	516	49.100	F
9/15	1568	F065E12	1326	24.5	1702	1600	1537	483	137	231	76	56	160	264	201	267	203	701	48.540	G
9/30	1573	F065A4D	1354	10.6	1349	1242	1189	404	112	183	53	51	135	229	173	216	165	460	48.520	G
9/30	1573	F06697C	1384	18.4	1615	1478	1356	447	127	216	64	56	152	249	203	251	190	561	-	-
9/30	1573	F065A3D	1322	-	1676	1463	1387	437	135	188	64	53	142	229	190	226	165	643	-	-
9/30	1573	F064F27	1323	6.8	1143	1090	1016	307	81	135	43	28	81	175	182	165	122	401	-	-
9/30	1573	F054773	1335	22.2	1645	1524	1478	470	140	206	64	51	145	254	190	246	188	650	49.050	F
9/30	1573	F054D0D	1345	15.9	1521	1402	1317	437	135	211	64	46	127	264	216	246	188	551	-	-
9/30	1573	F056360	1313	19.7	1567	1463	1384	437	130	201	66	41	145	254	208	241	185	602	-	-
9/30	1573	F055C21	1380	19.7	1591	1481	1436	444	122	201	64	51	140	236	188	241	180	584	-	-
10/6	1573	D4A7758	1393	12.2	1392	1334	1280	411	127	178	64	51	130	216	185	213	157	500	-	-
10/6	1573	E683364	1315	14.7	1430	1336	1270	414	122	190	71	48	112	229	196	229	173	551	-	-
10/6	1573	E427F69	1386	19.5	1691	1539	1475	442	142	175	66	64	142	216	198	221	157	610	-	-
10/6	1573	NO PIT	1398	12.7	1410	1303	1247	386	112	173	48	46	114	206	185	201	152	500	-	-
10/7	1568	F066502	1342	10.8	1448	1359	1264	416	117	193	53	51	137	231	218	221	170	465	-	-
10/8	1573	F06672B	1337	19.0	1554	1463	1356	442	130	193	64	58	157	234	175	229	168	607	-	-
10/8	1573	F06685C	1312	15.8	1472	1399	1339	427	132	190	56	46	119	224	190	221	170	559	-	-
10/8	1573	F056372	1378	12.9	1466	1338	1275	424	119	190	61	43	127	229	196	224	168	488	-	-
10/19	1573	F065014	1321	16.1	1453	1366	1308	419	127	190	53	38	127	226	170	229	178	589	49.020	H
10/19	1573	B026102	1328	16.6	1529	1402	1351	437	132	198	58	51	137	239	185	234	178	579	49.070	H
10/19	1573	B082208	1363	10.8	1384	1308	1240	391	114	190	56	46	122	231	178	224	173	450	49.130	H
10/19	1573	B024F2D	1302	13.6	1519	1407	1346	427	124	190	53	46	122	236	201	226	173	490	-	-
10/19	1573	B035740	1305	17.0	1504	1415	1359	442	124	210	61	46	132	252	190	244	188	572	-	-
10/21	1566	B020071	1316	19.3	1585	1486	1435	462	127	218	64	43	142	259	183	259	196	602	49.170	H
10/21	1568	B023408	1392	14.3	1562	1445	1372	457	132	206	61	46	137	252	190	244	185	508	-	-
10/21	1568	B015B78	1356	11.6	1331	1265	1219	394	112	184	56	48	132	203	178	211	155	495	-	-
10/22	1574	D34D23	1350	12.2	1422	1359	1283	409	114	185	53	43	107	224	193	216	168	495	-	-
10/22	1574	B025248	1349	8.4	1191	1123	1072	353	112	145	53	41	109	183	160	185	127	444	-	-
10/22	1574	D3C5708	1348	13.6	1483	1389	1320	424	137	190	58	43	135	226	175	229	170	577	-	-
10/27	1573	B023253	1331	17.9	1593	1478	1410	446	127	201	69	41	107	241	190	241	183	572	-	-
10/27	1573	D441A7C	1306	13.6	1428	1341	1283	419	124	196	61	43	107	239	188	236	178	546	-	-
10/29	1573	B024922	1339	15.6	1529	1422	1331	450	127	213	64	46	140	256	190	254	190	549	-	-

[1] For radio statistics see Table 2.

Four factors likely contributed to increased netting success in 1992. These were abnormally low flows in the Missouri River in the fall of 1992, use of radioed pallids to find unmarked fish, netting in areas of known pallid habitat and modification of our netting technique. Pallids were often found together. All but 4 pallids were caught while trying to recapture radioed pallids, or while netting in areas where many sightings of pallids had previously occurred.

Modification of our netting technique increased the amount of bottom habitat sampled. We used a longer net, extended our float lines and added a weight to the lead line. These changes assured that a longer length of net fished the river bottom. Since nearly all captured pallids were found near the lead line, these modifications probably increased our netting efficiency. Using a trammel net also allowed us to optimize our ability to catch both large and small sturgeon during the same drift. Trammel nets had the highest catch rates of pallids and shovelnose (3.4/hour and 18.8/hour). The second highest average annual catch rate of shovelnose was 13.1/hour caught with 125-foot experimental gill nets. However, no work was done to evaluate the relative efficiencies of trammel nets in unbiased tests.

Morphological measurements of the 33 pallid sturgeon captured in the study area in 1992 are shown in Table 4. A detailed discussion of these measurements is found later in this report. Pallids ranged in standard length from 1016 - 1537 mm, with weights from 6.8 - 24.5 kg. The length and weight distributions of the 1992 pallids are shown in Figures 7 and 8.

Radio transmitters were placed on 9 pallid sturgeon (Table 4), which were caught downstream as far as river mile 1567, and upstream to Yellowstone river mile 2 (Figure 3). Sex was not determined for pallid sturgeon. Two pallids were monitored throughout the field season, and transmitters were attached to 7 others during September and October. Radios worked well for an initial location, while the ultrasonic transmitters were beneficial to precisely locate fish for microhabitat measurements. In general, signal reception from all types of radios was satisfactory; many relocations were obtained throughout the field season from the 2 pallids transmittered in April and June, and 8 of 9 radioed pallids were successfully relocated at least 3 times after tagging. However, the pallid tagged in April (Type C, Table 2) was not relocated from July 10 - September 1 and no relocations were obtained from one of the radios with reduced output (Type H, Table 2). In all cases radio reception was dependent on fish depth. When sturgeon were deeper than 5 m it was difficult to receive a signal from any radio. When water temperature dropped in November, several pallids were not found during the first aerial pass. Signals were even more difficult to receive in December when 70 % of the Missouri was

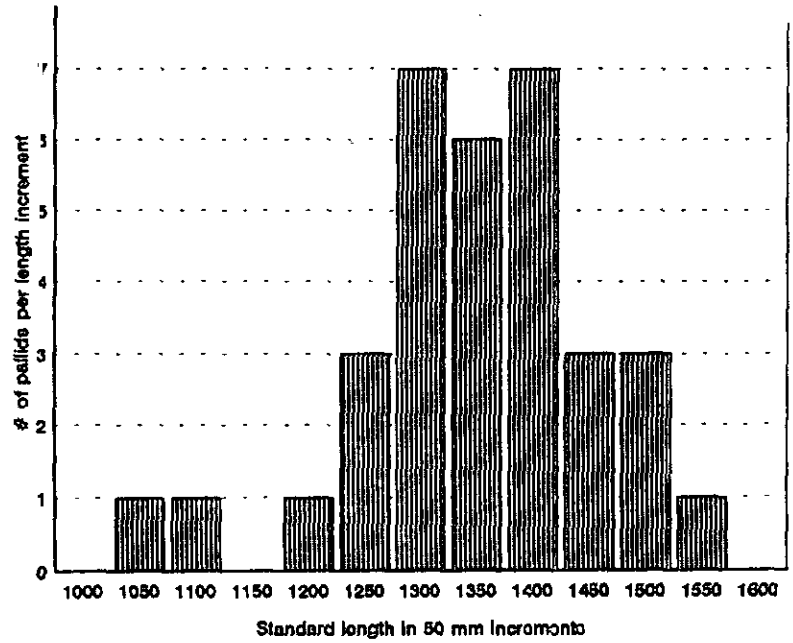


Figure 7. Standard length in 50 mm increments of 33 pallid sturgeon caught in 1992 (maximum of increment listed).

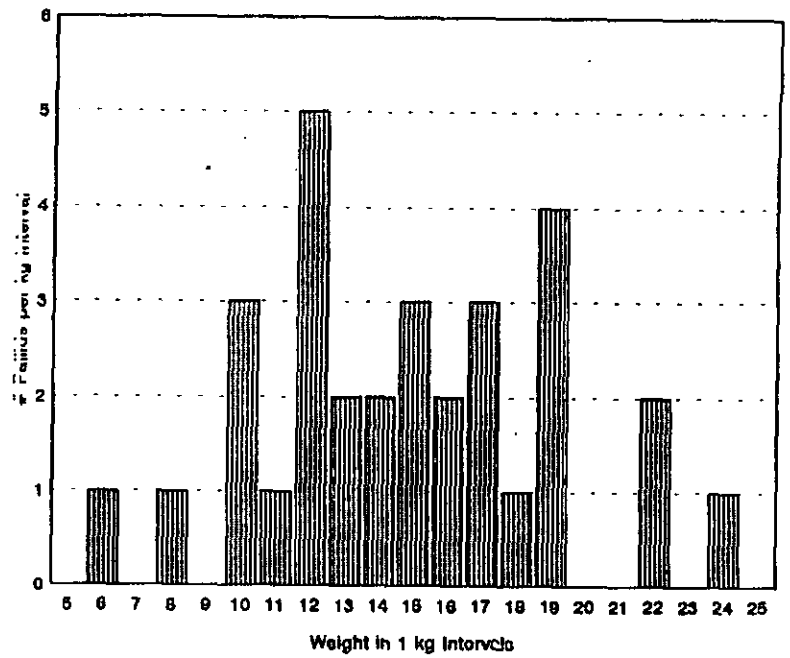


Figure 8. Weight distribution in 1 kg increments (maximum listed) of 33 pallid sturgeon caught in 1992.

ice-covered. During the December flight none of the pallids with low output transmitters were relocated.

Transmittered pallids were relocated as far upstream as river mile 8 on the Yellowstone and as far downstream as river mile 1530 on the Missouri (Figure 9 -12). Movement above the confluence was exhibited by 3 pallids and was always up the Yellowstone. In early June, pallid 49.682 was relocated and 49.100/49.102 was caught up the Yellowstone (Figures 9 and 10). Pallid 49.682 stayed near the confluence in the Missouri and in the Yellowstone until early July. However, pallid 49.100 moved 40 miles downstream soon after it was transmittered. A third pallid was found up the Yellowstone once in late October (Figure 10).

From July 10 - September 1, only one pallid, 49.100, was relocated (Figure 10). This fish exhibited little movement during this time, and was always found about 40 miles downstream from the confluence, which is more than 20 miles further downstream than any other pallid monitored during 1992.

During September and October, 8 transmittered pallids were relocated. Seven of these pallids moved less than 10 miles (Figures 9 - 12). One pallid (49.050) had a 15 mile range (Figure 10).

MDFWP collected 31 habitat measurements from pallid sturgeon (Appendix 3). Bramblett (Bramblett and White, 1992) made 322 additional observations of pallid sturgeon, which have been edited here to include only those measurements where habitat data was taken and where movement occurred between observations (Appendix 4). MDFWP found that pallid depth varied greatly and averaged 2.5 m in April - June and 3.1 m from September - October (Table 5). Nose velocity also varied greatly but averaged 0.6 - 0.7 m/s in the spring and fall. Most fall microhabitat measurements for both shovelnose and pallids were below the confluence (Appendix 3) so it is interesting to note that pallid relocations averaged nearly twice the depth, but had similar velocities as shovelnose relocations (Table 5).

It is worthwhile considering what effect transmitters may have had on pallid movement. Transmitter weights (in air) ranged from 0.05% to 1.1% of the recipient pallid's weight, well within the 2% loading recommended by Winter (1983). After they were transmittered all pallids displayed initial downstream movement. The internally transmittered pallid (Figure 9) and pallids transmittered with small external radios in September (Figure 11) all headed upstream within 2 weeks. Pallids radioed

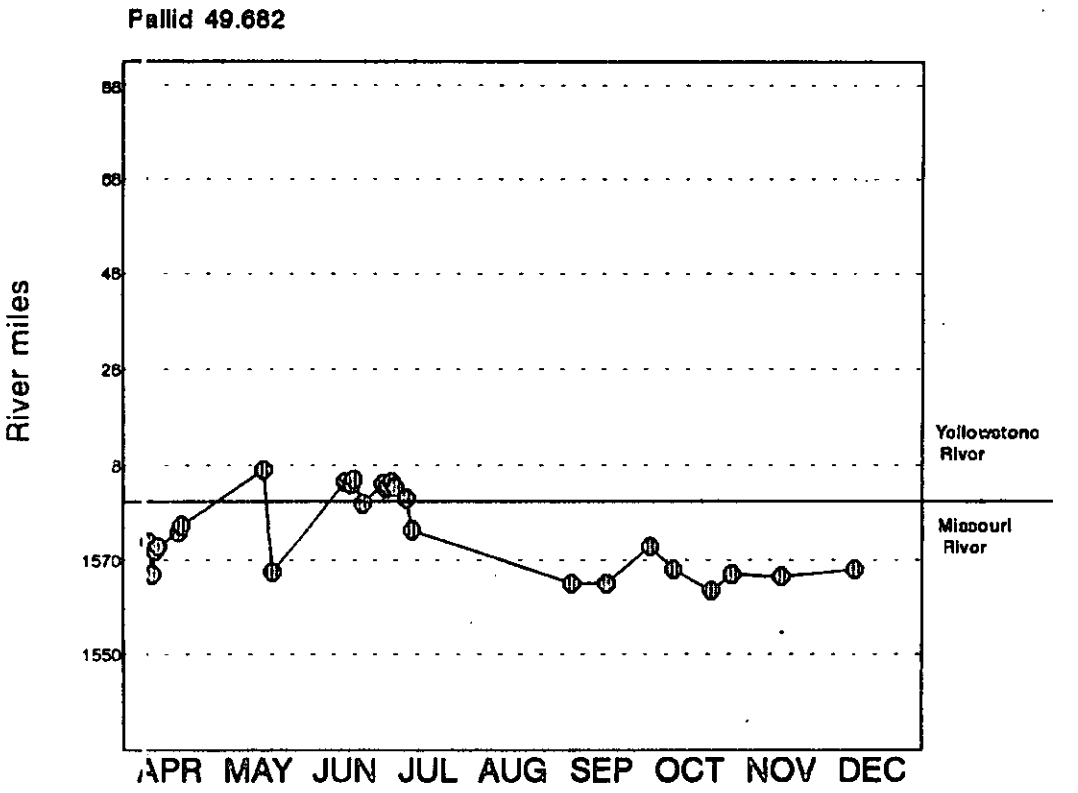


Figure 9. Movement of a pallid sturgeon implanted with sonic and radio transmitters in April 1992.

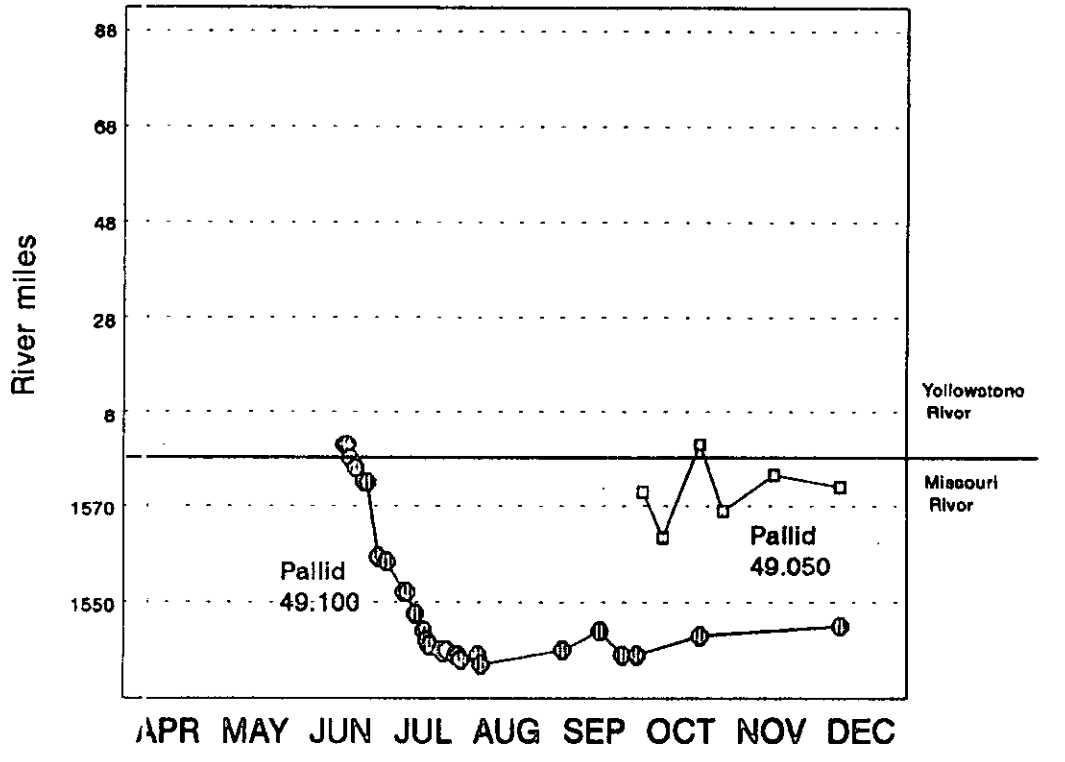


Figure 10. Movement of 2 pallid sturgeon outfitted in June and September 1992, with 83 g external transmitters.

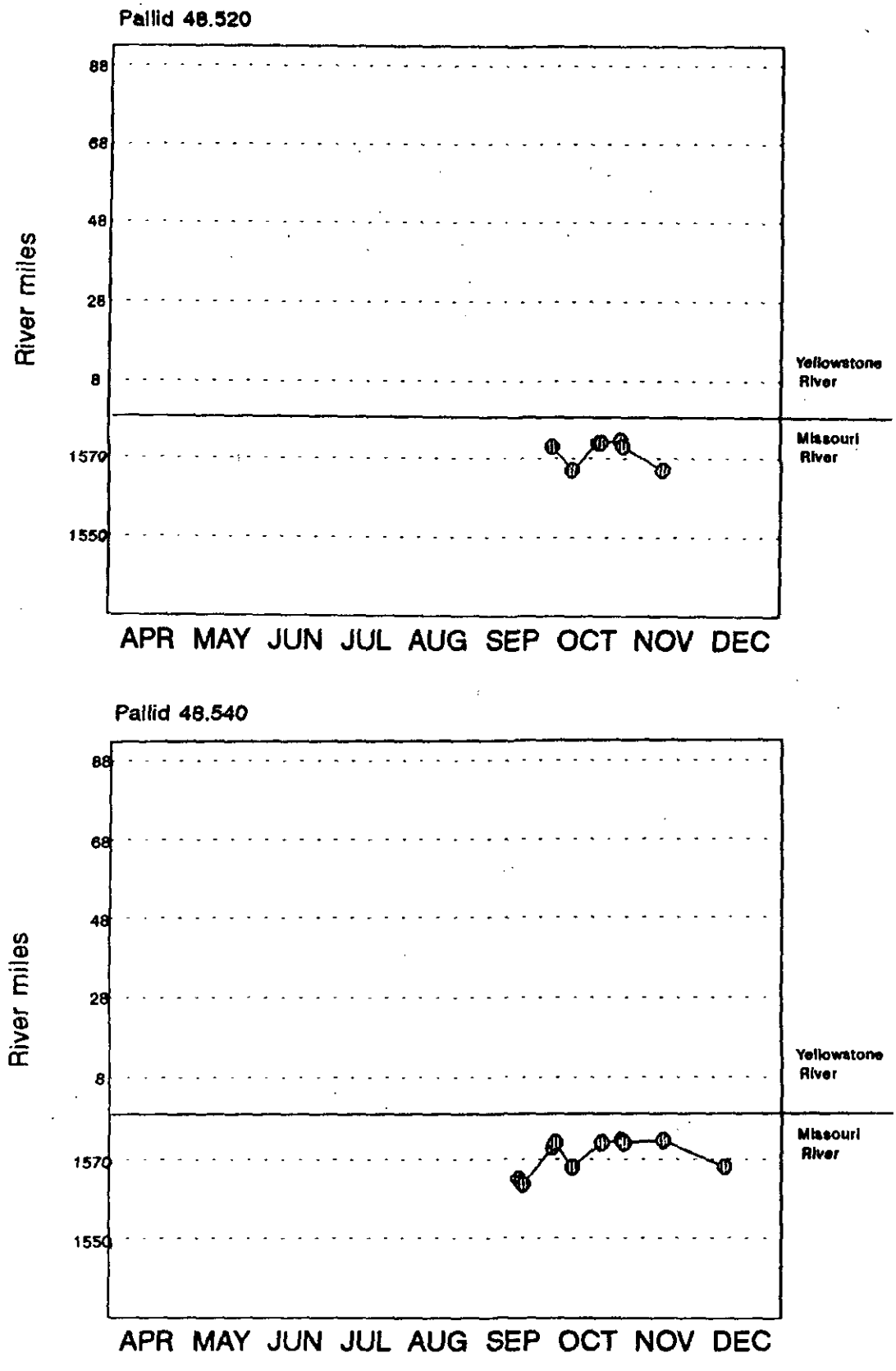


Figure 11. Movement of 2 pallid sturgeon outfitted in September 1992, with 14 g, 100 day external radio transmitters.

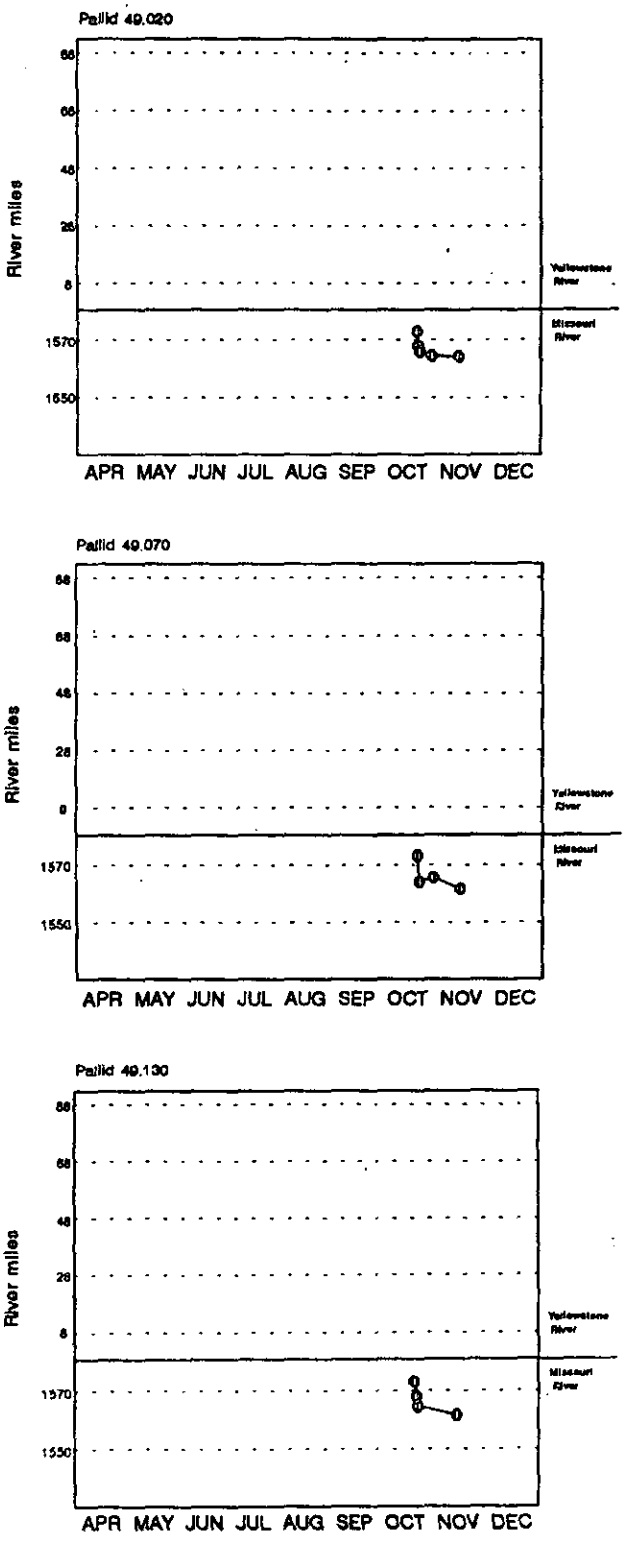


Figure 12. Movement of 3 pallid sturgeon outfitted in October 1992, with 14 g, 150 day, external transmitters.

Table 5. Summary of pallid and shovelnose sturgeon habitat measurements taken in 1992 by MDFWP. Velocity in m/s and depth in m.

Date	Species	Velocity range (mean)	Depth range (mean)
April - June	Pallid	n = 7 0.5-0.7 (0.6)	n = 9 0.9 - 4.9 (2.5)
September - October	Pallid	n = 17 0.0-0.9 (0.5)	n = 18 0.8 - 4.9 (3.1)
May	Shovelnose	n = 4 0.5-1.50 (1.0)	n = 4 0.9 - 3.0 (1.8)
September - October	Shovelnose	n = 14 0.4 - 0.6 (0.6)	n = 14 1.1 - 3.7 (1.7)

in October never returned to the capture site (Figure 12). Pallid 49.100 was the only sturgeon to exhibit extreme downstream movement after it was transmittered. At 1.1%, the transmitter loading weight for this fish was nearly twice that of any other externally transmittered sturgeon. Since loading was much less than 2%, it is likely that this 40 mile downstream movement was normal. However, we are concerned that the balance and drag problems which occur with external transmitters (Winter 1983) may have influenced this pallids behavior. A set of transmitters identical to those used on 49.100 was attached to a 22.2 kg (0.6% loading) pallid on September 30. Within 2 weeks this pallid was upstream of its capture site (Figure 10).

We were not successful in recapturing transmittered pallids. We did recapture a radioed shovelnose ten months after it was transmittered. This fish had internal transmitters similar to those in pallid 49.682. Most of the protruding antenna had broken off and movement of the remaining antenna in the antenna hole prevented healing.

Gardner (personal communication) recaptured 5 of his 6 radioed pallids. One pallid with an internal radio and an intact external antenna, recaptured 10 weeks after implantation, had an open wound where the antenna protruded from the fish. As with the shovelnose, the antenna could be moved through the opening which prevented healing. Two pallids with internal radios and internal antennae had completely healed within 10 weeks. One pallid with an external dorsal transmitter attached for 1 month showed no evidence of soreness at the attachment site. A second pallid, with an external dorsal radio, was not entirely healed when recaptured one month after it was transmittered.

Shovelnose sturgeon

Average annual catch rates for shovelnose were 10.6/hour and varied by section, season and net type (Table 3 and Appendix 2). Catch rates varied from 28.9/hour on the Yellowstone above the Highway 200 bridge to 3.7/hour on section 5 of the Missouri. The 402 shovelnose captured ranged in standard length from 168 - 909 mm with the majority between 500 and 600 mm (Figure 13). Measurements of most of these fish are listed in Appendices 5 and 6. Since transmittered shovelnose moved freely between the Missouri below the confluence and the Yellowstone River, all shovelnose information was combined for analysis.

In 1992, shovelnose were implanted with radios which ranged from 1.5 % - 2.4 % (in air) of the fishes body weight. Table 6 gives the statistics of transmittered shovelnose. Sex was not determined on shovelnose 49.710, or on those implanted in the Fort Peck tailrace. All other shovelnose implanted in 1991 and 1992 were females. Signals were easily received from the internal transmitters with protruding antennae once implanted in shovelnose. As previously described, the antennae hole of a single recaptured, implanted shovelnose had not completely healed ten months after surgery. We were able to successfully monitor habitat and location of 11 shovelnose throughout the summer and fall. Seven more shovelnose were relocated at least once in 1992. The two shovelnose transmittered with internal radios containing internal dipole antennae were repeatedly relocated in depths less than 12 feet.

Shovelnose monitored in the Yellowstone and Confluence areas in 1992 were implanted downstream as far as river mile 1574 and as far upstream as Yellowstone river mile 71 (Figures 2 and 3, and Table 6). Most relocations were below Intake but two shovelnose were relocated above Intake Diversion Dam (river mile 71.1). Five shovelnose were relocated below the confluence.

Shovelnose movement followed two general patterns; large seasonal movements from 40 - 70 miles or movements of less than 25 miles. Five shovelnose ranged up and downstream long distances (Figures 14, 15, and 16). Three of these fish moved about 70 miles upstream of the confluence, one of which moved above Intake. The 2 others moved 40 - 60 miles within the Yellowstone. In general, these sturgeon were the furthest upstream in June and July and the furthest downstream in the fall and winter. Three were initially tagged near Intake and 2 near the confluence. The remaining shovelnose travelled less than 25 miles from their place of implantation and did not follow any seasonal trends (Figures 17, 18, 19 and 20). One of these shovelnose, 48.921 (Figure 20), was last relocated in August above Intake. The two

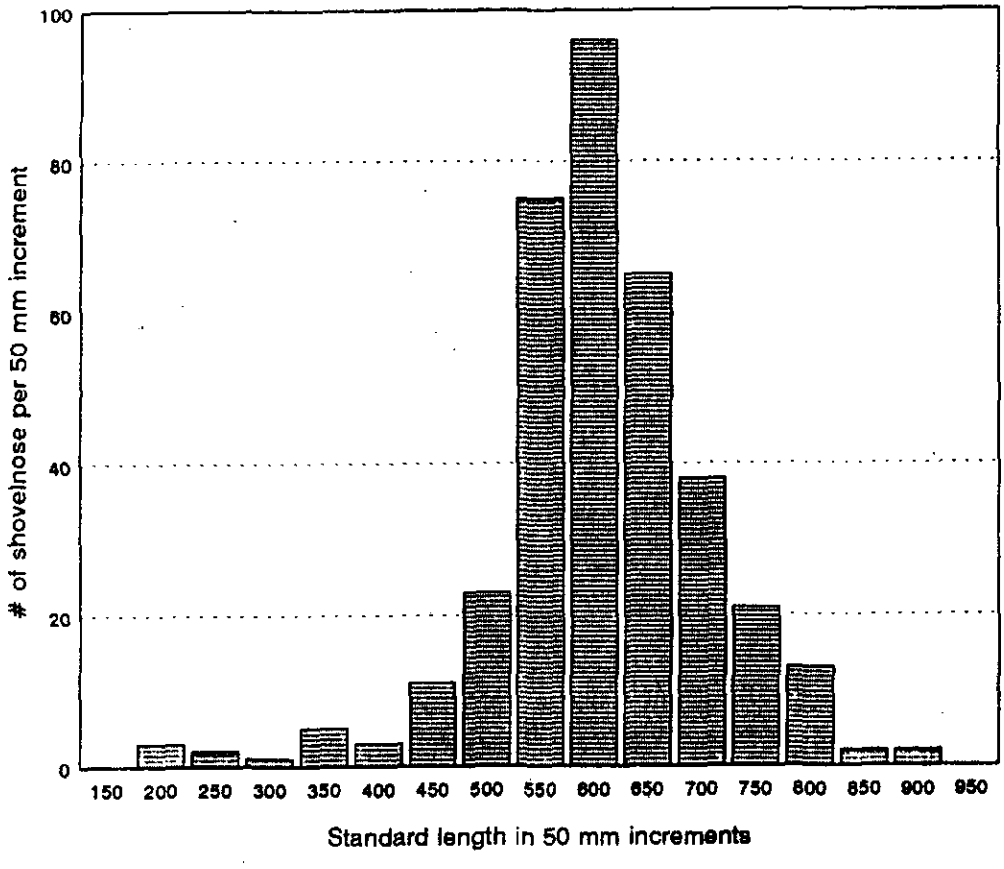


Figure 13. Standard length in 50 mm increments of 402 shovelnose sturgeon caught in 1992 (maximum of increment listed).

Table 6. Statistics of shovelnose sturgeon relocated in 1992, implanted with radio and/or sonic (S) transmitters. Length in mm and weight in grams (g).

Date	Implant location[1] river mile	Radio/Sonic frequency	Transmitter type[2](weight)	Weight	Total length	Fork length	Standard length
7/30/91	1770	3335 (S)	I (28)	771	640	-	-
7/31/91	1770	338 (S)	I (28)	953	-	-	-
8/6/91	69 Y	48.600/2525	A (73)	3087	919	-	-
8/7/91	69 Y	48.620/2236	A (73)	3405	927	-	-
8/7/91	69 Y	48.640/3342	A (73)	3087	914	-	-
8/8/91	1574	48.660/22234	A (73)	3087	917	-	-
8/8/91	1574	48.740/3333	D (39)	1771	856	-	-
9/4/91	1579	48.760/23233	D (39)	2633	940	861	813
10/9/91	11 Y	48.680/2442	A (73)	-	919	823	764
6/1/92	71 Y	48.840/285	B (64)	3490	1021	945	889
6/1/92	69 Y	48.861/294	B (64)	3200	886	823	760
6/1/92	71 Y	48.921/357	B (64)	4200	1039	947	889
6/2/92	71 Y	48.821/276	B (64)	3040	894	825	767
6/3/92	71 Y	48.883/339	B (64)	3777	910	878	820
6/3/92	71 Y	48.902/438	B (64)	3460	940	873	830
6/8/92	71 Y	48.942/366	B (64)	2900	868	803	767
9/28/92	1581	49.710	E (40)	2300	894	820	764
9/28/92	1581	49.790	E (40)	2700	856	787	742

[1] Y for Yellowstone miles
[2] See Table 2 for transmitter specifics.

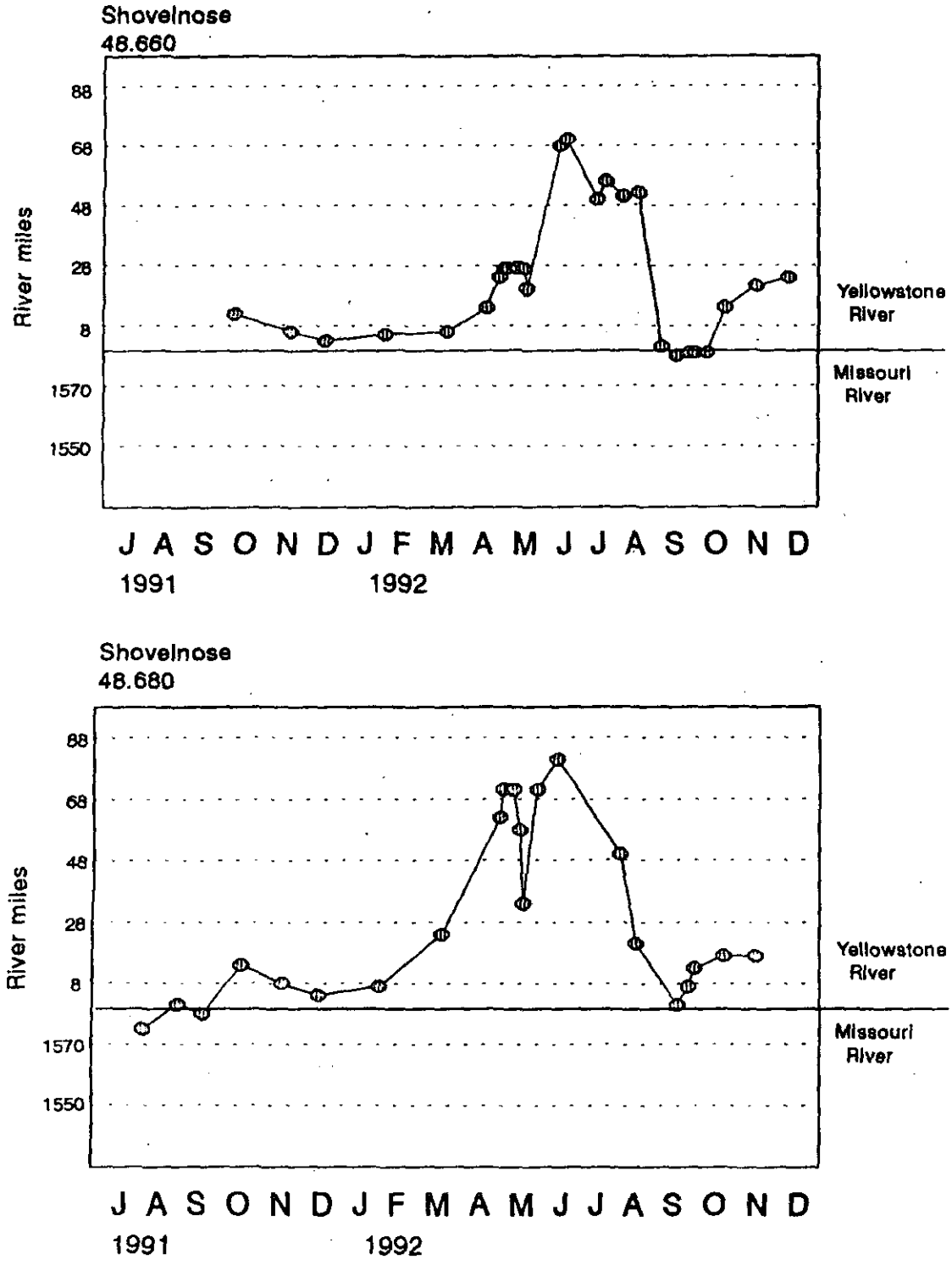


Figure 14. Long distance movement of 2 shovelnose sturgeon implanted with transmitters near the confluence of the Yellowstone and Missouri Rivers in 1991.

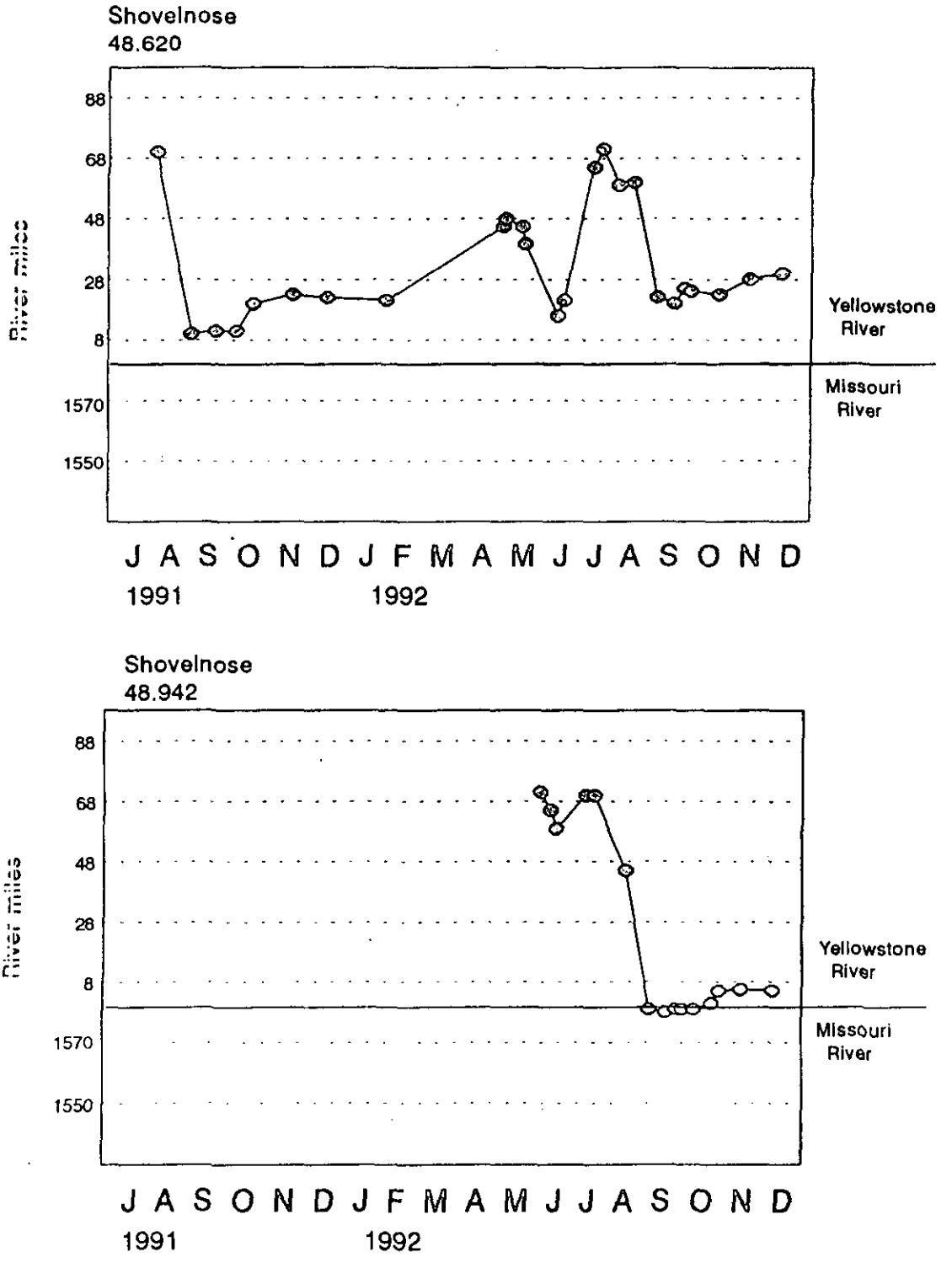


Figure 15. Long distance movement of 2 shovelnose sturgeon implanted with transmitters near Intake in 1991 and 1992.

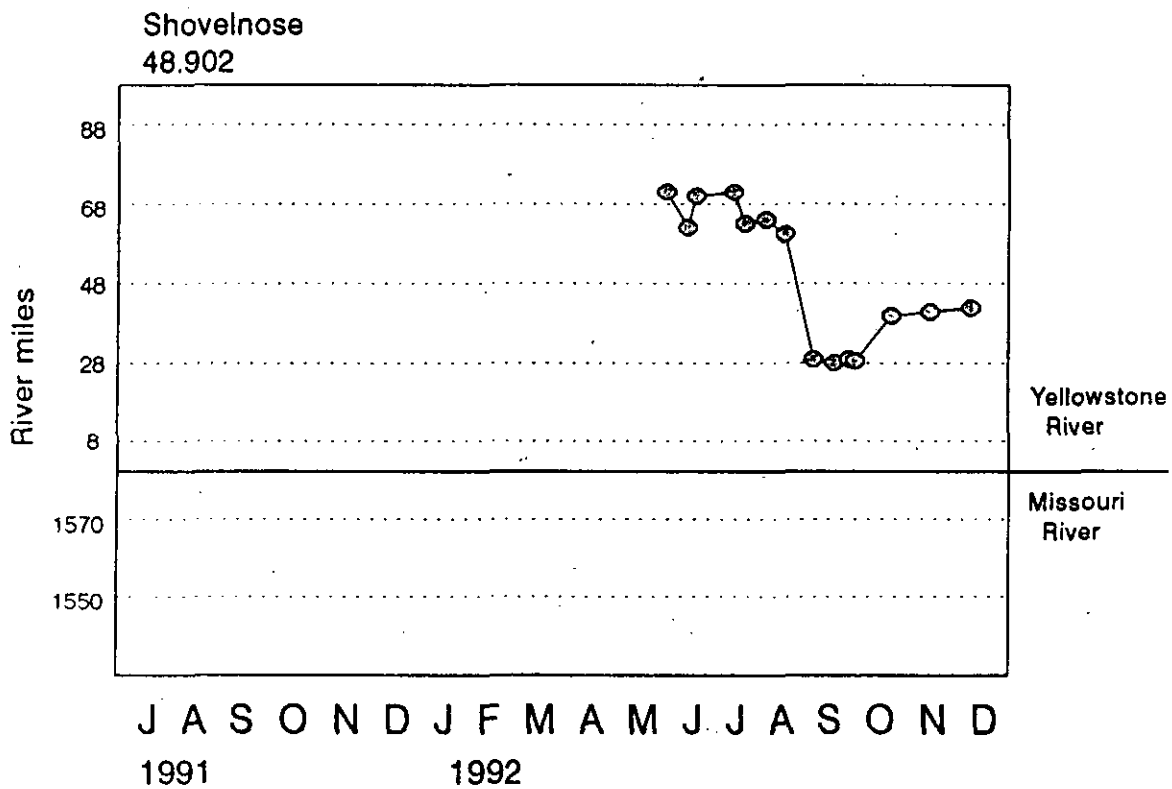


Figure 16. Movement of a shovelnose sturgeon implanted with transmitters near Intake in 1992.

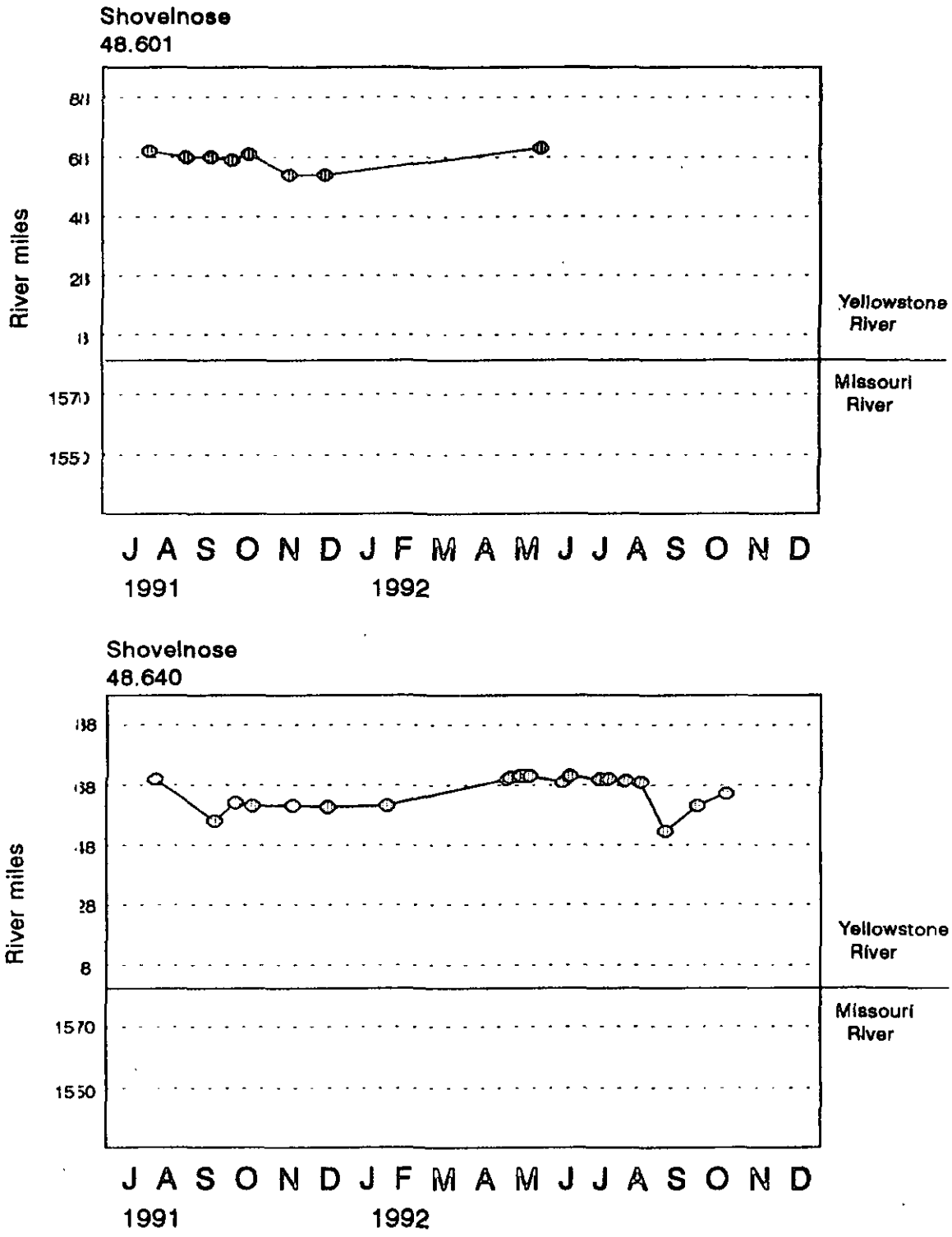
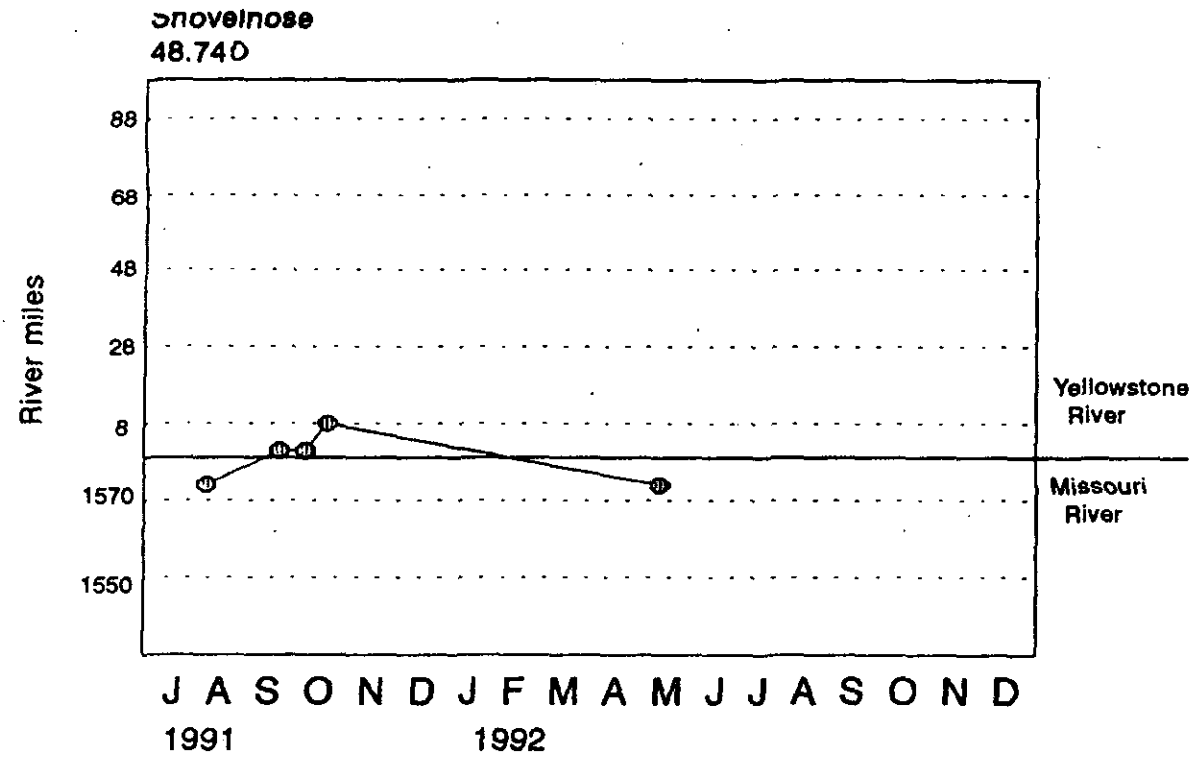


Figure 17. Movement of 2 shovelnose sturgeon implanted with transmitters in August 1991.



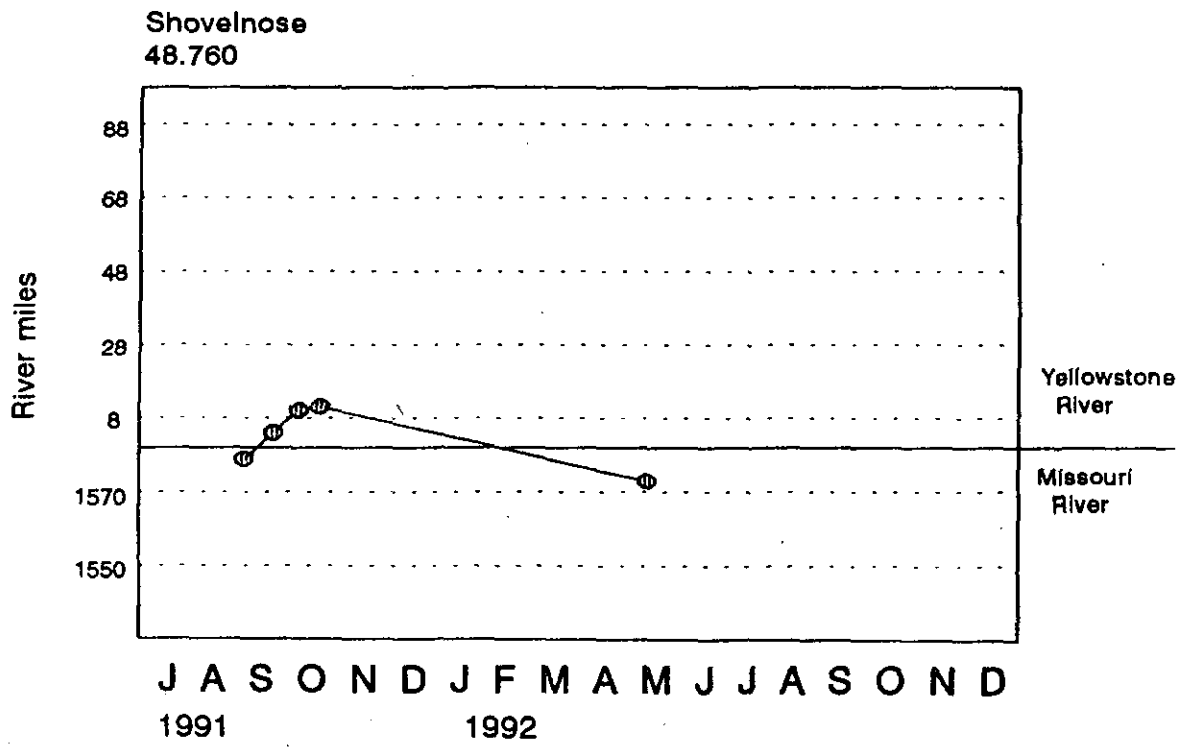


Figure 18. Movement of 2 shovelnose sturgeon implanted with transmitters in August and September 1991.

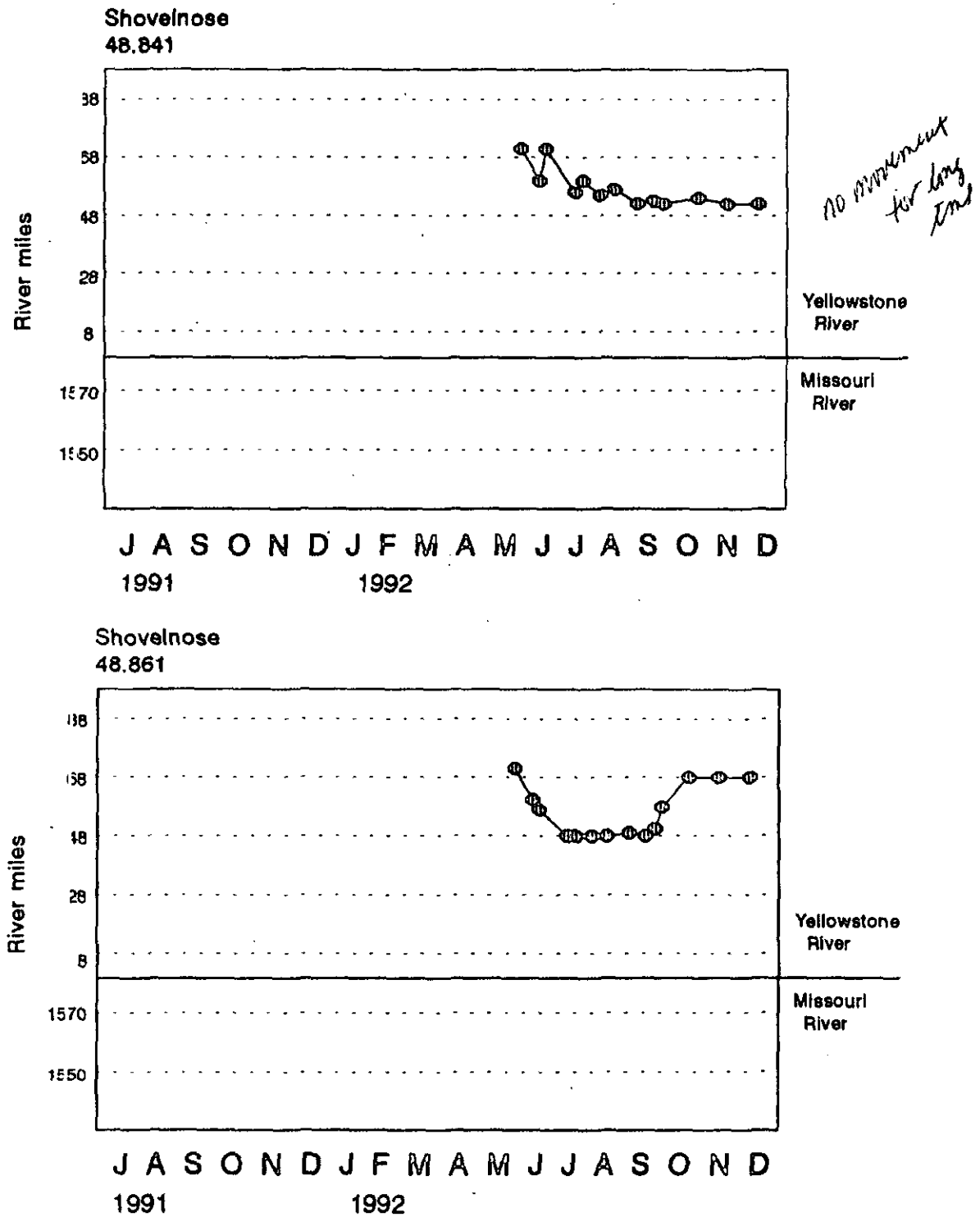


Figure 19. Movement of 2 shovelnose sturgeon implanted with transmitters in June 1992.

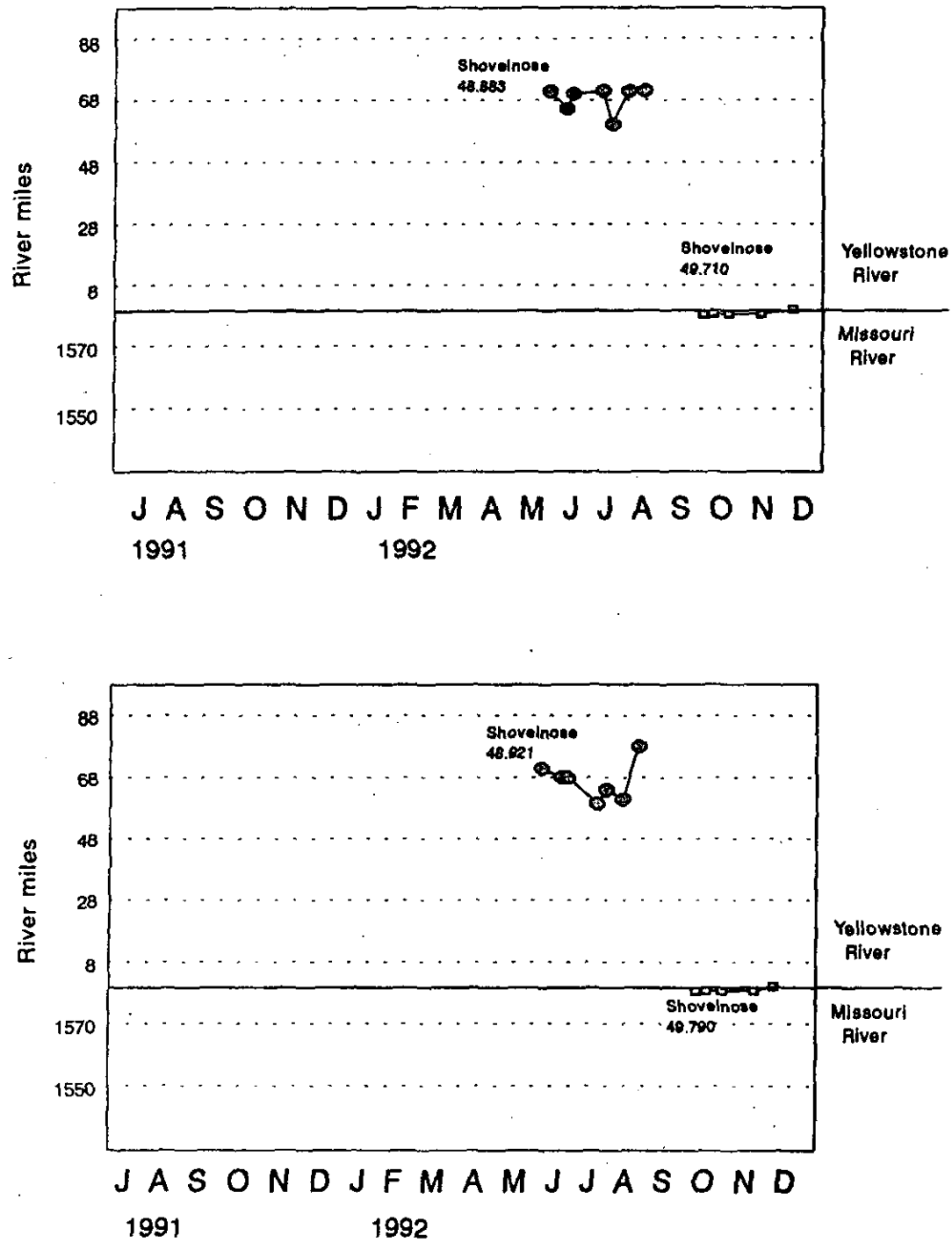


Figure 20. Movement of 2 shovelnose sturgeon implanted with transmitters in June 1992 and 2 shovelnose implanted in September 1992.

fish implanted with radios with internal antennae stayed near the confluence and moved less than 3 miles from September - December (Figure 20). Limited late fall and winter movement was typical of most sturgeon relocated in 1991 and 1992. Two shovelnose that were implanted with sonic transmitters in the Fort Peck tailrace in July 1991 were relocated in the tailrace in October 1992. These fish had moved little since implantation.

We collected 34 habitat measurements from shovelnose (Appendix 3). Bob Bramblett (Bramblett and White, 1992) made 177 observations of shovelnose sturgeon, which have been edited in Appendix 4 to include only those relocations where habitat measurements were taken and where movement occurred between observations. MDFWP found that shovelnose depth averaged 1.8 m in May and 1.7 m from September - October, and velocity averaged 0.5 m/s during both time periods. (Table 5).

We recaptured a 754 mm (total length), 1.8 kg shovelnose at the confluence that had been tagged at the mouth of the Tongue River in 1980. This fish had grown 41 mm and 0.2 kg in 12 years.

Morphological Measurements

Percent of standard length and ratios of several morphological measurements were used to differentiate between pallid and shovelnose sturgeon. Percent standard length of 10 different measurements taken from 320 shovelnose and 33 pallids are listed in Appendices 7, 8 and 9. Percent standard length of most morphometric measurements of individual pallids overlapped with those of individual shovelnose (Table 7). Calculation of several of these measurements into a character index value (Appendix 1) resulted in distinct groupings of pallids and shovelnose (Figure 21). The character index value varied from 387 to 520 for pallids, and 127 to 304 for shovelnose.

As in previous years, pallids captured in this study frequently exceeded the morphometric ratios of Bailey and Cross (1954) (Table 8). Individual values are shown in Appendix 10. Perhaps size as well as geographic location were responsible for this variation. The pallids used to determine Bailey and Cross's ratios had standard lengths of more than 200 mm but less than 700 mm, while those captured in the Fort Peck pallid sturgeon study were all greater than 1000 mm. Ratios from pallid and shovelnose in our study area did not overlap. However, ratios from shovelnose captured in this study did overlap those of pallids examined by Bailey and Cross (1954).

Table 7. Range and mean of percent standard length of selected morphological characteristics of pallid and shovelnose sturgeon captured in 1992.

	Pallids (n = 33)		Shovelnose (n=320)	
	Range	(Mean)	Range	(Mean)
Head length	30.0 - 34.4	(32.2)	22.5 - 32.7	(28.4)
Snout length	14.7 - 20.1	(17.7)	13.1 - 18.9	(15.7)
Mouth width	8.0 - 10.4	(9.4)	7.7 - 10.7	(7.7)
Snout to outer barbels	13.2 - 16.0	(14.6)	8.1 - 12.0	(9.7)
Mouth to inner barbels	3.6 - 5.6	(4.5)	5.2 - 7.8	(6.5)
Inner barbels	2.7 - 4.3	(3.6)	5.2 - 8.0	(6.5)
Outer barbels	7.6 - 11.6	(9.8)	7.2 - 10.8	(8.8)
Caudal peduncle	12.4 - 18.0	(14.4)	12.7- 25.8	(17.6)
Snout to anterior midmouth	15.0 - 19.1	(17.3)	8.6 - 17.8	(15.3)
Snout to midbarbs	10.7 - 14.3	(13.1)	6.3 - 12.0	(8.8)

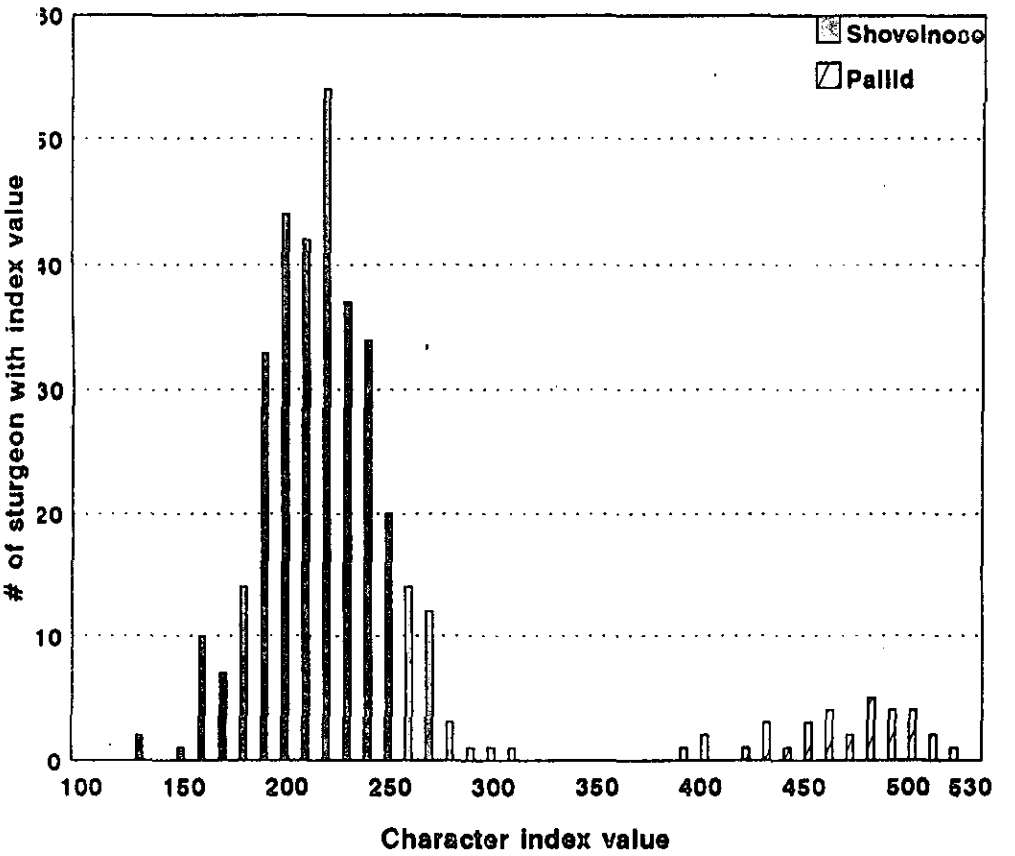


Figure 21. Character index of pallid and shovelnose sturgeon grouped in increments of 10. Maximum of increment shown.

Table 8. Comparison of morphometric ratios[1] of pallid and shovelnose sturgeon[2] found by Bailey and Cross (1954) and those captured in this study in 1992.

	Pallid sturgeon				Shovelnose sturgeon			
	1992 (n= 33)		B&C (n=12-14)		1992 (n=320)		B&C (n=47)	
Ratio[1]	Range	(Mean)	Range	(Mean)	Range	(Mean)	Range	(Mean)
1	2.66- 4.11	(3.26)	2.29-3.26	(2.87)	1.12-2.06	(1.50)	1.27-2.19	(1.60)
2	1.71- 2.72	(2.11)	1.63-2.00	(1.80)	0.81-1.54[3]	(1.18)	1.07-1.42	(1.25)
3	5.82- 9.28	(7.21)	5.54-7.00	(6.31)	3.59-5.62	(4.56)	4.00-5.04	(4.37)
4	2.67- 5.06	(4.12)	2.63-3.73	(3.26)	1.13-2.50	(1.51)	1.26-2.50	(1.64)
5	1.91- 3.57	(2.74)	1.72-2.41	(1.98)	1.12-1.83	(1.37)	1.17-1.48	(1.34)
6	6.96-11.01	(9.09)	6.35-8.00	(7.17)	3.57-6.91	(4.40)	3.65-5.76	(4.47)

[1] Ratios are 1= snout to outer barbel:mouth to inner barbel, 2= mouth width:mouth to inner barbel, 3= head length:mouth to inner barbel, 4= snout to outer barbel:inner barbel, 5= outer barbel:inner barbel, 6= head length:inner barbel.
[2] B & C values for shovelnose > 200 mm.
[3] One shovelnose had ratio 2 as 1.77, the mouth width was probably recorded incorrectly as 2.3 inches instead of 1.3 inches.

Based on field observation, the character index, percent standard length and ratios of several morphological measurements, no suspected pallid-shovelnose hybrids were captured in 1992.

Larval Fish

Larval fish were sampled on the Yellowstone, 2 miles above the confluence with the Missouri on June 21, July 15 and July 16, 1992. A total of 2678 m^3 was filtered. No chondrosteon eggs or larval fish were found in any sample. Larval fish and eggs were observed only during July sampling, and included 36 teleost eggs and several larval fish including 9 suckers, 4 channel catfish, 1 goldeye, and 1 minnow. Gardner (personal communication) sampled the Missouri and the Yellowstone weekly from May 26 - July 12 at the above site as well as at Intake, the Fairview Bridge and the Snowden Bridge. Preliminary results show 8 sturgeon larvae, 6 of which were collected from river mile 2. Sixty-two percent of the sturgeon larvae were sampled during the week of July 12.

Other species

Goldeye, river carpsuckers, channel catfish, sauger, paddlefish and blue suckers were the most common non-sturgeon species netted (Appendix 2). Buffalo species, flathead chub, shorthead redhorse, white sucker, walleye, cisco, and carp were also

captured. Throughout most of 1992, goldeye had the highest catch rates of any species. Once we started using trammel nets goldeye CPUE dropped dramatically, a change probably caused by mesh size. Sauger were only captured in April, May, September and October. River carpsuckers and blue suckers were common only in October (Appendix 2).

Related Studies

In 1992, above the headwaters of Fort Peck Reservoir, Gardner (personal communication) caught 16 pallid sturgeon, four of which were previously captured in 1990 - 1992. Gardner repeatedly recaptured transmittered pallids. Pallids were not found upstream of Stafford Ferry. He also caught more than 1000 shovelnose. Gardner (1992) evaluated pallid/shovelnose hybridization of sturgeon captured within his study area prior to 1992, and based on the character index found no evidence of pallid/shovelnose hybridization.

Backes et al (1992) were not successful in capturing pallids above Intake diversion dam, but report of one pallid snagged by anglers on June 26 at Intake. They netted 1083 shovelnose above Intake in 1992.

RECOMMENDATIONS

1. Commence a long term pallid project and increase crew size so pallid research can be intensified throughout the study area. A long-term commitment is needed to determine size-structure, abundance, seasonal habitat use, migration patterns and potential spawning areas of pallid sturgeon. Insight into size structure and life history requirements will help the CORPS manage the Missouri River to benefit pallid sturgeon.

2. Continue to use and improve telemetry techniques. In 1993, we must continue to monitor the long term transmitters which were previously deployed. Attempt to have 10 active radios on pallids each spring so relocations can be obtained during varying flows throughout the field season. Some shovelnose located in the same area should also be transmittered for species comparisons.

3. Using standardized sampling sites and radio telemetry attempt to establish habitat preferences of pallid sturgeon at varying flows.

4. Continue to collect habitat information from telemetry relocations and drift netting sites. Standardize habitat measurement collection by MSU and MDFWP crews.

5. Investigate possibilities for non-lethal stomach pumping for sturgeon so food habits of pallid sturgeon can be evaluated. Examine forage fish populations.

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Appendix 1. Calculations used to determine character index values found in Figure 21.

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1. Calculate percent standard length for head length, mouth width, snout to outer barbel, mouth to inner barbel, inner barbel, and outer barbel.

2. Find a single lowest and highest percent standard length for each characteristic using both pallid and shovelnose data. Then calculate the difference for these 2 values. For 320 shovelnose and 33 pallid sturgeon we found the following values:

	Minimum	Maximum	
Head length	22.5 (S)	34.4 (P)	
Mouth width	5.1 (S)	10.7 (S)	
Mouth to inner barbel	3.6 (P)	7.8 (S)	4.2
Snout to outer barbel	7.2 (S)	16.0 (P)	7.9
Inner barbel	2.7 (P)	8.0 (S)	5.3
Outer barbel	7.2 (S)	11.6 (P)	4.4

3. Calculate a character index value for head length with the formula:

100 x (head length - minimum head length)/(max head length - min head length)

4. Calculate index values for mouth width, snout to outer barbel, and outer barbel the same way. For inner barbel and mouth to inner barbel calculate as for head length but subtract that number from 100. This will insure that the most pallid like characteristics are all the highest numbers.

5. Add the 6 character index values for a total character index value.

Appendix 2. Average monthly CPUE of common species[1] (per hour of drift netting) in 1992.

Month	Net Type	Section	Minutes	Drifts	# SNS	# PAL	# RC	# GE	# CC	# SG	# PF	# B SU
April	exp-100'	6	21	5	0	0	0	6	0	0	1	0
	exp-125'	6	141	15	12	1	0	19	13	11	0	1
	3" -100'	6	75	15	3	0	0	0	0	0	3	0
	Totals		237	35	15	1	0	25	13	11	4	1
	CPUE		3.95 hours		3.8	0.2		6.3	3.3	2.8	1.0	0.2
May	exp-100'	6	27	2	1	0	0	3	2	2	0	0
	3'- 100"	6	37	7	0	0	0	0	0	0	0	0
	exp-100'	8	64	10	4	0	0	5	7	1	1	0
	3'- 100'	9	64	13	0	0	0	0	0	0	0	0
	Totals		192	32	5	0	0	8	9	2	1	
	CPUE		3.2 hours		1.6	0	0	2.5	2.8	0.6	0.3	0
June	exp- 50'	2	106	12	7	0	0	6	0	0	0	1
	exp-100'	6	37	4	10	0	0	3	26	0	0	0
	exp-125'	8	95	15	65	0	1	44	3	0	0	1
	exp-100'	9	199	18	24	1	0	41	28	0	0	0
	Totals		437	49	106	1	1	94	57	0	0	2
	CPUE		7.3 hours		14.5	.1	.1	12.9	7.8	0	0	0.3
July	exp-100'	3	31	5	1	0	0	3	0	0	1	0
	exp-100'	6	152	9	11	0	0	1	9	0	0	0
	exp- 50'	6	14	2	0	0	0	0	0	0	0	0
	exp-125'	6	147	11	11	0	0	0	0	0	0	0
	exp-100'	7	124	7	0	0	0	3	1	0	0	0
	Totals		468	34	23	0	0	7	10	0	1	0
	CPUE		7.8 hours		2.9	0	0	.9	1.3	0	.1	0

[1] SNS=shovelnose; PAL=pallid; RC=rivercarpsucker; GE=goldeye; CC=channel catfish; SG=sauger; PF=paddlefish; B SU=blue sucker

Appendix 2 continued. Average monthly CPUE of common species[1] (per hour of drift netting) in 1992.

Month	Net Type	Section	Minutes	Drifts	# SNS	# PAL	# RC	# GE	# CC	# SG	# PF	# B SU
August	exp-100'	3	52	6	10	0	0	10	0	0	0	0
	exp-125'	3	15	1	10	0	0	0	0	0	0	0
	exp- 50'	5	4	1	0	0	0	2	0	0	0	0
	exp-125'	5	55	14	3	0	0	8	0	0	0	1
	exp-125'	6	1	1	6	0	0	0	2	0	0	0
	Total		127	23	29	0	0	20	2	0	0	1
	CPUE		2.1 hours		13.7	0	0	9.4	.9	0	0	0.5
Sept	exp-100'	3	63	14	12	0	0	35	0	0	0	0
	tram-150'	3	13	3	0	0	0	0	0	0	0	0
	exp-100'	5	51	7	4	0	0	37	0	0	0	0
	exp-125'	5	53	8	3	0	1	9	3	0	0	0
	exp-100'	6	55	14	11	0	0	35	0	0	0	3
	tram-150'	6	198	37	97	9	4	3	0	1	1	2
	exp-100'	8	5	2	10	0	0	0	0	0	0	0
	Totals		438	85	137	9	5	119	3	1	1	5
	CPUE		7.3 hours		18.8	1.2	.7	16.3	.4	.1	.1	.7
Oct	tram-150'	6	379	65	87	24	77	0	2	5	8	32
	CPUE		6.3 hours		13.8	3.8	12.2	0	.3	.8	1.3	5.1
Total			38.0 hrs	323	402	33	83	274	99	18	14	41

[1] SNS=shovelnose; PAL=pallid; RC=rivercarpsucker; GE=goldeye; CC=channel catfish; SG=sauger; PF=paddlefish; B SU=blue sucker

Appendix 3. Pallid and shovelnose sturgeon habitat measurements from MDFWP crew.

Date	Radio #	Species[1]	River mile	Flow (CFS)	H2O temp. (C)	Cond. (uohms per cm)	Bottom velocity (m/s)	Depth fish (m)	Depth max (m)	Turbidity (NTU)	Substrate
4/11	49.682	P	1574.0	14120	4.0	610	-	4.9	5.5	-	Sand
4/21	49.682	P	1567.0	22500	6.0	-	-	0.9	6.7	6400	Sand
5/ 6	48.640	S	70.0	14700	18.0	364	1.50	1.8	-	225	Gravel
5/ 6	48.680	S	71.0	14700	18.0	364	1.20	0.9	-	225	Sand
5/13	48.760	S	1573.0	22170	14.0	382	0.70	3.0	-	510	Sand/Mud
5/14	48.660	S	27.0	17600	14.0	293	0.50	1.5	-	510	Sand/Mud
5/19	49.682	P	8.0	10700	20.0	416	0.60	2.4	-	120	Sand
5/21	49.682	P	1572.0	19970	18.0	517	0.65	3.0	-	120	Sand
5/22	49.682	P	1567.5	19960	14.0	536	0.70	3.7	-	120	Sand
6/16	49.682	P	4.5	14600	20.0	416	0.60	2.1	-	975	Sand
6/18	49.100	P	1.0	21200	20.0	352	0.55	0.9	-	850	Sand
6/19	49.100	P	1580.0	29530	19.0	353	0.50	2.0	4.0	940	Sand
6/21	49.682	P	1579.5	47420	19.0	483	0.63	2.4	7.6	2190	Sand
7/16	49.100	P	1542.0	25390	20.0	495	0.85	4.0	4.3	625	Sand
8/12	3335	S	1770.0	5500	12.8	-	-	5.8	-	-	-
8/12	338	S	1770.0	5500	13.8	-	-	9.4	-	-	-
8/26	3335	S	1769.0	5500	15.0	493	0.20	5.0	-	5	Sand
8/26	338	S	1770.0	5500	15.0	594	0.02	10.1	-	4	Sand
9/ 2	49.682	P	1568.0	11770	17.0	630	0.75	2.4	-	112	Sand/Gravel
9/ 3	48.622	S	21.0	5190	18.0	623	0.50	1.1	-	57	Sand
9/ 3	48.942	S	1582.0	11620	17.0	620	0.63	1.2	-	104	Sand
9/14	48.660	S	1578.0	9820	15.0	638	0.50	1.2	-	64	Sand/Gravel
9/14	48.942	S	1581.0	9820	14.0	638	0.60	1.7	-	49	Sand
9/15	49.682	P	1565.0	9680	15.0	650	0.65	3.3	3.7	51	Sand/Gravel
9/15	48.680	S	1581.0	9680	15.0	625	0.65	1.3	-	74	Sand
9/16	48.540	P	1564.0	9520	14.0	638	0.90	4.6	-	51	Sand
9/23	3335	S	1569.0	3000	14.0	612	-	4.3	-	8	Sand
9/28	48.660	S	1580.0	9140	12.0	650	0.63	1.8	-	37	Sand
9/28	48.942	S	1580.0	9140	12.0	650	0.63	1.8	-	37	Sand
9/29	48.540	P	1573.0	9210	12.0	650	0.50	4.3	-	35	-
9/29	49.682	S	1575.0	9210	12.0	650	0.65	4.9	4.9	34	-
9/30	48.540	P	1574.0	9240	-	-	0.45	2.1	4.6	32	Sand
10/ 7	48.520	P	1567.0	9590	-	-	-	-	-	-	-
10/ 7	48.540	P	1574.0	9590	-	-	-	-	-	-	-
10/ 7	49.050	P	1563.5	9590	12.0	662	0.59	1.5	-	41	Sand
10/ 7	49.682	P	1568.0	9590	11.0	652	0.55	2.0	-	44	Sand
10/ 7	48.660	S	1580.0	9590	11.0	661	0.60	1.4	-	36	Sand
10/ 7	48.942	S	1580.0	9590	11.0	675	0.55	1.5	-	36	Sand
10/ 7	49.710	S	1580.5	9590	11.0	650	0.40	2.4	-	37	Sand
10/ 7	49.790	S	1580.0	9590	11.0	652	0.43	1.5	-	37	Sand

[1] P=pallid; S=shovelnose

Appendix 3. *Continued.* Pallid and shovelnose sturgeon habitat measurements from MDFWP crew.

Date	Radio #	Species[1]	River mile	Flow (cfs)	Water temp. (C)	Cond. (uohms per cm)	Bottom velocity (m/s)	Depth fish (m)	Depth max (m)	Turbidity (NTU)	Substrate
10/18	48.520	P	1574.0	10290	6.5	651	0.58	1.7	2.2	37	Sand
10/18	48.540	P	1574.5	10290	6.5	651	0.65	2.0	2.2	37	Sand
10/18	49.020	P	1573.0	10290	6.5	665	0.55	4.9	5.3	32	Sand
10/18	49.070	P	1573.0	10290	6.5	665	0.55	-	5.3	32	Sand
10/18	49.130	P	1573.0	10290	6.5	665	0.55	-	5.3	32	Sand
10/20	49.050	P	1.0	7390	7.5	676	-	1.8	2.4	39	Sand/gravel
10/20	49.790	S	1580.0	10790	7.0	652	0.60	1.8	2.3	39	Sand
10/21	-	P	1568.0	10780	7.0	-	-	-	4.6	45	Sand/gravel
10/21	49.682	P	1563.5	10780	7.0	650	0.00	0.8	5.2	45	Sand
10/21	48.942	S	0.5	~~10780~~ 7390	9.9	682	0.45	3.7	4.3	50	Sand
10/26	3335	S	1769.0	3000	11.7	-	-	5.8	-	-	-
10/26	338	S	1770.0	3000	11.7	-	-	10.1	-	-	-
10/27	48.540	P	1574.5	10340	8.5	678	0.40	4.6	5.9	54	Sand
10/27	48.942	S	5.5	~~10340~~ 7390	8.5	699	0.60	1.5	1.8	43	Sand
10/28	48.520	P	1573.0	10130	6.5	687	-	4.7	5.5	57	Sand
10/28	49.020	P	1564.0	10130	7.0	689	0.25	4.9	7.3	36	Sand
10/28	49.050	P	1569.0	10130	7.0	682	-	2.9	3.7	39	Sand
10/28	49.070	P	1565.5	10130	7.0	667	0.50	2.1	3.0	43	Sand
10/28	49.682	P	1567.0	10130	7.0	700	-	-	3.0	-	sand/boulder

[1] P=pallid; S=shovelnose

Appendix 4. Habitat measurements of shovelnose and pallid sturgeon taken by Montana Cooperative Fish Research Unit in 1992.

Date	Time	Radio #	Sp[1]	River mile	Flow (cfs)	Temp. (C)	Cond (uohms /cm)	DO (mg/l)	Velocity surface (m/s)	Velocity bottom (m/s)	Depth fish (m)	Depth max (m)	Secchi Width (m)	Secchi disk (cm)	Substrate type[2]
5/19	-	49.682	P	5.0	10700	20.0	440	-	0.60	-	2.6	6.1	200	23.0	-
5/21	-	49.682	P	-	-	18.0	440	-	0.65	-	3.0	4.3	435	-	-
5/22	1400	49.682	P	1568.0	19960	13.0	561	9.2	0.60	-	4.6	-	-	-	-
6/ 5	1119	48.640	S	71.0	14700	-	-	-	-	-	-	-	340	-	-
6/ 5	1727	48.860	S	60.5	14700	-	-	-	-	-	3.7	3.7	310	-	-
6/ 8	1300	48.942	S	71.0	14700	21.0	357	-	-	-	-	-	-	27.0	-
6/ 8	1345	48.921	S	70.0	14700	-	-	-	-	-	1.3	2.1	350	-	-
6/ 8	1535	48.822	S	67.5	14700	-	-	-	-	-	-	-	240	-	-
6/ 8	1632	48.860	S	60.0	14700	22.0	360	8.5	-	-	3.0	3.4	375	22.0	-
6/ 9	1130	48.883	S	71.0	14900	18.0	349	8.5	-	-	-	-	700	28.0	-
6/ 9	1130	48.680	S	71.0	14900	18.0	349	8.5	-	-	-	-	700	28.0	-
6/ 9	1130	48.902	S	71.0	14900	18.0	349	8.5	-	-	-	-	700	28.0	-
6/ 9	1320	48.680	S	70.5	14900	-	-	-	-	-	2.1	2.1	150	-	4,5,6
6/ 9	1320	48.640	S	70.5	14900	-	-	-	-	-	2.1	2.1	150	-	4,5,6
6/ 9	1357	48.942	S	70.5	14900	-	-	-	-	-	0.9	1.2	-	-	4,5,6
6/ 9	1554	48.921	S	70.0	14900	23.0	-	-	-	-	1.8	1.8	-	-	1,2,3,4
6/ 9	1618	48.842	S	70.0	14900	21.0	-	-	-	-	1.6	1.8	-	-	1,3,4,5
6/ 9	1653	48.822	S	-	14900	-	-	-	-	-	2.4	4.0	-	-	-
6/ 9	1729	48.861	S	60.0	14900	-	-	-	-	-	2.7	3.5	-	-	1,3,4,5
6/10	1406	48.642	S	71.0	14200	20.0	347	10.5	-	-	2.7	3.5	-	24.5	3,5,6,7,8
6/10	1406	48.883	S	71.0	14200	-	-	-	-	-	1.5	3.1	-	-	1,6
6/10	1406	48.942	S	71.0	14200	-	-	-	-	-	1.2	1.7	-	-	6,7,8,9,10
6/10	1457	48.921	S	70.0	14200	-	-	-	-	-	1.6	1.8	145	-	1,2,3,4,5,6
6/10	1658	48.902	S	70.5	14200	-	-	-	-	-	1.5	1.8	190	-	4,5,6
6/10	1736	48.680	S	70.0	14200	-	-	-	-	-	0.8	1.6	225	-	3,4,5,6
6/10	1809	48.842	S	70.0	14200	-	-	-	-	-	1.9	1.9	145	-	1,2,3,4,5,6
6/10	1832	48.822	S	67.5	14200	-	-	-	-	-	2.4	3.7	113	-	4,5
6/10	1924	48.861	S	60.0	14200	-	-	-	-	-	2.4	3.0	120	-	4,5
6/11	1515	48.883	S	71.0	12900	22.0	372	10.5	-	-	2.4	3.6	-	36.5	1,3,4,5
6/11	1614	48.640	S	71.0	12900	-	-	-	-	-	1.9	2.4	-	-	4,5
6/11	1624	48.902	S	70.5	12900	21.0	-	-	-	-	1.4	1.5	150	-	3,4,5,6
6/11	1658	48.942	S	70.0	12900	21.0	-	-	-	-	1.8	1.8	127	-	1,6
6/11	1710	48.921	S	70.0	12900	21.0	-	-	-	-	1.4	1.8	135	-	1,3,5
6/11	1725	48.842	S	70.0	12900	21.0	-	-	-	-	1.9	1.9	150	-	6,7
6/11	1804	48.680	S	69.0	12900	21.0	-	-	-	-	-	-	150	-	3,4,5
6/11	1841	48.822	S	67.5	12900	21.0	-	-	-	-	3.4	3.5	130	-	1
6/11	1928	48.861	S	60.0	12900	21.0	-	-	-	-	2.3	3.4	110	-	1,4,5
6/12	1033			-	11900	20.5	378	9.0	-	-	-	-	-	45.0	-
6/12	1053	48.883	S	71.0	11900	-	-	-	-	-	1.2	2.4	145	-	1,4,5,6
6/12	1120	48.642	S	71.0	11900	24.0	-	-	-	-	0.9	2.1	120	-	4,5,6
6/12	1147	48.902	S	70.5	11900	24.0	-	-	-	-	1.5	1.5	182	-	5,6
6/12	1211	48.680	S	70.0	11900	24.0	-	-	-	-	1.3	1.5	135	-	1,4,5,6

[1] Sp = Species; S = shovelnose; P = pallid

[2] Turbulence may have caused inaccurated bottom velocity measurements (Bramblott and White, 1992)

[3] 0 = silt; 1 = sand; 2 = 4-25 mm; 3 = 25 - 50 mm; 4 = 50 - 75 mm; 5 = 75 - 100 mm; 6 = 150 - 225 mm; 7 = 225 - 300 mm; 8 = > 600 mm; 10 = bedrock.

Appendix 4. Continued. Habitat measurements of shovelnose and pallid sturgeon taken by Montana Cooperative Fish Research Unit in 1992.

Date	Time	Radio #	Sp[1]	River mile	Flow (cfs)	Temp. (C)	Cond (uohms /cm)	DO (mg/l)	Velocity surface (m/s)	Velocity bottom (m/s)[2]	Depth fish (m)	Depth max (m)	Secchi Width (m)	Secchi disk (cm)	Substrate type[3]
6/12	1222	48.921	S	70.0	11900	24.0	-	-	-	-	1.3	1.8	140	-	1,4
6/12	1242	48.942	S	70.0	11900	-	-	-	-	-	1.5	1.9	120	-	4,5,6
6/12	1251	48.842	S	70.0	11900	24.0	-	-	-	-	1.5	1.5	135	-	6
6/12	1323	48.822	S	-	11900	24.0	-	-	-	-	2.7	3.1	95	-	1
6/12	1404	48.861	S	60.0	11900	24.0	-	-	-	-	1.8	3.4	127	-	1,4,5,6
6/15	1630			-	14300	18.0	404	7.0	-	-	-	-	-	5.5	-
6/15	1702	48.883	S	71.0	14300	-	-	-	0.67	0.73	1.3	3.4	120	-	1,4
6/15	1719	48.942	S	71.0	14300	20.0	-	-	0.18	0.24	2.3	3.8	120	-	1
6/15	1747	48.640	S	71.0	14300	20.0	-	-	1.40	1.18	2.1	2.3	100	-	6
6/15	1817	48.902	S	71.0	14300	20.0	-	-	1.31	0.55	1.3	2.1	145	-	4,5,6
6/15	1902	48.921	S	70.0	14300	20.0	-	-	0.82	0.73	1.2	1.7	125	-	1,2,3,4
6/15	1902	48.822	S	71.0	14300	20.0	-	-	0.82	0.73	1.1	1.7	125	-	1,2,3,4
6/16	-	-		-	15200	16.0	372	-	-	-	-	-	-	12.0	-
6/16	1253	48.883	S	71.0	15200	18.0	-	-	0.58	0.55	1.7	2.7	100	-	6
6/16	1319	48.921	S	70.0	15200	-	-	-	1.01	0.55	2.4	2.5	90	-	6,7
6/16	1358	48.822	S	71.0	15200	20.0	-	-	0.52	0.48	0.6	1.1	140	-	4
6/16	1426	48.640	S	71.0	15200	20.0	-	-	2.16	1.37	2.0	2.1	105	-	4,5,6,7
6/16	1445	48.902	S	71.0	15200	19.0	-	-	1.43	0.88	0.9	1.8	135	-	4,5,6
6/16	1510	48.942	S	71.0	15200	20.0	-	-	0.52	0.15	3.7	3.7	125	-	1
6/16	1551	48.842	S	70.0	15200	20.0	-	-	1.22	0.37	3.4	3.6	115	-	-
6/16	1638	48.862	S	60.0	15200	20.0	-	-	1.89	1.07	3.4	3.6	115	-	1,6
6/17	1122	48.622	S	14.0	16600	20.0	388	-	-	-	-	-	95	10.0	1
6/18	932	49.682	P	-	21200	20.0	370	9.0	1.43	0.30	-	-	160	16.0	1
6/18	1545	49.102	P	4.0	21200	20.0	-	-	0.43	0.15	-	-	350	-	1
6/18	1545	49.102	P	1.0	21200	20.0	-	-	0.43	0.15	-	-	350	-	1
6/19	752	49.682	P	4.0	32700	19.0	369	7.0	1.71	0.12	-	-	135	5.5	1,2
6/22	1310	49.682	P	8.0	36000	20.0	413	8.0	1.46	0.08	-	-	750	4.5	1
6/24	1145	49.102	P	1576.0	43060	21.0	371	8.2	1.01	0.12	-	-	1100	3.8	1
6/25	1025	49.102	P	1575.0	41830	21.0	472	8.2	1.58	<0.00	-	-	950	5.5	1
6/26	614	48.640	S	70.5	28700	18.5	333	8.5	1.95	0.82	-	-	240	3.0	4,5
6/26	717	48.902	S	70.0	28700	-	-	-	1.07	0.70	-	-	185	-	1,4,5,6
6/26	747	48.883	S	70.0	28700	20.0	-	-	1.92	1.58	-	-	200	-	3
6/26	942	48.942	S	70.0	28700	20.0	-	-	1.92	1.58	-	-	200	-	3
6/26	1029	48.842	S	63.0	28700	22.0	-	-	1.77	1.74	-	-	195	-	4,5,6
6/26	1314	48.862	S	49.0	28700	22.0	-	-	-	<0.00	-	-	120	-	1
6/29	1430	49.682	P	4.0	24500	21.0	336	7.5	0.82	<0.00	-	-	200	9.0	1
6/29	1700	49.682	P	4.0	24500	21.0	-	-	1.37	<0.00	-	-	155	-	1
6/29	1804	49.682	P	4.0	24500	20.5	-	-	1.13	<0.00	-	-	185	-	1
6/30	1724	49.682	P	3.0	24400	17.5	330	7.5	1.65	<0.00	-	-	135	7.0	1,2
7/ 1	1618	49.682	P	2.5	25000	17.0	345	7.5	1.65	<0.00	-	-	135	7.0	1,2

[1] Sp = Species; S = shovelnose; P = pallid

[2] Turbulence may have caused inaccurate velocity measurements (Bramblett and White, 1992)

[3] 0 = silt; 1 = sand; 2 = 4-25 mm; 3 = 25 - 50 mm; 4 = 50 - 75 mm; 5 = 75 - 100 mm; 6 = 150 - 225 mm; 7 = 225 - 300 mm; 9 = > 600 mm; 10 = bedrock.

Appendix 4. Continued. Habitat measurements of shovelnose and pallid sturgeon taken by Montana Cooperative Fish Research Unit in 1992.

Date	Time	Radio #	Sp[1]	River mile	Flow (cfs)	Temp. (C)	Cond (uohms / cm)	DO (mg/l)	Velocity surface (m/s)	Velocity bottom (m/s)[2]	Depth fish (m)	Depth max (m)	Secchi Width (m)	Secchi disk (cm)	Substrate type[3]
7/ 2	1333	49.682	P	3.5	26200	17.5	359	7.5	1.77	<0.00	-	-	170	4.0	1,2
7/ 2	1541	49.100	P	1558.5	34600	17.5	-	-	0.79	<0.00	-	-	180	-	0,1,2
7/ 3	942	49.682	P	3.4	38100	17.5	344	9.5	1.74	<0.00	-	-	-	5.5	0,1,2
7/ 7	1344	49.682	P	3.0	29400	22.0	378	9.0	1.48	0.24	-	-	245	4.0	1
7/ 8	1755	49.100	P	1552.0	35870	22.0	476	9.8	0.49	<0.00	-	-	360	2.0	0,1
7/ 8	1755	49.100	P	1552.0	35870	-	-	-	0.82	<0.00	-	-	350	-	0,1
7/ 9	1150	49.682	P	1576.5	34130	22.0	469	8.2	1.25	<0.00	-	-	500	2.0	1
7/10	850	48.660	S	50.0	23100	21.0	443	9.0	0.70	0.79	-	-	130	3.5	2,3,4,5
7/10	1245	48.861	S	49.0	23100	-	-	-	0.03	0.15	-	-	100	-	1,2,3,4
7/10	1500	48.622	S	50.0	23100	20.0	-	-	1.34	1.25	-	-	145	-	2,3,4,5
7/12	1151	49.100	P	1547.5	29820	22.5	508	8.0	1.19	<0.00	-	-	175	3.0	1
7/13	1251	49.100	P	-	29210	20.0	500	8.0	1.16	<0.00	-	-	220	5.0	1
7/15	1015	49.100	P	1544.0	26390	21.0	501	8.5	1.13	0.87	-	-	600	5.5	1
7/16	1000	48.660	S	-	25720	20.0	441	8.0	1.04	0.91	1.2	1.8	145	11.0	3,4,6
7/16	1139	48.842	S	56.0	18000	20.0	-	-	1.49	1.19	1.2	1.5	190	-	-
7/16	1342	48.622	S	71.0	18000	20.0	-	-	1.58	1.55	2.4	2.4	195	-	-
7/16	1421	48.883	S	71.0	18000	20.0	-	-	1.77	1.25	2.1	2.2	125	-	3,4,5,6
7/16	1444	48.640	S	70.0	18000	20.0	-	-	1.55	0.67	1.2	2.4	180	-	3,4,5,6
7/16	1506	48.942	S	69.5	18000	-	-	-	1.52	<0.00	1.8	3.5	150	-	3,4,5,6,7
7/16	1535	48.902	S	70.0	18000	-	-	-	1.37	0.18	1.5	3.7	150	-	1
7/16	1703	48.921	S	59.0	18000	-	-	-	1.89	0.06	2.9	3.1	125	-	4,5,6
7/17	830	49.102	P	1541.0	17400	19.0	520	9.5	0.76	<0.00	2.4	6.7	230	7.5	0,1
7/21	1314	49.102	P	1540.0	13400	22.0	521	9.8	1.07	<0.00	2.1	2.9	205	8.5	0,1
7/23	630	49.102	P	1540.0	12500	20.0	540	9.0	1.28	<0.00	2.4	2.7	360	9.0	0,1
7/23	2045	48.883	S	-	12500	20.0	480	9.5	0.46	0.15	1.8	2.4	155	19.5	1
7/24	600	48.883	S	-	12900	20.0	480	8.5	1.52	0.94	1.2	1.3	108	23.0	5,6,7
7/26	1430	49.102	P	1539.0	15900	25.0	553	8.5	1.07	0.15	3.7	4.7	350	9.5	1
7/27	1141	49.102	P	1539.0	16700	23.0	602	8.2	1.10	<0.00	3.7	4.7	400	9.5	1
7/27	1711	49.102	P	1539.0	16700	23.0	-	-	1.04	<0.00	4.3	4.6	400	-	1
7/28	1313	49.102	P	1539.0	15000	22.0	560	-	1.07	<0.00	3.4	7.3	200	11.0	1
7/28	1830	49.102	P	1539.0	15000	-	-	-	1.13	<0.00	5.3	6.0	110	-	1
7/29	1020	49.102	P	-	13400	21.0	605	8.2	1.22	<0.00	3.0	3.5	245	5.0	1
7/30	1040	48.640	S	70.0	12300	20.0	-	-	1.34	0.73	1.4	1.5	200	-	6
7/30	1104	48.883	S	70.0	12300	20.0	624	10.0	1.43	0.06	1.9	1.9	150	4.0	1,3,4,5,6
7/30	1206	48.622	S	64.0	12300	20.5	-	-	1.22	<0.00	2.1	3.2	110	-	1
7/30	1340	48.842	S	55.0	12300	21.5	-	-	1.37	<0.00	3.0	3.5	70	-	1,3
7/30	1430	48.922	S	54.0	12300	22.0	-	-	-	-	-	-	150	-	4,5,6
7/30	1504	48.660	S	51.0	12300	22.0	-	-	1.71	1.31	0.9	1.7	85	-	3,4,5
7/30	1747	48.902	S	68.5	12300	22.0	-	-	1.46	0.49	1.5	2.5	120	-	3,4,5,6
7/31	1225	48.622	S	64.0	11200	22.0	645	8.2	1.71	1.31	1.4	3.4	28	3.5	3,4,5,6
7/31	1225	48.902	S	68.0	11200	-	-	-	1.40	1.13	1.5	1.8	210	-	3,4,5,6,7,8
7/31	1247	48.640	S	69.5	11200	-	-	-	1.62	1.28	0.6	1.1	120	-	3,4,5

[1] Sp = Species; S = shovelnose; P = pallid

[2] Turbulence may have caused inaccurate bottom velocity measurements.

[3] 0 = silt; 1 = sand; 2 = 4-25 mm; 3 = 25 - 50 mm; 4 = 50 - 75 mm; 5 = 75 - 100 mm; 6 = 150 - 225 mm; 7 = 225 - 300 mm; 8 = > 600 mm; 10 = bedrock.

Appendix 4. Continued. Habitat measurements of shovelnose and pallid sturgeon taken by Montana Cooperative Fish Research Unit in 1992.

Date	Time	Radio #	Sp[1]	River mile	Flow (cfs)	Temp. (C)	Cond (uohms /cm)	DO (mg/l)	Velocity surface (m/s)	Velocity bottom (m/s)[2]	Depth fish (m)	Depth max (m)	Secchi Width (m)	Secchi disk (cm)	Substrate type[3]
7/31	1313	48.883	S	70.0	11200	-	-	-	1.10	0.27	1.0	1.4	225	-	3,4,5,6
8/ 4	1120	49.100	P	1537.0	18160	20.0	632	9.0	0.91	<0.00	3.0	4.8	250	8.0	-
8/ 5	1040	48.660	S	-	-	21.0	639	9.0	2.13	1.22	1.4	1.5	100	6.5	3,4,5
8/14	1731	48.883	S	71.0	5730	25.0	705	8.1	-	-	1.3	-	275	22.0	8
8/14	1900	48.640	S	-	-	-	-	-	-	-	1.6	-	170	-	3,4,5,6
8/15	845	48.640	S	70.0	5730	23.0	729	7.5	-	-	1.4	-	170	26.0	7
8/15	1045	48.622	S	61.0	5730	23.5	-	-	1.83	-	2.0	-	105	-	7
8/15	1128	48.902	S	58.5	5730	24.0	-	-	-	-	1.8	-	190	-	8
8/15	1300	48.842	S	-	-	-	-	-	-	-	3.6	-	-	-	1,2
8/15	1412	48.660	S	52.0	5730	-	-	-	-	-	1.3	-	215	-	6
8/16	1702	48.640	S	-	-	27.0	720	10.0	-	-	-	-	-	35.0	-
8/17	1034	48.640	S	-	-	25.0	730	8.5	0.91	-	1.0	-	125	30.0	3,4
8/17	1300	48.622	S	-	-	-	-	-	1.83	-	2.0	-	105	29.0	5,6
8/17	1300	48.902	S	-	-	-	-	-	1.83	-	-	-	254	-	6
8/17	1352	48.842	S	-	-	-	-	-	-	-	-	-	-	-	
8/17	1425	48.660	S	-	-	-	-	-	0.91	-	1.2	-	175	-	4,5

[1] Sp = Species; S = shovelnose; P = pallid

[2] Turbulence may have caused inaccurate velocity readings (Bramblett and White, 1992)

[3] 0 = silt; 1 = sand; 2 = 4-25 mm; 3 = 25 - 50 mm; 4 = 50 - 75 mm; 5 = 75 - 100 mm; 6 = 150 - 225 mm; 7 = 225 - 300 mm; 9 = > 600 mm; 10 = bedrock.

Appendix 5. Measurements[1] (mm) of shovelnose sturgeon captured from the Missouri River in 1992.

Total	Fork	Std	A Head	I Snout	F Mouth width	B Snout to outer	E Mouth to inner	D Inner barbel	C Outer barbel	H Snout to mouth	G Snout to barbs	J Caudped	Girth	Weight (kg)
-	-	292	86	48	20	33	18	15	21	48	30	64	102	-
-	-	183	48	28	13	18	10	10	15	25	15	46	58	-
-	-	335	89	51	18	30	18	20	28	46	28	74	102	-
-	-	168	55	28	13	15	13	13	15	28	15	41	51	-
-	-	229	61	33	18	25	15	13	18	33	18	48	71	-
-	-	180	46	28	15	18	10	10	15	28	15	43	30	-
284	259	236	69	36	15	23	12	12	18	36	20	61	91	-
361	325	302	84	48	18	30	18	20	28	46	25	66	89	-
381	348	320	86	48	23	28	23	15	23	48	25	61	96	0.1
391	350	325	89	51	25	33	20	18	28	51	30	74	107	-
444	412	381	112	66	30	41	25	28	36	61	36	76	135	-
452	401	381	107	64	28	36	20	20	30	58	36	86	112	0.2
478	427	396	114	64	30	41	25	25	36	64	36	79	117	0.3
483	434	404	112	53	33	43	25	25	36	64	38	84	119	-
488	439	412	119	69	30	46	28	28	41	69	43	84	124	0.3
488	439	412	114	64	36	41	25	28	36	64	36	84	119	0.3
498	437	412	107	64	28	38	28	28	36	58	36	94	122	0.3
498	450	417	114	66	30	41	25	25	33	64	38	84	122	-
498	444	417	112	64	30	41	23	23	30	64	38	84	122	-
500	460	432	124	71	30	43	28	28	41	66	41	91	135	0.3
510	452	422	117	66	33	41	25	25	33	64	38	84	135	-
518	470	439	135	76	43	46	33	30	36	74	41	86	137	0.4
526	480	452	117	66	30	41	28	30	38	66	38	91	132	0.4
536	475	444	122	69	33	46	25	25	33	69	41	89	132	0.4
556	508	467	130	74	30	43	30	28	41	71	41	96	147	0.4
559	510	480	137	84	36	48	33	33	41	74	41	86	180	0.7
561	503	472	124	71	33	46	30	33	43	71	43	94	-	-
564	493	457	130	66	58	41	33	30	41	69	38	91	135	0.4
566	508	475	137	76	33	48	33	33	46	76	41	94	145	-
569	521	483	142	79	38	51	33	33	41	79	43	86	150	-
569	518	483	132	71	36	48	30	33	41	76	41	94	142	-
569	516	488	140	79	30	46	33	36	46	76	41	89	142	0.4
579	521	480	137	79	33	53	30	33	38	76	43	94	152	-
579	549	516	147	79	43	51	33	33	43	76	43	89	163	-
579	533	521	155	81	36	48	41	36	48	81	41	86	168	0.7
584	533	500	147	86	38	51	33	33	43	79	48	96	170	0.7
587	544	513	145	81	41	46	30	33	46	74	43	86	183	-
587	544	513	145	81	33	51	33	33	46	79	46	104	163	-
589	538	498	137	76	36	53	30	30	41	76	41	96	152	-
589	531	493	142	79	41	46	33	36	48	76	43	104	-	-

[1] See Figure 3 for placement of measurements.

Appendix 5. Continued. Measurements[1] (mm) of shovelnose sturgeon captured from the Missouri River in 1992.

Total	Fork	Std	A Head	I Snout	F Mouth width	B Snout to outer	E Mouth to inner	D Inner barbel	C Outer barbel	H Snout to mouth	G Snout to barbs	J Caud ped	Girth	Weight (kg)
589	538	506	140	76	36	46	36	33	41	79	41	94	-	0.7
589	544	503	142	76	41	48	36	33	43	76	41	89	168	-
589	546	508	155	84	43	51	36	33	43	84	43	89	178	-
592	528	493	147	81	41	48	30	30	46	74	43	81	-	-
594	533	503	145	79	36	46	30	28	46	74	41	112	168	-
594	549	516	155	86	43	58	36	36	46	86	51	81	178	-
597	549	516	147	79	41	43	38	38	43	79	43	89	158	0.7
599	564	554	145	84	36	48	33	33	51	76	43	86	178	-
602	556	518	147	81	41	46	36	30	46	76	43	94	165	0.7
602	559	521	145	81	38	48	38	36	43	76	38	94	165	0.7
602	541	513	150	89	38	56	33	33	43	86	53	94	160	-
604	572	538	155	89	41	48	38	36	51	81	43	94	190	-
607	574	536	147	81	41	46	33	33	48	76	41	102	165	0.6
607	561	526	150	84	33	48	36	36	46	76	41	91	158	0.6
610	566	523	152	81	40	48	38	38	51	76	38	96	178	-
610	559	523	152	86	36	48	33	36	48	79	46	96	170	0.6
612	544	510	135	76	36	46	30	33	48	74	43	102	168	0.6
612	566	528	160	89	36	53	36	36	48	84	46	94	170	-
615	564	531	145	81	41	53	33	33	41	84	43	91	155	0.6
615	572	541	145	89	41	51	36	36	46	81	46	107	183	0.7
617	572	541	152	84	43	48	36	36	48	81	48	99	160	0.7
617	559	523	140	76	38	56	30	33	46	76	43	99	158	-
620	559	518	158	81	43	51	33	33	43	81	48	91	-	-
620	566	531	158	91	38	56	36	33	43	89	53	86	160	0.6
622	572	533	158	89	43	58	41	36	48	89	53	89	178	0.8
622	559	523	150	84	36	51	38	38	51	81	46	94	178	-
625	572	531	152	84	41	53	41	41	53	84	48	91	155	0.6
627	589	551	152	84	36	51	36	36	53	79	46	107	185	0.8
627	579	546	155	89	36	56	36	36	48	86	51	107	185	-
627	579	544	165	89	58	56	41	36	48	86	48	96	198	0.8
630	574	541	158	79	41	46	36	36	46	79	41	94	155	-
630	561	523	163	91	43	56	33	36	48	86	51	86	178	-
630	569	531	150	84	41	53	33	36	48	81	51	96	178	0.7
630	572	533	152	79	43	51	36	36	46	84	51	99	196	0.8
632	566	538	160	94	43	53	36	36	53	84	48	94	183	-
632	574	536	158	89	43	56	38	36	43	84	48	94	165	-
635	587	549	160	89	36	53	36	38	51	84	66	96	201	0.9
635	582	538	165	91	43	58	36	36	46	86	48	96	163	-
635	577	541	150	84	38	48	36	36	46	81	46	102	163	0.7
635	579	536	165	89	43	61	36	33	46	86	48	86	-	-

[1] See Figure 3 for placement of measurements.

Appendix 5. Continued. Measurements[1] (mm) of shovelnose sturgeon captured from the Missouri River in 1992.

Total	Fork	Std	A Head	I Snout	F Mouth Width	B Snout to outer	E Mouth to inner	D Inner barbel	C Outer barbel	H Snout to mouth	G Snout to barbs	J Caud ped	Girth	Weight (kg)
635	584	579	142	79	36	51	36	38	46	81	46	107	173	-
635	577	541	137	79	33	51	30	30	43	76	43	107	170	-
638	574	531	152	86	43	51	33	33	48	86	48	107	-	-
638	574	546	158	86	41	56	36	30	43	86	51	96	188	-
638	589	549	168	89	51	53	41	38	53	89	51	89	173	-
640	594	551	170	86	43	56	33	36	51	61	48	94	168	-
640	574	536	152	86	41	48	41	41	48	79	43	112	165	0.6
640	589	554	155	84	36	53	33	33	48	81	48	94	190	-
643	594	551	158	86	43	48	33	33	51	79	48	91	180	-
643	599	564	127	76	36	48	33	36	46	79	41	102	168	-
643	589	546	155	81	43	51	36	36	48	79	46	99	158	0.6
645	610	564	163	86	43	51	38	38	48	86	51	104	190	0.9
645	569	549	145	84	38	51	33	30	41	81	48	99	173	0.7
648	572	538	140	74	41	48	33	33	48	76	43	102	160	0.6
648	599	559	158	86	48	56	38	36	48	84	56	91	198	1.0
650	584	544	163	86	28	56	30	28	41	81	48	94	-	-
653	594	561	165	91	43	51	38	36	51	89	46	91	180	0.9
653	617	551	150	81	41	53	36	38	51	86	48	102	168	-
655	597	564	145	81	41	46	33	38	48	79	46	107	178	0.8
655	610	566	163	86	43	51	38	38	53	81	43	102	190	0.9
655	592	556	150	84	41	56	36	38	48	81	51	89	165	0.7
658	597	559	155	79	51	58	33	36	53	84	51	89	175	-
658	610	569	165	96	43	61	38	38	51	91	53	99	190	0.9
658	597	561	160	89	43	53	38	38	53	89	51	99	180	0.9
660	599	564	158	91	46	58	38	38	48	89	53	109	178	0.8
660	597	564	170	96	46	66	38	38	53	94	58	86	178	0.9
660	655	572	158	96	46	53	36	36	48	86	51	94	51	-
660	589	544	152	81	41	51	36	38	53	84	48	86	188	0.8
663	599	566	158	84	46	51	38	38	56	84	48	94	188	-
663	602	564	165	91	41	56	38	38	51	89	51	81	165	0.7
666	612	584	165	89	43	56	38	36	51	84	51	99	173	0.9
666	615	579	165	86	46	51	33	33	46	81	46	76	-	-
666	610	572	165	94	48	56	38	38	53	86	51	99	198	0.9
666	610	572	165	89	43	58	38	38	48	89	51	94	183	-
666	592	554	150	89	36	56	36	36	48	79	43	112	163	0.7
668	620	574	165	91	43	61	36	36	53	89	53	89	206	1.0
668	610	577	165	91	38	53	38	38	48	89	53	104	193	-
668	627	597	170	96	43	56	41	33	48	91	51	99	206	1.1
668	607	574	168	104	43	61	38	33	46	94	56	107	193	-
671	615	579	158	94	41	56	36	38	56	86	53	109	170	0.8
671	615	579	165	94	41	53	41	36	51	89	48	112	201	1.0

[1] See Figure 3 for placement of measurements.

Appendix 5. Continued. Measurements[1] (mm) of shovelnose sturgeon captured from the Missouri River in 1992.

Total	Fork	Std	A Head	I Snout	F Mouth width	B Snout to outer	E Mouth to inner	D Inner barbel	C Outer barbel	H Snout to mouth	G Snout to barbs	J Caud ped	Girth	Weight (kg)
671	610	569	155	81	41	48	43	41	51	91	56	107	-	0.9
671	599	559	158	89	41	56	43	41	48	89	48	117	183	0.9
673	627	587	175	96	46	64	41	38	51	94	53	112	198	-
673	615	574	168	99	36	64	41	36	48	99	53	96	163	-
673	610	569	168	91	48	56	38	38	48	86	51	99	185	0.9
673	625	589	165	89	46	56	36	36	48	86	48	104	-	-
673	622	589	165	86	48	56	38	38	51	89	51	96	173	-
676	617	577	165	94	41	53	38	41	58	89	51	96	216	1.0
676	640	610	168	96	43	58	43	43	58	91	51	104	208	1.0
678	625	589	170	94	46	53	46	43	56	91	51	99	201	1.1
681	635	597	170	96	48	58	41	41	58	89	51	107	201	-
683	625	589	173	94	46	53	41	38	53	91	51	107	193	1.0
683	615	587	170	89	46	58	38	38	58	91	53	102	193	0.9
683	638	599	173	94	51	58	41	43	58	91	51	96	198	-
686	615	584	165	89	43	51	41	36	51	81	46	96	198	1.0
686	622	584	168	89	48	58	36	38	56	89	53	102	201	-
686	622	582	158	81	48	53	41	38	48	89	51	107	211	1.1
686	625	589	173	94	38	56	41	41	56	91	51	107	229	-
688	640	599	178	104	43	61	38	38	53	99	61	102	193	-
688	625	584	168	94	41	61	36	36	48	94	69	122	198	-
688	635	594	168	86	51	53	36	36	51	86	51	104	178	-
691	645	607	173	91	46	58	36	36	46	91	48	117	-	-
693	635	599	165	91	46	58	41	38	48	99	61	94	190	1.0
693	625	589	168	89	48	61	38	41	58	89	51	102	188	-
693	622	574	165	96	46	58	38	41	58	91	51	114	196	-
696	653	615	163	86	43	53	38	41	51	84	43	109	180	0.9
696	632	584	170	94	48	56	46	41	51	94	51	102	178	0.9
696	643	602	178	104	48	61	38	38	53	99	58	102	213	-
696	650	615	180	102	53	64	41	41	53	96	58	109	203	-
698	625	589	163	89	46	61	38	41	64	91	53	104	190	1.0
698	645	610	165	91	36	56	41	41	56	89	48	104	-	-
701	640	597	173	96	48	64	43	43	51	94	56	112	188	-
701	630	594	168	91	43	64	38	36	53	96	58	104	193	1.0
701	635	602	173	96	41	58	38	36	48	91	53	104	188	-
701	645	607	168	89	51	58	41	43	64	89	51	94	178	0.9
704	627	592	170	96	48	61	38	38	58	99	58	94	196	0.9
706	622	589	165	89	43	61	38	38	51	91	53	114	190	-
706	648	607	173	94	53	61	43	36	56	96	56	107	229	1.2
709	635	594	170	91	46	56	38	36	51	89	51	99	190	-
709	627	594	168	102	43	61	38	38	51	94	56	99	193	-
709	645	607	173	91	43	53	38	38	53	89	51	107	203	-

[1] See Figure 3 for placement of measurements.

Appendix 5. Continued. Measurements[1] (mm) of shovelnose sturgeon captured from the Missouri River in 1992.

Total	Fork	Std	A Head	I Snout	F Mouth width	B Snout to outer	E Mouth to inner	D Inner barbel	C Outer barbel	H Snout to mouth	G Snout to barbs	J Caudped	Girth	Weight (kg)
709	650	604	168	84	51	53	38	38	51	86	48	102	190	0.9
711	640	620	175	94	41	56	38	38	51	94	51	107	173	-
711	660	625	175	94	48	56	43	41	58	94	51	112	196	1.0
714	643	604	163	86	41	56	36	36	48	86	48	112	-	-
714	666	627	175	96	51	58	43	43	53	91	53	107	226	1.4
714	648	615	170	94	43	56	38	36	46	89	51	112	231	1.4
716	638	594	155	81	46	51	38	36	48	86	51	99	178	0.9
716	655	617	165	102	48	66	41	41	56	96	56	102	216	1.2
716	668	622	180	96	46	61	43	41	48	96	58	109	-	-
716	655	617	170	94	43	56	38	36	53	91	53	119	206	1.1
719	655	612	175	99	43	64	38	41	53	102	61	96	180	-
721	660	625	180	94	56	58	46	46	61	94	53	96	229	-
721	650	612	165	91	46	58	38	38	51	89	51	99	198	1.0
726	666	635	180	99	43	64	41	41	53	96	56	107	183	1.0
726	645	615	175	102	46	61	38	36	48	96	58	119	201	1.0
726	666	620	188	104	51	66	41	41	61	107	64	96	198	1.1
726	666	610	168	91	51	58	41	41	56	94	56	109	203	-
734	673	627	170	91	51	56	41	41	51	91	51	107	190	1.1
734	663	615	175	91	56	61	38	43	58	99	61	102	213	-
734	686	622	152	81	43	51	38	38	51	84	48	112	180	0.9
734	681	640	185	99	58	64	46	43	51	99	56	109	211	-
737	688	645	183	102	46	58	46	43	58	96	53	109	211	-
737	666	632	185	107	48	64	41	41	53	102	64	107	206	-
737	676	627	185	96	51	61	43	46	58	96	56	109	-	-
737	673	638	168	89	51	58	36	36	53	89	51	109	221	-
737	678	632	175	94	51	61	43	38	53	96	56	107	190	1.1
739	658	617	183	104	46	64	43	43	61	102	61	117	196	1.1
744	686	645	178	96	51	56	43	41	56	94	53	109	216	-
749	696	655	188	104	48	64	48	46	58	109	64	102	216	-
749	704	658	180	94	51	61	43	43	58	99	56	114	229	1.4
752	681	650	188	112	53	69	46	43	56	109	61	109	203	1.4
752	678	645	183	109	46	69	46	43	56	104	61	122	208	-
752	686	643	183	104	51	64	46	46	64	99	56	107	213	1.3
752	716	673	193	102	56	66	51	51	64	107	58	107	224	1.5
754	688	640	178	94	53	64	43	43	61	99	53	104	206	-
754	691	648	173	91	51	58	43	43	61	94	51	114	213	1.4
760	714	668	196	104	51	61	46	48	66	107	58	109	229	1.5
762	701	648	178	89	58	53	46	46	61	94	51	102	213	-
762	706	660	188	102	53	64	46	43	56	102	56	102	206	1.3
767	691	650	175	91	51	64	43	41	53	96	56	107	211	1.4
767	693	638	175	91	51	61	43	46	64	99	58	104	229	-
767	701	655	185	96	56	61	43	41	58	91	51	122	-	-

[1] See Figure 3 for placement of measurements.

Appendix 5. Continued. Measurements[1] (mm) of shovelnose sturgeon captured from the Missouri River in 1992.

Total	Fork	Std	A Head	I Snout	F Mouth width	B Snout to outer	E Mouth to inner	D Inner barbel	C Outer barbel	H Snout to mouth	G Snout to barbs	J Caud ped	Girth	Weight (kg)
770	693	650	180	102	58	64	43	41	51	99	56	102	208	-
770	696	648	180	91	56	64	41	46	56	99	56	109	229	1.5
770	698	658	183	94	58	58	48	46	64	102	56	112	218	1.4
772	732	691	201	114	53	66	43	46	56	107	64	122	226	-
772	701	660	198	109	56	69	46	43	61	109	64	109	236	1.6
775	698	655	185	99	51	64	46	46	64	102	58	114	190	1.2
775	716	673	193	114	51	76	43	46	64	114	69	107	216	-
777	698	660	185	109	43	66	46	48	66	104	61	122	224	1.4
780	711	671	193	104	56	66	48	48	58	107	64	102	224	1.6
780	706	660	193	107	56	66	38	41	53	99	61	109	252	-
780	709	671	188	107	51	69	43	46	61	104	61	124	218	-
782	701	660	190	102	58	64	41	41	61	102	64	107	229	1.5
782	711	671	180	96	48	64	41	43	58	102	61	112	-	-
785	721	683	198	117	53	74	48	36	64	114	71	107	241	1.7
787	709	668	180	104	51	61	41	41	58	94	56	119	211	1.4
795	726	688	196	112	53	66	46	46	64	112	64	122	216	1.5
800	732	691	201	107	56	69	51	51	64	112	64	112	254	1.8
800	719	686	198	114	58	71	43	46	64	112	69	117	259	-
800	726	681	198	107	61	69	48	51	66	109	61	109	211	-
800	724	681	203	114	61	74	48	48	64	114	66	107	213	1.5
810	752	704	206	112	66	66	51	51	69	107	58	127	224	-
810	732	686	185	99	58	64	43	43	66	96	53	114	241	-
813	749	698	203	102	56	66	48	48	64	109	64	114	229	1.8
818	767	719	206	112	56	66	51	53	66	109	58	107	254	2.0
820	757	706	203	107	58	71	46	41	58	107	64	112	-	-
823	742	711	198	107	48	64	46	46	71	107	61	137	218	1.5
831	760	724	208	119	61	71	53	56	74	112	64	122	259	2.0
831	777	732	213	114	61	66	51	51	69	114	64	114	241	2.1
833	775	729	213	117	64	66	48	46	58	112	66	132	-	-
836	764	721	203	117	53	74	48	46	64	117	69	117	231	-
836	770	729	216	114	66	66	46	46	64	112	64	135	218	-
848	787	737	211	112	69	69	48	48	76	107	64	112	279	-
848	757	706	198	109	48	64	48	46	61	94	56	109	259	-
856	787	742	229	119	76	79	51	51	74	119	71	104	297	2.7
864	815	775	221	114	69	76	48	48	74	114	69	112	290	2.8
864	787	749	211	109	58	71	48	48	69	114	66	114	259	2.3
871	798	747	206	109	64	66	51	51	69	107	58	132	279	2.3
874	780	732	211	109	58	71	46	46	61	117	71	119	231	-
879	787	742	213	117	66	76	51	53	74	64	66	114	262	-
884	813	757	221	117	69	76	48	51	66	119	71	117	310	-
892	828	777	221	117	71	69	53	58	81	109	58	114	262	2.7
894	820	764	224	119	66	74	51	58	81	117	66	117	254	-
902	838	780	221	127	64	81	51	51	69	127	74	127	284	2.7

[1] See Figure 3 for placement of measurements.

Appendix 5. Continued. Measurements[1] (mm) of shovelnose sturgeon captured from the Missouri River in 1992.

Total	Fork	Std	A Head	I Snout	F Mouth width	B Snout to outer	E Mouth to inner	D Inner barbel	C Outer barbel	H Snout to mouth	G Snout to barbs	J Caud ped	Girth	Weight (kg)
922	841	798	234	132	69	81	56	64	86	130	76	124	254	2.4
922	848	798	229	132	69	81	53	53	69	130	76	142	305	-
925	843	798	231	127	58	84	53	53	71	132	81	109	279	2.9
927	836	787	224	117	66	74	51	53	66	119	66	127	264	2.6
940	846	790	216	114	71	69	51	51	76	119	66	122	269	-
940	853	813	229	130	58	79	48	53	76	122	74	135	305	3.3
970	909	848	241	124	74	79	56	51	74	127	76	135	269	-

[1] See Figure 3 for placement of measurements.

Appendix 6. Measurements[1] (mm) of shovelnose sturgeon captured from the Yellowstone in 1992.

Total	Fork	Std	A Head	I Snout	F Mouth width	B Snout to outer	E Mouth to inner	D Inner barbel	C Outer barbel	H Snout to mouth	G Snout to barbs	J Caud ped	Girth	Weight (kg)
406	366	335	104	64	25	36	20	20	28	56	33	74	-	-
538	485	455	127	66	33	46	28	28	36	71	43	86	132	0.3
554	500	460	140	76	43	46	30	28	43	61	43	81	-	-
566	521	483	137	74	36	46	30	30	41	76	46	79	-	-
566	516	475	142	76	33	46	28	30	41	71	43	89	163	0.5
572	513	480	132	76	33	43	28	30	43	76	46	91	-	-
594	546	508	142	79	33	48	33	33	43	76	43	91	-	-
599	544	500	150	86	30	51	33	36	46	79	51	81	152	0.5
617	559	523	140	81	41	51	30	33	48	79	46	102	155	0.6
625	566	523	152	86	41	56	30	33	48	81	51	96	158	0.5
627	584	544	158	89	36	56	36	36	48	86	46	94	-	-
630	569	533	150	79	43	48	33	33	48	76	43	89	-	-
630	589	549	163	81	36	51	36	36	56	79	43	91	-	-
635	566	523	142	79	36	51	30	33	43	79	46	102	-	-
638	582	538	165	89	46	51	38	38	48	86	48	91	170	0.8
640	582	536	165	89	41	58	36	33	48	89	51	96	-	-
643	584	546	155	86	41	58	33	33	43	86	48	96	168	0.6
645	589	556	152	84	41	51	41	38	56	84	43	99	185	0.8
653	602	561	165	81	46	51	36	36	51	79	46	94	201	1.0
658	599	554	163	94	36	56	36	36	51	89	51	91	188	0.8
660	594	554	155	86	43	56	36	30	48	89	51	102	168	0.7
660	594	549	150	81	41	51	33	33	41	79	43	99	180	0.8
663	599	556	160	89	43	58	38	38	53	89	48	109	175	0.8
666	597	559	173	86	43	51	36	33	48	81	46	102	178	0.8
666	604	564	173	91	48	61	43	43	58	91	51	94	-	-
676	620	587	155	91	43	61	43	41	48	89	51	107	180	-
676	625	584	170	96	46	64	41	38	51	91	53	109	221	1.8
676	610	574	168	91	46	58	36	33	48	91	58	109	170	0.7
683	630	594	165	89	46	56	36	36	51	89	51	109	185	0.8
683	627	584	178	102	43	70	43	41	56	104	61	91	188	0.8
696	640	589	168	94	51	58	36	36	56	91	56	109	196	1.0
698	645	584	165	91	46	58	36	36	51	89	56	102	-	-
704	617	579	152	81	36	51	36	41	56	81	46	74	-	-
704	640	599	170	94	46	58	36	46	56	91	51	107	198	1.0
706	638	597	168	86	36	56	43	36	51	94	51	107	193	0.9
706	640	594	173	94	43	64	36	36	61	99	56	102	193	1.1
711	645	594	173	102	33	64	41	36	51	96	58	96	196	1.0
711	627	582	163	86	36	58	36	36	51	89	46	96	-	-
719	653	610	165	91	43	58	36	36	46	89	56	102	-	-
719	640	597	163	91	46	61	36	41	48	91	56	109	-	-
724	650	604	168	96	51	58	43	36	48	86	46	107	196	1.1

[1] See Figure 3 for placement of measurements.

Appendix 6. Continued. Measurements[1] (mm) of shovelnose sturgeon captured from the Yellowstone in 1992.

Total	Fork	Std	A Head	I Snout	F Mouth width	B Snout to outer	E Mouth to inner	D Inner barbel	C Outer barbel	H Snout to mouth	G Snout to barbs	J Caudped	Girth	Weight (kg)
724	660	617	1.68	96	48	61	36	36	51	91	51	96	-	-
729	650	604	1.70	96	43	58	36	33	46	91	56	109	183	0.9
732	666	622	1.85	107	48	66	41	36	51	102	61	107	193	1.0
737	668	625	1.80	102	46	61	36	41	51	91	56	104	211	1.2
742	666	620	1.78	102	51	64	41	41	51	96	51	112	196	1.3
744	673	622	1.70	89	48	56	38	38	58	86	51	102	216	1.4
747	676	627	1.65	89	48	51	41	41	58	86	46	112	208	1.4
749	688	630	1.93	109	46	64	43	43	61	107	61	107	203	1.2
749	701	655	1.90	102	53	61	46	43	56	102	58	114	218	1.5
762	691	678	1.93	104	58	74	46	41	53	107	56	114	224	1.5
764	696	645	1.83	96	46	56	34	34	48	89	51	104	-	-
767	691	640	1.85	107	46	61	43	41	58	94	56	109	213	1.3
782	709	666	1.78	96	51	61	43	43	48	94	56	112	231	1.6
785	732	683	2.03	107	46	64	43	41	56	96	58	109	208	1.5
792	711	671	1.93	107	56	66	43	46	58	102	58	104	229	1.5
810	732	673	2.11	117	46	64	43	48	61	104	61	109	-	-
813	696	648	1.80	112	41	64	41	46	58	104	41	112	226	1.5
828	760	719	1.88	104	56	71	41	43	58	104	61	117	-	-
856	775	719	2.26	132	58	94	46	46	64	112	71	127	239	2.0
861	787	747	2.11	114	58	76	48	30	56	117	64	122	239	2.0
886	823	760	2.18	117	61	66	46	56	71	112	64	112	320	3.2
894	826	767	2.24	124	64	74	51	48	71	119	71	117	305	3.0
907	838	787	2.26	119	58	71	46	51	66	122	61	124	274	2.8
1021	945	889	2.46	142	71	79	51	56	66	132	79	122	310	3.5
1039	947	889	2.56	135	61	79	58	56	74	132	71	124	323	4.2

[1] See Figure 3 for placement of measurements.

Appendix 7. Percent of standard length of morphometric measurements[1] of shovelnose sturgeon captured from the Missouri in 1992.

Total length (mm)	A Head	I Snout	F Mouth width	B Snout to outer	E Mouth to inner	D Inner barbel	C Outer barbel	H Snout to mouth	G Snout to barbs	J Caudal ped	Girth
-	29.6	16.5	6.9	11.3	6.1	5.2	7.3	16.5	10.4	21.7	34.8
-	26.4	15.3	6.9	9.7	5.6	5.6	8.3	13.9	8.3	25.0	31.9
-	26.5	15.2	5.3	9.1	5.3	6.1	8.3	13.6	8.3	22.0	30.3
-	32.7	16.6	7.6	9.1	7.6	7.6	9.1	16.6	9.1	24.2	30.3
-	26.7	14.4	7.8	11.1	6.6	5.6	7.8	14.4	7.8	21.1	31.1
-	25.3	15.5	8.4	9.9	5.7	5.7	8.4	15.5	8.4	24.0	16.9
284	29.0	15.1	6.4	9.7	5.2	5.2	7.5	15.1	8.6	25.8	38.7
361	27.7	16.0	5.9	10.1	5.9	6.7	9.2	15.1	8.4	21.8	29.4
381	27.0	15.1	7.2	8.7	7.2	4.8	7.2	15.1	7.9	19.1	30.2
391	27.3	15.6	7.8	10.2	6.2	5.5	8.6	15.6	9.4	22.7	32.8
444	29.3	17.3	8.0	10.7	6.7	7.3	9.3	16.0	9.3	20.0	35.3
452	28.0	16.7	7.3	9.3	5.3	5.3	8.0	15.3	9.3	22.7	29.3
478	28.8	16.0	7.7	10.2	6.4	6.4	9.0	16.0	9.0	19.9	29.5
483	27.7	13.2	8.2	10.7	6.3	6.3	8.8	15.7	9.4	20.7	29.6
488	29.0	16.7	7.4	11.1	6.8	6.8	9.9	16.7	10.5	20.4	30.3
488	27.8	15.4	8.7	9.9	6.2	6.8	8.7	15.4	8.7	20.4	29.0
498	25.9	15.4	6.8	9.3	6.8	6.8	8.7	14.2	8.7	22.8	29.6
498	27.4	15.8	7.3	9.7	6.1	6.1	7.9	15.2	9.1	20.1	29.3
498	26.8	15.2	7.3	9.7	5.5	5.5	7.3	15.2	9.1	20.1	29.3
500	28.8	16.5	7.1	10.0	6.5	6.5	9.4	15.3	9.4	21.2	31.2
510	27.7	15.7	7.8	9.6	6.0	6.0	7.8	15.1	9.0	19.9	31.9
518	30.6	17.3	9.8	10.4	7.5	6.9	8.1	16.8	9.2	19.7	31.2
526	25.8	14.6	6.7	9.0	6.2	6.7	8.4	14.6	8.4	20.2	29.2
536	27.4	15.4	7.4	10.3	5.7	5.7	7.4	15.4	9.1	20.0	29.7
556	27.7	15.8	6.5	9.2	6.5	6.0	8.7	15.2	8.7	20.6	31.5
559	28.6	17.5	7.4	10.1	6.9	6.9	8.5	15.4	8.5	18.0	37.6
561	26.4	15.1	7.0	9.7	6.5	7.0	9.1	15.1	9.1	19.9	-
564	28.3	14.4	12.8	8.9	7.2	6.7	8.9	15.0	8.3	20.0	29.4
566	28.9	16.0	6.9	10.2	6.9	6.9	9.6	16.0	8.5	19.8	30.5
569	29.5	16.3	7.9	10.5	6.8	6.8	8.4	16.3	9.0	17.9	31.1
569	27.4	14.7	7.4	10.0	6.3	6.8	8.4	15.8	8.4	19.5	29.5
569	28.6	16.1	6.3	9.4	6.8	7.3	9.4	15.6	8.3	18.2	29.2
579	28.6	16.4	6.9	11.1	6.4	6.9	7.9	15.9	9.0	19.6	31.7
579	28.6	15.3	8.4	9.9	6.4	6.4	8.4	14.8	8.4	17.2	31.5
579	29.7	15.6	6.8	9.3	7.8	6.8	9.3	15.6	7.8	16.6	32.2
584	29.4	17.3	7.6	10.2	6.6	6.6	8.6	15.7	9.7	19.3	34.0
587	28.2	15.8	7.9	8.9	5.9	6.4	8.9	14.4	8.4	16.8	35.6
587	28.2	15.8	6.4	9.9	6.4	6.4	8.9	15.3	8.9	20.3	31.7
589	27.6	15.3	7.2	10.7	6.1	6.1	8.2	15.3	8.2	19.4	30.6
589	28.9	16.0	8.2	9.3	6.7	7.2	9.8	15.5	8.8	21.1	-

[1] See Figure 3 for placement of measurements.

Appendix 7. Continued. Percent of standard length of morphometric measurements[1] of shovelnose sturgeon captured from the Missouri in 1992.

Total length (mm)	A Head	I Snout	F Mouth width	B Snout to outer	E Mouth to inner	D Inner barbel	C Outer barbel	H Snout to mouth	G Snout to barbs	J Caudal ped	Girth
589	27.6	15.1	7.0	9.0	7.0	6.5	8.0	15.6	8.0	18.6	-
589	28.3	15.2	8.1	9.6	7.1	6.6	8.6	15.2	8.1	17.7	33.3
589	30.5	16.5	8.5	10.0	7.0	6.5	8.5	16.5	8.5	17.5	35.0
592	29.9	16.5	8.2	9.8	6.2	6.2	9.3	15.0	8.8	16.5	-
594	28.8	15.6	7.1	9.1	6.1	5.5	9.1	14.7	8.1	22.2	33.3
594	30.0	16.8	8.4	11.3	6.9	6.9	8.9	16.8	9.9	15.8	34.5
597	28.6	15.3	7.9	8.4	7.4	7.4	8.4	15.3	8.4	17.2	30.5
599	26.2	15.1	6.4	8.7	6.0	6.0	9.2	13.8	7.8	15.6	32.1
602	28.4	15.7	7.8	8.8	6.9	5.9	8.8	14.7	8.3	18.1	31.9
602	27.8	15.6	7.3	9.3	7.3	6.8	8.3	14.6	7.3	18.1	31.7
602	29.2	17.3	7.4	10.9	6.4	6.4	8.4	16.8	10.4	18.3	31.2
604	28.8	16.5	7.5	9.0	7.1	6.6	9.4	15.1	8.0	17.5	35.4
607	27.5	15.2	7.6	8.5	6.2	6.2	9.0	14.2	7.6	19.0	30.8
607	28.5	15.9	6.3	9.2	6.8	6.8	8.7	14.5	7.7	17.4	30.0
610	29.1	15.5	7.6	9.2	7.3	7.3	9.7	14.6	7.3	18.4	34.0
610	29.1	16.5	6.8	9.2	6.3	6.8	9.2	15.0	8.7	18.4	32.5
612	26.4	14.9	7.0	9.0	6.0	6.5	9.5	14.4	8.5	19.9	32.8
612	30.3	16.8	6.7	10.1	6.7	6.7	9.1	15.9	8.7	17.8	32.2
615	27.3	15.3	7.6	10.0	6.2	6.2	7.6	15.8	8.1	17.2	29.2
615	26.8	15.4	7.5	9.4	6.6	6.6	8.4	15.0	8.4	19.7	33.8
617	28.2	15.5	8.0	8.9	6.6	6.6	8.9	15.0	8.9	18.3	29.6
617	26.7	14.6	7.3	10.7	5.8	6.3	8.7	14.6	8.3	18.9	30.1
620	30.4	15.7	8.3	9.8	6.4	6.4	8.3	15.7	9.3	17.6	-
620	29.7	17.2	7.2	10.5	6.7	6.2	8.1	16.7	10.0	16.3	30.1
622	29.5	15.7	8.1	10.9	7.6	6.7	9.1	16.7	10.0	16.7	33.3
622	28.7	15.0	6.8	9.7	7.3	7.3	9.7	15.5	8.7	18.0	34.0
625	28.7	15.8	7.6	10.0	7.6	7.6	10.0	15.8	9.1	17.2	29.2
627	27.6	15.2	6.5	9.2	6.5	6.5	9.7	14.3	8.3	19.4	33.6
627	28.4	16.3	6.5	10.2	6.5	6.5	8.8	15.8	9.3	19.5	33.9
627	30.4	16.4	10.7	10.3	7.5	6.5	8.9	15.9	8.9	17.8	36.4
630	29.1	14.5	7.5	8.4	6.6	6.6	8.4	14.5	7.5	17.4	28.6
630	31.1	17.5	8.3	10.7	6.3	6.8	9.2	16.5	9.7	16.5	34.0
630	28.2	15.8	7.6	10.0	6.2	6.7	9.1	15.3	9.6	18.2	33.5
630	28.6	14.8	8.1	9.5	6.7	6.7	8.6	15.7	9.5	18.6	36.7
632	29.7	17.5	8.0	9.9	6.6	6.6	9.9	15.6	9.0	17.5	34.0
632	29.4	16.6	8.1	10.4	7.1	6.6	8.1	15.6	9.0	17.5	30.8
635	29.2	16.2	6.5	9.7	6.5	6.9	9.3	15.3	12.0	17.6	36.6
635	30.7	17.0	8.0	10.8	6.6	6.6	8.5	16.0	9.0	17.9	30.2
635	27.7	15.5	7.0	8.9	6.6	6.6	8.4	15.0	8.4	18.8	30.1
635	30.8	16.6	8.1	11.4	6.6	6.2	8.5	16.1	9.0	16.1	-

[1] See Figure 3 for placement of measurements.

Appendix 7. Continued. Percent of standard length of morphometric measurements[1] of shovelnose sturgeon captured from the Missouri in 1992.

Total length (mm)	A Head	I Snout	F Mouth width	B Snout to outer	E Mouth to inner	D Inner barbel	C Outer barbel	H Snout to mouth	G Snout to barbs	J Caudal ped	Girth
635	24.6	13.6	6.1	8.8	6.1	6.6	7.9	14.0	7.9	18.4	29.8
635	25.4	14.5	6.1	9.4	5.6	5.6	8.0	14.1	8.0	19.7	31.5
638	28.7	16.3	8.1	9.6	6.2	6.2	9.1	16.3	9.1	20.1	-
638	28.8	15.8	7.4	10.2	6.5	5.6	7.9	15.8	9.3	17.7	34.4
638	30.6	16.2	9.3	9.7	7.4	6.9	9.7	16.2	9.3	16.2	31.5
640	30.9	15.7	7.8	10.1	6.0	6.5	9.2	11.1	8.8	17.1	30.4
640	28.4	16.1	7.6	9.0	7.6	7.6	9.0	14.7	8.1	20.9	30.8
640	28.0	15.1	6.4	9.6	6.0	6.0	8.7	14.7	8.7	17.0	34.4
643	28.6	15.7	7.8	8.8	6.0	6.0	9.2	14.3	8.8	16.6	32.7
643	22.5	13.5	6.3	8.6	5.9	6.3	8.1	14.0	7.2	18.0	29.7
643	28.4	14.9	7.9	9.3	6.5	6.5	8.8	14.4	8.4	18.1	28.8
645	28.8	15.3	7.7	9.0	6.8	6.8	8.6	15.3	9.0	18.5	33.8
645	26.4	15.3	6.9	9.3	6.0	5.6	7.4	14.8	8.8	18.1	31.5
648	25.9	13.7	7.5	9.0	6.1	6.1	9.0	14.2	8.0	18.9	29.7
648	28.2	15.5	8.6	10.0	6.8	6.4	8.6	15.0	10.0	16.4	35.5
650	29.9	15.9	5.1	10.3	5.6	5.1	7.5	15.0	8.9	17.3	-
653	29.4	16.3	7.7	9.1	6.8	6.3	9.1	15.8	8.1	16.3	32.1
653	27.2	14.7	7.4	9.7	6.5	6.9	9.2	15.7	8.8	18.4	30.4
655	25.7	14.4	7.2	8.1	5.9	6.8	8.6	14.0	8.1	18.9	31.5
655	28.7	15.3	7.6	9.0	6.7	6.7	9.4	14.4	7.6	17.9	33.6
655	26.9	15.1	7.3	10.0	6.4	6.8	8.7	14.6	9.1	16.0	29.7
658	27.7	14.1	9.1	10.5	5.9	6.4	9.5	15.0	9.1	15.9	31.4
658	29.0	17.0	7.6	10.7	6.7	6.7	8.9	16.1	9.4	17.4	33.5
658	28.5	15.8	7.7	9.5	6.8	6.8	9.5	15.8	9.1	17.7	32.1
660	27.9	16.2	8.1	10.4	6.8	6.8	8.6	15.8	9.5	19.4	31.5
660	30.2	17.1	8.1	11.7	6.8	6.8	9.5	16.7	10.4	15.3	31.5
660	27.6	16.9	8.0	9.3	6.2	6.2	8.5	15.1	8.9	16.4	8.9
660	28.0	15.0	7.5	9.3	6.5	7.0	9.8	15.4	8.9	15.9	34.6
663	27.8	14.8	8.1	9.0	6.7	6.7	9.9	14.8	8.5	16.6	33.2
663	29.3	16.2	7.2	9.9	6.8	6.8	9.0	15.8	9.0	14.4	29.3
666	28.3	15.2	7.4	9.6	6.5	6.1	8.7	14.3	8.7	17.0	29.6
666	28.5	14.9	7.9	8.8	5.7	5.7	7.9	14.0	7.9	13.2	-
666	28.9	16.4	8.5	9.8	6.7	6.7	9.3	15.1	8.9	17.3	34.7
666	28.9	15.6	7.6	10.2	6.7	6.7	8.5	15.6	8.9	16.4	32.0
666	27.1	16.1	6.4	8.3	6.4	6.4	8.7	14.2	7.8	20.2	29.4
668	28.8	15.9	7.5	10.6	6.2	6.2	9.3	15.5	9.3	15.5	35.8
668	28.6	15.9	6.6	9.2	6.6	6.6	8.4	15.4	9.2	18.1	33.5
668	28.5	16.2	7.2	9.4	6.8	5.5	8.1	15.3	8.5	16.6	34.5
668	29.2	18.1	7.5	10.6	6.6	5.7	8.0	16.4	9.7	18.6	33.6
671	27.2	16.2	7.0	9.7	6.1	6.6	9.7	14.9	9.2	18.9	29.4
671	28.5	16.2	7.0	9.2	7.0	6.1	8.8	15.4	8.3	19.3	34.7

[1] See Figure 3 for placement of measurements.

Appendix 7. Continued. Percent of standard length of morphometric measurements[1] of shovelnose sturgeon captured from the Missouri in 1992.

Total length (mm)	A Head	I Snout	F Mouth width	B Snout to outer	E Mouth to inner	D Inner barbel	C Outer barbel	H Snout to mouth	G Snout to barbs	J Caudal ped	Girth
671	27.2	14.3	7.1	8.5	7.6	7.1	8.9	16.1	9.8	18.8	-
671	28.2	15.9	7.3	10.0	7.7	7.3	8.6	15.9	8.6	20.9	32.7
673	29.9	16.4	7.8	10.8	6.9	6.5	8.7	16.0	9.1	19.1	33.8
673	29.2	17.3	6.2	11.1	7.1	6.2	8.4	17.3	9.3	16.8	28.3
673	29.5	16.1	8.5	9.8	6.7	6.7	8.5	15.2	8.9	17.4	32.6
673	28.0	15.1	7.8	9.5	6.0	6.0	8.2	14.7	8.2	17.7	-
673	28.0	14.7	8.2	9.5	6.5	6.5	8.6	15.1	8.6	16.4	29.3
676	28.6	16.3	7.0	9.2	6.6	7.0	10.1	15.4	8.8	16.7	37.4
676	27.5	15.8	7.1	9.6	7.1	7.1	9.6	15.0	8.3	17.1	34.2
678	28.9	16.0	7.8	9.0	7.8	7.3	9.5	15.5	8.6	16.8	34.1
681	28.5	16.2	8.1	9.8	6.8	6.8	9.8	14.9	8.5	17.9	33.6
683	29.3	16 0	7.8	9.0	6.9	6.5	9.0	15.5	8.6	18.1	32.8
683	29.0	15 2	7.8	10.0	6.5	6.5	10.0	15.6	9.1	17.3	32.9
683	28.8	15 7	8.5	9.7	6.8	7.2	9.7	15.2	8.5	16.1	33.0
686	28.3	15 2	7.4	8.7	6.9	6.1	8.7	13.9	7.8	16.5	33.9
686	28.7	15.2	8.3	10.0	6.1	6.5	9.6	15.2	9.1	17.4	34.4
686	27.1	14.0	8.3	9.2	7.0	6.5	8.3	15.3	8.7	18.3	36.2
686	29.3	16.0	6.5	9.5	6.9	6.9	9.5	15.5	8.6	18.1	38.8
688	29.7	17.4	7.2	10.2	6.4	6.4	8.9	16.5	10.2	17.0	32.2
688	28.7	16.1	6.9	10.4	6.1	6.1	8.3	16.1	11.7	20.9	33.9
688	28.2	14.5	8.5	9.0	6.0	6.0	8.5	14.5	8.5	17.5	29.9
691	28.4	15.1	7.5	9.6	5.9	5.9	7.5	15.1	8.0	19.2	-
693	27.5	15.2	7.6	9.7	6.8	6.4	8.1	16.5	10.2	15.7	31.8
693	28.4	15.1	8.2	10.4	6.5	6.9	9.9	15.1	8.6	17.2	31.9
693	28.8	16.8	8.0	10.2	6.6	7.1	10.2	15.9	8.9	19.9	34.1
696	26.5	14.1	7.0	8.7	6.2	6.6	8.3	13.6	7.0	17.8	29.3
696	29.1	16.1	8.3	9.6	7.8	6.9	8.7	16.1	8.7	17.4	30.4
696	29.5	17.3	8.0	10.1	6.3	6.3	8.9	16.5	9.7	16.9	35.4
696	29.3	16.5	8.7	10.3	6.6	6.6	8.7	15.7	9.5	17.8	33.1
698	27.6	15.1	7.8	10.4	6.5	6.9	10.8	15.5	9.0	17.7	32.3
698	27.1	15.0	5.8	9.2	6.7	6.7	9.2	14.6	7.9	17.1	-
701	28.9	16.2	8.1	10.6	7.2	7.2	8.5	15.7	9.4	18.7	31.5
701	28.2	15.4	7.3	10.7	6.4	6.0	9.0	16.2	9.8	17.5	32.5
701	28.7	16.0	6.7	9.7	6.3	5.9	8.0	15.2	8.9	17.3	31.2
701	27.6	14.5	8.4	9.6	6.7	7.1	10.5	14.6	8.4	15.5	29.3
704	28.8	16.3	8.2	10.3	6.4	6.4	9.9	16.7	9.9	15.9	33.1
706	28.0	15.1	7.3	10.4	6.5	6.5	8.6	15.5	9.0	19.4	32.3
706	28.4	15.5	8.8	10.0	7.1	5.9	9.2	15.9	9.2	17.6	37.7
709	28.6	15.4	7.7	9.4	6.4	6.0	8.5	15.0	8.5	16.7	32.0
709	28.2	17.1	7.3	10.3	6.4	6.4	8.5	15.8	9.4	16.7	32.5
709	28.4	15.1	7.1	8.8	6.3	6.3	8.8	14.6	8.4	17.6	33.5

[1] See Figure 3 for placement of measurements.

Appendix 7. Continued. Percent of standard length of morphometric measurements[1] of shovelnose sturgeon captured from the Missouri in 1992.

Total length (mm)	A Head	I Snout	F Mouth width	B Snout to outer	E Mouth to inner	D Inner barbel	C Outer barbel	H Snout to mouth	G Snout to barbs	J Caudal ped	Girth
709	27.7	13.9	8.4	8.8	6.3	6.3	8.4	14.3	8.0	16.8	31.5
711	28.3	15.2	6.6	9.0	6.1	6.1	8.2	15.2	8.2	17.2	27.9
711	28.1	15.0	7.7	8.9	6.9	6.5	9.3	15.0	8.1	17.9	31.3
714	26.9	14.3	6.7	9.2	5.9	5.9	8.0	14.3	8.0	18.5	-
714	27.9	15.4	8.1	9.3	6.9	6.9	8.5	14.6	8.5	17.0	36.0
714	27.7	15.3	7.0	9.1	6.2	5.8	7.4	14.5	8.3	18.2	37.6
716	26.1	13.7	7.7	8.5	6.4	6.0	8.1	14.5	8.5	16.7	29.9
716	26.7	16.5	7.8	10.7	6.6	6.6	9.1	15.6	9.1	16.5	35.0
716	29.0	15.5	7.3	9.8	6.9	6.5	7.8	15.5	9.4	17.5	-
716	27.6	15.2	7.0	9.1	6.2	5.8	8.6	14.8	8.6	19.3	33.3
719	28.6	16.2	7.1	10.4	6.2	6.6	8.7	16.6	10.0	15.8	29.5
721	28.9	15.0	8.9	9.3	7.3	7.3	9.8	15.0	8.5	15.4	36.6
721	27.0	14.9	7.5	9.5	6.2	6.2	8.3	14.5	8.3	16.2	32.4
726	28.4	15.6	6.8	10.0	6.4	6.4	8.4	15.2	8.8	16.8	28.8
726	28.5	16.5	7.4	9.9	6.2	5.8	7.9	15.7	9.5	19.4	32.7
726	30.3	16.8	8.2	10.6	6.6	6.6	9.8	17.2	10.2	15.6	32.0
726	27.5	15.0	8.3	9.6	6.7	6.7	9.2	15.4	9.2	17.9	33.3
734	27.1	14.6	8.1	8.9	6.5	6.5	8.1	14.6	8.1	17.0	30.4
734	28.5	14.9	9.1	9.9	6.2	7.0	9.5	16.1	9.9	16.5	34.7
734	24.5	13.1	6.9	8.2	6.1	6.1	8.2	13.4	7.8	18.0	29.0
734	29.0	15.5	9.1	9.9	7.1	6.7	7.9	15.5	8.7	17.1	32.9
737	28.3	15.7	7.1	9.1	7.1	6.7	9.1	15.0	8.3	16.9	32.7
737	29.3	16.9	7.6	10.0	6.4	6.4	8.4	16.1	10.0	16.9	32.5
737	29.6	15.4	8.1	9.7	6.9	7.3	9.3	15.4	8.9	17.4	-
737	26.3	13.9	8.0	9.2	5.6	5.6	8.4	13.9	8.0	17.1	34.7
737	27.7	14.9	8.0	9.6	6.8	6.0	8.4	15.3	8.8	16.9	30.1
739	29.6	16.9	7.4	10.3	7.0	7.0	9.9	16.5	9.9	18.9	31.7
744	27.6	15.0	7.9	8.7	6.7	6.3	8.7	14.6	8.3	16.9	33.5
749	28.7	15.9	7.4	9.7	7.4	7.0	8.9	16.7	9.7	15.5	32.9
749	27.4	14.3	7.7	9.3	6.6	6.6	8.9	15.1	8.5	17.4	34.7
752	28.9	17.2	8.2	10.6	7.0	6.6	8.6	16.8	9.4	16.8	31.3
752	28.3	16.9	7.1	10.6	7.1	6.7	8.7	16.1	9.5	18.9	32.3
752	28.5	16.2	7.9	9.9	7.1	7.1	9.9	15.4	8.7	16.6	33.2
752	28.7	15.1	8.3	9.8	7.5	7.5	9.4	15.9	8.7	15.9	33.2
754	27.8	14.7	8.3	9.9	6.7	6.7	9.5	15.5	8.3	16.3	32.1
754	26.7	14.1	7.8	9.0	6.7	6.7	9.4	14.5	7.8	17.6	32.9
760	29.3	15.6	7.6	9.1	6.8	7.2	9.9	16.0	8.7	16.3	34.2
762	27.5	13.7	9.0	8.2	7.1	7.1	9.4	14.5	7.8	15.7	32.9
762	28.5	15.4	8.1	9.6	6.9	6.5	8.5	15.4	8.5	15.4	31.1
767	27.0	14.1	7.8	9.8	6.6	6.2	8.2	14.8	8.6	16.4	32.4
767	27.5	14.3	8.0	9.6	6.8	7.2	10.0	15.5	9.2	16.3	35.9
767	28.3	14.7	8.5	9.3	6.6	6.2	8.9	13.9	7.8	18.6	-

[1] See Figure 3 for placement of measurements.

Appendix 7. Continued. Percent of standard length of morphometric measurements[1] of shovelnose sturgeon captured from the Missouri in 1992.

Total length (mm)	A Head	I Snout	F Mouth width	B Snout to outer	E Mouth to inner	D Inner barbel	C Outer barbel	H Snout to mouth	G Snout to barbs	J Caudal ped	Girth
770	27.7	15.6	9.0	9.8	6.6	6.2	7.8	15.2	8.6	15.6	32.0
770	27.8	14.1	8.6	9.8	6.3	7.1	8.6	15.3	8.6	16.9	35.3
770	27.8	14.3	8.9	8.9	7.3	6.9	9.7	15.4	8.5	17.0	33.2
772	29.0	16.5	7.7	9.6	6.3	6.6	8.1	15.4	9.2	17.6	32.7
772	30.0	16.5	8.5	10.4	6.9	6.5	9.2	16.5	9.6	16.5	35.8
775	28.3	15.1	7.8	9.7	7.0	7.0	9.7	15.5	8.9	17.4	29.1
775	28.7	17.0	7.5	11.3	6.4	6.8	9.4	17.0	10.2	15.9	32.1
777	28.1	16.5	6.5	10.0	6.9	7.3	10.0	15.8	9.2	18.5	33.8
780	28.8	15.5	8.3	9.8	7.2	7.2	8.7	15.9	9.5	15.2	33.3
780	29.2	16.2	8.5	10.4	5.8	6.1	8.1	15.0	9.2	16.5	38.1
780	28.0	15.9	7.6	10.2	6.4	6.8	9.1	15.5	9.1	18.6	32.6
782	28.8	15.4	8.8	9.6	6.1	6.1	9.2	15.4	9.6	16.2	34.6
782	26.9	14.4	7.2	9.5	6.1	6.4	8.7	15.2	9.1	16.7	-
785	29.0	17.1	7.8	10.8	7.1	5.2	9.3	16.7	10.4	15.6	35.3
787	27.0	15.6	7.6	9.1	6.1	6.1	8.7	14.1	8.4	17.9	31.6
795	28.4	16.2	7.7	9.6	6.6	6.6	9.2	16.2	9.2	17.7	31.4
800	29.0	15.4	8.1	9.9	7.4	7.4	9.2	16.2	9.2	16.2	36.8
800	28.9	15.7	8.5	10.4	6.3	6.7	9.3	16.3	10.0	17.0	37.8
800	29.1	15.7	9.0	10.1	7.1	7.5	9.7	16.0	9.0	16.0	31.0
800	29.9	15.8	9.0	10.8	7.1	7.1	9.3	16.8	9.7	15.7	31.4
810	29.2	15.9	9.4	9.4	7.2	7.2	9.7	15.2	8.3	18.1	31.8
810	27.0	14.5	8.5	9.3	6.3	6.3	9.6	14.1	7.8	16.7	35.2
813	29.1	14.5	8.0	9.4	6.9	6.9	9.1	15.6	9.1	16.4	32.7
818	28.6	15.6	7.8	9.2	7.1	7.4	9.2	15.2	8.1	14.8	35.3
820	28.8	15.1	8.3	10.1	6.5	5.7	8.3	15.1	9.0	15.8	-
823	27.9	15.0	6.8	8.9	6.4	6.4	10.0	15.0	8.6	19.3	30.7
831	28.8	16.5	8.4	9.8	7.4	7.7	10.2	15.4	8.8	16.8	35.8
831	29.2	15.6	8.3	9.0	6.9	6.9	9.4	15.6	8.7	15.6	33.0
833	29.3	16.0	8.7	9.1	6.6	6.3	8.0	15.3	9.1	18.1	-
836	28.2	16.2	7.4	10.2	6.7	6.3	8.8	16.2	9.5	16.2	32.0
836	29.6	15.7	9.1	9.1	6.3	6.3	8.7	15.3	8.7	18.5	30.0
848	28.6	15.2	9.3	9.3	6.6	6.6	10.3	14.5	8.6	15.2	37.9
848	28.1	15.5	6.8	9.0	6.8	6.5	8.6	13.3	7.9	15.5	36.7
856	30.8	16.1	10.3	10.6	6.8	6.8	9.9	16.1	9.6	14.0	40.1
864	28.5	14.8	8.9	9.8	6.2	6.2	9.5	14.8	8.9	14.4	37.4
864	28.1	14.6	7.8	9.5	6.4	6.4	9.2	15.3	8.8	15.3	34.6
871	27.5	14.6	8.5	8.8	6.8	6.8	9.2	14.3	7.8	17.7	37.4
874	28.8	14.9	8.0	9.7	6.2	6.2	8.3	16.0	9.7	16.3	31.6
879	28.8	15.7	8.9	10.3	6.8	7.2	9.9	8.6	8.9	15.4	35.3
884	29.2	15.4	9.1	10.1	6.4	6.7	8.7	15.8	9.4	15.4	40.9
892	28.4	15.0	9.1	8.8	6.9	7.5	10.5	14.1	7.5	14.7	33.7
894	29.2	15.6	8.6	9.6	6.6	7.6	10.6	15.3	8.6	15.3	33.2
902	28.3	16.3	8.1	10.4	6.5	6.5	8.8	16.3	9.5	16.3	36.5

[1] See Figure 3 for placement of measurements.

Appendix 7. Continued. Percent of standard length of morphometric measurements[1] of shovelnose sturgeon captured from the Missouri in 1992.

Total length (mm)	A Head	I Snout	F Mouth width	B Snout to outer	E Mouth to inner	D Inner barbel	C Outer barbel	H Snout to mouth	G Snout to barbs	J Caudal ped	Girth
922	29.3	16.6	8.6	10.2	7.0	8.0	10.8	16.2	9.6	15.6	31.8
922	28.7	16.6	8.6	10.2	6.7	6.7	8.6	16.2	9.6	17.8	38.2
925	29.0	15.9	7.3	10.5	6.7	6.7	8.9	16.6	10.2	13.7	35.0
927	28.4	14.8	8.4	9.4	6.5	6.8	8.4	15.2	8.4	16.1	33.6
940	27.3	14.5	9.0	8.7	6.4	6.4	9.6	15.1	8.4	15.4	34.1
940	28.1	15.9	7.2	9.7	5.9	6.6	9.4	15.0	9.1	16.6	37.5
970	28.4	14.7	8.7	9.3	6.6	6.0	8.7	15.0	9.0	15.9	31.7

[1] See Figure 3 for placement of measurements.

Appendix 8. Percent of standard length of morphometric measurements[1] of shovelnose sturgeon captured on the Yellowstone in 1992.

Total length (mm)	A Head	I Snout	F Mouth width	B Snout to outer	E Mouth to inner	D Inner barbel	C Outer barbel	H Snout to mouth	G Snout to barbs	J Caudal ped	girth
406	31.0	18.9	7.6	10.6	6.1	6.1	8.3	16.7	9.8	22.0	-
538	27.9	14.5	7.3	10.1	6.1	6.1	7.8	15.6	9.5	19.0	29.1
554	30.4	16.6	9.4	9.9	6.6	6.1	9.4	13.3	9.4	17.7	-
566	28.4	15.3	7.4	9.5	6.3	6.3	8.4	15.8	9.5	16.3	-
566	29.9	16.0	6.9	9.6	5.9	6.4	8.5	15.0	9.1	18.7	34.2
572	27.5	15.9	6.9	9.0	5.8	6.4	9.0	15.9	9.5	19.0	-
594	28.0	15.5	6.5	9.5	6.5	6.5	8.5	15.0	8.5	18.0	-
599	30.0	17.3	6.1	10.2	6.6	7.1	9.1	15.7	10.2	16.2	30.5
617	26.7	15.5	7.8	9.7	5.8	6.3	9.2	15.0	8.7	19.4	29.6
625	29.1	16.5	7.8	10.7	5.8	6.3	9.2	15.5	9.7	18.4	30.1
627	29.0	16.4	6.5	10.3	6.5	6.5	8.9	15.9	8.4	17.3	-
630	28.1	14.8	8.1	9.1	6.2	6.2	9.1	14.3	8.1	16.7	-
630	29.6	14.8	6.5	9.3	6.5	6.5	10.2	14.3	7.9	16.7	-
635	27.2	15.0	6.8	9.7	5.8	6.3	8.3	15.0	8.7	19.4	-
638	30.7	16.5	8.5	9.4	7.1	7.1	9.0	16.0	9.0	17.0	31.6
640	30.8	16.6	7.6	10.9	6.6	6.2	9.0	16.6	9.5	18.0	-
643	28.4	15.8	7.4	10.7	6.0	6.0	7.9	15.8	8.8	17.7	30.7
645	27.4	15.1	7.3	9.1	7.3	6.8	10.0	15.1	7.8	17.8	33.3
653	29.4	14.5	8.1	9.1	6.3	6.3	9.1	14.0	8.1	16.7	35.8
658	29.4	17.0	6.4	10.1	6.4	6.4	9.2	16.1	9.2	16.5	34.0
660	28.0	15.6	7.8	10.1	6.4	5.5	8.7	16.1	9.2	18.3	30.3
660	27.3	14.8	7.4	9.3	6.0	6.0	7.4	14.3	7.9	18.1	32.9
663	28.8	16.0	7.8	10.5	6.8	6.8	9.6	16.0	8.7	19.6	31.5
666	30.9	15.5	7.7	9.1	6.4	5.9	8.6	14.5	8.2	18.2	31.8
666	30.6	16.2	8.6	10.8	7.7	7.7	10.4	16.2	9.0	16.7	-
676	26.4	15.6	7.4	10.4	7.4	6.9	8.2	15.2	8.7	18.2	30.7
676	29.1	16.5	7.8	10.9	6.9	6.5	8.7	15.6	9.1	18.7	37.8
676	29.2	15.9	8.0	10.2	6.2	5.7	8.4	15.9	10.2	19.0	29.7
683	27.8	15.0	7.7	9.4	6.0	6.0	8.5	15.0	8.5	18.4	31.2
683	30.4	17.4	7.4	12.0	7.4	6.9	9.6	17.8	10.4	15.6	32.2
696	28.4	16.0	8.6	9.9	6.0	6.0	9.5	15.5	9.5	18.5	33.2
698	28.3	15.6	7.8	10.0	6.1	6.1	8.7	15.2	9.6	17.4	-
704	26.3	14.0	6.1	8.8	6.1	7.0	9.7	14.0	7.9	12.7	-
704	28.4	15.7	7.6	9.7	5.9	7.6	9.3	15.2	8.5	17.8	33.0
706	28.1	14.5	6.0	9.4	7.2	6.0	8.5	15.7	8.5	17.9	32.3
706	29.1	15.8	7.3	10.7	6.0	6.0	10.3	16.7	9.4	17.1	32.5
711	29.1	17.1	5.6	10.7	6.8	6.0	8.5	16.2	9.8	16.2	32.9
711	28.0	14.9	6.1	10.0	6.1	6.1	8.7	15.3	7.9	16.6	-
719	27.1	15.0	7.1	9.6	5.8	5.8	7.5	14.6	9.2	16.7	-
719	27.2	15.3	7.7	10.2	6.0	6.8	8.1	15.3	9.4	18.3	-
724	27.7	15.0	8.4	9.7	7.1	5.9	8.0	14.3	7.6	17.7	32.4

[1] See Figure 3 for placement of measurements.

Appendix 8. Continued. Percent of standard length of morphometric measurements[1] of shovelnose sturgeon captured on the Yellowstone in 1992.

Total length (mm)	A Head	I Snout	F Mouth width	B Snout to outer	E Mouth to inner	D Inner barbel	C Outer barbel	H Snout to mouth	G Snout to barbs	J Caudal ped	Girth
724	27.2	15.6	7.8	9.9	5.8	5.8	8.2	14.8	8.2	15.6	-
729	28.2	16.0	7.1	9.7	5.9	5.5	7.6	15.1	9.2	18.1	30.3
732	29.8	17.1	7.8	10.6	6.5	5.7	8.2	16.3	9.8	17.1	31.0
737	28.9	16.3	7.3	9.8	5.7	6.5	8.1	14.6	8.9	16.7	33.7
742	28.7	16.4	8.2	10.2	6.6	6.6	8.2	15.6	8.2	18.0	31.6
744	27.4	14.3	7.8	9.0	6.1	6.1	9.4	13.9	8.2	16.3	34.7
747	26.3	14.2	7.7	8.1	6.5	6.5	9.3	13.8	7.3	17.8	33.2
749	30.6	17.3	7.3	10.1	6.9	6.9	9.7	16.9	9.7	16.9	32.3
749	29.1	15.5	8.1	9.3	7.0	6.6	8.5	15.5	8.9	17.4	33.3
762	28.5	15.3	8.6	10.9	6.7	6.0	7.9	15.7	8.2	16.9	33.0
764	28.3	15.0	7.1	8.7	5.2	5.2	7.5	13.8	7.9	16.1	-
767	29.0	16.7	7.1	9.5	6.7	6.3	9.1	14.7	8.7	17.1	33.3
782	26.7	14.5	7.6	9.2	6.5	6.5	7.3	14.1	8.4	16.8	34.7
785	29.7	15.6	6.7	9.3	6.3	5.9	8.2	14.1	8.5	16.0	30.5
792	28.8	15.9	8.3	9.8	6.4	6.8	8.7	15.2	8.7	15.5	34.1
810	31.3	17.4	6.8	9.4	6.4	7.2	9.1	15.5	9.1	16.2	-
813	27.8	17.3	6.3	9.8	6.3	7.1	9.0	16.1	6.3	17.3	34.9
828	26.2	14.5	7.8	9.9	5.6	6.0	8.1	14.5	8.5	16.2	-
856	31.5	18.4	8.1	13.1	6.4	6.4	8.8	15.6	9.9	17.7	33.2
861	28.2	15.3	7.8	10.2	6.5	4.1	7.5	15.6	8.5	16.3	32.0
886	28.8	15.4	8.0	8.7	6.0	7.4	9.4	14.7	8.4	14.7	42.1
894	29.1	16.2	8.3	9.6	6.6	6.3	9.3	15.6	9.3	15.2	39.7
907	28.7	15.2	7.4	9.0	5.8	6.5	8.4	15.5	7.7	15.8	34.8
1021	27.7	16.0	8.0	8.9	5.7	6.3	7.4	14.9	8.9	13.7	34.9
1039	28.9	15.1	6.9	8.9	6.6	6.3	8.3	14.9	8.0	14.0	36.3

[1] See Figure 3 for placement of measurements.

Appendix 9. Percent of standard length of morphometric measurements[1] of pallid sturgeon captured in 1992.

Total length (mm)	PIT tag # (7F7)	A Head	I Snout	F Mouth width	B Snout to outer	E Mouth to inner	D Inner barbel	C Outer barbel	H Snout to mouth	G Snout to barbs	J Caudal ped	Girth
1143	F064F27	30.2	17.3	8.0	13.2	4.3	2.7	8.2	16.2	12.0	18.0	39.5
1191	B025248	32.9	17.1	10.4	13.5	5.0	3.8	10.2	17.3	11.8	14.9	41.5
1331	B015378	32.3	16.7	9.2	15.0	4.6	4.0	10.8	17.3	12.7	14.6	40.6
1349	F065A4D	34.4	19.5	9.5	15.6	4.5	4.3	11.5	18.4	14.1	14.7	39.2
1384	B082208	31.6	18.6	9.2	15.4	4.5	3.7	9.8	18.0	13.9	14.3	36.3
1392	D4A7758	32.1	16.9	9.9	13.9	5.0	4.0	10.1	16.7	12.3	14.5	39.1
1410	-	31.0	16.5	9.0	13.8	3.9	3.7	9.2	16.1	12.2	14.9	40.1
1422	D3E6D23	31.9	17.4	8.9	14.5	4.2	3.4	8.3	16.8	13.1	15.0	38.6
1428	D441A7C	32.7	18.6	9.7	15.2	4.8	3.4	8.3	18.4	13.9	14.7	42.6
1430	E6B3364	32.6	18.0	9.6	15.0	5.6	3.8	8.8	18.0	13.6	15.4	43.4
1435	F06627E	33.3	17.9	9.8	14.7	3.6	4.2	9.8	17.1	13.1	15.5	40.4
1448	F066502	32.9	18.3	9.2	15.3	4.2	4.0	10.8	17.5	13.5	17.3	36.7
1453	F065014	32.0	17.3	9.7	14.6	4.1	2.9	9.7	17.5	13.6	13.0	45.1
1466	F056372	33.3	17.9	9.4	14.9	4.8	3.4	10.0	17.5	13.1	15.3	38.2
1471	F06685C	31.9	16.7	9.9	14.3	4.2	3.4	8.9	16.5	12.7	14.3	41.8
1483	D3C5708	32.1	17.1	10.4	14.4	4.4	3.3	10.2	17.3	12.9	13.3	43.7
1504	B035740	32.5	18.5	9.2	15.5	4.5	3.4	9.7	17.9	13.8	14.0	42.1
1519	B024F2D	31.7	17.5	9.2	14.2	4.0	3.4	9.1	16.8	12.8	14.9	36.4
1519	F054D0D	33.2	20.1	10.2	16.0	4.8	3.5	9.7	18.7	14.3	16.4	41.9
1529	B024922	33.8	19.3	9.5	16.0	4.8	3.4	10.5	19.1	14.3	14.3	41.2
1529	B026102	32.3	17.7	9.8	14.7	4.3	3.8	10.2	17.3	13.2	13.7	42.9
1554	F06672B	32.6	17.2	9.5	14.2	4.7	4.3	11.6	16.9	12.4	12.9	44.8
1562	B023408	33.3	18.3	9.6	15.0	4.4	3.3	10.0	17.8	13.5	13.9	37.0
1565	F056360	31.6	18.4	9.4	14.5	4.8	2.9	10.5	17.5	13.4	15.1	43.6
1585	B020D71	32.2	18.1	8.8	15.2	4.4	3.0	9.9	18.1	13.6	12.7	41.9
1590	F055C21	31.0	16.5	8.5	14.0	4.4	3.5	9.6	16.8	12.6	13.1	40.7
1593	B023253	31.5	17.1	9.0	14.2	4.9	2.9	7.6	17.1	13.0	13.5	40.5
1615	F06697C	33.0	18.4	9.4	15.9	4.7	4.1	11.2	18.5	14.0	15.0	41.4
1631	F065AE4	33.0	18.6	9.3	14.4	4.1	4.0	7.6	17.2	13.4	12.4	41.2
1646	F054773	31.8	17.2	9.5	13.9	4.3	3.4	9.8	16.7	12.7	12.9	44.0
1676	F065A3D	31.5	16.5	9.7	13.6	4.6	3.8	10.3	16.3	11.9	13.7	46.3
1692	E427F69	30.0	14.7	9.7	11.9	4.5	4.3	9.7	15.0	10.7	13.4	41.4
1702	F065E12	31.4	17.2	8.9	15.0	5.0	3.6	10.4	17.4	13.2	13.1	45.6

[1] See Figure 3 for placement of measurements.

Appendix 10. Morphometric ratios[1] described by Bailey and Cross (1954) for pallid sturgeon caught in 1992.

Total length (mm)	PIT tag # (7F7)	Ratio 1	Ratio 2	Ratio 3	Ratio 4	Ratio 5	Ratio 6
1143	F064F27	3.12	1.88	7.11	4.82	3.00	11.01
1191	B025248	2.72	2.10	6.62	3.57	2.69	8.70
1331	B015378	3.27	2.00	7.04	3.79	2.73	8.15
1349	F065A4D	3.43	2.10	7.58	3.60	2.65	7.95
1384	B082208	3.41	2.04	7.00	4.17	2.67	8.56
1392	D4A7758	2.80	2.00	6.48	3.50	2.55	8.10
1410	-	3.58	2.31	7.99	3.78	2.50	8.45
1422	D3E6D23	3.48	2.14	7.67	4.29	2.47	9.47
1428	D441A7C	3.21	2.04	6.87	4.53	2.47	9.70
1430	E6B3364	2.68	1.71	5.82	3.94	2.31	8.57
1435	F06627E	4.11	2.72	9.28	3.53	2.34	7.96
1448	F066502	3.62	2.19	7.82	3.80	2.70	8.20
1453	F065014	3.57	2.38	7.86	5.00	3.33	11.00
1466	F056372	3.12	1.96	6.95	4.41	2.94	9.82
1471	F06685C	3.41	2.36	7.63	4.17	2.61	9.34
1483	D3C5708	3.26	2.35	7.26	4.41	3.12	9.82
1504	B035740	3.46	2.04	7.25	4.61	2.89	9.67
1519	B024F2D	3.57	2.34	8.01	4.17	2.67	9.34
1519	F054D0D	3.32	2.12	6.88	4.61	2.78	9.56
1529	B024922	3.36	2.00	7.08	4.67	3.06	9.84
1529	B026102	3.39	2.26	7.48	3.90	2.70	8.60
1554	F06672B	3.04	2.04	6.96	3.30	2.70	7.57
1562	B023408	3.37	2.17	7.50	4.50	3.00	10.00
1565	F056360	3.04	1.96	6.62	4.94	3.57	10.76
1585	B020D71	3.44	2.00	7.28	5.06	3.29	10.70
1590	F055C21	3.16	1.92	7.00	3.95	2.70	8.75
1593	B023253	2.93	1.85	6.48	4.94	2.63	10.95
1615	F06697C	3.40	2.00	7.04	3.86	2.73	8.00
1631	F065AE4	3.50	2.25	8.00	3.65	1.91	8.35
1646	F054773	3.24	2.20	7.40	4.05	2.85	9.25
1676	F065A3D	2.96	2.12	6.88	3.53	2.67	8.20
1692	E427F69	2.66	2.15	6.70	2.76	2.24	6.96
1702	F065E12	3.03	1.80	6.33	4.13	2.86	8.63

[1] Ratios: 1 = snout to outer barbel:mouth to inner barbel, 2 = mouth width:mouth to inner barbel, 3 = head length:mouth to inner barbel, 4 = snout to outer barbel:inner barbel, 5 = outer barbel:inner barbel, 6 = head length:inner barbel.