May 12, 2005

Pallid Sturgeon Spawning and Stocking Summary Report

1992 - 2004

Authors:
Steven Krentz, Missouri River FWMAO, Bismarck, ND
Rob Holm, Garrison Dam NFH, Riverdale, ND
Herb Bollig, Gavins Point NFH, Yankton, SD
Jan Dean, Natchitoches NFH, Natchitoches, LA
Mike Rhodes, Miles City SFH, Miles City, MT
Dave Hendrix, Neosho NFH, Neosho, MO
Gary Heidrich, Blind Pony SFH, Sweet Springs, MO
Bill Krise, Bozeman FTC, Bozeman, MT

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

Introduction

Stocking and augmentation was recognized early in the pallid sturgeon recovery program as a potentially valuable tool for restoring populations and providing fish to increase our understanding of this unique species through research. Due to the low wild population numbers of the pallid sturgeon, one of the first steps was to develop propagation techniques that would work effectively on this endangered species. Shovelnose sturgeon were identified as a potential surrogate for developing culture methods due to the similar physiology and internal organ structure. Due to the limited information available on even the abundant shovelnose sturgeon, information from other sturgeon species was also gathered to decrease the learning curve.

Missouri Department of Conservation staff were the first to successfully spawn pallid sturgeon in 1992 at the Blind Pony State Fish Hatchery facility. This success was primarily based on their extensive previous experience with lake sturgeon and paddlefish spawning. This event was initially perceived as a major step forward; however, discussions related to the lack of genetic information on the purity of the broodstock used for spawning, resulted in postponing stocking until 1994.

Since that first spawning, considerable progress has been made in the understanding of spawning needs and increasing the success of propagation efforts. However, this progress hasn't come easily. This report is meant to summarize some of those activities for those who haven't been intimately involved.

This report is the first attempt to quantify and summarize the stocking efforts as of October 1, 2004. All attempts were made to insure the data was as up to date as possible. However, during the analysis and process of assembling this information, minor discrepancies in the data have been found and are being updated and corrected. These corrections will be incorporated into subsequent reports and some totals may change slightly. These summaries will be modified as this report is further reviewed and additional data is brought forth.

Spawning Activities

1992

Blind Pony State Fish Hatchery

On April 23, 1992, two pallid sturgeon females, a suspected pallid/shovelnose hybrid female and four male pallids were successfully spawned. This resulted in approximately 91,000 pallid sturgeon eggs and 27,000 hybrid eggs. Four days later, an estimated 50 percent hatch was observed. On April 30, hatch success was estimated at 36 percent for an estimated number of 32,400 pallid sturgeon fry.

1995

Miles City State Fish Hatchery

Two females (1F477B7E21 & 1F497F180) and two males (7F7F06697C & 1F4A312640) were captured in the Yellowstone River and Confluence area and transported to Miles City SFH. These fish were staged and a determination was made, based on the previous work on white sturgeon, to hold off spawning at least 3 weeks. The females were checked 1 week later and subsequently found to have over-matured. Additional attempts were made to capture females, however, higher flows and spawn initiation prevented the capture of substitute females. All fish were returned to the river.

During attempts to capture additional females, several males were captured in the Yellowstone River near rivermile 9. Three of these fish (1F49517057, 7F7B024922, 1F49516C5B) had viable sperm extracted, which was sent to Bozeman for further testing and cryopreservation. Additional information is available in: “Pallid Sturgeon & Shovelnose Sturgeon Activities Conducted For Propagation at Miles City State Fish Hatchery, 1995," Missouri River Fish and Wildlife Management Assistance Office, U.S. Fish and Wildlife Service, Bismarck, North Dakota, 1996.

1996

Garrison Dam National Fish Hatchery

The primary objective for 1996 was to capture and mate two pallid sturgeon males and two females using a 2 x 2 breeding matrix. Sampling for adult broodstock was conducted on the following dates: April 27 - May 2, May 13-15, May 23-24 and May 29-30. No females were captured during this effort. Additional information is available in: "Pallid Sturgeon & Shovelnose Sturgeon Activities Conducted For Propagation at Garrison Dam NFH, 1996," Dryer, King, Krentz, 1996.

1997

Gavins Point National Fish Hatchery

Utilizing broodstock collected in the fall, 1996, from the Missouri and Yellowstone River Confluence area and transported to Gavins Point NFH, the first successful spawning of wild pallid sturgeon occurred in 1997 for the upper portion of the range. Both females were spawned on June 17 and 18 at approximately 64° F. A total of nearly 300,000 green eggs were produced from the two females, with an 80 percent eye-up and a hatch rate of nearly 45 percent. For additional information, please see report "Fiscal Year 1997 Sturgeon Activities and Accomplishments," Herb Bollig, Gavins Point National Fish Hatchery, 1997.

Garrison Dam National Fish Hatchery

Broodstock were captured in the spring of 1997 as a backup to the main spawning attempt at Gavins Point NFH and transported to Garrison Dam NFH for spawning. A total of one female and three males were captured, staged and spawned. Initial hormone dosages were administered on May 27, 1997. Although 65,500 eggs were collected and fertilized, a power failure during incubation resulted in the rapid cooling of the incoming water on the eggs, subsequently, no hatch resulted. For additional details, please see report "Pallid Sturgeon Propagation - 1997, Garrison Dam NFH," Rob Holm, 1997.

Blind Pony State Fish Hatchery

On May 2, 1997, two female pallid sturgeon were successfully spawned with anticipation of stocking approximately 3,000 into the Missouri and Mississippi Rivers.

On May 2, 1997, the Missouri Department of Conservation successfully spawned two of three captured females (7751, 7752, 7753). Phone correspondence with Jerry Hamilton described the procedure. On April 29, broodstock were received from a commercial fisherman at

Caruthersville, MO, and held in brood tanks at the hatchery. Water temperature in the brood tanks was gradually warmed from 55° to 60° F. At 6:00 a.m. on May 1, the fish were given a warm-up dose of hormone, the resolving dose was given at 6:00 p.m. No biopsy was performed on any of the fish. At 10:00 the following morning, ovulation checks began. The first eggs were noticed at 3:00 p.m., 21 hours after hormone injection, on two of the three fish. Milt taken from the males at 10:00 a.m. was poor. By 3:00, the motility was good. The milt was stored in bags on ice and mixed periodically (the milt was viable for 4 days, but motility had diminished). The pallids were hand stripped at regular intervals through the day. Two of three females ovulated. A total of 61,250 eggs were collected in three lots. The eggs had a 42 percent survival and produced 25,922 fry.

The fry were fed zooplankton and brine shrimp initially. They were switched to frozen adult brine shrimp until stocking. A total of 3,190 lbs of frozen shrimp was fed out for a cost of $8,300.

1998

Gavins Point National Fish Hatchery

During October and November of 1997, wild broodstock were transported to the Gavins Point NFH facility from the collections earlier that fall near the confluence of the Missouri and Yellowstone Rivers. The adults were held at the Garrison Dam NFH until acclimated. During the transfer, the broodstock used for the 1997 spawning were hauled back to the river and released. During spawning on June 3 and 4, over 284,000 green eggs were produced, with an eye-up of 39.4 percent and a hatch rate of 26.1 percent. After distribution for a variety of research projects, approximately 74,200 fry were hatched. On June 18 and 19, a heavy silt load came through the fry tanks and apparently caused a significant loss of the 1998 progeny. All of the fry produced from these crosses were lost. For additional information, please see report "Fiscal Year 1998 Sturgeon Activities and Accomplishments," Herb Bollig, Gavins Point National Fish Hatchery, 1998.

Garrison Dam National Fish Hatchery

Eggs sampled on June 9 provided a positive progesterone assay. On these findings, the four males were injected with LH-RHa on June 10 with a full dose (0.045 mg/kg body weight). The female was injected at the standard warm up dosage of 0.01 mg/kg body weight. She was injected the following morning with the resolving dose. On June 11, milt was collected from all four males with nearly 100 percent activation. By later that afternoon, the female began expelling eggs allowing the spawning to commence. The hatch was estimated at approximately 16 percent from the eggs that had eye-up, with a total take of approximately 143,220 (2310 milliliters) eggs. For additional details, please see report "Pallid Sturgeon Propagation - 1998, Garrison Dam NFH," Rob Holm, 1998.

Natchitoches National Fish Hatchery

Twenty-three wild, adult pallid sturgeon were collected from the Old River Control Complex, Concordia Parish, Louisiana, in December 1997 and transported to the Natchitoches NFH. Two females and six males were injected with LHRHa on March 17, 1998. One small (1.78 kg) female ovulated (210 mL x 46 eggs/mL = 9660 eggs) 27 hours post first hormone injection. The eggs were fertilized with sperm from the only producing male, and they hatched March 23-24. The hatch rate exceeded 90 percent; there were 8030 fry in troughs on March 25, and there were more fry in a recirculating system. The fry were initially fed brine shrimp or zooplankton, plus a special sturgeon starter diet. Later, they were fed Rangen Trout and Salmon feed. Water quality problems (ammonia, nitrites) developed in the temporary rearing system. There were significant mortalities in April and June. The remaining 120 fingerlings were moved on July 7 to another building having a biofilter. On October 14, the remaining 35 juveniles (95% C.I. = 274 to 314 mm FL) were implanted with PIT tags. They were stocked at the Old River Control Complex on October 15. The two successful broodfish were collected on the same day in December 1997, and had been collected prior on the same day in June 1994. They had both been implanted with transmitters in 1994 and were the first two pallid sturgeon recaptures in the area since studies had begun in 1991.

1999

Gavins Point National Fish Hatchery

Broodstock were captured in September and October of 1998 and transported to Gavins Point NFH in November. Spawning commenced on June 15, with a total take of nearly 145,000 green eggs, with an eye-up of 86 percent and a hatch rate of 48.3 percent. Due to the quarantine from the iridovirus outbreak in shovelnose sturgeon, the adults could not be returned back to the river and were held on station. For additional information, please see report "Fiscal Year 1999 Sturgeon Activities and Accomplishments," Herb Bollig, Gavins Point National Fish Hatchery, 1999.

Garrison Dam National Fish Hatchery

Broodstock were captured between April 12 and April 15 of 1999 from the Missouri and Yellowstone Confluence area and transported to Garrison Dam NFH. Initial hormone doses were administered on June 8. A total of 175,450 green eggs were collected that resulted in 4,641 fry 1 month later. For additional details, please see report "Pallid Sturgeon Propagation - 1999, Garrison Dam NFH," Rob Holm, 1999.

2000

Gavins Point National Fish Hatchery

Due to iridovirus concerns, no broodstock collection or spawning occurred for this facility. For additional information, please see report "Fiscal Year 2000 Sturgeon Activities and Accomplishments," Herb Bollig, Gavins Point National Fish Hatchery, 2000.

Garrison Dam National Fish Hatchery

Broodstock were captured between April 11 and April 17 of 2000 from the Missouri and Yellowstone Confluence area and transported to Garrison Dam NFH. Spawning was initiated on June 12 and concluded on June 17, 2000. A total of 175,407 eggs were collected from the three females, which resulted in approximately 33,000 hatched fry. For additional details, please see report "Pallid Sturgeon Propagation - 2000, Garrison Dam NFH," Rob Holm, 2000.

2001

Gavins Point National Fish Hatchery

Due to iridovirus concerns, no spawning occurred. For additional information, please see report "Fiscal Year 2001 Sturgeon Activities and Accomplishments," Herb Bollig, Gavins Point National Fish Hatchery, 2001.

Garrison Dam National Fish Hatchery

Spawning did not occur on station in 2001 due to iridovirus concerns. Broodstock were captured between April 24 and April 25 of 2001 from the Missouri and Yellowstone Confluence area and transported to Miles City SFH. Eggs were then transported to Garrison Dam NFH for backup purposes and continued rearing. For additional details, please see report "Pallid Sturgeon Propagation - 2001, Garrison Dam NFH," Rob Holm, 2001.

Miles City State Fish Hatchery

For additional information, please see report "Fiscal Year 2001 Sturgeon Activities and Accomplishments," Herb Bollig, Gavins Point National Fish Hatchery, 2001.

Streamside Spawning above Ft. Peck Reservoir - Included in Garrison Dam NFH summary. For additional details, please see report "Pallid Sturgeon Propagation - 2001, Garrison Dam NFH," Rob Holm, 2001.

2002

Gavins Point National Fish Hatchery

Due to a lack of space and available broodstock, no spawning occurred. For additional information, please see report "Fiscal Year 2002 Sturgeon Activities and Accomplishments," Herb Bollig, Gavins Point National Fish Hatchery, 2002.

Garrison Dam National Fish Hatchery

Broodstock were captured between April 22 and June 4 of 2002 from the Missouri and Yellowstone Confluence area and transported to Garrison Dam NFH. Hormone injections to induce ovulation were started on June 17. Approximately 75,555 eggs were collected from these efforts. For further details, please see report "Pallid Sturgeon Propagation - 2002, Garrison Dam NFH," Rob Holm, 2002.

Streamside Spawning above Ft. Peck Reservoir - Unsuccessful spawning attempt.

Miles City State Fish Hatchery

For additional information, please see "Upper Basin Pallid Sturgeon Workgroup - 2002 Annual Report, 2003."

Blind Pony State Fish Hatchery - Information not available at this time.

2003

Gavins Point National Fish Hatchery

Due to a lack of space and available broodstock, no spawning occurred. For additional information, please see report "Fiscal Year 2003 Sturgeon Activities and Accomplishments," Herb Bollig, Gavins Point National Fish Hatchery, 2003.

Garrison Dam National Fish Hatchery

Broodstock were captured between April 22 and May 14 of 2003 from the Missouri and Yellowstone Confluence area and transported to Garrison Dam NFH. Initial hormone injections were given on June 23, with spawning beginning on June 25. Approximately 205,280 eggs were collected from three females, with about 30,000 fry hatching. For additional details, please see report "Pallid Sturgeon Propagation - 2003, Garrison Dam NFH," Rob Holm, 2003.

Streamside Spawning above Ft. Peck Reservoir - Information not available at this time.

Miles City State Fish Hatchery - Information not available at this time.

Blind Pony State Fish Hatchery - Information not available at this time.

2004

Gavins Point National Fish Hatchery

Due to a lack of space, no spawning attempts were made. For additional information, please see report "Fiscal Year 2004 Sturgeon Activities and Accomplishments," Herb Bollig, Gavins Point National Fish Hatchery, 2004.

Garrison Dam National Fish Hatchery

For additional details, please see report "Pallid Sturgeon Propagation - 2004, Garrison Dam NFH," Rob Holm, 2005.

Streamside Spawning above Ft. Peck Reservoir

Three male and one female pallid sturgeon were captured at the Jones Island site on the upper Missouri River. The female was staged and determined ready for hormonal injection on June 9th. Males were injected on the evening of June 9 and checked the following morning to assure there would be milt prior to injecting the female. The female was injected on June 10. Only two of the three males captured above the dam were used for spawning. Milt from two additional males from below the dam was collected and transported to the spawning site at Jones Island to make four family lots rather than only two. Once the spawning process was complete, eggs were transported to the Bozeman Fish Technology Center. Approximately 150 mls from each lot was transported to the Gavins Point National Fish Hatchery for future brood. Approximately 1500 mls of eggs total were collected from the female for future broodstock. Each family lot had an equal representation of the collected eggs (375 mls/family). Percent fertilization was estimated

between 80 to 90 percent. Percent hatch was estimated between 70 to 80 percent. Percent survival to age 3 months was estimated between 2.5 to 6 percent. For further information please see "Pallid Sturgeon Propagation Report, Bozeman Fish Technology Center," Bozeman, Montana, 2004.

Miles City State Fish Hatchery - Information not available at this time.

Natchitoches National Fish Hatchery

Wild, adult pallid sturgeon were collected from the Old River Control Complex, Concordia Parish, Louisiana, in November 2003 to April 2004 and transported to the Natchitoches NFH. Seven females and seven males were injected with LHRHa on April 19-20. All males produced dense, motile sperm. Two females ovulated 27-29 hours post first injection. Crosses were made for nine families, but there was no embryological development or hatching. Five females and five males were injected May 5. Four males produced dense, motile sperm; the last male produced only dilute sperm, which was not used for propagation. Three females ovulated 27-32 hours post first injection; their egg masses equaled 25-35 percent of their pre-spawn body weights. Gametes from the three females and four males were used to produce 10 family lots. Embryological development was 25-75 percent on May 10, and the fry began hatching May 11. One lot did not develop, and another was represented by only a few individuals. The fingerlings exceeded rearing capacity at Natchitoches NFH and were transferred at intervals to Booker-Fowler State Fish Hatchery in Woodworth, Louisiana. By July, there remained about 14,000 fingerlings in eight family lots from matings of three female and three male pallid sturgeon.

From October 2004 to February 2005, the juvenile pallid sturgeon were tagged and stocked. All fish received a coded wire tag. The 4,755 from known family lots were implanted with PIT tags and released into the Old River Control Complex, Concordia Parish, Louisiana (RPA 6). The 6,826 from mixed family lots were marked with elastomer and were stocked at three sites in the Mississippi River across from, above and below the ORCC area (RPA 5). Most of the total 11,581 stocked juveniles averaged 70-90 grams each.

Tagging Efforts

Over the years, as information has been gained on the effectiveness and retention of tags, several varieties of tags have been used. However, there are methods that have been consistently used and still provide sufficient information on recaptured sturgeon to gain a better understanding and evaluate the stocking efforts. These are the Passive Integrated Transponders (PIT tags), coded wire tags, and latex elastomer. External tags have met with some difficulties, primarily due to the inability of the tag site to heal and the tag loss. External tags that have been used are primarily the dangler tag, the T-bar tag, the carlin tag and the stainless steel jaw tag. The jaw tags have not been adequately evaluated; however, in three individual adults that were tagged in the late 1980's, retention, healing and readability have all been good. This method probably merits continued use in adults only. Suitability for juveniles is somewhat tenuous, since most external tags do not allow continued expansion of the tissue with additional growth. External tags are generally not recommended unless specific to a study or for research purposes.

Below are some of the pro and cons of the various tagging methods that have been incorporated into the stocking efforts. More recently, genetics offers distinct possibility as a marking technique for family lots. Provided that genetics of the parents is known, it is possible that identification of the family lot for the progeny could be identified from tissue samples collected at the time of recapture.

PIT tags

Pros: Tags allow individual identification of fish that can be used to track effectiveness of stocking site or conditions.

Allow the evaluation of growth rates.

Allows for determination of tracking individual recapture information for evaluation of stocking efforts.

If done correctly, tag loss is minimal.

Cons: Cost for tag alone is about $4 per fish.

Fish should be at least 9 inch average size before tagging can be done with minimum loss.

Labor intensive and tagging effort is slower than other methods.

Coded Wire

Pros: Batch marking of large groups of progeny are fairly easily accomplished.

Cons: Does not allow for individual identification of fish since tag cannot be removed successfully.

Elastomer

Pros: Fairly inexpensive

Batch marking of large groups of progeny are fairly easily accomplished.

Cons: Color combinations are limited

Genetic

Pros: No initial tagging cost
Long-term viability since genetic material doesn't change.

Cons: Relatively expensive testing costs on an individual fish basis. Other tagging methods require equipment that is usable on all recaptures and require one-time acquisition. Testing fish genetically will probably initially cost approximately $30-$40 dollars per fish and must be conducted in the laboratory.

External Tags

Pros: Easy identification by anglers to allow another avenue of data collection.
Sequential numbered tags can allow for individual identification of pallids.

Cons: High rate of tag loss on some designs. Not all designs tested.
Continued irritation of tag site.

Table 1. Tagging location by tag type that have been used for pallid sturgeon augmentation efforts.

Type of Tag	**Tagging Location (thru 2004)**
PIT tag	Below dorsal fin (loin / dorsal musculature) in juveniles Base of dorsal fin in adults
Coded Wire Tag	Under 2nd or 3rd dorsal scute in juveniles Side of rostrum in juveniles - 2004
Elastomer Tag	Underside of rostrum
External Tags	Floy & Double T bar - base of pectoral fin
Dangler Tag	Through dorsal scutes
Monel Jaw Tag	Lower lip
Genetic Marker	Sample collected from trailing edge of pectoral fin

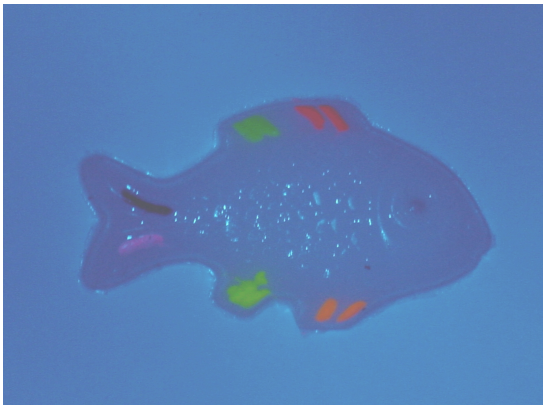


Figure 1. Elastomer colors under UV light.

Figure 2. Elastomer colors under natural light.

Actual color scheme for above samples.

Eye = blue;
front dorsal = red;
back dorsal = green;
top caudal = purple;
bottom dorsal = pink;
anal fin = yellow;
pelvic fin = orange.

Table 2. Elastomer tag colors available, fluorescence, and colors that they can be confused with

Elastomer colors		
Color	**Fluorescence**	**Confused with...**
red	**Yes**	orange
orange	**Yes**	red
green	**Yes**	yellow
yellow	**Yes**	green
pink	**Yes**	purple
brown	**No**	black, purple, blue
black	**No**	brown, purple, blue
blue	**No**	black, brown, blue
white	**No**	tissue color
purple	**No**	black, brown, blue

Table 3. Stocked pallid sturgeon information with elastomer tag combinations that were utilized for augmentation efforts.

Elastomer Combination	**Hatchery & # Stocked**	**Year Class / Stocked Year**	**RPA & #**
Double Red	Gavins Point NFH - 289	1997 / 1998	1 - 138 2 - 151
Double Orange	Gavins Point NFH - 293	1997 / 1998	1 - 138 2 - 155
Double Blue	Gavins Point NFH - 294	1997 / 1998	1 - 138 2 - 156
Double Green	Gavins Point NFH - 300	1997 / 1998	1 - 138 2 - 162
Double Yellow	Gavins Point NFH - 293	1997 / 1998	1 - 138 2 - 155
Double Red	Gavins Point NFH - 80	1997 / 2000	3 - 80
Double Orange	Gavins Point NFH -80	1997 / 2000	3 - 80
Double Blue	Gavins Point NFH -79	1997 / 2000	3 - 79
Double Green	Gavins Point NFH - 76	1997 / 2000	3 - 76
Double Yellow	Gavins Point NFH - 101	1997 / 2000	3 - 101
Double Red	Gavins Point NFH - 80	1999 / 2002	3 - 80
Right Green; Left Blue	Bozeman FTC - 553	2001 / 2002	1 - 553
Right Pink; Left Blue	Bozeman FTC - 546	2001 / 2002	1 - 546
Right Black; Left Blue	Bozeman FTC - 176	2001 / 2002	1 - 176
Right Brown; Left Blue	Bozeman FTC - 494	2001 / 2002	1 - 494
Right Purple; Left Blue	Bozeman FTC - 289	2001 / 2002	1 - 289
Left Blue	Bozeman FTC - 189	2001 / 2004	1 - 189
Right Green; Left Orange	Miles City SFH - 366	2001 / 2002	2 - 366
Right Green; Left Yellow	Miles City SFH - 368	2001 / 2002	2 - 368
Right Green; Left Blue	Miles City SFH - 247	2001 / 2002	2 - 247

Elastomer Combination	Hatchery & # Stocked	Year Class / Stocked Year	RPA & #
Right Green; Left Red	Miles City SFH - 298	2001 / 2002	2 - 298
Right Green	Garrison Dam NFH - 8,125	2001 / 2002	2 - 1,626 3 - 558 4 - 5,941
Right Green	Neosho NFH - 344	2001 / 2002	4 - 344
Right Red; Left Yellow	Miles City SFH - 2,035	2002 / 2003	2 - 2,035
Right Red; Left Yellow	Gavins Point NFH - 3,966	2002 / 2003	2 - 1,951 3 - 481 4 - 1,534
Right Pink;	Garrison Dam NFH - 5,314	2003 / 2003	4 - 5,314
Horizontal Yellow	Miles City - 2,468	2003 / 2004	2 - 2,468
Horizontal Yellow	Garrison - 2,417	2003 / 2004	4 - 2,417
Right Yellow	Gavins - 566	2003 / 2004	3 - 566
Horizontal Yellow	Neosho - 2,276	2003 / 2004	4 - 2,276
Horizontal Red	Garrison - 6,634	2004 / 2004	4 - 6,634
Left Red	Garrison - 31,390	2004 / 2004	2 - 16,777 4 - 14,824
Right Red	Garrison - 9,170	2004 / 2004	4 - 9,170

Stocking Efforts Please see Appendix A and B.

1994 (Total # stocked = 6,856)

Blind Pony State Fish Hatchery

These fish were the result of the 1992 spawning at Blind Pony SFH. The stocking locations for these fish included the habitats in the lower Missouri River and Middle Mississippi River.

1997 (Total # stocked = 3,675)

Blind Pony State Fish Hatchery

On September 20, 1997, 400 of the fingerling pallid sturgeon were stocked in the Missouri River at Cooley Lake Access. The remaining 3,400 were scheduled to be tagged and stocked on October 15, 1997.

A total of 3,675 pallid sturgeon were stocked from Blind Pony SFH in 1997. These fish resulted from the mating of two females and three males creating three families. Fish 7751 was crossed with 7757; 7752 was crossed with 7760 and 7764.

1998 (Total # stocked = 1,599)

Gavins Point National Fish Hatchery

A total of 1,470 one-year-old pallid sturgeon were stocked into Recovery Priority Areas 1 and 2 for 1998.

Valley City National Fish Hatchery

An additional 94 pallid sturgeon juveniles were added to the stocking effort of RPA's #1 & #2 in 1998 for tracking purposes and determination of survival and behavioral patterns. These fish were reared at Valley City to facilitate the extra growth that was needed to accommodate for the transmitters.

Garrison Dam National Fish Hatchery

Due to inadequate facilities to overwinter fish, all fish produced in 1998 were transported to Gavins Point NFH for continued rearing.

Natchitoches National Fish Hatchery

Thirty-five pallid sturgeon progeny produced in 1998 were stocked on October 14, below the Old River Control Structure on the Atchafalya River (RPA #6).

1999 (Total # stocked = 0)

No stocking accomplished due to iridovirus concerns and unsuccessful spawning.

2000 (Total # stocked = 1,193)

Gavins Point National Fish Hatchery

A total of 679 juvenile pallid sturgeon were stocked into RPA #2 and 514 into RPA #3. The fish stocked into RPA #2 were from the 1998 (200) and 1999 (479) spawns. The fish stocked into RPA #3 were from 1997 (416) and 1998 (98).

Garrison Dam National Fish Hatchery

All pallid sturgeon juveniles produced from the 1999 and 2000 spawning efforts were destroyed due to iridovirus concerns.

2001 (Total # stocked = 0)

No stocking accomplished due to iridovirus concerns. Pallid sturgeon produced from the 1999 and 2000 spawn at Garrison Dam NFH were euthanized due to the unknown nature and presence of iridovirus and the need for continuing research to resolve the fish health status before utilizing these fish in the stocking effort.

2002 (Total # stocked = 13,321)

The juvenile pallid sturgeon were stocked into the RPA's of 1, 2, 3, and 4. The total stocked for above Ft. Peck Dam was 2,058 for RPA #1; for above Garrison Dam in RPA #2, the total was 3,060; for RPA #3 below Ft. Randall Dam, the total number of pallids stocked was 739; and for below Gavins Point Dam in the Missouri, the total for 2002 was 7,464. This entire area encompasses the Missouri River from the mouth of the Marias River, downstream to the confluence of the Missouri and Mississippi Rivers.

2003 (Total # stocked = 19,142)

Juvenile pallid sturgeon were stocked into the RPA's of 2, 3, and 4. Total number of fish stocked by Recovery Priority Area are as follows: for RPA #2, a total of 3,986 were stocked; RPA #3, 601; and for RPA #4, 14,555. This encompasses the Missouri River from Ft. Peck Dam, downstream to the confluence of the Missouri and Mississippi Rivers.

2004 (Total # stocked = 68,425)

This was the first year that juvenile pallid sturgeon were stocked throughout the entire range of the pallid sturgeon. Stockings occurred in the RPA's of 1 through 6. This was primarily due to the successful spawning of pallid sturgeon at Natchitoches NFH in Louisiana and the cooperative effort provided by the Louisiana Department of Wildlife and Fisheries, with the additional rearing provided at the Booker Fowler State Fish Hatchery. Other hatchery facilities that also contributed to the stocking efforts this year were the Neosho NFH in Missouri, the Gavins Point NFH in South Dakota, Garrison Dam NFH in North Dakota, and the Miles City State Fish Hatchery and the Bozeman Fish Technology Center in Montana. However, a significant amount of assistance was provided by staff from several agencies with spawning and stocking efforts, which made the stocking of progeny possible. Without the cooperative efforts on transportation, tagging and coordination of activities, these releases would undoubtedly be more complicated and would not likely occur as efficiently as they do. Stocking efforts for 2004 were as follows:

RPA #1 = 3,239	RPA #3 = 515	RPA #5 = 6,478
RPA #2 = 19,245	RPA #4 = 35,372	RPA #6 = 3,576

This was also the first year that unmarked pallid sturgeon fry were released. Approximately 150,000 fry from Garrison Dam NFH and Miles City SFH were released below Ft. Peck Dam as part of an experiment related to larval drift rates.

2005 **TO BE CONTINUED.**

Results

To date, evaluation of the stocking efforts is proceeding forward, although slowly. The major factors influencing recaptures and subsequent evaluation, is the ability to adequately fund field collections to collect sufficient data, the efficiency of gears capable of sampling juvenile sturgeon, the large scale habitats in the lower Missouri and Mississippi Rivers, and the experience of the field crews. Since 2003, through efforts funded by the U.S. Army Corps of Engineers, many of these deficiencies are starting to be addressed. Additional crews were added to the monitoring effort and a basin-wide approach is being implemented to utilize various gears that will ultimately provide the data necessary to make a quantitative evaluation of the pallid sturgeon stocking efforts. The experience of the field crews is showing a significant improvement in the recapture of juvenile pallid sturgeon, with just over 500 recaptures to date. Although there's no doubt that the experience of the crews and the level of effort is improving, the number of pallid juveniles available for recapture has increased significantly also. Additional analysis in the next few years should be able to start showing trends that will allow managers to evaluate the ultimate success of the stocking efforts.

Meanwhile, additional research and practices are being implemented to improve spawning success and predictability. Hatchery personnel are continually evaluating their efforts and improving the science related to the spawning and culturing of sturgeon.

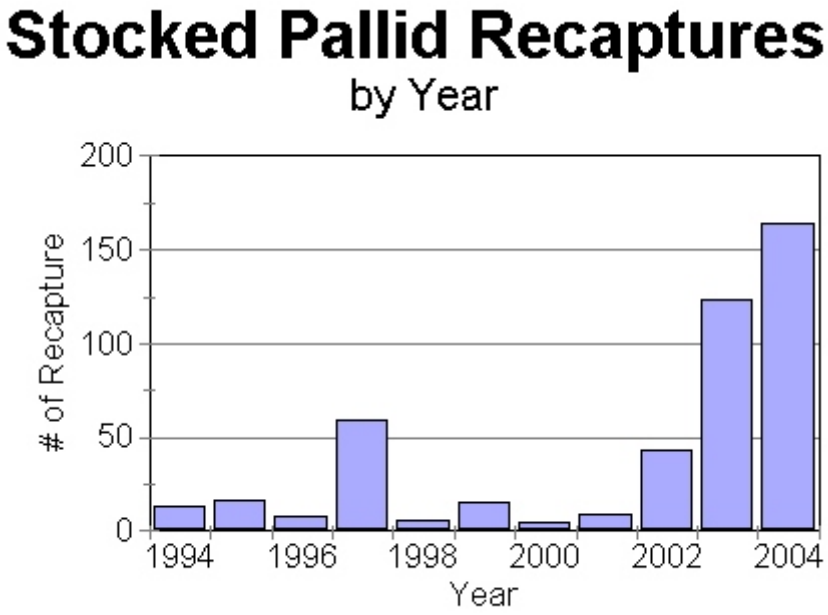


Figure 3. Number of recaptured stocked pallid sturgeon by year of sampling effort.

Table 4. Frequency of recapture by year class and recapture year for pallid sturgeon from stocking efforts.

Year Stocked / Sample Year	1994	1997	1998	2000	2002	2003	2004	Unknown
1994	100.0%							
1995	100.0%							
1996	100.0%							
1997	94.9%	5.1%						
1998	33.3%	16.7%	50.0%					
1999	60.0%	6.7%	33.3%					
2000	0.0%	0.0%	100.0%	0.0%				
2001	0.0%	0.0%	90.0%	10.0%				
2002	0.0%	2.3%	27.9%	11.6%	48.8%			9.0%
2003	0.0%	2.4%	25.2%	19.5%	35.8%	14.6%		2.0%
2004	0.5%	0.5%	28.0%	5.1%	18.2%	25.7%	17.3%	5.0%

Discussion

The Pallid Sturgeon Recovery Team and the regional Recovery Workgroups (Lower, Middle, and Upper) have taken an approach that is based on the best available information. The anticipation is that continued efforts in habitat restoration and reduction in threats will ultimately result in successful recruitment and possibly recovery. Spawning and stocking is a very important first step due to the longevity of these fish and the uncertainties of early life history, to prevent the near term extirpation of several portions of the population. It is extremely important the pallid sturgeon, as a species, still exists to take advantage of the restoration efforts that are underway or planned.

Risk, optimism, and uncertainty are an integral part of this recovery effort. It is hoped that the pallid sturgeon progeny being stocked will act and behave similarly to wild hatched pallids. It is also hoped that survival is substantial enough to allow recruitment of a wide proportion of the representative genetics being stocked. There are considerable uncertainties and the fear of losing the species or the fear of doing something wrong will likely continue to influence good decisions. However, the level of uncertainty needs to be weighed against what will happen to the species if nothing is done; extirpation.

It should be noted that the ongoing stocking efforts will likely result in the same situation as this species is currently facing, senescence without recruitment if the habitat features that limits recruitment are not fully identified and restored. The priority recovery actions need to be focused on the habitat restoration efforts that have been proposed. However, a science feedback loop needs to be continued in order to better focus specific recommendations on the factors that are limiting pallid sturgeon recovery. This requires that population monitoring and focused research be continued with an improved coordination and review of the results in order to better facilitate the implementation of the findings.

Acknowledgments

Obviously, the hatcheries and the staff who dedicated their careers and lives to spawning and raising fish, for the extra time and patience that has been required for the pallid sturgeon efforts need to be acknowledged. The participating agencies (U.S. Fish and Wildlife Service, U.S. Army Corp of Engineers, Western Area Power Administration, Missouri Department of Conservation, Montana Fish, Wildlife and Parks, and Louisiana Department of Fish and Wildlife), who have contributed the funding and assistance to make much of this possible and develop better facilities to culture the sturgeon. And finally, the participants in the Upper, Middle and Lower Basin Recovery Workgroups who have supported the propagation and stocking efforts.

LITERATURE CITED

Bollig, H. 1997. Fiscal year 1997 sturgeon activities and accomplishments. Gavins Point National Fish Hatchery, Yankton, SD.

Bollig, H. 1998. Fiscal year 1998 sturgeon activities and accomplishments. Gavins Point National Fish Hatchery, Yankton, SD.

Bollig, H. 1999. Fiscal year 1999 sturgeon activities and accomplishments. Gavins Point National Fish Hatchery, Yankton, SD.

Bollig, H. 2000. Fiscal year 2000 sturgeon activities and accomplishments. Gavins Point National Fish Hatchery, Yankton, SD.

Bollig, H. 2001. Fiscal year 2001 sturgeon activities and accomplishments. Gavins Point National Fish Hatchery, Yankton, SD.

Bollig, H. 2002. Fiscal year 2002 sturgeon activities and accomplishments. Gavins Point National Fish Hatchery, Yankton, SD.

Bollig, H. 2003. Fiscal year 2003 sturgeon activities and accomplishments. Gavins Point National Fish Hatchery, Yankton, SD.

Bollig, H. 2004. Fiscal year 2004 sturgeon activities and accomplishments. Gavins Point National Fish Hatchery, Yankton, SD.

Bozeman Fish Technology Center. 2004. Pallid sturgeon propagation report. Bozeman Fish Technology Center, Bozeman, MT.

Dryer, M.P., Krentz, S., and W. King. 1996. Pallid sturgeon & shovelnose sturgeon activities conducted for propagation at Garrison Dam NFH.

Holm, R. 1997. Pallid sturgeon propagation - 1997. Garrison Dam National Fish Hatchery, Riverdale, ND.

Holm, R. 1998. Pallid sturgeon propagation - 1998. Garrison Dam National Fish Hatchery, Riverdale, ND.

Holm, R. 1999. Pallid sturgeon propagation - 1999. Garrison Dam National Fish Hatchery, Riverdale, ND.

Holm, R. 2000. Pallid sturgeon propagation - 2000. Garrison Dam National Fish Hatchery, Riverdale, ND.

Holm, R. 2001. Pallid sturgeon propagation - 2001. Garrison Dam National Fish Hatchery, Riverdale, ND.

Holm, R. 2002. Pallid sturgeon propagation - 2002. Garrison Dam National Fish Hatchery, Riverdale, ND.

Holm, R. 2003. Pallid sturgeon propagation - 2003. Garrison Dam National Fish Hatchery, Riverdale, ND.

Holm, R. 2004. Pallid sturgeon propagation - 2004. Garrison Dam National Fish Hatchery, Riverdale, ND.

Missouri River FWMAO. 1996. Pallid sturgeon & shovelnose sturgeon activities conducted for propagation at Miles City State Fish Hatchery, 1995. U.S. Fish and Wildlife Service, Bismarck, North Dakota

Upper Basin Pallid Sturgeon Workgroup. 2003. 2002 Annual Report.

Appendix A.

Pallid Sturgeon Augmentation in the Recovery Areas by Family (01/01/2005)										
Year Class	**Hatchery**	**Female** Pit tag	**Male** Pit tag	**RPA** Number stocked						**Total stocked**
				#1	**#2**	**#3**	**#4**	**#5**	**#6**	
1992	Blind Pony SFH	7F7D380727 7F7D353F2C	7F7D434651 7F7F065570 7F7F065244				2,412	4,444		6,856
1997	Blind Pony SFH	7751, 7752, 7753					2,012	1,663		3,675
1997	Gavins Point NFH	1F4B246E04	1F4A4A1439	138	151	80				369
		1F4B246E04	7F7D291A07	138	155	80	28			401
		1F4B246E04	7F7F06583D	138	156	79				373
		1F4A301354	1F4A4A1439	138	163	76				377
		1F4A301354	7F7D291A07	138	155	101	7			401
1998	Natchitoches NFH								35	35
1998	Gavins Point NFH	7F7F056171	1F47760123	0	100	49				149
		7F7F056171	1F4A363031	0	100	49				149

Appendix A.

Pallid Sturgeon Augmentation in the Recovery Areas by Family (01/01/2005)											
Year Class	**Hatchery**	**Female** Pit tag	**Male** Pit tag	**RPA** Number stocked						**Total stocked**
				#1	**#2**	**#3**	**#4**	**#5**	**#6**	
1999	Gavins Point NFH	7F7B021573	7F7D441774	0	160	66	202			428
		7F7B021573	7F7F06583D	0	159	50	130			339
		7F7B021573	113719262A	0	160	65	200			425
2001	Miles City SFH	220E345E09	1F4A111C6A		368					368
		220E345E09	1F4A27214F		366					366
		7F7F06672B	7F7D3C5708		247					247
		7F7F06672B	115631222A		298					298
2001	Bozeman FTC	411D262C1F	1F4A4B5973	494	71					565
		411D262C1F	411D0E2C5F	289						289
		411D262C1F	41476A0462	553						553
		411D262C1F	411D0B4E09	176						176
		411D262C1F	17509415139	546	84					630
		411D262C1F		189						189

Appendix A.

Pallid Sturgeon Augmentation in the Recovery Areas by Family (01/01/2005)											
Year Class	**Hatchery**	**Female** Pit tag	**Male** Pit tag	**RPA** Number stocked						**Total stocked**
				#1	**#2**	**#3**	**#4**	**#5**	**#6**	
2001	Garrison Dam NFH	411D0B4E09	1F4A111C6A							
		411D0B4E09	1F4A27214F							
		7F7F06672B	7F7D3C5708							
		7F7F06672B	115631222A			71	773			844
		411D262C1F	1F4A4B5973		353	70	69			492
		411D262C1F	411D0E2C5F		320	137	558			1,015
		411D262C1F	41476A0462		424	70	1,741			2,235
		411D262C1F	411D0B4E09		191	0	0			191
		411D262C1F	17509415139		338	70	170			578
		220E345E09	1F4A111C6A			70	747			817
		220E345E09	1F4A27214F			70	1,883			1,953
2001	Neosho NFH	7F7F06672B	7F7D3C5708				289			289
		220E345E09	1F4A111C6A				646			646
		220E345E09	7F7D3C5708				9			9
		220E345E09	432C063C4E				12			12

Appendix A.

Pallid Sturgeon Augmentation in the Recovery Areas by Family (01/01/2005)											
Year Class	**Hatchery**	**Female** Pit tag	**Male** Pit tag	**RPA** Number stocked						**Total stocked**
				#1	**#2**	**#3**	**#4**	**#5**	**#6**	
2002	Garrison Dam NFH	116224546A	1F477B3A65				1,323			1,323
		116224546A	116167123A				1,419			1,419
		116224546A	220F107A6F				1,601			1,601
		116224546A	7F7D461025				1,105			1,105
2002	Gavins Point NFH	116224546A	1F477B3A65		653	120	383			1,156
		116224546A	116167123A		645	121				766
		116224546A	220F107A6F		0	120	529			649
		116224546A	7F7D461025		653	120	262			1,035
		116224546A	1F4A27214F		0	120	360			480
2002	Miles City SFH	116224546A	220F107A6F		2,035					2,035
2002	Neosho NFH	116224546A	1F477B3A65				793			793
		116224546A	220F107A6F				738			738
		116224546A	7F7D461025				728			728

Appendix A.

Pallid Sturgeon Augmentation in the Recovery Areas by Family (01/01/2005)											
Year Class	**Hatchery**	**Female** Pit tag	**Male** Pit tag	**RPA** Number stocked						**Total stocked**
				#1	**#2**	**#3**	**#4**	**#5**	**#6**	
2003	Garrison Dam NFH	44426F185B	7F7D291A07				1,912			1,912
		44426F185B	1F521B1E56				1,468			1,468
		44426F185B	41475D3C5D				1,207			1,207
		44426F185B	1F4A363031				110			110
		7F7F054855	115669540A				365			365
		7F7F054855	115675486A				400			400
		7F7F054855	132313521A				104			104
		132256586A	1F47760123				490			490
		132256586A	132114552A				471			471
		132256586A	132157621A				1,204			1,204
2003	Miles City SFH	7F7F054855	115669540A		1,182					362
		7F7F054855	115675486A		705					705
		132256586A	132114552A		474					474
		132256586A	132157621A		107					107

Appendix A.

Pallid Sturgeon Augmentation in the Recovery Areas by Family (01/01/2005)											
Year Class	**Hatchery**	**Female** Pit tag	**Male** Pit tag	**RPA** Number stocked						**Total stocked**
				#1	**#2**	**#3**	**#4**	**#5**	**#6**	
2003	Gavins Point NFH	44426F185B	7F7D291A07			33				33
		44426F185B	1F521B1E56			60				60
		44426F185B	41475D3C5D			131	51			182
		7F7F054855	115669540A			59				59
		7F7F054855	115675486A			30				30
		132256586A	1F47760123			92				92
		132256586A	132114552A			55				55
		132256586A	132157621A			55				55
2003	Bozeman FTC	7F7F054855	115669540A	838						838
		7F7F054855	115675486A	1,003						1,003
		132256586A	1F47760123	16						16
		132256586A	132157621A	459						459
		44426F185B	1F4A363031	540						540
		44426F185B	41475D3C5D	16						16

Appendix A.

Pallid Sturgeon Augmentation in the Recovery Areas by Family (01/01/2005)											
Year Class	**Hatchery**	**Female** Pit tag	**Male** Pit tag	**RPA** Number stocked						**Total stocked**
				#1	**#2**	**#3**	**#4**	**#5**	**#6**	
2003	Bozeman (cont.)	No info (26)		26						
		Retagged (152)		152						
2003	Neosho NFH	44426F185B					883			883
		7F7F054855					482			482
		132256586A					911			911
2004	Garrison Dam NFH	114476216A	7F7D487531		459		3,508			3,967
		114476216A	1F4A4B5973		450		828			1,278
		114476216A	7F7E55466D		3,745		4,727			8,472
		114476216A	1F4A312640		1,805		7,830			9,635
		114476216A	430E452777		4,867		8,672			13,539
		114476216A	1F477B3A65		310					99
		114476216A	431565767B		38					38
		115551683A	7F7D3C555D		106					106
		7F7F066452	7F7F065834		116					116
		454910202B	1F47606357		1,770		2,768			4,538

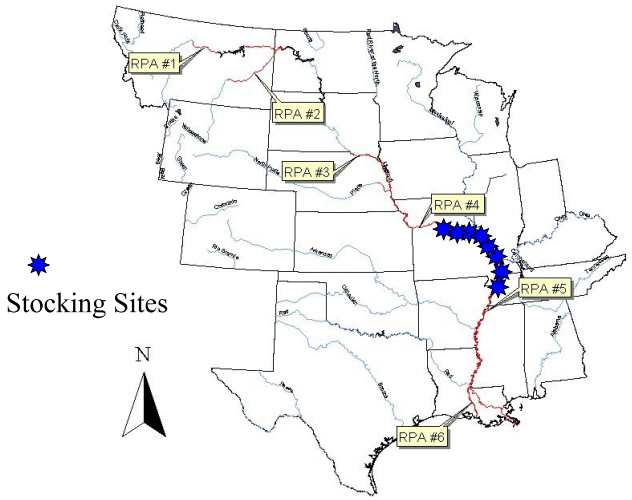
Appendix A.

Pallid Sturgeon Augmentation in the Recovery Areas by Family (01/01/2005)											
Year Class	**Hatchery**	**Female** Pit tag	**Male** Pit tag	**RPA** Number stocked						**Total stocked**
				#1	**#2**	**#3**	**#4**	**#5**	**#6**	
2004	Garrison (cont.)	454910202B	220F0F7677		1,252		1,459			2,711
		454910202B	115679374A		1,489		836			2,325
		454B380D60	7F7D376F73		82					82
		454B380D60	7F7F065834		288					288
	Fry (130,000)									
2004	Natchitoches NFH	131711311A	11612346							
		131711311A	131709760A							
		131723552A	11612346							
		131723552A	131872586A							
		131723552A	131709760A							
		131726531A	11612346							
		131726531A	131872586A							
		131726531A	131709760A							

Appendix A.

Pallid Sturgeon Augmentation in the Recovery Areas by Family (01/01/2005)											
Year Class	**Hatchery**	**Female** Pit tag	**Male** Pit tag	**RPA** Number stocked						**Total stocked**
				#1	**#2**	**#3**	**#4**	**#5**	**#6**	
2004	Miles City SFH Fry (25,000)									
2004	Booker-Fowler SFH							6,478	3,576	10,054
	TOTALS			**5,987**	**27,750**	**2,369**	**61,815**	**12,585**	**3,611**	**114,117**

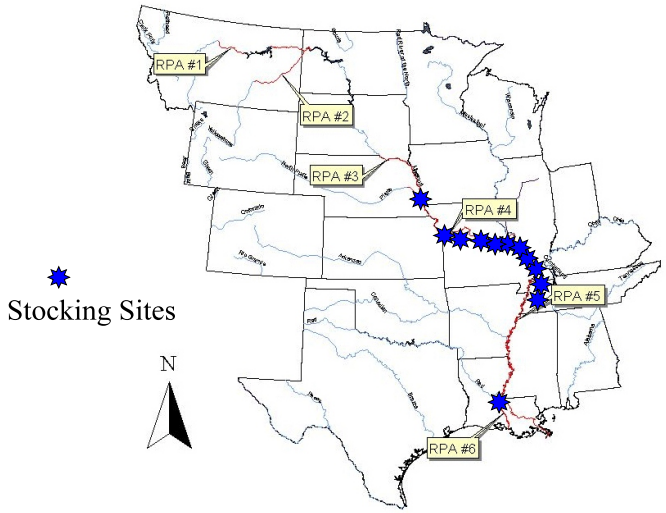
Appendix B



Pallid Sturgeon Stocking Sites

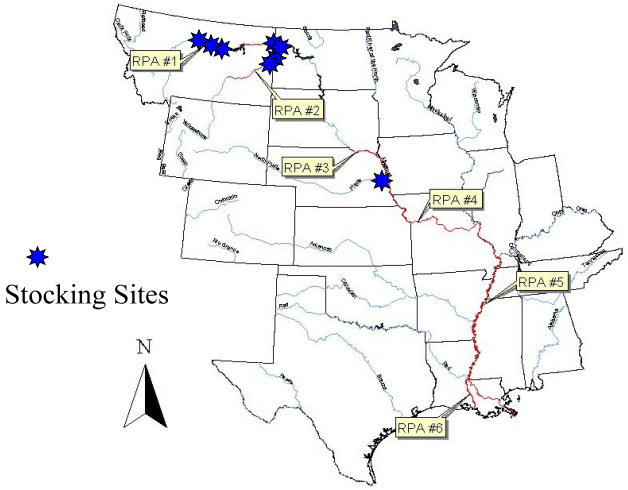
1994 Stocking Sites

1997 Stocking Sites



Pallid Sturgeon Stocking Sites

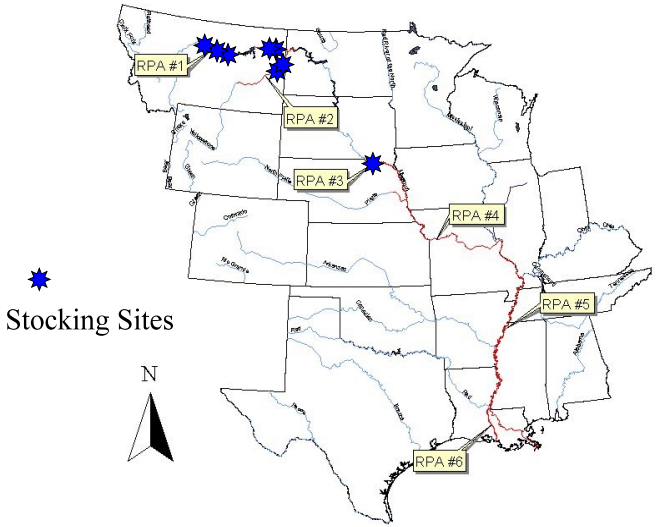
Appendix B



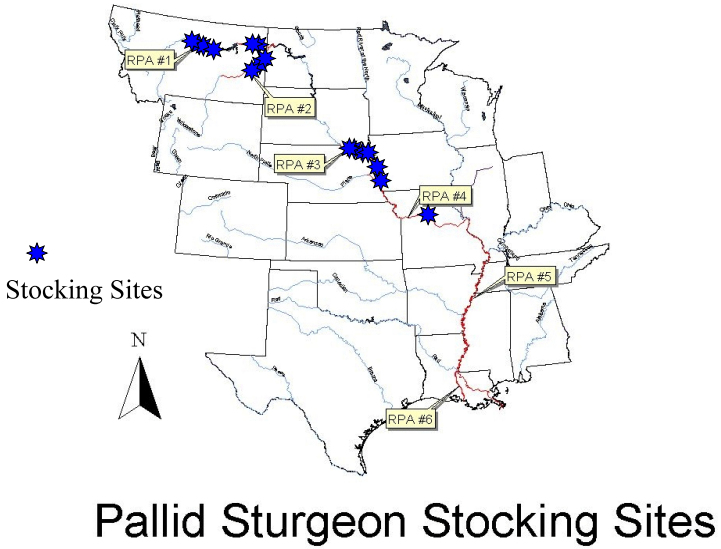
Pallid Sturgeon Stocking Sites

1998 Stocking Sites

2000 Stocking Sites



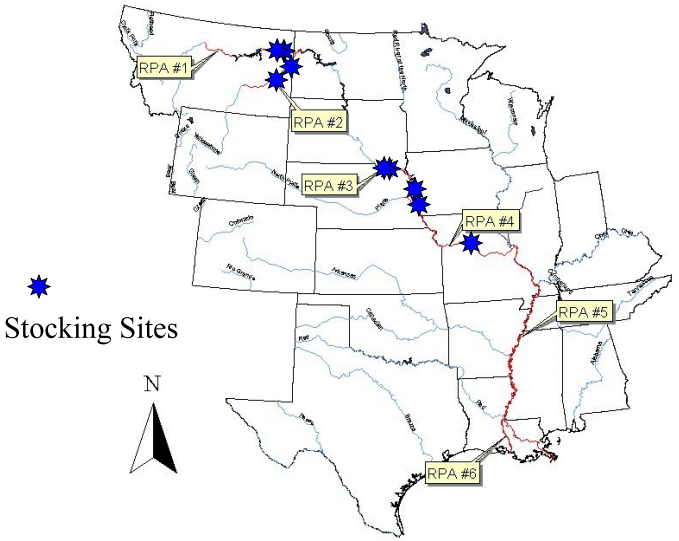
Pallid Sturgeon Stocking Sites



Pallid Sturgeon Stocking Sites

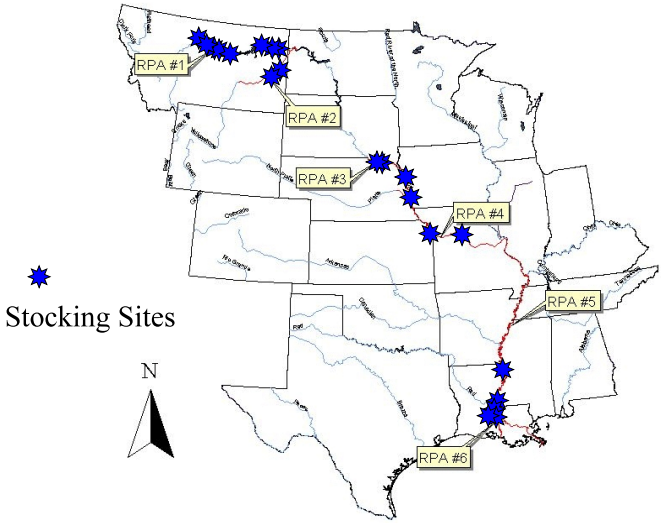
2002 Stocking Sites

2003 Stocking Sites



Pallid Sturgeon Stocking Sites

Appendix B



Pallid Sturgeon Stocking Sites

2004 Stocking Sites

Appendix C

Stocking Location	RPA	River mile	1994	1997	1998	2000	2002	2003	2004
Atchafalya River	6				35				
Atchafalya River	6								3576
RPA #6 Subtotal	**3611**								
Mississippi River	5								6478
Mississippi River	5	54.0	687						
Mississippi River	5	109.0	931	400					
Mississippi River	5	125.0	947	398					
Mississippi River	5	889.0	952	401					
Mississippi River	5	925.0	927	464					
RPA #5 Subtotal		**12585**							
Missouri River	4	28.5	832	400					
Missouri River	4	68.5	603	398					
Missouri River	4	97.5	977	400					
Missouri River	4	97.5							
Missouri - Boonville	4	195.1					2695	4621	13650
Missouri River	4	299.0		24					
Missouri River	4	339.5		389					
Missouri - Leavenworth	4	397.0							13803

Appendix C

Stocking Location	RPA	River mile	1994	1997	1998	2000	2002	2003	2004
Platte River	4	5.0		401					
Missouri - Bellevue	4	601.4					2513	4936	7868
Missouri - Boyer Chute	4	637.4							51
Missouri - Ponca State Park	4	753					215		
Missouri - Mulberry Bend	4	775					1761	4998	
Missouri - St. Helena	4	799					280		
RPA #4 Subtotal		**61815**							
Missouri - Standing Bear Bridge	3	845						300	271
Missouri - Verdel	3	855				514	558		
Missouri - Sunshine Bottom	3	866.2					181	301	244
RPA #3 Subtotal		**2369**							
Missouri - Yellowstone Confluence	2	1581.3			40				
Missouri - Nohly	2	1590			279				
Missouri - Culbertson	2	1621				124	587	1033	4358
Milk River	2	11.5							821
Missouri River - Milk	2	1761.5							3482
Missouri - Wolf Point	2	1701.5				124	694	1026	4432
Yellowstone - Fairview	2	9				216	630	887	
Yellowstone - Big Sky Bend	2	17			255				

Appendix C

Stocking Location	RPA	River mile	1994	1997	1998	2000	2002	2003	2004
Yellowstone - Sidney Boat Ramp	2	31			255	215	698		3347
Yellowstone - Intake	2	70					451	1040	2805
RPA #2 Subtotal		**27799**							
Missouri - Fred Robinson Bridge	1	1920.6			275		894		764
Missouri - Judith Landing	1	1983.1					372		569
Missouri - Judith Landing	1	1983.3			230				
Missouri - Coal Bank	1	2029.5					374		620
Missouri - Loma	1	2052							672
Missouri - Mouth of Marias River	1	2052.8			230		418		
Marias River	1	60							614
RPA #1 Subtotal		**6032**							
TOTALS			**6856**	**3675**	**1599**	**1193**	**13321**	**19142**	**68425**