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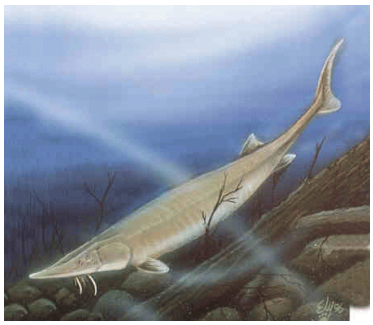
PALLID STURGEON RECOVERY UPDATE

- the latest research and management actions for recovery -



PALLID STURGEON RESEARCH AND RECOVERY EFFORTS IN THE UPPER MISSOURI RIVER, MT

In 2003, a total of 40 pallid sturgeon were captured (8 adults (*comprised of 5 recaptures and 3 new fish*); 29 juvenile-1997 year class and 3 juvenile-2001 year class) **.**

We attempted on-site spawning in June again (3rd year) and captured only 4 male pallids for on-site propagation. No female pallids were netted, therefore, we ended up only sending sperm from 3 males for cryopreservation at Garrison Dam National Fish Hatchery (GDNFH).

There were not any juvenile pallid sturgeon stockings above Fort Peck this year because of Montana Fish, Wildlife, and Parks (MTFWP) restrictions as it relates to sturgeon iridovirus concerns for the upper Missouri River, MT.

The 7th year of pallid sturgeon baseline abundance survey was completed. The purpose of the survey is to monitor changes in the pallid population using a standardized approach so comparisons can be made for evaluating treatments directed at improving the pallid sturgeon population. The sampling area is the same 16 miles of river where I believe most of the adult pallids live. Our effort consists of drifting 50, 2" trammel nets in a prescribed manner at randomly selected sites during late September. This effort in 2003 captured a total of 6 pallids (*1 juvenile-01 year class, 4 juvenile-97 year class, and 1 wild adult*)**.** This was an increase from previous years.

The main interest of the pallid work in the study area has been directed at an evaluation of the release of ~750 juvenile pallids, now 6 years-old ('97 year class). We are trying to answer the following questions; What habitat conditions do they prefer, are they surviving and are they in a healthy condition? What are the best strategies for stocking pallids in the study area.? Are they surviving at an acceptable rate? Since 1999 (1 yr after release) we sampled 57 different pallid sturgeon from the '97 year class. Intuitively, I would say, yes, the '97 year class have good survival in RPMA #1.

We hope to do a Peterson mark/recapture type estimate next year. We will attempt to capture 30+ pallid sturgeon from the 97 year class and call it a recovery run. Using 2003 as a marking run (N=29) and using PIT tags for "marks" we should be able to get a rough abundance estimate.

Are the pallid sturgeon from the '97 year class exhibiting good condition and growth? The pallids grew an average of 1.3 inches over the year. Although growth of the hatchery pallids in the wild appear to be slow, on occasion we do catch a nice one. The Montana State University team sampled one '97 year class fish that was 3.32 lb. This was a 1998 radio fish and was 0.84 lb at the time of release (8/18/98); therefore it grew approximately 0.50 lbs/yr.

Stocking strategies in the upper Missouri River continue to be evaluated. We released the '97 year class at three sites to evaluate what location is best for survival. The upriver sites are represented by 66% of the recaptures, which suggests that releasing fish in these areas has been a successful strategy. This observation is particularly significant considering the fact that around 70% of our sampling effort is directed at the lower area where we have sampled only 33% of the '97 year class.

We are continuing our evaluation of our tagging system. We have been witnessing a higher than normal rate of tagging loss for PIT tags. Following is a summary of tag loss by year:

- 1998 screened 3and all had PITs
- 1999 screened 3and all had PITs
- 2000 screened 4 and 3 had PITs
- 2001 screened 9 and 4 had PITs
- 2002 screened 9 and 4 had PITs
- 2003 screened 27and 19 had PITs

The elastomere tags are all holding good but tag visibility is starting to get compromised by thickening skin tissue.

This is year-2 since we released the '01 year class. Its still to early to tell what survival rate is but we have observed some severe pectoral fin deformities. Of the 3 '01 year class recaptures sampled this year, two had severe pectoral fin curl while the third appeared to have minor deformity. Matt Toner with Bozeman Fish Technology Center (where the fish were reared) reported that this batch had rated 14.4% very good; 43.7% good; 29.8% moderate; 10.6% poor and 1.5% worse case condition when released. Matt believes the pectoral deformities are caused by micro-nutrient deficiencies of the facility water supply.

Several state species of special concern (SSC) were sampled in the study area this year. Totals of 230 sicklefin chub and 143 sturgeon chub were captured while trawling. Included in this total are, 20+ sturgeon chub that were sampled in the Coal Banks area; a first-time recording for this species at this upriver location. Other SSC sampled this year were paddlefish (~50), sauger (~2000), and blue sucker (~30). Only 2 age-0 shovelnose were sampled in our 135 trawl tows.

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Habitat Use, Movements, Growth and Food Habits of Hatchery-Reared Juvenile Pallid Sturgeon and Indigenous Juvenile Shovelnose Sturgeon

In 1998, 736 hatchery-reared juvenile pallid sturgeon (HRJPS) were stocked into the Missouri River above Fort Peck Reservoir (Recovery Priority Area 1 of the Pallid Sturgeon Recovery Plan). Evaluation of these HRJPS is necessary to determine their performance in a natural lotic environment. Stocking pallid sturgeon that cannot adapt to their natural lotic environment would be an inefficient way to recover the species. Therefore, we decided to compare the habitat use, movements, growth, and food habits of 1997 year class HRJPS and indigenous juvenile shovelnose sturgeon (JSNS) in Recovery Priority Area 1. Although similar in many aspects, pallid and shovelnose sturgeon are two distinct species, and differences in ecology should exist. Therefore, a large amount of resource overlap between the two species may indicate limiting habitat for HRJPS. Alternatively, observed differences in habitat use, movements, and food habits may help define the needs of HRJPS relative to JSNS.

In the summer of 2003, we implanted radio transmitters in 10 HRJPS from the 1997 year class and 13 JSNS. Abiotic habitat variables measured at each fish location included temperature, velocity, substrate, macrohabitat, and presence of islands and alluvial bars within 350 m. Cross section profiles were recorded at each fish location by driving the boat from one riverbank to the other along a transect. Longitudinal profiles were also recorded while driving the boat from 50 m downstream to 50 m upstream of each fish location. Depth was recorded in 5 m increments in all profiles. These data were useful in determining maximum depth, relative depth, and distance to thalweg of each fish location. In addition, diet information was obtained from all captured HRJPS and JSNS using a gastric lavage.

Nine radio-tagged HRJPS and 12 JSNS were relocated. Differences in use of macrohabitat between the two species were observed in June and July, however, more similarities were apparent in August. Relative depth of HRJPS increased from June-August in cross section profiles, but was similar in longitudinal profiles. Relative depth data for JSNS have not been analyzed.

Diet information was obtained from 16 HRJPS (2 from the 2001 year class and 14 from the 1997 year class) and 64 JSNS. Stomach contents were obtained from eight of the HRJPS (1 from the 2001 year class and 7 from the 1997 year class). Fish made up 82% of the wet weight of HRJPS. Other diet items found in HRJPS stomachs included Chironomidae, Ephemeroptera, Trichoptera, detritus, and plant material. Diet data for JSNS have not been analyzed, however, no fish were found in the diet.

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LOWER MISSOURI AND YELLOWSTONE RIVERS PALLID STURGEON STUDY

The Montana Department of Fish, Wildlife & Parks (MTFWP) Pallid Sturgeon Study crew, the Fort Peck Flow Modification Project crew (Pat Braaten, Dave Fuller, Nate McClenning, Willie Waller), and the U. S. Fish and Wildlife Service (USFWS) combined efforts during the last two weeks of April and the first two weeks of May to capture adult pallid sturgeon for hatchery broodfish. All sampling was completed within a few river miles of the Fairview Bridge on the Yellowstone River, and the confluence of the Missouri and Yellowstone rivers. Collectively we captured 49 pallid sturgeon, consisting of 42 different individuals. The recapture rate of previously marked pallid sturgeon was very high; only 7 of 42 fish were unmarked (83% recapture rate). This is similar to the 81% recapture rate observed during 2002, and much higher than the 50% recapture rate observed during several years previous to 2002 in these netting efforts. Catch-per-unit-effort of pallid sturgeon from MTFWP's netting efforts was one pallid captured per 57.8 minutes drift time, or one pallid captured per 7.2 net drifts.

During the 2003 broodstock collection efforts, the Pallid Sturgeon Study crew captured 16 different wild pallid sturgeon in 983 minutes of drifting 124 6"x10" trammel nets, resulting in a CPUE of 0.9766 wild pallid sturgeon per drift hour or 0.1290 per net drift. During the 2003 field season, we captured an additional three wild pallid sturgeon in 3,774 minutes of drifting 100 75 foot and 365 150 foot trammel nets, resulting in a CPUE of 0.0477 wild pallid sturgeon per drift hour or 0.0065 per net drift. Three of the 18 wild pallid sturgeon captured were unmarked fish. The abundance of wild pallid sturgeon in RPMA #2 during 2003 was estimated using all available catch records from the Pallid Sturgeon Study crew, the Fort Peck Flow Modification Project crew, and the USFWS. It was estimated that 151 wild pallid sturgeon remained in RPMA #2 during 2003. Upper and lower 95% confidence limits were 236 and 89, respectively. With no natural recruitment occurring, wild pallid sturgeon in RPMA #2 will be extirpated during 2018 if abundances continue to decline at rates similar to those observed during 1991 – 2003.

Western Area Power Administration provided additional funding during 2003 so that we could better evaluate hatchery reared pallid sturgeon (HRPS) stocked into RPMA #2. We completed another year of standardized sampling in hopes of testing fish community responses to Fort Peck Spillway releases, but no releases occurred. Consequently, the majority of our fieldwork during 2003 was focused on sampling and evaluating HRPS stocked into RPMA #2. During the 2003 field season, the Pallid Sturgeon Study crew sampled 26 HRPS in 3,733 minutes of drifting 100 75 foot and 361 150 foot 6"x1" and 6"x¾" mesh trammel nets, resulting in a CPUE of 0.44179 per drift hour or 0.0564 per net drift. We also sampled four HRPS with 201 setlines (42,233.55 hook hours), resulting in a CPUE of 0.0199 per setline or 7.1×10^{-5} per hook hour. Twenty-seven HRPS sampled during 2003 were 2001 progeny stocked during 2002, one was a 2002 progeny stocked during 2003, one was a

1998 progeny stocked during 2000, and one was a 1999 progeny stocked during 2000. Five of 19 HRPS appeared to have shed their PIT tags, resulting in a 26.32% shedding rate. An angler near the Big Muddy swirl hole reported one additional HRPS capture.

Bill Gardner reported that his crew was having success angling for HRPS and he encouraged us to give it a try, so we spent 13.08 hours angling for HRPS during 2003. While no HRPS were sampled, we managed to capture many other species, including some shovelnose sturgeon. I plan on comparing catch rates between angling and other methods once we have more angling hours logged. Angling should be a useful technique for sampling in backeddies, snag-filled areas, and other sections of the river that cannot be effectively sampled with trammel nets.

Matt Baxter and crew assisted with the tagging of HRPS spawned at Miles City fish hatchery. Hatchery-reared pallid sturgeon spawned at the Miles City fish hatchery were tagged on August 5th and stocked later that week, while HRPS spawned at Gavins Point National Fish Hatchery were stocked on August 28th. Stockings of both batches, which consisted of 4,124 individuals, occurred at Intake, Fairview, Culbertson, and Wolf Point.

MTFWP received cost-share funds from the Billings Chapter of Montana Walleyes Unlimited to purchase radio telemetry tags to be used in a Missouri River sauger telemetry study. We began radio transmitter implantation in September of 2002 and implanted two additional sauger during 2003. It has been difficult to capture sauger large enough to accommodate the transmitters, but we will continue our efforts until all 32 tags are implanted. The Fort Peck Flow Modification Project crew has agreed to track the tagged sauger. The information collected during this study will provide a basic understanding of sauger habitat use in this reach of the Missouri River, and will provide additional data to evaluate the Fort Peck Dam flow modifications.

Office time during 2003 was spent: (1) entering data collected during 2003; (2) analyzing data from HRPS sampled during 2003; (3) estimating survival of 1997 and 1999 progeny HRPS stocked into RPMA #2; (4) calculating population abundance estimates for wild pallid sturgeon in RPMA #2 during 2002-2003; (5) forecasting population abundances of HRPS in RPMA #2; (6) providing comments on the 'Stocking Plan Addendum'; (7) completing the AFS Peer Review questionnaire; and (8) completing various administrative duties. Draft reports have been written for items 2, 3, and 4, and they are currently being revised. Electronic copies will be available when revisions are final.

With little hope of spillway releases occurring in the near future, we are planning on abandoning our standardized sampling efforts designed to test fish community responses to spillway releases. During the 2004 field season, we will focus on adult collection efforts and evaluation of HRPS stocked in RPMA #2. With Western Area Power Administration and the Bureau of Reclamation committing additional funding to the Pallid Sturgeon Study crew, we are looking to implement a spatially comprehensive trammel netting, trawling, and setline effort to evaluate HRPS in RPMA #2. A spatially comprehensive sampling effort has been difficult to employ in the past due to a lack of personnel and river access issues, but such an effort will allow us to estimate growth rates, weight-length relationships, movements, and most importantly, survival rates of HRPS stocked in RPMA #2. We also plan to implant 70 HRPS with radio transmitters and release 35 near Sidney, MT and 35 at the Fairview Bridge on the Yellowstone River. We will track these fish for the life of their transmitter batteries (1-3 months) in hopes of answering some questions regarding HRPS movements immediately after stocking in the Yellowstone River.

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FORT PECK FLOW MODIFICATION BIOLOGICAL DATA COLLECTION PLAN

The Fort Peck Flow Modification Biological Data Collection Plan (hereafter the Data Collection Plan) is a multi-year monitoring project designed to evaluate the influence of proposed flow and water temperature modifications from Fort Peck Dam on physical habitat elements and biological response of pallid sturgeon *Scaphirhynchus albus* and other native fishes. The Data Collection

Plan for 2003 was comprised of six main monitoring components: 1) measuring water temperature and turbidity at several locations downstream from Fort Peck Dam, 2) examining movements by pallid sturgeon that inhabit areas immediately downstream from Fort Peck Dam, 3) examining flow- and temperature-related movements of paddlefish *Polyodon spathula*, blue suckers *Cycleptus elongatus*, and shovelnose sturgeon *Scaphirhynchus platorynchus*, 4) quantifying larval fish distribution and abundance, 5) sampling for young-of-year (YOY) sturgeon, and 6) conducting a larval sturgeon drift study. The Data Collection Plan is supported by the U. S Army Corps of Engineers, and was initiated in 2001. Thus, the 2003 field season represents the third year of data collection activities. Similar to 2001 and 2002, spillway releases from Fort Peck Dam did not occur during 2003 due to insufficient precipitation and low water levels in the reservoir.

For Monitoring Component 1, water temperature was monitored between April and October at 18 locations during 2003 using continuous-recording (1-hr intervals) water temperature loggers. Turbidity was monitored at three locations in the Missouri River (Frazer Rapids, Poplar, Nohly) and one location in the lower Yellowstone River using continuous-recording (1-hr intervals) turbidity loggers. Water temperature and turbidity were also monitored at 2-3 day intervals concurrent with larval fish sampling (see below).

For Monitoring Component 2, one adult pallid sturgeon was sampled in the Fort Peck Dam tailrace in mid-November 2003 using a gill net. This occurrence represents the first documented incidence of pallid sturgeon in the tailrace during the last few years. The pallid sturgeon was surgically implanted with a combined acoustic/radio transmitter (CART tag), and will be tracked during the next few years.

Activities for Monitoring Component 3 during 2003 included implanting blue suckers, shovelnose sturgeon, and paddlefish with CART tags during September 2003, and relocating fish implanted with CART tags during previous years (i.e., 2001, 2002). In September 2003, a total of 20 shovelnose sturgeon, 19 blue suckers, and 1 paddlefish sampled in the Missouri River between Fort Peck Dam and the Yellowstone River confluence were implanted with CART tags. The three species were relocated in the Missouri River from Fort Peck Dam to near the headwaters of Lake Sakakawea (350 km) and in the lower Yellowstone River (113 km). Relocations were obtained at weekly intervals from April through July 2003, and at bi-weekly intervals from August through October 2003. Adult pallid sturgeon implanted by the U. S. Fish and Wildlife Service were also relocated during the tracking intervals as part of this study component. Between April and October, a total of 9,360 km of river were tracked by boat in the Missouri River and lower Yellowstone River. Tracking efforts resulted in 794 relocations of shovelnose sturgeon, 557 relocations of blue suckers, 289 relocations of paddlefish, and 173 relocations of pallid sturgeon. Flights were also conducted during September and October to relocate fish in areas not tracked by boat. Flights resulted in two relocations of blue suckers and four relocations of shovelnose sturgeon upstream from Intake Diversion Dam. In addition, three paddlefish and one pallid sturgeon (at-large for more than one year) were relocated in the headwaters of Lake Sakakawea. Six continuous-recording telemetry ground stations were also deployed throughout the Missouri River to record upstream and downstream movement events of fish. Four individuals of each species were selected for the internet-based and newspaper-based Adopt-A-Fish Program. This program is administered by Walleyes Unlimited and the Billings Gazette, and provides the opportunity for classrooms throughout the country to adopt a fish, name a fish, follow weekly movements via the internet, and learn about fish in the Missouri River.

For Monitoring Component 4, larval fish were sampled during 21 individual sampling events between late May and early August. A total of 2,052 larval fish samples were obtained from four sites in the Missouri River downstream from Fort Peck Dam (below Fort Peck Dam, spillway channel, Wolf Point, Nohly), and one site in the Milk River and Yellowstone River.

For Monitoring Component 5, benthic trawling was conducted during August and September to sample for YOY sturgeon. Trawling was conducted primarily in the lower 60 km of the Missouri River upstream from the headwaters of Lake Sakakawea, and to a lesser extent in the lower 4 km of the Yellowstone River. Trawling resulted in the collection of 137 YOY sturgeon, and based on initial observations, a few of these individuals exhibit pallid sturgeon characteristics. These individuals will be more closely examined in the near future.

A multi-year comprehensive study of larval sturgeon drift behavior

and drift dynamics as directed under Monitoring Component 6 was initiated in late June 2003. The overall goal of this study is to obtain an understanding of larval sturgeon (shovelnose and pallids) drift behavior and drift dynamics related to hydraulic conditions in the Missouri River. This initial study was conducted in a natural side channel of the Missouri River, and had the following objectives: 1) to examine the vertical distribution of larval shovelnose sturgeon in the water column, 2) to determine drift rates of larval shovelnose sturgeon, and 3) to provide initial considerations for modeling larval sturgeon drift dynamics in the Missouri River.

In addition to monitoring activities, information on hatchery-raised and adult pallid sturgeon was also obtained during 2003. Field activities resulted in the collection of 25 hatchery-raised juvenile pallid sturgeon, and three adult pallid sturgeon. Personnel also assisted in collecting pallid sturgeon broodstock during the spring.

Activities associated with the Data Collection Plan will be expanded in 2004, and continue through at least 2008 as outlined in a new 5-year agreement with the U. S. Army Corps of Engineers. The expanded Data Collection Plan includes: 1) measuring water temperature and turbidity, 2) examining seasonal use and movements of pallid sturgeon in the Missouri River upstream from the Yellowstone River confluence, 3) examining flow- and temperature related movements of shovelnose sturgeon, paddlefish, and blue suckers, 4) quantifying larval fish distribution and abundance, 5) quantifying the distribution and abundance of YOY sturgeon, 6) examining the drift behavior, drift rate, and transport of larval sturgeon, 7) quantifying the food habits of piscivorous fishes, 8) evaluating the effectiveness of the Fort Peck spillway fish barrier, and 9) assisting in pallid sturgeon broodstock collection.

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Evaluation of a Gastric Lavage Method on Juvenile Pallid Sturgeon

Due to the endangered status and the limited knowledge on the early life history of the pallid sturgeon *Scaphirhynchus albus*, a non-lethal method for investigating food habits was tested for safety and efficiency on age-1 pallid sturgeon. Pallid sturgeon were fed a mixture of prey items including earthworms *Lumbriscus terrrestris*, red worms *Alloloborpha calliginosa*, meal worms *Tenebrio molitor*, and wax worms *Galleria mellonella*. Two test groups were gastric lavaged and one group was not lavaged but held as a control (N = 30 in each group). Over a 60 d test period, no mortality was observed. No significant differences were detected in the lengths and relative condition between the gastric lavaged groups and the control group over the 60 d test period. The efficiency of the lavage procedure also was evaluated on juvenile pallid sturgeon (N = 29). A proportion of food items were recovered from 100% of the sturgeon with food items in their stomach. The average recovery rate for all food items combined by number and by weight was 74.9% and 73.7% respectively.

Introduction

The pallid sturgeon *Scaphirhynchus albus* was listed as a federally endangered species in 1990 (Dryer and Sandvol 1993). The early life history of the pallid sturgeon is not completely understood, at least partially because little to no recruitment has occurred on the Missouri River above Gavins Point Dam for more than 40 years, which coincides with the closure of Missouri River dams (Keenlyne and Jenkins 1993). Currently there is no information available on the food habits of juvenile pallid sturgeon

Most studies on food habits have involved sacrificing large numbers of fish. Examination of food contents from the stomach of carcasses has been conducted for pallid sturgeon and shovelnose sturgeon *S. platorynchus* (Carlson et al. 1985); Atlantic sturgeon *Acipenser oxyrinchus* (Johnson et al. 1997); lake sturgeon *A. fulvescens* (Choudhury et al. 1996); Gulf sturgeon *A. o. desotoi* (Mason and Clugston 1993); and white sturgeon *A. transmontanus* (Sprague et al. 1993). Given the endangered status of most sturgeon species, a safe method of studying food habits is needed.

Gastric lavage, or stomach flushing, is an effective and efficient method used to safely remove food items without sacrificing the fish (Meehan and Miller 1978). Gastric lavage involves inserting a tube down the esophagus into the stomach where water is flushed to induce

regurgitation. Gastric lavage has been used in food habit studies of various sturgeon species with varying success and differential mortality rates. While performing gastric lavage on juvenile white sturgeon, Sprague et al. (1993) found that water injected at too high pressure could rupture the swim bladder and result in death. Brosse et al. (2002) evaluated gastric lavage methods on adult Siberian sturgeon *A. baeri* with fork lengths (FL) of 780 – 1050 mm and recovered food items with no mortality, but found a significant difference in weight change between the lavaged and the control sets of sturgeon after 60 d ($P = 0.008$). Haley (1998) found no mortality while using gastric lavage techniques on shortnose sturgeon *A. brevirostrum* (mean FL, 732 mm; range 533 - 937 mm) and juvenile Atlantic sturgeon (mean FL, 718 mm; range 484 – 1,150 mm). Although there was no mortality, the fish were anesthetized in tricaine methanesulfonate (MS-222) allowing the muscular region of the alimentary canal to relax. The Pallid Sturgeon Recovery Team has prohibited the use of MS-222 on pallid sturgeon due to detrimental effects, including mortality (Steve Krentz, Pallid Strugeon Recovery Team Leader, personal communication; U. S. Fish and Wildlife Service [USFWS], Bismarck, ND; December 2002). Food items have also been recovered with ease from the shovelnose sturgeon with no mortality (Dane A. Shuman, personal communication; University of Nebraska-Lincoln, School of Natural Resource Sciences, Lincoln, NE; November 2002). The objective of this study was to evaluate the safety, in terms of mortaility or growth after being gastric lavaged, and to evaluate the efficiency of this technique to recover food items from juvenile pallid sturgeon.

Methods

The safety and efficiency of the gastric lavage technique was tested at the Bozeman Fish Technology Center (USFWS) in Bozeman, MT from February to April 2003. The tests were performed on hatchery-reared, age-1 pallid sturgeon (mean FL, 408 mm; range 179-515 mm and mean weight, 215 g; range 80-480 g). The pallid sturgeon were not fed for a period of 4 d before being fed a mixture of different types of prey including earthworms *Lumbriscus terrrestris*, red worms *Allolobophora calliginosa*, meal worms *Tenebrio molitor*, and wax worms *Galleria mellonella*,. Two test groups (lavage 1 and lavage 2) were gastric lavaged and one test group was kept as a control (N = 30 in each group). The control group was measured, weighed, fed, and maintained at similar temperatures (22°C to 23°C) over the same period of time as the sturgeon that were gastric lavaged. Another group (N = 29; mean FL, 407 mm; range 179 – 490 mm and mean weight 219 g; range 135 – 350 g) was gastric lavaged, then sacrificed to evaluate food removal efficiency.

A gastic lavage method was performed that followed the techniques of Foster (1977) and by using a pressurized reservoir (Light et al. 1983; and Brosse et al. 2002) on juvenile pallid sturgeon. The advantage of using a pressurized air tank is that it provided a continuous supply of water during the gastric lavage process. The apparatus was a 5.5-L hand pumped pressurized garden sprayer tank fitted with a 3.18 mm outside diameter polyethylene tube. The pulsed gastric lavage procedure began 30 min after feeding. With the pallid sturgeon held dorsal side down at a 45-degree angle, the polyethylene tube was slowly inserted through the esophagus as far as the first stomach loop. Water was then lightly pulsed into the stomach to dislodge food items as the tube was slowly withdrawn from the stomach and esophagus. After the stomach filled with water, the anterior of the sturgeon, approximately where the stomach is located, was lightly massaged to facilitate regurgitation. The food items were regurgitated onto a 500 μm-mesh sieve. This process was repeated until regurgitation ceased, assuming the stomach was emptied. The procedure lasted approximately 2-3 min for each fish, during which time the gills were constantly hosed with fresh water.

All pallid sturgeon were measured and weighed before being gastric lavaged, at 30 d, and at 60 d. Differences in mean length were examined between the gastric lavaged and control sturgeon groups over the 30 d and 60 d test period using a two-way analysis of variance (ANOVA) with a least-squares means multiple range test (SAS 1988).

Condition indices between the gastric lavaged and control test groups of sturgeon were compared using the relative condition factor (Kn; Anderson and Neumann 1996). Relative condition factor is calculated as $Kn = (W/W')$, where W is weight of the individual and W′ is the length-specific mean weight predicted by a weight-length equation calculated for that population. Keenlyne and Evanson (1993) provided a weight-length regression [$\log_{10}W = -6.378 + 3.357 \log_{10}L$ ($r^2 = 0.974$)] for pallid sturgeon. Because of a significant interaction term in a two-way ANOVA, differences in mean Kn between groups over the 30-d and 60-d period was determined using a one-way

ANOVA with the least-squares means multiple range test. Examining the growth and Kn over the test period will indicate whether the sturgeon resumed feeding and grew after being gastric lavaged.

A group of 29 pallid sturgeon was tested for gastric lavage efficiency. After a fish was gastric lavaged and regurgitation was presumed to have ceased, the food items collected on the 500 μm-mesh sieve were identified and weighed. The sturgeon was then sacrificed to examine remaining food items in the stomach. The remaining food items were also identified and weighed. Efficiency was calculated as the percent by number and weight of food items recovered from a sturgeon.

Results

Safety of the method

Throughout the 60 d test period, no mortality was observed in the gastric lavaged or control groups. In all groups, there was no significant growth in length after 30 d ($P = 0.261$). However, the pallid sturgeon showed a significant increase in length between 30 d and 60 d for all groups ($P = 0.002$). There was no significant differences between the control group and the two lavaged groups at 0 d (lavage 1, $P = 0.400$; lavage 2, $P = 0.229$), at 30 d (lavage 1, $P = 0.350$; lavage 2, $P = 0.0958$), or at 60 d (lavage 1, $P = 0.585$; lavage 2, $P = 0.0952$).

Mean Kn did not significantly differ between the control group and the two gastric lavaged groups at 0 d (lavage 1, $P = 0.319$; lavage 2, $P = 0.520$), at 30 d (lavage 1, $P = 0.8903$; lavage 2, $P = 0.500$), or at 60 d (lavage 1, $P = 0.123$; lavage 2, $P = 0.132$). Throughout the 60-d test period, the control group Kn was nearly intermediate between the two gastric lavaged groups.

After the 60 d test period, five of the gastric lavaged sturgeon were sacrificed to examine the digestive tract at the Bozeman Fish Health Center (USFWS). No damage was observed through the digestive tract. Gross examinations of the swim bladder revealed no water. However, four of the five sturgeon had inflated swim bladders. A histological examination of the swim bladder tissues was conducted, but was inconclusive in determining that any changes were due to the gastric lavage procedure (Staton 2003).

Efficiency of the method

Juvenile pallid sturgeon ($N = 29$) were tested for food removal efficiency. Some food items were recovered in all sturgeon that had food items in the stomach when the gastric lavage procedure began ($N=25$). Overall, the average food recovery rate for all food items by numbers and by weight recovered was 74.9% and 73.7% respectively. The percent composition by weight of food items recovered from the sturgeon were earthworms 86.7% ($N = 11$, $SE = 0.249$, Range 0-100), red worms 82.9% ($N = 21$, $SE = 0.239$, Range 0-100), meal worms 49.4% ($N = 14$, $SE = 0.376$, Range 0-100), and wax worms 75.0% ($N = 4$, $SE = 0.391$, Range 0-100).

Discussion

Due to the endangered status and limited knowledge of the early life history of the pallid sturgeon, the safety of gastric lavage was investigated. Gastric lavaging is considered a safe and effective method for removing food items from fish stomachs (Meehan and Miller 1978; Hyslop 1980; Hartleb and Moring 1995; Haley 1998; Brosse et al. 2002). No pallid sturgeon mortality was observed over the 60 d test period, similar to gastric lavage findings on other sturgeons (Haley 1998; Brosse et al. 2002). Haley (1998) attributed the success and presumed safety of the technique to using flexible intramedic tubing and anesthetizing the sturgeon with MS-222. The Pallid Sturgeon Recovery Team has prohibited the use of MS-222 on pallid sturgeon so a gastric lavage technique was tested without anesthesia. The results of the growth and Kn analysis of the juvenile pallid sturgeon tests indicate that the gastric lavage procedure did not cause undue stress and feeding resumed soon after handling. Using a pressurized tank with a constant supply of water and not anesthetizing the sturgeon has the advantage of limiting handling time to 2-3 min per fish compared to 20 min per fish in the study by Haley (1998).

A proportion of food items were recovered from 100% of the pallid sturgeon with food items in their stomach. Food items were recovered up to 2 h after fish were fed. Meal worms were recovered at a much lower rate compared to earthworms, red worms, and wax worms. Meal worms have a hardened exoskeleton compared to the soft-bodied earthworms, red worms, and wax worms, which may explain the variation of recovery rates. Brosse et al. (2002) also found variations in the recovery rate of prey items, where only 50% of the vermiform prey and 75% of larger prey, fish and shrimp, were recovered. Brosse et al. (2002) also found that the recovery rate of food items after 2 h or more was much lower, indicating the technique will most likely recover the most recently ingested food items. Further investigations are needed on the recovery rate of different prey items in the wild. Without

knowledge of recovery rates, the gastric lavage technique may only provide a qualitative determination of food habits (Haley 1998). Extreme caution is advised while employing gastric lavage for juvenile pallid sturgeon, as the small, 3.18 mm outside diameter tubing could easily puncture the swim bladder if excessive pressure is used to insert the tube down the esophagus. In some cases, constriction of the alimentary canal was experienced while inserting the tube and while injecting water into the stomach. Care was taken to reduce the amount of water injected into the stomach which allowed time for the sturgeon to relax and begin regurgitation. Brosse et al. (2002) inserted a large diameter tube (12 mm) into the digestive tract of an adult Siberian sturgeon, then a smaller diameter tube (6 mm) within the larger tube to prevent puncturing the swim bladder and allow food items to flush out while injecting water. Further studies are needed to determine the appropriate tube sizes for various sizes of pallid sturgeon.

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Continued Development of a Bioenergetics Model for Juvenile Pallid Sturgeon

At present, 19 respiration experiments measuring the routine metabolic rates of juvenile pallid sturgeons have been completed. Measurements were made on 139 individual pallid sturgeon at 11 temperatures (range: 4 to 21.5 °C) from three year classes: 34 fish from the 2001 year class, 94 fish from the 2002 year class, and 11 fish from the 2003 year class. Experiments on pallid sturgeon from the 2001 year class were conducted at the Bozeman Fish Technology Center (BFTC) while experiments using the 2002 and 2003 year classes were done at the Gavins Point National Fish Hatchery. Survival of fish during the experiments was excellent, only 5 fish died during trials conducted with the 2001 year class at BFTC. Data analysis is ongoing and initial results will be presented on December 8, 2003 in the Sturgeon and Paddlefish session at the 64th Midwest Fish and Wildlife Conference in Kansas City, Missouri.

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Evaluation of Sampling Techniques for Juvenile Pallid Sturgeon and Food Habits of Sturgeon in the Missouri River

The U. S. Army Corps of Engineers (USACE) (USACE 2002) has proposed to develop standard operating procedures (SOP) for a long-term monitoring program of pallid sturgeon. However, there is no knowledge of when or where to effectively capture pallid sturgeon. The Upper Missouri River Basin Pallid Sturgeon Work Group (UBPSWG 2002) has also identified the need to evaluate sampling techniques and gear, particularly for juvenile pallid sturgeon. Gear type, habitat, and species behavior, all contribute to seasonal variability in catch per unit effort (CPUE) (Pope and Willis 1996; Jordan and Willis 2001).

Recruitment through the juvenile stage is believed to be one of the major factors limiting pallid sturgeon recovery. Currently, there is no diet studies completed on juvenile pallid sturgeon. Knowledge of the food habits of juvenile pallid sturgeon and the sympatric shovelnose sturgeon is vital to identifying the limiting factors to pallid sturgeon recruitment and eventual recovery. The information from this study will fill a gap in the life history of the endangered pallid sturgeon and evaluate the utility of RPA III as a recovery site. Fisheries managers will have a better understanding of the diets of the juvenile pallid sturgeon enabling sound decisions for recovery efforts such as stocking/augmentation programs. The diet information gained in this study is also essential for future studies including bioenergetics modeling (Klumb 2002).

Study Objectives

Objective 1**:** To determine the effectiveness of a benthic beam trawl, drifting trammel nets, static gill nets, hoop nets, and set lines to capture juvenile pallid sturgeon in different seasons and habitats.

Objective 2**:** To determine growth and condition of juvenile pallid sturgeon in the riverine portion of Lewis and Clark Lake and assess Recovery Priority Area III as a suitable area for continued sturgeon stocking and recovery efforts.

Objective 3**:** To determine the relative weights (Wr) of

shovelnose sturgeon in the riverine portion of Lewis and Clark Lake compared to other shovelnose sturgeon populations within the geographic distribution of the species.

Objective 4**:** To compare the food habits of juvenile pallid sturgeon and adult shovelnose sturgeon in the riverine portion of Lewis and Clark Lake.

Objective 5**:** To determine the seasonal food habits of juvenile pallid sturgeon and adult shovelnose sturgeon.

Study Area – Recovery Priority Area III (RPA III)
The riverine section of Lewis and Clark Lake extends approximately 71 km with a maximum depth of 12 m and a channel width of 45-90 m, from Fort Randall Dam to Springfield, SD where its features become more like a reservoir.

Methods
Sampling Gear
Fish sampling occurred once every two weeks from April through October during 2003. Techniques included four "standard gears" for pallid sturgeon assessment in the protocol described in a proposal (USACE 2002) for a standard operating procedure (SOP) for long-term monitoring of the fish community in the Missouri River. The standard gears are static gill net sets, drifted trammel nets, hoop nets, and a benthic beam trawl. Additionally, I targeted shovelnose sturgeon and juvenile pallid sturgeon with set lines as a "wild gear."

When water temperatures were below 12 EC, gill nets were set overnight for a maximum of 18 hours. I used multi-filament gill nets that were 1.8 m deep X 38 m in length consisting of five 8 m long panels with bar mesh sizes of 2.54 cm, 3.81 cm, 5.08 cm, 7.62 cm, and 10.16 cm, float lines of 1.27 cm poly-foamcore, and lead line of 22.7 kg leadcore.

Trammel nets were drifted for a target distance of 300 m. A global positioning system (GPS) unit was used to quantify the distance sampled. Trammel nets were 1.8 m deep X 38 m with outside wall panels of 15.24 cm bar mesh and an inside wall panel of 2.54 cm bar mesh with a float line of 1.27 cm poly-foamcore and lead line of 22.7 kg leadcore.

The beam trawl used was 0.5 m deep and 2 m wide with an outer chafing net with bar mesh of 0.635 cm, an inner net with bar mesh of 0.318 cm, and a cod length of 2 m. As with the trammel net, the target towing distance for each beam trawl was 300 m.

Hoop nets (1.2 m diameter hoop; 4.8 m in length with 3.81 cm bar mesh) were set overnight for a maximum of 18 h.

I used set lines throughout the sampling periods using Mustad Tuna Circle hooks (10/0 and 12/0). Each set line was 2 m in length and anchored to keep the bait near the river bottom (3 pound anchor). The line size was #60 braided nylon twine with barrel swivels and hooks were staged at 1 m intervals from the anchor. The set lines were marked with a float attached to a 40 ft line attached to the anchor with snap hooks. Set lines were set overnight baited with earthworms and leeches (when available May through August) for a maximum of 18 h.

Food Habits
The materials used for the gastric lavage were similar to those used by Foster (1977) and Brosse et al. (2002). The apparatus used was a hand pumped pressurized garden sprayer tank. A polyethylene tube with an outside diameter of 6.4 mm was fitted on the end of the garden sprayer hose. With the sturgeon held dorsal side down at a 45-degree angle, the polyethylene tube was slowly inserted down the esophagus as far as the first stomach loop. Water was then lightly pulsed into the stomach to dislodge food items as the tube was slowly withdrawn from the stomach and esophagus. After the stomach was filled with water, the ventral side of the sturgeon, approximately where the stomach is, was lightly massaged to facilitate regurgitation. The food items were regurgitated onto a 500 Fm-mesh sieve. This process was repeated until regurgitation ceased, assuming the stomach was emptied. The procedure lasted approximately 2-3 min for each fish, during which time the gills were constantly hosed with freshwater. The food items collected on the 500 µm-mesh sieve were then preserved in 10% formalin. The safety of the gastric lavage technique was evaluated on hatchery reared juvenile pallid sturgeon at the Bozeman Fish Technology Center before being attempted on fish in the field.

2003 Results
Gill nets
11 pallid sturgeon were captured in April (2), October (2), and November (7) in 106 gill net nights.

Trammel nets
33 pallid sturgeon were captured in April (3), June (1 adult), July (1), August (23), September (2), and October (3). 534 trammel nets were drifted for approximately 114,077 m.

Hoop nets
No pallid sturgeon were captured in 198 (4,005 hours) hoop net nights from April through September.

Beam Trawl
No pallid sturgeon were captured in 353 beam trawl tows for approximately 105,900 m from April to August. Beam trawling was abandoned after the apparent failure to catch any fish species. In 2004, a new trawl design will be used to sample the fish community.

Set lines
16 juvenile pallid sturgeon were captured in April (3), May (1), July (2), August (2), September (2), and October (6) (Table 1). Set lines were set for 2,002 hook nights for 14,897 hours. All pallid and shovelnose sturgeon were captured on nightcrawlers. Only two smallmouth buffalo were captured in 472 hook nights with leeches.

Table 1. Mean lengths and weights of juvenile pallid and adult shovelnose sturgeon captured on setlines.

Sp	Hook size	N	mm	g
PLS	10/0	11	611.7	721.1
PLS	12/0	5	569.0	581.2
SNS	10/0	8	650.8	1082
SNS	12/0	8	671.5	1213

Juvenile Pallid Sturgeon Relative Condition Factor (Kn)
Condition indices on juvenile pallid sturgeon were evaluated using the relative condition factor (Kn; Anderson and Neumann 1996). Relative condition factor is calculated as Kn = (W/W′), where W is weight of the individual and W′ is the length-specific mean weight predicted by a weight-length equation calculated for that population. Keenlyne and Evanson (1993) provided a weight-length regression [$\log_{10}W = -6.378 + 3.357 \log_{10}L$ ($r^2 = 0.974$)] for pallid sturgeon throughout its range.

Although all juvenile pallid sturgeon have declined in Kn, most appeared healthy and doing well at the time of being recaptured.

Shovelnose Sturgeon Relative Weight (Wr)
Relative weight was calculated for shovelnose sturgeon captured in 2003. Relative weight (Wr) is calculated as: Wr = W/Ws X 100 where W is the actual weight and Ws is the length-specific standard weight for that species (Wege and Anderson 1978). A standard weight (Ws) equation was developed for shovelnose sturgeon by Quist et al. (1998).

Food habits of juvenile pallid and adult shovelnose sturgeon
Gastric lavage was performed on all sturgeon captured in 2003. Analysis of diet contents has not occurred. 100 % of the prey items collected from shovelnose sturgeon were aquatic insect larvae. Most of the prey items collected from juvenile pallid sturgeon were aquatic insect larvae, although a few minnows were collect from two pallid sturgeon.

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NEBRASKA GAME, FISH AND PARKS COMMISSION PALLID AND LAKE STURGEON CATCH REPORTS

Nebraska Game Fish and Parks Commission has documented reported catches by anglers of pallid and lake sturgeon throughout the year. Each catch is rated into one of three categories;
1. Actual observation of the fish by a fishery biologist, where a positive identification can be made.
2. A catch reported by an individual that has either caught a sturgeon in the past or one that correctly answers questions asked about identification. A report that is accurate.
3. A reported catch that leaves doubt as to what specie it might be.

In 2003 there were two reported pallid sturgeon catches that were rated #1, 54 catches rated #2 and four rated #3. There were also three lake sturgeon catches that were reported. Two were considered #1 and one was rated #2. All anglers were sent a pin and book when possible.

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NEBRASKA GAME AND PARKS COMMISSION PALLID STURGEON UPDATE

The Nebraska Game and Parks Commission is participating with the U.S. Army Corps of Engineers in the Long Term Pallid Sturgeon Assessment. NGPC is working on the reach from the Platte River (River Mile 595.0) to the Kansas River (R.M. 367.5).

Gill net sampling began in March of 2003. In 100 net nights, over 2,400 sturgeon where sampled, two of which were pallids. Both

pallids were sampled from the inside bend, wing dike tip pools. The first was sampled on March 24 on Nebraska Bend. It had been previously PIT tagged and had a fork length of 561 mm and weighed 580 grams. It was spawned in 1999 and stocked on April 25, 2002 at Booneville, Missouri (RM 195.1). Prior to stocking, it had a fork length of 570 mm and weighed 390 grams. The second was collected on March 26 on Upper Barney Bend. This pallid was checked for PIT and coded wire tags, but was not tagged. It had a measured fork length of 1,080 mm and weighed 4,250 grams.

After gill netting, we sampled with drifted trammel nets, hoop nets, two-meter beam trawls and 16 ft. otter trawls. While sampling on May 29 with an otter trawl, a pallid sturgeon was sampled on Calumet Bartlett Bend at the toe of the upper revetment which was lined with limestone. The sturgeon had a fork length of 894 mm and weighed 2,750 grams, and had not been previously tagged.

During fall gill netting, two more pallids were sampled. The first was sampled on November 10 in the engineered Hamburg Chute. It was sampled below a limestone hard point in a pool. It had not been previously tagged, and had a fork length of 1,027 mm and weighed 3,990 grams. The second was collected on November 11 on Lower Cottier Bend, in an outside bend revetment scallop hole. It had been previously PIT tagged and had a fork length of 562 mm and weighed 428 grams. It was spawned in 1999 and stocked on November 1, 2002 at Bellevue, NE (R.M. 601.4). Prior to stocking, it had a fork length of 488 mm and weighed 506 grams.

Nebraska Game and Parks Commission has received funding from the USACE to continue work in 2003-2004 on the Long Term Pallid Sturgeon and Associated Fish Community Assessment project.

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GRAND ISLAND, NE ECOLOGICAL SERVICES FIELD OFFICE

Negotiations continued throughout 2003 on the development of a Platte River Recovery Implementation Program for the whooping crane, interior lest tern, piping plover, and pallid sturgeon. The hydrologic effects of the proposed Program as developed to date, appeared to be largely neutral for pallid sturgeon in the lower Platte River. As a result, in order to provide defined benefits, an approximately $4 million research plan on use of the Platte River by pallid sturgeon has been designed and funding has been tentatively agreed to by the participants. The findings of the research are to be used to develop additional pallid sturgeon recovery measures that can be undertaken in the Platte River in the future. Recently identified additional anticipated depletions to spring peak flows would constitute an adverse effect to pallid sturgeon, and as a result, negotiations on a means to offset this adverse effect are ongoing. A resolution to this issue is expected in early 2004, and final development of the proposed Program, along with completion of the associated NEPA and ESA reviews is anticipated by the end of 2004.

Funding has continued for studies performed by Dr. Ed Peters and his staff at the University of Nebraska, to monitor water quality parameters and collect information on bed sediment in the lower Platte River and its major tributaries. This data collection will provide additional information that can be used in conjunction with Dr. Peters' ongoing pallid sturgeon and sturgeon chub research in the lower Platte River.

Field work has been completed for the health risk assessment for pallid sturgeon in the lower Platte River using shovelnose sturgeon as a surrogate. Results of histological analyses on the shovelnose sturgeon tissues collected are expected by the end of 2003. Production of the report will follow accordingly.

The Nebraska Field Office has worked with the Federal Highways Administration (FHWA) on Platte and Missouri River bridge construction and replacement projects to ensure wider spans, which pose less of a channel constriction issue, and construction timing so as to minimize activity in the river during the time of high pallid sturgeon use. Staff has also worked with the Corps of Engineers (COE) on dredge discharge to the Platte River to address timing issues similar to those considered with FHWA.

The Nebraska Field Office also worked with the Omaha Public Power District on its effort to relicense the Fort Calhoun Nuclear Station, along the Missouri River. As a conservation measure in the relicensing process, OPPD will contribute $100,000 to habitat restoration on DeSoto National Wildlife Refuge. The restoration will consist of a series of 100-200 ft. notches in the revetment lining the outside bend of the river on refuge lands. In the area of the notches, the river is expected to scour into the bankline, creating an area of slower water adjacent to the main channel, of the type that pallid sturgeon are being found using by Nebraska Game and Parks Commission (NGPC) researchers and recreational anglers reporting pallid captures to the NGPC. The COE is investigating a series of additional habitat restoration activities that could also be carried out on the refuge (e.g. chute development, top widening, levee notching and chevron construction). Additional details on the proposed activities are expected in 2004.

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U.S. Army Corps of Engineers Update Kansas City & Omaha Districts

The Corps is involved in a variety of pallid sturgeon activities in the Missouri River Basin. Pallid sturgeon population assessment, propagation/population augmentation and focused research efforts are ongoing throughout the Missouri River system encompassing both the Omaha and Kansas City Districts of the U.S. Army Corps of Engineers.

Population Assessment
Efforts in the development of Standard Operating Procedures (SOP) guiding population assessment activities on the Missouri River are progressing. The population assessment program has been partially implemented during this development phase over the past couple of years. Partial implementation of the program in the early phases has enabled the crews to "field test" the sampling methods while collecting data on pallid sturgeon and a series of representative native species. These field tests have been critical in the development and refinement of the SOP's. State and federal agencies located throughout the basin comprise the existing crews conducting population assessment surveys in conjunction with this program. The Corps is in the process of assembling additional sampling crews to incorporate all of the high priority river segments as identified in the 2000 Missouri River Biological Opinion.

Propagation/Population Augmentation
The Corps has provided support to the 6 hatcheries (2 State, 4 Federal) to increase propagation production to fulfill annual stocking goals for the Missouri River system. This annual support will continue as it has in the past. In addition to this annual support, the Corps and partners are pursuing the expansion and modification of the hatchery facilities to further enhance production capabilities, improve water quality and overall quality of the hatchery reared pallids.

Focused Research
The Corps is supporting research efforts in the Fort Peck Reach to evaluate flow enhancement via the spillway at Fort Peck Dam. Biological data collection efforts were initiated in 2001 and will continue through 1-year following the "full-test". All sampling efforts prior to the "full-test" will serve as preliminary data to evaluate the benefits of the prescribed warm water releases (spring rise) identified in the 2000 Missouri River Biological Opinion.

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Rock Island, IL Ecological Services Field Office

In 2003, the U.S. Fish and Wildlife Service's Environmental Contaminants Program was awarded a grant to investigate sturgeon contaminants risks in the Middle Mississippi River. The grant is administered by the Rock Island, IL Ecological Services Field Office (RIFO) under the On-Refuge Contaminants Investigation Program. The partners for the investigation include the Mark Twain National Wildlife Refuge Complex, the Middle Mississippi River National Wildlife Refuge and the U.S. Geological Survey Biological Resources Division Columbia Environmental Research Center in Missouri (CERC). The investigation has three phases. The first and second phases will be completed by the CERC. The first and second phases include egg toxicity testing to determine the

adverse affects levels for PCBs and a now banned organochlorine insecticide known as chlordane. Phase one, PCB egg toxicity testing, was completed in 2003. The toxicity test results data are currently being analyzed.

In 2004, we initiated the second phase of the investigation. The second phase includes the egg toxicity with chlordane. The third phase is to identify those reaches in the Upper Mississippi River that pose a risk to sturgeon based on the results generated by the toxicity tests. This will be accomplished by using GIS to compare existing wild sturgeon whole body contaminants data to the adverse affects concentrations determined by the toxicity testing. The states and other federal projects have generated a series of wild sturgeon meat and roe contaminants data for much of the Middle Mississippi River. The GIS model will highlight those reaches where the wild sturgeon whole body contaminants data are above the adverse affects levels for reproduction.

This risk characterization will be used to help conserve the federally listed endangered pallid sturgeon along about 175 river miles of the Middle Mississippi River along Illinois and about 150 river miles of the Missouri River along Iowa. The final report for the investigation is scheduled for FY05.

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Genetic Discrimination of Pallid and Shovelnose Sturgeons

We are employing multiple genetic (microsatellite) markers to distinguish between pallid and shovelnose sturgeons. This technique requires only a tiny piece of tissue (e.g. fin punch or barbell clip) and thus can be done non-invasively. To date the research has focused on sturgeons from the Middle Mississippi River. Sturgeon are initially classified using a previously developed character index (CI, Willis et al. 2002) to exclude as many potential hybrids as possible. Once the baseline data for each species are developed the technique can be applied to all Scaphirhynchus specimens to further refine morphological indices and to determine whether morphologically intermediate sturgeons are hybrids.

Presently, we have analyzed 60 shovelnose and 53 pallid sturgeons from the Middle Mississippi River at 12 DNA microsatellite loci. Results show significant genetic differentiation between pallid and shovelnose sturgeons with two distinct gene pools of Scaphirhynchus in the middle Mississippi that are largely concordant with morphological identification. Assignment testing, which involves removing individual sturgeons from the data set and assigning them to the most likely species based on data from the remaining sturgeons correctly place 95% of all sturgeons (52/53 pallids and 64/69shovelnose) into the species suggested by the CI data. The six specimens that were not consistently scored using molecular and morphological traits may be hybrids, a hypothesis that we will address in the next phase of this project.

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Illinois Department of Conservation

Although there are currently no projects being conducted by the Illinois Department of Natural Resources (IDNR) that directly involve pallid sturgeon, staff working under the Boundary Rivers Program of the IDNR have started evaluating shovelnose sturgeon populations on the Mississippi River with a small mark-recapture study. A total of nine pallid sturgeon have been collected, measured, weighed and released under this study. All of these fish were collected from Mississippi River Mile 190, by drifting 3" mesh trammel nets over a gravel bar. Five pallid sturgeon were captured on May 16, 2003 and two pallid sturgeon captured on May, 23 and July 15, 2003.

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MIDDLE MISSISSIPPI RIVER PALLID STURGEON STUDIES

A total of 41 pallid and 3,636 shovelnose sturgeon have been captured, tagged, and released over a 16-month sampling period in the Middle Mississippi River. The ratio of pallid to shovelnose sturgeon is 1:89. Total effort for all gears (gill nets, trawls, trotlines) and agencies (Missouri Department of Conservation, Southern Illinois University-Carbondale, and Corps of Engineers Waterways Experiment Station) combined is 15,452 hours, which is equivalent to 644 days of sampling. Sampling confirmed known areas where sturgeon are seasonally abundant: Chain of Rocks low water dam, Modoc, and RM 70 near Neely Creek. Recaptured sturgeon provided evidence that shovelnose move from the Middle Mississippi River upstream to pooled reaches of the Upper Mississippi River and the lower reach of the Missouri River during winter/spring. Pallid recaptures indicated no substantial movement during summer months; one pallid was recaptured twice at the same location (Chain of Rocks) during summer 2003.

Other activities included the telemetry and genetics study, both being conducted by SIU. During Year 1, 16 pallid sturgeon were fitted with transmitters and tracked throughout the 200-mile reach. As of May 2003, SIU had 136 pallid sturgeon relocations, covering a total of 1,290 river miles. In addition to boat tracking, remote receivers will be used during Year 2 and coordinated with pallid sturgeon researchers in the lower Missouri River to the extent possible. Genetics study indicated strong differentiation between pallid and shovelnose sturgeons using microsatellite DNA techniques, suggesting that pallid, shovelnose, and "intermediate" sturgeon can be identified genetically within 1-2 years.

Summer 2003 sampling has been completed with only 3 pallid sturgeon collected during the warmwater period. However, higher catches are anticipated for the remainder of Year 2 sampling (i.e., through May 2004) as water temperatures decline. Age and diet of pallid sturgeon will continue to be investigated, both of which will require coordinated meetings to agree on final methodologies and results.

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CONTE ANADROMOUS FISH RESEARCH CENTER

Completed in 2003

In 2003, Conte Anadromous Fish Research Center completed a study of the behavior and passage of large juvenile pallid sturgeon in an experimental side baffle upstream fish passage. We found that pallids, like other sturgeon, will use this fishway type. The key seems to be keeping velocities in the fishway low so fish can swim in the prolonged mode. A report was submitted to the U.S. Corps of Engineers and a paper was submitted for publication to the American Fisheries Society (AFS).

We completed another study of downstream migration timing and diel behavior of yearling pallid sturgeon in an experimental artificial stream. When experiments began in early September, yearling pallid sturgeon were migrating downstream. Movement peaked at a water temperature of 11 C in late October and ceased at 6 C in early December. Fish actively swam head first downstream, and did not drift passively. Most movement was at night. There has been a paper written and submitted for publication to AFS.

In Progress

Conte AFRC has initiated further study of downstream migration of early life stages in nine artificial stream tanks in July 2003. We are investigating (1) the effect of three water velocity environments on the duration of migration of pallid free embryos and larvae, and (2) the vertical distribution of pallids during migration. A report will be written in December 2004.

We are currently writing a paper on the seasonal habitat selection of age 0 pallid sturgeon. Completion of this paper will be sometime in early 2004.

Planned

2004 will include the continuation of the study of migration duration of pallid sturgeon in laboratory streams. Shovelnose sturgeon will possible be used for comparison with the results from the pallid sturgeon study.

We would like to conduct a test on large juvenile pallid sturgeon in a prototype spiral fish ladder that shortnose and lake sturgeon and

many species of riverine fishes use.

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USGS Columbia Environmental Research Center Research Activities

Researchers at the USGS Columbia Environmental Research Center (CERC) are involved in several integrated studies examining the reproductive biology and ecology of the pallid sturgeon and shovelnose sturgeon.

Reproductive Studies
Recovery efforts require information on sturgeon reproductive physiology and the influence of environmental variables on reproductive maturation and spawning. CERC is developing minimally-invasive methods to determine pallid and shovelnose sturgeon gender, age, and reproductive status. The study uses age, blood hormone levels and anatomical and histological gonad observations in developing endoscopic and ultrasonic methods. Between May 2001 and June 2002 we collected 380 shovelnose sturgeon from the lower Missouri River. Additionally, in April of 2002 data on 16 pallid sturgeon and 9 shovelnose sturgeon were collected from the Upper Missouri River below Fort Peck Reservoir and Lower Yellowstone River in cooperation with USFWS pallid sturgeon propagation efforts. These reproductive assessment techniques are to be applied in the field with pallid sturgeon and shovelnose sturgeon to monitor reproductive status and maturation of fish implanted with telemetry devices.

Ultrasound and Endoscope Effectiveness
Our research objective was to evaluate the effectiveness of endoscopic and ultrasonic imagery to distinguish different stages of gonadal maturity throughout the year in the laboratory and field.

Success of the methods depended on their invasiveness (i.e., field ultrasound < laboratory ultrasound < endoscope through oviduct < endoscope through abdominal incision). Minimally invasive techniques (i.e., endoscopic methods) identified late stage adults with greater than 90%. Except for the endoscope through an abdominal incision, all four methods were more successful at identifying males than females with success at identifying gender greater in later stages of reproductive maturation. April and May were the months with the most advanced reproductive stage, the same months when ultrasound was most effective. A manuscript presenting these results is currently in review. We will continue to work on development of methods for using these techniques to assess not only egg stage but gonadal size and female fecundity in sturgeon. (Contact: Mark Wildhaber, USGS Columbia Environmental Research Center, 4200 New Haven Road, Columbia, MO 65203, 573 876-1847, mwildhaber@usgs.gov).

Fort Peck Pallid Sturgeon Gender Identification
Our specific objective was to evaluate the effectiveness of endoscopic and ultrasonic imagery to visually observe the gonads of pallid sturgeons in the field.

Ultrasonic and endoscopic methods gave similar results on shovelnose sturgeon collected in the Upper Missouri and Lower Yellowstone rivers as was observed for the shovelnose sturgeon collected in Lower Missouri River. For pallid sturgeon collected in Upper Missouri and Lower Yellowstone rivers ultrasound was successful at identifying gender; however, the endoscope through the oviduct was only successful at identifying gender when the oviduct was not opaque. These results have been presented in a report to the U.S. Army Corps of Engineers (Contact: Mark Wildhaber, USGS Columbia Environmental Research Center, 4200 New Haven Road, Columbia, MO 65203, 573 876-1847, mwildhaber@usgs.gov).

Fecundity and Hormones
Fecundity estimates have been made and egg maturation (distance from animal pole to germinal vesicle) was measured. Blood plasma collected from all fish has been analyzed for 17ß-estradiol. Analysis of 11-ketotestosterone and vitellogenin are pending. Results from initial 11-ketotestosterone testing indicated exceptionally low levels (up to 1000 times lower) than would be expected for males based on existing information from other sturgeon species. Results are being verified using a different method, although we (and an outside laboratory) determined that another androgen, testosterone, is at normal levels. Shovelnose sturgeon vitellogenin was isolated and purified. We have found that the gulf sturgeon anti-body to vitellogenin cross-reacts with the shovelnose vitellogenin and are near finalizing optimization of an ELISA Measured hormone levels are being correlated with histological observations of shovelnose sturgeon reproductive stage to improve imagery analysis and monitor reproductive activity

of Missouri River sturgeons being observed in telemetry studies. (Contact: Diana Papoulias, USGS Columbia Environmental Research Center, 4200 New Haven Road, Columbia, MO 65203, 573 876-1902. dpapoulias@usgs.gov)

Hermaphrodism
Laboratory examination of the reproductive organs of shovelnose sturgeon collected from the lower Missouri River have revealed a significant incidence of fish with an atypical condition described as hermaphroditism (organs exhibit characteristics of both males and females). The condition was characterized by fish having reproductive organs that were mostly male tissue with the addition of eggs/oocytes . Of the 380 fish collected, 25 were intersex individuals. Although we are uncertain of the genetic sex of these individuals, assuming that the affected individuals were males, we are observing an incidence of intersex as high as 13 % among males. Whether this condition also occurs in pallid sturgeon is unknown. The causative factors and consequences of hermaphroditism on the reproduction of Missouri River sturgeon are also uncertain. Livers were also collected from a sub sample of fish and have been tested for EROD as an indicator of exposure to certain contaminants. (Contact: Diana Papoulias, USGS Columbia Environmental Research Center, 4200 New Haven Road, Columbia, MO 65203, 573 876-1902, dpapoulias@usgs.gov)

Contaminants
Investigators at CERC are also collaborating with Mike Coffey, Rock Island Ecological Field Office, USFWS, on a study to determine the effects of contaminants on the embryonic development and behavioral responses in early life stages of the shovelnose sturgeon as a surrogate for the endangered pallid sturgeon. During FYs 2002 and 2003 we artificially spawned shovelnose sturgeon and exposed sturgeon embryos to TCDD, PCB, and chlordane. This work will continue in FY2004. We also provided assistance this year to Matt Schwarz, Nebraska Field Office, USFWS, for his health risk assessment for pallid sturgeon on the Lower Platte River using shovelnose sturgeon as a surrogate. The information we provided included quantification of macrophage aggregates in liver; histopathology of kidney, spleen, liver, and gonad; reproductive staging of gonads; and liver EROD. (Contact: Diana Papoulias, USGS Columbia Environmental Research Center, 4200 New Haven Road, Columbia, MO 65203, 573 876-1902, dpapoulias@usgs.gov or Don Tillitt, USGS Columbia Environmental Research Center, 4200 New Haven Road, Columbia, MO 65203, 573 876-1886, dtillitt@usgs.gov).

Aging
Numerous studies have examined age and growth of shovelnose sturgeon but only one of these studies attempted to validate age estimation techniques. Therefore, our objective was to use marginal increment analysis to validate annulus formation in pectoral fin rays of the shovelnose sturgeon collected from the Lower Missouri River. We also compared precision of age estimates between two different readers.

Marginal increment distance indicated that an opaque band was laid down in pectoral fin rays during the summer for most of the population, however, opaque bands were formed throughout the year in some individuals Presence of split annuli, false annuli, spawning bands, imbedded rays, and deteriorating sections made individual growth rings difficult to separate. Agreement of age estimates by two readers for shovelnose sturgeon was only 18%, and differences in ages between the two readers increased for older-aged fish. Results will soon be published in the North American Journal of Fisheries Management. (Contact: Vincent H. Travnichek, Missouri Department of Conservation, Resource Science Center, 1110 South College Avenue, Columbia, MO 65201, 573 882-9880, travnv@mdc.state.mo.us or Mark Wildhaber, USGS Columbia Environmental Research Center, 4200 New Haven Road, Columbia, MO 65203, 573 876-1847, mwildhaber@usgs.gov).

Habitat Use by Telemetry
Habitat-use studies are focused on the timing of movements in relation to reproductive status, environmental conditions, and habitat availability in the river. A pilot study was successfully conducted with shovelnose sturgeon to determine the applicability of electronic data storage tags (DST) for use in these species. Shovelnose sturgeon were surgically implanted with acoustic telemetry location tags and small archival devices (DST) that continuously record the temperature and depth of the habitats selected by the fish. Three of eight tagged fish were followed and successfully recaptured after several months to retrieve the archival tag and to examine changes in reproductive status. Data from the depth sensor within the DST devices indicated that adult sturgeon generally used depths greater than 2 meters and may remain active throughout the winter. Temperature data from DST devices implanted within the fish closely followed the temperature of the river. By

comparing temperature data collected by the DST devices with temperature data collected at different locations in the Missouri River and its tributaries it may be possible to determine whether these fish enter tributaries to spawn or search for food.

Two pallid sturgeon were implanted with ultrasonic telemetry transmitters and archival temperature/depth recording tags in 2003. A female in the early stages of egg development was implanted in late March. A non-spawning male was implanted in late May. The female remained within a two-mile reach of river throughout the year and we continue to monitor her movements. The male swam upstream immediately after implantation. Movement averaged nearly 8.1 km per day (metric maintains consistency with the rest of the document over the next 17 days). The tagged fish moved rapidly through several habitat rehabilitation sites (Overton, Jameson Island, Lisbon Bottoms), but did not occupy any of these sites for any length of time. Contact was lost with the male fish in late August, 161 km upstream from the implantation site. Both fish were relocated at depths ranging from 1.4 to 10.8 m. Depths used by both fish averaged nearly 4 m and depths less than 2 m were rarely used. Two areas used by these fish were intensively mapped using single-beam bathymetry, acoustic Doppler current profiler, a substrate classification system and sidescan sonar. We will continue to monitor habitat use the winter. We hope to recapture and reexamine both individuals to reassess their reproductive status and replace the implanted tags. (Contact: Aaron Delonay, USGS Columbia Environmental Research Center, 4200 New Haven Road, Columbia, MO 65203, 573 876-1878, adelonay@usgs.gov).

Habitat Use Assessment and Availability

CERC Pallid Sturgeon investigations include evaluations of habitat used by pallids, habitat available in the river, and the processes that create and maintain habitat. Generally, habitat can be evaluated as combinations of depth, velocity, and substrate. In aquatic systems, habitat availability varies with hydrologic and geomorphic characteristics. The CERC River Studies Branch assesses habitat availability through hydroacoustic mapping and hydraulic modeling of river reaches. Specific efforts are applied to identifying and mapping potential spawning sites. Habitat use is assessed through hydroacoustic mapping of habitat patches occupied by pallid sturgeon and identified by telemetry studies.

Availability

Habitat availability has been addressed in four related studies. Habitat availability at index discharges was assessed (with habitat use) in the Fort Randall segment of the Missouri River. A coordinated assessment of hydroacoustic mapping and side-scan sonar at pallid sturgeon locations has been completed and will be published in a USGS open-file report in December 2003. Habitat availability in four side-channel chutes of the Lower Missouri River has been assessed through mapping and modeling, and will be published in a USGS open-file report in January 2004. This effort included 1-dimensional modeling to assess shallow-water habitat less than 1.5 m deep; this depth class is thought to be an index of habitat that is important for juvenile pallids and which is lacking in the Lower Missouri River (USFWS, 2000). Multi-dimensional hydraulic models have been constructed for the Missouri River at Hermann, Missouri, for simulation of habitat availability under 2000 and 1894 conditions. A manuscript describing this effort is in preparation.

Mapping has been 80% completed for a two-dimensional hydraulic model for 10 km of the Missouri River just upstream of Boonville, Missouri. The area of this map includes the confluence of the Lamine River and locations frequented by telemetered pallid sturgeon and Asian carp. Multi-dimensional hydraulic modeling will allow assessment of habitat availability (measured as depth, velocity, and substrate) over a wide range of flow frequencies. This information is critical in accounting for shallow-water habitat under baseline conditions and after construction of projects under the Missouri River Mitigation Program. (Contact: Robb Jacobson, USGS Columbia Environmental Research Center, 4200 New Haven Road, Columbia, MO 65203, 573 876-1844, rjacobson@usgs.gov).

Sediment Transport

Sediment transport is a critical component of aquatic habitat. At present, total sediment load of the Missouri River is very poorly quantified, and almost nothing is known about reach-scale sediment dynamics. Sediment availability may be a limiting factor in attempts to construct new habitat. In addition, sediment availability and transport mechanics are important design considerations for side-channel chutes whose longevity depends on precise balances between water and sediment load. CERC is initiating sediment studies to address these issues. (Contact: David Gaeuman, USGS Columbia Environmental Research Center, 4200 New Haven Road, Columbia, MO 65203, 573 441-2978, dgaeuman@usgs.gov).

Habitat Use
Habitat use is assessed through hydroacoustic mapping of patches (100's of m2 in area) around pallid sturgeon locations as identified by telemetry. Mapping includes depth, velocity, and substrate. Habitat selection can be evaluated by comparing habitat of occupied patches to habitat mapped in the surrounding reach. Habitat use has been evaluated in the Fort Randall reach and at pallid sturgeon locations in the Lower Missouri River approximately RM 181-183 and RM 221-222. (Contact: Robb Jacobson, USGS Columbia Environmental Research Center, 4200 New Haven Road, Columbia, MO 65203, 573 876-1844, rjacobson@usgs.gov)

Spawning Substrate
Cobble and gravel deposits have been identified as important spawning substrates for sturgeon. To date, 221 km of the lower Missouri River (river miles 263-126) have been surveyed for locations of potential spawning substrate. A total of 51 deposits and 27 bedrock outcrops in contact with the river have been mapped. The location, size and composition have been recorded for each of the deposits. Digital photographs have been taken at each site. We are investigating the origins of these deposits with the intent of providing a predictive model for where spawning substrates occur within the Missouri River valley. At present, four origins are apparent: re-deposited glacial till, local stream gravel (Ozark plateau), local limestone/dolomite deposited railroad ballast. The remaining 201 km of the lower river (Osage River to St. Louis) will be mapped in 2004. The information will be available to interested researchers as an interactive map using Internet Map Service technology. If interested in receiving the ArcView shapefile and photos prior to the availability of the map service contact Mark Laustrup, USGS Columbia Environmental Research Center, 4200 New Haven Road, Columbia, MO 65203, 573 876-1831, mlaustrup@usgs.gov.

MISSOURI COOPERATIVE FISH AND WILDLIFE RESEARCH UNIT DEPARTMENT OF FISHERIES & WILDLIFE SCIENCES UNIVERSITY OF MISSOURI

In the spring of 2002 Kerry Reeves, Lori Patton, and David Galat began a three year research project designed to characterize nursery habitat use by larval fishes in the lower Missouri River. To accomplish this, we are using a hierarchical framework to define nursery habitat with comparisons at the macro- (between primary and secondary channels, as well as sandbar types), meso- (sandbar regions), and micro- geographic scales (physical factors acting at $0.25m^2$). Nursery habitat will be defined using, species presence/absence, relative abundance, and species richness curves as indicators, then characterized using current velocity, depth, temperature, substrate type, bank slope, shoreline sinuosity, and distance from shore.

During 2002, sampling began 15 March, and ended 30 September. Samples were collected along ten sandbars and the associated primary and secondary channels between river miles 157 and 214. Each sandbar was sampled eight times during this period. Seven additional sampling trips were conducted focusing on diurnal patterns in larval fish habitat use. Samples were collected along sandbars using a push-cart with paired, 60 X 30-cm icthyoplankton nets with 500-µm mesh. Primary and secondary channel samples were collected using bow-mounted nets of the same design. Both gears sampled from the surface of the water to either the substrate, or a maximum depth of 30 cm.

During 2003 sampling began 10 April, and ended 30 September. Samples were collected along the same ten sandbars and their associated primary and secondary channels. Each sandbar was sampled four times, and additionally there were a total of four trips focused on diurnal patterns in habitat use. During 2003 a drop net with a $1/4m^2$ area X 1m in height was used to collect samples along the sandbar. This was done to more accurately characterize the micro-habitat characteristics influencing larval fish habitat use, and to sample the water column from the surface to the substrate. Primary and secondary samples were collected using the same method as 2002.

During 2002 approximately 90,000 larval fishes representing 40 taxa were identified. Of these, four were larval sturgeon. Totals for larval fish collection during 2003 are forthcoming, but four larval sturgeon have been identified so far. Analysis of larval fish habitat use is ongoing, with initial results presented at the 2003 Midwest Fish and Wildlife conference. The single larval pallid sturgeon was collected on June 21, 2002 approximately 2m from the downstream end of a sandbar formed behind a wing dike at river mile 171.

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U.S. Army Corps of Engineers Research and Development Center Waterways Experiment Station

The U.S. Army Corps of Engineers, Engineer Research and Development Center at Waterways Experiment Station (CEWES) began preliminary field investigations of pallid and shovelnose sturgeon populations near Rosedale, MS in 1997 with specimens from only a few gillnet and trotline samples. This research was part of a 3-year work unit on sturgeons funded by the Corps of Engineers Ecosystem Management and Restoration Research Program (EMRRP). Because the EMRRP research addressed multiple species of sturgeons, work on pallid sturgeon was limited to a descriptive study of swimming performance and to analysis of taxonomic data obtained from the handful of field-collected specimens. With four years of funding from the U.S. Army Engineer Mississippi Valley Division (MVD), the project has since then broadened in scope to include the entire Lower Mississippi River (LMR) and almost every aspect of *Scaphirhynchus* biology. A formal study was devised in 2000 with emphasis placed on habitat characterization and morphometric/meristic data collection. Concerted efforts to keep data collection consistent while methods were honed and updated have yielded a substantial database despite the elusive nature of the species. To date, a total of 115 pallid and 2,590 shovelnose sturgeons have been captured, tagged and released by CEWES in the LMR, yielding an overall pallid: shovelnose ratio of 1:23. Total effort for all gears (gill nets, trawls, trotlines) combined is 15349.4 hours, which is equivalent to 692 days of sampling .

Sampling the entire LMR is problematic given the vast geographic scale, so the sampling scheme was designed to address the influence of the river's large geomorphologic features as well as more subtle microhabitat characteristics. Use of a hierarchical system for habitat characterization allows for habitat assessments at multiple scales now and in the future. The objective of the first sampling year was to determine gear efficiency and seasonal chronology of sturgeon abundance. The second and third years focused on delineating the full geographical range of sturgeon in the LMR and capturing as many specimens as possible. An on-going goal is to determine habitat use and preference, which requires sampling in locations and during seasons when sturgeon-capture is unlikely as well as the locations and seasons that typically yield good catches.

Telemetry is not practical within 950 miles of free-flowing river, so emphasis has been placed on increasing recapture potential. In addition to PIT tags, CEWES uses external tags and this year will implement an educational campaign to increase recovery of the tags from commercial and recreational fishermen. Recaptures have already yielded invaluable data in the Middle Mississippi River and hopefully, similar results can be achieved in the LMR with time and effort.

From each pallid sturgeon captured, 17 morphological measurements, 5 meristic counts, several qualitative characters, a genetic tissue sample, a fin ray clip, and a fecal sample are collected along with all of the habitat variables from the capture site. Collection of these data allows taxonomic discrimination, age and growth investigation, and diet evaluation to be eventually linked with geographical and seasonal variables. While species discrimination using current methods is contentious, collaboration among investigators may provide resolution to this important issue in the next 1-2 years. CEWES plans to work with a team from St. Louis University and University of Alabama to establish field-identifiable species-specific characters for LMR sturgeon.

All pectoral fin ray clips collected by CEWES through November 2003 have been processed and several independent age reads are being recorded for each mounted specimen. Results from this study suggest that pallid sturgeon growth is highly variable among individuals but that annual mortality does not appear to be high. Initial examination of fecal material suggests disparity among shovelnose and pallid sturgeon diets. The presence of fish remains in almost all pallid samples and none of the shovelnose samples indicates that the pallid sturgeon has greater energy needs and different feeding habits than the shovelnose sturgeon. Forensic examination of fecal material indicates certain invertebrate taxa are habitual food items and that particular fish parts may be identifiable to familial taxonomic levels.

In December 2003, a study was initiated on the effects of sand and gravel mining on pallid sturgeon. Mississippi Limestone Corporation (MLC), in cooperation with the Corps of Engineers Memphis District and CEWES, allowed sampling to occur in association with actual gravel dredging activities near Tunica, MS. Comparing sturgeon data from dredged sites to data from undisturbed reference sites may

identify the effects, if any, of dredging on sturgeon behavior and/or occurrence. Trawling and trotlining were employed in tandem during the sampling event to document the occurrence of young of year and adults, respectively. CEWES plans to coordinate similar sampling events during future operations of the MLC dredge, and conduct a more detailed geomorphic assessment of dredged areas.

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TRAWL COLLECTIONS FROM THE MISSISSIPPI RIVER IN THE VICINITY OF VICKSBURG, MS

We were only able to sample for 9 days during 2003 due to extended high water stage and other complications. Of these, 8 days were at river stages ranging from 15-25 ft; the lowest stage sampled was 9 ft. We made 54 trawl pulls above Vicksburg, Mississippi at RM 439, 444, 446, 456,471, and 478. A total of 78 shovelnose sturgeon, 5 pallid sturgeon, and one intermediate were collected. Pallids were taken at approximately RM 478, 456, and 444, and ranged from 439-739 mm FL. Shovelnose were collected at all sites and ranged from 76-656 mm FL. Young of year shovelnose sturgeon (<140 mm FL) were more common in shallow (<9 ft), sand/gravel areas below gravel bars. One shovelnose tagged on 8/12/02 was captured, released, and reported by a commercial fisherman on 1/6/03. This fish had moved approximately 40 miles downstream.

By-catch consisted of shrimp, various aquatic insects, one softshell turtle, and 11 species of fish, including blue cat, channel cat, flathead, striper, paddlefish, drum, speckled chub, silver chub, shad, sauger, and blue sucker. An interesting side note was the discovery of the endangered fat pocketbook mussel (*Potamilus capax*) inhabiting the bases of Ajax and Ben Lomond dikes in secondary channels between RM 481- 489.

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BOZEMAN FISH HEALTH CENTER

Bozeman Fish Health Center continued its support of the pallid sturgeon recovery program in 2003 by conducting fish health assessments on hatchery reared juvenile pallid sturgeon. We conducted three assessments on fish from Garrison National Fish Hatchery and Miles City State Fish Hatchery, twice from Gavins Point National Fish Hatchery, and once from Neosho National Fish Hatchery.

For the fish health assessments, pallid sturgeon are randomly sampled to represent the family groups and/or rearing tanks at a rate of 60 fish/female for necropsy and histological evaluation.

Information regarding rearing conditions (e.g. water temperature, feeding rate, diet, mortality, etc) for the 30 d prior to sample collection is also requested from each hatchery.

The fish health assessments include gross necropsy, virus status, liver condition, and skin condition. Gross necropsy includes length and weight as well as any lesions present on the fish that are sampled. Virus status indicates whether the pallid sturgeon iridovirus is present or absent. If the virus is present then the severity of the infection is rated on a scale of one to five with one representing minimal infection of one or two infected cells present in the entire section of pectoral fin and five being a severe infection with too many cells to count in an entire section of pectoral fin. The condition of the liver is also examined to determine the fishes health. Fatty vacuolation of hepatocytes is scored from zero to five with zero being no fat present and five representing hepatocytes membranes that have ruptured due to fat accumulation in the cell resulting in the loss of normal liver architecture. A score of four is considered borderline pathological, five is pathological. Fat utilization and accumulation is an active process often resulting in observable zones of fat storage (particularly around vessels). To accommodate this occurrence, three sections of liver (obtained from 3 different areas) are examined and zones are scored separately for each section, then averaged to obtain a score for that individual liver. Skin condition is determined by examining one barbel and one pectoral fin from each fish. The number of mucus cells per ten fields at 10x are counted as well as the number of sensory epithelia (taste buds,

sensory pits) per ten fields at 10x and the condition (normal, degenerate, necrotic) of these cells is noted.

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BOZEMAN FISH TECHNOLOGY CENTER

Bozeman Fish Technology Center continued its research on sturgeon species in 2003 by completing several studies. The first study was "The effects of density on the health and growth of shovelnose sturgeon". The main purpose of this study was to evaluate the expression of the pallid sturgeon iridovirus in relationship to fish density. The second study was "The effect of diet modification on growth and quality of shovelnose sturgeon". The primary purpose for this study was to evaluate several different feeds and compare the overall quality of fish. This study coincides with the third study "The effect of dietary energy level on growth and lipid deposition of shovelnose sturgeon". The purpose of this study was to evaluate several different feeds and compare lipid deposition in the liver.

We also collected preliminary data for comparative analysis of two anesthetics: ms-222, Aqui-s for inducing fish to a handleable and fully anesthetized stage.

Currently we are studying the effects of vitamin D3, flourine and phosphorous on growth, survival and quality of shovelnose sturgeon. There are seven families of juvenile pallid sturgeon being held at the Technology Center. One family will be transported to Gavins Point National Fish Hatchery for future brood. The remaining six families will be stocked in the Upper Missouri River above Fred Robinson Bridge. A total of 3031 fish are presently located at the Bozeman Fish Technology Center.

Future activities include additional nutritional studies, further fin curl analysis and studying egg temperature tolerance during incubation. We also plan on assisting with capturing and spawning of adult pallid sturgeon above Fort Peck Reservoir and rearing any progeny from those efforts.

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GAVINS POINT NATIONAL FISH HATCHERY

After over 20,000 pallid sturgeon fry (2002 year-class) were transferred from the Garrison Dam National Fish Hatchery, ND, last year. Two months later 2,000 juveniles were shipped to the USGS Columbia Environmental Research Center in Missouri for their use in approved research pertaining to the recovery of that species. In mid-December 2002, approx. 3,740 juveniles from three families were transferred to the Neosho NFH, MO, for rearing, and later tagging and stocking in RPMA # 4.

The nine families of 2001 year-class future broodstock and stocking fish were PIT tagged. Approximately 159 of these fish, excess to our future broodstock needs, were stocked at two sites in the Missouri River below Gavins Point Dam. Additionally, hatchery facilities completing PIT tagging of pallid sturgeon now use the computer software that works in conjunction with the reader to scan the tag number into the database after the tag is injected into the fish. The fork length (mm) and weight (gms) are entered into the system along with other pertinent information.

Upper Basin Pallid Sturgeon Workgroup meetings were attended in Miles City, MT, in December and March; and the Middle Basin Pallid Sturgeon Workgroup meeting was attended in January. Herb has worked on both the Stocking Committee and the Propagation Committee with the goal of updating both the Stocking Plan and the Propagation/Genetics Plan. The Propagation Committee met at the Garrison Dam NFH in July 2003, and at the Gavins Point NFH in October 2003, with the final updated product to be completed by the March 2004. Additionally, we assisted Rob Klumb, Great Plains FWMAO Pierre, SD, with his research project entitled "Bioenergetics Model Development For Juvenile Pallid Sturgeon". He is exploring trophic interactions between fishes and their prey by using bioenergetics models. The objectives of this project are to derive empirical respiration parameters and energy densities for pallid sturgeon.

All twenty of the 20 foot and 30 foot diameter circular fiberglass tanks, along with nearly 90 percent of the plumbing supplies, were purchased for the Gavins Point NFH by the Corps of Engineers to be installed later in the new Advanced Rearing and Broodstock

Holding Facility. Now all we need is the building, but we are getting closer.

Our hatchery crew dismantled the two ultraviolet light disinfection units within the Endangered Species Building and replumbed them so that each one can be operated separately or both at the same time. If one UV unit needs maintenance at any time, then that one can be shut off while the other one continues to operate and disinfect the water. We were unable to operate this system in this way prior to project completion. The pallid sturgeon have better disease protection now.

Rick Barrows, Bozeman Fish Technology Center MT, provided our hatchery with an experimental broodstock diet (Sturgeon Grower 0305) for the 1998 year-class future spawners. This was a test diet to see whether these fish will consume the feed and how well they will perform once they start consuming it. Thus far, it appears that the fish are doing well on this diet.

Two fish health inspections were conducted on the juvenile pallid sturgeon at our hatchery. These were completed on 10/22/02 and 5/13/03. Fish were found to be nonsymptomatic for the iridovirus.

Hatchery staff provided spawning assistance to the staff at the Miles City State Fish Hatchery, MT, during the month of June 2003. Females were cathetorized, eggs were boiled in Ringer's solution, sectioned, and observed for polarization determination. LHRH injections were given to three females on June 30 and July 1 after it was determined that they were ready to spawn. Spawning occurred on July 1st and 2nd. A total of 6 families were made from the 224,000+ green eggs produced. Overall eyeup was 86.3 percent.

A total of 601 of the 2002 year-class pallid sturgeon juveniles were PIT tagged and stocked below Fort Randall Dam (RPMA # 3) on 7/24/03.

The hatchery crew PIT tagged 200 of the pallid sturgeon 2002 year-class fish for future broodstock.

The 2002 year-class pallid sturgeon juveniles were PIT tagged and elastomere tagged on 8/26/03. These 1,951 fish were stocked in RPMA # 2 in the Missouri River and lower Yellowstone River on 8/28/03 at four different sites with assistance from the Miles City SFH, MT.

The 2002 year-class pallid sturgeon juveniles were PIT tagged and elastomere tagged on 9/3/03. These 1,535 fish were stocked in RPMA # 4 in the Missouri River below Gavins Point Dam at three different sites.

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GARRISON DAM NATIONAL FISH HATCHERY

Through the efforts of Montana Fish, Wildlife and Parks, U.S. Geological Survey, and U.S. Fish and Wildlife Service personnel, adult pallid sturgeon were captured near the confluence of the Missouri and Yellowstone Rivers for spring spawning . Three females and eleven males were held at Garrison Dam National Fish Hatchery for spawning efforts. Three females and four males were transported to the Miles City State Fish Hatchery (one of the females held and spawned at Miles City (#4855) was spawned in 1999 at Garrison Dam NFH). The fish were concentrated up the Yellowstone River with the majority of the fish collected near the Highway 85 bridge.
Spawning occurred on June 25th following positive readings for both polarity indices and the progesterone assay on the two known females. One of the females spawned this year was a 30 pound fish that was assumed to be a male. All fish were injected with LH-RH to induce ovulation (0.05 mg/kg females, 0.02 mg/kg males). Matings were chosen based on the genetic makeup of the adults. Milt and eggs were transported by private plane between Miles City and Garrison Dam to accomplish the matings.

Results of the spawning of one female went very well with a collection of nearly 160,000 eggs and creation of five production lots and one additional brood lot. The second female ovulated poorly with production of 10,000 eggs, none of which proved viable. The third surprise female ovulated slowly with a collection of 38,000 eggs. The egg viability was poor with a total hatch of 250 fry. Post hatch mortality left us with only a handful of fish for the broodstock program.

Eggs from the first and third female were driven to Bozeman FTC. Eggs from the two successful spawns at Miles City SFH (six family lots) were driven to Garrison Dam NFH. Milt from all males spawned was received and frozen at Garrison Dam NFH with the assistance of the Warm Springs FTC. Success in the cryopreservation of milt this year lacked consistency with some samples showing 50% post freeze motility and others little to none.

Survival and growth of the 2003 progeny from both facilities was excellent. Gavins Point NFH received 4425 progeny from four females, representing 13 family groups. The fish were shipped at three times from October 6 - Nov 20. The average size of the fish was nearly 6 inches (36.6 per pound). Neosho NFH also received progeny from Garrison. A total of 3919 seven inch (19.3 fish per pound) fish representing three females and nine males were transported to their facility on October 30th. Direct stockings into RPA #4 took place on two occasions. Mulberry Bend, NE received 1763 seven inch fish comprised of three females and seven family lots on November 3rd. Bellevue, NE and Booneville, MO received 1800 fish each of the same lots on December 2nd. The fall stocked fish were coded wire and elastomer tagged. Garrison Dam NFH is currently maintaining 4000 progeny for the RPA #4 stockings this spring.

Stocking of the 2002 year class was completed mid July. A total of 5,448 ten inch fish representative of one female and four males were stocked at three sites in RPA #4. Water temperature at the stocking sites was 80°F, twelve degrees warmer than the hatchery. Tempering was done at the time of stocking.

A pallid sturgeon from the 1992 spawn at Blind Pony SFH held in a 400 gallon aquarium at Garrison Dam NFH for the past 7 years (transferred from Gavins Point) died the first of September. The fish weighed 3.8 pounds and was full of jet black eggs. The ovaries weighed 243 grams (14.5% body weight). The polarity index of the eggs indicated that the eggs were fully developed and ready for spawn. Apparently even under not so ideal conditions, some pallid females are sexually mature in 10 years and at less than 4 pounds!

A pallid from Garrison Dam NFH stocked at Bellevue, Nebraska in April 2002 at 174 mm FL was recaptured this spring. The length at capture was 350 mm - 6.9 inches of growth.

In July 2003, Montana Fish, Wildlife, and Parks (MTFWP) personnel collected 21 of the 2001 progeny (per MTFWP reports). Garrison Dam NFH had stocked 1626 of the 2001 progeny at 5 sites in RPA #2 on July 25th of 2002. Fifteen of the twenty-one fish sampled were from Garrison Dam NFH. Six fish were from Miles City SFH (1277 stocked). The average growth of the recaptured fish was 2 inches in the year spent at large. The range was 0.5 - 3.4 inches. Five more hatchery reared pallid sturgeon were sampled in August, two in September, and two in October for a total of 30 sampled. Three of the last four fish sampled were caught on a setline with a nightcrawler. Two of the three caught were from Garrison's 2001 progeny. They had grown to twelve and a half inches FL. One of the October fish sampled from Garrison was stocked at Intake, moved down the Yellowstone 70 miles and back up the Missouri 62 miles where it was sampled. The fish had grown 3 inches in the 14 months at large.

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NATCHITOCHES NATIONAL FISH HATCHERY

Wild adult sturgeon of genus *Scaphirhynchus* were captured from the Old River Control Complex (ORCC) in Concordia Parish, Louisiana for spawning attempts at the Natchitoches National Fish Hatchery (NNFH). Sturgeon collections were made on five dates from November 2002 to May 2003 via gill netting by commercial fishermen working with biologists of the Louisiana Department of Wildlife and Fisheries (LDWF). Of the 473 sturgeon collected, 20 (4.2%) were identified as the endangered pallid sturgeon *S. albus* (PLS); the rest were the more common shovelnose sturgeon *S. platorynchus* (HSN) and the hybrid between the two (PXH).

Fish collections were made on November 13, December 5, February 11, March 20 and May 16. The pallid sturgeon and some of the other sturgeon were implanted with a PIT tag and later released near the capture site on November 13, February 11, May 16 and May 28. Of the 31 sturgeon weighed, measured and PIT tagged, fork lengths ranged from 739 to 1002 mm (one small one which was released un-tagged was 358 mm) and body weights ranged from 1.56 to 4.22 kg.

Sturgeon were injected with LHRH on April 30, May 13 and May 22, for various reasons. No sturgeon females with strong pallid characteristics ovulated sufficiently for propagation at NNFH. Some pallid sturgeon males produced relatively large quantities of high-density sperm having at least 80% initial motility. Most of the sperm was given to Dr. Akos Horvath (who actually collected it), a sturgeon sperm cryopreservation expert from Hungary conducting post-doctoral research at Louisiana State University with Dr. Terry Tiersch. Dr. Horvath cryopreserved the sperm on-site at NNFH and

transferred the samples to LSU for more permanent storage there in liquid nitrogen. His intent was to later test the ability of the cryopreserved sperm to fertilize sturgeon eggs and to produce embryonic development at least to neurulation. His research design involved the evaluation of two levels of cryoprotectant and two types of sperm extender.

Two shovelnose sturgeon females ovulated sufficiently to test the cryopreserved sperm for Dr. Horvath's research. He used 12 treatments per female – each treatment of 2 g of eggs was fertilized with cryopreserved sperm having two cryoprotectant levels, two types of sperm extender and from two males. Additionally, control groups of eggs from each female were fertilized with fresh sperm from males 8656A and 6297A. Dr. Horvath confirmed cleavage to the two and four-cell stage within about four hours after fertilization in all treatment groups, and embryonic development past neurulation three days later. In general, Dr. Horvath reported 60-70% fertilization rates for all treatments. Thus, his protocols for sturgeon sperm cryopreservation were considered successful and approximately equivalent.

Two additional sturgeon spawning and research activities were evaluated using fish and oocytes from this FY. One involved our methodology to determine germinal vesicle migration through calculation of the polarity index. We found that we could use digital photomicrographs of bisected ooctyes projected onto a computer monitor for making polarity index measurements.

The other technique evaluated with sturgeon from this year was gastic lavage. We found that the University of Florida protocol prevented lavage water from entering the gas bladder. Thus, the technique we had used for sturgeon food habits last year proved safe for use with sturgeon.

One pallid sturgeon having an imbedded o-ring was severely infected with iridovirus.

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SCAPHIRHYNCHUS CONFERENCE

A conference exploring all aspects (political/social issues, systematics, population status/ distribution, artificial propagation/rearing, ecology, and behavior) of the biology of the shovelnose, pallid, and Alabama sturgeon will be held in St. Louis, Missouri, on January 11-13, 2005. Presentations and a poster session will be held on January 11-12 and on the 13th there will be a round table workshop on pallid sturgeon for interested parties. A Call for Papers will be sent in the near future and presentations are currently being solicited. For more information contact Dr. Tom Keevin (314)331-8462 or Dr. Rick Mayden (314)977-3494.

PALLID STURGEON TIP LINE OPERATIONAL

The U.S. Fish and Wildlife Service has recently developed a Pallid Sturgeon Tip-Line for anglers to call in pallid sturgeon captures and any pertinent information they may have on location and tags. This was in response to having a central collection point for any agency that wants to provide a call in number for anglers. It does not preclude agencies from developing their own collection methods, only providing another option for collecting information on the stocking efforts. Currently the plans are to respond to any calls, collect information and provide this information back to the monitoring crews in each state where the capture occurred. The last couple of years have resulted in several phone calls to various persons about the capture of tagged pallid sturgeon. This has provided monitoring crews with important information on where to possibly direct sampling efforts. Please feel free to use the number in any publication educating anglers about pallid sturgeon. The number to use is **1-888-203-9577**.

The Pallid Sturgeon Recovery Update is available online at the U.S. Fish and Wildlife Service website under pallid sturgeon activities:

www.mountain-prairie.fws.gov/moriver