Final Report

MANAGEMENT OF THE COMMERCIAL SHOVELNOSE STURGEON FISHERY WITHIN THE SYMPATRIC RANGE OF PALLID STURGEON

Developed Under the Direction of

Mississippi Interstate Cooperative Resource Association
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This final report from the MICRA Executive Board includes supporting documents that were a part of the decision making process for the recommendations provided. Project reports included herein were made possible by funds provided by MICRA and the states of Illinois, Kentucky, and Missouri. Report findings are those of the individual authors. Views expressed herein may not reflect those of all member states and agencies.

Acknowledgements

The MICRA Executive Board would like to extend it's appreciation to all state agencies and biologists who participated in this effort. Special thanks are extended to the States of Illinois, Missouri, and Kentucky for providing study funding; and to Rob Maher (Illinois), Paul Rister (Kentucky), and Vince Travnichek (Missouri) for their coordination of sample collections.

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SECTION I

MICRA Executive Board Report and Recommendations

In January 2007, the MICRA Executive Board was asked by the Paddlefish/Sturgeon Committee to consider petitioning the USFWS for a Similarity of Appearance Listing (SOA) for shovelnose sturgeon. The request was based on documented illegal harvest of the federally-listed pallid sturgeon by commercial fishers of shovelnose sturgeon, identification in the Pallid Sturgeon Recovery Plan of illegal harvest of pallid sturgeon as a primary threat to the species, as well as pallid sturgeon size and age structure differences between commercial and non-commercial reaches of the Mississippi River. The MICRA Executive Board initiated a review of the proposal in June 2007 and has continued the review until the conclusion of the process in August 2009.

Several steps were arranged to address the issue. First, a meeting of all interested parties was convened in May 2007 to present the current status and knowledge of the issues and to seek solutions to address the issue. Several MICRA Executive Board meetings and conference calls were held subsequent to the May 2007 meeting to discuss the issue and map a strategy to properly address the issue. The Executive Board formed a Sturgeon Working Group comprised of states within the basin that manage commercial shovelnose sturgeon fisheries. Informational meetings were held in February 2008 and March 2008 in the Missouri and Mississippi river sub-basins to provide a forum for all interested parties. In June 2008, MICRA hosted a meeting of all states currently managing a commercial shovelnose sturgeon fishery in the Mississippi River basin. The meeting resulted in a document that outlines a decision process and timeline for MICRA to address the '*Management of the Commercial Shovelnose Sturgeon Fishery Within the Sympatric Range of Pallid Sturgeon'* (Section II). The meeting participants agreed upon a series of statements regarding the recovery of pallid sturgeon that provided a common understanding of the issue and a framework for discussions.

These agreed upon statements were:

1. It is illegal to harvest pallid sturgeon, as well as hybrids or intermediates of shovelnose and pallid sturgeon.
2. This process only addresses the illegal harvest of pallid sturgeon by commercial fishers of shovelnose sturgeon.
3. Based on the pallid sturgeon recovery plan and findings of researchers,
    a. Commercial fishing of non-sturgeon species does not present a threat to the recovery of pallid sturgeon.
    b. Recreational angling of shovelnose sturgeon and all other species does not present a threat to the recovery of pallid sturgeon.
4. Several other threats currently are detrimental to the recovery of pallid sturgeon and these threats must be addressed by additional federal and state initiatives.
5. Law enforcement activities are a primary avenue for reducing all illegal harvest of pallid sturgeon and appropriate agencies must increase all enforcement activities.
6. Only by a cooperative effort by state and federal agencies can the recovery of pallid sturgeon be achieved.

The meeting participants also agreed that prior to implementing and evaluating any additional management strategies (both state and/or federal based), it is first necessary to confirm that commercial fishers can accurately distinguish shovelnose sturgeon from pallid sturgeon. Two fundamental issues were identified that needed to be addressed in order for states within the range of pallid sturgeon to continue, with MICRA support, to manage commercial shovelnose sturgeon fisheries within the sympatric range.

These two fundamental issues were:

1. The validation of an effective field technique for distinguishing shovelnose sturgeon.
2. The validation of the effective use of the field technique by commercial fishers to eliminate the harvest of pallid sturgeon.

To address these two issues, MICRA and the states of Illinois, Kentucky, and Missouri agreed to cooperatively fund an evaluation of the 2008-2009 commercial sturgeon harvest in these three states. The results of the study were intended to answer the fundamental issues and direct MICRA's future decision making on this issue. Results of the cooperatively-funded study were presented by biologists and researchers in June 2009 to the MICRA Sturgeon Working Group and final reports were submitted to the MICRA Executive Board in July 2009 (Sections III and IV). No genotypic pallid sturgeon were harvested by commercial fishers in the three states that cooperated in the study. As a result, the Sturgeon Working Group proposed a set of management strategies (Section V) to the MICRA Executive Board for consideration by states that continue to manage for the commercial harvest of shovelnose sturgeon within the range of pallid sturgeon.

The MICRA Executive Board met on July 29-30, 2009, to review and discuss the study results and recommendations of the Sturgeon Working Group in light of the decision-making process agreed to in June 2008 (Section II). Following a thorough review of the study findings, the Executive Board concluded that the study results were inconclusive based on the following findings.

1. Although no genotypic pallid sturgeon were harvested by commercial fishers, the management strategy and existing methods failed to limit the harvest to only shovelnose sturgeon.
2. Based on the Character Index (CI) described by Wills et al. (2002), four pallid sturgeon, as well as hybrid sturgeons, were harvested.
3. Genetic analyses determined several harvested sturgeon to be intermediate between pallid and shovelnose.
4. Illinois certified commercial fishermen were unable and/or unwilling to comply with Illinois regulations as demonstrated by the fact that more than 10% of the sturgeon harvested should have been released by commercial fishers.

In addition, the MICRA Executive Board agreed upon the following recommendations.

As to petitioning the USFWS on a Similarity of Appearance Listing:

- In light of the USFWS making known its intent to propose a Similarity of Appearance Listing,
  - MICRA will not petition the USFWS as requested by the Paddlefish/Sturgeon Committee.
  - MICRA encourages the USFWS to work cooperatively with all affected states (i.e., those states within the sympatric range of shovelnose and pallid sturgeon).
  - MICRA feels that the best management approach should be determined by the affected states.
  - MICRA encourages appropriate actions by states to maintain management authority of shovelnose sturgeon rather than to cede this authority to the federal government.

As to the Future Management of the Commercial Sturgeon Fishery within the Sympatric Reach:

- Study findings suggested that under the best conditions
  - It is extremely difficult to identify shovelnose sturgeon from hybrids or intermediates of shovelnose and pallid sturgeon,
  - Current regulations governing the harvest of shovelnose sturgeon are not 100% effective at limiting harvest to genotypic shovelnose sturgeon,
  - Commercial sturgeon fishers did not harvest genotypic pallid sturgeon,
  - Any commercial fishery for shovelnose sturgeon within the sympatric range will likely result in some level of non-compliance, regardless of the management strategies employed or the amount of law enforcement available,

- The Executive Board encourages states to take appropriate actions to keep management authority of shovelnose sturgeon within state jurisdiction through the timely implementation of focused strategies.

1. It is the MICRA Executive Board's opinion that any commercial fishery for shovelnose sturgeon, regardless of the management strategies employed or the amount of law enforcement available, will likely result in some level of non-compliance. Consequently, it seems apparent that the only way to eliminate harvest of pallid sturgeon and their hybrids is to close commercial fishing in the sympatric range of shovelnose and pallid sturgeon.
2. If a state decides not to close the commercial shovelnose sturgeon fishery within the sympatric reach, the MICRA Executive Board recommends, at a minimum, the timely implementation of the attached management strategies (Section V). The implementation of these management strategies must be dependant upon a commitment to increased law enforcement and research to refine criteria for field identification of shovelnose sturgeon.

SECTION II

MANAGEMENT OF SHOVELNOSE STURGEON WITHIN THE SYMPATRIC RANGE OF PALLID STURGEON

Prepared by the MICRA Sturgeon Working Group September 2008

Background: The Pallid Sturgeon Recovery Plan identifies illegal harvest of pallid sturgeon by commercial fishers as a primary threat to the survival and recovery of the species (USFWS 1993). Illegal harvest of pallid sturgeon has been documented in the Mississippi River, and appears to be a significant impediment to the recovery of the species (USFWS 2007). Researchers have reported pallid sturgeon populations within the lower reaches of the Mississippi River and Missouri River with older individuals and lower annual mortality estimates than the middle Mississippi River reach. In contrast to the lower reaches of the Mississippi River, commercial harvest of shovelnose sturgeon is permitted in the middle Mississippi River (Tennessee, Kentucky, Missouri, and Illinois) and in the selected reaches of the Missouri River (Missouri). Based on these findings, the 5-year review document for the pallid sturgeon states that illegal harvest of pallid sturgeon during commercial harvest of shovelnose sturgeon is having a substantial and detrimental effect on the pallid sturgeon in the middle Mississippi River (USFWS 2007). In addition, illegal harvest of pallid sturgeon is expected to increase in the middle Mississippi and lower Missouri Rivers, and illegal harvest to be an issue in the lower Mississippi and Atchafalaya Rivers, as caviar prices increase (USFWS 2007).

Nine of 13 state agencies which have jurisdiction over the regulation of commercial fisheries within the range of pallid sturgeon have prohibited the commercial fishing of shovelnose sturgeon to eliminate harvest of pallid sturgeon. Two state agencies (Missouri in 2003 and Tennessee in 2007) have unsuccessfully attempted to close their commercial shovelnose sturgeon fisheries. Consequently, four states (Illinois, Kentucky, Missouri, and Tennessee) currently allow commercial fishing for shovelnose sturgeon in sympatric pallid sturgeon reaches of the middle Mississippi River and Missouri River. These four states agencies have implemented focused management strategies with a goal to eliminate the incidental harvest of pallid sturgeon and plan to evaluate their effectiveness. These focused management strategies include restrictions on the harvesting of any sturgeon species other than morphometric and meristic distinct shovelnose sturgeon, closure of commercial fishing for shovelnose sturgeon in sensitive reaches, season and length restrictions, certification of commercial fishers, and requirements in the handling of harvested shovelnose sturgeon.

The USFWS has the legal authority to prohibit all commercial shovelnose sturgeon fishing in the United States by listing the species (shovelnose sturgeon) as Federally Threatened under the Endangered Species Act (ESA) based on similarity of appearance (SOA). A SOA listing is warranted if the Federally Endangered pallid sturgeon can not be adequately distinguished from the shovelnose sturgeon.

In January 2007, MICRA was asked to consider petitioning the USFWS for a SOA listing for shovelnose sturgeon. Initiated in June 2007 and continuing through July 2008, MICRA has conducted several meetings and conference calls in an effort to gather information and opinions from all 28 MICRA states. The process described herein is the result of those findings.

MICRA Supported Process to Addressing the
Illegal Harvest of Pallid Sturgeon by Commercial Fishers of Shovelnose Sturgeon

The sole goal of this MICRA supported process is to eliminate the illegal harvest of pallid sturgeon by commercial fishers of shovelnose sturgeon within the sympatric reach of shovelnose sturgeon and pallid sturgeon, a stated threat outlined in the pallid sturgeon recovery plan.

MICRA member states agree:

1. It is illegal to harvest pallid sturgeon, as well as hybrids or intermediates of shovelnose and pallid sturgeon.
2. This process only addresses the illegal harvest of pallid sturgeon by commercial fishers of shovelnose sturgeon.
3. Based on the pallid sturgeon recovery plan and findings of researchers,
    a. Commercial fishing of non-sturgeon species does not present a threat to the recovery of pallid sturgeon.
    b. Recreational angling of shovelnose sturgeon and all other species does not present a threat to the recovery of pallid sturgeon.
4. Several other threats currently are detrimental to the recovery of pallid sturgeon and these threats must be addressed by additional federal and state initiatives.
5. Law enforcement activities are a primary avenue for reducing all illegal harvest of pallid sturgeon and appropriate agencies must increase all enforcement activities.
6. Only by a cooperative effort by state and federal agencies can the recovery of pallid sturgeon be achieved.

MICRA members agree that prior to implementing and evaluating any additional management strategies (both state and/or federal based), it is first necessary to confirm that commercial fishers can accurately distinguish shovelnose sturgeon from pallid sturgeon. MICRA has identified two fundamental issues that need to be addressed in order for member states within the range of pallid sturgeon to continue, with MICRA support, to manage commercial shovelnose sturgeon fisheries within the sympatric range. These two fundamental issues are the endpoints to the MICRA process and must be addressed in a timely manner.

***Fundamental Issues*:**

1) Validation of an effective field technique for distinguishing shovelnose sturgeon
    a) If technique is effective **(Yes),** then member states proceed to validate if commercial fishers can use the tool effectively to eliminate the harvest of pallid sturgeon;
    b) If the technique is not effective **(No),** then member states or the USFWS should proceed with closing the commercial shovelnose sturgeon fishery;
    c) If no evaluation of an identification technique is attempted **(No Progress),** then MICRA recommends closure of the commercial shovelnose sturgeon fishery.
2) Validation of the effective use of the field technique by commercial fishers to eliminate the harvest of pallid sturgeon
    a) If commercial fishers can use the tool effectively **(Yes)**, then states that wish to

allow commercial shovelnose sturgeon fishing should implement additional management strategies identified by MICRA;

b) If commercial fishers continue to harvest pallid sturgeon **(No),** then states or USFWS should proceed with closing the commercial shovelnose sturgeon fishery;
c) If no evaluation of commercial fishers' ability to use the tool is attempted **(No Progress),** MICRA recommends closure of commercial shovelnose sturgeon fishery.

MICRA and the states of Illinois, Kentucky, and Missouri will participate in a study to address these two fundamental issues. The completion date for this cooperative study is **June 30, 2009**. A study plan is included herein (Appendix I) and will address both issues simultaneously. ***Issue # 1*** will be addressed by MICRA, as well as Kentucky and Missouri. This is imperative because currently no criteria have been legally set for the identification of shovelnose sturgeon in those states. ***Issue # 2*** will be addressed by MICRA and Illinois. In 2007, Illinois implemented legal identification criteria for shovelnose sturgeon and all commercial roe harvesters fishing in the sympatric pallid sturgeon reach must be certified in the identification procedure.

Tennessee conducted an evaluation of these issues in 2007 and has since concluded that the proposed field identification technique is inaccurate. Their results conservatively estimated that 1.8% of all sturgeon harvested were pallid sturgeon and commercial fishers misidentified 29% of the encountered pallid sturgeon. Based on these findings, TWRA concluded that closure of the shovelnose sturgeon fishery within the range of pallid sturgeon was the only option to prevent the harvest of pallid sturgeon.

Endpoint Decisions: Addressing Issues # 1 and # 2

The endpoint will be addressed with the completion of the cooperative study. The study completion date is June 30, 2009.

For the fundamental issues to be considered **successfully** addressed **(YES)**,

Study Findings report that:

1. A 100% accurate field identification technique was identified and commercial fishers demonstrated an ability and willingness to use this technique to ensure that no genotypic pallid sturgeon (i.e., LOD > 2.0) are harvested; and
2. Illinois certified commercial fishers, operating under Illinois' newly implemented management approach (i.e. suite of management regulations, mandatory certification program, and field identification technique) correctly identified all genotypic pallid sturgeon and that no genotypic pallid sturgeon were harvested by Illinois certified commercial fishers.

Based on this conclusion, MICRA will recommend a suite of management strategies (Appendix II) for states to incorporate into their state fishery management plans to further reduce the likelihood of the harvest of pallid sturgeon in commercial shovelnose sturgeon fisheries. MICRA also will recommend continued monitoring and evaluation of the commercial shovelnose sturgeon fishing programs and the harvest of pallid sturgeon within all states managing this fishery.

For the fundamental issues to be considered **not successfully** addressed **(NO):**

Study Findings report that:

1. Field identification technique was not 100% accurate; or
2. Commercial fishers did not demonstrated an ability and willingness to use this technique to ensure that no genotypic pallid sturgeon (i.e., LOD > 2.0) are harvested; or
3. Illinois certified commercial fishers did not correctly identify all genotypic pallid sturgeon.

Based on this conclusion, MICRA will recommend and support two options:

1. The preferred option is for **all states which currently allow commercial fishing of shovelnose sturgeon within the sympatric range of the pallid sturgeon** to implement procedures to close the commercial sturgeon fisheries.

2. A secondary option is for the **USFWS to use its authority to list shovelnose sturgeon as federally threatened** under the ESA SOA listing process for the protection of pallid sturgeon. Many member states are concerned that an SOA listing could unnecessarily affect recreational and other commercial fisheries throughout the Mississippi River basin. To address these concerns MICRA requests the SOA listing follow the concerns outlined in Appendix III.

3. An additional option is for the development of **habitat conservation plans** to address the incidental harvest of pallid sturgeon by commercial fishers of shovelnose sturgeon. **It is not a preferred option supported by MICRA or its member states**, but it is an option made available under the ESA. It is offered in that context. The development of a habitat conservation plans is a cooperative effort by state and federal agencies, as well as the private sector. Financial support would be required from the private sector to address the issues of harvest, as well as the more complex question of take.

MICRA and its member states are committed to the resolving the pallid sturgeon recovery plan's declared threat of harvest of pallid sturgeon by commercial fishers of shovelnose sturgeon. Consequently, MICRA does not anticipate a ***No Progress*** condition in addressing these two fundamental issues.

***Conclusion*:**

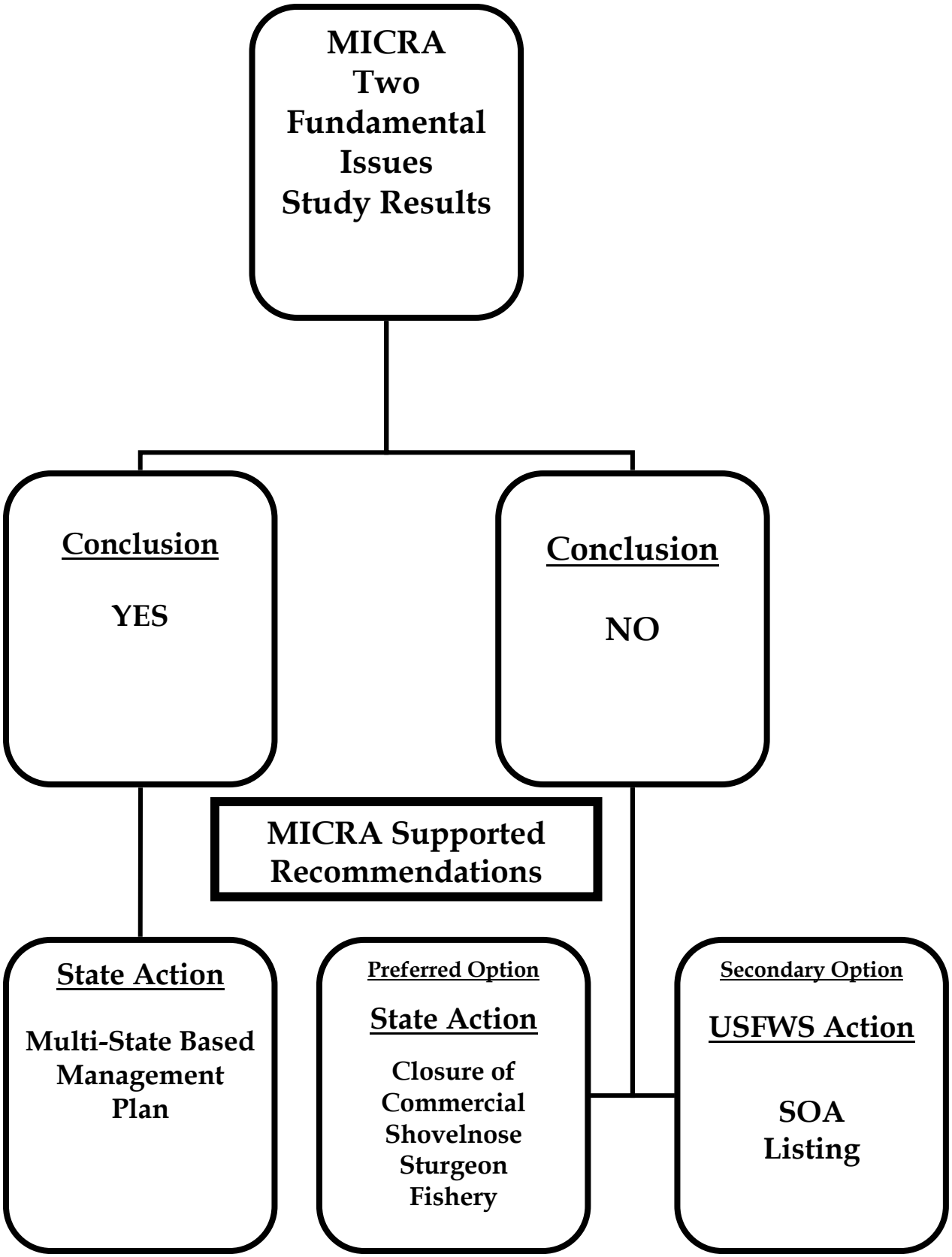
The process provided herein is the result of a 12-month MICRA sponsored effort. This process is not entirely supported by all member states, but was reached through a consensus of affected states. MICRA supports the rights of states to manage their fisheries and the legal authority of the USFWS to act on endangered species concerns. MICRA also recognizes and encourages the important role of the states and the USFWS to effectively manage fisheries and protect jeopardized species in interjurisdictional water bodies.

Literature Cited:

U.S. Fish & Wildlife Service (USFWS). 1993. Recovery plan for the pallid sturgeon (*Scaphirhynchus albus*). U.S. Fish & Wildlife Service, Region 6, Denver, Colorado.

U.S. Fish & Wildlife Service (USFWS). 2007. Pallid sturgeon. 5-year review summary and evaluation. U.S. Fish & Wildlife Service, Billings, Montana.

Decision Tree



APPENDIX I

STUDY PLAN OUTLINE

Fishery biologists from Illinois, Kentucky, and Missouri will each randomly select several days during the 2008-2009 fishing season to accompany or intercept commercial fishers and obtain carcasses of sturgeon harvested from 5 general sites in the lower Missouri and Mississippi rivers:

- Lower Missouri River below Columbia, MO;
- Chain of Rocks reach in the Middle Mississippi River;
- Thebes, IL reach in the Middle Mississippi River;
- Wolf Island area in southern portion of Kentucky waters;
- Caruthersville, MO reach in the Lower Mississippi River.

Samples will be collected from sturgeon harvested by commercial fishers rather than by sampling conducted by biologists to demonstrate the commercial fishers' ability to distinguish shovelnose sturgeon using the proposed field identification techniques. Biologists will select a minimum of 200 sturgeons harvested from each site with the weakest shovelnose sturgeon characteristics, as determined by visual inspection, to collect morphometric and meristic data needed to calculate a Character Index (CI; Sheehan et al. 1999; Wills et al. 2002). Two tissue samples (i.e., fin clips) will be collected and archived from each of the 200 selected sturgeon. Sturgeon carcasses will be preserved for at least one year following the collection of data and tissue samples. One tissue sample from each of the 20 sturgeon with the lowest calculated CI at each site will be provided to Southern Illinois University at Carbondale (SIU) for genotypic identification.

Researchers at SIU will isolate genomic DNA from provided fin clips and genotype each sturgeon at 16 disomic microsatellite loci as described in (Schrey et al., 2007). Each genotype will be compared to a baseline of 125 shovelnose and 100 adult pallid sturgeons from the lower Missouri and middle Mississippi rivers. The baseline was constructed by plotting morphological species ID based on the Wills et al. (2002) index against model-based genetic assignment in STRUCTURE (Pritchard et al., 2000) as described in Schrey et al. (2007). The baseline includes only sturgeon from the lower Missouri (east of Kansas City and mostly east of Jefferson City) and middle Mississippi (Alton to Cairo) and does not include any known hatchery fish (all fish were checked for PIT tags). The genetic criteria for identifying a specimen as a pallid sturgeon was a composite Q-value for the genetic group dominated by field-identified pallid sturgeon of greater than 0.80 and a 95% posterior confidence region that did not include Q = 0.5. The criteria for identifying a shovelnose sturgeon was a composite Q-value less than 0.2 and a 95% posterior confidence region that did not contain Q = 0.5. To identify individual unknown sturgeon we employ the WhichRun software package of Banks and Eichert (2000) which computes the likelihood of generating an individual's genotype in user-supplied baselines and compares the ratio of assignment to each baseline to determine how confidently a fish is assigned. The benefit of this approach is that it provides not only identification but also indicates the robustness of the identification. Fish will be identified as a pallid sturgeon if the log of the odds ratio (LOD) is greater than 2.0, indicating that an individual's genotype is 100X more likely to have originated in the pallid gene pool than the shovelnose sturgeon gene pool. Generally "good" pallid have LOD values greater than 3. This approach is conservative in that

some true pallid sturgeons may have an LOD < 2 but it is extremely unlikely that a shovelnose or hybrid would have an LOD > 2. This is the same criterion used by the USFWS to screen pallid sturgeon broodstock for genetic purity, and the same methodology used to quantify the bycatch of pallid sturgeon in Tennessee's commercial shovelnose sturgeon fishery.

***Literature Cited*:**

Schrey, A. W.; Sloss, B. L.; Sheehan, R. J.; Heidinger, R. C.; Heist, E. J., 2007: Genetic discrimination of middle Mississippi River *Scaphirynchus* sturgeon into pallid, shovelnose, and putative hybrids with multiple microsatellite loci. Conserv.Genet. 8, 683-693.

Sheehan, R. L.; Heidinger, R. C.; Hurley, K. L.; Wills, P. S.; Schmidt, M. A., 1997: Middle Mississippi River pallid sturgeon habitat use project: year 2 annual progress report. Fisheries Research Laboratory and Department of Zoology, Southern Illinois University, Carbondale, pp. 54.

Wills P. S.; Sheehan, R. J.; Heidinger, R.; Sloss, B. L.; Clevenstine, R., 2002: Differentiation of pallid sturgeon and shovelnose sturgeon using an index based on meristics and morphometrics. In: W.Van Winkle, P. J. Anders, D. H. Secor and D. A. Dixon (Eds). Biology, management, and protection of North American sturgeon. Am. Fish. Soc. Symposium 28, Bethesda, MD, pp. 249-258.

APPENDIX II

SUGGESTED DRAFT
STATE IMPLEMENTED MANAGEMENT STRATEGIES

If the study described within this document validates the availability of an accurate field identification technique and its effective use by commercial fishers to distinguish shovelnose sturgeon from pallid sturgeon, then states that wish to allow commercial shovelnose sturgeon fishing must implement additional management strategies. A conceptual framework for state implemented management strategies is proposed herein, however a MICRA sponsored workshop will be held to develop a holistic set of recommended management strategies to reduce the harvest of pallid sturgeon.

State implemented management strategies may be comprised of a suite of both regulatory and educational tools. For management strategies to be effective in interjurisdictional waters all regulatory parties must implement these strategies in a similar and timely manner. Unfortunately, individual states are governed by differing rule making procedures. Thus, timing and content may differ between and amongst states, but it is the purpose of this MICRA supported process to work cooperatively to achieve the elimination of the harvest of pallid sturgeon if commercial fishing for shovelnose sturgeon is permitted.

A. Legal Criteria to Regulate Shovelnose Sturgeon Commercial Fishing
    a. Closure in Sensitive Reaches
    b. Species: (only shovelnose sturgeon)
    c. Seasons
    d. Individual Length Limits
    e. Harvested Individual Body Intactness
    f. Gill Net Mesh Size
    g. Individual Net Permits (all users of gill nets in regulated reaches)
    h. Fishing Techniques
        i. Tending Nets
        ii. Net Set Times
        iii. Number of Nets Tended

B. Legal Certification and Permitting of Commercial Fishers
    a. Identification Proficiency of Shovelnose Sturgeon
    b. "Bad Actors" Provision
    c. Restriction of Number of Fishers
    d. Reporting Requirements

APPENDIX III

MICRA GUIDELINES FOR AN ENDANGERED SPECIES ACT SIMILARITY OF APPEARANCE LISTING OF SHOVELNOSE STURGEON

1) Limited to shovelnose sturgeon;

2) Limited to the confirmed range of pallid sturgeon where commercial fishing for shovelnose sturgeon is permitted;

3) Restricts only the commercial harvest of shovelnose sturgeon;

4) Does not impact the states' abilities to manage any recreational fishery, including shovelnose sturgeon;

5) Developed in active consultation with states;

6) Includes a federally funded evaluation component and the ability to rescind the SOA listing if determined unnecessary; and

7) Implemented with adequate time for states to implement regulation changes to protect commercially harvested shovelnose sturgeon populations outside the range of pallid sturgeon and other roe producing species (i.e., no sooner than January 1, 2011).

SECTION III

FIELD IDENTIFICATION OF MISSISSIPPI RIVER BASIN STURGEON

Authors

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Submitted to the MICRA Sturgeon Working Group July 2009

Introduction

It has recently been suggested that illegal harvest of federally endangered pallid sturgeon (*Scaphirhynchus albus*) via the legal commercial harvest of shovelnose sturgeon (*S. platorynchus*) in portions of the Missouri and Mississippi rivers is hampering recovery efforts of the species (Colombo et al. 2007; U.S. Fish and Wildlife Service [USFWS] 2007). Incidental and illegal harvest of pallid sturgeon has been documented in the Mississippi River (Bettoli et al. 2009; Sheehan et al. 1997; USFWS 1997; D. Burleson, USFWS personal communication), and this may be a significant impediment to survival and recovery of the species in some portions of its range. The USFWS expects incidental and illegal take of pallid sturgeon to increase in the middle Mississippi and lower Missouri rivers, and to potentially become an issue in the lower Mississippi and Atchafalaya rivers, as caviar sources are reduced world-wide and caviar prices increase, resulting in increased commercial pressures on shovelnose sturgeon.

Most (9 of 13) states within the range of pallid sturgeon have prohibited the commercial harvest of shovelnose sturgeon to reduce take and aid in recovery of the pallid sturgeon. Two additional states, Missouri and Tennessee, have attempted to close their commercial shovelnose sturgeon fisheries in the past few years, but they were unsuccessful. Four states (Illinois, Kentucky, Missouri, and Tennessee) currently allow commercial shovelnose sturgeon harvest in waters where pallid sturgeon occur, and these states are utilizing varying approaches from a suite of available management strategies, including closure of certain areas to commercial shovelnose sturgeon fishing, size restrictions for harvestable fish, harvest seasons, additional permitting requirements for commercial fishers harvesting shovelnose sturgeon, and species identification training for commercial fishers harvesting shovelnose sturgeon. These states are actively managing shovelnose sturgeon fisheries within their jurisdictions, and they are evaluating their effectiveness to eliminate illegal or incidental take of pallid sturgeon. In addition to the suite of management options available to the states, the USFWS has the ability to close all commercial shovelnose sturgeon fisheries in the United States by listing this species as Federally Threatened under the Endangered Species Act (ESA) based on Similarity of Appearance (SOA) with the Federally Endangered pallid sturgeon.

Mississippi Interstate Cooperative Resource Association (MICRA) states with shovelnose sturgeon commercial fisheries have formed a working group that has met several times within the last year to discuss management of these fisheries in a way that prevents take and does not impede survival or recovery of pallid sturgeon. MICRA members agree that prior to implementing and evaluating additional management strategies, it is first necessary to confirm

that commercial fishers can distinguish shovelnose sturgeon from pallid sturgeon. MICRA has identified this as a fundamental issue that needs addressing in order for states within the range of pallid sturgeon to continue to manage commercial shovelnose sturgeon fisheries within the sympatric range. That is, can commercial fishers use morphological characteristics to differentiate between the two species to eliminate the harvest of pallid sturgeon? Tennessee Wildlife Resources Agency (TWRA) quantified the by-catch of pallid sturgeon in Tennessee's commercial shovelnose sturgeon fishery during spring 2007 (Bettoli et al. 2009). Their results conservatively estimated 1.8% of all sturgeon harvested in Tennessee to be pallid sturgeon. Five additional pallid sturgeons were captured by commercial fishers, correctly identified, and released during this study. However, no such study has been conducted within the other three states (Illinois, Kentucky, and Missouri) that allow commercial shovelnose sturgeon harvest in areas sympatric with pallid sturgeon.

The State of Illinois instituted a number of special regulations in August 2007 for the commercial harvest of roe-bearing species intended to prevent the harvest of pallid sturgeon. In addition to prohibiting the commercial harvest of shovelnose sturgeon x pallid sturgeon hybrids, commercial sturgeon fishers in the Mississippi River downstream of Lock and Dam 26 are required to successfully complete a shovelnose sturgeon identification training program that certifies the fisher's ability to distinguish shovelnose sturgeon from pallid sturgeon or their hybrids. Any sturgeon belonging to the genus *Scaphirhynchus* that contains any one of the three morphological characteristics listed below is considered illegal for harvest:

1) belly completely lacking in scales;
2) bases of outer barbels located slightly farther behind bases of inner barbells; or
3) length of inner barbels going at least 6.3 times into length of head.

MICRA states were interested in evaluating the by-catch of pallid sturgeon in the harvest of shovelnose sturgeon by commercial fishers licensed by the State of Illinois to determine if the state's new regulations provide a framework for commercial fishers to effectively use morphological characteristics to differentiate shovelnose sturgeon and eliminate the harvest of pallid sturgeon. The states of Missouri and Kentucky were also interested in evaluating by-catch in the harvest of shovelnose sturgeon by their licensed commercial fishers to evaluate the effectiveness of their current regulations at preventing harvest of pallid sturgeon.

Methods

Fishery biologists from Illinois, Kentucky, and Missouri attempted to collect 200 sturgeon carcasses (fish minus the roe) from commercial fishers at each of five general sites in the lower Missouri and Mississippi rivers including: Lower Missouri River below Columbia, MO; Chain of Rocks reach in the Middle Mississippi River; Middle Mississippi River between Kaskaskia and Thebes, IL; Wolf Island area in southern portion of Kentucky in the Lower Mississippi River; and the Caruthersville, MO reach in the Lower Mississippi River. Samples were collected between October 1, 2008 and May 31, 2009. Samples were collected from sturgeon harvested by commercial fishers rather than by sampling conducted by biologists to demonstrate the commercial fishers' ability to distinguish shovelnose sturgeon. Fish were frozen by commercial fishers, picked up by each respective state, and taken to their lab facilities for storage.

Fish were thawed and then morphometric and meristic data were collected from each fish following Wills et al. (2002). These measurements were then used to calculate a Character Index

(CI) and morphometric character index (mCI) using regression equations from Wills et al. (2002). These two indices have been used to differentiate pallid from shovelnose sturgeon, as well as identify possible hybrids between the two species. CI values less than -0.45 and mCI values less than -0.70 indicate a pallid sturgeon, while CI values greater than 0.51 and mCI values greater than 0.83 indicate a shovelnose sturgeon. However, considerable overlap exists in index values between hybrids and parental species. An overlap between pallid sturgeon and hybrids are indicated by CI values between -0.45 and -0.09 and mCI values between -0.70 and 0.22. An overlap between shovelnose sturgeon and hybrids are indicated by CI values between 0.37 and 0.51 and mCI values between 0.41and 0.83. CI values between -0.08 and 0.36 and mCI values between 0.23 and 0.40 indicate a hybrid sturgeon, not overlapping with either parental species.

Each fish was also examined for barbel alignment (straight alignment on shovelnose sturgeon; inner barbels anterior to outer barbels on pallid sturgeon), and presence (shovelnose sturgeon) or absence (pallid sturgeon) of scales on the belly. Finally, head length was divided by the mean inner barbel length for each fish, and values exceeding 6.3 are indicative of a pallid sturgeon. These three characteristics are used by biologist to differentiate the two species (Pflieger 1997) and have also been recently used by commercial fishers in Illinois to differentiate shovelnose sturgeon from pallid sturgeon and shovelnose sturgeon x pallid sturgeon hybrids.

Once morphometric and meristic data were collected from a fish, it was marked with a floy tag having a unique identification number. A tissue sample (i.e., fin clip) was then collected from each fish. The sample was placed in an individually numbered vial for future genetic analysis, and each vial could be traced back to each individual fish. Each individual fish was then placed in a plastic bag and sealed for storage in a freezer. Each bag was labeled with the floy tag number for that individual fish. Thus, if an individual fish needed further examination in the future, it could be done fairly easily. Character and morphometric character indices were calculated for each fish. Tissue samples from the 20 sturgeon with the lowest calculated CI values (most pallid-like) from each site were provided to Southern Illinois University at Carbondale (SIU) for genotypic identification.

Results

We collected 946 sturgeon carcasses from commercial fishers during the study. We collected 233 sturgeon from the lower Missouri River, 228 fish from Chain of Rocks area on the Mississippi River, 235 sturgeon from the Middle Mississippi River between Kaskaskia and Thebes, Illinois, and 200 fish from the Wolf Island area of the lower Mississippi River in Kentucky. An additional 50 fish were collected from Pool 26 along the Mississippi River outside the purported range of pallid sturgeon. No sturgeon were collected from the lower Mississippi River near Caruthersville, MO as originally planned. There were no commercial fishers licensed in Missouri from this section of the river. However, there were commercial fishers licensed in Tennessee that fished this area, but by the time this was realized, it was too late to coordinate collections from them.

While processing the fish, biologists watched for any fish that was a possible pallid sturgeon based on visual characteristics. None of the 946 fish examined were thought to be a pallid sturgeon based on the professional judgment of the biologists examining the fish. However, CI scores indicated that four fish were pallid sturgeon (Figures 1-5) including two fish from the

Missouri River (Figure 1), one fish from Pool 26 (Figure 2), and one fish from the Chain of Rocks area (Figure 3). No fish were deemed to be a pallid sturgeon based on mCI scores from any of the sites (Figures 6-10). Numerous fish fell into the pallid sturgeon/hybrid overlap zones based on both the character index (31 total fish; Figures 1-5) and morphometric character index (30 total fish; Figures 6-10). Seven fish from the Missouri River had CI scores that placed them in the pallid/hybrid overlap category (Figure 1), and 16 fish that had mCI scores that placed them in this same category (Figure 6). No fish from Pool 26 on the Mississippi River had CI scores low enough to be placed in the pallid/hybrid overlap category (Figure 2), but one fish scored low enough to be placed in this category using mCI scores (Figure 7). The Chain of Rocks site had 14 sturgeon that had CI scores low enough to be classified in the pallid/hybrid overlap category (Figure 3), yet only five sturgeon were classified in the pallid/hybrid overlap category based on mCI scores from this site (Figure 8). Ten fish collected from the Mississippi River between Kaskaskia and Thebes, Illinois had CI scores that placed them in the pallid/hybrid overlap category (Figure 4), but only three fish from this site had low enough mCI scores to place them in this same category (Figure 9). Finally, no fish from the lower Mississippi River in Kentucky had CI scores low enough to be placed in the pallid/hybrid overlap category (Figure 5), but five fish from this site scored low enough to be placed in this category using mCI scores (Figure 10).

Again, biologist collecting data from the sturgeon did not consider any of the 946 fish they examined to be a pallid sturgeon based on visual characteristics. However, five fish from the Missouri River had barbel alignment (inner barbels anterior to outer barbels) consistent with that of a pallid sturgeon (2.1%). None of the fish examined from the Missouri River had bellies that were absent of scales (pallid sturgeon characteristic), but 17 fish had partial or small scales on their bellies (typical of a hybrid). Additionally, none of the sturgeon examined from the Missouri River had a value exceeding 6.3 (indicative of pallid sturgeon) when head length was divided by the mean inner barbel length (5.41 was highest value).

Samples collected by the State of Illinois from the Mississippi River had 78 sturgeon out of 513 total fish (15.2%) that had barbel alignment consistent with that of a pallid sturgeon. However, the biologist examining these fish indicated that on 28 of the 78 fish, the inner barbels were only slightly anterior to the outer barbels. However, deleting these 28 fish still leaves 9.7% of the sturgeon examined with barbel alignment consistent with pallid sturgeon. None of the fish examined from the Mississippi River by the State of Illinois had bellies that were absent of scales, but 11 fish had partial or small scales on their bellies. None of the sturgeon from the Mississippi River examined by the State of Illinois had a value exceeding 6.3 when head length was divided by the mean inner barbel length (5.43 was highest value).

Only two fish from the lower Mississippi River collected by the State of Kentucky had barbel alignment consistent with that of a pallid sturgeon (1.0%). None of the sturgeon examined by the State of Kentucky had bellies that were absent of scales, but nine fish had partial or small scales on their bellies. Finally, 5.47 was the highest value observed when head length was divided by the mean inner barbel length for the sturgeon collected and examined by the State of Kentucky.

Discussion

MICRA agreed in the summer of 2008 that the results of this study must show that zero genotypic pallid sturgeon were harvested by Illinois licensed commercial fishers for the field technique proposed by the State of Illinois and its application by commercial fishers to be considered a success (see Heist and Boley 2009 for results of genetic analyses). It was also agreed that if the field identification technique and its application by commercial fishers was determined to be effective and eliminated take of pallid sturgeon, MICRA would recommend a suite of management strategies for the four States that currently allow commercial harvest of shovelnose sturgeon within the range of pallid sturgeon to incorporate into state fishery management plans to further reduce the likelihood of harvest of pallid sturgeon in commercial shovelnose sturgeon fisheries. Since no pallid sturgeon were identified in this study based on genetic analyses (Heist and Boley 2009), the working group is finalizing a recommended suite of management strategies for consideration by Illinois, Kentucky, Missouri, and Tennessee. These recommendations are not applicable in other portions of the basin where similar evaluations have not been conducted.

Using the Character Index proposed by Wills et al. (2002), four pallid sturgeon were identified out of the 946 sturgeon examined, yet these fish all had negative LOD scores and Q-values less than 0.1, indicative of shovelnose sturgeon. It should be again noted that biologists did not consider any of the 946 fish they examined to be a pallid sturgeon based on initial visual inspection and professional judgment prior to calculating CI and mCI values. Twenty fish that were genetically tested appeared to be some form of hybrid/backcross based on Q-values > 0.1, while using the three characters of barbel alignment, presence/absence of belly scales, and ratio of head length to inner barbell length showed that about 10% of the fish harvested showed characteristics that were intermediate between pallid and shovelnose sturgeon. However, the detection of hybrids using morphological criteria provides only circumstantial evidence of hybridization between these two species due to the tautology of the argument that the presence of a fish intermediate co-occurring with two species is evidence of hybridization (Campton 1987).

Results of this study are contrary to that seen in Tennessee (Bettoli et al. 2009) in as much that no pallid sturgeon were documented in the harvest of commercial fishers. However, pallid sturgeon appear to be more common in the lower Mississippi River in Tennessee where the ratio of pallid to shovelnose sturgeon is 1:50 (Bettoli et al. 2009) compared to the middle Mississippi River near Chain of Rocks (ratio 1:80; R. Maher, unpublished data) or the Missouri River (ratio 1:424; V. Travnichek, unpublished data). Unlike the Bettoli et al. (2009) study, biologists in this study did not accompany commercial fishers on the water at the time the sturgeon were harvested, so the occurrence of pallid sturgeon in the catch could not be quantified. However, it is likely that the commercial fishers in the current study handled several thousand sturgeons to harvest 946 gravid female shovelnose sturgeon. Based on the reported ratio of pallid to shovelnose sturgeon above, it is reasonable to expect commercial fishers encountered and successfully identified several pallid sturgeons. The results then indicate that commercial fishers in our study could differentiate pallid sturgeon from shovelnose sturgeon in the portions of the Missouri and Mississippi rivers we examined. If commercial fishers harvested pallid sturgeon, but did not include these fish in the samples provided to the biologists, this would further demonstrate their ability to distinguish pallid sturgeon from shovelnose sturgeon. However, commercial fishers are harvesting probable intermediate

hybrids, and given the contentious nature of the Similarity of Appearance issue, these fish should probably be eliminated from the commercial harvest to eliminate any possibility of harvesting a pallid sturgeon.

In addition to requiring commercial fishers to be certified annually in their ability to distinguish shovelnose sturgeon, the State of Illinois prohibits the harvest of any sturgeon that has a belly completely lacking in scales, the bases of outer barbels located slightly farther behind bases of inner barbels, or the length of inner barbels going at least 6.3 times into length of head. More than 10% of the fish harvested in Illinois during this study should have been thrown back given these regulations. In addition, biologists reported considerable variation in barbel alignment. Further refinement of these morphological requirements is warranted. If these three, or other, characteristics are used in the future by the four States (Kentucky, Illinois, Missouri, and Tennessee) that currently allow commercial fishing for shovelnose sturgeon as part of a joint shovelnose sturgeon commercial fishing management plan, then additional training and education will be needed to ensure commercial fishers know what they are looking for. Additionally, increased law enforcement will be needed, and law enforcement staff will also need to be educated as well on what exactly the characteristics are and how they are to be measured.

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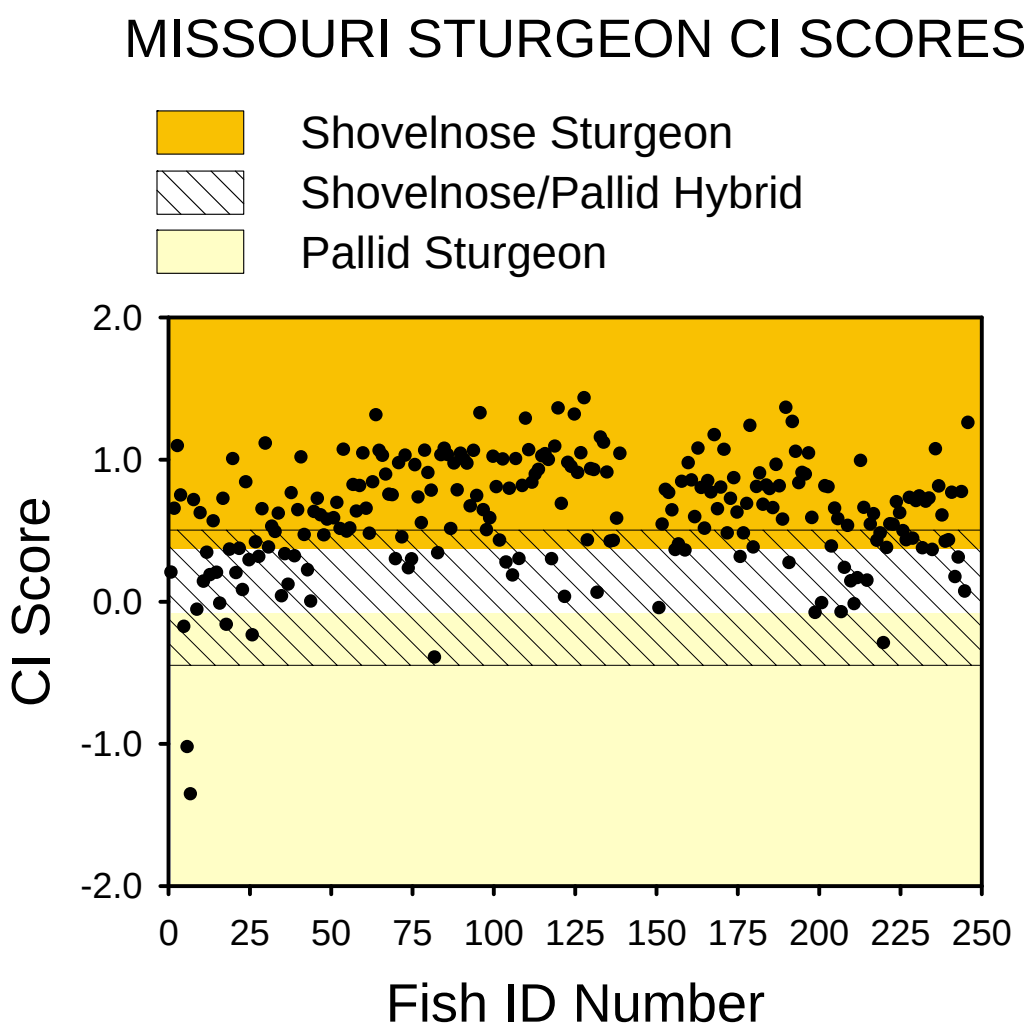

Figure 1. Character Index (CI) scores for sturgeon harvested by commercial fishers from the Missouri River during Fall 2008 and Spring 2009. See Wills et al. (2002) for explanation of CI scores.

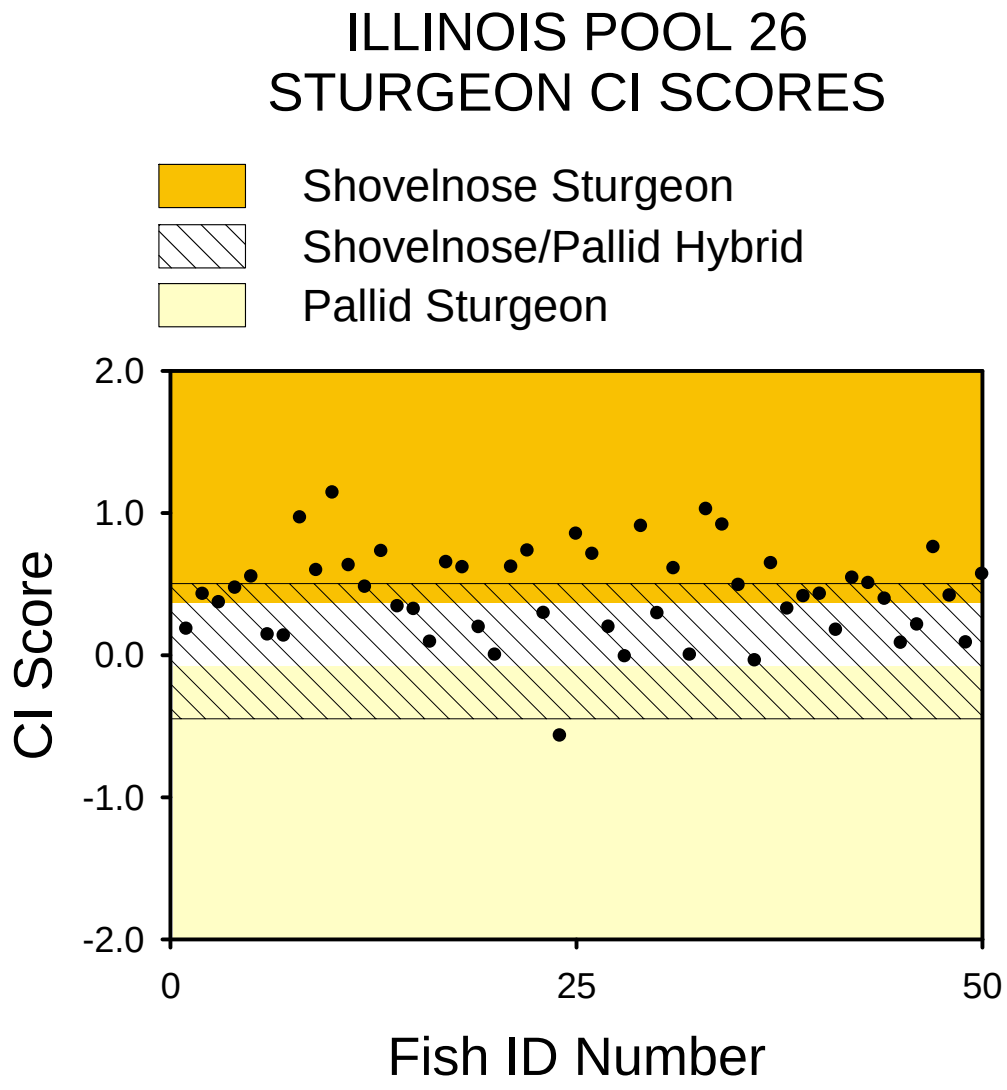

Figure 2. Character Index (CI) scores for sturgeon harvested by commercial fishers from Pool 26 of the Mississippi River during Fall 2008 and Spring 2009. See Wills et al. (2002) for explanation of CI scores.

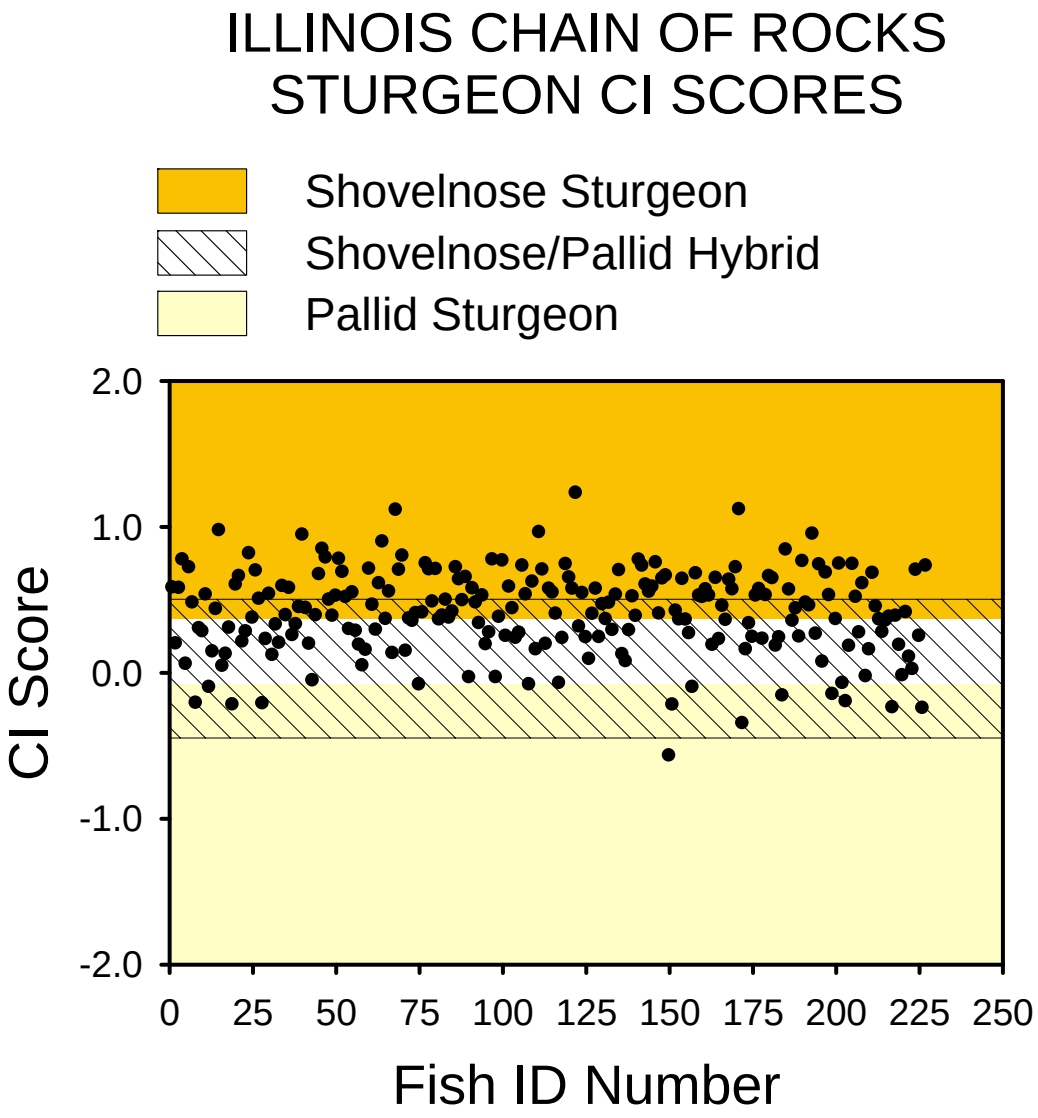

Figure 3. Character Index (CI) scores for sturgeon harvested by commercial fishers from Chain of Rocks area on the Mississippi River during Fall 2008 and Spring 2009. See Wills et al. (2002) for explanation of CI scores.

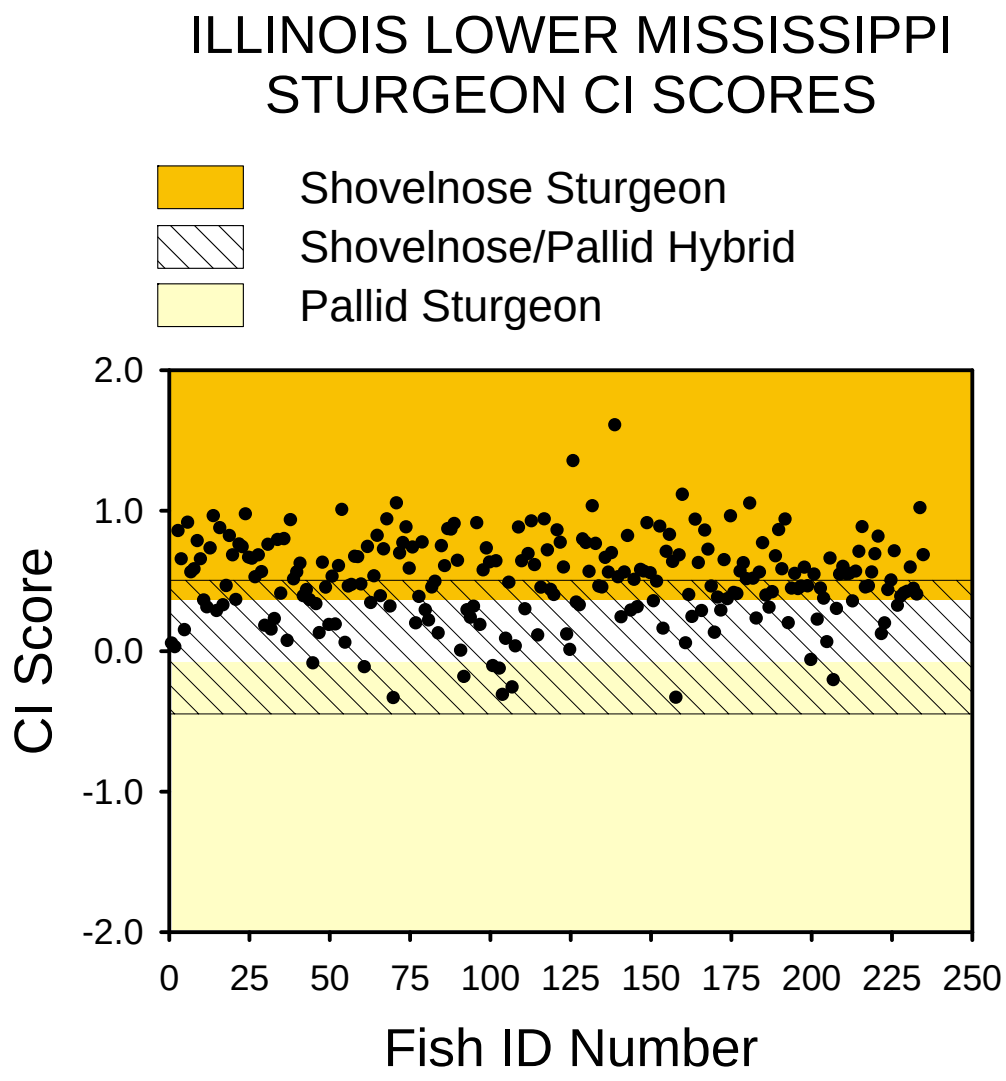

Figure 4. Character Index (CI) scores for sturgeon harvested by commercial fishers from the middle Mississippi River between Kaskaskia and Thebes, Illinois during Fall 2008 and Spring 2009. See Wills et al. (2002) for explanation of CI scores.

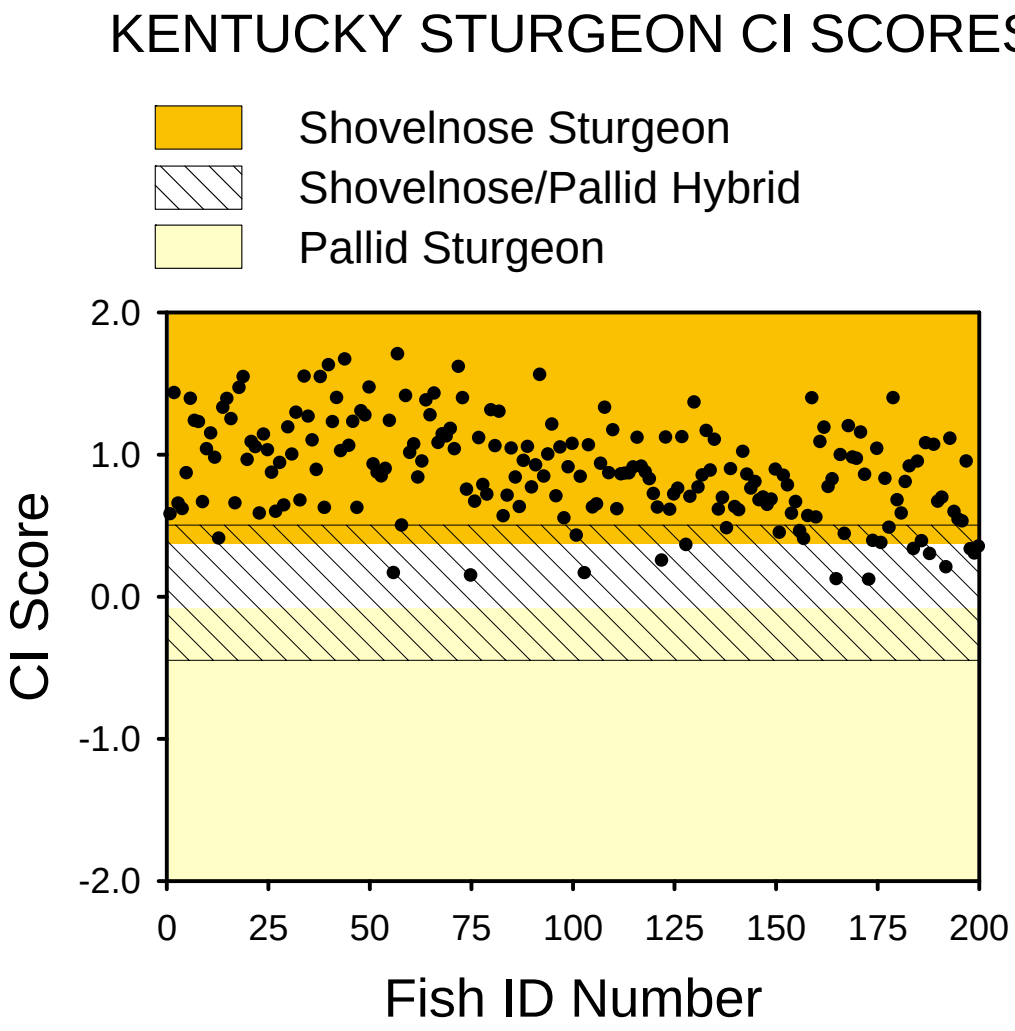

Figure 5. Character Index (CI) scores for sturgeon harvested by commercial fishers from the lower Mississippi River near Wolf Island, Kentucky during Fall 2008 and Spring 2009. See Wills et al. (2002) for explanation of CI scores.

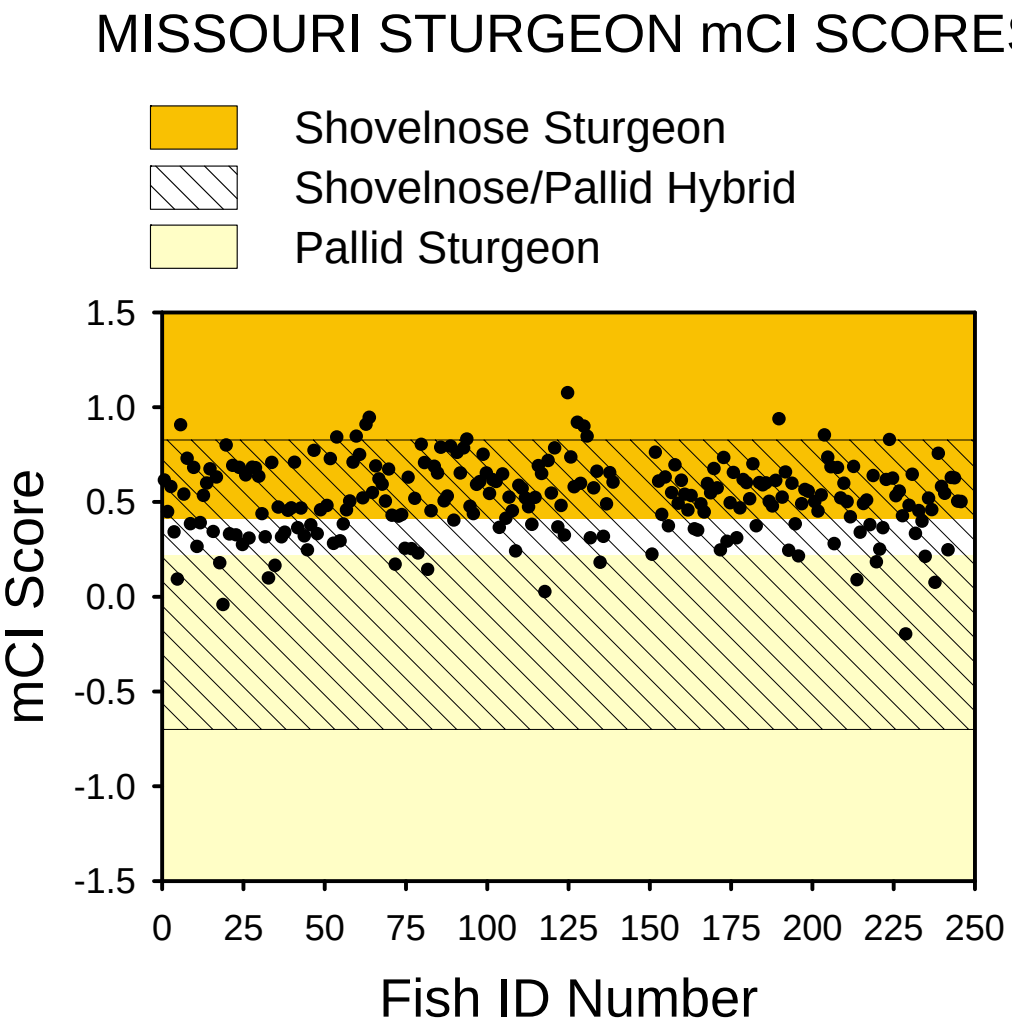

Figure 6. Morphometric Character Index (mCI) scores for sturgeon harvested by commercial fishers from the Missouri River during Fall 2008 and Spring 2009. See Wills et al. (2002) for explanation of mCI scores.

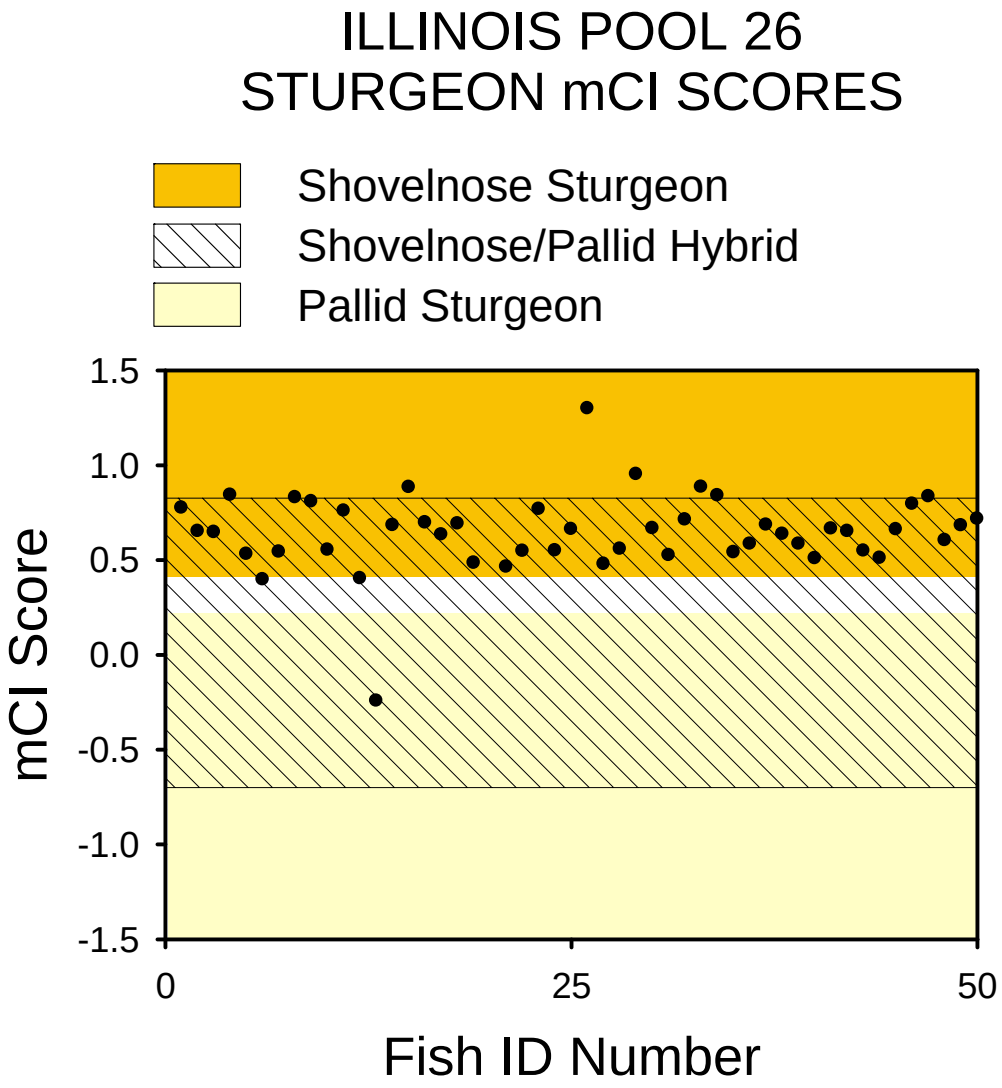

Figure 7. Morphometric Character Index (mCI) scores for sturgeon harvested by commercial fishers from Pool 26 of the Mississippi River during Fall 2008 and Spring 2009. See Wills et al. (2002) for explanation of mCI scores.

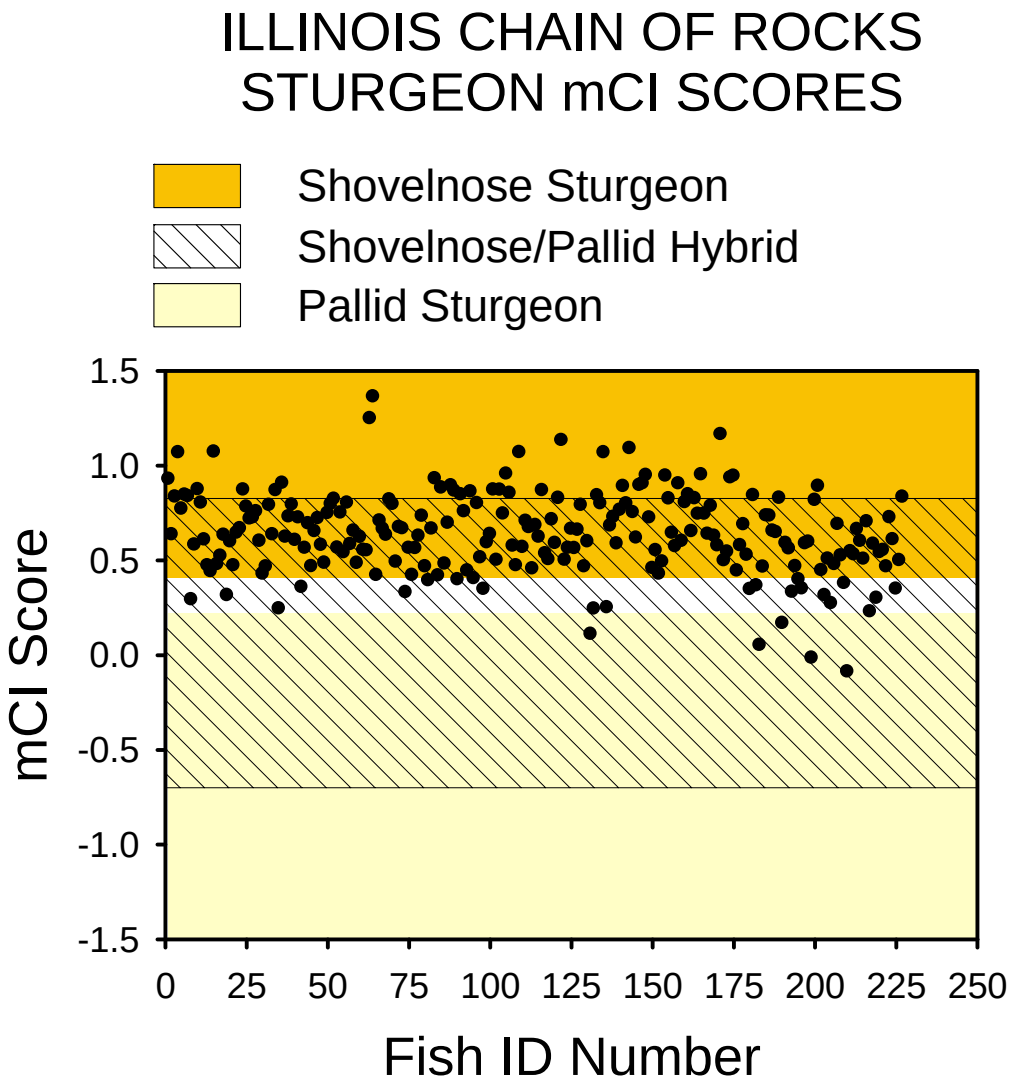

Figure 8. Morphometric Character Index (mCI) scores for sturgeon harvested by commercial fishers from Chain of Rocks area on the Mississippi River during Fall 2008 and Spring 2009. See Wills et al. (2002) for explanation of mCI scores.

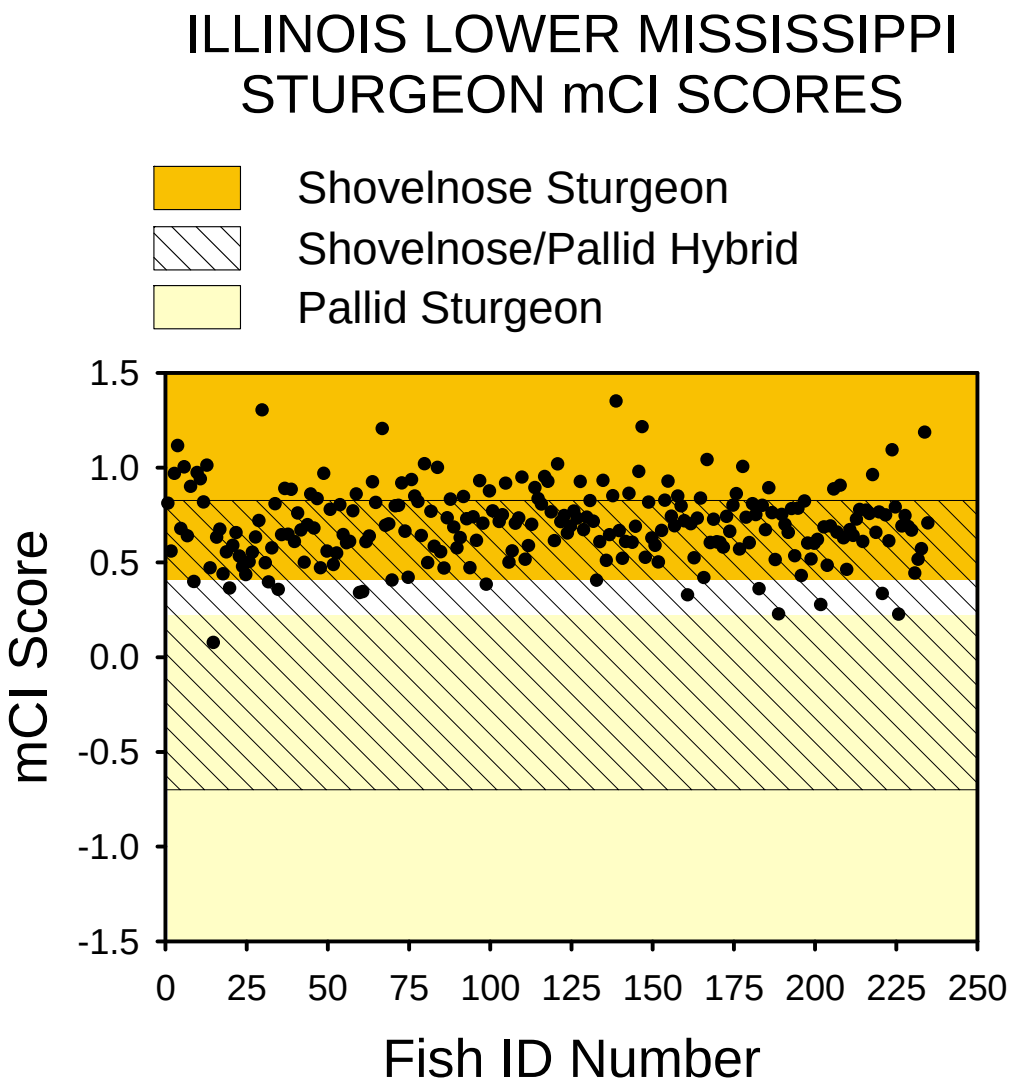

Figure 9. Morphometric Character Index (mCI) scores for sturgeon harvested by commercial fishers from the middle Mississippi River between Kaskaskia and Thebes, Illinois during Fall 2008 and Spring 2009. See Wills et al. (2002) for explanation of mCI scores.

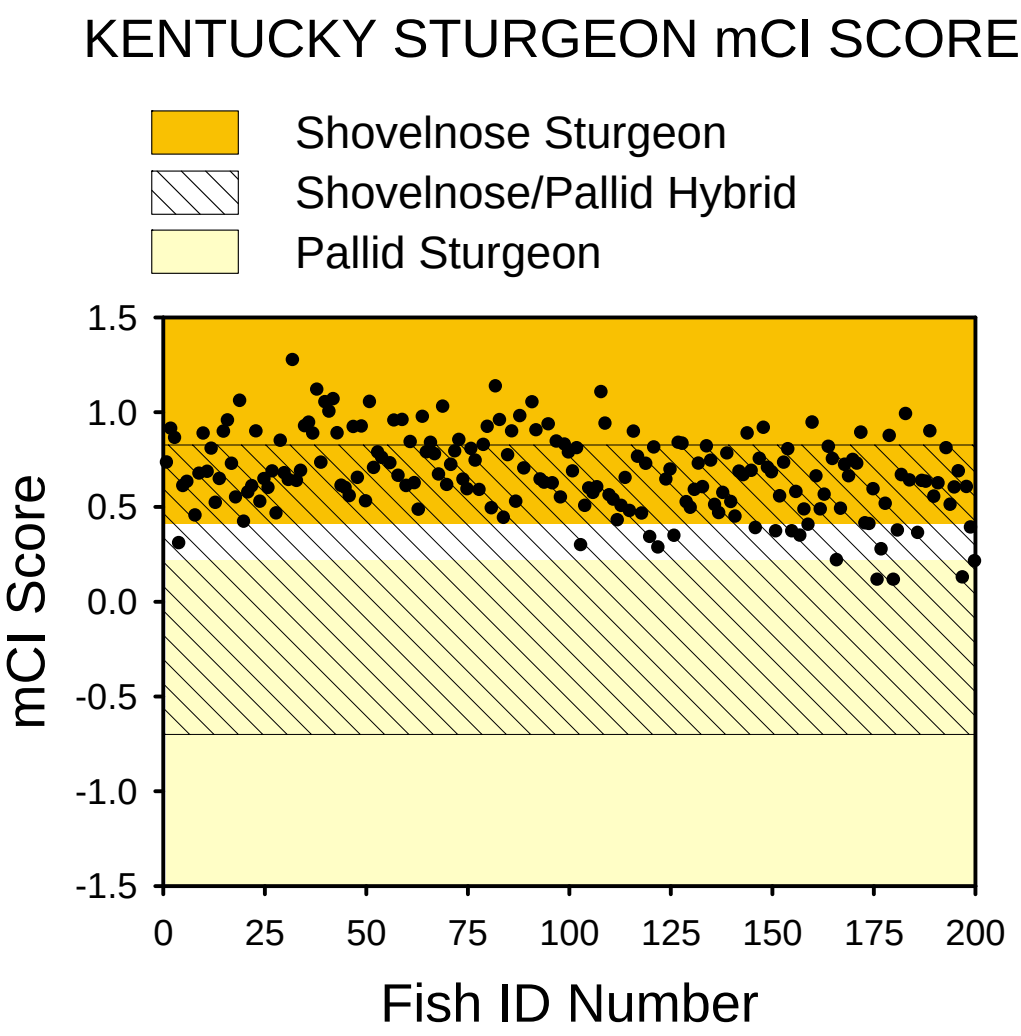

Figure 10. Morphometric Character Index (mCI) scores for sturgeon harvested by commercial fishers from the lower Mississippi River near Wolf Island, Kentucky during Fall 2008 and Spring 2009. See Wills et al. (2002) for explanation of mCI scores.

SECTION IV

GENETIC IDENTIFICATION OF MISSISSIPPI RIVER BASIN STURGEON

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Introduction

Illegal harvest of endangered pallid sturgeon (*Scaphirhynchus albus*) in commercial fisheries for shovelnose sturgeon (*S. platorhynchus*) may be a threat to pallid sturgeon recovery (USFWS 1993). A previous study (Bettoli et al. 2009) demonstrated the taking of endangered pallid sturgeon in the commercial shovelnose sturgeon fishery in Tennessee. To determine the ability of commercial fishermen to distinguish shovelnose sturgeon from pallid sturgeon and their putative hybrids, harvested sturgeon from Kentucky, Illinois, and Missouri were examined using morphological and genetic criteria to determine whether pallid sturgeon were present in the catch.

Methods

Fisheries biologists (Rob Maher, Illinois; Paul Rister, Kentucky; and Vince Travnichek, Missouri) collected 946 sturgeon harvested by commercial fishers from multiple river reaches (Table 1) during the 2008-2009 commercial fishing season, including 50 sturgeon that were harvested outside the recognized range of pallid sturgeon (Pool 26 near Winfield, MO). All fish collected from the Middle Mississippi River were harvested by commercial fishers that had successfully completed a mandatory Illinois certification program. Other commercial fishers who provided samples used in this study were not required to complete a certification program, however two of four commercial fishers that harvested fish from the Missouri River had twice completed the mandatory Illinois certification program. The Illinois commercial fisher that provided samples from the Mississippi River, Pool 26, did not complete the mandatory certification program.

Morphological and meristic data were taken from sampled sturgeons to calculate the Character Index (CI) and Morphometric Character Index (mCI) of Wills et al. (2002). Wills et al. (2002) identified pallid sturgeon as having CI values of less than -0.46 and mCI values of less than -0.71. Fisheries biologists selected those fish with the lowest CI values and originally submitted 84 tissue samples (44 from Illinois, 20 from Kentucky, and 20 from Missouri) to Southern Illinois University Carbondale (SIU) for analysis. These fin clips will be referred to as the "selected" samples because they were selected for genetic analysis based on morphology. Following a meeting in which the preliminary results from this study were discussed, MICRA submitted an additional 20 tissue samples drawn at random from the rest of the tissue samples collected. These fin clips, which will be referred to as the "random" samples, comprised 8 fin clips from Illinois, 5 from Kentucky, and 7 from Missouri.

Researchers at SIU isolated genomic DNA from provided fin clips and genotyped each sturgeon at 16 disomic microsatellite loci as described in Schrey et al. (2007). The genotype of each fish was compared to a baseline of 74 pallid and 153 shovelnose sturgeon. The baselines were constructed using the Structure software package of Pritchard et al. (2000) to sort 321 *Scaphirhynchus* collected from the lower Missouri River (below river mile 250) and middle Mississippi River (between Alton and Cairo). The baseline does not include any known hatchery fish (all fish were checked for PIT tags). Structure uses only genotype information to sort individuals into K-groups where K is assigned by the user. Previous research (Schrey et al. 2007) indicated that the value of K that maximized the probability of the data was 2, and that when Structure was used to sort middle Mississippi River *Scaphirhynchus* into 2 groups these groups were largely concordant with morphologically identified pallid and shovelnose sturgeon. Structure was run using the admixture model and no *a priori* species designation. Structure calculates a Q-value which is the fraction of an individual's genotype that assigns to each group. We also calculated the 95% critical region for the Q-value which is analogous to a confidence limit. In previously collected individuals used to construct the baseline data, we found 74 fish with Q-values greater than 0.9, 95% critical regions that excluded 0.5, and morphologies consistent with pallid sturgeon. These 74 fish comprised the pallid sturgeon baseline. 153 fish had Q-values less than 0.1, 95% critical regions that excluded 0.5, and morphologies consistent with shovelnose sturgeon. These 153 fish comprised the shovelnose sturgeon baseline. 94 fish had assignments less than 0.9 to a single cluster and/or 95% critical regions including Q = 0.5 and were eliminated from the baselines. LOD scores and Q-values for the baseline fish are presented in Figure 1.

To identify the harvested fish we calculated the microsatellite allele frequencies in the baseline pallid and shovelnose sturgeon groups and employed the Whichrun software package of Banks and Eichert (2000). Whichrun calculates the probability of producing an individual's genotype in one or more baselines using allele frequencies provided by the user. The ratio of the probability of producing a genotype in the pallid baseline divided by the probability of producing it in the shovelnose baseline indicates how much more likely a fish is to be a pallid as opposed to a shovelnose sturgeon. We report the LOD score, which is the $\log_{10}$ of this ratio. For example, a fish with an LOD of 2.0 is 100 times more likely to be a pallid, while one with an LOD of -2 is 100 times more likely to be a shovelnose. We employed an *a priori* criterion of LOD ≥ 2.0 to identify a harvested sturgeon as a pallid sturgeon. We also employed an additional Structure run including baseline pallid sturgeon, baseline shovelnose sturgeon, and the commercially harvested sturgeon to compute Q-values for the commercially harvested sturgeon.

Results

Morphological and genetic data from all of the commercially harvested sturgeon are presented in Tables 2-5. Wills et al. (2002) designated pallid sturgeon as having CI values less than -0.45 and mCI values less than -0.70. CI values for the selected samples ranged from -1.358 to 0.446 with a mean of -0.039; mCI values ranged from -0.016 to 0.912 with a mean of 0.494. CI values for the random samples ranged from 0.234 to 1.702 with a mean of 0.797; mCI values ranged from 0.287 to 1.201 with a mean of 0.663. Four fish (2 from Illinois, 2 from Missouri) had CI values in the pallid range of Wills et al. (2002). None of the random samples had CI values in the pallid range and none of the selected or random fish had mCI values in the pallid range. The fisheries biologists reported that despite the CI and mCI scores, none of the fish they examined

had the appearance of being pallid sturgeon. There did not appear to be a correlation between CI and mCI values for the selected and random samples (Figure 3). Wills et al. (2002) designated shovelnose sturgeon as having CI values greater than 0.51 and mCI values greater than 0.83. Among the 84 selected samples none had CI values large enough to be considered shovelnose sturgeon and only six had mCI values large enough to be considered shovelnose sturgeon. Among the 20 random samples 15 had CI values high enough to be considered shovelnose sturgeon while 5 had large enough mCI scores. The remaining CI and mCI scores fell within the remaining three categories listed by Wills et al. (2002) viz. "pallid overlap hybrid", "hybrid", and "shovelnose overlap hybrid."

Q-values for the selected fish ranged from 0.003 to 0.522 with a mean Q of 0.055 (Tables 2-4). LOD scores for the selected fish ranged from -13.398 to 0.497 with a mean LOD of -5.953 (Table 5). Q-values for the random fish ranged from 0.018 to 0.359 with a mean Q of 0.096. LOD scores for the random fish ranged from -12.069 to -2.105 with a mean LOD of -7.564. None of the fish had Q-values or LOD scores consistent with being pallid sturgeon, although several values were intermediate between those of pallid and shovelnose indicating the presence of hybrids and/or backcross sturgeon.

Discussion

Unlike the study of Bettoli et al. (2009), which was conducted in Tennessee, we did not detect any pallid sturgeon in the commercial catches in Illinois, Kentucky, or Missouri. Although we can conclude that no pallid sturgeon were retained in the current study, without on board data collection we do not know how many pallid sturgeon were captured and released. Based on discussions with the fisheries scientists, the ratio of pallid:shovelnose sturgeon is approximately 1:424 in the lower Missouri (Vince Travnichek, personal communication) and 1:80 in the Mississippi River at Chain of Rocks (Rob Maher, personal communication). Thus we would have expected that out of 946 fish observed some would be pallid sturgeon unless the fishers were somewhat successful at recognizing and releasing pallid sturgeon. The ratio of pallid to shovelnose sturgeon in Tennessee is reportedly closer to 1:50 (Bettoli et al. 2009), and thus pallid sturgeon would be expected to be a larger constituent of the catch there. It is also likely, given the knowledge that fisheries biologists would be examining their catch, that fishers were more careful not to retain morphological pallid sturgeon.

While no genetic pallid sturgeon were observed in this study, many had morphological CI-values consistent with hybrids or backcrosses and four had CI-values consistent with pallid sturgeon. F_1 hybrids in fishes tend to be morphologically intermediate between species, with F_n and backcross fish spanning the morphological continuum between parental species (Neff and Smith 1979). Hatchery-produced hybrids between pallid and shovelnose sturgeon were more similar to shovelnose sturgeon in one study (Kuhajda and Mayden 2001). A few fish had LOD values or Q-values that were outside the range of the shovelnose baselines (Tables 2-5, Figure 2). The baselines are constructed conservatively in that they may exclude good pallid or shovelnose sturgeon to reduce the risk that hybrids or backcrosses are included in the baselines (Schrey et al. 2007). Thus some of the harvested fish which fell outside the range of the baselines may be pure shovelnose sturgeon. The morphological and genetic data collected to date are consistent with multiple generations of hybridization and backcrossing between pallid and shovelnose sturgeon. Disentangling the array of multi-generation hybrids and backcrosses will require more than the sixteen loci we are currently scoring. Even when loci exhibit fixed allelic

differences among parental species, it may take 70 or more loci to accurately identify advanced backcrosses (Boecklen and Howard 1997).

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Table 1. Locations of commercial *Scaphirhynchus* collections sites by state.

Name	Description
Illinois Collection Sites	
Thebes	Thebes; Mississippi River Miles 35-40 [1]
Cape	Cape Girardeau; Mississippi River Mile 50 [1]
Kaskaskia	Kaskaskia/Mississippi River Confluence; Mississippi River Miles 112-122 [1]
Chain	Chain of Rocks; Mississippi River Mile 189 [1]
Winfield	Pool 26; Mississippi River Mile 240 [1]
Kentucky Collection Sites	
MRM910	Island #8; Mississippi River Mile 910 [2]
MRM935	Wolf Island; Mississippi River Mile 9 [1]
Missouri Collection Sites	
MOR	Missouri River below Columbia, MO
[1] ***River miles are upstream from confluence with Ohio River***	
[2] ***River miles are upstream from Gulf of Mexico***	

Table 2. Morphological and genetic data for selected commercially harvested *Scaphirhynchus* in Illinois. Locations are described in the Table 1. Morphological measures are the CI and mCI of Wills et al. (2002). Genetic indices are LOD using Whichrun (Banks and Eichert 2000) and Q-value using Structure (Pritchard et al. 2000).

Vial #	Site	CI	mCI	LOD	Q
IL-008	Thebes	0.006	0.686	-9.677	0.006
IL-055	Thebes	-0.335	0.844	-10.273	0.014
IL-058	Thebes	0.052	0.323	-0.601	0.245
IL-083	Kaskaskia	0.069	0.885	-8.568	0.013
IL-106	Kaskaskia	-0.091	0.856	-10.646	0.007
IL-116	Kaskaskia	0.056	0.642	-3.074	0.05
IL-122	Kaskaskia	-0.118	0.34	-1.288	0.319
IL-131	Kaskaskia	-0.338	0.402	0.997	0.522
IL-157	Kaskaskia	-0.001	0.625	-9.217	0.007
IL-158	Kaskaskia	-0.188	0.842	-7.527	0.011
IL-164	Thebes	-0.066	0.596	-6.273	0.014
IL-171	Kaskaskia	-0.11	0.767	-10.841	0.005
IL-173	Kaskaskia	-0.129	0.711	-0.032	0.435
IL-174	Kaskaskia	-0.315	0.746	-10.27	0.006
IL-175	Kaskaskia	0.083	0.912	-10.616	0.005
IL-177	Kaskaskia	-0.263	0.555	-3.657	0.034
IL-179	Kaskaskia	0.03	0.702	-3.164	0.073
IL-184	Thebes	0.06	0.687	-6.604	0.011
IL-190	Thebes	-0.211	0.654	-11.212	0.005
IL-264	Winfield	-0.568	0.549	-2.697	0.112
IL-270	Chain	-0.21	0.293	-3.495	0.072
IL-278	Chain	-0.101	0.608	-7.613	0.011
IL-283	Winfield	-0.04	0.584	-5.287	0.013
IL-304	Chain	-0.221	0.315	0.044	0.148
IL-314	Chain	-0.213	0.757	-3.17	0.081
IL-329	Chain	-0.056	0.563	-7.448	0.012
IL-351	Cape	0.051	0.807	-7.145	0.009
IL-354	Cape	0.025	0.555	-5.424	0.014
IL-369	Chain	-0.083	0.564	-3.681	0.054
IL-401	Chain	-0.035	0.399	-5.441	0.018
IL-409	Chain	-0.034	0.348	-6.421	0.03
IL-419	Chain	-0.083	0.472	-1.15	0.129

Table 2. *continued*

Vial #	Site	CI	mCI	LOD	Q
IL-428	Chain	-0.074	0.535	-6.197	0.013
IL-461	Chain	-0.571	0.457	-3.979	0.04
IL-462	Chain	-0.222	0.552	-10.86	0.005
IL-468	Chain	-0.102	0.573	-3.595	0.039
IL-483	Chain	-0.349	0.498	-4.184	0.036
IL-495	Chain	-0.16	0.465	-2.226	0.094
IL-515	Chain	-0.15	-0.016	-4.496	0.031
IL-519	Chain	-0.074	0.446	-3.729	0.086
IL-522	Chain	-0.199	0.314	-3.223	0.147
IL-528	Chain	-0.026	0.378	-9.091	0.004
IL-537	Chain	-0.24	0.229	-4.516	0.025
IL-548	Chain	-0.245	0.499	-10.035	0.005

Table 3. Morphological and genetic data for selected commercially harvested *Scaphirhynchus* in Kentucky. Locations are described in Table 1. Morphological measures are the CI and mCI of Wills et al. (2002). Genetic indices are LOD using Whichrun (Banks and Eichert 2000) and Q-value using Structure (Pritchard et al. 2000).

Vial #	Site	CI	mCI	LOD	Q
KY-013	MRM935	0.405	0.519	-12.046	0.006
KY-056	MRM935	0.163	0.727	-9.456	0.008
KY-075	MRM935	0.146	0.591	-8.063	0.009
KY-101	MRM910	0.427	0.685	-7.525	0.019
KY-103	MRM910	0.162	0.295	-5.899	0.021
KY-122	MRM910	0.251	0.283	-2.978	0.029
KY-128	MRM910	0.361	0.831	-9.387	0.007
KY-151	MRM910	0.446	0.369	-7.619	0.009
KY-157	MRM910	0.403	0.346	-6.011	0.007
KY-165	MRM910	0.119	0.751	-3.415	0.028
KY-167	MRM910	0.438	0.488	-2.187	0.164
KY-173	MRM910	0.116	0.411	-4.912	0.068
KY-174	MRM910	0.389	0.406	-3.469	0.041
KY-176	MRM910	0.374	0.113	-0.012	0.107
KY-184	MRM910	0.331	0.637	-7.387	0.008
KY-186	MRM910	0.386	0.36	-3.143	0.036
KY-188	MRM910	0.296	0.63	-5.331	0.042
KY-198	MRM910	0.331	0.603	-9.524	0.007
KY-199	MRM910	0.299	0.389	-7.388	0.021
KY-200	MRM910	0.349	0.211	-9.117	0.014

Table 4. Morphological and genetic data for selected commercially harvested *Scaphirhynchus* in Missouri. Locations are described in the Table 1. Morphological measures are the CI and mCI of Wills et al. (2002). Genetic indices are LOD using Whichrun (Banks and Eichert 2000) and Q-value using Structure (Pritchard et al. 2000).

Vial #	Site	CI	mCI	LOD	Q
MO-060	MOR	-0.082	0.551	-8.868	0.012
MO-105	MOR	-0.18	0.088	-3.502	0.126
MO-106	MOR	-1.027	0.901	-1.865	0.072
MO-107	MOR	-1.358	0.536	-2.938	0.104
MO-109	MOR	-0.06	0.38	-13.398	0.003
MO-116	MOR	-0.016	0.338	-5.422	0.023
MO-118	MOR	-0.167	0.173	-8.444	0.02
MO-123	MOR	0.078	0.321	-2.153	0.301
MO-126	MOR	-0.24	0.637	-5.284	0.019
MO-135	MOR	0.035	0.159	-5.246	0.022
MO-144	MOR	-0.002	0.316	-8.025	0.008
MO-201	MOR	-0.048	0.219	-7.58	0.011
MO-251	MOR	-0.013	0.496	-4.733	0.021
MO-257	MOR	-0.078	0.274	-3.104	0.05
MO-261	MOR	-0.021	0.497	-10.975	0.008
MO-270	MOR	-0.295	0.179	-6.54	0.035
MO-295	MOR	0.068	0.499	-8.309	0.006
MO-322	MOR	0.031	0.363	-4.263	0.01
MO-334	MOR	0.06	0.306	-4.284	0.074
MO-382	MOR	-0.396	0.138	-12.618	0.004

Table 5. Morphological and genetic data for randomly-selected commercially harvested *Scaphirhynchus* in Illinois, Kentucky, and Missouri. Locations are described in the table 1. Morphological measures are the CI and mCI of Wills et al. (2002). Genetic indices are LOD using Whichrun (Banks and Eichert 2000) and Q-value using Structure (Pritchard et al. 2000).

Vial #	Site	CI	mCI	LOD	Q
IL-097	Kaskaskia	0.507	0.881	-6.089	0.098
IL-124	Kaskaskia	0.339	0.634	-11.038	0.021
IL-128	Kaskaskia	0.721	1.201	-6.719	0.054
IL-146	Kaskaskia	0.743	0.551	-5.202	0.115
IL-162	Kaskaskia	0.234	0.467	-7.953	0.039
IL-480	Chain	0.569	0.628	-12.069	0.018
IL-488	Chain	0.569	0.578	-2.105	0.208
IL-532	Chain	0.451	0.53	-8.037	0.054
KY-016	MRM935	1.246	0.954	-7.33	0.135
KY-057	MRM935	1.702	0.953	-11.187	0.031
KY-152	MRM910	0.848	0.553	-5.493	0.167
KY-179	MRM910	1.394	0.872	-4.645	0.192
KY-194	MRM910	0.592	0.508	-11.389	0.033
MO-202	MOR	0.539	0.757	-6.064	0.187
MO-224	MOR	0.866	0.287	-7.764	0.044
MO-290	MOR	0.43	0.577	-2.522	0.359
MO-296	MOR	1.254	0.497	-10.158	0.033
MO-314	MOR	0.924	0.376	-7.442	0.054
MO-376	MOR	0.957	0.624	-8.381	0.035
MO-394	MOR	1.057	0.827	-9.701	0.036

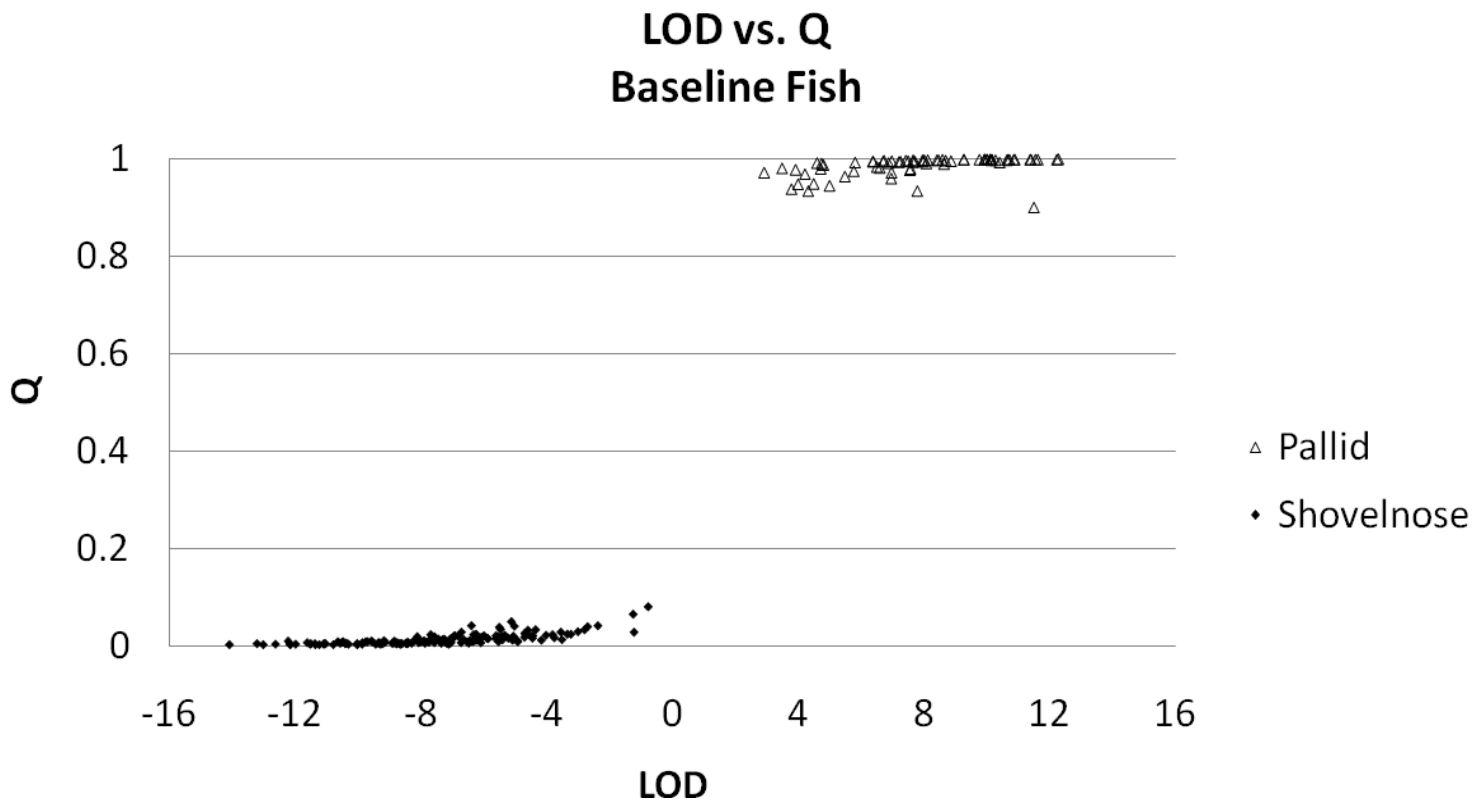

Figure 1. LOD scores and Q-values for 74 pallid sturgeon and 153 shovelnose sturgeon used to identify commercially caught *Scaphirhynchus*.

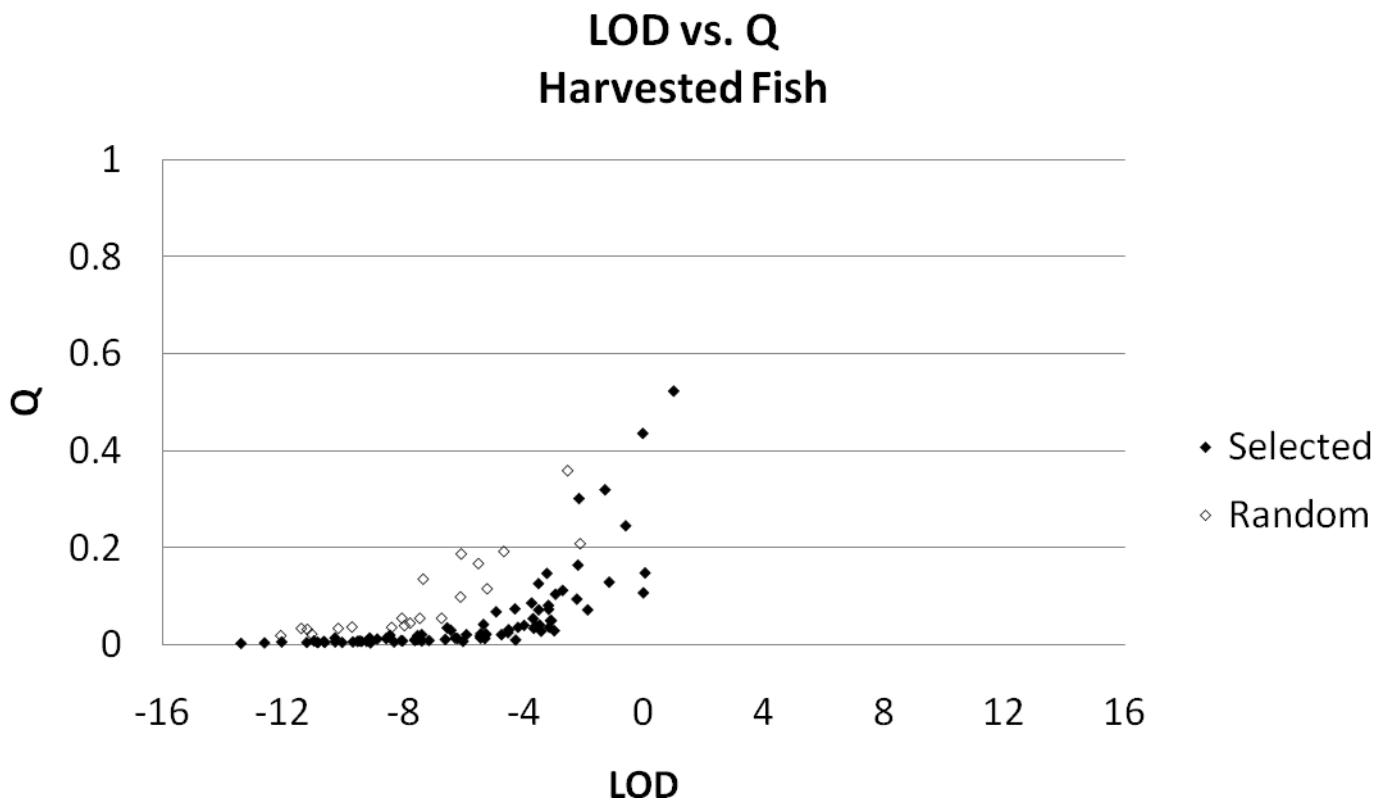

Figure 2. LOD scores and Q-values for commercially harvested *Scaphirhynchus*. Fish with LOD scores near zero and/or Q-values greater than 0.2 may be hybrids or backcrosses.

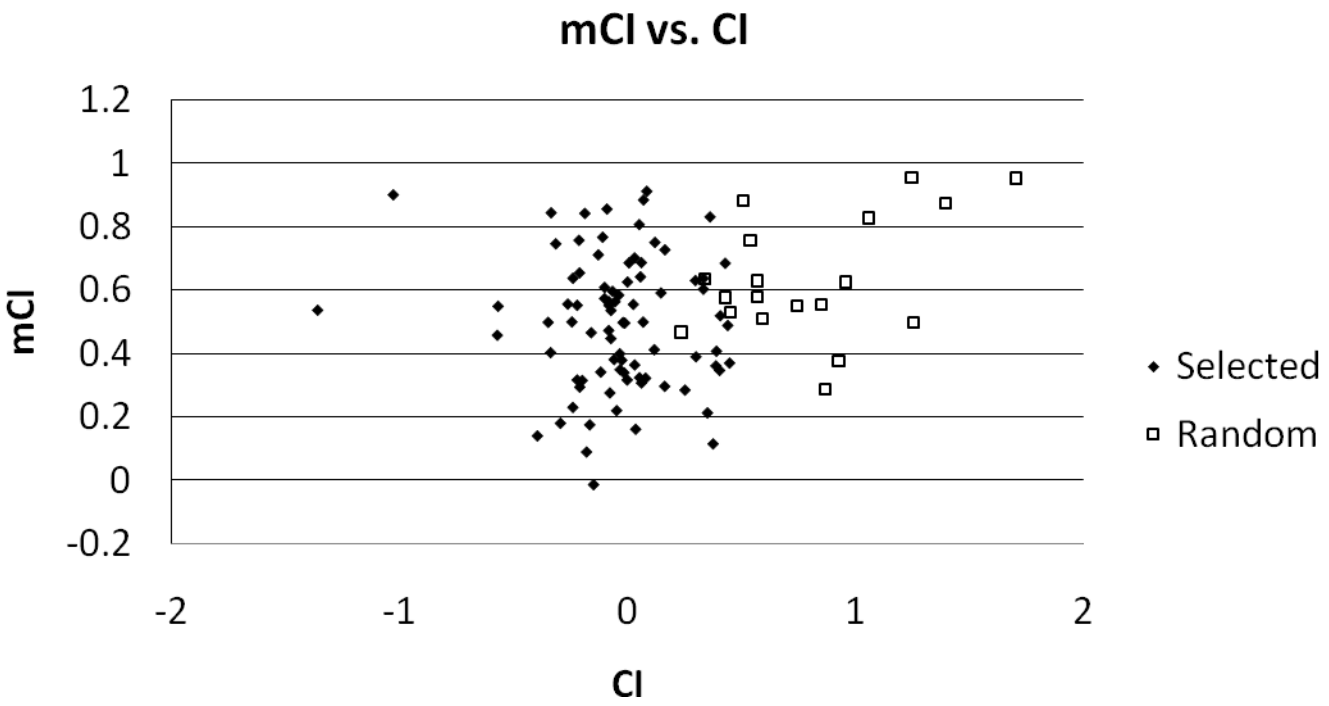

Figure 3. Wills et al. (2002) morphometric character index (mCI) and character index (CI) for commercially harvested sturgeon selected for low CI score (selected) and at random from remaining sturgeon (random).

SECTION V

MICRA STURGEON WORKING GROUP RECOMMENDATIONS

Submitted to the MICRA Executive Board July 2009

These recommendations are suggested by the MICRA Sturgeon Working Group for states that will continue to manage for the commercial harvest of shovelnose sturgeon in the sympatric range. State agencies should work cooperatively to implement these recommendations.

Biological Associated Recommendations

Species

Recommendation:

- Only shovelnose sturgeon are legal to harvest.

Identifying characteristics

Recommendations:

- A standard suite of characteristics should be set to identify legal fish. Sturgeon not meeting these criteria should be considered illegal.
- States currently allowing harvest of shovelnose sturgeon should adopt similar legal identifying characteristics.

Considerations:

Approach I: Fish with any of the following three characteristics are illegal to harvest under current law in Illinois.

1. Bases of outer barbels located slightly farther behind bases of inner barbels.
2. Belly completely lacking scales.
3. Length of inner barbels going at least 6.3 times into length of head

Approach II: Tennessee is considering a similar approach as a temporary measure. The following four characters are under consideration:

1. Belly entirely covered in large embedded scales.
2. All four barbel insertion points must be in a straight line perpendicular to the head.
3. Outer barbels must not extend beyond the mouth (as determined by a straight line drawn through the middle of the mouth, perpendicular to the head).
4. Outer barbels must be less than 1.5 times as long as the inner barbels.

Certification and Permits Associated Recommendations

Training and Certification

Recommendation:

- Training and certification should be required for all shovelnose sturgeon commercial roe fishers. Only certified fishers can work in sympatric range.

Considerations:

- State based training and certification program.
- A MICRA training and certification program used states.

Law Enforcement Based Recommendations

Law Enforcement Training

Recommendation:

- Law Enforcement agents should complete the same training program as the shovelnose sturgeon commercial roe fishers.

Consideration:

- State based or MICRA training program.

Law Enforcement Effort

Recommendations:

- States that continue to manage commercial shovelnose sturgeon fisheries should commit to increased Law Enforcement effort.
- States should focus enforcement efforts during the roe harvest peak
- A state enforcement summary on annual basis should be provided.

Consideration:

- Current enforcement efforts direct towards sturgeon issues should be ascertained before making a recommendation on minimum number of man days/river mile.

Legal Based Recommendations

Prosecution for Illegal Harvest

Recommendations:

- States should work cooperatively as part of the Interstate Compact to enforce similar laws.
- Federal agents should work cooperatively with state agencies in enforcement efforts
- Possession of a pallid sturgeon by a certified roe fisherman should result in a lifetime suspension of roe license.

Considerations:

- Will states be able to suspend a roe permit if a licensed fisherman loses his permit in another state?
  - Wisconsin and Tennessee licenses can only be revoked or suspended by a judge
  - In Wisconsin, multiple citations will prevent future sales, but can't revoke a license
- Will legal process work in a timely and efficient manner

Fishery Management Associated Recommendations

Seasons

Recommendation:

- Season dates should be based on water temperature.

Consideration:

- Pallid sturgeon recovery team handling protocol begins to limit net soak times at water temperatures above 55 ^{o}F.

Fishery Management Associated Recommendations: (continued)

Length Limits

Recommendations:

- All states should have the same size limits.
- States should consider a slot length strategy.

Considerations:

- What is the smallest size for a gravid pallid sturgeon?
- 24″-32″ slot length limit for shovelnose sturgeon
- What about reports of intermediates that develop into pallid sturgeon at larger sizes?
  - Intermediates were tagged in the LMR and recaptured at a later date. The fish had strong pallid characteristics when recaptured.
  - 12″ is an adequate size to differentiate the species
  - Pallid sturgeon are allometric.
  - A 24″ length limit should be adequate to differentiate intermediates

Geographic Closures

Recommendation:

- States should continue to identify important habitats to protect.

Consideration:

- Sensitive reaches (Chain of Rocks is currently closed 300 yards downstream). Tributary confluences with main river.

Possession Requirements

Recommendation:

- Ovaries must be whole, in tact, and inside the body cavity until the fish reach the point of sale

Considerations:

- Kentucky requires the eggs be kept intact and inside the body until the fish is at a HACCP certified facility.
- Illinois and Missouri both require ovaries to be whole, in tact, and left inside the body cavity while on the water
- Tennessee is the same but includes the adjacent banks

Gill Nets and Individual Net Identification Requirements

Recommendations:

- Gill Net Mesh Size: None
- Commercial roe fishers and researchers should attend nets between 9AM and 4PM, and no dead sets during this period (i.e., unattended nets).

Considerations:

- This issue was raised to attempt to quantify the ghost net issue.
  - Ghost nets can be a problem with researchers and resource agencies too. Attendance requirements would likely be more effective at reducing ghost nets.