A Summary Report
of Cooperative Inter-agency Management Activities and Recommendations
for Commercial Paddlefish Fisheries in the Mississippi and Ohio Rivers

Paddlefish Commercial Harvest States Workgroup
Paddlefish and Sturgeon Committee
Mississippi Interstate Cooperative Resource Association (MICRA)

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MICRA Paddlefish and Sturgeon Committee
Paddlefish Commercial Harvest States Workgroup Agency Representatives

Alabama Department of Conservation and Natural Resources

Steve Rider

Arkansas Game and Fish Commission

Jeff Quinn[1]
Allison Asher

Illinois Department of Natural Resources

David Glover[2]
Sara Tripp

Indiana Department of Natural Resources

Craig Jansen[1]
Phil Kacmar

Kentucky Department of Fish and Wildlife Resources

Jessica Morris[1]
Joshua Tompkins

Mississippi Department of Wildlife, Fisheries and Parks

Dennis Riecke

Missouri Department of Conservation

Joe McMullen

Tennessee Wildlife Resources Agency

Eric Ganus

MICRA

Ryan Hupfeld, Paddlefish and Sturgeon Committee Chair
Greg Conover, MICRA Coordinator

[1] Initial agency representative when the MICRA Paddlefish and Sturgeon Committee Commercial Harvest States Workgroup was formed in 2014. Initial agency representatives were replaced at different times with a new agency representative before this report was completed and submitted to the MICRA Executive Board.

[2] Initial agency representative on the MICRA Paddlefish and Sturgeon Committee Commercial Harvest Workgroup beginning in 2020. Illinois did not participate on the workgroup when it was initially formed in 2014.

Executive Summary

In 2012, the U.S. Fish and Wildlife Service (USFWS) funded the Association of Fish and Wildlife Agencies (AFWA) CITES Technical Work Group to evaluate existing Paddlefish data and establish biological reference points for Paddlefish as a single mixed stock throughout the Mississippi River Basin to document sustainability of harvest and enable the USFWS to make non-detriment findings using a basinwide approach rather than a state-by-state approach. The results of the final report (Sharov et al. 2014) were presented to state agency representatives, USFWS staff, and other interested parties during a workshop in January 2014. AFWA facilitated discussion about the implications of the report findings and recommendations with the intent of assisting the states to agree to a set of common Paddlefish management goals and objectives. During the workshop, the commercial harvest states agreed that $F_{30\%}$ was an appropriate biological reference point for Paddlefish stocks in the basin. However, several states questioned whether Paddlefish should be managed on a basin-wide or sub-basin approach and whether Paddlefish populations within the basin or sub-basins are at risk of not meeting F30%. Despite the states' interest in addressing the data limitations identified by Sharov et al. (2014), the states uniformly expressed a lack of resources to collect the requested time series catch, indices of abundance, and age and size structure data. The states agreed that age and growth data are the most crucial data needed throughout the basin and should be the immediate focus to assess Paddlefish population mortality against the $F_{30\%}$ benchmark. In 2014, eight states (Alabama, Arkansas, Illinois, Indiana, Kentucky, Mississippi, Missouri, and Tennessee) managed commercial Paddlefish fisheries and agreed to further discussion through the formation of a MICRA Paddlefish commercial harvest states workgroup. The workgroup developed a collaborative project plan to collect a 3-year fishery dependent data set of Paddlefish jawbone samples for age and growth analysis. MICRA contracted with Dr. Michael Wilberg, Atlantic Transglobal, to update the Sharov et al. (2014) analysis using the additional age and growth data collected by the commercial harvest states in 2014-2017. Based on the additional analysis, Dr. Wilberg (2019) concluded that a 36" minimum length limit for the Mississippi and Ohio rivers is needed to achieve $F_{30\%}$. The workgroup agreed that a consistent management approach in the Mississippi and Ohio rivers is needed among the commercial harvest states and that a suite of regulations would likely be needed to achieve $F_{30\%}$ rather than relying solely on the 36" minimum length limit recommended by Wilberg (2019). The workgroup met multiple times from September 2019 to June 2021 to discuss potential Paddlefish regulations for the states' boundary waters (i.e., Mississippi and Ohio rivers) that would likely be most effective at reducing mortality and that would be enforceable. Although most states supported considering a 34" minimum length limit standard for commercial Paddlefish fisheries in the Mississippi and Ohio rivers, the group did not reach consensus. The workgroup agreed that standardized season dates based on 58^{o}F water temperature would reduce Paddlefish mortality. The workgroup developed several recommendations to improve cooperative inter-agency Paddlefish management, beginning with the development of a basinwide Paddlefish management framework to address the need for consistent data collection, reporting, and analysis among states within the basin. Several questions and concerns about the data used to develop the model and assumptions used by Wilberg (2019) resulted in the workgroup recommending future research needs including sensitivity analysis, age validation, and spatially explicit population modeling to better inform collaborative Paddlefish management in the basin going forward.

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Background

"In 1989, the U.S. Fish and Wildlife Service (USFWS) was petitioned to list Paddlefish as a federally threatened species under the Endangered Species Act. The petition was not granted, primarily because of a lack of empirical data on Paddlefish population size, age structure, growth, or harvest rates across the present 22-state range. Nonetheless, concern for Paddlefish populations prompted the USFWS to recommend that Paddlefish be protected through the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)" (Jennings and Zigler 2000). The addition of Paddlefish to Appendix II of CITES in 1992 requires international trade in Paddlefish and their parts be authorized through a system of permits to ensure that the species survival is not threatened.

As an Appendix II listed species, CITES requires that countries exporting Paddlefish products restrict trade to levels that are not detrimental to Paddlefish populations (i.e., maintain sustainable harvest). Non-detriment findings for species listed in Appendix II are required for continued exports. Rosser and Haywood, 2002 provides details, explanations, and guidance for scientific authorities seeking non-detriment findings.

"The complete collapse of the Caspian Sea sturgeon stocks that followed the end of the Soviet Union [in 1991] resulted in increasing pressure on Paddlefish, and other sturgeon species, to meet the demands of the international caviar market" (AFWA 2022). The USFWS became concerned about increased harvest levels and demand for U.S. Paddlefish roe as indicated by an increasing number of applications for caviar exports, particularly from the Kentucky Lake in Tennessee (USFWS 2009b). A study by Scholten and Bettoli (2005) found that more than 50% of U.S. commercially harvested Paddlefish came from Tennessee waters (Hoffnagle and Timmons 1989, Timmons and Hughbanks 2000) and the majority of that harvest (approximately 80%) came from Kentucky Lake on the lower Tennessee River. In response to the findings of Scholten and Bettoli (2005), the Tennessee Wildlife Resources Agency (TWRA) developed a 5-year management plan with a schedule of more restrictive regulatory actions to protect Kentucky Lake Paddlefish from overfishing (USFWS 2009b) that was agreed upon by the Tennessee Wildlife Resources Commission (TWRC) and the state's commercial fishing industry (R. Gnam, USFWS, personal communication). In Tennessee, commercial harvest of Paddlefish is managed by the TWRA who makes recommendations about management and regulation of Paddlefish harvest to the Tennessee Wildlife Resources Commission (TWRC). The TWRC has the responsibility of reviewing, approving, and promulgating Paddlefish regulations (USFWS 2009b).

In June 2008, the USFWS received a letter from the European Union (EU) Scientific Review Group (SRG) raising concerns regarding increased export of Paddlefish from the United States, questioned the USFWS's non-detriment findings for Paddlefish exports, and requested a report on the conservation status and management of Paddlefish to determine whether continued imports into the EU would be allowed (R. Gnam, USFWS, personal communication). As a result of the SRG's letter, the USFWS sent a data call to all Paddlefish range states in September 2008 requesting the most recent information on the status, harvest, and management of Paddlefish in their jurisdictions to prepare a summary report for the SRG (R. Gnam, USFWS, personal communication). MICRA also coordinated *A Review of State Agency*

Paddlefish Management in the Mississippi River Basin that was provided to the USFWS in March 2009. The USFWS Division of Scientific Authority convened a Paddlefish workshop in conjunction with the MICRA Paddlefish and Sturgeon Committee meeting in January 2009 to clarify the EU position on U.S. Paddlefish, the implications of their potential rejection of the USFWS's non-detriment findings, and to discuss managing Paddlefish caviar fisheries in a sustainable manner (USFWS 2009a). In March 2009, the USFWS delivered the report requested by the SRG detailing the current conservation status and management of Paddlefish in the United States (USFWS 2009a). Following a review of the report, the EU SRG agreed to the continued imports of U.S. Paddlefish products into the EU, with continued monitoring, and asked to be informed of any changes in Tennessee that may affect future non-detriment findings (R. Gnam, USFWS, personal communication).

Meanwhile, the TWRC met in September 2008 and reversed course by deciding to remove all season restrictions and minimum length regulations for all waters open to commercial harvest of Paddlefish in Tennessee (R. Gnam, USFWS, personal communication). The USFWS informed the TWRC in October 2008 that without adequate regulations and a sustainable management plan in place, the USFWS would not be able to issue a state-wide general advice that would allow export of Paddlefish roe harvested from Tennessee (R. Gnam, USFWS, personal communication). In addition, the Service would have difficulty in making non-detriment findings for individual applications to export eggs or flesh (R. Gnam, USFWS, personal communication). Despite reinstating some Paddlefish regulations in November 2008, TWRC did not implement the previously agreed upon 5-year management plan (USFWS 2009b) and announced that it would not revisit the proposed Paddlefish regulation changes until 2011 (R. Gnam, USFWS, personal communication).

In June 2009, the USFWS concluded that "under the current regulatory framework, the Kentucky Lake Paddlefish population in Tennessee is not being managed in a sustainable manner and export cannot continue without a detrimental impact to Paddlefish populations. Therefore, the Service is unable to make a non-detriment finding for export of Paddlefish already harvested from Kentucky Lake in Tennessee, during the 2008-2009 season. Without such a non-detriment finding, CITES export permits for Paddlefish products from Kentucky Lake, Tennessee will be denied" (USFWS 2009b).

During the January 2010 MICRA Paddlefish and Sturgeon Committee meeting (MICRA 2010), the USFWS discussed an international resolution adopted by CITES parties regarding "Conservation of and trade in sturgeons and Paddlefish" (CITES 2016). The resolution urges "regional agreements between range States of wild sturgeon and Paddlefish aiming at proper management and sustainable utilization of these species" and describes a process for the establishment of catch and export quotas for shared stocks among countries. The USFWS expressed a need for developing a long-term plan for making non-detriment findings on a river drainage basis for shared Paddlefish stocks rather than by the current state-by-state approach. The USFWS stated that a shared management approach between the states for shared stocks would bring the U.S. closer to compliance with the CITES resolution and encouraged the states to work together to develop a basin-wide management framework or sub-basin management plans. The USFWS noted that a basinwide (or sub-basin) management approach would require consistent state regulations (e.g., harvest seasons, length limits, gear restrictions, license and reporting

requirements) and uniform, enforceable regulations so that the shared stocks can be managed cooperatively by the states. It is imperative to have good estimates of recruitment, growth, and mortality to know if stocks are being exploited at sustainable levels. However, nearly all MICRA sub-basins identified distribution, extent of harvest, and exploitation as significant needs for Paddlefish management in 2010. The AFWA CITES Technical Work Group identified a need for the MICRA Paddlefish database to be analyzed to better understand migratory patterns, contribution of hatchery-reared Paddlefish to recruitment, and compensating for mortality through other factors. The USFWS also expressed interest in applying marine stock assessment approaches to riverine sturgeon and Paddlefish stocks to better assess sustainability of harvest and inform non-detriment findings. As an initial step towards a shared management approach, the USFWS funded a study by Southern Illinois University to assess basic demographic information for lower Mississippi River Paddlefish to provide science-based recommendations to managers and assist with harmonizing Paddlefish regulations in the lower Mississippi River Basin.

Introduction

In January 2012, representatives from the USFWS and AFWA's CITES Technical Work Group, and Alexei Sharov met with MICRA's Paddlefish and Sturgeon Committee to discuss a proposal to evaluate existing Paddlefish data and establish biological reference points for Paddlefish as a single mixed stock throughout the Mississippi River Basin to document sustainability of harvest and enable the USFWS to make non-detriment findings using a basinwide approach rather than a state-by-state approach. Access to MICRA's basinwide Paddlefish database was requested and subsequently granted for the proposed project. This evaluation and analysis of existing Paddlefish data were funded by the USFWS through the AFWA CITES Technical Work Group and was initiated later in 2012. In 2013, Alexi Sharov, Michael Wilberg and J. Robinson prepared a draft report entitled, '*Developing Biological Reference Points and Identifying Stock Status for Management of Paddlefish (Polyodon spatula) in the Mississippi River Basin*' that was circulated for comment to all paddlefish range states (AFWA 2014).

"On January 17, 2014, the authors presented their findings in a webinar sponsored by AFWA that allowed for questions and discussion of the results and their implications. On January 28, 2014, AFWA facilitated a discussion between state representatives, USFWS staff and other interested parties at a face-to-face meeting in Kansas City, Missouri" (AFWA 2014; Appendices 1 and 2). The stated purpose of the meeting was "to develop management measures, potentially by region or basin, where needed for sustainable management of Paddlefish based on the recommendations found in the report" (AFWA 2014). A specific objective of the workshop was "to assist the USFWS in their review leading to issuance of appropriate (non-detriment findings) to state agencies, so that states can continue to sustain commercial and recreational fisheries and Paddlefish populations into the future. The workshop provided the opportunity for state fish and wildlife agencies and USFWS representatives to discuss management measures to ensure the sustainability of the species; domestic and international trade in this species; and a discussion of future management and trade in Paddlefish" (AFWA 2014). The expected outcome of the workshop was for the states "to agree to a set of common goals for Paddlefish management and the elements of management objectives (reference points and monitoring) that have

the best probability of acceptance through each state's administrative and regulatory process" (AFWA 2014).

During the workshop, the commercial harvest states agreed that $F_{30\%}$ was an appropriate biological reference point for Paddlefish stocks in the basin (AFWA 2014). However, there were still questions among the management agencies concerning whether Paddlefish should be managed on a basin-wide or sub-basin approach and whether Paddlefish populations within the basin or sub-basins are at risk of not meeting F30%. Rather than a single basinwide approach for evaluating Paddlefish stocks, the commercial harvest states proposed updating or developing management plans for six different management units: Upper Mississippi River, Lower Mississippi and White rivers, Arkansas River, Ohio River, Tennessee and Cumberland rivers, and the Mobile River. Despite the states' interest in addressing the data limitations identified by Sharov et al. (2014), the states uniformly expressed a lack of resources to collect the requested time series catch, indices of abundance, and age and size structure data. The states agreed that age and growth data are the most crucial data needed throughout the basin and should be the immediate focus to assess Paddlefish population mortality against the $F_{30\%}$ benchmark.

State agency comments were carefully considered, responded to, and the draft report was reissued as final in February 2014 (AFWA 2014). Sharov et al. (2014) concluded that most Paddlefish stocks are "data poor" due to very limited or an absence of time series of basic fishery dependent data (e.g., catch, indices of abundance, and systematic age and size structure). Due to the limitation of adequate fishery dependent data, catch-related fishery models could not be used for the assessment. Based on analysis and modeling of the available data, the authors "suggested management parameters that would support sustainable fisheries for the group to consider." The report also included several management recommendations for sustainable levels of Paddlefish exploitation, as well as research recommendations for improving data collection of critical fishery information.

In 2014, eight states (Alabama, Arkansas, Illinois, Indiana, Kentucky, Mississippi, Missouri, and Tennessee) managed commercial Paddlefish fisheries and agreed to further discussion through the formation of a MICRA Paddlefish Commercial Harvest States Workgroup. The workgroup's charge was to: 1) develop plans for coordinated age and growth data collection; 2) update or develop Paddlefish commercial fishery management plans for the identified management units; 3) explore long-term strategies for coordinated data collection, analysis, and management plan implementation; and 4) consider how to best utilize AFWA's remaining funding from the USFWS grant for the Paddlefish report.

Methods

An initial meeting of the workgroup was held in November 2014. Fisheries administrators and/or the commercial fisheries biologist from all workgroup states except Illinois participated in the meeting. The purpose of the workgroup meeting was 1) to develop plans for coordinated age and growth data collection beginning with the upcoming 2014-2015 Paddlefish season, and 2) to consider how to best utilize AFWA's remaining funding from the USFWS grant for the Paddlefish report. During the meeting, the states developed a collaborative project plan to collect a 3-year fishery dependent data set of

Paddlefish jawbone samples for age and growth analysis. Fishery-dependent and independent data collection methods were used during the project period. Paddlefish sampled during the project period (November 1 through April 30) were collected post-mortem or from live specimens. Horizontal, monofilament and monotwist gill nets (101.6, 127 and 152.4-mm-bar measure mesh) with a depth (4.26 – 6.09 m) and length (22.86 m - 91.44 m) either tied down or straight panel were fished overnight. Weight (nearest 0.25 kg) and EFL (mm) were recorded for all paddlefish with jawbones, sex, and maturity collected when available. The seven participating states identified target sample sizes for the following management units: Alabama River; White River; Lower Mississippi River, including the Yazoo River; Barkley Lake, Cumberland River; Kentucky Lake, Tennessee River; upper Ohio River (above McAlpine Dam); and the lower Ohio River (below McAlpine Dam). The states agreed to have all samples aged by a single Paddlefish aging expert, specifically Dr. Dennis Scarnecchia at the University of Idaho. The additional data were to be used to update the analysis by Sharov et al. (2014) and the results used for developing new or updating existing Paddlefish management plans for each of the identified management units. The states agreed that contracting for the aging of the Paddlefish jawbone samples was the highest priority need for the available AFWA funding. AFWA agreed to fund Dr. Scarnecchia for the aging of jawbones collected during the 2014-2015 Paddlefish season. It was further agreed that MICRA and the individual states would be responsible for funding the aging of the two additional years of jawbone samples. Specific methods used for aging the jawbone samples are detailed in the final project report submitted to AFWA (Scarnecchia 2015).

MICRA contracted with Dr. Michael Wilberg, Atlantic Transglobal, to update the Sharov et al. (2014) analysis for the Mississippi and Ohio rivers using the additional age and growth data collected by the workgroup states in 2014-2017. The specific methodology for the additional data analysis is detailed in the final report submitted by Wilberg (2019) to the states.

Following initial discussions during the September 2019 meeting, the workgroup met via conference calls or in-person meetings on November 7, 2019; January 14, 2020; March 4, 2021; and June 9, 2021, to continue discussing potential management alternatives to the recommended 36” minimum length limit for reducing Paddlefish mortality in the basin. An additional conference call was held on February 11, 2020, with the Illinois DNR workgroup representative to review additional information provided by Dr. Wilberg regarding the analysis. A final workgroup meeting was held March 24-25, 2022, to review the workgroup’s history and progress, and to begin preparation of a project summary report.

To inform these discussions, the states gathered and compiled current Paddlefish regulations and reporting forms, available historic water temperature data, and historic Paddlefish harvest data. Ohio River water temperature data was obtained from USGS.gov for both Markland locks and dam (L&D) (https://waterdata.usgs.gov/nwis/dvstat?referred_module=sw&search_site_no=03277200&format=sites_selection_links) and Olmstead L&D (https://waterdata.usgs.gov/nwis/dvstat?referred_module=sw&search_site_no=03612600&format=sites_selection_links). For both locations, mean statistics were populated for every calendar day within the available period of approved daily mean data. Olmstead temperature data were available from 10-1-2013 to 9-30-2021, and Markland data were available from 10-1-2010 to 9-30-2022. The upstream

hydro side temperature data were used for Markland L&D as it encompassed the largest dataset. Similarly, water temperature data were obtained from a gauge station on the Mississippi River near Cape Girardeau, MO, from 2-24-2000 to 11-13-2019. Also, water temperature data was collected from the Tennessee portion of the Mississippi River (RM 750) using two (2) onset (U20L-02 data logger) data loggers, from 10-1-2017 to 05-30-2019. Data loggers were deployed on the right descending bank at a depth of 6 m below a gauge height measuring zero at the Memphis River gauge. Each data logger was buoyed with 60 ounces of floatation, anchored to shore and the bottom of the river with 3/8-inch metal cable and a 17 kg hollow cinder block measuring 8 in X 8 in X 16 in, respectively. Mean daily water temperatures were averaged and compared with temperature data collected from the Cape Girardeau gauge station to evaluate paddlefish season in Tennessee. These data were used to determine when water temperature exceeded 58°F, a threshold recommended by Bettoli and Scholten (2006) to keep initial bycatch mortality below 15% in a commercial gill net fishery.

Illinois, Kentucky, Missouri, and Tennessee evaluated their historic Paddlefish harvest data for the Mississippi River fishery. Similarly, Illinois, Kentucky, and Indiana evaluated their historic Paddlefish harvest data for the Ohio River. Harvest from November 1 to November 14 and April 17 to April 30 were summarized using those data on the Ohio River to evaluate potential harvest impacts if the commercial Paddlefish season were shortened by two weeks at either the beginning or end of the season, respectively. Likewise, harvest data on the Mississippi River were summarized to determine how shortening the commercial season would impact total harvest in each state.

Results and Discussion

There are currently six states in the Mississippi River basin that have active commercial fisheries for Paddlefish: Arkansas, Illinois, Indiana, Kentucky, Missouri, and Tennessee. Following the 2018 commercial Paddlefish season, the Alabama Department of Conservation and Natural Resources indefinitely suspended future commercial Paddlefish fishing seasons on the Alabama River. Similarly, the Mississippi Department of Wildlife, Fisheries, and Parks closed the state's commercial Paddlefish fishery following the 2019 commercial Paddlefish season. Details on Paddlefish regulations and harvest in Alabama and Mississippi were reported by Rider et al. (2019). Information reported from the six current commercial harvest states indicate that harvest of Paddlefish has been declining in recent years (Figures 1 and 2; Appendix 3). Although state reporting requirements, season limits, length limits and number of licensed roe harvesters has changed over time, reduced harvest across all states has basinwide implications for Paddlefish stocks. The state with the highest harvest of Paddlefish in the most recent reports was Kentucky, followed by Arkansas, Tennessee, Indiana, Missouri, and Illinois (order varies depending on the year). Water bodies where harvest occurred was dominated by the Mississippi River and Ohio River, followed by other water bodies in various states. However, this does not account for all Paddlefish harvest, as many of these commercial harvest states and others in the basin have active recreational fisheries for Paddlefish.

Annually, since 1998 CITES has requested information on Paddlefish populations and fisheries from states that permit commercial harvest to justify decisions concerning non-detriment findings. From 1998

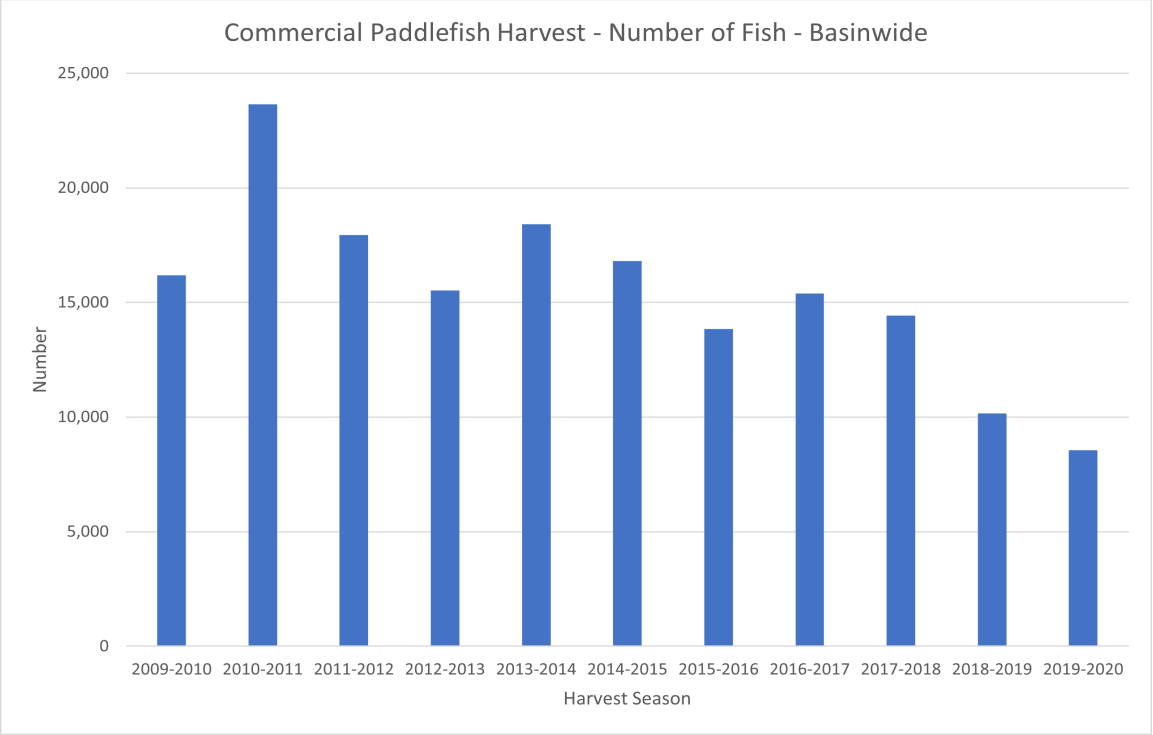

Figure 1. Number of Paddlefish commercially harvested from all states and waterbodies combined from 2009-2010 harvest season to 2019-2020 harvest season.

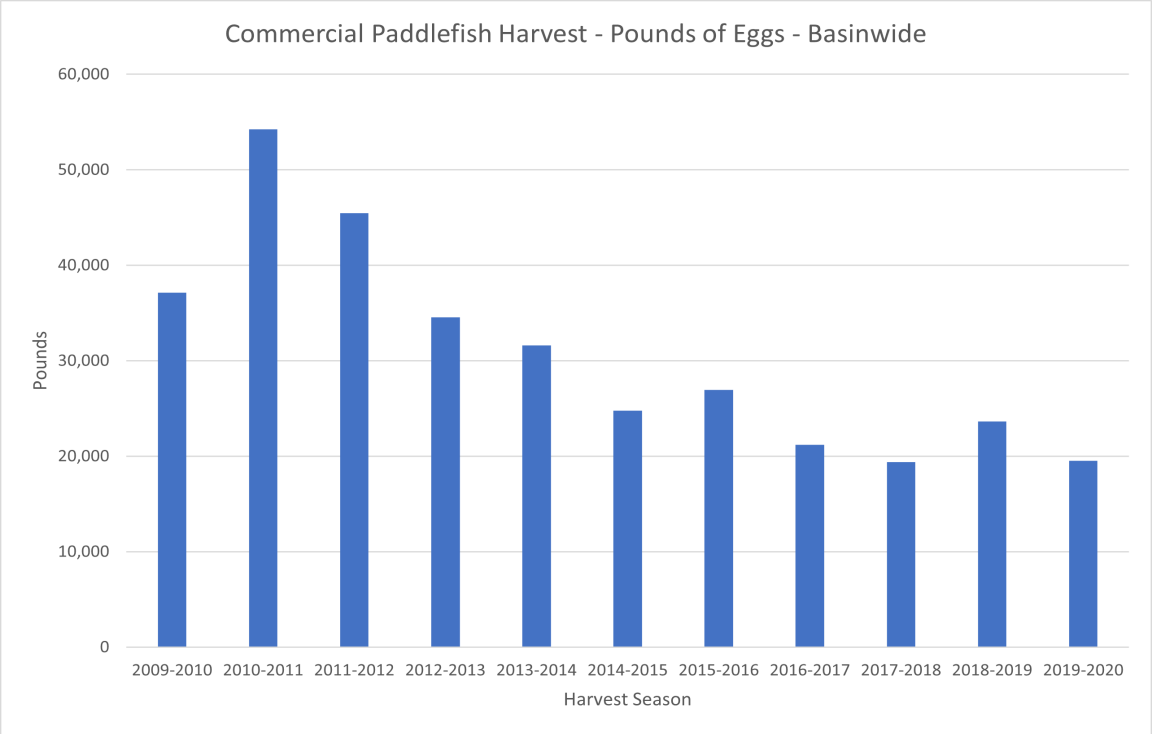

Figure 2. Pounds of Paddlefish eggs commercially harvested from all states and waterbodies combined from 2009-2010 harvest season to 2019-2020 harvest season.

to present 271,308 pounds of Paddlefish eggs/caviar have been exported from the U.S, with peak exports occurring from 2007 to 2010 (4-year average exceeded 25,000 lbs. annually) (Figure 3). Since 2013 Paddlefish egg/caviar exports have steadily declined with less than 1,000 lbs. exported during 2020 and no exports occurring during 2021 or 2022 (as of 19 July 2022).

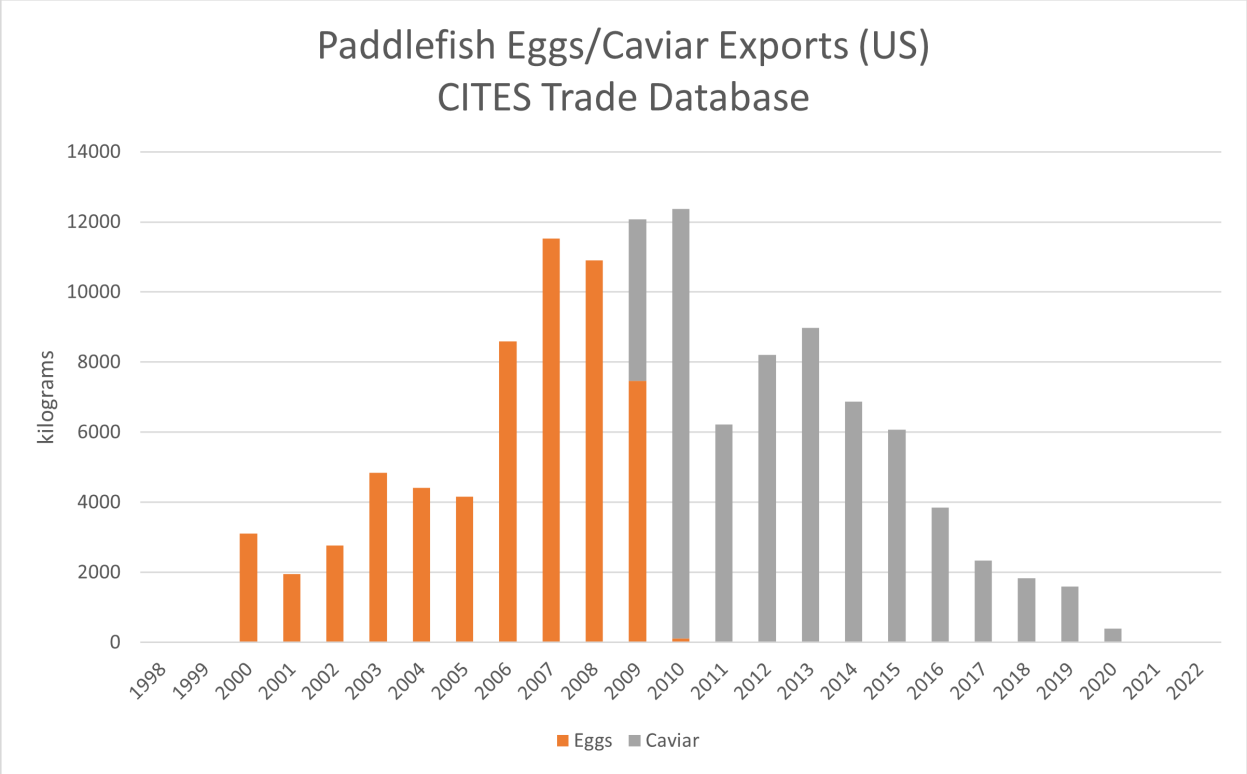

Figure 3. Pounds of Paddlefish eggs/caviar exported from the U.S. from 1998 to 2022 (CITES Trade Database - https://trade.cites.org). Both 'eggs' and 'caviar' are reported in the database but are used synonymously.

Age and Growth Data

In December 2015, Dr. Scarnecchia provided a final report on *Paddlefish age determination for commercial fisheries* to AFWA summarizing the aging of 2,436 jawbone samples, including 1,724 collected during the 2014-2015 season (Table 1) and 712 historic samples. Data and photographs of the jawbone sections were also provided to the seven participating states. Scarnecchia (2015) reported that age determination presented several challenges due to false annuli and the lack of additional information on the individual samples to assist in estimating age (e.g., length, weight, maturation state). Scarnecchia (2015) concluded that the current effort "should be viewed as an initial step in developing reliable age determination methods for the stocks in various states" and recommended age validation and additional years of data from each stock to improve age determination accuracy in the future.

Table 1. Number of target and actual Paddlefish jawbones collected by management unit and state during the 2014-2016 commercial Paddlefish seasons. Totals are reported in the final row.

State	Sub-basin	Management Unit (River/Pool/Reservoir)	Number of Samples			
			Target	2014-2015	2015-2016	2016-2017
AL	Alabama River	Alabama River	300	219	159	196
KY	Cumberland River	Barkley Lake	150	123	0	0
TN	Cumberland River	Barkley Lake	150	127	259	0
KY	Lower Mississippi River	Lower Mississippi River (KY/MO border)	0	210	0	0
MO	Lower Mississippi River	Lower Mississippi River (MO/KY and MO/TN borders)	300	95	173	166
TN	Lower Mississippi River	Lower Mississippi River (TN/AR border)	300	244	222	125
MS	Lower Mississippi River	Lower Mississippi River (MS/AR border)	150	11	8	0
MS	Lower Mississippi River	Lower Mississippi River (Yazoo River)	150	186	59	0
IN	Ohio River	Upper Ohio River (Above McAlpine Dam)	150	66	86	0
KY	Ohio River	Upper Ohio River (Above McAlpine Dam)	150	0	0	0
IN	Ohio River	Lower Ohio River (Below McAlpine Dam)	150	18	125	0
KY	Ohio River	Lower Ohio River (Below McAlpine Dam)	150	210	0	0
KY	Tennessee River	Kentucky Lake	150	0	0	0
TN	Tennessee River	Kentucky Lake	150	215	0	0
AR	White River	White River	300	0	50	45
7 States	6 Sub-basins	7 Management Units	2700	1724	1141	532

Dr. Scarnecchia aged additional jawbone samples collected by the states during the 2015-2016 and 2016-2017 Paddlefish seasons; however, all states and management units were not represented in all three years of sample collections. Proposed annual targets were not achieved for most management units in most years and the total number of collected samples decreased each season from 1724, to 1141, and then 532 (Table 1). Data and photographs of jawbone sections for the additional two seasons were provided to the respective states at the conclusion of the project.

Updated Data Analysis

Five of the six remaining commercial harvest states (all except Illinois), participated in the additional modeling and met with Dr. Wilberg to discuss the model prior to the additional analysis. "One of the primary reasons for conducting the analysis was to determine if the minimum length limits currently in place are adequate for management of commercial Paddlefish fisheries in the Mississippi and Ohio rivers" (Wilberg 2019). Dr. Wilberg provided a final project report to the states in June 2019, concluding that with the additional three years of age and growth data collected by the states, the new modeling results "indicated that under the base model assumptions a minimum size limit of 36 (inches) may be appropriate to achieve $F_{30\%}$ and to increase caviar yield over the long term." Dr. Wilberg noted in the report that the results of the analysis "were quite sensitive to assumptions about the female maturation curve, and additional research on this topic is warranted."

Dr. Wilberg provided a project overview and discussed the data analysis and results, including the recommended 36" minimum length limit for the Mississippi and Ohio rivers, during a meeting of the Lower Mississippi River Conservation Committee (LMRCC) Fish Technical Section in September 2019. All workgroup member states, except Illinois, participated in the meeting. The meeting included several presentations and updates prior to Dr. Wilberg's project overview including:

- the USFWS spoke to CITES export needs and informed the states that the permit process would benefit from a consistent management approach and Paddlefish regulations in all states;
- an Indiana Department of Natural Resources Law Enforcement Officer spoke to the state biologists about law enforcement observations and challenges with enforcing Paddlefish regulations in the Ohio River; and
- an update was provided on the draft Lower Mississippi River Basin Paddlefish Management Plan.

The presentations were followed by a moderated discussion about the recommended 36" minimum length limit and management alternatives to achieve $F_{30\%}$. The workgroup agreed that a consistent management approach in the Mississippi and Ohio rivers is needed among the commercial harvest states and that a suite of regulations would likely be needed to achieve $F_{30\%}$ rather than relying solely on the 36" minimum length limit recommended by Wilberg (2019). The group discussed potential Paddlefish regulations for the states' boundary waters (i.e., Mississippi and Ohio rivers) that would likely be most effective at reducing mortality and that would be enforceable. The biologists were challenged to not be restrained by what regulations they believed their agency would support but rather to focus

strictly on the biological basis when considering potential regulatory options. The objective of the discussion was to reach agreement on a suite of minimum regulatory standards to achieve $F_{30\%}$ that would be submitted to the LMRCC Executive Committee and then to MICRA for consideration by the commercial harvest state fish chiefs. The discussion concluded with the workgroup members agreeing to additional meetings to further explore a suite of enforceable management alternatives (to the recommended 36" minimum length limit) that would be effective at reducing Paddlefish mortality including minimum length limits; season length/dates; number of permits, fishermen, and roe buyers; gear restrictions (number of nets, length of nets, mesh size, and drifting vs stationary sets); and reporting requirements.

During the January 2020 workgroup meeting, considerable time was spent reviewing the previous five year's data collection, analysis, and subsequent discussions with the newly engaged representative from Illinois DNR. Illinois voiced the position that the state would not consider a different minimum length limit or other regulatory changes intended to reduce mortality until there was additional analysis to indicate Paddlefish mortality is greater than 30%. Illinois also objected to a single basinwide management strategy for Paddlefish until spatial analysis is conducted and the results support such an approach.

Several questions regarding the data analysis by Wilberg (2019) were raised and provided to Dr. Wilberg following the meeting. Dr. Wilberg replied: "There appears to be two requests for additional analyses: reanalyze the size-at-age data, and conduct a thorough review/reanalysis of Paddlefish maturity. Once these analyses are redone, redo the SPR reference point model. These analyses are possible, but the amount of work associated with them would not be trivial. Given my other work, I estimate that conducting these additional analyses would take until the end of the summer and will cost ~$8-10k." No additional analyses were funded. Following are short responses provided by Dr. Wilberg regarding three specific questions that were then discussed with the IL DNR representative in an additional conference call February 11, 2020.

1. *Refit the von Bertalanffy growth function using L_{inf} as a constant and solving for k and t_0. These are highly correlated parameters and changes to L_{inf} by using an average length of fish age-15+ should result in changes to K and t_0 that were determined by Sharov et al. (2014)*

   There is not a single growth curve in the Sharov et al. report. Rather, it includes a broad review and analysis of growth of Paddlefish throughout its range. I have some concerns about some of the data we analyzed in that report as well as some of the published studies as the aging did not appear to be very accurate in several places. For our more recent report, we had updated data from the commercial sampling in each of the states and wanted to incorporate that into the analyses. The growth parameters are not estimable from the catch monitoring data alone, but these data do provide some information about growth. I thought updating the Sharov et al. values with the new data was a better approach than just using the values from that report.

2. *Incorporate all existing data to estimate length at maturity to ensure estimate is more reflective of total range (MO, IN, etc.). Was all existing data used from MO and IN from 2014 through 2017?*

   If I'm understanding this question, the answer is no- the maturity from the commercial catch sampling from MO and IN were not used to estimate maturation curves. The main issue with any estimation of maturation curves for Paddlefish is that immature fish generally seem to be underrepresented in the sampling. I was concerned that immature fish were underrepresented in the data that were provided by the states, which would bias the maturity curve toward younger, smaller fish. Based on conversations with Jeff Quinn, I thought the Arkansas data avoided those problems. That's why we used those.

3. *Conduct sensitivity analyses using a range of length at maturity (size at which 50% are mature) to determine how recommended minimum length limits change across this range. The range should be reflective of our confidence in length at maturity based on re-analysis using all existing data.*

   This sensitivity analysis could be done; however, the main challenge will be to develop the maturity curves to include more of the available data. If the immature fish are underrepresented in the sampling, this will cause a bias in the maturation curve, which we want to avoid. Therefore, it's possible some of the data may not be useful for estimating maturation.

General concerns with age-based models

The Scarnecchia 2015 report states that age determination within the Mississippi River Basin presented several challenges and that age validation would be an important step in moving toward reliable age determination and stock assessment. However, this report and other studies, have raised concerns about accuracy of aging and the utility of age-based models. Quinn and Deriso (1999) stated that errors in aging can result in bias in both mortality and growth estimates. The Wilberg 2019 report built upon existing models and included samples from throughout the Mississippi and Ohio River commercial fishing states, however there were still many questions. States involved agreed it was a good starting point for multi-jurisdictional efforts in Paddlefish management, but there were many questions regarding the parameters used in the analysis that could greatly affect the results and recommendations.

Age validation is an important but often overlooked step in accurate age estimation. In long lived species like Paddlefish, this is often an extensive effort that can take decades. Jennings and Zigler (2009) described considerable spatial variation among populations in length at age, weight at age, and longevity, which further magnifies the need for age validation throughout the basin. Scarnecchia et. al (2019) indicated that southern stocks of Paddlefish presented more challenges to age validation than northern stocks due to more halo or false annuli being present in southern stocks. In Missouri, where 3 reservoirs had been stocked for over 20 years with coded-wire tagged (CWT) fish, researchers had the

opportunity to validate ages of some southern stocks. Despite the agreement between readers and only slight deviation from the validated ages, ages of older Paddlefish were often underestimated due to the uncertainty of false annuli, similar to Scarnecchia et al 2006. Paddlefish ages were accurate for fish up to 12 years of age but were then underestimated for fish older than 12 years of age based on CWT information (Sara Tripp, unpublished data). Underestimation of ages can result in erroneous estimates of recruitment, growth, and mortality (Scarnecchia et. al 2019), therefore accurate aging is crucial for effective stock assessment.

Previous studies have provided a wide range of total annual mortality estimates for Paddlefish using catch-curve analysis (Scholten and Bettoli 2005; Hupfeld et al. 2016; Risley et al. 2017), but questions remain about aging accuracy for these long-lived fish (Scarnecchia et al. 2006; Pierce et al. 2011; Risley et al. 2017) and what percentage of total mortality comes from exploitation (Devine et al. 2019). Many exploitation studies have estimated fishing mortality or exploitation to be a small portion (2.5 – 10%) of the total annual mortality in Paddlefish populations within the Mississippi River Basin (Devine et at. 2019, Risley et al. 2017). Timmons and Hughbanks (2000) estimated that combined recreational and commercial exploitation in the lower Tennessee and Cumberland rivers ranged from 14.4% to 25.4%. The range of exploitation rates in these studies are likely due to environmental conditions within each system. Scholten and Bettoli (2005) stated that extended periods of high discharge affect the ability of commercial fishers to effectively fish with gill nets. Levels of exploitation likely vary spatially within the Mississippi River basin depending on fishing pressure, efficiency, state regulations, and market demand for the flesh and roe of Paddlefish (Devine et al. 2019, Risley et al. 2017).

Alternative Management Actions Discussions

Beginning in September 2019, the workgroup met multiple times to discuss a potential suite of minimum regulatory standards for consideration by the management agencies as an alternative to the 36” minimum length limit recommended by Wilberg (2019). States managing a commercial Paddlefish fishery in 2019 included Arkansas, Illinois, Indiana, Kentucky, Missouri, and Tennessee. Indiana, Missouri, and Tennessee participated in all workgroup discussions and Kentucky participated in most meetings. Arkansas participated in the September 2019 and March 2022 meetings, missing the bulk of the discussions regarding a consistent management strategy for the basin. Illinois participated in the 2014 AFWA workshop but then did not participate in any workgroup meetings until January 2020. This late engagement with the workgroup resulted in Illinois not participating in the workgroup’s planning and execution of age and growth data collection, pre-project modeling and data analysis discussions with Dr. Wilberg, nor the workgroup’s initial discussions and agreement to propose a suite of minimum regulatory standards for the basin as an alternative to the 36” minimum length limit for the Mississippi and Ohio rivers resulting from the additional age and growth data analysis conducted by Wilberg (2019). The regulatory options considered by the workgroup included an alternative minimum length limit; season length/dates; number of permits, fishermen, and roe buyers; gear restrictions (number of nets, length of nets, mesh size, and drifting vs stationary sets); and reporting requirements.

Minimum Length Limit

Wilberg (2019) recommended a 36” minimum length limit for the Mississippi River Basin to achieve $F_{30\%}$. In 2019, minimum length limits for Paddlefish in the Mississippi and Ohio rivers ranged from 24” (MO) to 35” (AR) (Table 2). The workgroup members agreed that it would be desirable to propose a minimum length limit less than 36” combined with additional regulatory tools to achieve the reduced mortality that the 36” minimum length limit is intended to achieve. Although most states supported considering a 34” minimum length limit standard for commercial Paddlefish fisheries in the Mississippi and Ohio rivers, the group did not reach consensus. Adopting a standard minimum length limit for the Mississippi and Ohio rivers is challenging for some states that use a single statewide minimum length limit to manage their commercial fisheries. Effective 28 February 2022, Missouri’s statewide commercial Paddlefish minimum length limit increased from 24" to 32".

Table 2. Minimum length limits for commercial Paddlefish fisheries as of 2019.

STATE	**Mississippi River**	**Ohio River**
ARKANSAS	35"	-
ILLINOIS	28"	32"
INDIANA	-	32"
KENTUCKY	32"	32"
MISSOURI	24"*	-
TENNESSEE	34"	-

** Effective 28 February 2022: Missouri Commercial Paddlefish Minimum Length Limit increased from 24" to 32".*

Season Length and Dates

The workgroup considered the questions “is a shorter season warranted to achieve $F_{30\%}$?” and if so, “is it more important to consider changing early or late season dates?”. To answer these questions, the states agreed to calculate the percentage of harvest that would be reduced by shortening the season by two weeks on each end.

All states with commercial Paddlefish harvest on the Mississippi River had different opening and closing season dates in 2019-2020 (Table 3). Shortening the season in Illinois could reduce total annual harvest by approximately 2.8% (16.9 fish), nearly all of which would be accounted for in the first two weeks of the season (Table 4). Kentucky’s Mississippi River harvest would be reduced by approximately 20.3% (174 fish) with a shortened season, 66% of which would occur in the first two weeks of their season. Shortening Missouri’s yearlong season by two weeks on both ends would not have reduced Paddlefish harvest. Arkansas and Tennessee did not provide information for this task since the states’ harvest seasons were already substantially shorter than the other Mississippi River states.

Table 3. 2019-2020 season dates and lengths for commercial Paddlefish fisheries.

STATE	Mississippi River	Ohio River
ARKANSAS	Nov. 20-April 10 (142 days)	-
ILLINOIS	Oct. 1-May 31 (243 days)	Nov. 1-April 30 (181 days)
INDIANA	-	Nov. 1-April 30 (181 days)
KENTUCKY	Nov. 1-April 30 (181 days)	Nov. 1-April 30 (181 days)
MISSOURI[1]	July 1-June 30 (365 days)	-
TENNESSEE[2]	Nov. 15-April 15 (152 days)	-

[1] *Effective 28 February 2022: Missouri's Commercial Paddlefish Season dates were established as November 1-April 15 for a total season length of 166 days.*

[2] *Effective 22 October 2021 Tennessee's Commercial Paddlefish Season dates were established as November 1-April 15 for a total season length of 166 days.*

Table 4. Average annual reduction (number and percent of total) in historic commercial Paddlefish harvest by state in the Mississippi River if harvest seasons were shortened by two weeks at the beginning and two weeks at the end of the season dates.

STATE	Mean harvest during first two weeks of season	Mean harvest during last two weeks of season
ARKANSAS[1]	-	-
ILLINOIS[2]	16.8 (2.8%)	0.1 (0.0%)
KENTUCKY[3]	114.8 (13.4%)	59.2 (6.9%)
MISSOURI[4]	0	0
TENNESSEE[5]	-	-
TOTAL	131.6 (16.2%)	59.3 (6.9%)

[1] *Arkansas did not provide information for this task since the state's harvest season was already substantially shorter than most other Mississippi River states.*

[2] *Illinois data based on commercial Paddlefish harvest from 2010 to 2020.*

[3] *Kentucky data based on commercial Paddlefish harvest from 2014 to 2019.*

[4] *Missouri's commercial Paddlefish harvest was open from July 1 - June 30. During 2014 to 2020, no harvest was reported during the last two weeks or the first two weeks of the season.*

[5] *Tennessee did not provide information for this task since the state's harvest season was already substantially shorter than most other Mississippi River states.*

For the Ohio River, Illinois, Indiana, and Kentucky collectively have the same November 1 to April 30 season dates (Table 3). Among the three states, the mean annual Paddlefish harvest during the years provided (2010 to 2020 for Illinois, 2014 to 2019 for Indiana and Kentucky) was 7,377 Paddlefish. By pushing back the season start date two weeks to November 15th, on average 12.0% (887 fish) of the harvest would be reduced (Table 5). Likewise, closing the season two weeks sooner in the spring (April 15th) would decrease harvest an additional 8.4% (620 fish), for a total potential harvest reduction of 20.4% (1507 fish) on the Ohio River. The majority of Ohio River harvest (94.8%) is reported by Kentucky commercial fishers.

Table 5. Average annual reduction (number and percent of total) in historic commercial Paddlefish harvest by state in the Ohio River if harvest seasons were shortened by two weeks at the beginning and two weeks at the end of the season dates.

STATE	Mean harvest during first two weeks of season	Mean harvest during last two weeks of season
ILLINOIS[1]	4 (5.1%)	1 (1.2%)
INDIANA[2]	11 (3.4%)	61 (18.4%)
KENTUCKY[3]	872 (12.5%)	558 (8.0%)
TOTAL	887 (12.0%)	620 (8.4%)

[1] *Illinois data based on commercial Paddlefish harvest from 2010 to 2020.*

[2] *Indiana data based on commercial Paddlefish harvest from 2014 to 2019.*

[3] *Kentucky data based on commercial Paddlefish harvest from 2014 to 2019.*

The workgroup had much discussion regarding season length and dates, most of which revolved around water temperature data. It was agreed that beginning and ending commercial Paddlefish seasons based on water temperature data makes sense, with the primary driver being a reduction in bycatch (i.e., sub-legal Paddlefish) mortality. Bettoli and Scholten (2006) reported 71% of Paddlefish netted in the Kentucky Lake commercial fishery were moribund when water temperature exceeded 62.6°F. Additionally, they noted 60% of total Paddlefish captured during the study were sub-legal (<34") and mature females only accounted for 8% of the total catch (Bettoli and Scholten 2006). Therefore, in primarily caviar driven fisheries, the majority of Paddlefish caught are released, necessitating regulations that minimize initial by-catch mortality. They recommended adjusting season dates based on a 58°F threshold to keep initial bycatch mortality below 15%, which largely guided the workgroup's discussion. The workgroup members agreed to compile water temperature data for the Mississippi and Ohio rivers

and consider potential commercial Paddlefish season start and end dates based on the 58° F water temperature threshold.

In the Ohio River, water temperature at Markland L&D was generally lower than that at Olmstead L&D. On average, water temperatures in the spring exceeded 58°F on April 19th at Olmstead L&D and April 26th at Markland L&D. During the fall, water temperature fell below 58°F on November 12th and November 5th at Olmstead L&D and Markland L&D, respectively. As an additional check for accuracy using a different approach, Olmstead L&D mean daily water temperature was calculated for each year from 2013 to 2020. Then season start and end dates were determined for each year based on the 58°F threshold, and using those, average start and end dates were calculated. With this approach, April 15th and November 13th were the average days that water temperature exceeded, and then fell below, 58°F, respectively. For the Mississippi River at Cape Girardeau, annual average water temperature exceeded 58°F on April 20th and then fell below 58°F on October 28th.

Based on these results, the workgroup agreed that standardized season dates based on 58°F water temperature would reduce Paddlefish mortality. From a regulatory perspective, if season dates were changed, most states agreed that the 1st, 15th, or last day of the month would be logical start/stop dates. A couple of states could be more specific with dates as long as it were a multiple of five. Most Mississippi River states agreed that a November 1 to April 15 season is appropriate (Table 6). Arkansas is the exception, where Mississippi River water temperature data suggests a November 20 to April 10 harvest season. On the Ohio River, Illinois, Indiana, and Kentucky were all in agreement that a November 15 to April 15 season would be most appropriate (Table 6).

Table 6. Recommended season dates and lengths for commercial Paddlefish fisheries in the Mississippi and Ohio Rivers based on a 58° F water temperature threshold.

STATE	**Mississippi River**	**Ohio River**
ARKANSAS	Nov. 20 – April 10 (142 days)	-
ILLINOIS	Nov. 1 – April 15 (166 days)	Nov. 15 – April 15 (152 days)
INDIANA	-	Nov. 15 – April 15 (152 days)
KENTUCKY	Nov. 1 – April 15 (166 days)	Nov. 15 – April 15 (152 days)
MISSOURI[1]	Nov. 1 – April 15 (166 days)	-
TENNESSEE[2]	Nov. 1 – April 15 (166 days)	-

The recommended season dates based on the 58° F water temperature threshold would require regulatory changes and shorten the season length in nearly all commercial harvest states. Arkansas' statewide season dates and length currently align with the 58° F water temperature threshold in the

lower Mississippi River and therefore no changes are necessary. Prior to 2022, Tennessee's season opened on November 15th and remained open for 152 days. Tennessee was the only state that considered lengthening its season to align with the recommended standard. The recommended season dates would have the biggest impact on Missouri and Illinois where season lengths in 2022 were 365 and 243 days, respectively.

Two states have already made changes to their Paddlefish season dates based on the workgroup's discussions. Effective 22 October 2021, Tennessee's Commercial Paddlefish Season dates were established as November 1-April 15 for a total season length of 166 days. Effective 28 February 2022, Missouri's Commercial Paddlefish Season dates were established as November 1-April 15 for a total season length of 166 days.

Number of Permits, Fishers, and Roe Buyers

The workgroup discussed the potential to prevent future growth in license sales by capping at current or recent levels (or reciprocal with border state) to limit potential for increased fishing mortality by managing a limited entry fishery. Types and numbers of licenses and permits vary greatly among the six states.

Arkansas:

- No limits
- 2018-19: 21 roe takers/sellers, and 5 buyers/exporters
- 2015-16: 40 roe takers/sellers and 5 roe buyers/exporters
- Arkansas does not permit nonresident commercial fishers

Illinois

- 50 permits for roe-bearing species for Mississippi River north and south zones
- 10 permits Ohio River and Mississippi River south zone (L&D 26 to Ohio River)
- 15 permits Illinois River
- 75 total possible; 65 sold in 2019

Indiana

- Ohio River Roe Harvester capped at 15 total (in-state and out-of-state combined)
- 2-3 sold last several years

Kentucky

- 101 residents and 18 nonresidents (statewide)
- ~60's past 5 years

Missouri

- No limits
- 2021-2022: 3 resident harvesters, 1 resident dealer

- No non-resident licenses have been issued since 2009

Tennessee

- 40 residents and 5 nonresidents (statewide)
- ~10 licenses were sold for the Mississippi River during the last several years

The workgroup members agreed that more data and discussion are needed before considering a recommended standard before limiting the number of permits, fishers, or roe buyers.

The workgroup briefly discussed the possibility of gravid fish only regulations. In some areas such as Tennessee, virtually all Paddlefish harvest is that of gravid females, and thus such regulation would be moot. However, in the Ohio River, particularly with regards to harvest reported in Indiana, a gravid fish only regulation may protect a significant amount of non-gravid females from being harvested, thus increasing their chance of future reproduction. Since 2012, Indiana licensed roe harvesters have been required to report the lengths of every Paddlefish harvested along with noting whether each fish had eggs. From 2012 to 2021, 43% of all Indiana reported Paddlefish harvested did not have eggs (Table 7). Based on Hupfeld et al. 2016, we can assume 47% of all Ohio River Paddlefish are female, thus a large portion of the harvested Paddlefish that did not have eggs were likely non-gravid females. Additionally, Paddlefish data collected by Indiana DNR biologists from 2018 to 2020 indicates only 14% of legal-sized female Paddlefish were gravid. In areas where there is significant harvest of Paddlefish without eggs, restricting harvest to only gravid females could be another tool to help states achieve the F30 goal by reducing non-gravid female mortality.

Table 7. Non-gravid Paddlefish harvest reported by licensed Indiana roe harvesters, 2012 - 2021.

Year	**Paddlefish Harvest (N)**	**Gravid (N)**	**Non-gravid (N)**	**% Non-gravid harvest**
2012	1467	1012	455	31%
2013	430	188	242	56%
2014	767	229	538	70%
2015	457	184	273	60%
2016	97	62	35	36%
2017	165	116	49	30%
2018	340	284	56	16%
2019	613	380	233	38%
2020	807	346	461	57%
2021	447	388	59	13%
Total	5590	3189	2401	43%

Gear Restrictions

The workgroup discussed several possible gear restrictions that could be used to reduce Paddlefish mortality. A standard for a maximum number of nets, net length, and total yards fished was considered. Workgroup members discussed current limits on the number of nets, total yardage fished, and net tagging requirements. A suggestion was made that the states could limit the number of net tags per fisher with a standard tagging requirement per net. Before considering a standard for gear restrictions, the workgroup members agreed that a standardized effort is needed to understand catch and selectivity of stationary sets and drifting nets. As an initial step, the members agreed to update the state regulations table (Appendix 4) with the maximum yards of net that can be fished.

The workgroup also discussed the utility of a 5" or 6" standard for minimum mesh size to reduce handling of smaller female Paddlefish. Several additional data needs were identified before the workgroup would consider a specific recommendation.

- Evaluation of length curves of females caught by different mesh sizes: 4", 5", and 6"
    - How do hobbled nets affect catch for each mesh size?
        - Scholten and Bettoli (2007) determined a lack of size selectivity in hobbled gillnets and changing minimum mesh size regulations for gillnets would not influence the size of Paddlefish captured.
        - Sharov et al. (2014) determined that there was size selectivity in gillnets.
- Evaluation of mono-filament vs twist vs multi-filament nets?
    - This was not considered an immediate data need.

Reporting Requirements

The workgroup members discussed each state's reporting requirements. Reporting requirements are varied among the states and consistency would be difficult to achieve. No minimum reporting standards were considered.

Arkansas

- Monthly reporting required with daily details
- Harvest date, county, and roe weight, flesh weight, number of egg sacks, and number of fish harvested
- Data not collected on individual fish

Illinois

- Monthly reporting required (commercial fishers and roe dealers) with daily details
- Days harvested by species, pounds of fish, flesh, and roe harvested
- Data not collected on individual fish

Indiana

- Monthly reporting required

- Number and pounds of fish harvested and effort (feet of nets fished) for commercial fishers and roe harvesters
- Roe harvesters maintain daily records on individual fish (species, length, egg bearing)
- Roe dealers must submit a monthly dealers report

Kentucky

- Monthly reporting required
- Maintain daily records
- Data not collected on individual fish

Missouri

- Monthly reporting required with daily details
- Harvester Reporting: location (river/river mile), gear type/amount, and number of fish, pounds of flesh (live weight), and pounds of eggs harvested.
    - No distinction between drift, dead set, or combined gears.
- Dealer Reporting: date of purchase, seller's name, seller's license number and state, state of harvest, species purchased, pounds of flesh purchased, pounds of eggs purchased, and receipt number
- Data not collected on individual fish

Tennessee

- Monthly Commercial Fishing Reports with daily details (e.g., date, waterbody, Gear used and number, Harvest by species and pounds, Disposition that records pounds and where it was sold)
- Daily Commercial Roe Fish Harvest Reports with daily details (e.g., date, waterbody, species of harvest, gear used and number, individual fish data that include (species, length, female/male, and row drained egg weight) and flesh weights
- Monthly Wholesale Dealer Reports with date product received, seller's name, license number, state of harvest, species harvested and pounds purchased, and roe weights

Law Enforcement Considerations

Law enforcement officers are generally supportive of homogenizing regulations between bordering states, especially when a waterway forms the border of those states. They also recognize the need for increased information sharing between state biologists and officers, both within their respective agencies and between state agencies. Annual meetings of personnel from bordering states were recommended. Concerns regarding jurisdiction and prosecution of commercial fishing violations were also raised as commercial fishers are often licensed in multiple states and fish 'both sides of the river' which is often regulated by differing state agencies. Additionally, there are growing concerns in some areas about Paddlefish stocks per communications between officers and commercial fishers. Some commercial fishers have indicated that their harvests are lower and efforts less productive than previous years, and those fishers show willingness to alter harvest regulations to protect future stocks.

There is a need for consistent reporting requirements between states; both in regard to what information is required on the reports, and the timing of when reports are to be submitted. Officers are in favor of online reporting systems that require daily inputs of harvest, sales, and purchase transactions. The reports of particular interest are those from commercial fishers that hold licenses in multiple states, and reports from roe-buyers and exporters. Some states do not require the first line roe-processor to identify their buyer, which makes it difficult for officers to trace roe and validate reports from buyer to buyer.

Overall, there is a consensus among law enforcement officers that reports submitted by commercial fishers may represent fish harvested, but the methods used to harvest those fish are not always legal methods of commercial take. There is growing concern among officers that recreational harvest of Paddlefish is being reported by commercial fishers through false reporting to purchase or sell the roe. However, working cases of this nature often requires multiple officers and coordination between agencies can be time consuming and difficult in conjunction with other activities that conservation officers are tasked with. Therefore, more personnel, training, and better equipment for working commercial fishing activities is warranted. However, it is doubtful that these actions will occur without the directive of state agency leadership emphasizing the importance of Paddlefish management.

Saltonstall-Kennedy Grant Proposal

Concurrent to the collection and analysis of Paddlefish jawbones from 2014-2017, the workgroup continued to meet to discuss: 1) progress and issues related to the on-going age and growth work; 2) development of a basinwide framework for Paddlefish management and multi-state commercial fishery management plans for the identified management units; and 3) long-term strategies for coordinated data collection, analysis, and management plan implementation. MICRA submitted a comprehensive proposal in partnership with the commercial harvest states and Dr. Scarnecchia (University of Idaho) to the National Oceanic and Atmospheric Administration's (NOAA) for the Saltonstall-Kennedy Grant each year from 2014-2020. The objectives of the comprehensive proposal were to:

1. implement a coordinated stock assessment protocol for the Paddlefish with emphasis on improved sampling of commercial fisheries for population age structure and growth/maturation information,
2. develop and prepare uniform, error-checked and user-friendly databases for use in Paddlefish stock assessment and other management activities,
3. convene a Commercial Fisheries Working Group within MICRA to design, develop and refine a Paddlefish Management Framework primarily in relation to commercial harvest,
4. through the Commercial Fisheries Working Group, develop and refine state and multi-state Paddlefish management plans consistent with the framework plan, and
5. explore possible approaches for stable, long-term sustained funding of these stock assessment programs through various fishery-based approaches, e.g., caviar quality assurance and quality control.

Despite repeatedly being recommended for funding by program reviewers, MICRA's proposal was never funded by NOAA. Alternative external funding sources were also considered but were unsuccessful.

Recommendations

Research Needs

Age Validation

Age estimation of Paddlefish has largely been limited to traditional methods of reading growth zone structure in dentary bone sections (Scarnecchia et al. 2006; Pierce et al. 2011; Sharov et al. 2014; Hupfeld et al. 2016). However, dentary bone age underestimation of individuals is possible and can vary with locality (Scarnecchia et al. 2006; Pierce et al. 2011; Sharov et al. 2014). Additionally, dentary bone age estimates have never been validated because of the difficulty with recovering tagged paddlefish in a large river system (Grady et al. 2005). Given the uncertainties in age estimation of Paddlefish using dentary bone sections, it is recommended to better understand the accuracy of dentary bone age estimation, and if needed, develop more accurate techniques to estimate dynamic rate functions.

One of the most reliable and successful techniques for evaluating the validity of age estimates for fishes through ontogeny, as well as determining lifespan, is bomb radiocarbon (14C) dating (Campana 2001). Recent work using bomb-produced 14C as a time specific marker has proven useful in age determination studies on fishes around the world. The method relies on a change in naturally occurring 14C due to the testing of thermonuclear devices in the atmosphere in the 1950s and 1960s, a signal that persists in aquatic environments to this day. Many studies using this technique have revealed discrepancies in age interpretation from various growth structures (scales, spines, otoliths) and the problem is usually associated with a significant underestimation of age and lifespan. This technique may provide pertinent information for determining the accuracy of dentary bone sections aging.

Additionally, mark-recapture techniques have been used in recent years on moderate to long lived fishes, including Paddlefish, that likely provide a more accurate method to estimate dynamic rate functions than traditional methods (i.e., fin rays and dentary bones) (Hamel et al. 2015; Kramer et al. 2019). While more accurate, gathering enough recaptures within the Mississippi River Basin to calculate dynamic rate functions will take an enormous amount of effort.

Spatially Explicit Population Modeling (Accounting for Heterogeneity)

Spatial heterogeneity in population demographics can be an important consideration for managing widely distributed fish species (Erickson et al. 2021). Differences in population demographics can be the result of different environmental conditions experienced by organisms, genetic differences, or a combination of the two. Differences in individual growth rates, for example, can affect the amount of time required to reach sexual maturation and the amount of time fish remain invulnerable to fishing mortality in a size-selective fishery (Jonsson et al. 2013). Regardless of the mechanism(s) for spatial

heterogeneity, it is clear that differences in growth, recruitment, and survival may require different management approaches across the entire geographic distribution (Erickson et al. 2021).

The Paddlefish population model used by Dr. Wilberg assumed Paddlefish to be a single population (i.e., homogenous population demographics), justified by the large movements observed in this species. While Paddlefish are known to be migratory, previous data suggests that highly mobile individuals are only a portion of the population. As such, their life-history and vulnerability to a fishery are related to potentially both local conditions and basin-wide conditions. Kendall and Quinn (2013) found variation in spatial and temporal trends in life history traits such as age and length at maturation in populations with size-selective exploitation. Risley et al. (2017) stated that levels of exploitation likely vary spatially within the Mississippi River basin due to many different factors such as fishing pressure, gear efficiency, state regulations, and demand for the flesh and roe of Paddlefish. This provides the opportunity for heterogeneity and may require equitable state-specific regulations. As such, movement data are required across the basin to determine whether the mixed stock assumption is met or whether models that take into account spatial heterogeneity in population dynamics and harvest are required. In order to obtain this movement data, multiple techniques could be employed. Tagging fish both with internal and external tags allow fish to be either detected when recaptured by others (researchers, agency staff, or fishers) or when swimming by stationary receivers. Detection probability should be measured for both short and long-durations so that discussions and conclusions can be adequately drawn when irregular variation in transmitter detection probabilities are observed (Hayden et al. 2016). Extensive movements have been documented using conventional tagging methods (i.e., CWT, jaw bands) in which Paddlefish were captured and marked and then recaptured and reported by others (Devine et al. 2019, Pracheil et al. 2012, and Stancill et al. 2002). However, unless the fish is recaptured this type of movement information is not quantifiable. This is a unique time, where there is a collaborative stationary receiver array deployed throughout the Mississippi River Basin and its tributaries which has allowed researchers to identify many long-range movements by multiple species including Paddlefish (Tripp et al. 2019). An advantage of telemetry is that if detected by receivers you can quantify the movement of each fish and develop a proportion or percentage of those that move outside the management zones, which could help determine the need for a basinwide management plan or state/basin specific management.

Microchemistry is an emerging tool to assess movement patterns of fish through a process that links the trace metals (i.e., strontium and barium) from the ambient water that are also found in calcified structure of fish (Kennedy et al. 2002; Rude and Whitledge 2019). The scale of which this type of tool can be used is uncertain because of a lack of understanding of the spatiotemporal variations of metal-to-calcium ratios (i.e. Sr:Ca and Ba:Ca) in the large lotic watershed with multiple tributaries. However, a comprehensive analysis of water chemistry throughout the watershed has the potential to unveil migratory fish movement patterns on a broad scale (Rude and Whitledge 2019). An advantage of microchemistry is that once captured, and a calcified structure is taken and processed, its movement patterns prior to the point of capture can be determined if on a broad scale the watersheds they move between are chemically different (Kennedy et al. 2002). Both techniques could help determine whether Paddlefish within the Mississippi River should be managed on a basinwide strategy or if there are

populations within the basin that don't mix enough to have differences in age/length at maturation and mortality rates (fishing and total) (Bock et al. 2017; Rude and Whitledge 2019). If there is heterogeneity among sub-basins, this could prompt rerunning the model to use area specific parameters such as maturation schedule and fishing mortality rates to populate the model but also to determine what other factors may be affecting Paddlefish populations in these areas.

Sensitivity Analysis

One of the primary goals of a stock assessment is to estimate the uncertainty in the status of the stock and in the target and threshold values (Cooper and Weir 2006). One way to examine the uncertainty in a stock assessment is with a sensitivity analysis. In nearly all assessments, some parameters (such as natural mortality) are assumed known and fixed. A sensitivity analysis refits the assessment model with different values for the assumed parameters to examine how much, if any, the outputs change. Regardless of the modeling framework used in the future it is recommended that uncertainty of results is clearly portrayed (Privitera-Johnson and Punt 2020). Generally speaking, sensitivity analysis is a process used to understand how different values of input variables can affect dependent output variables. Sensitivity analyses can also be performed on the functions themselves. For example, modelers could allow recruitment to be estimated by a stock recruitment function (such as Ricker or Beverton-Holt) or could attempt to produce individual recruitment estimates for each year (Cooper and Weir 2006). By performing sensitivity analysis on models, it helps understand which inputs have the most impact on the model results. This can help managers understand which input variables are the most important to know accurately and which variables introduce the most uncertainty in result. For example, Kallis et al. (2020) used sensitivity analyses to assess the importance of model assumptions and variation in modeled processes (e.g., growth, movement) on Spatially Explicit Invasive Carp Population (SEIcarP) model results and hence, model-based management recommendations. Using the sensitivity analysis Kallis et al. (2020) were able to explore how uncertainty in demographic rates (e.g., growth curve) influences model results (i.e., population trajectories). One recommendation that was made due to the results of the sensitivity analysis was to implement standard operating procedures for age determination and spawning periodicity, which would decrease uncertainty and variation in the growth model predictions. As in this Asian carp example, sensitivity analyses provide critical information to prioritize future data collection to maximize the amount of model accuracy and precision gained with limited time and resources. Moreover, conducting sensitivity analyses alongside any future modeling endeavors is recommended to minimize the potential for incorrect interpretations that could lead to mismanagement of this extremely important resource.

Conservation and Management: abiotic and biotic causes of fluctuating harvest rates and stocks

It is important to understand the abiotic and biotic factors that can cause paddlefish stocks and harvest to fluctuate (Casal 2006, Dudgeon et al. 2006; Pracheil et al. 2009, Vörösmarty et al. 2010). Jennings and Zigler (2009) concluded that a general lack of information and understanding of factors that affect Paddlefish vital rates and population size, interjurisdictional movements, and anthropogenic activities "present significant challenges for managing Paddlefish populations". For nearly a century, Paddlefish stocks have been negatively affected by overharvest; habitat alterations brought about by river

modifications for navigation, flood control, and hydropower; and decreases in water quality from increased pollution and sedimentation (Jennings and Zigler 2009). Although Paddlefish are particularly susceptible to commercial and illegal harvest (Jennings and Zigler 2009), declines in harvest may not necessarily be due to declining stock abundance. For example, Mississippi closed its commercial paddlefish fishery due to a lack of interest from commercial fishers.

Additionally, the effects of invasive species on Paddlefish populations are not well understood and are an increasing concern for managers. Irons et al. (2007) reported multiple lines of evidence suggesting negative impacts of Bighead and Silver carps on native planktivores (i.e., Bigmouth Buffalo and Gizzard Shad) in the Illinois River and is cause for concern that Paddlefish are susceptible to similar negative impacts. Following the initiation of incentive programs to increase the harvest of Bighead and Silver carps, commercial paddlefish harvest in Tennessee decreased as some commercial fishers switched from targeting Paddlefish to targeting Bighead and Silver carps (Eric Ganus, unpublished data). Further, Paddlefish are susceptible to bycatch mortality in other commercial gill net fisheries (such as Bighead and Silver carp fisheries), as Bettoli and Scholten (2006) determined that Paddlefish mortality was directly related to soak time and water temperature. In the Ohio River, Paddlefish harvest peaked in the early 2000's, well before invasive carp incentive programs were implemented, indicating that there are other reasons for declining Paddlefish harvest in this part of the basin.

States that allow recreational or commercial harvest of Paddlefish should have monitoring programs (both fisheries dependent and fisheries independent) in place to detect and report on Paddlefish stock abundance so that future management decisions are based on the most up-to-date data available. In addition, it will be imperative to understand the causes of increased or decreased harvest and the potential relationship of these changes to Paddlefish abundance, so that the Paddlefish populations can be managed properly.

Collaborative Paddlefish Management

The workgroup recommends the development of a basinwide Paddlefish management framework to address the need for consistent data collection, reporting, and analysis among states within the basin so that comparisons can be made, and all data can be used in any basinwide analysis if needed. The Paddlefish and Sturgeon Committee recommended that MICRA directly fund Dr. Scarnecchia to assist the Paddlefish and Sturgeon Committee in the development of a basinwide Paddlefish management framework to be completed over a two-year period. In June 2022, the MICRA Executive Board approved funding for the development of a comprehensive, basin-wide, Paddlefish management framework to serve as a guide for management approaches, research, outreach, and regulation for Paddlefish stocks and fisheries nationwide. The project specifically includes the following objectives:

- Convene and facilitate a Working Group within MICRA.
- Consider, adopt/adapt previously developed Paddlefish management plans (state/sub-basin/regional) and use them as a starting point for a basin-wide framework.

- Identify opportunities for collaborative data collection, stock assessments, and cooperative fishery management.
- Identify commonalities among agencies for recreational and commercial fisheries management, species conservation, and restoration.
- Articulate philosophies, consistent or reconcilable policies, and relevant goals and objectives for sustaining the stocks and providing for species conservation, public benefit, and sound long-term public policy.
- Identify the structure and roles of commercial and recreational fisheries, the roles of hatchery production and wild fish, relevant inter-jurisdictional management and regulatory issues, riverscape-level habitat issues, and broad enforcement issues.
- Develop basin-wide commercial harvest databases for Paddlefish including roe harvest and roe buyers.

The resulting framework is intended to inform the updating, or development of, interstate management plans for both commercial and recreational Paddlefish fisheries.

To improve cooperative inter-agency Paddlefish management, the workgroup recommends all basin states managing a commercial Paddlefish fishery:

1. Cooperatively manage for $F_{30\%}$ for interjurisdictional, commercial Paddlefish fisheries throughout the Mississippi River basin. Consider regulation changes (e.g., season length/dates, permit quotas, gear restrictions, and minimum length limits) as needed to achieve/maintain $F_{30\%}$.
2. All states managing commercial or recreational Paddlefish fisheries participate in the development of the basinwide framework for Paddlefish management throughout the basin.
3. Update/develop sub-basin or waterbody specific Paddlefish management plans as needed.
4. Each state managing a commercial Paddlefish fishery aligns their season dates with those recommended in this report to limit harvest within a 58^{o} F water temperature threshold to minimize bycatch and sub-legal fish mortality.
    a. Regularly evaluate water temperatures and adjust commercial Paddlefish harvest seasons as necessary to limit harvest to times when water temperatures are less than 58° F.
5. Regularly engage Law Enforcement personnel in interjurisdictional Paddlefish management discussions with agency biologists, including coordination meetings with neighboring states (as needed) and the MICRA Paddlefish and Sturgeon Committee.
6. Identify Paddlefish harvest information needs (e.g., biologic and law enforcement oriented) and standardize methods for documenting and reporting commercial Paddlefish harvest data.

a. Standardize commercial Paddlefish harvest reporting to ensure comparable/meaningful metrics are collected by state management agencies.

b. Annually submit Paddlefish harvest data to MICRA with agency reports.

7. Collaboratively address priority research needs identified in this report.
8. Annually request a summary report from CITES that includes all information provided by state agencies.

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Appendix 1: AFWA State Agency Paddlefish Meetings January 2014

ASSOCIATION of FISH & WILDLIFE AGENCIES

The voice of fish and wildlife agencies

Hall of the States
444 North Capitol Street, NW
Suite 725 • Washington, D.C. 20001
Phone: 202-624-7890
Fax: 202-624-7891
E-mail: info@fishwildlife.org
www.fishwildlife.org

Memorandum

To: State Wildlife Agency Directors and Fish Chiefs

From: Jack Buckley, Massachusetts Division of Fisheries and Wildlife Department of Fish and Game and Deb Hahn, AFWA

Date: September 25, 2013

Re: USFWS Draft Paddlefish Report – State Agency Review and Comment Request

Attached is the draft report titled, *Developing Biological Reference Points and Identifying Stock Status for Management of Paddlefish (Polydon spatula) in the Mississippi River Basin* by A. Sharov, M. Wilberg, and J. Robinson. The report was produced for the Association under a grant from the US Fish and Wildlife Service (USFWS) and is submitted to you for your review and comment. The draft report represents a first step in developing a flexible management framework for sustainable management of paddlefish that will preserve the states regulatory flexibility to manage in the context of local needs, while allowing the USFWS to move forward with non-detriment findings (NDFs) as required under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

All species of sturgeon and paddlefish are listed in the Appendices of CITES. As a result, international trade in sturgeon and paddlefish caviar is regulated. As a species listed under CITES, the USFWS is required to issue a NDF to approve the international export of paddlefish. The CITES Technical Work Group has been working collaboratively with the USFWS on CITES issues involving sturgeon and paddlefish for many years. However, increased pressure on U.S. paddlefish due to the collapse of the Caspian sturgeon fishery and past actions by the European Union can have significant implications for state authority and the future international export of paddlefish caviar. The Association's CITES Technical Work Group took on this project after receiving your support in order to proactively address the potential conflict between states' individual management frameworks and the federal government's treaty obligations under CITES. As with other issues, we are working to find a balance between state management authority and federal government treaty obligations.

We want to emphasize that the draft report serves as a first step in addressing paddlefish management. We encourage a substantive and science based discussion around this report and the development of a management framework. The report will be the focus of discussion on next steps for the development of a management framework at a workshop to be held on January 28, 2014 in Kansas City, MO. We will send an invitation to this workshop at a later date and will provide travel support for the fish chiefs from each state.

In order to address concerns and make changes to the report before the workshop, please send your comments in track changes to Deb Hahn (dhahn@fishwildlife.org) before November 14, 2013. A revised draft report will be sent to you prior to the January workshop.

If you have any questions or would like to discuss the report or any other issues related to this project please call either Deb Hahn (202-624-8917) or Jack Buckley (617-626-1572).

PADDLEFISH CONSERVATION

JANUARY 2014

Advancing paddlefish management and conservation

PADDLEFISH WEBINAR - JANUARY 17, 9:00 AM – 11:00 AM ET

We will conduct a webinar in advance of the January 28 Paddlefish Workshop. The first hour will include a presentation of the report and the analysis. The second hour will be open for questions.

To Join:

http://mat.adobeconnect.com/paddlefishjan17/

(Sign in as a guest. **You must type your name in order to be accepted into the webinar**)

Dial-in Number: 1-888-450-5996

Access Code: 560022#

Limited to 100 participants. First come, first serve.

PADDLEFISH WORKSHOP – JANUARY 28, 2014; 8:30AM – 4:30 PM

The purpose of the workshop is to discuss management measures and the conservation status of paddlefish (*Polyodon spathula*) based on the Draft report *Developing Biological Reference Points and Identifying Stock Status for Management of Paddlefish (Polydon spatula) in the Mississippi River Basin*. U.S. paddlefish populations are under increased pressure in part due to the collapse of some paddlefish populations outside of the U.S. and USFWS is finding it increasingly challenging to develop Non Detriment Findings for international trade from commercial states. For these reasons it is important and timely to conduct a workshop that provides the opportunity for state fish and wildlife agency and USFWS representatives to discuss the status of the species, including management measures to ensure the sustainability of the species; domestic and international trade in this species; and a discussion of future management and trade in paddlefish.

Founded in 1902, the Association of Fish & Wildlife Agencies represents North America's fish and wildlife agencies to advance science-based management and conservation of species and their habitats for the public's long-term benefit and use. www.fishwildlife.org

ASSOCIATION of FISH & WILDLIFE AGENCIES

State Agency Paddlefish Management Meeting

January 28, 2014
Kansas City, MO

Paddlefish Meeting Framework and Agenda

Meeting Objective: The purpose of this meeting is to develop *management measures potentially by region or basin* for sustainable management of paddlefish based on the recommendations found in the report , *Developing Biological Reference Points and Identifying Stock Status for Management of Paddlefish (Polydon spatula) in the Mississippi River Basin"* by A. Sharov, M. Wilberg, and J. Robinson so that USFWS can provide appropriate Non-detriment Findings (NDF) to state agencies with commercial fishers and so that states can continue to sustain commercial and recreational fisheries and paddlefish populations into the future. The workshop provides the opportunity for state fish and wildlife agency and USFWS representatives to discuss the management measures to ensure the sustainability of the species; domestic and international trade in this species; and a discussion of future management and trade in paddlefish.

More specifically, we will,

1. Review common themes and discuss the recommendations from the report based on the comments received from the state fish and wildlife agencies and discussed during the January 17 webinar.
2. Review the needs and requirements behind Non Detriment Findings (NDFs)
3. Discuss the appropriateness of managing paddlefish populations via basin or region.
4. Discuss components of a management framework that address the findings and objectives identified in the report, applying generally accepted fishery management practices, such as:
    a. Principles of sustainable exploitation of paddlefish populations (optimum harvest rates, preservation of sufficient spawning stock biomass, etc;)
    b. Precautionary approach –steps to ensure that overfishing will not occur due to scientific and management uncertainty;
    c. Monitoring and management tools (using minimum size, season limits, or limits to open areas, catch statistics, survey collections, etc);
    d. Regional stock assessments;
    e. Other acceptable alternative developed by meeting participants.

Expected outcomes**:** By the end of the workshop, participants will strive to agree to a set of common goals for paddlefish management and the elements of management objectives (reference points and monitoring) that have the best probability of acceptance through each state's administrative and regulatory process.

AGENDA

Pick-up at Sheraton Kansas City Hotel - 8:00 am

8:15 am Coffee/Registration

8:30 am Welcome and Introductions

8:45 am Agenda review and meeting objectives

9:00 am Presentations:

1. *Review* Paddlefish report and comments; *Options* for minimum management frameworks
2. Non-detriment findings (NDFs) overview (5-10 minutes)

10:15 am Break

10:30 am Group and/or Breakout groups discussions:

1. What are the goals for sustainable Paddlefish management in your basin/region and/or state?
    a. Commercial
    b. Recreational
2. Can we develop a management regime by basin or sub-basin? What would that entail?
3. What set of tools would achieve sustainability in your basin/region/state?
    a. Minimum size
    b. Season length
    c. Daily limits
    d. Limited Entry
    e. Bycatch
    f. Other

Noon Lunch provided

1:00 pm Morning Recap

1:30 pm Group and/or Breakout groups discuss:

1. How can we deal with the data gaps?
    a. What are the options?
    b. How could states work together?
    c. What funding is available?
2. How to determine if the objective has been achieved? (i.e., what monitoring is necessary and/or realistic?)

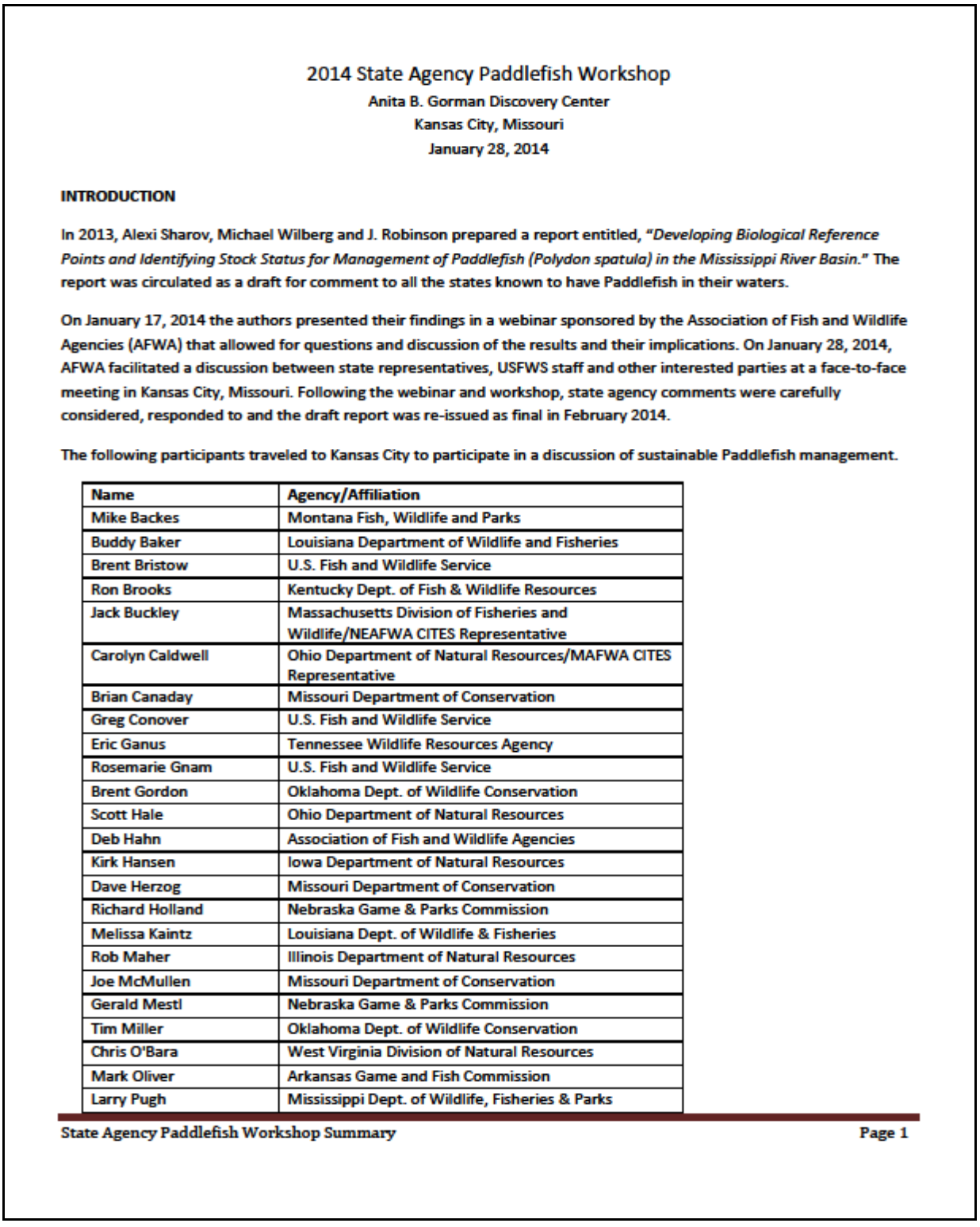
3:30 pm Afternoon Recap

4:00 pm Next Steps

4:30 pm Adjourn

Appendix 2: AFWA January 2014 State Agency Paddlefish Workshop Summary

Double click on the image below to open the full workshop summary as an Adobe PDF document.



2014 State Agency Paddlefish Workshop

Anita B. Gorman Discovery Center
Kansas City, Missouri
January 28, 2014

INTRODUCTION

In 2013, Alexi Sharov, Michael Wilberg and J. Robinson prepared a report entitled, *"Developing Biological Reference Points and Identifying Stock Status for Management of Paddlefish (Polydon spatula) in the Mississippi River Basin."* The report was circulated as a draft for comment to all the states known to have Paddlefish in their waters.

On January 17, 2014 the authors presented their findings in a webinar sponsored by the Association of Fish and Wildlife Agencies (AFWA) that allowed for questions and discussion of the results and their implications. On January 28, 2014, AFWA facilitated a discussion between state representatives, USFWS staff and other interested parties at a face-to-face meeting in Kansas City, Missouri. Following the webinar and workshop, state agency comments were carefully considered, responded to and the draft report was re-issued as final in February 2014.

The following participants traveled to Kansas City to participate in a discussion of sustainable Paddlefish management.

Name	Agency/Affiliation
Mike Backes	Montana Fish, Wildlife and Parks
Buddy Baker	Louisiana Department of Wildlife and Fisheries
Brent Bristow	U.S. Fish and Wildlife Service
Ron Brooks	Kentucky Dept. of Fish & Wildlife Resources
Jack Buckley	Massachusetts Division of Fisheries and Wildlife/NEAFWA CITES Representative
Carolyn Caldwell	Ohio Department of Natural Resources/MAFWA CITES Representative
Brian Canaday	Missouri Department of Conservation
Greg Conover	U.S. Fish and Wildlife Service
Eric Ganus	Tennessee Wildlife Resources Agency
Rosemarie Gnam	U.S. Fish and Wildlife Service
Brent Gordon	Oklahoma Dept. of Wildlife Conservation
Scott Hale	Ohio Department of Natural Resources
Deb Hahn	Association of Fish and Wildlife Agencies
Kirk Hansen	Iowa Department of Natural Resources
Dave Herzog	Missouri Department of Conservation
Richard Holland	Nebraska Game & Parks Commission
Melissa Kaintz	Louisiana Dept. of Wildlife & Fisheries
Rob Maher	Illinois Department of Natural Resources
Joe McMullen	Missouri Department of Conservation
Gerald Mestl	Nebraska Game & Parks Commission
Tim Miller	Oklahoma Dept. of Wildlife Conservation
Chris O'Bara	West Virginia Division of Natural Resources
Mark Oliver	Arkansas Game and Fish Commission
Larry Pugh	Mississippi Dept. of Wildlife, Fisheries & Parks

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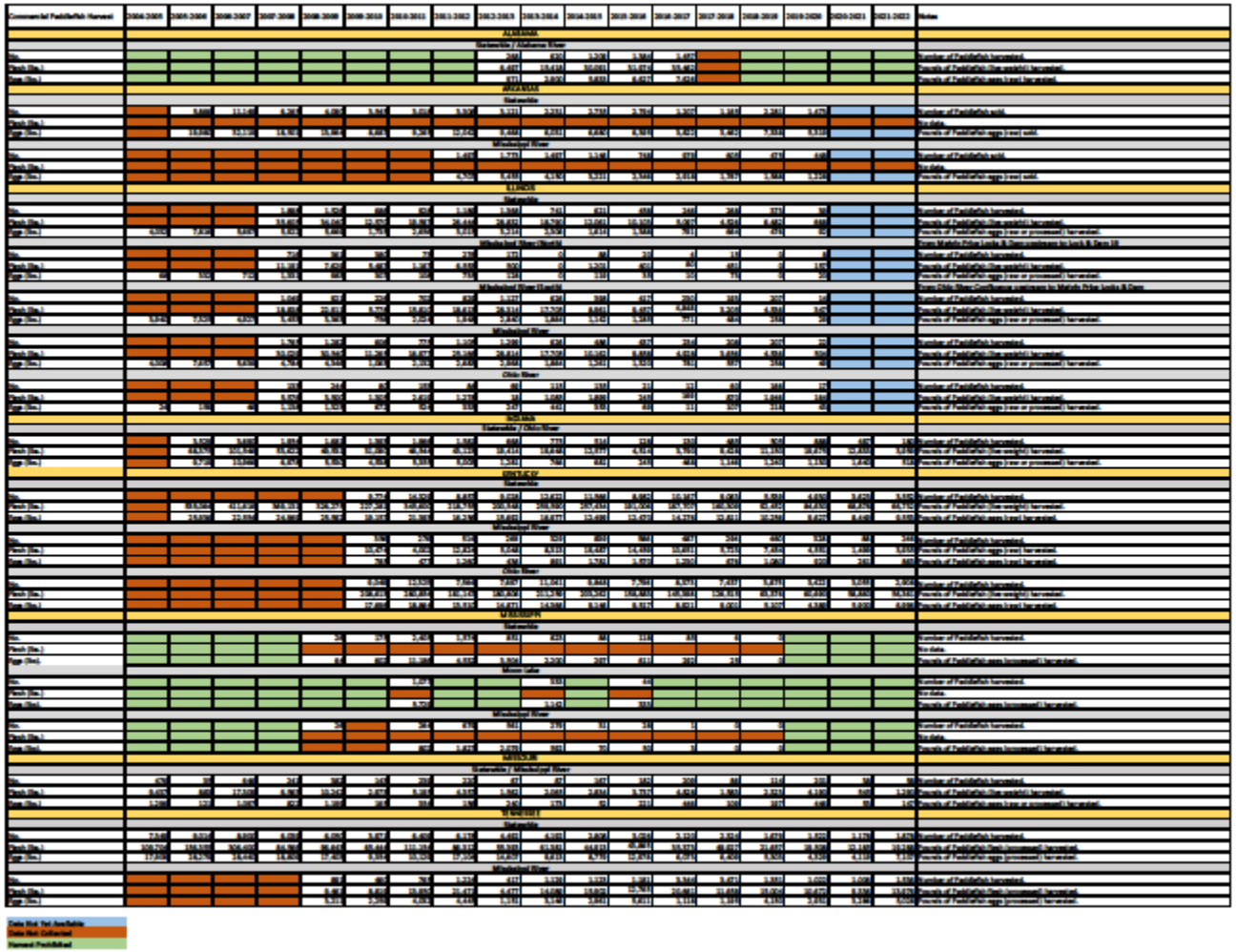
Appendix 3. Paddlefish Harvest Data by State

Double click on the image below to open the data table as an Adobe PDF document.



Appendix 4. State Commercial Paddlefish Fishery Regulations Table (as of January 2023)

State	Alabama	Arkansas	Illinois	Indiana	Kentucky	Mississippi	Missouri	Tennessee
Status	Closed – No commercial harvest	Open	Open Mississippi River (below Lock & Dam 19) Illinois River (below Route 89) Ohio River	Open – Ohio River	Open Statewide	Closed – No commercial harvest	Open – Mississippi River	Open
Link		https://agfc-omnibus.s3.amazonaws.com/eregs/regulation_pdfs/large/agfc_regulation_30.00_large.pdf	https://www.ifishillinois.org/programs/commercialfish.html		https://fw.ky.gov/Fish/Pages/Commercial-Fishing.aspx		https://www.sos.mo.gov/adrules/csr/current/3csr/3csr.asp	https://tnsos.org/rules/WildlifeProclamations.php
Minimum Length Limit (Eye to fork)		Mississippi River: 35” Ozark and Dardanelle Pools of Arkansas River: 37” Arkansas River: 36” Other areas of the state open	Mississippi River: 28” Ohio River: 32”	32”	Statewide: 32” Kentucky Lake and Lake Barkley: 38”		32”	34”

State	Alabama	Arkansas	Illinois	Indiana	Kentucky	Mississippi	Missouri	Tennessee
		to paddlefish harvest: 34”						
Gear Restrictions		Statewide: Gill and trammel nets must be no less than 3.5-inch barmesh. Nets must be marked with gear tags. Arkansas River below JW Trimble Dam: Roe takers are required to use only multifilament nets between Nov 20 – Dec 5 and Mar 2 – April 10 Arkansas River above Dam 2: Unlawful to possess nets other than 3.5” mesh or 6” or larger	Except during ice cover conditions, hoop net and baskets must be attended at least once every 72 hours. Trammel and gill nets must be attended from 10 a.m. to 4 p.m. when taking or possessing roe-bearing species.	All permitted commercial gear, but primarily gill and trammel nets are used. Minimum bar mesh for gill or trammel nets is 4”.	Statewide: Hoop nets – minimum 1” bar mesh in Ohio, Mississippi, lower Tennessee, and lower Cumberland rivers. Minimum of 3” bar mesh everywhere else. Maximum of 60’ leads. Commercial gear tag must be attached on first hoop of each net. Gill and trammel nets - only permitted in the Ohio and Mississippi rivers and can be fished weighted or		Trammel and gill nets must be attended at all times by the permittee’s immediate presence where nets are set. Gill and trammel nets having a mesh smaller than 2 inches bar measure, measured when wet, may not be used.	A commercial fisher (type 100, 101 and 103) that has purchased a commercial roe fish permit (supplemental) (type 108 or 110) is limited to fishing twelve (15) gill nets during paddlefish season on the Mississippi River. The only legal gear for the taking of paddlefish is five (5) inch bar mesh or greater from the Mississippi River.

State	Alabama	Arkansas	Illinois	Indiana	Kentucky	Mississippi	Missouri	Tennessee
		mesh while fishing for Paddlefish			as flag nets. Minimum bar mesh is 3” in the Mississippi River and 4” in the Ohio River. Commercial gear tag is required at every 100’ of net. Trotlines: not allowed for use in the Ohio or Mississippi rivers for paddlefish harvest, but legal in rest of the state. Must have more than 50 hooks, placed no closer than 18” apart, and not be longer that 6,000’. Have one commercial gear tag			

State	Alabama	Arkansas	Illinois	Indiana	Kentucky	Mississippi	Missouri	Tennessee
					attached to line. Kentucky and Barkley Lakes: Whip net sets – must be attended at all times, gill or trammel nets 3”-4.5” bar mesh only. Stationary sets – tended once every 24 hours, gill or trammel nets with minimum 3.5” bar mesh			
Season Length		Nov. 20-April 10 (142 days)	Mississippi and Illinois Rivers: Oct. 1-May 31 (243 days) Ohio River: Nov. 1-April 30 (181 days)	Nov. 1-April 30 (181 days)	Statewide for nets (gill, trammel, and hoop): Nov. 1-April 30 (181 days). Statewide for trotlines (excluding the MS and Ohio Rivers): Nov 1 – May 31.		Mississippi River: Nov. 1-April 15 (166 days)	Nov. 1-April 15 (166 days)

State	Alabama	Arkansas	Illinois	Indiana	Kentucky	Mississippi	Missouri	Tennessee
					Kentucky Lake and Lake Barkley (gill and trammel nets only): Nov 1 – March 31			
License Sales Limit		None	Maximum of 50 permits in the North/South Mississippi River Zones, 10 for the Ohio River/Mississippi South Zone, and 15 for the Illinois River. Computerized random drawing.	Ohio River Roe Harvester licenses are annually capped at 15 total (resident or non-resident, in aggregate)	Statewide roe harvester permit: 101 residents, 18 nonresidents. Kentucky and Barkley Lakes permit: 25 total, 7 of which may be non-residents.		None	Statewide: maximum of 40 permits for roe fish species
Reporting Requirements		Commercial fishers must submit monthly reports of daily fishing activities. Roe buyers/export	List all helpers prior to commercial season.	Maintain daily fishing records. Monthly Report required. Same for roe harvesters. Roe dealers must submit a	Monthly Report required of all commercial fishers. Daily transaction report required for roe-harvesters.		Monthly report with daily details required for commercial fishers and roe fish dealers.	Commercial Fishers must submit a Daily Commercial Roe Fish Harvest Report during Commercial Paddlefish Season.

State	Alabama	Arkansas	Illinois	Indiana	Kentucky	Mississippi	Missouri	Tennessee
		ers must report roe buying transactions monthly.		monthly dealers report	Monthly report required for Roe-bearing fish buyers			Wholesale Fish Dealers must submit Monthly Wholesale Fish Dealer Reports from all purchases of roe fish.
Other Requirements		Commercial Fishing Permit Resident Roe Taker/Seller Permit Resident Roe Taker/Helper Permit Resident Roe Buyer/Exporter Permit Nonresident Roe Buyer Permit	Commercial sport and fishing licenses. Commercial roe harvest permit. Commercial roe dealer permit. Commercial watercraft device tag.	All nets must be marked with one gear tag for every 100 ft of net. All gill and trammel nets must be checked at least every 24 hours, at which time all fish captured must be removed.	Harvester permits may only be issued to non-residents if that state will also sell a non-resident harvester permit to a Kentucky resident. Roe harvesters may only sell, ship, barter, or provide harvested roe from roe-bearing fish to a Kentucky permitted buyer, and must possess		Commercial fishing permit. Roe Fish Commercial Harvest Permit. Roe Fish Dealer Permit.	Supplemental permit required for paddlefish harvest. See TWRA website for additional regulations

State	Alabama	Arkansas	Illinois	Indiana	Kentucky	Mississippi	Missouri	Tennessee
					a valid bill of lading if transporting unprocessed roe			