

Research Article

# Body Size Descriptions of a Trophy-Class Shovelnose Sturgeon (*Scaphirhynchus platyrhynchus*) Population in a Large Unexploited River System

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Sturgeon species (Acipenseridae) around the world have undergone substantial population declines over the past century due to a suite of anthropogenic actions and overharvest. Shovelnose sturgeon are the smallest and most abundant sturgeon species in North America and still support commercial and recreational fisheries despite notable declines in abundance and population structure throughout much of their range. The Rock River, located in Northwestern Illinois, USA, has recently attracted angler attention in response to numerous state record shovelnose sturgeon captured via recreational angling (unregulated recreational fishery), thus prompting the need to understand the size structure and demographics of this largely undescribed population to inform management actions. This study was the first to describe relative condition and size distributions of shovelnose sturgeon in the Rock River, Illinois. A total of 1324 unique shovelnose sturgeon were captured between Fall of 2022 and Winter 2024–2025, with 22% of captured fish meeting or exceeding trophy size class requirements ( $\geq 810$  mm). Shovelnose sturgeon in the Rock River can reach larger body sizes (length and weight) than other regional systems. The Rock River supports the highest proportion of trophy class shovelnose sturgeon in the world. Although no commercial exploitation occurs, recreational angling is currently unregulated, and this population may be vulnerable to substantial shifts in population structure that may warrant management action. Future research seeks to gain a better understanding of population dynamics and develop robust long-term monitoring protocols to inform data-driven management.

**Keywords:** demographics; *Scaphirhynchus platyrhynchus*; size structure; unexploited

## 1. Introduction

Sturgeon species (Acipenseridae) around the world have undergone substantial population declines over the past century due to a suite of anthropogenic actions, including overharvest, construction of dams causing restrictions to migrations and access to habitats, pollution, and poaching [1, 2]. Sturgeon species are particularly sensitive to these types of human

activities due to unique life history attributes such as late maturity, intermittent spawning, large scale migrations, habitat requirements throughout various stages of ontogeny, and high susceptibility of adults to overharvest [3–7]. As a result, ~85% of sturgeon species globally are listed as threatened or endangered [8]. European and Asian sturgeon populations have generally experienced the largest population declines due to overharvest motivated by the caviar industry, resulting in

nearly all populations in the Black, Caspian, and Adriatic seas being listed as endangered [9–11]. The collapse and harvest closure of numerous European and Asian sturgeon populations have raised concern that there may be increased demand on North American sturgeon species [12, 13], including Atlantic sturgeon *Acipenser oxyrinchus oxyrinchus* [14], Lake sturgeon *Acipenser fulvescens* [6, 15], and shovelnose sturgeon *Scaphirhynchus platyrhynchus* [4, 12, 16].

Shovelnose sturgeon is the smallest (~1 m max length), yet the most abundant and widespread sturgeon species in North America, inhabiting large river systems throughout the Upper Mississippi River (UMR; Figure 1) and associated tributaries [17, 18]. Despite being abundant and possessing life history attributes that promote resiliency (i.e., faster maturation ~5–7 years [19]), compared to other sturgeons, shovelnose sturgeon populations have been substantially reduced over the past 100 years and are considered extirpated or at risk across 50% of their native range [19]. Historically, shovelnose sturgeon was unfavored in the commercial fishery market due to their small body size (resulting in reduced egg fecundity) and was often viewed as a nuisance by commercial fisherman targeting other sturgeon species (i.e., Lake Sturgeon [20]). However, as global declines of large-bodied sturgeon species became apparent in the 1900s [6, 9, 21], a market emerged for alternative sturgeon species such as shovelnose sturgeon. Despite declining population trends, shovelnose sturgeon is one of the few species to be commercially and recreationally targeted in North America [19, 22]. Currently, seven states have commercial fisheries for shovelnose sturgeon in the United States of America, and 13 states have a recreational fishery [23]. Commercial harvest of shovelnose sturgeon is primarily focused on the Mississippi River and Missouri River [19], and exploitation via commercial harvest has been documented to negatively affect population size and age structures and reproductive dynamics [4, 5, 24, 25]. Recreational fishing, including catch-and-keep fisheries for shovelnose sturgeon, are not well understood (but see [26]) but their impacts on populations are believed to be low [19].

Illinois, USA, is centrally located within the range of shovelnose sturgeon and is bordered by major river systems with well-studied populations (i.e., Mississippi River, Missouri River, and Wabash River; Figure 1), supporting both commercial and recreational harvest. Populations throughout the UMR are generally considered stable and are not listed under any conservation status [17, 19, 23]. While commercial harvest of shovelnose sturgeon within the UMR and Illinois is strictly regulated (i.e., size restrictions and harvest season), harvest rates have increased over the past 3 decades [12] and are expected to continue to increase basin-wide [16]. Alternatively, recreational angling in Illinois is currently unregulated, and potential harvest rates and impacts remain unknown. The Rock River is a large tributary of the UMR, located in northwest Illinois, USA. The Rock River originates in central Wisconsin and flows 481 km through a series of 25 dams and mixtures of urban and agricultural landscapes before its confluence with the Mississippi River at Moline, Illinois, USA (Figure 1). Commercial exploitation of the Rock River shovelnose sturgeon

population has never been allowed by the Illinois Department of Natural Resources, as the heavily restricted commercial fishery that does exist on the Rock River (only six special use permits are issued to commercial fisherman) does not permit the harvest of shovelnose sturgeon. Recently, the Rock River has gained attention from both recreational anglers and commercial fishermen due to several reports of trophy-class and state-record-size shovelnose sturgeon being captured during 2021–2024 via recreational angling. Given the presence of record-sized shovelnose sturgeon and increasing publicity, the Rock River population has been identified as a research priority by the Illinois Department of Natural Resources, prompting an assessment of this undescribed population [27].

Although commercial harvest of shovelnose sturgeon is prohibited in the Rock River, there is an unregulated recreational fishery for the species that allows catch and keep. The Rock River has a history of producing state-record-size shovelnose sturgeon dating back to 1988, when the state record barely exceeded 2280 g (~5 lb.). This was surpassed in 2003 with a shovelnose sturgeon weighing just over 3600 g (~8 lb. <https://ifishillinois.org>). Notably, since 2021, this record has been broken three times in the Rock River, with the most recent state record being captured in 2024, weighing 5870 g (12 lb., 15 oz). Despite these catches and reports of record-breaking sized individuals, the shovelnose sturgeon population in the Rock River has never been thoroughly examined and described, and all aspects of population demographics (body size, sex ratios, and age) and dynamics (i.e., reproduction, recruitment, and mortality) are unknown. Given the recent attention from anglers, current unregulated recreational fishery, and susceptibility to exploitation, a thorough understanding of the Rock River shovelnose sturgeon population dynamics is required to determine the status and proper management of this population [28].

This research is the first step of a multifaceted approach to further understand this population, inform sustainability of the fishery, and guide data-driven management strategies for the Rock River shovelnose sturgeon population. The objectives of this study were to (1) describe population level demographics including body size (length and weight) and sex of shovelnose sturgeon in the Rock River and compare these characteristics to other regional populations, and (2) locate and document age-0 (young-of-year) and juvenile shovelnose sturgeon in the Rock River to begin to evaluate reproductive success or identify recruitment bottlenecks. These data will be used to establish baseline metrics to measure population-level changes and to identify future research needs and any need for management.

**1.1. Study Site.** This research occurred in the Rock River, Illinois, within the first impounded river section upstream of its confluence with the Mississippi River (Figure 1). The Milan Dam in Moline, Illinois, is the first barrier located just 7 km upstream from the confluence with the Mississippi River, creating ~153.5 km (95 miles) of impounded river before reaching the second upstream barrier, Sterling Dam, located in Sterling, Illinois (Figure 1). The Milan and Sterling

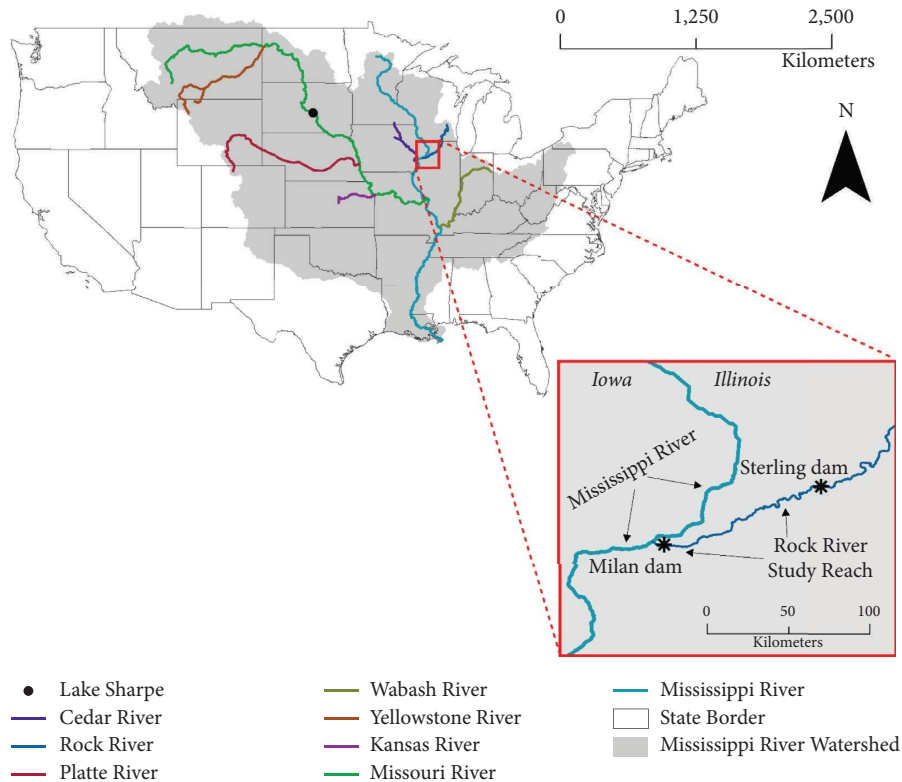


FIGURE 1: Major tributaries hosting Shovelnose Sturgeon (*Scaphirhynchus platyrhynchus*) within the Mississippi River Watershed, USA. The inset map identifies the Rock River and focal study reach located between the Milan and Sterling dams in Illinois.

dams were constructed in mid 1800s to early 1900s and are ~3–4.5 m high. This section of the Rock River experiences large fluctuations in seasonal flows, and the long-term median flow is 145 m<sup>3</sup>/s (USGS 5443500 [29]). Fish passage at the Milan Dam is not well understood, but a passage study of a few species of fish conducted during spring spawning periods indicated that upstream fish passage is extremely limited (99%–100% of the time) for all species evaluated—although shovelnose sturgeon was not considered in this evaluation [30].

In June 2009, tens of thousands of gallons of fuel-grade ethanol were spilled into a tributary of the Rock River, near Rockford, Illinois, ultimately distributed downriver and into the mainstem of the Rock River [31]. Impacts from the spill resulted in numerous fish kills extending downstream and into our focal research area between Milan and Sterling Dams. A total of 26 species were reported to be affected, including shovelnose sturgeon. It is estimated that 736 shovelnose sturgeon were killed during this event. Notably, all shovelnose sturgeon were located in the river section downstream of the Sterling Dam, and no reports of shovelnose sturgeon were documented above this barrier. The long-term impacts of the spill are unknown.

## 2. Methods

**2.1. Fish Collection/Multigear Approach.** A multigear approach was used to capture shovelnose sturgeon across various life stages [32–35] that included trammel nets, gill nets, trot lines, benthic trawls, angling, and boat

electrofishing. Surveys took place periodically from October 2022 to March 2025 (Table 1). Our sampling strategy and gear selection were not standardized during this phase of research but were intentionally adaptive based on river/environmental conditions (e.g., season, water levels, water velocity, water temperature, and debris accumulation) and/or guided by direct shovelnose sturgeon observations using side scan sonar (SSS; Hummingbird Helix10 MSI GPS G3N, Johnson Outdoors Inc. Racine, WI) in an effort to maximize shovelnose sturgeon captures [34, 36]. The adaptive sampling approach intentionally used in this study allowed field crews to adjust to changing river conditions [36] and to take advantage of unique observations of shovelnose sturgeon behavior that increased catch rates. Therefore, the effort and catch rates reported in this manuscript should be interpreted cautiously as time, effort, and location are not standardized between or among gears. For example, netting primarily occurred in the Spring and Fall sampling periods (water temperature < 21°C), to avoid net stress and mortality that can occur at warmer water temperatures. Netting efforts were stopped in late Fall during leaf abscission as the accumulation of drifting leaves fouls nets, making them ineffective for catching shovelnose sturgeon, but would resume when debris accumulation was minimal. The initiation of field surveys (Fall 2022–Spring 2023) was largely conducted in an exploratory manner to locate shovelnose sturgeon (i.e., netting in deeper holes and electrofishing shallow shorelines), with no prior knowledge of location, occupancy, or localized abundance. In the late Fall and

TABLE 1: Sampling and catch summary, and biological description of Shovelnose Sturgeon (*Scaphirhynchus platyrhynchus*) captured from the Rock River, Illinois from 2022–2025.

Year	Season	Dates	Gear	Effort	Count	FL range (mean, SD)	Weight range (mean, SD)	CPUE
2022	Fall	Oct 10–21	TN	46	98	644–911 (773.1, 61.2)	1111–4900 (2725, 837)	2.1
2023	Spring	May 1–12	TN	52	204	501–906 (758.2, 58.2)	508–4824 (2478, 692)	3.9
		May 2, 8, 10	EF	NA	27	566–909 (738.2, 82.4)	790–4935 (2364, 978)	NA
	Fall	Oct 9–Nov 6	TN	45	59	615–885 (765.1, 63.8)	1040–4968 (2816, 889)	1.3
		Oct 10	EF	NA	1	747	2122	NA
	Winter	Dec 13	EF	NA	1	760	2438	NA
2024	Winter	Nov 30–Dec 12	TL	40	90	615–937 (794.9, 67.0)	1002–5271 (2895, 827)	2.3
		Dec 13, 20	TW	7	175	575–885 (757.0, 60.7)	820–4647 (2397, 689)	25.0
		NA	AG	NA	1	938	5874	NA
	Spring	Mar 4–13	GN	17	109	631–930 (768.8, 67.4)	1281–5088 (2519, 858)	6.4
		Feb 19–23	TL	13	59	647–888 (792.2, 53.9)	1607–4124 (2796, 646)	4.5
		May 10, 15, 16	EF	NA	39	635–911 (789.6, 57.9)	1270–5500 (3071, 972)	NA
	Summer	Mar 20–Jun 11	GN	54	124	579–859 (730.1, 52.3)	795–4348 (2006, 584)	2.3
		May 17–Jun 17	STL	134	39	631–905 (756.8, 59.5)	932–4826 (2433, 831)	0.3
	Fall	Aug 29–Sept 3	STL	110	3	545–794 (687.3, 128.3)	602–3120 (1885, 1260)	0.0
		Jul 9–Aug 8	MM	69	0	NA	NA	0.0
		Sept 4	EF	NA	33	511–906 (722.4, 101.1)	409–4128 (2049, 1021)	NA
	Winter	Oct 1–Nov 10	EF	NA	100	496–894 (705.2, 92.6)	402–4396 (1907, 901)	NA
Oct 8, Nov 6, Dec 9		GN	6	11	539–858 (754.4, 87.9)	606–3598 (2497, 909)	1.8	
2025	Winter	Mar 9–Mar 13	GN	7	133	604–879 (762.9, 60.0)	938–4333 (2487, 733)	19.0
		Mar 12	TW	6	25	585–888 (774.3, 69.8)	913–5600 (2820, 1083)	4.2
		NA	AG	NA	14	677–906 (778.1, 64.0)	1212–4069 (2582, 820)	NA

Note: Effort is quantified as individual net, trot line, benthic trawl run. Count represents total fish captured (including recaptures), and CPUE is catch-per-unit-effort. AG = Recreational angling, EF = Boat electrofishing, MM = Modified Missouri Trawl, TW = Balloon trawl.

Abbreviations: GN = Gill net, ST = Siamese trawl, TL = Trot line, TN = Trammel net.

Winter periods of 2023–2024 and 2024–2025, SSS was used to locate aggregations of shovelnose sturgeon (when available). Using SSS, shovelnose sturgeon were visible in large congregations in discrete locations (seasonally, see Discussion), which provided the opportunity to conduct targeted sampling and maximize captures (i.e., locate fish and position gear in immediate proximity to congregations). Initial species confirmation was made using an AquaVu HD7 underwater camera (Aqua-Vu, Minnetonka, MN). During the Spring of 2024, shovelnose sturgeon congregations were infrequent or absent, and thus the aid of SSS to position gears (e.g., gill nets) was minimal. Lastly, in the Summer of 2024, sampling efforts focused on benthic trawling in an additional effort to capture young-of-year and juvenile shovelnose sturgeon. Detailed descriptions of each gear and deployment strategy are provided below.

Trammel nets (manufactured by Duluth Nets, Duluth, Minnesota) consisted of 5.1–7.0-cm inner square mesh and 25.4-cm outer wall mesh, 1.8 m tall × 91.4 m long [34]. Trammel nets were anchored to bottom, positioned parallel to river flows, and fished overnight for ~24 h. Trammel nets were deployed semirandomly in deeper water throughout the river relative to available depths within this river section. Sites were selected without the aid of SSS or knowledge of fish presence or absence.

Gill nets were custom fabricated (manufactured by Duluth Nets, Duluth, Minnesota) and consisted of 5.1-cm and 6.4-cm square mesh with a total net height of 1.2 m × 45.7 m long [32, 33, 36]. Gill nets were fished in a targeted manner when congregations of sturgeon were located using SSS. Gill

nets ( $N = 4$ ) were anchored to bottom and positioned parallel to river flows. The use of SSS and GPS positioning allowed for gill nets to be positioned within the immediate proximity to sturgeon congregations and fish for ~2 h/day.

Trotlines [32, 33, 37, 38] were constructed from 1.0-cm diameter lead rope as the main line with a total length of 33.5 m. Each trotline consisted of 10 - 3/0 size long-shank Baitholder J-Hooks, baited with nightcrawlers (*Lumbricus terrestris*) [32], attached to the mainline using a 3/8"; long line clip and a 25.4-cm dropper line made from 40 lb. test fluorocarbon. Trotlines (up to five per day) were deployed in immediate proximity to shovelnose sturgeon observed via SSS, positioned parallel to river flows, and allowed to fish overnight for a maximum of 24 h.

The two-seam slingshot balloon trawl (manufactured by Innovative Net Systems, Milton Louisiana) was 4.8 m wide × 0.6 m tall at the mouth and 4.5 m long, with a body made of #12 nylon netting in 1.8-cm bar mesh and an inner bag of 3.0-mm bar mesh, and foot rope paired with chain to maintain contact with river bottom (see [32, 36]). This trawl was only used during the Winter of 2023 and 2025 (see Table 1) when congregations of sturgeon were in high density within a river location that was free of snags and conducive to benthic trawling (confirmed using SSS). Prior to performing the trawls, sturgeon congregations were located using SSS and buoy was placed in the river to serve as a visual marker identifying a targeted zone for trawling. The trawl boat would position upstream of the targeted zone, deploy the trawl, and tow along bottom in a downstream direction with the boat powered in reverse,

while maintaining enough speed to pull the trawl without collapsing upon itself in the river current. Trawl distance was not standardized as sturgeon congregation would move their river position slightly when encountered by the boat and trawl, but each trawl was ~75 m in length with a run time of ~2 min.

The Siamese trawl (manufactured by Innovative Net Systems, Milton Louisiana) was 2.4 m wide  $\times$  0.5 m tall at the mouth and 4.8 m long, with the body made from 1000 denier polyester in 4.0-mm bar mesh. The head rope supported two equally spaced plastic floats (5.1 cm wide  $\times$  12.7 cm long), and the foot rope was paired with 2.4 m of chain to ensure consistent contact with the river bottom when trawling in heavy current or undulating benthic surfaces (i.e., sand ridges). An interior sorting bag consisted of 38.0-mm knotted high-density polyethylene used to separate large and small fishes. Sampling with the Siamese trawl was performed over a variety of smooth substrates (sand and gravel) in areas free of benthic snags (confirmed using SSS) in effort to attempt to capture young-of-year or juvenile cohorts. Although not the primary use of this gear, adult-sized shovelnose sturgeon were also captured in the Siamese trawl. Trawl distance using the Siamese trawl was not standardized and ranged from ~50 m to ~500 m. The Siamese trawl was fished on the bottom and towed in a downstream direction, while the boat was powered in reverse. There were few instances in Spring of 2024 where “adult-sized” shovelnose sturgeon were observed on SSS and targeted sampling could be conducted.

The mini-Missouri trawl (manufactured by Innovative Net Systems, Milton Louisiana) is a dual-mesh trawl, modified from the standard Missouri trawl also used to target small benthic juvenile fishes [39, 40]. The mini-Missouri trawl is 2.4 m wide  $\times$  0.5 m tall at the mouth and has a total length of 4.6 m. The exterior cover is made of 3.18-mm heavy delta style mesh, and the interior cod end was made of 1.0-mm diameter nylon twine with 17.5 bar mesh. The head rope also supported two equally spaced foam floats (3.2 cm wide  $\times$  6.0 cm tall), with a 2.4-m chain paired to the foot rope to ensure benthic contact. The mini-Missouri trawl was deployed throughout the river and fished over smooth substrates (sand and gravel) in areas free of benthic snags (confirmed using SSS). Trawl distance was not standardized and ranged from 50 m to ~500 m. The mini-Missouri trawl was fished on the bottom and towed in a downstream direction while the boat was powered in reverse. The SSS was used to identify benthic snags and was not used to locate sturgeon using this gear.

Boat electrofishing was conducted during the daytime by working in a downstream direction, generally focusing along shorelines, or shallow water areas (i.e., < 2.0 m) to maximize efficacy and detection (see also [33, 34]). Mid-channel sections were surveyed when water depths were sufficiently shallow to yield fish (i.e., < 3.0 m). Electrofishing was conducted using a custom-built 6.7-m aluminum plate boat (AAD Welding, Peoria, IL) with a 7000-W Honda inverter generator (EU7000is) and ETS pulsed-DC electrofishing control box with filter. The control box was set to 60 Hz and a 25% duty cycle, and power output was adjusted based on water temperature, conductivity, and fish behavior. No SSS was used to aid in boat electrofishing efforts.

Recreational angling was used on two occasions to collect shovelnose sturgeon. First, a local recreational angler contacted the Illinois Department of Natural Resources and Illinois River Biological Station biologists (authors of this paper) to report a potential new state record (Year 2024). Biologists were able to meet with the angler on the site, tag and collect biological information, and release the fish alive back into the Rock River. This fish was confirmed as the new state record (Year 2024), and biological information was included in this manuscript. Similarly, on one other occasion, Illinois River Biological Station biologists ( $N=3$ ) participated in recreational angling targeting shovelnose sturgeon (Year 2025) to collect pilot data on recreational catch rates. Data from shovelnose sturgeon captures during the pilot survey were included in this manuscript. Specific dates, times, locations, and strategies of recreational captures are not provided in this manuscript.

**2.2. Biological Data Collection.** Upon capture, all individual shovelnose sturgeon were measured (fork length [FL], nearest mm), and weighed (nearest g). All fish were initially scanned for the presence of a passive integrated transponder (PIT) tag. New captures were implanted with a PIT tag (12.5 mm  $\times$  2.03 mm, 134.2 kHz, Biomark) into the flesh of the opercle [41], and the unique 15-digit identification code was recorded. All fish were externally marked with a colored T-bar tag (FD-94 anchor tags, Floy Tag and Manufacturing Inc., Seattle, Washington) inserted at the anterior base of the dorsal fin. Tissue samples were collected from all individual fish by trimming a ~1 cm  $\times$  1 cm section from the lower lobe of the caudal fin. Tissue samples were stored in 95% ethanol and archived for future genetic investigations. Sex was confirmed by examining gametes via expression or by extracting oocytes using a needle and syringe—otherwise sex was recorded as unknown [33, 42]. For known-sex fish, gamete stage/maturity was visually determined following descriptions provided by Colombo et al. [43] and Webb et al. [44]. The number of known-sex individuals during this study should be viewed as conservative because our sex determination relied on observing gametes—coupled with sex-specific spawning periodicity (individual male and female do not spawn every year) and differences in gamete development (i.e., M1-M2 for males or F1-F8 for females, see [44]) making it difficult to assign sex or maturity stage [18, 33, 45]. If a fish was recaptured, FL, weight, and PIT and FLOY tag information were recorded. All individuals were released at the site of capture after processing.

**2.3. Data Analysis.** Shovelnose sturgeon capture data were pooled across all sampling years and gears prior to data analysis; several shovelnose sturgeon were captured with caudal deformities and were removed from analysis (see results). The size structure of shovelnose sturgeon was described using length–frequency distributions and reported as abundance of catch per 25-mm length bin. Sex-specific length–weight relationships were also described.

Standard weight ( $W_s$ ) was calculated for all captured shovelnose sturgeon using Quist et al.’s formula [46] as follows

$$\log_{10} W_s = -6.287 + 3.330 \times \log_{10} (\text{FL}), \quad (1)$$

where FL represents fork length and  $W_s$  represents the individual  $W_s$  for a similar length fish.  $W_s$  was used to calculate relative weight ( $W_r$ ) for each fish using

$$W_r = \left( \frac{W}{W_s} \right), \quad (2)$$

where  $W$  is the observed weight of the individual fish and  $W_s$  is the length specific  $W_s$ .

Stock density has historically been reported in terms of proportional stock density (PSD) and relative stock density (RSD), but there was longstanding confusion about the utility, and terminology of these indices—especially considering both indices were calculated the same [47]. To streamline the meaning and communication of these indices, RSD was discontinued in favor of using proportional size distribution (PSD); PSD also was renamed to include “size distribution” rather than “stock density” as PSD (or even RSD before being discontinued) does not always reflect

population density [48, 49]. Furthermore, PSD can be calculated traditionally (using a minimum length) or incrementally (minimum and maximum length), and study objectives might dictate whether traditional or incremental PSD is reported. To facilitate comparisons among the literature that used varying terminology, we assessed the size structure of shovelnose sturgeon by calculating both traditional and incremental PSD. To ensure appropriate translation of terminology across studies, we followed the guidance of the authors in [47] that reported terminology of former PSD and RSD indices and the corresponding revised terminology for PSD. Traditional PSD was calculated as follows:

$$\text{PSD} - X = \left( \frac{\text{number of fish} \geq \text{specified length category}}{\text{number of fish} \geq \text{stock length}} \right) \times 100, \quad (3)$$

whereas incremental PSD was calculated as follows:

$$\text{PSD} - [X - X] = \left( \frac{\text{number of fish within length range of specified length category}}{\text{number of fish} \geq \text{stock length}} \right) \times 100. \quad (4)$$

The length (in mm) categories used to determine traditional PSD included stock (S)  $\geq 250$ , quality (Q)  $\geq 380$ , preferred (P)  $\geq 510$ , memorable (M)  $\geq 640$ , and trophy (T)  $\geq 810$  [46]. The length (in mm) range used to determine incremental PSD included [S-Q] = 250–379, [Q-P] = 380–509, [P-M] = 510–639, [M-T] = 640–809, and [T+] =  $\geq 810$ .

### 3. Results

A total of 1363 shovelnose sturgeon were captured (Table 1), which includes 39 fish recaptures (see below), resulting in 1324 unique individuals. Fifteen individuals had caudal deformities ( $n = 18$ , 1.3% of total catch) and were removed from length and weight analyses ( $N = 1345$  individuals used for analyses). Shovelnose sturgeon ranged in length from 496 to 938 mm FL (mean = 757.4 mm, SD = 69.3) and weight from 402–5874 g (mean = 2472.0 g, SD = 842; Table 1; Figures 2 and 3).  $W_r$  of shovelnose sturgeon ranged from 61.5 to 186.4 (mean = 118.1, SD = 16.0, Figure 4). Zero age-0 shovelnose sturgeon were collected during this study despite 313 benthic trawls conducted targeting this life stage.

A total of 125 males and 115 females were confirmed, and all other individuals were of unknown sex ( $n = 1105$ ). Males ranged in lengths from 511 to 859 g (mean = 734.3 mm, SD = 58.2), weight from 409 to 3733 g (mean = 2089 g, SD = 605), and  $W_r$  ranged from 76 to 154 (mean = 112, SD = 14.5). Females ranged in lengths from 541 to 911 mm (mean = 805.8 mm, SD = 61.3), weight from 668 to 5600 g (mean = 3213 g, SD = 877.6), and  $W_r$  ranged from 98 to 170 (mean = 127, SD = 16.1). Fish of unknown sex ranged in lengths from 496 to 938 mm (mean = 756.0 mm, SD = 69.0), weight from 402 to 5874 g (mean = 2438.8 g, SD = 817), and  $W_r$  ranged from 62 to 186 (mean = 118, SD = 15.8).

The PSD was calculated for all stock classes. PSD was 100 for stock, quality, and preferred length categories, followed by 95 and 22 for memorable and trophy classes, respectively (Table 2). The incremental PSD-[M-T] hosted the highest proportion of individuals (73.1%) followed by PSD [T], [P-M], and [Q-P], respectively (Table 2). The  $W_r$  for each PSD [X-X] category ranged from 61.5 to 186.4 (Table 2).

Recapture events were rare but occurred on 40 occasions, representing 39 individuals (3% of total catch). The majority of recaptures (75%, 30 out of 40 recaptures) occurred within 1 year (range = 1–667 days, mean = 220 days), which should be expected considering the infancy of the Rock River investigation and ongoing tagging efforts. Changes in FL of recaptured individuals ranged from –13 mm to +63 mm, corresponding to daily growth ranging from –0.8 mm to +4 mm (mean = 0.15 mm/day). A total of 17 out of 40 (43% of recaptures) showed negative or no growth.

### 4. Discussion

The results of this study are the first to characterize the unique size structure of shovelnose sturgeon in the Rock River and establish baseline population metrics for this currently unregulated fishery. Due to the large body sizes of shovelnose sturgeon captured via recreational angling and the growing popularity of this fishery, demographic descriptions combined with long-term monitoring are necessary to provide data-driven management of this population. Shovelnose sturgeon in the Rock River can achieve larger sizes and greater proportions of memorable- and trophy-size classes than other populations across their range, with the simplest explanation for the current population structure likely being due to the lack of exploitation

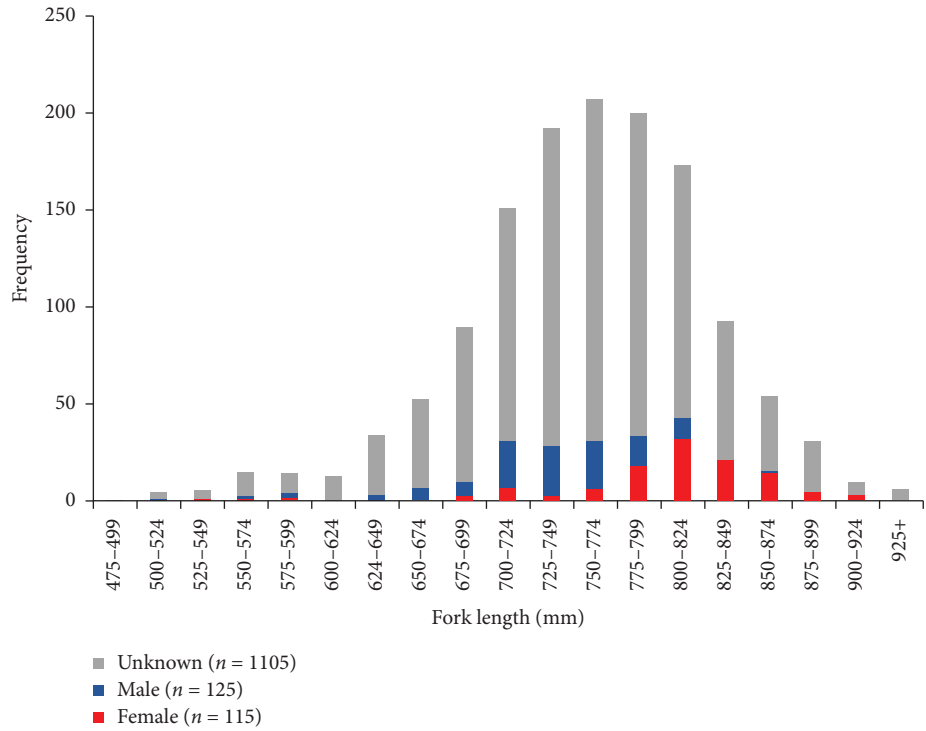


FIGURE 2: Length-frequency histogram of Shovelnose Sturgeon (*Scaphirhynchus platyrhynchus*) captured (N = 1345) in the Rock River, IL, 2022-2025. Males are shown in blue, females shown in red and unknown sex shown in grey.

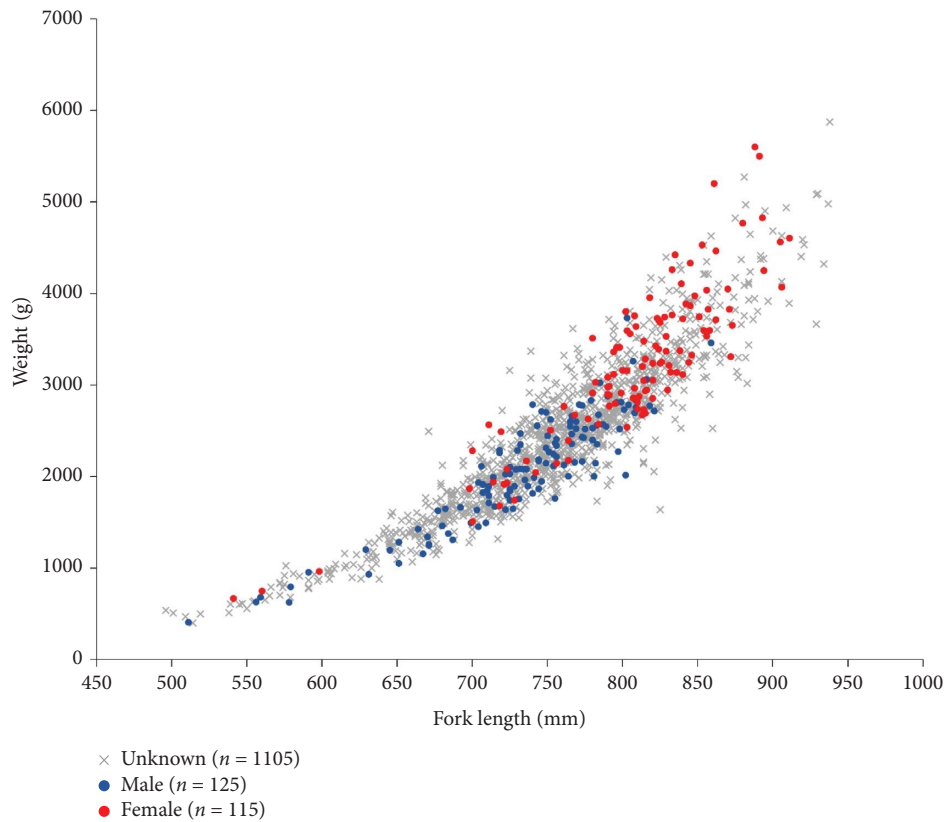


FIGURE 3: Length weight relationship for Shovelnose Sturgeon (*Scaphirhynchus platyrhynchus*) (N = 1345) in the Rock River 2022-2025. Males are shown in blue, females shown in red and unknown sex shown in grey.

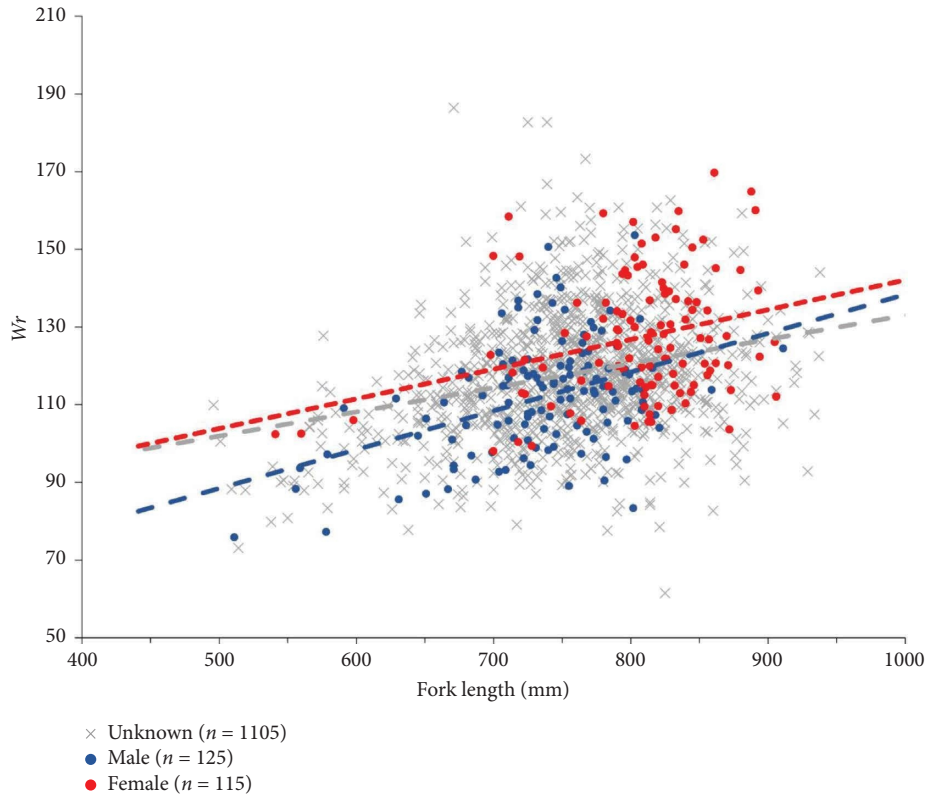


FIGURE 4: Relationship between relative weight ( $Wr$ ) and fork length of Shovelnose Sturgeon (*Scaphirhynchus platyrhynchus*) captured in the Rock River, IL, 2022–2025. Males are shown in blue, females shown in red and unknown sex shown in grey. Dashed lines represent sex specific trend lines, and the line color corresponds to sex determination.

TABLE 2: Stock indices and relative weights ( $Wr$ ) for Shovelnose Sturgeon (*Scaphirhynchus platyrhynchus*) captured in the Rock River, Illinois from 2022–2025.

PSD-X, [X-X]	PSD-X Value (count)	PSD [X-X] Value (count)	PSD [X-X] $Wr$ Range (mean, SD)
S, [S-Q]	100 (1345)	NA (0)	NA
Q, [Q-P]	100 (1345)	< 1 (3)	88.2–109.9 (99.6, 10.9)
P, [P-M]	100 (1342)	5 (67)	73.1–127.5 (98.1, 11.2)
M, [M-T]	95 (1275)	73 (983)	77.5–186.4 (118.4, 15.4)
T, [T]	22 (292)	22 (292)	61.5–169.7 (121.6, 15.7)

Note: Proportional size distribution (PSD-X) and incremental stock density (PSD[X-X]) are presented following definitions by Neumann et al. [46] and metrics provided by Quist et al. [45]. PSD-X categories are S = Stock, Q = Quality, P = Preferred, M = Memorable, and T = Trophy. Incremental PSD [X-X] categories are [S-Q] = Stock to Quality, [Q-P] = Quality to Preferred, [P-M] = Preferred to Memorable, [M-T] = Memorable to Trophy, and [T] =  $\geq$  Trophy. Relative weight ( $Wr$ ) is provided for PSD [X-X] categories. Count is the number of individuals within PSD-X and PSD [X-X]. No stock size individuals were captured, which prevented us from calculating PSD [S-Q].

(commercial and recreational (see [4, 12, 23, 33, 50–52]). Many contemporary sturgeon populations around the world are described as relics of the past and are yet to recover [53], which limits our ability to understand and describe the structure and dynamics of truly stable and natural populations (i.e., true maximum size, true maximum age, and recruitment dynamics [19, 54]). Although the Rock River has been manipulated throughout time by various anthropogenic disturbances (i.e., dams, pollution, and isolated fish kills), the shovelnose sturgeon population may reflect a more unaltered, natural population structure that provides a unique opportunity to improve our knowledge of species ecology and life history.

The Rock River population is unique because it appears that these fish can not only reach a larger body size than other regional systems but also these large individuals represent a greater proportion of the population than other systems. In 1988, the Illinois state record of shovelnose sturgeon only weighed 2280 g (~5 lb.), whereas the current state record (year 2024) weighed 5874 g (12 lb., 15 oz), which may suggest a shift in population structure; however, it is more likely that this population has persisted undescribed and unexploited in a river system that provides enough time and resources to maximize size and longevity. The mean length of shovelnose sturgeon captured in the Rock River was 757.4-mm FL, and mean weight of 2472 g, and more

than 27% of the Rock River population is > 800 mm and > 2900 g. Body size (length and weight) for shovelnose sturgeon populations is highly variable across their range [46, 55, 56], often attributed to differences in local abundance, exploitation and harvest, lentic versus lotic systems, and environmental/habitat parameters [12, 23, 38, 46, 57]. Generally, shovelnose sturgeon have been described as small, reaching maximum lengths of ~1000 mm and weights of 4500 g, with most individuals weighing less than 2500 g [19, 58]. The largest individual reported in the present study was 938-mm FL and weighed 5870 g, and although larger individuals have been reported in the scientific peer-reviewed literature, these instances are rare. For example, the largest individual we found in the published peer-reviewed literature was from Lake Sharpe, South Dakota (reservoir on the Missouri River), that measured 1092 mm and weighed 6350 g. However, this individual was an anomaly and most shovelnose sturgeon in the population were between 600 and 650 mm (median = 635 mm) in length, with an average weight of 1179 g, and fish > 800 mm were rare [59]. Similarly, several studies within the Wabash River have reported maximum lengths ranging from 858 to 910 mm, but mean lengths only ranged from 662 to 683 mm [33] ([909 mm, mean = 662 mm] [52], [910 mm, mean = 668 mm] [50], and [858 mm, mean = 683 mm]), with only 1.3% of fish > 800 mm [50]. Furthermore, mean weight for shovelnose sturgeon in the Wabash River was ~1193 g [33, 52], but a range of 52–3381 g (mean = 1208 g) was reported by Kennedy et al. [50]. Body size descriptions of shovelnose sturgeon are available from numerous other populations across their distribution, but only size range (minimum–maximum) is reported, which is not as informative in the context of size structure as mean length. For example, shovelnose sturgeon in the Lower Platte River, Nebraska, ranged in size from 285 to 797 mm [38, 60], from 122 to 648 mm in the Kansas River [61], and from 220 to 850 mm in various pools throughout the UMR [62]. The shovelnose sturgeon population in the Rock River has some of the largest body sizes reported on record, but PSD indices may better describe the abundance and frequency of these larger size classes.

The PSD values (traditional and incremental) reported for shovelnose sturgeon from the current study are unmatched, and the Rock River hosts the highest abundance of trophy-class shovelnose sturgeon documented in the literature (PSD-T = 22). There are very few studies that report PSD-T values > 1, which may be expected considering the minimum FL to reach trophy length of 810 mm and that most populations rarely document individuals ≥ 800 mm in length (see above). However, the Wabash River was one of the few systems found in the literature that showcased adults reaching maximum sizes > 800 mm and the presence of memorable and trophy sized individuals [33, 50, 52]. For example, PSD was 100 and PSD-P was ≥ 97, but PSD-M was reduced to 68–81 [50], PSD-M = 81 [33], PSD-M = 68 [52], and PSD-M = 71; and PSD-T decreased to 1 or < 1 [50], PSD-T ≤ 1, [33], PSD-T = 1 [52], and PSD-T = 1. Additionally, Koch [62] provided PSD-T values of 2 and 1 for the UMR, Pool 11 and Pool 18, respectively; however, PSD-M values

were 32 and 36, respectively, from a relatively low sample size of ~300 individuals per location. PSD values for the Rock River population (current study) were 100 for stock, quality, and preferred sizes classes and remained high for PSD-M (95). Notably, PSD-T was 22, which stands as the highest reported proportion in the literature and is 22-fold higher than any reported PSD-T. Furthermore, incremental PSD values for the Rock River population demonstrate that most individuals (PSD-[M-T] = 73) can be categorized into the [M-T] class, followed by [T+] (PSD-T = 22). PSD values from numerous other systems were explored (e.g., Missouri River [63], Kansas River [61], Lower Platte River [38], and UMR,) [62], but a lack of any individuals within memorable or trophy classes precluded any comparisons, underscoring the novelty of the length distribution and proportional size distributions of shovelnose sturgeon in the Rock River.

It appears that stock, quality, and preferred classes (i.e., < 640 mm) are abundant within most other shovelnose sturgeon populations, but sharp declines are observed for memorable and trophy sizes classes (i.e., ≥ 640 mm), contrary to our results from the Rock River. Notably, minimum size limits for harvest (commercial and recreational) are often set to 610–635 mm [23], therefore reduction in larger size classes is often attributed to harvest (see also [12, 23, 33, 52]). In the Rock River, ~95% of the population meets and exceeds a minimum size of 610 mm, and at this time, it is suspected that recreational harvest is very low (which may help explain the abundance of large sizes classes). Importantly, PSD indices have been used as a management tool to indicate trends in harvest, recruitment, and sustainability. For example, declines in PSD-M have been observed over time throughout the Wabash River and may indicate influence from commercial exploitation, but alternatively, increased recruitment in smaller size classes may have shifted indices [33]. The Rock River population is skewed toward large individuals, which is most likely due to the lack of harvest. However, observed size distributions could be due to gear biases and the inherent difficulty of capturing small (e.g., < 500 mm) size classes [33, 34, 50, 60, 64], and not necessarily indicating survival/recruitment bottlenecks during early life stages. PSD trends are not available for the Rock River at this time, but should be closely monitored, and consistent low or high values may warrant investigation.

Shovelnose sturgeon in the Rock River demonstrate these fish are in above-average or “robust” condition, and Wr values often exceed those described in other populations. Quist et al. [46] summarized Wr values from 32 populations and reported that the state of Montana, USA, had the highest Wr values, thus a target range of 95–105 should be used [65], and 80–90 for all other populations. The mean Wr (mean = 118, range = 62–186) for the Rock River population exceeded all target values set by Quist et al. [46]—even for what was recommended for Montana—and all other Wr values reported in the literature [33, 38, 52, 60–62]. The Rock River population would benefit from a system-specific calculation for Wr (see [46]). Additionally, our results contrast other studies where Wr often declined with increasing fish size [33, 38, 46, 52, 59], as Wr for Rock River

shovelnose sturgeon appeared to increase as length increased (Figure 4). While regional differences in  $W_r$  are expected to exist, we also acknowledge that the values presented in this study represent all individuals regardless of sampling year, season, spawning phase, or maturity status. Therefore, excessively low or high values may represent individuals that are in postspawn condition or peak spawning condition (see also [18, 33]). Future work should look to evaluate body condition metrics based on sex and spawning or maturity stage.

The Rock River has consistently produced state-record shovelnose sturgeon since 1988 and currently hosts the Illinois state record (year 2025) and third-largest shovelnose sturgeon (938 mm FL, 5874 g body weight) captured by rod and reel in the world (see Supporting Table S1). The current Indiana state record, world record (first), was caught in the Wabash River and weighed 6616 g (14 lb., 8 oz), but no length was provided [66]. The Montana state record, second-largest in the world, was captured in the Missouri River weighing 6407 g (14 lb., 2 oz) and was 100.9 cm long, although it was unclear if total length or FL was measured (Montana Fish, Wildlife and Parks). The state record from Iowa, USA, was captured in the Des Moines River in 1974 and weighed 5443 g (12 lb. 0 oz) and measured 83.8 cm [67] and has remained the record for over 50 years. Other notable angling catches of shovelnose sturgeon have been documented individuals reaching 6800–8165 g (15–18 lb.) and lengths up to 1090 mm (<https://fishing-worldrecords.com>), but we were unable to confirm these reports (Table S1).

This study provided numerous challenges in the field that required modification, improvements, and adaptive solutions (i.e., targeted sampling and seasonal gear selection), as well as continuously identified topics of new research (e.g., sex identification); therefore, our nonstandardized assessments may be viewed as limitations to our study design. However, the continued development of research and growing resolution in data has improved our knowledge of the Rock River and understanding of Shovelnose Sturgeon in this system, but the interpretation of our results should recognize these potential limitations. We were unable to determine sex for ~82% of shovelnose sturgeon collected during this study (see also [18, 33]). Fish sex was determined by visual confirmation of gametes (expression of milt [males] or egg extraction [females]). Male sex was confirmed during Spring of 2023 and 2024, as males freely express milt during presumed spawning time and peak sexual maturity (i.e., maturity stage M2). Females do not freely express gametes; therefore, many speculative females (i.e., large bellies) were classified as unknown sex prior to incorporating additional sex determination methodology. In Spring of 2024, we began to use an extraction device for oocytes [42], which aided in our confirmation of females and was not seasonally dependent. It is also important to consider that the overall population will consist of a mixture of male and females at various stages of maturity/gamete development at any given time, therefore our sex-based information should be viewed cautiously. For example, oocytes (eggs) were extracted from suspected females based on physical appearance (i.e., large soft bellies and/or swollen

red vents [33]), which often confirmed female sex through the presence of “black-egg” (stage F4/F5 [44]) gametes; however, if a female was in an alternate development stage (F1–F3), or postspawn, we would not have the ability to confirm sex in the field using this methodology. Similarly, males were only confirmed through the expression of milt during spring seasons (May/June), presumably for spawning. Nonreproductive males and unconfirmed females were classified as unknown sex. However, future research on this population seeks to identify sex-associated DNA markers, which would provide the ability to retroactively assign sex to undetermined individuals and provide clarity on sex ratios, sex-specific dynamics, and quantify future reproductive potential in the Rock River [68–71]. Additionally, catch rates presented in this manuscript should not be used for comparison of catch-per-unit-effort (CPUE) among other populations, or for gear efficiency, as the methods used during this study were not standardized nor was effort across time or gears (but see [72]). The eight unique gears used during this study were selected from other shovelnose sturgeon studies for their ability to successfully capture the species across a range of sizes and ontogenetic stages (i.e., larvae to adult life stages; see [35]) and should underscore our attempt to increase gear efficiency and reduce size-selective biases, while employing the multigear approach as suggested by Hupfeld [34]. Moreover, sampling occurred year-round, except for periods of ice cover during peak winter months, which should optimize our ability to capture all life stages and sizes. We also acknowledge that our sampling strategy largely focused on using SSS to help locate shovelnose sturgeon and optimize gear selection and position (i.e., targeted sampling), which may introduce inherent bias, but this strategy allowed us to make in situ changes based on environmental conditions and observations of fish behavior to improve catch rates. Considering the novel size of shovelnose sturgeon in the Rock River, we may also explore that our gears may be limiting the documentation of larger individuals (although unlikely), and the incorporation of larger mesh sizes (e.g., trammels nets and gill nets) may collect larger individuals not documented in this study.

The Rock River shovelnose sturgeon population is skewed toward large individuals and the apparent lack of fish < 500 mm (although not uncommon for the species), combined with a skewed size distribution, may warrant investigation into spawning dynamics, reproductive success, and recruitment patterns to better understand the stability of this population. Substantial effort was devoted to benthic trawling to target young-of-year and juvenile life stages [32, 34, 36, 73–75] during Spring and Summer of 2024, but these efforts were unsuccessful ( $N=313$  benthic trawls) despite sampling the appropriate seasonal timeframe [32, 76, 77]. Lack of young-of-year may be due to the difficulty capturing this life stage [33, 34, 36], or this life stage may occupy microhabitats that have not yet been identified in the Rock River (see [73, 74]). Another possibility may be that some proportion of newly hatched, free-drifting larvae may rapidly drift downstream and over the Steel Dam in Milan, Illinois, and out of our study reach (see Figure 1). Our study section of the Rock River is ~154 river kilometers and

larval shovelnose sturgeon may drift 94–250 km [78], depending on water velocities. During Spring 2024 sampling, we had expected to locate spawning shovelnose sturgeon using SSS (see [79, 80]), which would have provided a starting point for various early life history examinations, including larval production/drift, but no spawning was observed and spawning locations remain unknown. Without identifying a spawning location, it becomes increasingly challenging to prioritize sections of river to target early life stage surveys.

To help guide management recommendations and further our understanding of this unique population of shovelnose sturgeon in the Rock River, additional studies are ongoing and in development. Using acoustic telemetry, we seek to monitor adult movements throughout the Rock River to understand immigration and emigration rates through the Milan and Sterling Dams, as well as examine seasonal behaviors and habitat use, and help identify spawning locations within the Rock River. Additionally, future studies will use advanced age estimation methodologies (e.g., bomb radiocarbon techniques [81]) to describe the age structure of the Rock River population. Continued mark and recapture efforts, evaluation of gear efficacy, and application of spatial and temporal trends in catch rates will aid the development of long-term monitoring (see [18]) and standardized sampling protocols to help describe changes in population structure and describe the sustainability of this population. Environmental factors (e.g., water temperatures, food availability, and prey selection) play a role in fish growth and maximum size projections [82], and we seek to explore food web/trophic dynamics (see [83]) in the Rock River to better understand these relationships. It is likely that this trophy-class population of shovelnose sturgeon in the Rock River, Illinois, exists largely due to the lack of exploitation; however, this population may be vulnerable to changes in population structure without proper conservation and management regulation (see [84, 85]).

Currently, the Rock River does not have regulations in place for the recreational angling and harvest of shovelnose sturgeon. The long-term goals of this study, and future studies, are to provide data to inform management to protect and conserve this population. While additional information will help describe trends in recruitment and sustainability for this population, we have several important observations that may serve as the first step toward management action. First, seasonal behaviors of shovelnose sturgeon are apparent in the Rock River and increase their vulnerability to harvest. For example, 77% of all captures reported in this study occurred during the Winter and Spring seasons and increase to 98% when adding Fall to this assessment. During these seasons (Fall, Winter, and Spring), we observe shovelnose sturgeon congregating in large groups (exceeding 2000 individuals; S. Tucker, unpublished data) in relatively discrete areas (investigation current and ongoing). The congregating behavior of shovelnose sturgeon during these months may increase vulnerability to angling and excessive harvest, or targeted sex-specific harvest (females), resulting in negative impacts toward future spawning and recruitment cycles. A proactive recommendation for management

regulation may be to consider seasonal protections during times of increased vulnerability (e.g., Fall, Winter, and Spring) by promoting a catch-and-release-only fishery; however, the data collected in this study and in the future will be provided to the agencies responsible for protective management actions. Additionally, the technologies used in recreational fishing (i.e., fish finders and sonars) are constantly improving and the use of more advanced technology (i.e., SSS and live-imaging systems) is becoming standard equipment for recreational anglers. Advanced technologies provide anglers with the ability to locate and identify target species—potentially increasing harvest rates—but the impacts on fish populations as a result of advanced technologies are not well understood (especially for shovelnose sturgeon), but we would assume using these technologies would increase angler success (see also [86–89]). Notably, the use of SSS was a key component to our methodology and certainly aided our ability to locate shovelnose sturgeon and strategically position gears to optimally increase catch rates. It is reasonable to assume that this technology would also improve recreational catch rates, especially during times of shovelnose sturgeon congregation. It may be nearly impossible to regulate the use of these technologies on this system, but their utility in fishing strategy must be considered. Lastly, while this shovelnose sturgeon population is currently described as an unpopular (or merely unknown) recreational fishery, there is growing popularity and attention from regional anglers, as well as the rapid distribution of knowledge through various media outlets (i.e., social media platforms and news articles) that continue to highlight this population. Future studies targeting the knowledge gaps described above will improve our understanding of population dynamics in the Rock River and facilitate the development of appropriate management actions that will ensure the sustainability of this species and its fishery.

## Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

## Disclosure

The findings and conclusions in this article are those of the authors and do not necessarily represent the views of the funding source.

## Conflicts of Interest

The authors declare no conflicts of interest.

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## Supporting Information

Additional supporting information can be found online in the Supporting Information section. (*Supporting Information*)

Table S1: List of state record and world record size shovelnose sturgeon as of 2025. A single asterisk (\*) represents the current world record, two asterisks (\*\*) represent the present study, and an “–” represents that the State, Rank, or Year were not available.

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