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Abstract

The Shovelnose Sturgeon *Scaphirhynchus platorynchus* remains the most abundant riverine sturgeon species in North American despite the anthropogenic modifications that have occurred throughout their historic range; however, their populations have declined throughout Nebraska since the construction of Fort Randall and Gavins Point Dams. Therefore, the objective of this study was to present the current status of Shovelnose Sturgeon in the Missouri River along Nebraska's border. Data was acquired from 2003 to 2012 from all reaches of the Missouri River along Nebraska's eastern border. Catch rates of Shovelnose Sturgeon increased in a downstream trend and were highest in the reach below the Missouri and Platte River confluence. Based on gill net samples which collected the majority (39%) of Shovelnose Sturgeon, annual catch per unit efforts indicate a declining population above Gavins Point Dam and a stable population below in the open Missouri River. The length frequency distributions of Shovelnose Sturgeon collected were similar across all reaches with the exception of those captured between Fort Randall and the headwaters of Lewis and Clark Lake which were significantly larger than fish captured below the Platte River confluence. Although no age-0 Shovelnose Sturgeon were captured in the unchannelized reaches, age-0 abundance increased in a downstream trend throughout the channelized reaches. Preferred-sized fish (510-640 mm, N = 53,741) were the most common size category of Shovelnose Sturgeon captured throughout all reaches and across all years followed by quality-sized (380-510 mm, N = 12,089) and memorable-sized (640-810 mm, N = 4,569) fish. Our data concludes the overall population of Shovelnose Sturgeon above Gavins Point Dam appears to be slightly declining while the population in the open, lower river appears to be stable.

Key words: Missouri River, Shovelnose Sturgeon, *Scaphirhynchus*, Status

Introduction

Shovelnose Sturgeon *Scaphirhynchus platorynchus* populations have declined throughout North America but remain the most abundant riverine sturgeon species (Keenlyne 1997, Mayden and Kuhajda 1997, Pflieger 1997). Large-scale habitat alterations (i.e., dam construction, channelization, and bank stabilization) fragmented habitats and migration pathways, reduced spawning habitat, and altered the historic flow regime which contributed to sturgeon population declines. Additionally, commercial exploitation negatively affected the populations, especially as Shovelnose Sturgeon were once considered a nuisance species to commercial fishermen and were destroyed when caught (Coker 1930). Furthermore, the increased demand for a local caviar source has added pressure to North American sturgeon populations as global declines of *Acipenseriformes* continue (Birstein *et al.* 1997). However, due to life history characteristics (i.e., earlier maturation and fast growth rates, Pikitch *et al.* 2005) Shovelnose Sturgeon appear less vulnerable to population declines witnessed among other sturgeon species (Morrow *et al.* 1998).

Shovelnose Sturgeon is the smallest and widest-ranging freshwater sturgeon in North American (Keenlyne 1997, Figure 1). Indigenous to the Missouri and Mississippi River basins, Shovelnose Sturgeon evolved in these large river systems (Bailey and Cross 1954). Shovelnose Sturgeon is a benthic fish species that inhabits areas with swift current and sand and gravel substrate (Carlson *et al.* 1985). Shovelnose Sturgeon can attain weights of 6.8 kg in their northern range; however, they rarely exceed 2.0 kg with the majority of fish collected weighing less than 1.0 kg from the Missouri River along Nebraska's eastern border (K. Steffensen, unpublished data).

Shovelnose Sturgeon historically inhabited 24 states (Keenlyne 1997). A recent survey by Koch and Quist (2010) found Shovelnose Sturgeon were extirpated in four states (AL, NM, PA, and WV), declining in one (KS), stable in nine states (AR, IA, IL, MO, MS, MT, ND, NE, and OK), increasing in two states (LA and WY) and with an unknown population status in eight states (IN, KY, MN, OH, SD, TN, TX, WI). The two states with increasing populations included: Wyoming, which implemented an artificial supplementation program and Louisiana, which recently closed commercial fishing. Currently, the Shovelnose Sturgeon is listed as a federally threatened species under the similarity of appearance provisions of the Endangered Species Act of 1973 (U.S. Fish and Wildlife Service 2010). This provision was enacted to protect the endangered Pallid Sturgeon *S. albus* and is enforced in rivers where the pallid

Figure 1. Shovelnose Sturgeon. Image copyright of Joseph R. Tomelleri.

and Shovelnose Sturgeon co-exist. This ruling did not eliminate range-wide commercial fishing for Shovelnose Sturgeon but does provide protection throughout the lower Missouri River and middle and lower Mississippi River. Nebraska ceased commercial fishing for Shovelnose Sturgeon in 1956 when sturgeon and paddlefish were reclassified as game fish (Omaha World Herald 1955). At the time, commercial harvest of Shovelnose Sturgeon was minimal and estimated at only 563 kg (1,242 lbs.) per year. Recreational angling for Shovelnose Sturgeon is allowed throughout Nebraska except on the Missouri River upstream of the Big Sioux River (rkm 1,181.3). Currently, there is no size limit and a 10 fish per day bag limit.

The historic change in Nebraska's Shovelnose Sturgeon population is difficult to document as limited, sporadic sampling occurred and sampling methodologies were not consistent. Prior to the construction of Fort Randall and Gavins Point Dams, Johnson (1942) described Shovelnose Sturgeon as common throughout the Missouri River. Sprague (1960) documented that the catch and condition of Shovelnose Sturgeon declined over a 5-year period after the construction of Gavins Point Dam. Subsequently, Held (1969) noted that the distribution of Shovelnose Sturgeon has been limited by the construction of the Missouri River mainstem reservoirs. Schmulbach, Gould and Groen (1975) classified the Shovelnose Sturgeon population in the river below Gavins Point Dam as abundant (46.5% of the total catch) in the unchannelized reach compared to the channelized reach where the species was uncommon (0.3%). Carlson *et al.* (1985) sampled six sites in the lower Missouri River, including one site near Brownsville, NE (rkm 859.4) and captured 481 Shovelnose Sturgeon. However, the amount of effort was not reported, but the Brownville site had the second highest occurrence of Shovelnose Sturgeon in the lower Missouri River. The Benthic Fish Study (Berry, Wildhaber and Galat 2004) sampled four reaches along the Nebraska border from 1996-1998 using a suite of five gears. Shovelnose Sturgeon were collected in all four reaches with the greatest number (N = 103) collected in the channelized reach between the Big Sioux (rkm 1,190.7) and Little Sioux (rkm 1,076.7) rivers. Shovelnose Sturgeon comprised less than one percent of the species composition in the reaches from Fort Randall Dam (rkm 1,415.9) to the headwaters of Lewis and Clark Lake (1,343.5) and from Gavins Point Dam (rkm 1303.3) to Ponca, NE (rkm 1,211.6). Relative abundance increased in the channelized reaches, where Shovelnose Sturgeon comprised 4.9% of the catch in the Big Sioux to Little Sioux rivers reach and 1.5% of the catch in the Platte (rkm 958.2) to the Nishnabotna rivers (rkm 872.1) reach. Hesse, Mestl and Robison (1993) noted that Shovelnose Sturgeon populations were declining throughout Nebraska's portion of the Missouri River. Therefore, the objective of this paper is to evaluate the current population status of Shovelnose Sturgeon in the Missouri River along Nebraska's border by comparing annual catch rates and their size structure.

Materials and methods

Study area

For this analysis, the Missouri River along Nebraska's border was divided into 5 reaches, four riverine reaches and one reservoir, based on physical and morphological characteristics (Figure 2). The upper unchannelized reach begins at the Nebraska/South Dakota border (rkm 1,411.0) and continues downstream to the headwaters of Lewis and Clark Lake (rkm 1,331.7). Fort Randall Dam is 5.0 rkm upstream of the state border between South Dakota and Nebraska and highly influences this reach through hypolimnetic and power peaking discharges (Hesse and Mestl 1993a). Water management practices have altered the natural hydrograph and temperature regime, reduced turbidity, and degraded the channel upstream of the Niobrara River (Hesse and Mestl 1993b). The Niobrara and Missouri river confluence is located at rkm 1,358.0. Resembling the unaltered river before development, the Missouri River downstream of the Niobrara River confluence has formed a large braided delta extending into the former headwaters of Lewis and Clark Lake. The effects of the hypolimnetic releases from Fort Randall are reduced by Niobrara River outflows, with increased water temperature, turbidity and bed load.

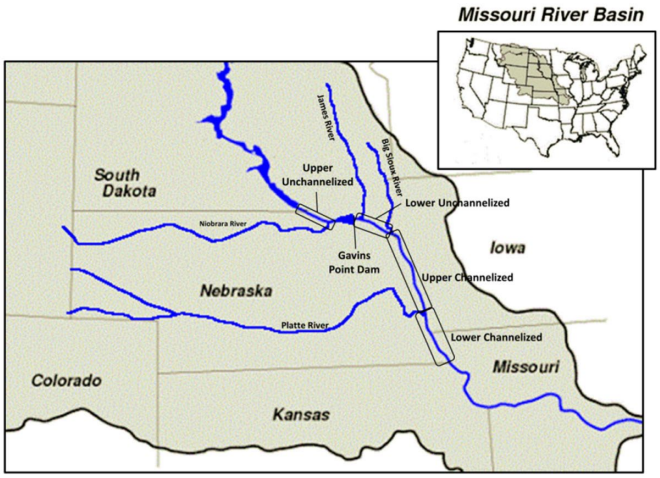

Figure 2. Map of the Missouri River basin. The four study reaches along Nebraska's eastern border are indicated within the rectangles.

Gavins Point Dam (rkm 1,305.2) impounds the Missouri River forming Lewis and Clark Lake which is the smallest and most downstream main-stem Missouri River reservoir. The main purpose of Gavins Point Dam is to stabilize the irregular discharges from Fort Randall Dam to support navigation on the lower Missouri River (Hesse and Mestl 1993a). The lower unchannelized reach begins at Gavins Point Dam and continues downstream to approximately Ponca, NE (rkm 1,211.8) where channelization begins. Like the upper unchannelized reach, this reach also experiences channel bed degradation, hydrograph alterations, and reduced turbidity levels; however, water temperatures are less affected (Heese and Mestl 1993b).

Downstream of the lower unchannelized reach is a 29.5 rkm reach where channelization begins by "training" the river through a series of bends and dike structures. This reach more closely resembles the channelized reach; therefore, capture data is included with the upper channelized reach. The channelized portion of the Missouri River starts upstream of Sioux City, IA (rkm 1,182.4) and continues to the confluence with the Mississippi River (rkm 0.0) and includes 394.0 rkm along Nebraska's eastern border. Along the Nebraska border, this channelized section was divided into two reaches by the Platte River (rkm 957.6); the upper channelized reach (Ponca, NE to the Platte River confluence) and lower channelized reach (Platte River confluence to the Nebraska/Kansas state line [rkm 788.4]). The upper channelized reach has a highly degraded channel; however, tributary (i.e., Big Sioux River and Little Sioux River) impacts increase turbidity levels. The lower channelized river has an aggrading channel due to the influence of the Platte River and floods more frequently. Seasonally, the Platte River can highly influence the tributary, temperature and hydrograph on the lower channelized reach. Channel morphology in the channelized reaches consists of a series of dike structures on the inside bends and revetment on the outside bends and is limited to a few habitats types.

Data collection

Data were acquired from three Field Offices associated with the U.S. Army Corps of Engineers (USACE) funded Pallid Sturgeon Population Assessment (PSPA) Project. USACE formed a long-term monitoring and assessment project in response to the 2000 Missouri River Biological Opinion (Bi-Op, USFWS 2000) and the 2003 Amendment (USFWS 2003). Sampling was initiated in 2003 in the upper unchannelized and lower channelized reaches with full implementation along Nebraska's eastern border in 2005. The U.S. Fish and Wildlife Service (USFWS) Great Plains Fish and Wildlife Conservation Office sampled the upper unchannelized reach while South Dakota Department of Game, Fish and Parks (SDGFP) sampled the lower unchannelized reach. Nebraska Game and Parks Commission (NGPC) sampled the two channelized reaches. The PSPA Project operates under a stratified random design in which the reaches are the strata and the experimental unit (i.e., river bends) are annually randomly selected (Welker and Drobish 2012a). Twenty-five percent of the bends per segment were randomly selected and sampled with a suite of standard gears. Standard gears were deployed annually throughout all reaches in the available habitats. Sampling efforts began in late-February into early-March when ice flows subside and continue through late-November. Sampling was limited throughout all reaches in 2011 due to the record inflows in the upper Missouri River basin which subsequently resulted in record discharges from the Missouri River mainstem dams (Steffensen, Eder and Pegg 2014).

Shovelnose Sturgeon were collected following the standard operating procedures developed for the PSPA Project using a variety of gears (Welker and Drobish 2012a, Welker and Drobish 2012b). Gears used (annually) to monitor the Shovelnose Sturgeon population trends included: gill nets, trot lines, otter trawls, and trammel nets. Benthic static gill nets and trot lines were fished overnight for a maximum set time of 24 hours. Catch per unit effort (CPUE) for gill nets were measure by fish per net night and fish per 20 hook nights for trot lines. Benthic 4.9 m otter trawls were actively towed downstream while 1.0" mesh trammel nets were drifted in the river's current. Catch per unit effort for otter trawls were measured by fish per 100 m trawled and fish per 100 m drifted for trammel nets. All Shovelnose Sturgeon sampled were measured to the near-

est millimeter fork length and weighed to the nearest gram. See Welker and Drobish (2012a, 2012b) for sampling gear specifics.

Catch per unit effort was calculated for each gear deployment then averaged to get an annual CPUE and a measure of variance. Annual CPUE's were calculated for the standard gears (i.e., gill nets, trot lines, otter trawls, and trammel nets) used in the PSPA Project and a gear trend (i.e., increasing, decreasing, or stable) was assigned based on the slope of a linear regression (PROC REG in SAS 9.2) line and if the slope was significantly different ($\alpha = 0.05$) than a zero slope. Population trends were then based on annual catch rate change amongst the suite of gear but also accounted for recruitment and the size distribution within each reach. Size distributions were compared using the Kolmogorov-Smirnov test (PROC NPAR1WAY in SAS 9.2). The population's size structure was compared spatially and temporally using the incremental proportional size distribution (PSD) indices (Guy *et al.* 2007) and the condition factor of relative weight (W_r, Quist, Guy and Braaten 1998).

Results

Over 71,000 Shovelnose Sturgeon were captured from the Missouri River along Nebraska's eastern border since sampling began in 2003 under the PSPA Project. Catch per unit effort (CPUE) of Shovelnose Sturgeon increased in a downstream trend with all gears (Figure 3). Shovelnose Sturgeon were most frequently captured in the lower channelized reach (N = 40,091)

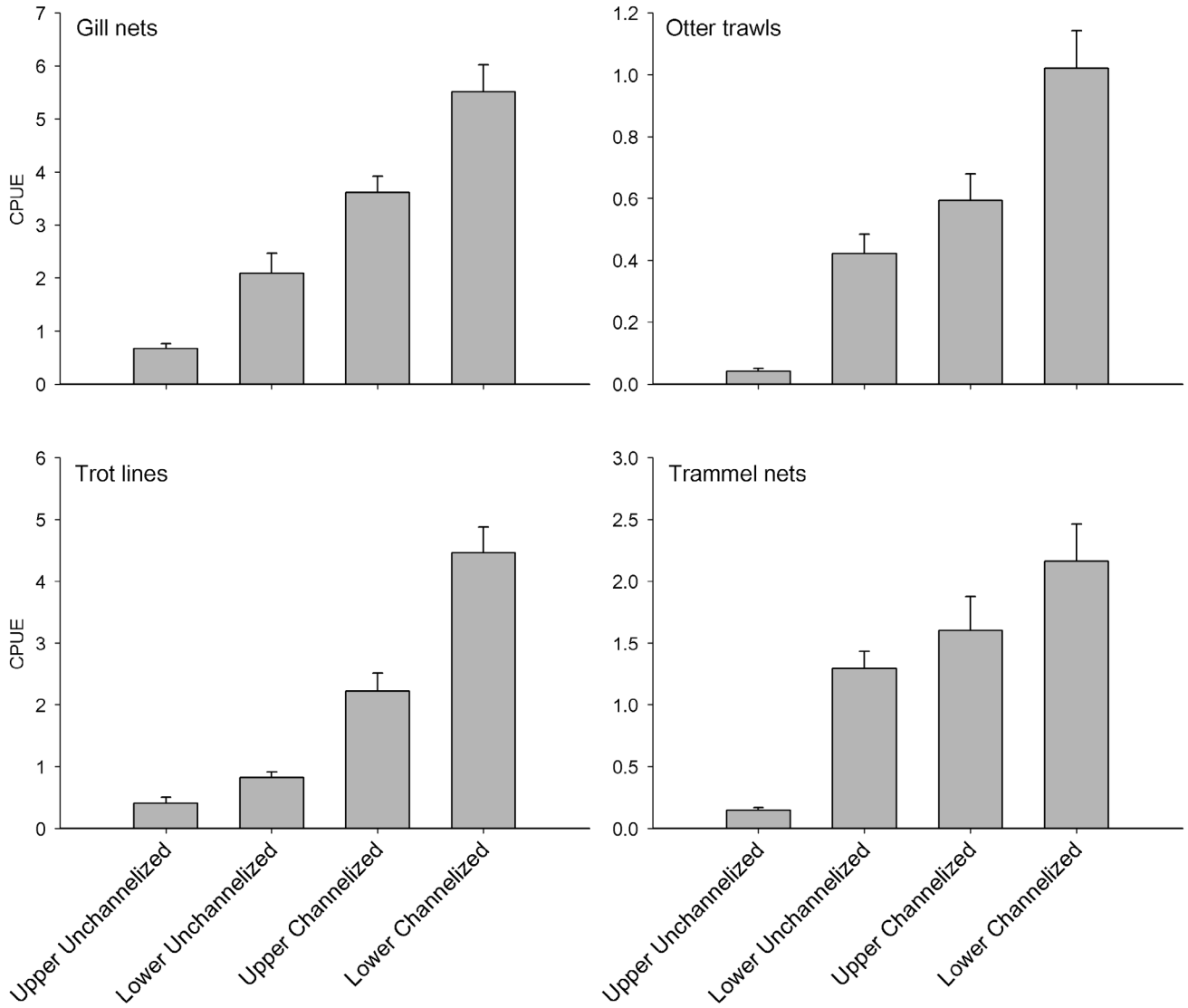

Figure 3. Mean catch per unit effort (± 2 SE) of Shovelnose Sturgeon by reach in the Missouri River along Nebraska's eastern border from 2003-2012. Note that the y-axis scales are different for each graph.

Table 1. Mean catch per unit effort, gear trend (+ = positive, - = negative, empty = no change) and overall reach population status (I = Increasing, D = Decreasing, S = Stable) for Shovelnose Sturgeon collected by reach in the Missouri River from 2003–2012. N/S indicates no sampling occurred.

Reach	Gear	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Trend	Status
Upper Unchannelized	GN	0.36	0.26	0.46	0.79	1.22	0.67	0.98	0.48	0.23	0.38		D
	TN	0.16	0.09	0.14	0.09	0.17	0.37	0.11	0.10	0.07*	0.11		
	OT	n/s	n/s	0.05	0.07	0.05	0.04	0.03	0.02	n/s	0.03	-	
	TL	n/s	n/s	n/s	n/s	n/s	n/s	0.59	0.60	0.25	0.18		
Lower Unchannelized	GN	n/s	n/s	1.06	1.08	3.06	2.09	3.01	1.94	0.75	2.07		S
	TN	n/s	n/s	1.74	1.27	1.59	1.50	1.15	0.96	n/s	0.87	-	
	OT	n/s	n/s	0.41	0.54	0.44	0.86	0.28	0.17	n/s	0.33		
	TL	n/s	n/s	n/s	n/s	n/s	n/s	1.35	0.88	1.02	0.56		
Upper channelized	GN	n/s	n/s	2.12	2.51	3.66	4.33	2.55	4.20	4.77	4.68	+	S
	TN	n/s	n/s	1.26	0.77	2.07	1.94	1.76	1.82	n/s	1.89		
	OT	n/s	n/s	0.39	0.60	0.47	0.66	0.48	0.92	n/s	0.73		
	TL	n/s	n/s	n/s	n/s	n/s	n/s	1.54	3.21	2.46	1.38		
Lower channelized	GN	10.55	4.84	4.36	4.88	5.11	6.20	6.06	5.87	4.29	5.88		S
	TN	0.81	1.80	1.99	1.82	2.63	1.86	2.21	2.43	n/s	3.95		
	OT	0.82	0.87	0.61	0.76	1.34	1.19	1.03	1.71	n/s	1.09	+	
	TL	n/s	n/s	n/s	n/s	n/s	n/s	3.37	6.48	4.51	2.70		

*: Incomplete sampling due to flooding conditions

followed by the upper channelized reach (N = 18,367) and the lower unchannelized reach (N = 10,693). In the upper unchannelized reach, Shovelnose Sturgeon were most frequently captured in gill nets (N = 1,172) and trammel nets (N = 737). Catch per unit effort with gill nets peaked in 2007 with approximately double the long-term mean (overall CPUE = 0.66 fish per net night, Table 1, Figure 4). Catch rates in the upper unchannelized reach are stable for all gears except otter trawls catch rates are significantly declining (t = 2.67, P = 0.0441). Similarly in the lower unchannelized, Shovelnose Sturgeon were most frequently captured in gill nets (N = 3,350) and trammel nets (N = 3,333) and catch rates with gill nets peaked in 2007. The 2007 catch rate was approximately fifty percent above the long-term mean (CPUE = 2.09 fish per net night). Catch rates in the lower unchannelized reach are stable for all gears expect trammel nets catch rates are significantly declining (t = 3.19, P = 0.0242). In the upper channelized reach, gill nets (N = 9,322) captured the majority of Shovelnose Sturgeon and catch rates are significantly increasing (t = 3.23, P = 0.0179) followed by trot lines (N = 3,938) and trammel nets (3,274). Catch rates with gill nets have increased annually the past three years; however, trot lines catch rates are declining. Lastly in the lower channelized reach, trot lines (N = 18,231) collected the majority of Shovelnose Sturgeon followed by gill nets (N = 13,858). Trot line catch rates have declined since 2010. The long-term annual CPUE (5.51 fish per net night) with gill nets is similar to the CPUE observed from 2004 to 2012. Catch rates in the lower channelized reach are stable for all gears expect otter trawl catch rates are significantly increasing (t = 2.75, P = 0.0249). The overall population of Shovelnose Sturgeon in the unchannelized reaches appears stable.

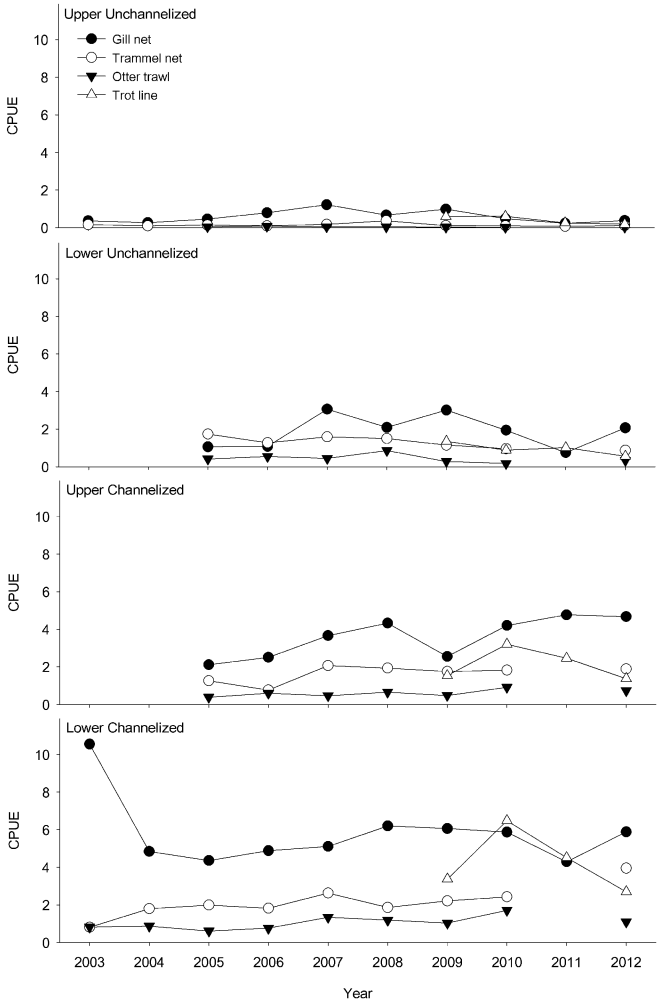

Figure 4. Annual catch per unit effort for Shovelnose Sturgeon by reach in the Missouri River along Nebraska's eastern border from 2003-2012.

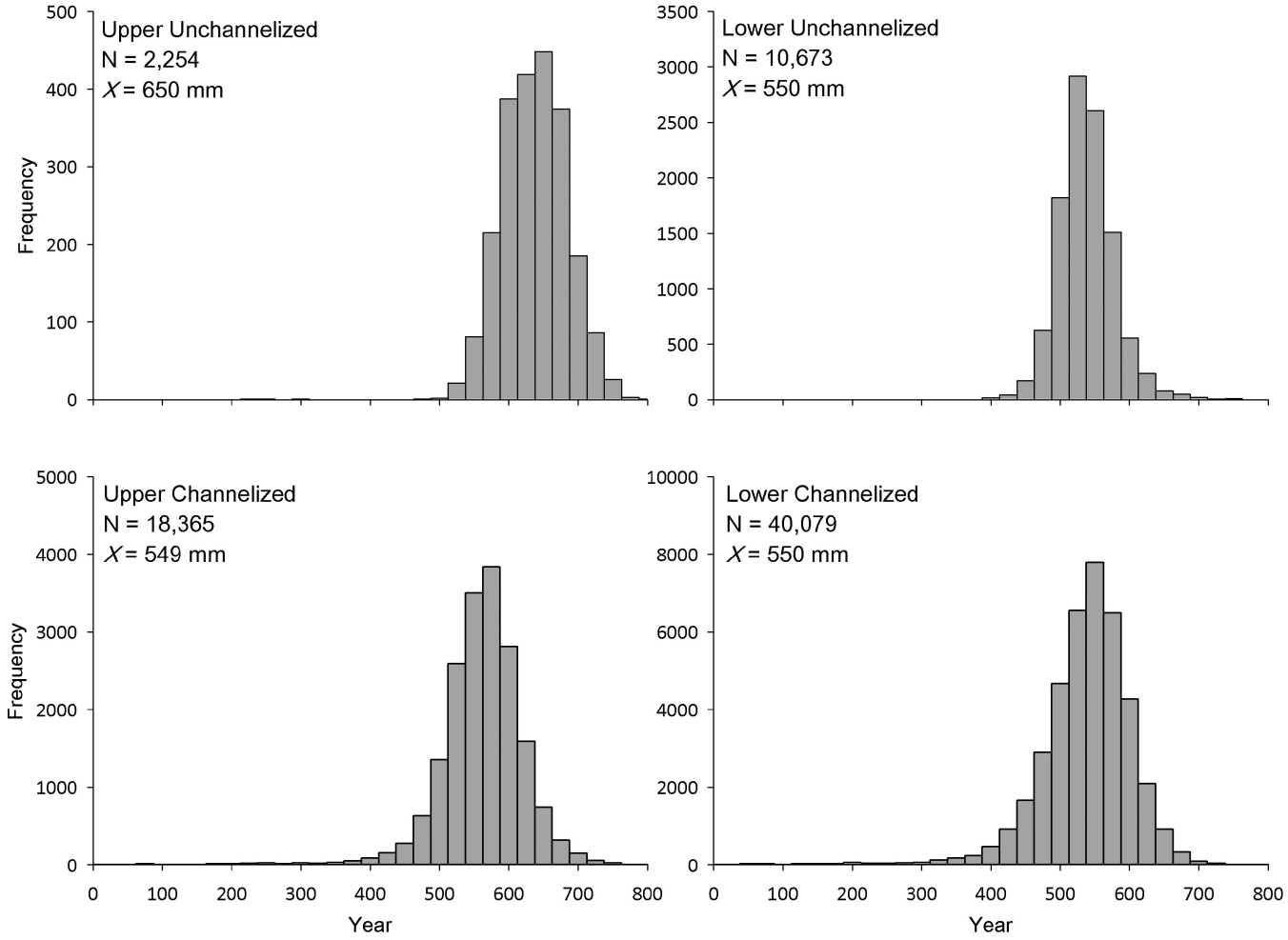

Figure 5. Length-frequency of Shovelnose Sturgeon captured in the Missouri River along Nebraska's eastern border from 2003-2012 by reach. Note that the y-axis scales are different for each graph.

The length frequency distributions of Shovelnose Sturgeon were similar across all reaches except where those captured in the upper unchannelized reach were significantly larger than fish captured in the lower channelized reach (KS_a = 1.97, P = 0.0008, Figure 5). The mean length of Shovelnose Sturgeon in the upper unchannelized was 650 mm (SD = 48 mm) compared to an overall mean of 550 mm (SD = 62) in the lower three reaches of the open Missouri River.

Age-0 Shovelnose Sturgeon were not collected in either unchannelized reach. Age-0 capture frequency increased in a downstream trend throughout the channelized reaches with similar sampling efforts throughout reaches. A total of 49 age-0 Shovelnose Sturgeon were captured in the upper channelized reach compared to 115 in the lower channelized reach. The northernmost capture of an age-0 Shovelnose Sturgeon was at rkm 1,130.1 near Macy, Nebraska, which is 175.1 rkm below Gavins Point Dam. However, most age-0 Shovelnose Sturgeon (N = 44) captured in the upper channelized reach were captured in the lower 36.2 rkm, while age-0 sturgeon were collected throughout the entire lower channelized reach. Age-0 Shovelnose Sturgeon were captured from June through November. The majority were captured in September (N = 62) followed by July (N = 49) and August (N = 22). Some Shovelnose Sturgeon are exhibiting a protracted spawning behavior as a few small, age-0 fish are being captured in August and September (Figure 6).

Preferred-sized Shovelnose Sturgeon (510-640 mm, N = 53,741) were the most common size group captured throughout all reach and across all years (Table 2), followed by quality-sized (380-510 mm, N = 12,089) and memorable-sized (640-810 mm, N = 4,569) fish. Overall, 59% of Shovelnose Sturgeon captured in the upper unchannelized reach were memorable-sized whereas only 5% were memorable-size in the lower three reaches. Conversely, 85% in the lower unchannelized, 77% in the

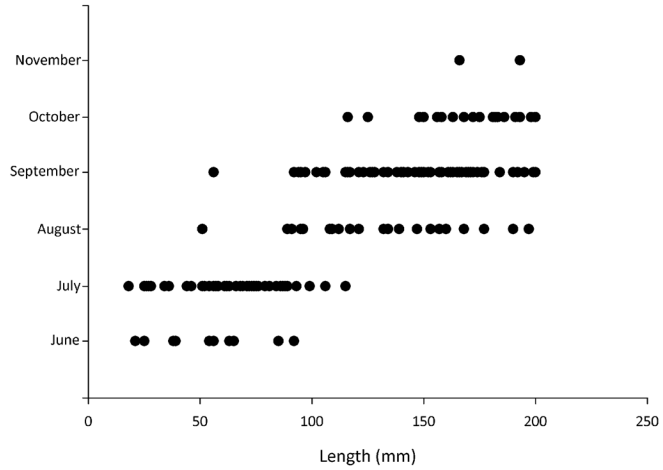

Figure 6. Length-at-capture by month for all age-0 Shovelnose Sturgeon in the Missouri River along Nebraska's eastern border from 2003-2012.

upper channelized, and 74% in the lower channelized were preferred-sized Shovelnose Sturgeon. Sub-stock (≤ 250 mm, N = 343) and stock-sized (250-380 mm, N = 622, < 1%) fishes were sampled infrequently as were trophy-sized (≥ 810 mm, N = 8, < 1%) fish.

Differences in mean relative weight (W_r) for stock and quality-sized Shovelnose Sturgeon were highly variable between reaches. Preferred and memorable-sized Shovelnose Sturgeon varied spatially and temporally (Figure 7). Average W_r for preferred-sized fish was highest in the upper channelized reach (W_r = 100) followed by the lower channelized (W_r = 88) and upper channelized (W_r = 86) reaches. Memorable-sized fish followed the similar trend with the upper unchannelized reach having the highest W_r. Relative weight for quality, preferred, and memorable-sized fish has increased the past four years in all reaches, except in the lower unchannelized reach where W_r declined in 2012.

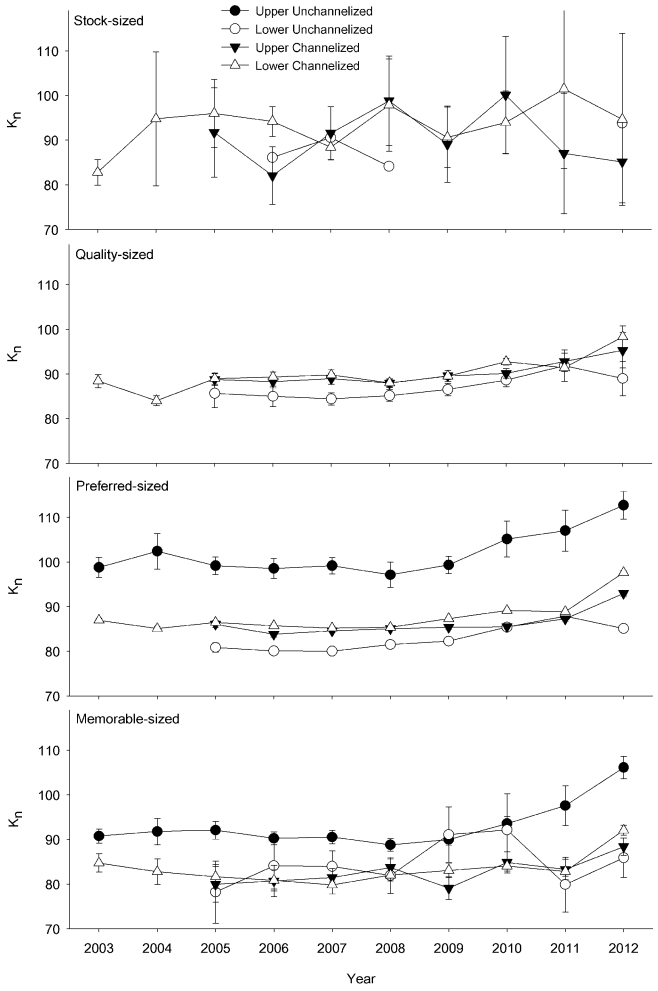

Figure 7. Relative weight (W_r) for (A) stock-sized, (B) quality-sized, (C) preferred-sized, and (D) memorable-sized Shovelnose Sturgeon by reach in the Missouri River along Nebraska's eastern border from 2003-2012. W_r was calculated using the equation in Quist, Guy and Braaten (1998).

Discussion

The Shovelnose Sturgeon population appears to be stable throughout the lower Missouri River but maybe declining in the upper unchannelized reach. The lowest occurrence of Shovelnose Sturgeon occurred in the upper unchannelized reach and this population is predominantly large adult sized fish in average to above average condition. Fort Randall Dam was completed in 1956 and Gavins Point Dam was closed in 1955, thus eliminating the potential for upstream movement and reducing the potential for downstream immigration. However, it is unlikely that the current population is a sole remnant of pre-dam construction. Due to the presence of a diversity of ages, some level of recruitment into the adult population must be occurring. The Niobrara River flows into this reach and may provide a suitable spawning area. The lower three reaches are a portion of the open lower Missouri River which flows 1,305 rkm to the confluence with the Mississippi. Annual reproduction of Shovelnose Sturgeon occurs in the lower Missouri River with the abundance of age-0 Shovelnose Sturgeon increasing downstream along the lower river (Huenemann and Steffensen 2013, Steffensen and Huenemann 2013). Braaten *et al.* (2008) indicated the drift distance of larval Shovelnose Sturgeon varied from 94 to 250 rkm, depending on water velocities. Therefore, larval Shovelnose Sturgeon hatched in the lower unchannelized reach would drift into the channelized reach explaining the lack of age-0 fish collected in the lower unchannelized. Also for Shovelnose Sturgeon that spawn in the Platte River, their progeny would likely drift downstream of the Nebraska's border of the Missouri River, if their drift distance approached the maxi-

Table 2. Percent incremental proportional size density (PSD) for Shovelnose Sturgeon collected by reach in the Missouri River from 2003-2012.

Reach	Year	Stock (250 - 380 mm)	Quality (380 - 510 mm)	Preferred (510 - 640 mm)	Memorable (640 - 810 mm)	Trophy (≥ 810 mm)
Upper Unchannelized	2003	0	0	38	62	0
	2004	1	0	54	45	0
	2005	0	0	45	55	0
	2006	0	0	43	57	0
	2007	0	0	47	53	0
	2008	0	0	38	62	0
	2009	0	0	38	62	0
	2010	1	0	29	69	1
	2011	0	0	46	54	0
	2012	0	0	30	70	0
Lower Unchannelized	2005	0	13	84	3	0
	2006	0	12	85	3	0
	2007	0	14	83	3	0
	2008	0	14	84	2	0
	2009	0	12	86	2	0
	2010	0	12	87	1	0
	2011	0	11	83	6	0
	2012	0	7	89	4	0
Upper Channelized	2005	1	20	76	3	0
	2006	2	22	73	3	0
	2007	2	22	72	4	0
	2008	0	21	75	4	0
	2009	1	18	77	4	0
	2010	1	19	77	3	0
	2011	0	14	81	5	0
	2012	0	5	86	9	0
Lower Channelized	2003	3	18	73	6	0
	2004	1	22	73	4	0
	2005	1	24	71	4	0
	2006	5	22	70	3	0
	2007	4	26	67	3	0
	2008	1	21	73	5	0
	2009	1	23	72	4	0
	2010	0	21	74	5	0
	2011	0	14	80	6	0
	2012	0	5	83	12	0

mum values reported. However, length frequency histograms for the channelized reaches indicate Shovelnose Sturgeon are present or may return as juveniles.

Gill nets catch rates of Shovelnose Sturgeon continue to increase throughout the lower Missouri River below the Nebraska state line (Figure 8), except for the reach immediately below the state line to the Kansas River. The Platte River to Kansas River is the longest section between major tributaries. The Platte River influences the upper part of this section where catch rates are 1.5 fish per net night higher than the reach between the Nebraska/Kansas state line and the Kansas River. Catch rates below the Grand River (rkm 402.3) are approximately two fish per net night greater than Nebraska's most productive reach (i.e., lower channelized reach) and almost twelve times higher than Nebraska's least productive reach (i.e., upper unchannelized reach).

In addition to the mainstem Missouri River, two tributaries in Nebraska support Shovelnose Sturgeon populations (i.e., the Platte River and to a lesser extent the Niobrara River). Historically, Shovelnose Sturgeon inhabited the Platte River to Casper, WY (Baxter and Stone 1995). Their historic range in the Niobrara River is unknown. Spencer Dam (rkm 63.3) was constructed on the Niobrara River in 1927 and impedes all upstream migrations eliminating 129 km of riverine habitat. Wanner *et al.* (2010) studied the lower Niobrara River and captured Shovelnose Sturgeon (N = 17) throughout the

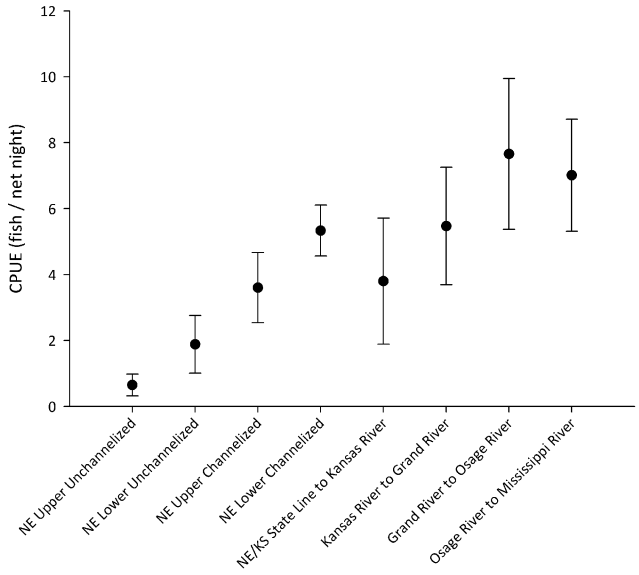

Figure 8. Mean gill net catch per unit effort (±2SE) of Shovelnose Sturgeon by reach for the middle and lower Missouri River. Reaches are divided by influences of major tributaries except where the Nebraska/Kansas state line bisects the reach between the Platte and Kansas rivers.

lower 63 rkm below Spencer Dam. However, no larval or juvenile Shovelnose Sturgeon were captured, which is representative of the population throughout the upper unchannelized reach (Shuman and Klumb 2013).

The Platte River has been more intensively studied. Peters and Parham (2008) sampled the sturgeon populations in the lower Platte River (confluence of the Platte and Loup rivers [rkm 162.0] to the confluence with the Missouri River [rkm 0.0]) from 2000 through 2004 followed by Hamel and Pegg (2012) from 2009 to 2012. Peters and Parham (2008) collected Shovelnose Sturgeon throughout the lower Platte River and estimated the lower Platte River population at 23,000 to 69,000 fish based on an area-density expansion method. Hamel and Pegg (2013) found a similar distribution of Shovelnose Sturgeon with the majority collected in the lower 52.8 rkm below the confluence of the Elkhorn River. Finally, Hamel and Pegg (2013) recaptured several Shovelnose Sturgeon marked (i.e., floy tagged) in the Missouri River, documenting inter-river movements. The Platte River provides suitable spawning areas for migrating adults, as *Scaphirhynchus* reproduction has been documented (Reade 2000, G. Mestl, NGPC, pers. comm.).

Generally, Shovelnose Sturgeon spawn in the spring when water temperatures are between 15.5-20.5°C (Carlson and Pflieger 1981). However, the occurrence of small (< 50 mm) age-0 fish collected in September and October indicates some Shovelnose Sturgeon exhibit protracted spawning in August and September. Rugg (2013) noted reproductively ready female Shovelnose Sturgeon in the lower Platte River appeared to be exhibiting a bimodal spawn. Based on our capture data, the secondary (i.e., fall) spawn is less predominate. However, Rugg (2013) also noted that the proportion of reproductively ready males and females in the population was similar in April and May compared to September and October. Based on the lack of age-0 shovelnose of a size indicating fall spawning, we speculate that survival of post-hatched Shovelnose Sturgeon may be lower in the fall. On the other hand, it could be that our detection probability is lower on small fish because they are too small to be vulnerable to otter trawls and our trawling efforts are limited in the late fall (K. Steffensen, unpublished data). Continuation of the trawling efforts into the late fall, especially below the Platte River, may provide additional information into the species reproductive tendencies and strategies and quantify the strength of this secondary spawning period.

Evaluation of the Shovelnose Sturgeon population is dependent upon using an effective suite of gears throughout all seasons. Currently, the PSPA Project includes four gears (i.e., gill nets, trammel nets, otter trawls and trot lines) that sample the Shovelnose Sturgeon population. Gill nets are effective at collecting large Shovelnose Sturgeon and appear to monitor changes in the population effectively (Wildhaber *et al.* 2011). Due to the sympatric Pallid Sturgeon's handling protocols (USFWS 2008), gill nets are deployed annually in similar water temperatures and conditions. One caveat is catch per unit effort in the lower channelized reach in 2003 was double the long-term but that is an artifact of the sampling regime. All gill nets in 2003 were fished in wing dike pool habitats; whereas starting in 2004, half the effort was direct to the channel border habitats. Catch rates in channel borders are generally lower than wing dike pool habitats (Huenemann and Steffensen 2013, Steffensen and Huenemann 2013). Trot lines also effectively sample the adult fish community but are highly influenced by water temperature and the feeding behavior of the non- *Scaphirhynchus* fish community. Generally, as water temperatures increase, catch rates of *Scaphirhynchus* species decline due to increase competition for the available baited hooks and gear saturation occurs. Otter trawls capture far less large Shovelnose Sturgeon compared to gill nets; however, otter trawls which capture small sturgeon, provide the opportunity to detect reproduction and recruitment to the population.

Shovelnose Sturgeon are a highly migratory species; therefore, a system-wide monitoring program is required to detect changes in the population. Several previous studies have looked at the Shovelnose Sturgeon populations in the Nebraska portion of the Missouri River (Sprague 1960, Held 1969, Schmulbach, Gould and

Groen 1975, Carlson *et al.* 1985, Berry, Wildhaber, Galat 2004). However, inconsistencies in methodologies and limited geographic extent limit our ability to infer long-term changes in the Shovelnose Sturgeon population. The PSPA Project was specifically designed to monitor the long-term population trends and our data concludes the overall population of Shovelnose Sturgeon in the upper unchannelized appears to be slightly declining while the population in the open, lower river appears to be stable. The population in the upper unchannelized reach consists of an older Shovelnose Sturgeon population with limited number of individual remaining. The Shovelnose Sturgeon population maybe extirpated in the next 10 to 20 years as no reproduction or recruitment has been documented. Although the lower unchannelized reach is open to the lower Missouri River, limited number of Shovelnose Sturgeon are collected annually. Gill net catch rates are approximately double in the upper channelized reach and triple in the lower channelized reach compared to the lower unchannelized reach. As sampling continues, Shovelnose Sturgeon population trends will continue to be monitored.

Management Recommendation

The Shovelnose Sturgeon recreational fishery is only open below the Big Sioux River with a daily bag limit of 10 fish and a possession limit of 20 with the current state record of 2.0 kg (4 lbs. 8 oz). With angler's inability to distinguish between the endangered Pallid Sturgeon and Shovelnose Sturgeon (Killgore *et al.* 2007, Peters and Parham 2008, Bettoli *et al.* 2009), we recommend considering a ban on recreational Shovelnose Sturgeon harvest in the channelized reach to protect the endangered Pallid Sturgeon. Anglers and bait vendors frequently talk about catching (and often times harvesting) 4+ lbs. Shovelnose Sturgeon. Our capture data suggests only 6% of the sturgeon greater than four pounds are Shovelnose Sturgeon; therefore, we feel juvenile Pallid Sturgeon are being misidentified and frequently harvested. An alternative to banning sturgeon harvest would be implementing a maximum size of Shovelnose Sturgeon harvest to further protect large Pallid Sturgeon. Finally, a creel study to quantify angler exploitation rates could be beneficial to understanding the harvest rates by recreational fishermen.

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