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# The Status of Fishes in the Missouri River, Nebraska: Blue Sucker *Cycleptus elongatus*

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## Abstract

Blue Sucker *Cycleptus elongatus* are a large-bodied, benthic fish that are considered an indicator species for riverine health. A combination of historic commercial fishing and anthropogenic modifications to riverine habitat led to blue suckers being listed as a candidate species for the federal threatened or endangered species list in 1993. However, they were never designated a federally protected species. Locally, Blue Suckers are currently listed as a Nebraska Natural Legacy Project's Tier 1 species but population changes and trends have not been quantified. Therefore, the objective of this paper was to evaluate the current population status of Blue Sucker in the Missouri River along Nebraska's border. Over 12,000 Blue Suckers were sampled in Nebraska from 2003 to 2012 as part of a targeted effort to characterize the benthic fish community in the Missouri River. Blue Suckers were rarely sampled upstream of Gavins Point Dam. Sampling results from this reach indicate this remnant population is comprised of mostly large adults with very limited reproduction. Capture frequency increased downstream of Gavins Point Dam with adequate reproduction and recruitment to sustain the population in these reaches. Gill net catch consisted of 14% Blue Suckers in the unchannelized reach downstream of Gavins Point and 23% of the benthic fish community in the channelized reach upstream of the Platte River. Age-0 Blue Suckers were most frequently detected in 2011 during the extreme flooding conditions but were also detected in higher abundance in 2006 when the river remained in its channel. The overall population downstream of Gavins Point Dam appears stable or perhaps slightly increasing. Blue Suckers, as with most native fish populations, were negatively affected when the Missouri River was highly modified through dam construction and channelization. However, reproduction and recruitment is occurring and Blue Sucker are not as imperiled as Pallid Sturgeon *Scaphirhynchus albus* or the native *Macrhybopsis* species.

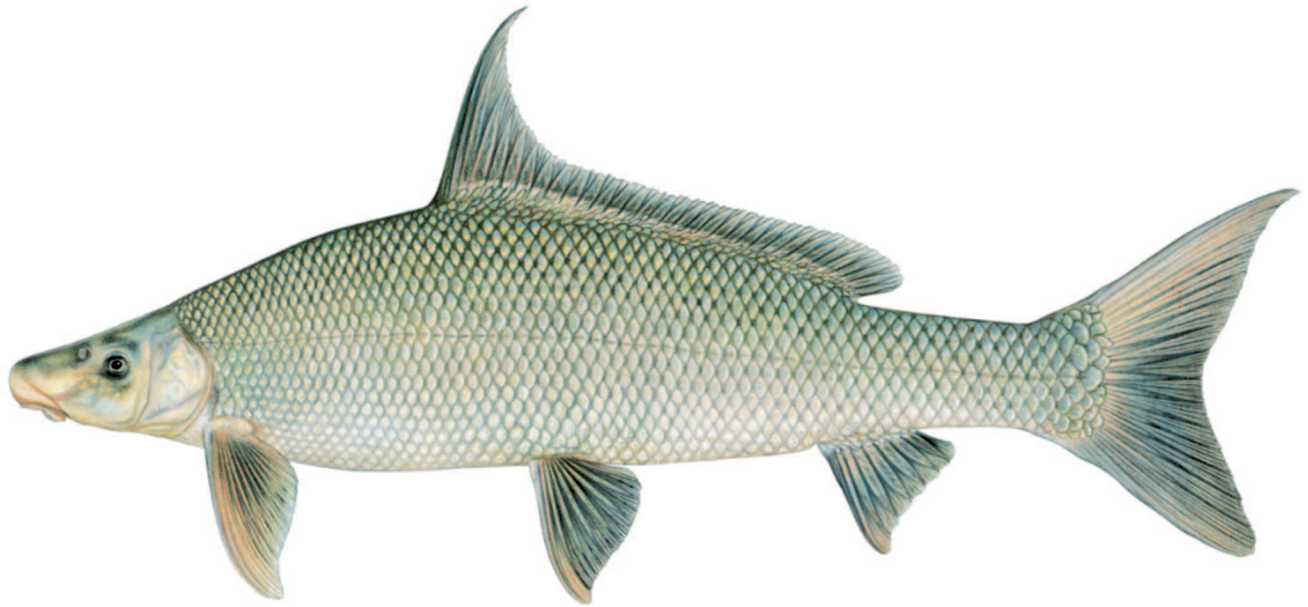
**Keywords:** Blue Sucker, *Cycleptus*, Missouri River, Native, Status, Trends

## Introduction

Blue Sucker *Cycleptus elongatus* are a large-bodied, benthic *Catostomidae* species that were historically considered one of the finest freshwater food fishes and a valuable food resource (Coker 1930). Throughout the late 1800s and early 1900s, all suckers species were commercially harvested at rates of over 900,000 kg (2.1 million lbs.) annually (Coker 1930). Similarly, Blue Sucker were highly exploited in Nebraska with 3,990 kg (8,800 lbs.) harvested from the Missouri River in 1894, principally around Niobrara, Dakota, Blair, Omaha, Plattsmouth and Nebraska City (Smith 1898). These reports did not distinguish sucker species but likely included Blue Suckers, White Suckers *Catostomus commersonii*, and Carpsucker *Carpionodes* spp. Blue Sucker populations appear to be sensitive to habitat degradation and fragmentation as their population declined throughout the 20<sup>th</sup> century (Pflieger 1997, Jelks *et al.* 2008). These anthropogenic activities blocked spawning migrations, reduced habitat availability (i.e., channelization), and altered the natural hydrograph and temperature regime (Coker 1930, Hesse *et al.* 1993). As a result, Blue Suckers were proposed as a candidate for listing as a federally endangered or threatened species; how-

ever, after a status review they were not designated a protected species (Elstad and Werdon 1993). Blue Suckers are currently listed as a Nebraska Natural Legacy Project's Tier 1 species (Schneider *et al.* 2011). Additionally, South Dakota Game, Fish and Parks list Blue Suckers as an S3 species (SDGFP 2014), meaning the species is either very rare and local throughout its range, or found locally in a restricted range, or vulnerable to extinction throughout its range because of other factors. Range-wide, Jelks *et al.* (2008) list Blue Suckers as a vulnerable species.

Blue Sucker historic distribution included 23 states and northern Mexico (Elstad and Werdon 1993). However, the species is now extirpated from Pennsylvania (NatureServe 2014). In Nebraska, Blue Sucker were not noted in Nebraska's early ichthyologic records. The first reported occurrence occurred in 1954 when several Blue Suckers were collected from the Missouri River in Dakota, Thurston and Burt counties (Jones 1963). At that same time, a Blue Sucker was collected in the newly created Lewis and Clark Lake (1957 unpublished data in Jones 1963) and documented in tributaries (Elstad and Werdon 1993). However in 1974, the distribution map by Morris *et al.* (1974) shows Blue Suckers only occurring in the main-



**Figure 1.** Blue Sucker. Image copyright of Joseph R. Tomelleri.

stem Missouri River. Most recently, Peters and Parham (2008) identified 30 Blue Sucker larvae captured from the Platte River, Nebraska and Neely et al. (2010) observed blue suckers in the Big Sioux and Platte rivers.

#### **Identification and habitat preferences**

The body morphology of Blue Suckers (i.e., elongated, streamlined body with a small head) is adapted for maintaining position in swift current without expending high amounts of energy (Figure 1). Similar to other native Missouri River benthic species (e.g., sturgeons and chubs), Blue Suckers have a small eyes that indicate they are not site feeders. Its sub-terminal mouth is covered with wart-like papillae which enable them to feed effectively on immature aquatic insects, including caddisflies, midges and hellgrammites (Rupprecht and Jahn 1980, Moss *et al.* 1983, Pflieger 1997). Blue Suckers inhabit areas with swift water velocities and hard substrate associated with the main channel and prefers areas that lack silt. Blue Suckers generally spawn in tributaries and are known to travel great distances to find suitable spawning habitat (i.e., flooded gravel bars, Moss *et al.* 1983, Neely, Pegg and Mestl 2009). However, Blue Suckers have been observed spawning in side channels in the unchannelized Missouri River below Gavins Point Dam (G. Mestl, NGPC, Pers. Comm). Males mature quicker (age 4, 503 mm) than females (age 6, 573 mm) with high levels of variation reported for maximum age (Moss *et al.* 1983, Hand and Jackson 2003, Vokoun *et al.* 2003, Bednarski and Scarnecchia 2006). However, a recent assessment suggests Blue Suckers can attain at least 18 years of age in Nebraska reach of the Missouri River (J. Wilhelm, NGPC, Pers. Comm.). Spawning occurs in mid-

April into May when water temperatures are between 20-23°C in riffles of 1-2 m depth (Moss *et al.* 1983, Neely, Pegg and Mestl (2009). Age-0 Blue Sucker grow rapidly, attaining length of 244 mm by the end of the first growing season (Moss *et al.* 1983).

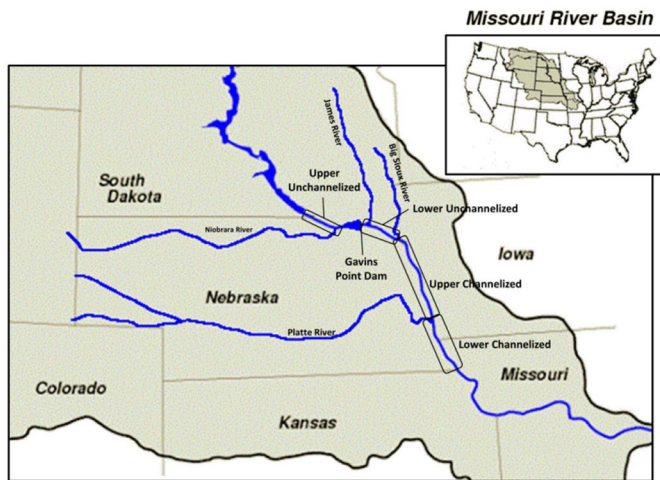
Blue Sucker sensitivity to anthropogenic modification suggests that they can serve as an indicator species for system condition and health. There is very little information available on the historical population status of Blue Suckers in Nebraska, but Hesse *et al.* (1993) noted that Blue Sucker populations seemed stable. The objective of this paper was to evaluate the current population status of Blue Sucker in the Missouri River along Nebraska's border.

#### **Materials and methods**

##### **Study area**

For this analysis, the Missouri River along Nebraska's border was divided into five reaches, four riverine 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 1993). Water management practices have altered the natural hydrograph and temperature regime, reduced turbidity, and degraded the channel upstream of the Niobrara River. The Niobrara and Missouri river confluence is located at rkm 1,358.0. Resembling the unaltered





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

river, the Missouri River downstream of the Niobrara River confluence has formed a large braided delta extending into the 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.

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 irregular discharges from Fort Randall Dam to support navigation on the lower Missouri River (Hesse and Mestl 1993). 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.

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) inputs increase turbidity levels. The lower channelized river has an aggrading channel due to the influence of the Platte River and floods more frequently. Seasonally, inputs from the Platte River can highly influence the turbidity, 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 limit habitat diversity.

### 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 with reaches are the strata and individual river bends as the experimental units which are annually randomly selected (Welker and Drobish 2012a). Twenty-five percent of the river bends per strata 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 main stem dams.

Blue Suckers 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 Blue Sucker population trends included: gill nets, otter trawls, and trammel nets. Benthic static gill nets were fished overnight for a maximum set time of 24 hours and catch per unit effort (CPUE) was calculated as the number of fish per net night. Benthic 4.9 m otter trawls were actively towed downstream while 1.0” trammel nets were drifted in the current. Catch per unit effort for both gears was calculated as the number of fish collected per 100 m sampled. All Blue Suckers were measured to

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

Catch per unit effort were calculated for each gear deployment and averaged by year to get an annual CPUE and a measure of variance. Annual CPUE were calculated for standard gears (i.e., gill nets, otter trawls, and trammel nets) used in the PSPA Project and a population trend (i.e., increasing, decreasing, or stable) was assigned based on the slope of a linear regression line. Population trends were subjectively based on annual catch rate change amongst the suite of gears but also accounted for recruitment and the size distribution within each reach. Length frequency distributions were compared with a Kolmogorov-Smirnov test. Finally, additional data from the PSPA project was used from the lower Missouri River (Nebraska/Kansas state line [rkm 788.4] to the confluence of the Mississippi River [rkm 0.0]) to compare overall CPUE for gill nets and trammel nets.

### Results

A total of 12,168 Blue Suckers was captured by the PSPA project from the Missouri River along Nebraska’s eastern border since sampling began in 2003. Gill nets captured the most Blue Suckers (N = 6,413) followed by trammel nets (N = 4,298) and otter trawls (N = 1,457, Figure 3). Blue Suckers were most frequently captured in the upper channelized reach (N = 6,579) followed by the lower channelized (N = 2,841) and lower unchannelized (N = 2,690). Blue Suckers were infrequently collected in the upper unchannelized reach (N = 58). With one exception, this same spatial trend was seen among all three gears. The greatest CPUE for all three gears was from the upper channelized, followed by the lower channelized, lower unchannelized and upper unchannelized, except for gill nets where more Blue Suckers were caught in the lower unchannelized than the lower channelized. Gill nets and trammel nets only sampled blue suckers ≥age-1, but age-0 blue suckers were collected with otter trawls. Mean length of gill nets collected fish was 660 mm (range = 216 – 925) and trammel nets (mean length = 640 mm, range = 221 – 980); whereas, otter trawls collected fish was 602 mm (range 40 – 896).

Blue Suckers were rarely collected in the upper unchannelized reach. The few that were captured were sampled with gill nets (N = 37) and trammel nets (N = 12) with Blue Suckers infrequently sampled with otter trawls. The overall low catch created difficulty discerning trends in the overall population in that reach (Figures 4, 5 and 6). In the lower unchannelized reach, annual catch rates varied with gill nets (0.35 – 1.29 fish per net night) and trammel nets (0.15 – 0.48 fish per 100 m drifted) with no population trends observed (Figures 4, 5, and 6).

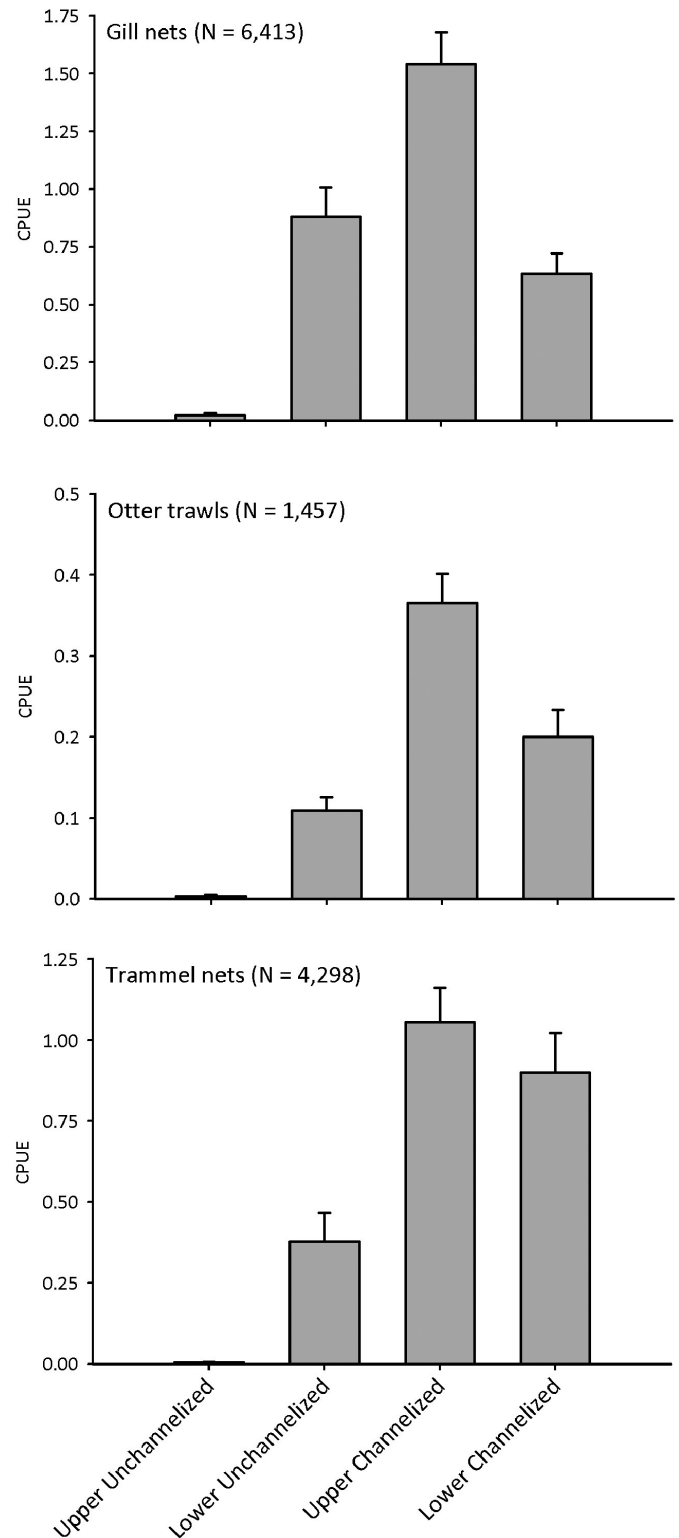
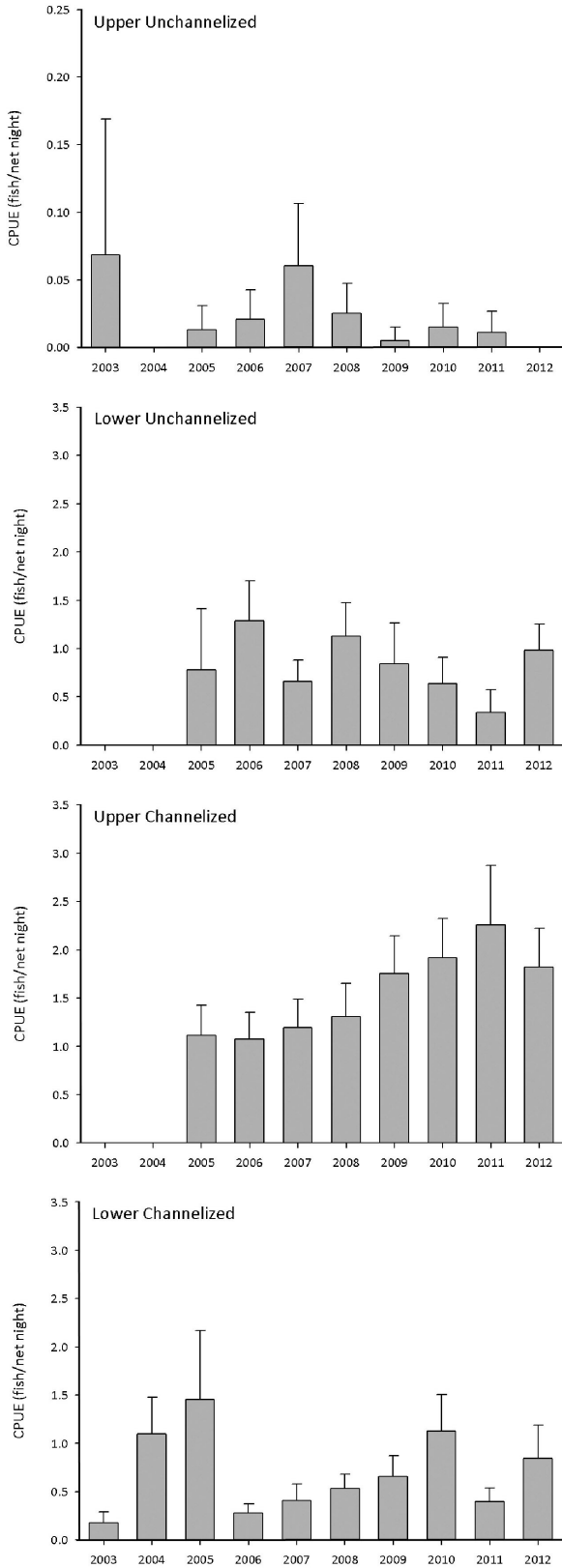
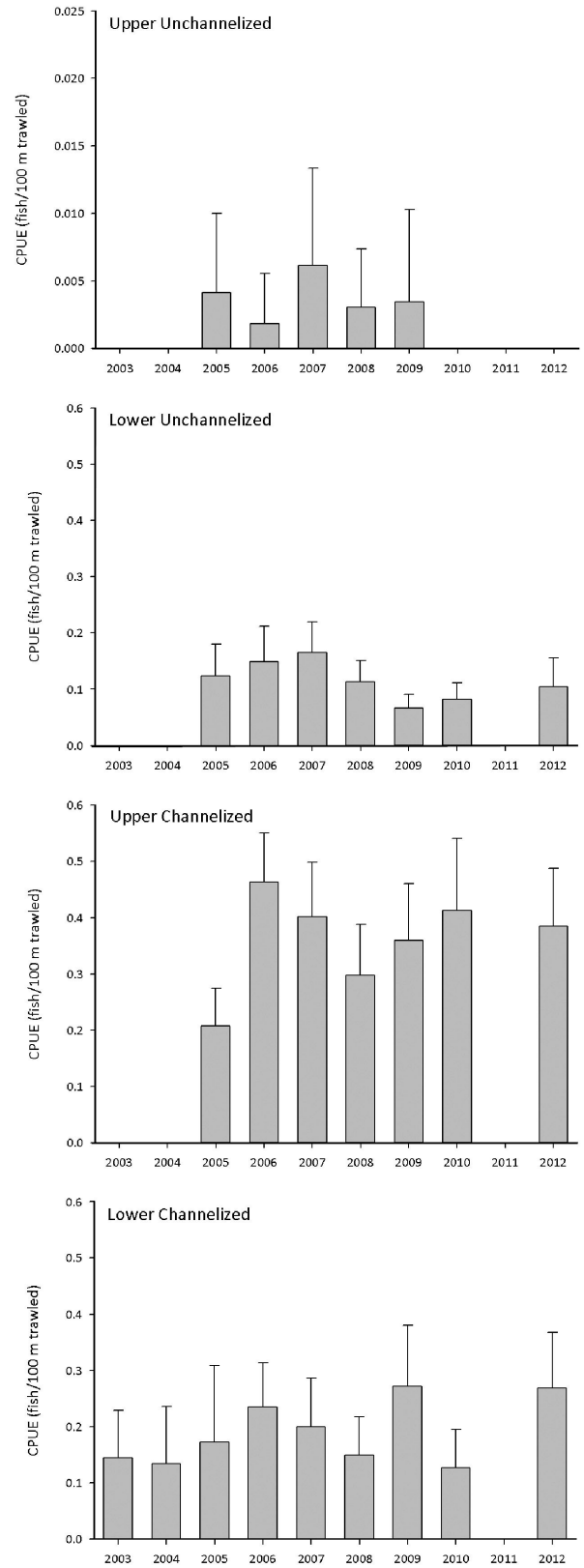


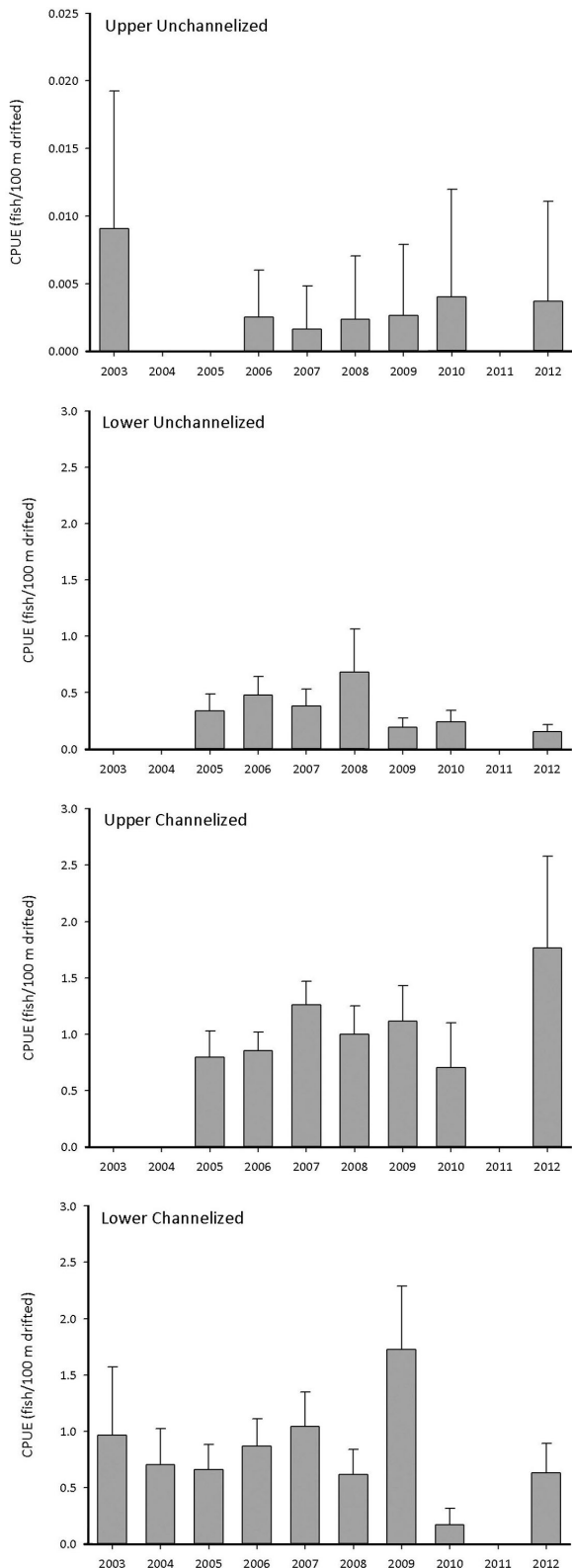
Figure 3. Overall catch per unit effort ( $\pm 2$  SE) for Blue Suckers by reach in the Missouri River along Nebraska’s eastern border from 2003-2012. Note that the y-axis scales are different for each graph.



**Figure 4.** Mean gill net catch per unit effort ( $\pm 2$  SE) for Blue Suckers by reach in the Missouri River along Nebraska's eastern border from 2003-2012. Note that the y-axis scale is different for the upper unchannelized graph.



**Figure 5.** Mean otter trawl catch per unit effort ( $\pm 2$  SE) for Blue Suckers by reach in the Missouri River along Nebraska's eastern border from 2003-2012. Note that the y-axis scale is different for the upper unchannelized graph.

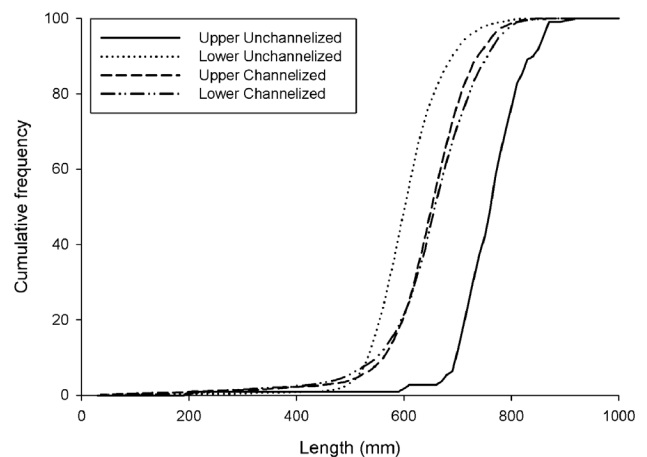


**Figure 6.** Mean trammel net catch per unit effort ( $\pm 2$  SE) for Blue Suckers by reach in the Missouri River along Nebraska’s eastern border from 2003-2012. Note that the y-axis scale is different for the upper unchannelized graph.

Catch rates with gill nets have significantly increased in the upper channelized reach since 2005 ( $F = 23.80$ ,  $P = 0.0028$ , Figure 4); whereas, trammel net and otter trawl catch rates have been more variable and have shown no statistical trends (Figure 5 and 6). In the lower channelized reach, gill net catch rates display no significant changes in the population. Recently, CPUE increased over the long-term mean but no significant trends have been observed.

The Blue Sucker population in the upper unchannelized reach was comprised of larger fish than the other three reaches (lower unchannelized  $KS_a = 2.74$ ,  $P < 0.0001$ , upper channelized reach  $KS_a = 3.19$ ,  $P < 0.0001$  and the lower channelized reach  $KS_a = 2.82$ ,  $P < 0.0001$ , Figure 7). The length frequency distributions in the lower three reaches were similar. The mean length of Blue Suckers in the upper unchannelized reach was 765 mm ( $SD \pm 77.1$ ) compared to a mean of 645 mm ( $SD \pm 90.4$ ) for the lower three reaches.

Age-0 Blue Suckers were most frequently captured in the upper channelized reach ( $N = 63$ ) followed by the lower channelized reach ( $N = 15$ ) and the lower unchannelized reach ( $N = 12$ ). No age-0 Blue Suckers have been collected in the upper unchannelized reach. This is noteworthy, as the upper unchannelized reach is isolated between two dams with little likelihood of immigration. Age-0 Blue Suckers were most frequently captured in July ( $N = 37$ ) at lengths  $\geq 40$  mm. Age-0 fish continued to be collected through August ( $N = 25$ ), September ( $N = 25$ ) and October ( $N = 1$ ). The greatest number of age-0 Blue Suckers captured during standardized sampling were observed in 2006 ( $N = 54$ ) followed by 2007 ( $N = 14$ ) and 2009 ( $N = 12$ ).

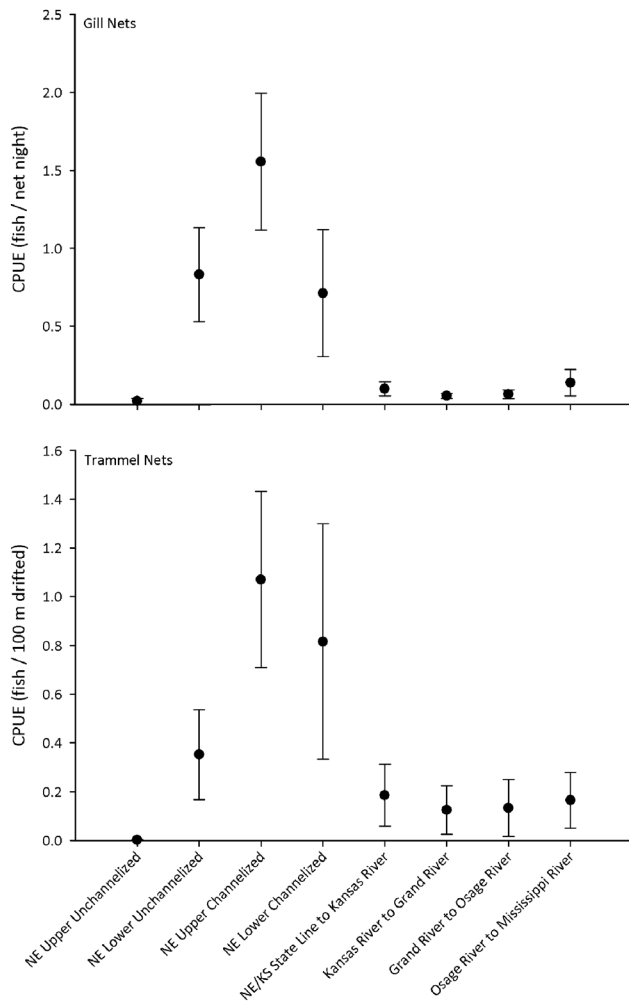


**Figure 7.** Cumulative length-frequency distribution of Blue Suckers captured in the Missouri River along Nebraska’s eastern border from 2003-2012 by reach.



### Spatial Missouri River comparison

Blue Sucker catch rates in gill nets and trammel nets along Nebraska's eastern border are much higher than catch rates observed in the downstream reaches of the Missouri River (Figure 8). The reaches from Gavins Point to the Nebraska/Kansas state line had a mean gill net CPUE of 1.03 fish per net night from 2005 to 2012; whereas, catch rate from the Kansas state line to the confluence with the Mississippi River was only 0.09. Similarly, mean CPUE from trammel nets was 0.75 fish per 100 m drifted in the Nebraska reaches compared to 0.15 fish per 100 m drifted in the Missouri River downstream of Nebraska.



**Figure 8.** Overall catch per unit effort for gill nets and trammel nets throughout the lower Missouri River from 2005-2012. Data for the reaches downstream of the Nebraska/Kansas state line was acquired from Kennedy *et al.* 2006, Utrup *et al.* 2006ab, Catton *et al.* 2007, Plauck *et al.* 2007, Utrup *et al.* 2007, Niswonger *et al.* 2008, Plauck *et al.* 2008, Utrup *et al.* 2008, Herman *et al.* 2009, Niswonger *et al.* 2009, Plauck *et al.* 2009, Herman *et al.* 2010, Horner *et al.* 2010, Plauck *et al.* 2010, Niswonger *et al.* 2011, Rid-enour *et al.* 2011ab, Meyer *et al.* 2012, Niswonger *et al.* 2012, Rid-enour *et al.* 2012, Meyer *et al.* 2013, Niswonger *et al.* 2013 and Wrasse *et al.* 2013.

### Historic local Missouri River comparison

Historically, the Missouri River was not sampled with gill nets or trammel nets; therefore, the best available historic data for comparison are from electrofishing surveys. In the early to mid-1970's, the Nebraska Game and Parks Commission surveyed the fish community around the construction areas of two nuclear power plant sites (i.e., Fort Calhoun Station [FCS] at rkm 1,039.5 in the upper channelized reach near Blair, Nebraska and Cooper Nuclear Station [CNS] at rkm 857.1 near Brownville, Nebraska in the lower channelized reach). Overall, Blue Sucker CPUE was greater at the FCS site in the upper channelized reach but Blue Suckers were noted as a rare species at both sites (Hesse, Bliss and Zuerlein 1982). Blue Suckers were collected infrequently during electrofishing surveys conducted throughout the 1980s' and comprised less than one percent of the total fish collected (NGPC archival database). The most recent electrofishing survey occurred from 2004 to 2006 when NGPC assisted the U.S. Geological Survey with the Environmental Monitoring and Assessment Program (EMAP). Blue Sucker catch rates from the EMAP study varied compared to the PSPA Project data. The greatest catch rates were observed in the lower unchannelized (CPUE = 7.9 fish/500-m) followed by the upper channelized (CPUE = 4.2) and the lower channelized (CPUE = 2.9). However, Blue Suckers only comprised 2% of the total catch in all three reaches where collected. No Blue Suckers were sampled in the upper un-channelized reach the EMAP study (K. Steffensen, NGPC, unpublished data).

### Discussion

Historic records of Blue Sucker occurrences in the Missouri River are less frequent than we expected. Blue Suckers are native to the entire Missouri River downstream Great Falls (Galat *et al.* 2005) and are easily identified, being the only fish in the genus *Cycleptus* in the Missouri River. However, early ichthyologic studies did not specifically note Blue Suckers in their capture records (Meek 1894, Evermann and Cox 1896, Johnson 1942). In the Missouri River, the earliest collection reports are from the J.F. Bell Museum of Natural History in 1938 (Elstad and Werdon 1993) and first reports from state and federal agencies documenting Blue Suckers did not occur until the second half of the 20<sup>th</sup> century. At that point, "suckers" were documented as being stocked in 1943 in Nebraska; however, the sucker species remain unknown (Jones 1963). Blue Sucker populations persist above Fort Peck Dam (Fort Peck, MT) which was closed in 1937, suggesting Blue Suckers were present in the Missouri River prior to Nebraska's stocking efforts (Galat *et al.* 2005). However, historic Blue Sucker abundance in the Missouri River along Nebraska's border remains uncertain.



Currently, Blue Sucker populations appear stable throughout the lower three reaches (i.e. Gavins Point Dam to the Nebraska/Kansas state line) where catch rates across all gears have been consistent and reproduction and recruitment maintains the population. Conversely, Blue Sucker populations in the upper unchannelized reach between Fort Randall and Gavins Point Dams may be in need of special attention. An adult Blue Sucker population still occurs but because no age-0 and only one age-1 fish have been captured over the past ten years. The population made up of what appears to be very large, possibly older, fish greater than 700 mm, and it is unknown if this population is viable or will be extirpated in the near future. Understanding why reproduction or recruitment is not occurring in that reach needs to be further investigated as similar trends (i.e., large adult population with minimal to no reproduction and recruitment) are being observed with other native species (Steffensen *et al.* 2014ab).

Concerns about reproduction and recruitment exist throughout Nebraska's reach of the Missouri River. Although age-0 Blue Suckers have been captured in the lower three reaches, catch is infrequent and typically in low abundance. The population downstream of Gavins Point Dam appears stable as the current level of recruitment maybe sufficient. Blue Suckers are a long-lived species and annual reproduction may not be necessary for species longevity. Otter trawls are critical in detecting reproduction and recruitment. It is possible young Blue Suckers occupy a habitat niche not currently sampled by otter trawls or other gears. However, it is more likely the current river configuration and management (i.e., lack of a natural hydrograph and temperature regime) does not provide the necessary cues and conditions to prompt Blue Sucker spawning.

For example, ancillary sampling during the 2011 Missouri River flood captured very high abundances of age-0 Blue Suckers. The Nebraska Game and Parks Commission sampled four floodplain sites in the upper and lower channelized reaches during the 2011 Missouri River flood and captured 147 age-0 Blue Suckers (Steffensen, Eder and Pegg 2014c); however, age-0 Blue Suckers were not captured in the upper unchannelized reach or lower unchannelized reach even though extreme flooding occurred throughout the Missouri River (Shuman *et al.* 2013, Stukel, Kral and Loecker 2012). In addition to age-0 Blue Suckers sampled during the 2011 Missouri River flood, age-0 Blue Suckers were documented in artificially constructed side channels along Nebraska's eastern border in 2006 - 2008 (Eder 2009). Age-length relationships estimate the age-0 Blue Suckers collected by Eder (2009) were spawned in mid to late-May. Blue Suckers were found to grow to approximately 240 mm by the end of the first growing season, which is similar to growth rates observed in the Missouri River (LaBay *et al.* 2008) and other river systems (Moss *et al.* 1983).

Collection reports from Funk and Robinson (1974), Schmulbach *et al.* (1975), Kallemyn and Novotny (1977), Hesse *et al.* (1982) and Tondreau *et al.* (1983), indicated Blue Suckers were not abundant in the Missouri River or were not sampled effectively with the gears used in their studies. These aforementioned studies used a wide variety of gears (i.e., gill nets, hoop nets, seining, and electrofishing) so Blue Suckers should have likely been sampled, if present. Our catch data with gill nets and trammel nets suggest Blue Suckers comprise greater than 10% of the adult benthic fish community. We hypothesize during the 1970s and early 1980s that the Blue Sucker populations in the Missouri River were depressed from commercial exploitation. Although still a commercial species, the present size structure of the Blue Sucker population in Nebraska indicates that currently there is little commercial pressure on the species.

The Blue Sucker population was highly exploited in the late 1800s and early 1900s when commercial fishing removed tons of fish annually, especially on the Mississippi River. Blue Suckers and other native fish species were further impacted when the Missouri River was highly modified through dam fragmentation and channelization. However, Blue Suckers were most common in the Nebraska reach of lower Missouri River. Gill net data indicates Blue Suckers are captured approximately ten times more frequently along Nebraska's border versus the lower reaches (i.e., Kansas state line to the confluence with the Mississippi River). Neely, Pegg and Mestl (2009) observed that Blue Suckers make substantial upstream migrations in the fall and preposition themselves for spring spawning before returning to their home range post spawn. Trammel nets are deployed after Blue Sucker spawning occurs and fish migrated back to their home area; however, trammel net catch rates are still about five times higher along Nebraska's border compared to the downstream reach. Therefore, we conclude Blue Suckers are most abundant in the upper reaches of the lower Missouri River along Nebraska's border.

It has been suggested that Blue Suckers are an indicator species for riverine health (Hesse and Mestl 1993, Neely *et al.* 2008). As a native benthic species, Blue Suckers were affected similarly to *Scaphirhynchus* and *Macrhybopsis* species to river alterations. Therefore, we hypothesize that Blue Sucker will positively respond to river management which more resembles a natural flow regime. Continued monitoring of environmental factors that influence reproduction and recruitment will play a critical role in improving the overall Missouri River ecosystem.

### Management Recommendation

Zuerlein (1988) reported the commercial fishing harvest statistics in Nebraska from 1944 to 1985 but Blue Sucker were not independently reported. Blue Suckers

were lumped into a miscellaneous classification which included bullhead species, suckers species, Mooneye *Hiodon tergisus*, Goldeye *H. alosoides*, Gizzard Shad *Dorosoma cepedianum*, Freshwater Drum *Aplodinotus grunniens*, gar species, Bowfin *Amia calva*, and American Eel *Anguilla rostrata*. An average of 1,994 kg (4,397 lbs.) of these miscellaneous species were harvested annually from 1944 to 1985 and an additional 2,651 kg (5,845 lbs.) from Iowa and 13,076 kg (28,828 lbs.) from Missouri commercial fisherman fishing (Zuerlein 1988). The significant difference is commercial take between the Nebraska/Iowa reach and the Missouri reach of the Missouri River may likely contribute to the catch rates trends observed over the past ten years (Figure 8). Hesse *et al.* (1993) suggested Blue Sucker harvest should be restricted until a harvestable surplus could be sustained; however, no restriction occurred. Then from 1998 to 2006 the annual miscellaneous species harvest in Nebraska increased to 9,265 kg (20,426 lbs.) annually (range = 2,784 – 22,361 kg, K. Steffensen, unpublished data). Therefore, we recommend Nebraska commercial fisherman be required to report Blue Suckers individually. These data could then be used to access commercial harvest to determine annual exploitation rates of Blue Suckers. Furthermore as Blue Suckers are a highly migratory species, interjurisdictional management of commercial fishing regulations are necessary. Finally, to bolster the suppressed population in the upper unchannelized reach, we recommend either a translocation program of fish from below Gavins Point Dam or a hatchery supplementation program.

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