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Cover Page Footnote

CTM thanks the Nebraska Game and Parks Commission (NGPC) for Scientific and Educational Permit no. 791. We also acknowledge members of the Chadron State College “P3 team” for assistance in the field, especially J. Balmat, K. Charron, P. Johnson, C. Lecher, M. Messersmith, B. Pinkleman, S. Rolfsmeier, and V. Villeda. For use of the backpack electrofisher and information we thank S. Schainost (NGPC). Finally, we thank the numerous landowners who allowed us access to properties under their care, the Hussey, O’Rourke, Price, Rasmussen, Rising, Schenbeck, and Sharps families. Without their assistance, this study would not have been possible.

The Fishes of Chadron Creek, Dawes County, Nebraska

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Running Title: Fishes of Chadron Creek, Nebraska

Abstract

This first modern comprehensive survey of fishes collected from Chadron Creek, Dawes County, Nebraska, documents collections made with a small seine and backpack electrofisher during November 2007 and February and March 2008. Chadron Creek's fish community is of low diversity. The total of 3 collections at each of 9 stations along the length of Chadron Creek resulted in 254 individual fishes, which represented only 7 species within 4 families. Water quality parameters, including dissolved oxygen, pH, conductivity, total dissolved solids, temperature and fecal coliform counts indicate that Chadron Creek is a healthy stream capable of supporting a greater diversity of fishes. Land management practices may be responsible for elevated fecal coliform levels at one locality on the creek. Comparisons of fishes collected herein are made with historical records of fish collected between 1893 and 2000, and show that there are 50% fewer species present than those known from historical accounts.

Introduction

Fishes are important vertebrate components of any ecosystem's biodiversity. In order to maintain quality stewardship, management, and protection of these wildlife resources on public and private lands throughout the U.S., basic survey data are essential as a source of baseline information on species diversity, richness, and relative abundance. One such watershed is located in extreme northwestern Nebraska at Chadron Creek (Fig. 1), a small, perennial, spring-fed stream with headwaters near the top of the Pine Ridge escarpment about 19 km S of Chadron, Dawes County (Fig. 1). It continues north and northwest through Chadron State Park and converges with the White River a few km W of Chadron after it descends about 305 m (1,000 ft) in elevation. Chadron Creek is an important water resource for the region and is diverted for part of the municipal water supply and, to a lesser degree, for agriculture. The riparian areas along Chadron Creek contain chokecherry, cottonwood, green ash, hackberry, wild plum, and buffaloberry, and several introduced grass species. Sub-irrigated meadows lining its banks provide wildlife habitat and rangeland, two mainstays of the region's economy. Thus, as a field study area with relevance for scientific studies, Chadron

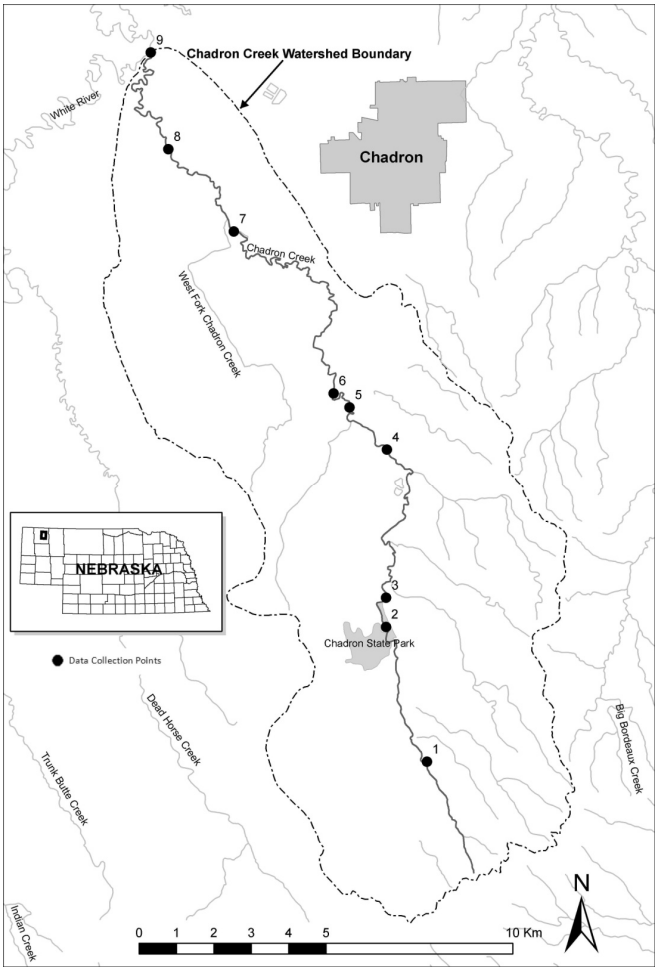

Figure 1. Nine localities in Chadron Creek, Dawes County, NE, where fishes were surveyed.

Creek is ideal.

To our knowledge, the first major report of fishes in the area was conducted by naturalists connected with the Pacific Railroad Survey parties, some of whom surveyed Chadron Creek in July 1893 and reported 9 species (Evermann and Cox 1896). Previously, P.H. Kirsch collected the Central Stoneroller (*Campostoma pullum*) in January 1893, and more than 4 decades later (July 1935), R. Van Dorp and P.M. Blossom collected Longnose Dace, *Rhinichthys cataractae* from Chadron Creek (S. Schainost, *pers. comm.*). Most interestingly, 3 specimens (USNM 76036 [2], UMMZ 245950 [1]) of Mountain Suckers (*Catostomus platyrhynchus*) were collected on 11 July 1893 and reported by Evermann and Cox (1896). The present occurrence of this species in Nebraska is considered extremely rare (Tomelleri and Eberle 1990) and it is listed as S1 (critically imperiled) in the state (Sowa *et al.* 2006). No mountain suckers have been collected in the state since 1939 when Raymond Johnson collected specimens from a tributary of Hat Creek, part of the Cheyenne River drainage (Schainost and Koneya 1999). Since it has not been collected in Nebraska for over 70 years, and since many sections of streams in which it was historically found now become seasonally dry, the species is considered extirpated from the state (Schainost and Koneya 1999; Belica and Nibbelink 2006). The most recent summary on fishes of the state was provided by Hrabik *et al.* (2012).

Since those initial surveys, aquatic habitats in the White/Hat Basin have been negatively impacted by agricultural pumping and demands for irrigation water. Early farmers built diversions and dug canals to farm the arid region. They reported that some of the flow of Chadron Creek was diverted during the irrigation season and that it flowed only during high runoff and some portions were dry the remainder of the year due to this irrigation. Indeed, for the first time in many decades, lower parts of Chadron Creek dried in the summer of 2007, just prior to this survey.

During various periods between 1973 and 2000, personnel from the Nebraska Department of Environmental Quality (NDEQ) and Nebraska Game and Parks Commission (NGPC) collected fishes from Chadron Creek (S. Schainost, *pers. comm.*). In addition, Brown Trout (*Salmo trutta*) were introduced into Chadron Creek in 1914 and Rainbow (*Oncorhynchus mykiss*) and Brook Trout (*Salvelinus fontinalis*) were collected in the 1990's (NDEQ samples). However, no modern comprehensive fish survey has been conducted and published in the refereed literature on Chadron Creek. Therefore, the purpose of our study was two-fold: (1) to provide a current baseline survey of the fishes of Chadron Creek and compare with previous unpublished reports, and (2) document information on water quality of the creek because it plays an important role in indicating the health of this watershed and its ecosystem.

Materials and Methods

Fifty meter segments (3 passes each) of Chadron Creek were surveyed at 9 sites along its length (when accessible) on 11 November 2007, 24 February 2008, and 30 March 2008 (see Fig. 1) at latitudes and longitudes as follows: **(1)** 42°40'55.31"N, 103°00'4.05"W; **(2)** 42°42'34.18"N, 103°00'34.56"W; **(3)** 42°42'37.52"N, 103°00'32.31"W; **(4)** 42°42'57.24"N, 103°00'43.12"W; **(5)** 42°43'6.38"N, 103°00'33.59"W, **(6)** 42°43'18.89"N, 103°00'34.236"W; **(7)** 42°49'15.20"N, 103°03'50.56"W; **(8)** 42°49'42.14"N, 103°04'38.00"W; and **(9)** 42°50'47.80"N, 103°04'42.06"W. These locations were logged using GPS, and characterized according to size, presence of fish/water, and types of aquatic vegetation.

The protocol for fishes involved careful, standardized field collections, species level identification, enumeration, and analyses using aggregated biological attributes or quantification of the numbers of key species (Barbour *et al.* 1999). Taxonomic keys were used to identify fish to species level and those measuring <20 mm were not included in analyses because of difficulty in verifying identification (particularly cyprinids). Dissection of pharyngeal teeth was necessary to verify the identity of some minnows. We used a backpack electrofisher (pulsed direct current) to obtain a representative sample of the fish assemblage at each reach that was isolated with block nets. Small nylon seines (3.1 m long × 1.8 m deep) with a 1.6 mm Ace mesh and dip nets were used when applicable. Attempts were made to collect fishes from each of the 9 sites and those collected were counted, preliminarily identified, sorted, and fixed in 10% formalin. They were transferred to 45% ethanol for storage prior to final identification in the laboratory. Voucher specimens were deposited in the Henderson State University (HSU) fish collection, Arkadelphia, Arkansas.

We analyzed water quality using standard chemical parameters (Standard Methods 2005) including dissolved oxygen, pH, conductivity, total dissolved solids, and temperature. Measurements represent an average of 3 readings from the lower, middle, and upper portions of each individual 50 m site, when accessible. In addition, counts of fecal coliform colonies were made

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at sites 1–7 in Fall 2007 and Spring 2008 (site 7 was not sampled in Winter 2008 and samples were not obtained from sites 8 and 9 during any sampling period).

Families are arranged in phylogenetic order and species and common names are listed as given by Page *et al*. (2013). Fishes were collected by the senior author.

Results and Discussion

Aquatic Vegetation

Aquatic (floating and submerged) vegetation included duckweed (*Lemna turionifera*), submerged waterweed (*Elodea canadensis*), white water crow's foot (*Ranunculus longirostris*), emergent watercress (*Nasturtium officinale*), and cutleaf water parsnip (*Berula erecta*). This vegetation provided adequate cover for fishes to hide and feed on macroinvertebrates.

Fishes

The total of 3 collections at each of 8 of 9 stations along the length of Chadron Creek resulted in 254 individual fishes, which represented only 7 species within 4 families as follows.

CYPRINIDAE

***Notropis stramineus* (Cope, 1865) – Sand Shiner.** This shiner generally inhabits streams ranging from small spring discharges to large rivers where it usually is associated with sandy substrate in areas with little or no aquatic vegetation and moderate to slow current; however, it is rarely found in upland areas. It was originally reported from Chadron Creek by Evermann and Cox (1896) as *Notropis blennius* (Table 2). A single specimen was also collected in 1994 by Peters (REMAP, FHSM 3030) (Table 2). Although we did not collect specimens from the lower 4 sites on Chadron Creek, it appears to be a common shiner of the northern regions of this watershed similar to that described previously (Table 1). It is considered one of the most abundant fishes of medium-sized, sandy-bottomed rivers that are typical of the Nebraska prairie (Hrabik *et al*. 2012).

***Pimephales promelas* Rafinesque, 1820 – Fathead Minnow.** This is another cyprinid historically known from Chadron Creek (Table 2). Additional specimens were collected by NDEQ in 1993 (Table 2). However, as we collected only a single specimen during this study (Table 1), we suggest the species may be an uncommon inhabitant of this watershed. It is widespread in North America, inhabiting a wide variety of aquatic habitats, and tolerant of high temperatures, turbidity, and low oxygen. Fathead Minnows are considered to be common throughout Nebraska and are important as bait (Hrabik *et al*. 2012).

***Rhinichthys cataractae* (Valenciennes *in* Cuvier and Valenciennes, 1842) – (Longnose Dace).** Longnose dace have historically been reported from Chadron Creek since 1893 (Table 2). During our study, several specimens were collected from 5 of 8 (63%) sites in the watershed (Table 1). In the Horse Creek drainage of nearby eastern Wyoming, *R. cataractae* biomass was primarily related to submerged aquatic vegetation, main channel run habitat, and overhead cover features (Hubert and Rahel 1989). Very similar ecological conditions were present in Chadron Creek. Interestingly, *R. cataractae* has the widest range of any North American minnow (Page and Burr 2011) and it is common in streams of northwestern Nebraska (Hrabik *et al*. 2012).

***Semotilus atromaculatus* (Mitchill, 1818) – (Creek Chub).** The Creek Chub was not reported from Chadron Creek until 1993–1994 (NDEQ and REMAP samples, Table 2). We commonly found various age and size classes of this cyprinid (Table 1); it appears to be the most common species of this watershed. The Creek Chub often inhabits headwater creeks where there are few other fishes, a scenario found in Chadron Creek. It is common in many streams throughout Nebraska (Hrabik *et al*. 2012).

CATOSTOMIDAE

***Catostomus commersonii* (Lacépède, 1803) – (White Sucker).** The White Sucker has been known from Chadron Creek since 1893 (Table 2). There is an additional 1935 record collected by Van Dorp and Blossom from Chadron Creek in the UMMZ (UMMZ 108528). Two additional White Suckers were collected in 1993 and 2000 (Table 2). This sucker appears to be uncommon in Chadron Creek as only a single specimen was collected during this study (Table 1). Populations are apparently secure (S4) in the state (NatureServe 2015) and it is common in all drainages in Nebraska (Hrabik *et al*. 2012).

SALMONIDAE

***Salmo trutta* (Linnaeus, 1758) – (Brown Trout).** This fish is native to Europe, North Africa, and western Asia; it was introduced to North America around 1883

and now widely stocked throughout south Canada and much of the United States (Page and Burr 2011). Although Brown Trout was first stocked in Chadron Creek in 1914 (Hrabik *et al*. 2012), it was not until 1987 that they were first vouchered from the creek (Table 2) and appears to be perfectly suited for continual stocking into this cool, high gradient stream. Juvenile specimens of *S. trutta* were commonly collected in pools and riffles of 2 upper reaches of Chadron Creek in the vicinity of the State Park (Table 1) although the creek has 21 km of trout-supporting water. In addition, Brown Trout have been reported to have a negative effect on the nongame fish community via piscivory (Garman and Nielson 1982); however, we do not know what effect they might have on similar communities in Chadron Creek. We did not save voucher specimens of *S. trutta* (all were released) due to them being a game fish and to avoid negatively influencing the fisheries of the site.

GASTROSTEIIDAE

***Culaea inconstans* (Kirtland, 1840) – (Brook Stickleback).** The Brook Stickleback was not known from Chadron Creek until McAllister *et al*. (2010) documented a single specimen from this watershed. The species is considered S3 (vulnerable) in the state (NatureServe 2015) and is also listed as a Tier II, Species at Risk, in the state by the Nebraska Natural Legacy Project (Hrabik *et al*. 2012).

Conclusions

When comparing historical records of fishes from Chadron Creek (Table 2) to those reported in the present survey (Table 1), there are 50% fewer species present than were known from historical accounts. Of these, there are 3 more cyprinids, one catostomid, 2 (non-native) salmonids, one ictalurid, and one centrarchid known from historical records (Table 2). Although the Stonecat (*Noturus flavus*), *C. pullum* (as *C. anomalum*), Blacknose Shiner (*Notropis heterolepis* as *N. cayuga*), Flathead Chub (*Platygobio gracilis*), and *C. platyrhynchus* were reported from the original historical 1893 collections of Evermann and Cox (1896), they have not been collected since (over 100 yrs) in Chadron Creek proper. Unfortunately, voucher specimens of these collections have apparently been lost or discarded. Of these fishes, *N. heterolepis* and *C. platyrhynchus* are critically imperiled (S1) species in Nebraska (NatureServe 2015). In Missouri, the former species has apparently disappeared from several Ozark streams that were occupied prior to 1900 (Pflieger 1997). One additional fish, the Green Sunfish (*Lepomis cyanellus*) has also not been collected in Chadron Creek proper since the original collection of 6 specimens by NDEQ personnel in 1993. However, there is a 1935 collection of 4 *L. cyanellus* from the Chadron Creek watershed at McDowell's Pond, 8.0 km S of Chadron, and another collected in 1939 by R.E. Johnson and R. Wallace from the White River system of Missouri River drive (near the site of the current Chadron Reservoir and Chadron Reservoir #2). In addition, there is also a record of *R. cataractae* from the same latter site (UMMZ 134485).

There are also records of other fishes from near the mouth of Chadron Creek in the mainstem White River. The Red Shiner (*Cyprinella lutrensis*) and *N. flavus* were collected there after our survey period in July 2012 and are deposited in the Auburn University Museum of Natural History (AUMNH), Auburn, AL. Therefore, it is likely *C. lutrensis* will soon become a member of the Chadron Creek ichthyofauna and the Stonecat exists in a local extant source population.

The only 2 sites on Chadron Creek that did not support fish were sites 1 (Chadron Creek WMA) and 8 (US 80 bridge). The former location was a headwater site with flowing water and a small pond while the latter location was completely dry during sampling.

Water quality data (Table 3) suggest that Chadron Creek is a healthy stream capable of supporting a greater variety of fishes. In addition, microbiological analysis of fecal coliform colonies (Table 3) reveal very low values for sites 1–6; however, site 7 (Fall sample only) had very high values and suggests a difference in land use management with runoff from grazing livestock in the area. These sites with low fecal coliform counts were mostly drained by higher elevations in the National Forest or the State Park and, unfortunately, data is missing for site 7 in winter. However, site 7 did support a good population of *N. stramineus*, *R. cataractae* and *S. atromaculatus*.

We have provided the first definitive modern survey of the fishes of Chadron Creek. However, we freely admit that collection of several species (particularly minnows) may have been missed due to seasonal migration and/or use of differing winter habitats. Additional surveys should be conducted in the region (during all parts of the year, if possible) as some of the streams of the northwestern White and Hat river basins are remote and difficult to access. This could help determine whether or not *C. platyrhynchus* is actually extirpated in the state.

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Table 1. Fishes collected during this survey from Chadron Creek (2007–2008).

Species	Date collected	No. collected	Site(s)	HSU Cat. No.
CYPRINIDAE				
Notropis stramineus	Nov. 2007, Mar. 2008	40	5–6, 7, 9	3380, 3382
Pimephales promelas	Nov. 2007	1	5	3377
Rhinichthys cataractae	Nov. 2007, Feb.–Mar. 2008	33	2–4, 6–7	3378
Semotilus atromaculatus	Nov. 2007, Feb.–Mar. 2008	172	4–7	3379
CATOSTOMIDAE				
Catostomus commersonii	Nov. 2007	1	6	3381
SALMONIDAE				
Salmo trutta[1]	Nov. 2007, Feb.–Mar. 2008	6	2–3	–
GASTEROSTEIDAE				
Culaea inconstans[2]	Mar. 2008	1	5	3186

[1]Released.
[2]Previously reported by McAllister *et al*. (2010).

Table 2. Historical records of fishes collected from Chadron Creek (1893-2000).

Species	Date collected	No. collected	Cat. No. (if known)
CYPRINIDAE			
Campostoma pullum	1 Jan. 1893	4	USNM 76148[1]
	11 Jul. 1893	1	USNM 76198
Notropis heterolepis	11 Jul. 1893	1	–
N. stramineus	11 Jul. 1893	1	–
	12 Jul. 1994	1	FHSM 3030[2]
Pimephales promelas	11 Jul. 1893	1	–
	11 Aug. 1993	5	UNSM 6446[3]
Platygobio gracilus	11 Jul. 1893	1	MCZ 31722[4]
Rhinichthys cataractae	11 Jul. 1893	1	–
	5 Jul. 1935	10	UMMZ 108527[5]
	5 Jul. 1935	294	UMMZ 108529
	13 Aug. 1973	4	–
	5 Aug. 1992	4	UNSM 6179
	11 Aug. 1993	26	UNSM 6445
	12 Jul. 1994	658	UNSM 8708
	31 Oct. 2000	8	–
Semotilus atromaculatus	11 Aug. 1993	14	–
CATOSTOMIDAE			
Catostomus commersonii	11 Jul. 1893	1	CAS/SU 75147[6]
	5 Jul. 1935	1	UMMZ 108528
	11 Aug. 1993	1	–
	31 Oct. 2000	1	–
C. platyrhynchus	11 Jul. 1893	2	USNM 76036
SALMONIDAE			
Onchorhychus mykiss	12 Jul. 1994	1	–

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Table 2 Historical records of fishes collected from Chadron Creek (1893-2000). *(cont'd)*

Species	Date collected	No. collected	Cat. No. (if known)
Salmo trutta	28 Jul. 1987	47	UNSM 4867
	12 Jun. 1990	26	–
	5 Aug. 1992	26	UNSM 6178
	11 Aug. 1992	26	–
	12 July 1994	29	UNSM 8709
	31 Oct. 2000	39	–
Salvelinus fontinalis	31 Oct. 2000	1	–
ICTALURIDAE			
Noturus flavus	11 Jul. 1893	1	–
CENTRARCHIDAE			
Lepomis cyanellus	11 Aug. 1993	6	UNSM 6444

[1]USNM = Smithsonian National Museum of Natural History, Washington, DC.
[2]FHSM = Fort Hays Sternberg Museum of Natural History, Hays, KS.
[3]UNSM = University of Nebraska State Museum, Lincoln, NE.
[4]MCZ = Museum of Comparative Zoology, Harvard University, Cambridge, MA.
[5]UMMZ = University of Michigan Museum of Zoology, Ann Arbor, MI.
[6]CAS/SU = California Academy of Sciences, San Francisco, CA.

Table 3. Selected water quality measurements taken in Chadron Creek (Fall 2007-Winter 2008).

Site No.[1]	1	2	3	4	5	6	7[2]
Fall 2007							
Water temp (°C)	11.8	9.7	9.9	11.7	9.7	10.5	7.8
pH	7.3	7.6	8.0	8.0	7.7	7.8	7.8
TDS (ppm)	194.7	226.3	222.5	233.0	245.0	254.5	271.8
Conductivity (µS)	386.1	456.8	444.6	476.2	493.8	508.9	538.4
Avg. fecal coliforms[3]	0.3	4.1	25.8	9.2	2.9	21.4	656.2
Winter 2008							
Water temp (°C)	10.1	5.1	5.3	6.5	5.8	5.7	–
DO (mg/l)[4]	11.5	11.4	11.3	11.9	12.3	13.0	–
pH	7.0	7.5	7.7	8.1	8.2	8.1	–
TDS (ppm)	193.3	227.0	227.7	233.9	232.4	237.2	–
Conductivity (µS)	400.6	444.0	445.2	463.8	459.5	482.9	–

[1]Sites 8 (dry) and 9 were not sampled for water quality. [3]Average fecal coliforms were not taken in winter sampling.
[2]Site 7 was frozen for winter sampling. [4]Dissolved oxygen (DO) measurements were not taken in fall sampling.