Biological and Water Quality Monitoring at Tallgrass Prairie Preserve in Oklahoma

Kimberly Elkin
The Nature Conservancy, Freshwater Conservation, Stonewall, OK 74871

Bob Hamilton
Tallgrass Prairie Preserve, Pawhuska, OK 74056

Abstract: From 2013 to 2015, aquatic monitoring was conducted at the Tallgrass Prairie Preserve (TGP) in Pawhuska, Oklahoma. Biological monitoring consisted of fish and macroinvertebrate Index of Biotic Integrity (IBI). Ten streams are located on the TGP with 21 fish species and 14 macroinvertebrate orders. The overall fish IBI score was 39 which indicates a good fishery. The overall macroinvertebrate IBI score was 37 which indicates a good macroinvertebrate community. Water quality consisted of water temperature, dissolved oxygen, conductivity, pH, sodium, and chloride parameters. Conductivities ranged around 0.3 ms/cm with water temperatures varying from 13 Celsius in the spring to 38 Celsius in the summer. Dissolved oxygen ranged from 7mg/L to 14mg/L. Overall, streams on the preserve have good diversity based on the IBI with an abundant number of fish species and macroinvertebrate taxa represented.

Introduction

Tallgrass Prairie Preserve is a 40,000-acre conservation preserve owned by The Nature Conservancy (TNC) in the northeast portion of Oklahoma. The preserve was acquired in 1989 and consists of tallgrass prairie rangeland, with scattered crosstimber woodlands and riparian corridors along stream courses. The preserve is managed with the use of prescribed fire, invasive species control, and seasonal grazing by cattle leases and a permanent herd of about 2,000 bison. The preserve is located in the upper reaches of the Sand Creek watershed (Figure 1). The property has been maintained in native grassland, with habitat for target species such as greater prairie-chicken, Henslow's sparrow, upland sandpiper, short-eared owl, rough-legged hawk and the American burying beetle. In the 1990's, an inventory was conducted of the fauna and flora of the TGP which included fish surveys of all the streams and ponds on the preserve. Stewart et al. 1999 found 23 fish species at 11 sites on the preserve. Bass 1994 sampled macroinvertebrates and water quality at three of the 10 stream sites that TNC researched. Bass 1994 found 134 taxa represented at six stream sites.

Aquatic monitoring started in 2013 to gather data for the preserve since there was a 22-year gap in aquatic data collection. This data will assist in detecting future declines in fish and macroinvertebrate populations. It also provides information to the preserve director about the streams and what stream improvements can be undertaken to improve the water quality and biology.

Methods

1. Biology

Fish were collected at 10 stream sites using backpack shockers and 10-foot seine nets with a five-person field crew. IBI methods were used for sampling fish, which includes sampling all macrohabitats including riffles, pools and runs over a 300-meter stream reach. Macrohabitats were sampled using the depletion method until

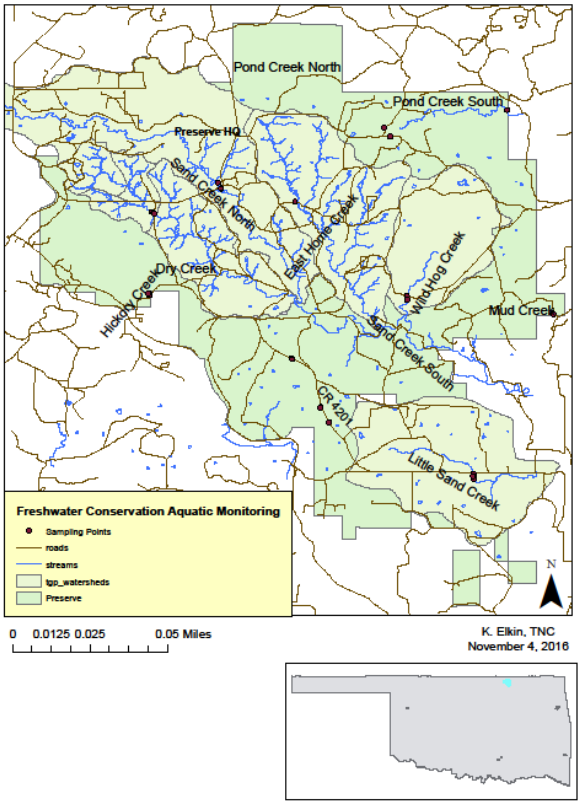

Figure 1. Tallgrass Prairie Preserve study area

no new species were collected in the riffles, pools and runs. The depletion method samples all fish species in a reach of stream until no new fish species were collected. If a new species were collected, the depletion method started over for that macrohabitat until no new species were sampled. The IBI were designed to include a range of attributes for fish assemblages (Karr 1986). The 12 measures or metrics fall into three broad categories: Species Composition, Trophic Composition, and Fish Abundance and Condition (Karr 1986). Fish were identified to species in the field and released back into the stream. Unidentified fish species were preserved in 10% formalin and identified to species at the Pontotoc Ridge Preserve (PRP) Environmental Research Facility in Stonewall, Oklahoma.

Macroinvertebrates were sampled using D-frame aquatic dip-nets. Riffles, pools and runs were sampled over a 300-meter stream reach. Field crews of seven to eight people consisting of Oklahoma State University (OSU), TNC and Brigham Young University (BYU) staff collected for a specified amount of time based on the number of people collecting. Staff were positioned within the 300-meter stream reach to sample the different macrohabitats. Macroinvertebrates were preserved in 70% denatured ethyl alcohol for identification to order, family and genus at the PRP Environmental Research Facility located in Stonewall, Oklahoma.

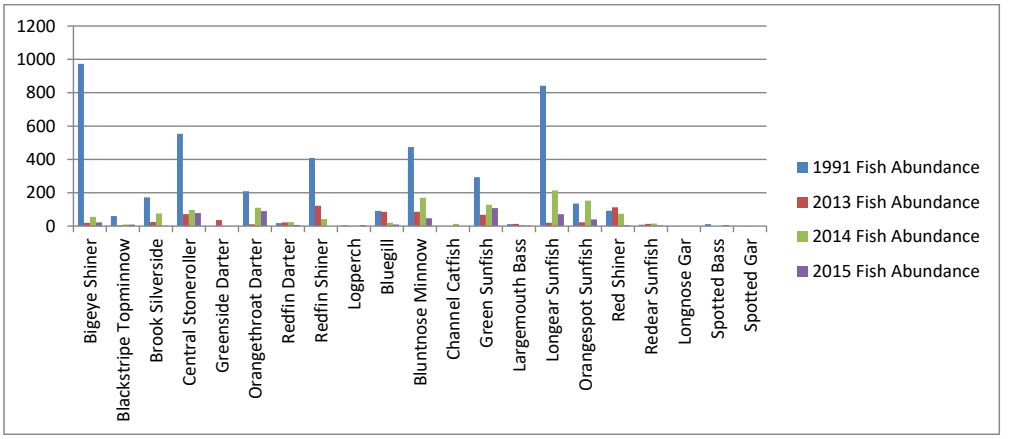

Figure 2. Fish abundance at Tallgrass Prairie Preserve

Table 1. Overall fish IBI score for 10 streams on the Tallgrass Prairie Preserve

Fish IBI indicated a good fishery based on nine metrics. Metrics based on Karr 1986 were modified to fit Oklahoma ecoregions (Monty Porter, Oklahoma Water Resources Board (OWRB) personal communication). Nine metrics were used to evaluate the streams on the preserve. Scores were divided into a value of five, three and one point per metric based on the value calculated for each metric.

Watershed Size	Metric	Score of 5	Score of 3	Score of 1
<100 sq.miles	Total # of species		21	
	# of species comprising >75% of sample	8		
	Shannon's Diversity based on #	10.7		
	# of sunfish	4		
	# of intolerant sp.	8		
	% of tolerant sp.		42%	
	% of lithophils		25%	
	% of DELT anomalies	0%		
	Fish # (total individuals)	1394		
	Total Score			**39**

2. Water Quality

Water quality measurements were collected with a Hach Hydrolab DS5 water quality meter. Parameters measured included water temperature, conductivity, pH and dissolved oxygen. Riffles, pools and runs were sampled over a 300-meter stream reach. Sodium and chloride samples were taken to determine sodium and chloride concentrations. Samples were taken from pools in the stream and analyzed by the OSU Soil, Water and Forage Analytical Laboratory.

Results

Fish abundance at TGP indicated 21 different species were found on the preserve (Figure 2). Darters, minnows, shiners, stonerollers, catfish, sunfish, bass and gar were all present during fish surveys. The largest population numbers found were the Centrachidae (sunfish) and Cyprinidae (minnow) families. Fish abundance was higher in 1991, and this could be due to the amount of time spent seining and angling fish. From 2013-2015, streams were sampled until no new species

Table 2. Macroinvertebrate taxa from 10 streams on the Tallgrass Prairie Preserve. Macroinvertebrates were represented by 14 orders with the most abundant orders represented by Gastropoda, Ephemeroptera and Decapoda.

Total #	Order	Family	Genus
1	Diptera	Tipulidae	Triogma
2	Annelida	Oligochaeta	
123	Ephemeroptera	Potomanthidae	Anthopotamus
23	Gastropoda	Hydrobiidae	Pyrgulopsis
9	Gastropoda	Viviparidae	Viviparous
5	Gastropoda	Pleuriceridae	Leptotoxis
38	Decapoda	Cambarinae	Orconectes
2	Decapoda	Cambarinae	
7	Decapoda	Orconecteidae	Orconectes
9	Trichoptera	Helicopsychidae	Heliopsyche
1	Ephemeroptera	Leptophlebiidae	Hydrosmilodon
6	Hemiptera	Gerridae	Gerris
4	Oligochaeta		
40	Gastropoda	Hydrobiidae	Tryonia
1	Diptera	Chironimidae	
1	Odonata	Libellulidae	Libellula
2	Odonata	Calipotergyidae	
1	Hemiptera	Corixidae	
3	Ryhnchobdellida	Piscicolidae	Piscicola
3	Gastropoda	Planorbidae	Planorbula
15	Mollusca	Corbiculidae	Corbicula
1	Diptera	Tipulidae	Tipula
5	Trichoptera	Glossiphoniidae	Placobdella
81	Ephemeroptera	Heptageniidae	Stenacron
1	Coleoptera	Dytiscidae	
9	Diptera	Chironomidae	
2	Diptera	Simulidae	
10	Trichoptera	Leptoceriidae	Oecetis
8	Trichoptera	Leptoceriidae	Leptocerus
2	Plecoptera	Perlidae	Perlesta
3	Coleoptera	Dytiscidae	
1	Tipulidae	Tapaniidae	
1	Coleoptera	Elmidae	

were found in each macrohabitat. Some streams were sampled faster than other streams due to the number of species present while sampling and based on stream order. Fish IBI indicated a good fishery (Table 1).

Macroinvertebrate diversity consisted of 14 orders found on TGP (Table 2). Macroinvertebrate IBI indicated a good macroinvertebrate community (Table 3). Decapoda (crayfish) Gastropoda (snail), and Ephemeroptera (mayfly) were the most dominant macroinvertebrate orders present.

Dissolved oxygen concentration ranged from seven to 14 mg/L in various streams (Figure 3). Water temperature ranged over 25 degrees Celsius between streams (Figure 4). Multivariate regression analysis depicted no relationship between dissolved oxygen, conductivity and pH (Table 4). Sodium concentrations ranged from four to 45 ppm (Figure 5), while chloride concentrations ranged from three to 75 ppm (Figure 6).

Table 3. Overall macroinvertebrate IBI score for 10 streams on the Tallgrass Prairie Preserve of Oklahoma.

The macroinvertebrate IBI score represents a good macroinvertebrate community. Taxa abundance was high in streams sampled at the preserve. Eleven metrics were used to calculate the macroinvertebrate IBI score. Metrics were developed by OWRB to represent the ecoregions of Oklahoma. A score of five, three or one were given to each metric to develop an overall IBI score. These metrics were established by OWRB to represent the ecoregions of Oklahoma.

Metric	5	3	1
Total Taxa		16	
# EPT Taxa		7	
% EPT- % Hydropsychidae			0%
% Scrapers		20%	
% Clingers		55%	
% Diptera	3.4%		
% Chironomidae	2.8%		
% Isopoda	0.0%		
% Tolerant Organisms			25%
HBI		5.10	
% Intolerant Organisms	56.0%		
Total IBI Score			**37**

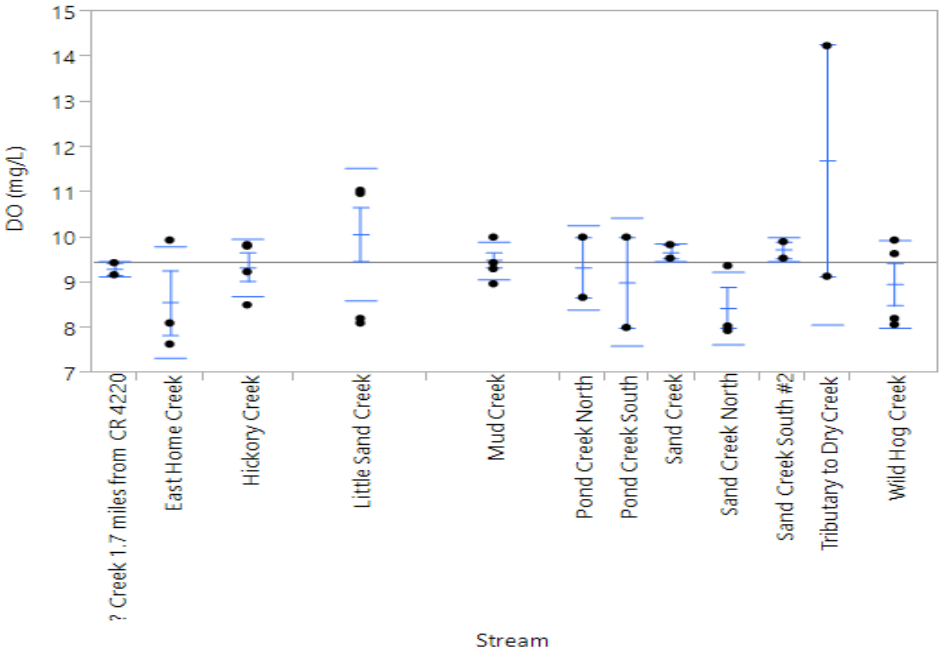

Figure 3. One-way ANOVA of dissolved oxygen concentrations.

Dissolved oxygen concentrations varied from 7.0 mg/L in the early morning to 14.0 mg/L in the late afternoon. Dissolved oxygen fluctuates with temperature, salinity and pressure changes in the aquatic environment. Dissolved oxygen concentrations vary in prairie stream systems due to the shallow depths encountered in these stream systems. Small order streams had shallower macrohabitat and higher dissolved oxygen levels.

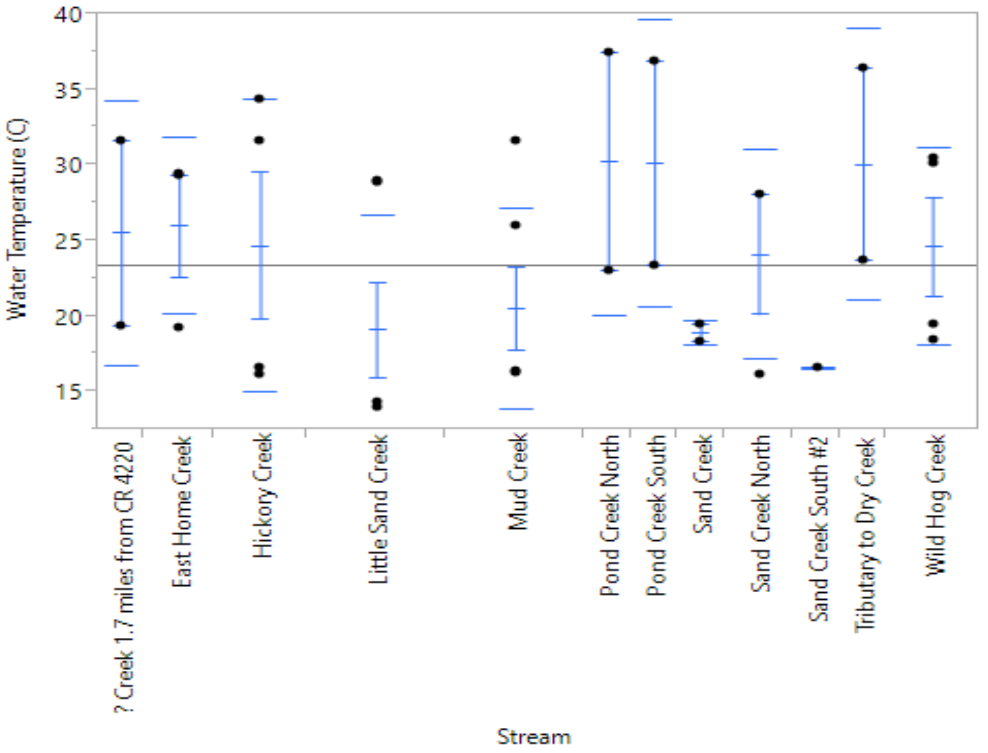

Figure 4. One-way ANOVA of water temperatures.

Water temperatures ranged from 13 Celsius in the early morning to 38 Celsius in the late afternoon. Small order streams had higher water temperatures due to the smaller depths encountered.

Table 4. Water quality multi-variate regression analysis

R-squared values show a weak correlation between dissolved oxygen, conductivity and pH. Dissolved oxygen concentrations varied depending on the time of day the measurements were taken and based on stream order. Conductivity values were consistently around 0.3 ms/cm.

Summary of Fit

RSquare	0.310062
RSquare Adj	0.121898
Root Mean Square Error	1.878919
Mean of Response	25.67
Observations (or Sum Wgts)	15

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	3	17.452109	5.81737	1.6478
Error	11	38.833691	3.53034	**Prob > F**
C. Total	14	56.285800		0.2351

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	-1.111521	30.70841	-0.04	0.9718
LDO (mg/L)	-0.284572	0.233808	-1.22	0.2490
Conductivity (ms/cm)	10.434446	5.763814	1.81	0.0976
pH	2.4768387	3.076296	0.81	0.4378

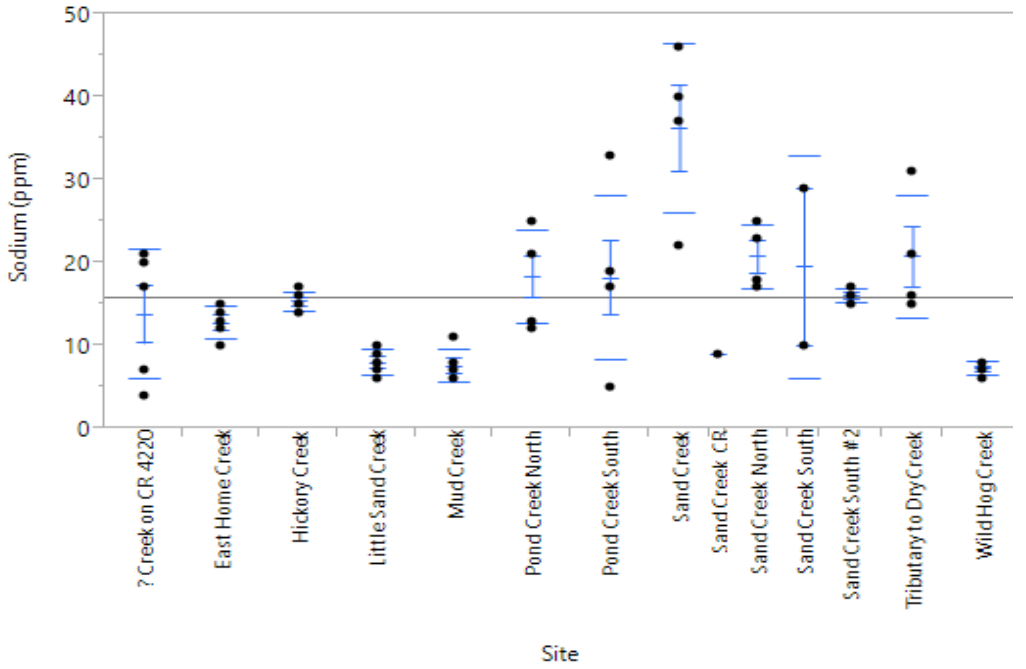

Figure 5. Sodium concentrations for streams on the Tallgrass Prairie Preserve.

Sodium occurs naturally in streams on the preserve due to the limestone substrate present in the streams. Sodium reached as much as 45 ppm in some streams with four ppm in other streams.

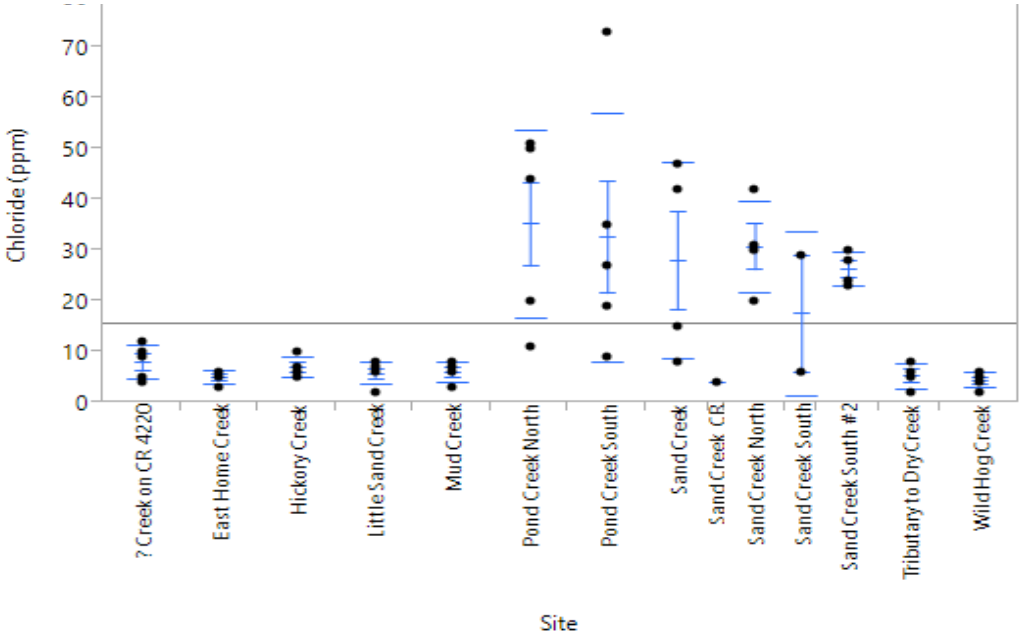

Figure 6. Chloride concentrations for streams on the Tallgrass Prairie Preserve

Chloride concentrations ranged from three ppm to 75 ppm in streams located on the preserve. Natural sources of chloride occur in these streams due to the geologic deposits, soils and saline groundwater.

Discussion

Biological integrity is the capability of supporting and maintaining a balanced, integrated and adaptive community of organisms having a species composition, diversity and functional organization comparable to that of the natural habitat of the region (Hawkins 2006). The natural habitat of the tallgrass prairie indicates that these fish species and macroinvertebrate orders were representative of this prairie ecoregion. This preserve has 40,000 acres with several streams that were protected from major anthropogenic factors. Stream fish assemblages are influenced indirectly by natural and anthropogenic landscape features acting through intermediate factors like flow and temperature regimes and water quality and physical habitat (Gido and Jackson 2010). The fish found on the TGP appear to be of high quality based on the IBI.

TGP has one main stream, Sand Creek, which flows across the preserve with several tributaries. Fish were sampled in 1991 after TNC's purchase of the TGP at Sand Creek and several of the tributaries. The overall fish IBI score for 10 streams indicated a good fishery.

The overall macroinvertebrate IBI score indicates a good macroinvertebrate community. Fish and macroinvertebrate IBI scores are used to assess the environmental quality of streams (Hotz 2010). Based on the IBI score for fish and macroinvertebrates, streams on the TGP were still of high quality.

Overall, TGP offers a unique look at several different tributary streams and one mainstem stream that provides biological and water quality data from a prairie ecoregion.

Acknowledgments

TNC would like to thank Tony Brown and Perry Collins of the Tallgrass Prairie Preserve for assistance in the field. TNC would like to thank Tawnda Hopper and Kay Krebbs for assistance during overnights at the preserve. TNC would like to thank Jim Burroughs, Donnie King, Darren Rythe, Jeanne Odonell, Buck Ray and Curtis Tackett of the Oklahoma Department of Wildlife Conservation (ODWC) for assistance during fish surveys. TNC would like to thank Sarah Hogden and Kaleb Thayer of Oklahoma State University (OSU) for assistance in the field.

References

Bass, D. 1994. Community structure and distribution patterns of aquatic macroinvertebrates in a Tall Grass Prairie stream ecosystem. Proceedings of the Oklahoma Academy of Natural Sciences. 74. 3-10.

Gido, K.B. and D. A Jackson. 2010. Community ecology of stream fishes: Concepts, Approaches and Techniques. American Fisheries Society Symposium 73. Bethesda, Maryland. USA.

Hawkins, C.P. 2006. Quantifying biological integrity by taxonomic completeness: its utility in regional and global assessments. Ecological Applications. Volume 16. Issue 4: 1277-1294.

Hotz, R. 2010. Evaluation of fish and macroinvertebrate indices of biotic integrity in the bioassessment of the Illinois River Basin. Inquiry. Volume 11: 55-62.

Karr, J.R., K.D. Fausch, P.L. Angermeier, P.R. Yant, and I.J. Schlosser. 1986. Assessing biological integrity in running waters: A method and its rationale. Illinois Natural History Survey.

Porter, Monty. 2016. Oklahoma Water Resources Board. Personal communication.

Stewart, J. G., F. P. Gelwick, W.J. Matthews, and C.M. Taylor. 1999. An annotated checklist of the fishes of the Tallgrass Prairie Preserve, Osage County, Oklahoma. Proceedings of the Oklahoma Academy of Sciences 79: 13-17.

Submitted May 24, 2016 Accepted November 30, 2016

A New Record of and Additional Notes for the River Otter, *Lontra canadensis,* from Logan County, Oklahoma

William Caire
University of Central Oklahoma, Edmond, OK 73034

Lynda Samanie Loucks
University of Central Oklahoma, Edmond, OK 73034

Cari M. Deen
University of Central Oklahoma, Edmond, OK 73034

Tracy L. Holshouser
University of Central Oklahoma, Edmond, OK 73034

River otters, *Lontra canadensis*, were at one time found across most of Oklahoma. What little is known about the historical distribution in the early 1800s and 1900s in Oklahoma has been summarized by Blair and Hubbell (1938), Duck and Fletcher (1944), Bissonette and Maughan (1978), Hatcher (1984), Caire et al. (1989), Oklahoma Department of Wildlife Conservation (2008), Barrett (2008) and Barrett and Leslie (2010). The Oklahoma Game and Fish Department (1952) reported that otters were very rare or had been extirpated in most areas of Oklahoma by 1952 (Caire et al., 1989). Early historical reports are scarce and scattered across the state but include the Red River (Marcy, 1854), Muskogee County (Foreman, 1926), Comanche County (Conover, 1927), Caddo County (Nice, 1931), Woodward County (Blair, 1939) and Kiowa County (Halloran and Glass, 1964). In an attempt to reestablish the river otter in Oklahoma, on 21 March 1984, 5 male and 5 female otters were released into the Wister Wildlife Management Area in LeFlore County and in April 1985 seven otters (4 males and 3 females) were released into the McGee Creek Wildlife Management Area in Atoka County by the Oklahoma Department of Wildlife Conservation (Barrett, 2008). Over a two-year period in the mid-late 1990s, 22 river otters were reintroduced into the Wichita Mountains Wildlife Refuge in Comanche County (Barrett, 2008). Other reports (Hatcher, 1984; Base, 1986; White and Hoagland, 1997; Barrett, 2008) suggest the reintroductions have been successful and that the river otter distribution in Oklahoma is spreading westward, with specimens from Cleveland County preserved in the Sam Noble Museum of Natural History collections. A map in Barrett and Leslie (2010) suggests the presence of river otters in Kingfisher County based on USDA Animal and Plant Health Inspection Service capture reports for 2004. On 13 February 2016, an adult male river otter, *L. canadensis*, was found dead on Oklahoma State Highway 33, 0.8 km N of Coyle. The coordinates of the specimen location are 35°57’50.1”N 97°14’10.3”W; elevation 265 m. From where the otter was found dead on the road to the western edge of the Cimarron River is 0.5 km. The habitat along the river near this locale is dominated by willow (*Salix*), cottonwood (*Populus deltoides*) and tamarisk (*Tamarix*).

This is the first record of an otter from Logan County and in north central Oklahoma. There are no reports of otters being taken from Logan County from 2008 to 2016 (ODWC). The nearest known reports are from Cleveland County (Barret and Leslie, 2010).

The male otter is deposited in the University of Central Oklahoma Natural History Museum (UCONHM 7158). External measurements were total length, 119 cm; length of tail, 47 cm; length of body, 72 cm; length of hind foot, 12.5 cm; length of ear, 2.3 cm; weight, 10.6 kg. In addition to skin and skeletal remains, internal organs and contents were preserved in alcohol and tissue samples (lung, kidney, heart, muscle) were preserved in the UCONHM frozen tissue collection. The animal had been run over by a vehicle, the back broken and the skull completely crushed.

Reproductive data for river otters in Oklahoma is scant. This scrotal male specimen had testes lengths of 52 mm (right) and 55 mm (left). Hamilton and Eadie (1964) used the length of the testes to estimate the age of otters in New York. Length of testes of males 3 years or older are reported to range from 30–36 mm during March and April and 35–50 mm in November and December and based on these values, this otter would have been at least 3 years old. Friley (1949) separated males into four age groups based on the baculum size. The baculum measured 100 mm in length, and weighed 7.4 g., which placed it in Friley's (1949) older adult male category.

Barrett and Leslie (2012) noted that the age of river otters decreased from east-to-west and colonizing populations to the west had a higher proportion of younger individuals. Not having a large sample of otters or any data as to how long this otter had been in Logan County precludes discussion of whether this was an established resident or an older instead of younger colonizing individual.

Descriptions of the internal anatomy of river otters from Oklahoma are few. The length of river otter trachea has been described as intermediate between that of terrestrial carnivores and marine mammals and a shorter trachea facilitates air exchange and increases lung ventilation in diving mammals (Tarasoff and Kooyman, 1973b). The mean tracheal length of river otters is reported as 15.3 cm, or 23.2% of the body length (Tarasoff and Kooyman, 1973b; Lariviere and Walton, 1998). However, the length of trachea in this river otter was 21.1 cm (measured from the top of the forking of the branching of the bronchi to the rim of the trachea below the bottom of epiglottis). This is 29.2% of the body length and considerably longer than reported for river otters elsewhere (Lariviere and Walton, 1998). We know of no other measurements of tracheal length of river otters from Oklahoma. The lobes of the lungs match the descriptions presented in the literature (Tarasoff and Kooyman, 1973a). They are triangular in shape, and there are four lobes in the right lung (cranial, middle, caudal, and accessory) and two in the left (cranial and caudal). After combing and brushing the fur, the only ectoparasites found were several sucking lice. However, Kimber and Kollias (2000) indicated ectoparasites on river otters are rare. The length of the small intestine was 35 cm and the large intestine was 26.6 cm. The kidneys were reniculated and similar in gross morphology as reported by Baitchman and Kollias (2000).

Fish have been reported as a common diet item of river otters (Knudsen and Hale, 1968; Reid et al., 1994). Hatcher (1984) reported the stomach and intestine contents of two otters from Latimer County contained crayfish, newts (*Notophthalmus viridescens*), an unidentified fish, and a gastropod. Shackelford and Whitaker (1997) reported piles of fish scales at river otter feeding sites in Oklahoma. We examined the stomach and intestinal contents of this otter and it contained numerous fish scales (Centrarchidae).

Acknowledgments

We thank Jerrod Davis, furbearer biologist, Oklahoma Department of Wildlife Conservation, for information about otter harvest in Oklahoma.

References

Baitchman EJ, Kollias GV. 2000. Clinical anatomy of the North American river otter (*Lontra canadensis*). J Zoo and Wildlife Med 31:473-483.

Barrett DA. 2008. Status and population characteristics of the northern river otter (*Lontra canadensis*) in central and eastern Oklahoma. (MSc thesis). Stillwater (OK): Oklahoma State University. 32 p. Available from: OSU Library.

Barrett DA, Leslie DM Jr. 2010. Current distribution of North American river otters in central and eastern Oklahoma, with seven new county records. Occas Papers Nat Sci Res Lab Texas Tech Univ 294:1-13.

Barrett DA, Leslie DM Jr. 2012. Spatio-temporal variations in age structures of partially re-established populations of northern river otters (*Lontra canadensis*). Amer Midl Nat 168:302-314.

Base DL. 1986. Evaluation of experimental reintroduction of river otters in Oklahoma. Unpublished report, Oklahoma Department of Wildlife Conservation Nongame Wildlife Program, Oklahoma City (OK): 40 p.

Bissonette JA, Maughan OE. 1978. Southeastern Oklahoma coal investigation: endangered species. Project No. 14-16-002-77-080: U.S. Fish and Wildl Ser. 101p.

Blair WF. 1939. Faunal relationships and geographic distribution of mammals in Oklahoma. Amer Midl Nat 22:85–133.

Blair WF, Hubbell TH. 1938. The biotic districts of Oklahoma. Amer Midl Nat 20:425-454.

Caire W, Tyler JD, Glass BP, Mares MA. 1989. Mammals of Oklahoma: Norman (OK): Univ Okla Press. 567p.

Conover GW. 1927. Sixty years in southwest Oklahoma: Anadarko, (OK): N. T. Plummer, Printer. 119 p.

Duck LG., Fletcher JB. 1944. A survey of the game and furbearing animals of Oklahoma. Oklahoma Game and Fish Commission, Oklahoma City State Bull 3:1–44.

Foreman G. 1926. Pioneer days in the early southwest: Cleveland (OH): Arthur H. Clark Co. 334p.

Friley CE. 1949. Age determination by use of the baculum in the river otter, *Lutra canadensis*. J Mam 30:102–110.

Halloran AF, Glass BP. 1964. Additional mammal notes from the Wichita Mountains region of Oklahoma. Proc Okla Acad Sci 44: 56-58.

Hamilton WJ, Eadie WR. 1964. Reproduction in the otter, *Lutra canadensis*. J Mam 45:242-252.

Hatcher RT. 1984. River otters in Oklahoma. Proc Okla Acad Sci 64:17–19.

Kimber KR, Kollias GV. 2000. Infectious and parasitic diseases and contaminant-related problems of North American river otters (*Lontra canadensis*): A review. J Zool and Wildl Med 31:452–472.

Knudsen KF, Hale JB. 1968. Food habits of otters in the Great Lakes region. J Wildl Manag 32:89-93.

Lariviere S, Walton LR. 1998. *Lontra canadensis*. Mammalian Species Account, J Mam 587:1-8.

Marcy RB. 1854. Exploration of the Red River of Louisiana in the Year 1852: Washington (D.C.). A. O. P. Nicholson, Pubic Printer. 368p.

Nice MM. 1931. The Birds of Oklahoma. Revised Edition. Publ Univ Okla Bio Sur 3:1-224.

Oklahoma Game and Fish Department. 1952. Furbearers and game mammals of Oklahoma. Oklahoma City, OK.

Oklahoma Department Wildlife Conservation. 2008. Status and population characteristics of the northern river otter (*Lontra canadensis*) in central and eastern Oklahoma. Final Report. Federal Aid Grant No. W-158-R.

Reid DG, Code TE, Reid ACH., Herrero SM. 1994. Food habits of the river otter in a boreal ecosystem. Canadian J Zool 72:1306-1313.

Shackelford J, Whitaker J. 1997. Relative abundance of the northern river otter, *Lutra canadensis*, in three drainage basins of southeastern Oklahoma. Proc Okla Acad Sci 77:93–98.

Tarasoff FJ, Kooyman GL. 1973a. Observations on the anatomy of the respiratory system of the river otter, sea otter, and harp seal. Part I. The topography, weight, and measurements of the lungs. Canadian J Zool 51:163–170.

Tarasoff FJ, Kooyman GL. 1973b. Observations on the anatomy of the respiratory system of the river otter, sea otter, and harp seal. Part II. The trachea and bronchial tree. Canadian J Zool 51:171–177.

White J, Hoagland J. 1997. Additional observations of the long-tailed weasel (*Mustela frenata*) and the river otter (*Lutra canadensis*) in southeastern Oklahoma. Proc Okla Acad Sci 77:111-112.

Submitted June 14, 2016 Accepted November 21, 2016