11-30-1970

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Transactions of the Kansas Academy of Science, Vol. 73, No. 1, 1970
This issue was published November 30, 1970

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Abstract

The possible effects of proposed watershed management practices on fish resources of the Nemaha Basin were poorly understood; thus, a study was undertaken to ascertain the species of fish present and their relative abundance and distribution within the basin. Thirty-five species were collected, 34 of them from the Big Nemaha River system and 28 from the Little Nemaha River system. These data may be used as a basis for future studies of fish population changes in the Nemaha Basin and possibly as a basis for studies in other watersheds.

Introduction

In recent years, the Nemaha Basin in southeastern Nebraska and northeastern Kansas has experienced periodic flooding resulting in heavy property damage and some loss of life. In an effort to decrease the number and severity of floods, numerous watershed districts have been initiated. Also, there were investigations and preliminary planning by the U. S. Army Corps of Engineers relative to a series of impoundments in the Nemaha Basin. As the effects of such extensive watershed developments on the fishes inhabiting the streams of the basin were poorly understood, a study to determine the occurrence and relative abundance of fish species present was undertaken. This will provide the basis for determining future changes in the population structure of the fishes of the Nemaha Basin.

Published accounts of the fishes of the Nemaha Basin are few. Johnson (1942) discussed the subject briefly in his doctoral thesis entitled "The Distribution of Nebraska Fishes." Collections were made in the Nemaha Basin by Metcalf in August, 1961, as indicated in his discussion of *Notropis dorsalis* (1966). However, these data remain basically unpublished. Cross (1967) indicated that there are few published accounts of fishes from the Kansas portion of the Nemaha Basin.

Physical Characteristics

The topography of the upper portion of the Nemaha Basin is gently sloping to rolling while the lower portion is moderately rolling with

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[1] A contribution of Federal Aid in Fish Restoration, Project F-4-R, Nebraska.

steeply rolling slopes in localized areas adjacent to the flood plain. Shale and limestone outcrops are present on only a few of the steepest slopes and are of minor extent except in the southern portions of Pawnee and Richardson Counties, where exposures are numerous and extensive. Burchett and Reed (1967) described the soils generally as being of the Sharpsburg-Marshall or Wymore-Pawnee groups. The soils are well suited for agriculture and practically all of the arable lands are cultivated. Corn, sorghums, wheat, and soybeans are the most important tilled crops. Land use, as defined by the Soil Coservation Service, in the Nemaha Drainage is summarized in Table 1. Stream banks support narrow intermittent belts of elm, cottonwood, willow, ash, walnut, mulberry, oak, maple, and sycamore. Woodlands are most extensive in the southern portions of Pawnee and Richardson Counties.

The climate of southeastern Nebraska is characterized by those fluctuations of rainfall, temperature and wind typical of the Great Plains. According to Blair (1941) the mean annual precipitation is 31.0 inches with June being the month of heaviest rainfall. The mean annual temperature is approximately 52° F.; the mean July temperature, the warmest month, is 77.9° F.; the mean January temperature, the coolest month, is 25.5° F. The average growing season for the area is 166 days.

The Nemaha Basin comprises approximately 1,769,000 acres or about 2,764 square miles. The basin is drained by two major streams, the Little Nemaha River to the north and the Big Nemaha River to the south. The Little Nemaha River is approximately 73 miles long and drains 573,833 acres. The stream originates in the southeastern corner of Lancaster County, Nebraska, and follows a southeasterly course through Otoe and Nemaha Counties to its junction with the Missouri River near the town of Nemaha, Nemaha County, Nebraska. The elevation varies

Table 1. Land use in the Nemaha Basin expressed as a percent for each drainage.*

Drainage	Total acreage	Land use†			
		Cropland	Range	Woodland	Other
Little Nemaha	573,833	82.2	13.0	2.7	2.1
Big Nemaha	1,195,175	71.3	20.2	4.3	4.2
Total	1,769,008	74.9	17.9	3.7	3.5

* Data were extracted from inventory data on conservation needs supplied by the Soil Conservation Service.

† "Cropland" denotes land being tilled; idle cropland and summer fallow land; land in cover crops or soil-improvement crops not harvested or pastured, and rotation pastures.

"Rangeland" includes grazing lands and tame hay.

"Woodland" includes lands which were at least 10% tree covered or lands from which the trees had been removed to less than 10%, but had not been developed for another use.

"Other" land consists of farmsteads and non-farm residences; country schools, churches and cemeteries; and wildlife areas.

from approximately 880 feet above mean sea level at the mouth to 1,250 feet at the headwaters, with an average gradient of 5.1 feet per mile. The two major tributaries, North Fork Little Nemaha River (locally known as Wilson Creek) and South Fork Little Nemaha River have their confluences with the Little Nemaha near the town of Talmage, Otoe County, Nebraska. The North Fork rises near Elmwood in Cass County, Nebraska, and flows in a southeasterly direction for 24 miles. The South Fork originates in Lancaster County, Nebraska, and flows easterly for 28 miles.

The Big Nemaha River is approximately 96 miles long and drains 1,195,175 acres. From its source along the southern border of Lancaster County, Nebraska, at an elevation of approximately 1,350 feet, it follows a southeasterly course through Gage, Johnson, Pawnee and Richardson Counties to its confluence with the Missouri River at an elevation of 860 feet. The average gradient of the stream is 5.1 feet per mile.

The two major tributaries, Muddy Creek and South Fork Big Nemaha River, join the Big Nemaha in Richardson County, Nebraska, near the towns of Preston and Salem, respectively. Muddy Creek has its origin in Johnson County, Nebraska, and is approximately 47 miles in length. South Fork Big Nemaha River is approximately 66 miles long and originates near the southern border of Nemaha County, Kansas. Approximately 366,500 acres of the watershed are located in Kansas in portions of Marshall, Nemaha, and Brown Counties.

Prior to 1920, the lower reaches of both the Little and Big Nemaha Rivers and their major tributaries were straightened and deepened by dredging. Edwards (1917) stated "The old channel of the [Big] Nemaha and its two forks is very crooked and inadequate to carry the great volume of water which comes down the valley in time of heavy rains in the spring and summer season." Dredging of both streams was begun in about 1908. In the upper reaches of both rivers the stream beds are well entrenched, causing extensive erosion of the land, including the stream banks. The lower reaches are a-grading and meandering within their channels.

Stream flow data for the Little and Big Nemaha Rivers are presented in Tables 2 and 3 (after U. S. Department of the Interior, 1957–1966).

Methods and Materials

Collection of Fishes. Seines of various lengths (10, 20, 40 and 80 feet) with depths of 4 or 6 feet and meshes of 1/4 inch were used. In quiet water areas, seining was done randomely; however, in areas of fast water, seine-hauls were made with the current. Emulsified rotenone was

used infrequently to collect fish from pools that were unseinable. A six-volt, backpack shocker, with a field of approximately 6 feet in diameter, was used in tributaries. In addition, limited use was made of a 125-foot trammel net, and of several experimental gill nets, 150 feet in length and with mesh square that varied from ½ to 2 inches.

Specimens were preserved in 10% formalin and were deposited, unless otherwise noted, with the Research Division, Nebraska Game and Parks Commission.

Physical Characteristics. Turbidity of the water was estimated through the use of a U. S. Geological Survey turbidimeter and a Secchi disk. The temperatures of the air and water were taken with an ordinary mercury thermometer and in a manner similar to that described by Lagler (1956).

Table 2. Stream flow in cubic feet per second for Little Nemaha River at Gaging Station No. 6-8115 (Drainage area 801 square miles) and Big Nemaha River at Gaging Station No. 6-8150 (Drainage area 1,340 square miles).*

	Little Nemaha			Big Nemaha		
Water-Year†	Average flow	Maximum flow	Minimum flow	Average flow	Maximum flow	Minimum flow
1957	130	15,100	10	131	13,200	5
1958	456	49,200	22	933	35,100	14
1959	307	12,300	40	593	20,500	65
1960	430	48,000	66	974	46,900	78
1961	204	7,410	52	532	31,900	61
1962	408	20,900	69	870	31,600	109
1963	261	28,600	35	350	20,000	45
1964	99	41,000	20	265	22,000	18
1965	464	36,000	26	754	47,700	34
1966	108	5,380	22	139	2,690	25

* Data from U. S. Geological Survey.
† Oct. 1–Sept. 30, inclusive.

Table 3. Monthly averages of mean daily discharge in cubic feet per second for the water-years 1957 through 1966. Measurements made at Little Nemaha River Gaging Station No. 6-8115 and Big Nemaha River Gaging Station No. 6-8150.*

	Mean daily discharge (cfs)											
Stream	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
Little Nemaha	184	121	84	100	243	492	224	403	555	524	220	292
Big Nemaha	537	243	136	262	426	904	433	604	1001	909	244	949

* Data from U. S. Geological Survey.

The volume of flow was determined at each collecting site the methods suggested by Lagler (1956).

Collecting Stations

Each collecting site consisted of a 100-yard section of the stream. Collecting stations are shown in Figure 1 and are described below. Each station was designated by the letter L for Little Nemaha River or B for Big Nemaha River and a number indicating its general position within the drainage (numbering sequence proceeded from the river mouth to the headwaters). The name of each stream is followed by the county in which the collection occurred, the legal description of the collecting site, the date of collection(all dates are for the year 1967), and the physical characteristics of the stream.

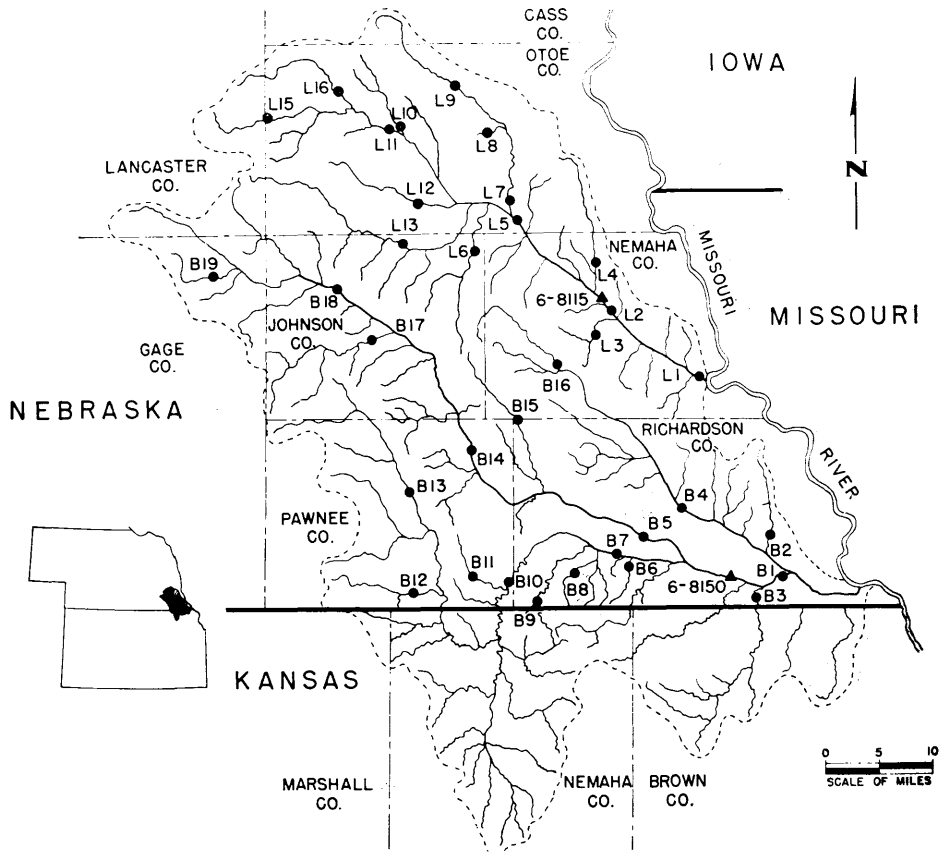

Figure 1. The location of collecting stations and U. S. Geological Survey gaging stations in the Nemaha Basin. Dots indicate collecting stations and triangles indicate gaging stations.

Little Nemaha Drainage

L-1. Little Nemaha River. Nemaha Co., Sec. 12, T4N, R15E. November 1. Current slight; bottom and banks of mud and some sand; turbidity 30 ppm; average width 59 ft.; depths to 5 ft. Evidence on shore of intensive fishing at this site.

L-2. Little Nemaha River. Nemaha Co., Sec. 9, T5N, R14E. October 3. Flow 28.3 cfs; bottom of sand; turbidity 23 ppm; average width 75 ft.; depths to 3.5 ft.

L-3. Longs Creek. Nemaha Co., Sec. 29, T5N, R14E. October 3. Flow 4.3 cfs; bottom of mud and limestone with numerous riffles; turbidity slight; average width 12 ft.; depths to 1.5 ft.

L-4. Rock Creek. Nemaha Co., Sec. 29, T6N, R14E. August 30. Flow 1.1 cfs; bottom of mud and rubble with some riffles; turbidity 75 ppm; average width 12 ft.; depths to 5 ft.

L-5. Little Nemaha River. Otoe Co., Sec. 24, T7N, R12E. October 2. Flowing through diverse channels, 85.5 cfs; bottom sand; turbidity 18 ppm; width, average 71 ft., maximum 114 ft.; depths to 3 ft.

L-6. Spring Creek. Johnson Co., Sec. 17, T6N, R12E. October 20. Flow slight; bottom mud; turbidity 26 ppm; widths from 3 to 33 ft.; depths to 6 ft.

L-7. North Fork Little Nemaha River. Otoe Co., Sec. 13, T7N, R12E. August 23. Flow slight over sand-mud bottom, 7.6 cfs; turbidity 35 ppm; width, average 19 ft., maximum 36 ft.; depths to 3.5 ft.

L-8. Deer Creek. Otoe Co., Sec. 15, T8N, R12E. October 20. Small stream; flow slight, 0.4 cfs; sand-mud bottom; width, average 2.5 ft., maximum 7 ft.; depths to 1.3 ft.

L-9. North Fork Little Nemaha River. Otoe Co., Sec. 24, T9N, R11E. August 24. Deep slack-water areas connected by wide shallow riffles; flow slight, 2.6 cfs; bottom mud; turbidity 100 ppm; width, average 15.5 ft., maximum 24.3 ft.; depths to 6 ft.

L-10. Wolf Creek. Otoe Co., Sec. 7, T8N, R11E. August 25. Stream deeply entrenched, bank height to 25 ft.; stream flow moderate, 8.5 cfs; bottom sand and mud, limestone bedrock exposed in some areas, much detritus; width, average 16 ft.; depths to 4 ft.

L-11. Little Nemaha River. Otoe Co., Sec. 12, T8N, R10E. October 27. Numerous quiet pools; flow 8.3 cfs; bottom sand and mud; stream bed wide with broad exposed rubble and sand bars; widths to 34 ft.; depths to 5.5 ft.

L-12. Muddy Creek. Otoe Co., Sec. 21, T7N, R11E. August 24. Small deeply entrenched stream; flow slight; bottom sand and mud; width, average 4.5 ft., maximum 17 ft.; depths to 3 ft.

L-13. South Fork Little Nemaha River. Johnson Co., Sec. 6, T6N, R11E. August 29. Broad, shallow stream with infrequent pools; flow moderate, 12.6 cfs; bottom mud with some sand and rubble; turbidity 30 ppm; widths to 32 ft.; depths to 3 ft.

L-14. Hooper Creek. Otoe Co., Sec. 30, T9N, R10E. August 25. Small stream; flow 0.9 cfs; bottom mud with much organic detritus; turbidity 85 ppm; width, average 5.7 ft., maximum 11 ft.; depths to 2.5 ft.

L-15. Little Nemaha River. Lancaster Co., Sec. 11, T8N, R8E. October 2. Deep pools connected by small riffles; flow 1.7 cfs; bottom sand and mud with an abundance of limestone and shale; turbidity 18 ppm; widths to 26 ft., depths to 6 in. on riffles and to 5 ft. in pools.

Big Nemaha Drainage

B-1. Big Nemaha River. Richardson Co., Sec. 16, T1N, R17E. October 26. Flowing through diverse channels, 33.2 cfs; bottom sand and mud with some organic detritus; turbidity 335 ppm; width, average 42 ft., maximum 109 ft.; depths to 4.5 ft.

B-2. Half Breed Creek. Richardson Co., Sec. 31, T2N, R17E. September 26. Stream slightly swollen by recent rains; flow 4.0 cfs; bottom sand and mud; turbidity 250 ppm; width, average 13 ft., maximum 19 ft.; depths to 3 ft.

B-3. Walnut Creek. Richardson Co., Sec. 36, T1N, R16E. October 3. Strong riffles and large pools; flow 6.7 cfs; bottom mud and sand; much refuse and organic and inorganic detritus; turbidity 85 ppm; width, average 8 ft., maximum 18 ft.; depths to 11 in. on riffles and to 3 ft. in pools.

B-4. Muddy Creek. Richardson Co., Sec. 15 T2N, R15E. October 24. Flow 16.2 cfs; bottom sand and mud; turbidity 75 ppm; width, average 32 ft., maximum 67 ft.; depths to 3 ft.

B-5. Big Nemaha River. Richardson Co., Sec. 31, T2N, R15E. October 26. Broad exposed sand and rubble bars; flowing through diverse channels, 27.1 cfs; bottom sand with rubble on riffles, numerous brush piles; turbidity 30 ppm; widths to 113 ft.; depths to 6 ft. Area favored by anglers. Large beaver dam located upstream from collecting site.

B-6. Honey Creek. Richardson Co., Sec. 12, T1N, R14E. September 26. Riffles and pools; flow 1.5 cfs; bottom mud and sand with limestone and shale on riffles; turbidity 65 ppm; width, average 7 ft., maximum 16 ft.; depths to 2.5 ft.

B-7. South Fork Big Nemaha River. Richardson Co., Sec. 11, T1N, R14E. October 24. Large pools and riffles with broad exposed rubble bars; flow 56.0 cfs; bottom sand and gravel; turbidity 95 ppm; width, average 65 ft., maximum 112 ft.; depths to 9.5 ft.

B-8. Easly Creek. Richardson Co., Sec. 13, T1N, R13E. October 14. Flow 2.3 cfs.; bottom mud, limestone detritus on riffles; turbidity 50 ppm; widths 3 to 27 ft., average 11 ft.; depths to 2 ft.

B-9. Four Mile Creek. Richardson Co., Sec. 33, TIN, R13E. October 17. Flow 3.1 cfs; bottom mud and sand with much organic detritus; turbidity 180 ppm; width, average 12 ft., maximum 17 ft.; depths to 3.5 ft.

B-10. South Fork Nemaha River. Pawnee Co., Sec. 35, T1N, R12E. October 17. Lodge pools and broad shallow riffles; flow 35.0 cfs; bottom sand, gravel, and limestone bedrock; turbidity 200 ppm; width, average 40 ft., maximum 69 ft.; depths to 5 ft.

B-11. Lores Branch. Pawnee Co., Sec. 17, T1N, R12E. October 19. A quiet pool nearly ¼ mi. long; flow slight; bottom mud; turbidity 100 ppm; width, 20 to 25 ft.; depths to 3 ft.

B-12. Johnson Creek. Pawnee Co., Sec. 29, T1N, R11E. October 17. Riffles and pools; flow 3.3 cfs; bottom sand with some limestone and shale; turbidity 45 ppm; width, 3 to 17 ft.; depths to 5 ft.

B-13. Turkey Creek. Pawnee Co., Sec. 28, T2N, R11E. October 17. Flow 3.3 cfs; bottom sand and mud; turbidity 250 ppm; width, average 9.7 ft., maximum 23 ft.; depths to 6 ft.

B-14. Big Nemaha River. Pawnee Co., Sec. 17, T3N, R12E. August 31. Pools and fast water areas; flow 23.4 cfs; bottom sand and mud; turbidity 30 ppm; widths to 48 ft.; depths to 3 ft.

B-15. Long Branch. Nemaha Co., Sec. 36, T4N, R12E. November 1. Small stream, flow 2.2 cfs; bottom mud, much organic detritus; turbidity 20 ppm; width, average 10 ft., maximum 16 ft.; depths to 2.5 ft.

B-16. Muddy Creek. Nemaha Co., Sec. 3, T4N, R13E. October 24. Pools and riffles; flow 7.4 cfs; bottom mud and sand with some rubble on riffles; turbidity 75 ppm; widths to 19 ft.; depths to 2.5 ft.

B-17. Yankee Creek Johnson Co., Sec. 27, T5N, R10E. August 30. Current fast; flow 6.5 cfs; stream deeply entrenched with vertical banks, 25 to 30 ft.; bottom sand and rubble with numerous riffles; turbidity 25 ppm; widths to 18 ft.; depths to 4 ft.

B-18. Big Nemaha River. Johnson Co., Sec. 32, T6N, R10E. August 31. Stream bed broad lacking well defined pools; flow 24.3 cfs; bottom sand; width, average 32 ft., maximum 49 ft.; depths to 4.5 ft.

B-19. Shaw Creek. Lancaster Co., Sec. 30, T6N, R8E. August 31. Flow 1.3 cfs; bottom sand and mud; turbidity 35 ppm; widths to 6 ft.; depths to 2 ft.

Annotated List of Species

In this list, the scientific and common names used are those adopted by the American Fisheries Society (Bailey *et al.,* 1960).

Lepisosteus platostomus Rafinesque.

The shortnose gar, a known inhabitant of the Missouri River, was not collected during this survey; however, additional sampling at lower mainstream sites may have produced this species.

Lepisosteus osseus (Linnaeus): Stations L-2 and B-7.

Longnose gar were rare, and were taken only in quiet pools of large streams. In addition to those specimens collected, several gar (thought to be longnose) were observed floating near the surface of a large pool at B-2.

Dorosoma cepedianum (LeSueur): Station L-1, L-4, L-5, B-1, B-2, B-4, B-7 and B-14.

The gizzard shad was usually found in quiet water and was most abundant near the confluence of Muddy Creek and the Big Nemaha River. Most specimens collected were young-of-the-year.

Hiodon alosoides (Rafinesque): Stations L-1 and B-1.

The goldeye was collected only from lower mainstream sites where it seemingly showed a preference for deep pools with a moderate current.

Esox lucius Linnaeus.

The northern pike was not collected during this survey; however, during August 1963, Witt and Kendle (1964, unpublished progress report for Job 18, Federal Aid Project F-4-R-9, Nebraska Game and Parks

Commission) collected several specimens from the Little Nemaha River near collecting site L-1. The northern pike is known to occur in portions of the Missouri River. In addition, limited introductions of this species have been made in the Nemaha Basin in recent years.

Cyprinus carpio Linnaeus: Stations L-1, L-2, L-4, L-5, L-6, L-7, L-9, L-10, L-11, L-13, L-14, L-15, B-1, B-2, B-4, B-5, B-6, B-7, B-10, B-14, and B-18.

The carp was found throughout the basin; however, it was most abundant in low-gradient streams containing an abundance of organic matter. Young-of-the-year specimens were collected from several very small streams.

Semotilus atromaculatus (Mitchill): Stations L-1, L-3, L-4, L-5, L-6, L-7, L-8, L-9, L-10, L-12, L-13, L-14, L-15, B-2, B-3, B-5, B-6, B-8, B-9, B-10, B-11, B-12, B-13, B-14, B-15, B-16, B-17, B-18 and B-19.

Creek chubs were found in all types of habitats but were most abundant in clear creeks and in the headwater regions of the more turbid streams.

Rhinichthys atratulus (Hermann): Station B-12.

Three juvenile blacknose dace were collected from the headwaters of a clear, spring-fed stream, Johnson Creek (Witt, 1969). The specimens (University of Kansas Museum of Natural History, No. 12689) were seined from an area of fast water flowing over a bottom of sand and gravel. Riffles were located immediately above and below the site of collection. Prior to our survey, the blacknose dace was known in Nebraska only from a local area in the northeastern corner of the state (Johnson, 1942).

Hybopsis aestivalis (Girard): Stations L-1, L-5, B-1 and B-5.

The speckled chub was collected only from the lower mainstream sites and showed a strong preference for fast water areas with a substrate of clean sand.

Hybopsis gracilis (Richardson): Stations L-2, L-5, L-7, L-11, L-13, B-1, B-4, B-5, B-7, B-10, B-14, B-17 and B-18.

Flathead chubs were common inhabitants of the larger streams with shifting sand bottoms.

Hybopsis storeriana (Kirtland): Stations L-1, L-2, B-1, B-4 and B-5.

The silver chub, an inhabitant of large, sandy rivers (Cross, 1967), was collected only from the lower mainstream portions of the Little and

Big Nemaha Rivers. This species was most abundant at L-1 comprising 11.8% of the collection.

Phenacobius mirabilis (Girard): Stations L-3, L-4, L-5, L-6, L-7, L-8, L-9, L-10, L-11, L-12, L-14, L-15, B-1, B-2, B-3, B-4, B-5, B-6, B-7, B-8, B-9, B-10, B-12, B-14, B-15, B-16 and B-18.

The suckermouth minnow was widespread in the basin, occurring most frequently near riffles over bottoms of sand, gravel or rubble. This species was most abundant at B-5 comprising 6.4% of the collection.

Notropis atherinoides Rafinesque: Stations L-1, L-2, L-4, L-5, L-7, B-1, B-4, B-5, B-7, B-10 and B-14.

The emerald shiner was a common inhabitant of the large, deep, sluggish portions of the Nemahas and of their major tributaries.

Notropis blennius (Girard): Stations L-5, B-1, B-5 and B-7.

The river shiner showed little tendency to ascend far upstream from the Missouri River, where it is reported to be common (Cross, 1967).

Notropis dorsalis (Agassiz): Stations L-1, L-3, L-6, L-7, L-8, L-9, L-10, L-11, L-14, B-3, B-10, B-13, B-16 and B-17.

The first published record of the bigmouth shiner in the Nemaha River System was by Metcalf (1966). The apparent failure of earlier collectors to take this now common species suggests that the bigmouth shiner has extended its range southward. This theory is supported by the fact that *N. dorsalis* was not known to occur in Kansas until the mid 1950's (Cross, 1967). Morris (1960) in his survey of the fishes of the Nebraska portion of the Platte River, found this species to be present at nearly every collection site.

In the Nemaha Basin, this minnow was more widely distributed in the Little Nemaha Drainage than in the Big Nemaha Drainage and was the most abundant species at L-6.

Notropis lutrensis (Baird and Girard): All stations.

The red shiner was the most abundant species (35.5%) in the Big Nemaha Drainage and was second in abundance in the Little Nemaha Drainage.

In his survey of the fishes of Nebraska, Johnson (1942) stated "Regions of greatest abundance [for the red shiner] are the Nemaha Rivers and small tributaries adjacent to the eastern Platte."

Notropis stramineus (Cope): All stations.

The sand shiner was ubiquitous occurring in all types of habitats

studied. This species was the most abundant species in the Little Nemaha Drainage and was second in abundance in the Big Nemaha Drainage.

Notropis topeka Gilbert.

The occurrence of the Topeka shiner in the Nebraska portion of the Nemaha Basin is doubtful except possibly in those tributaries of the Big Nemaha River that drain limestone uplands occurring along the Nebraska-Kansas border. Bailey and Allum (1962) noted one locality of occurrence in the Nemaha Basin. This collection was from Nemaha Creek, a tributary of the South Fork Big Nemaha River, Nemaha Co., Kansas.

The distribution, habitat and abundance of the Topeka shiner in Kansas have been discussed by Minckley and Cross (1959), and would indicate that this species was never common in the Nemaha Drainage.

Hybognathus hankinsoni Hubbs: Station L-11.

The brassy minnow was rare in the Nemaha Drainage as only five specimens were collected; three specimens are deposited in the University of Kansas Museum of Natural History, No. 12675. The presence of the brassy minnow at only L-11 is difficult to explain as numerous other collecting sites had similar characteristics. Johnson (1942) failed to collect this species in the Nemaha Drainage; however, the brassy minnow is known to occur in the Missouri River (Johnson, 1942; Cross, 1967) and to the north in the Platte River (Morris, 1960). Metcalf (1966) noted that the few, isolated records from the Kansas River Basin suggest that this species is a relict.

Hyboqnathus placitus Girard: Stations L-2, L-4, L-5, L-7, L-11, B-1, B-4, B-5, B-7 and B-10.

The plains minnow was found most commonly in shallow areas of low gradients with sand bottoms. This species was normally found in association with the silvery minnow, *Hyboqnathus nuchalis.* External differences employed to distinguish the plains minnow from the slivery minnow were: eye diameter, greater in *nuchalis;* scales on the belly, larger and more regular in *nuchalis;* head width to distance from tip of snout to back of eye, greater in *placitus.* The configuration of the posterior process of the basioccipital bone from numerous specimens was examined to determine the degree of accuracy of using external characteristics to separate the two forms (Cross, 1967). Of the 131 specimens examined, 96.1% had been correctly identified. However, it should be noted that the overlapping of external counts and measurements was greater in juveniles than in adults and made identification of those individuals extremely difficult.

Hybognathus nuchalis Agassiz: Stations L-1, L-4, L-7, L-10, L-11, L-12, L-13, L-15, B-1, B-4, B-5, B-8, B-10, B-14 and B-18.

In the Nemaha Basin, the slivery minnow reaches its greatest abundance in those portions of larger streams that have low gradients and a substrate of sand. This species was the most numerous form at L-2 comprising 29.5% of the collection.

Additional comments on this species have been made in the discussion of *H. placitus.*

Pimephales promelas Rafinesque: Stations L-2, L-3, L-4, L-5, L-6, L-7, L-8, L-10, L-11, L-12, L-13, L-14, L-15, B-1, B-2, B-3, B-4, B-5, B-6, B-7, B-8, B-9, B-10, B-11, B-12, B-13, B-14, B-15, B-16, B-18 and B-19.

Seemingly, small muddy streams were preferred by the fathead minnow; however, this species was taken in all types of habitat.

Campostoma anomalum (Rafinesque): Stations B-1, B-2, B-3, B-6, B-7, B-8, B-9, B-12, B-16 and B-17.

The stoneroller was not taken from the Little Nemaha Drainage, but was found distributed throughout the southern portion of the Big Nemaha Drainage. The streams of this area are characterized by clean rocky bottoms, frequent riffles, moderate to high gradients and low to moderate turbidities. This species was usually taken in riffles or fast-water areas. Only three specimens were taken in muddy or sand habitats (B-2 and B-16).

Ictiobus cyprinellus (Valenciennes): Station B-2.

The bigmouth buffalo was rarely collected in the Nemaha Basin, although its scarcity may reflect inadequate sampling of the larger waters for adult fish. This species was represented by only two young-of-the-year specimens which were collected from a small tributary to the Big Nemaha River.

Carpiodes velifer (Rafinesque).

The only record of the highfin carpsucker from the Nemaha Basin is a single specimen collected by Johnson (1942) from Muddy Creek in the Big Nemaha Drainage.

Carpiodes carpio (Rafinesque): Stations L-1, L-2, L-5, L-6, L-7, L-10, L-11, L-12, L-13, L-14, L-15, B-1, B-4, B-5, B-7, B-10, B-12, B-13, B-14, B-16 and B-18.

The larger populations of river carpsuckers occurred in calm, deep pools or backwater areas; however, river carpsuckers were collected from a

variety of habitats. During September and October, large numbers of young-of-the-year carpsuckers were captured at several collecting sites when seining slack water areas.

Ictalurus melas (Rafinesque): Stations L-1, L-6, L-7, L-9, L-10, L-11, L-12, L-13, L-14, L-15, B-1, B-2, B-4, B-5, B-6, B-7, B-8, B-9, B-10, B-11, B-12, B-13, B-14, B-15, B-16 and B-19.

The black bullhead was distributed throughout the Nemaha Basin, but was less commonly taken at main stream collecting sites. Large numbers of bullheads of a harvestable size were taken from surprisingly small streams.

Ictalurus natalis (LeSueur): Stations L-9, L-10, L-15, B-3 and B-9.

The yellow bullhead was taken at only five stations, compared with 26 stations for the black bullhead. Yellow bullheads were most common in clear, permanently flowing tributaries that had rocky or gravel bottoms.

Ictalurus punctatus (Rafinesque): Stations L-1, L-2, L-4, L-5, L-6, L-9, L-10, L-11, L-13, L-14, B-1, B-3, B-4, B-5, B-7, B-10, B-14, B-17 and B-18.

Channel catfish were most common in the larger streams where they were frequently taken from brush piles associated with pools, undercut banks and deeper fast water areas.

At station L-7 on 23 August, 231 young-of-the-year specimens were collected from a pool that had a maximum depth of 18 in., a length of 23 ft. and a maximum width of 9 ft. In this particular pool, the substrate was gravel and there was an abundance of water deposited woody cover.

The channel catfish is the most sought after game fish in the Nemaha Basin.

Pylodictis olivaris (Rafinesque): Stations L-5 and B-5.

This species was represented by only two specimens, a young-of-the-year collected from a shallow backwater area of the Little Nemaha River and an adult (20.4 inches) collected from a sluggish, deep pool of the Big Nemaha River.

Noturus gyrinus (Mitchill).

The tadpole madtom probably has been extirpated in the Nemaha Basin; none are known to have been collected since Johnson (1942) collected several specimens from the South Fork of the Big Nemaha River. The reason for the apparent decline of this species is unknown.

Noturus flavus Rafinesque: Stations B-3, B-6, B-9, B-10, B-12 and B-17.

Stonecats were collected only from the sand and rubble bottomed streams that were common to the southern portions of the Big Nemaha Drainage. This species was usually collected in riffles. Johnson (1942) failed to collect this now seemingly common species.

Fundulus kansae (Garman): Stations L-5, L-6, B-7 and B-19.

The plains killifish was, in all cases, a minor constituent in the fish fauna. This species was represented in three collections by single specimens.

Micropterus salmoides (Lacépède): Stations L-4, L-9, L-15, B-9, B-11, B-17 and B-19.

Largemouth bass were abundant at L-15, an area consisting of deep pools, moderate flow, low turbidity and with a substrate of limestone and shale, and at B-11, a deep slack water area with a mud bottom. Only young-of-the-year and sub-adults were taken at the other collecting sites.

The absence of largemouth bass from Johnson's (1942) collections would indicate either a recent introduction or an increase in abundance. This species has been stocked in numerous ponds in the watershed which might explain its increase in abundance in the streams of the Basin; however, early records (Meek, 1894; Everman and Cox, 1896) suggest that the largemouth bass was native to Nebraska.

Lepomis cyanellus Rafinesque: Stations L-3, L-5, L-6, L-8, L-9, L-10, L-11, L-14, L-15, B-2, B-3, B-4, B-6, B-9, B-11, B-13, B-14, B-15, B-16, B-17, B-18 and B-19.

The green sunfish was the most abundant centrarchid and was collected from a variety of habitats. However, this species was normally found associated with overhanging banks or in pools where loose rocks, brush, or aquatic vegetation provided cover.

Lepomis humilis (Girard): Stations B-11, B-12 and B-13.

Orange-spotted sunfish were abundant at only two collecting sites, B-11 and B-12. Both sites were characterized by low gradients, moderate turbidities and bottoms of mud or silt. It is interesting to note that this species was collected only from the Big Nemaha Drainage, although several streams in the Little Nemaha Drainage appeared to have similar physical characteristics.

Lepomis macrochirus Rafinesque: Stations L-6, L-14, B-2, B-4, B-9, B-11, B-14 and B-16.

The bluegill was rare, occurring exclusively in pools, usually near cover. This species has been widely stocked in the ponds and lakes of Nebraska which probably accounts for its establishment in lotic waters. The bluegill, like the other centrarchids, was usually represented by immature specimens.

Pomoxis annularis Rafinesque: Stations L-11, B-1, B-7, B-10 and B-15.

White crappies were rare, except in a few, large, mainstream pools. Johnson (1942) failed to take this species suggesting that it has become established only recently.

Stizostedion canadense (Smith).

The sauger was not collected in this survey; however, during August, 1963, Witt and Kendle (1964, unpublished progress report for Job 18, Federal Aid Project F-4-R-9, Nebraska Game and Parks Commission) collected several from the Little Nemaha River near its confluence with the Missouri River. The sauger is a known inhabitant of the Missouri River.

Stizostedion vitreum (Mitchill).

The walleye was not collected during this survey, but is included as it is known to occur in the drainage. A single specimen, 297 mm in standard length and weighing 355 g, was collected by the writer from the Little Nemaha River near collecting site L-11 on September 16, 1965. In addition, the Nebraska Game and Parks Commission has received sporadic reports of walleyes being caught by fishermen from both Nemahas.

Etheostoma niqrum Rafinesque: Stations L-3, L-4, B-1, B-18 and B-19.

Shallow pools adjacent to riffles were preferred by johnny darters; however, one specimen was collected from the main stream of the Big Nemaha River, (station B-18). Johnny darters were most abundant at L-3 where they comprised 11.7% of the total collection.

Aplodinotus qrunniens Refinesque: Stations L-2, L-11, B-1, B-7 and B-15.

The freshwater drum was a minor constituent in the fish fauna. All specimens were sub-adults and were collected from the deeper mainstream pools. Trautman (1957) stated that drum can tolerate turbid water, but show a preference for clear water and clean bottoms.

Table 4 lists the number of specimens of each species collected for each stream system.

Table 4. Numbers of individuals collected and the relative abundance (percent of total population) of each species for the Little Nemaha River and the Big Nemaha River.

Species	Big Nemaha R.		Little Nemaha R.	
	Number of specimens	Percent of population	Number of specimens	Percent of population
Lepisosteus osseus	4	T	1	T
Dorosoma cepedianum	52	0.4	39	0.5
Hiodon alosoides	6	T	2	T
Cyprinus carpio	29	0.2	37	0.5
Semotilus atromaculatus	552	4.4	268	3.3
Rhinichthys atratulus	3	T	.. ..	.. ..
Hybopsis aestivalis	8	0.1	5	T
Hybopsis gracilis	88	0.7	77	1.0
Hybopsis storeriana	14	0.1	15	0.2
Phenacobius mirabilis	210	1.7	151	1.9
Notropis atherinoides	342	2.8	147	1.8
Notropis blennius	28	0.2	4	T
Notropis dorsalis	51	0.4	859	10.7
Notropis lutrensis	4,408	35.5	2,355	29.3
Notropis stramineus	3,577	28.8	2,381	29.6
Hybognathus hankinsoni	.. ..	.. ..	5	T
Hybognathus nuchalis	268	2.2	425	5.3
Hybognathus placitus	232	1.9	230	2.8
Pimephales promelas	1,272	10.3	237	2.9
Campostoma anomalum	302	2.4	.. ..	.. ..
Ictiobus cyprinellus	2	T	.. ..	.. ..
Carpiodes carpio	368	3.0	217	2.7
Ictalurus melas	103	0.8	64	0.8
Ictalurus natalis	14	T	5	0.1
Ictalurus punctatus	105	0.8	305	3.8
Pylodictus olivaris	1	T	1	T
Noturus flavus	31	0.2	.. ..	.. ..
Fundulus kansae	3	T	2	T
Micropterus salmoides	45	0.4	17	0.2
Lepomis cyanellus	168	1.4	138	1.7
Lepomis humilis	74	0.6	.. ..	.. ..
Lepomis machrochirus	18	0.1	2	T
Pomoxis annularis	19	0.1	10	0.1
Etheostoma nigrum	4	T	43	0.5
Aplodinotus grunniens	4	T	.. ..	.. ..
Totals	12,405	99.5	8,042	99.7

T = represents trace
.. .. = not collected

Discussion

Major Wharton's unpublished journal of a march of the 1st Dragoons to the Pawnee Country, in August and September, 1844, noted that the waters of the Nemaha Basin were cool, clear, and flowing over sandstone and limestone. As noted previously, this type of habitat is

presently confined to the southren portions of Pawnee and Richardson Counties and to a few local areas in the Little Nemaha system. If one assumes that there has been a decrease in this type of habitat, one can also assume that there has been a subsequent decrease or loss of those species associated with this type of habitat. Unfortunately, early collectors failed to sample the waters of the Nemaha Basin, thus, faunal changes that may have occurred prior to Johnson's study (1942) are impossible to ascertain. Faunal changes within the basin have probably been slight in the interim since Johnson's work even though the list of species collected during this survey is considerably longer than that compiled by Johnson. This difference is probably a reflection of effort as Johnson made an extensive survey of the fishes of the entire state and probably was not able to expend as much effort on the Nemaha River system as was expended during our intensive study.

The faunas of the Big Nemaha River and the Little Nemaha River were generally similar. Collectively, 35 species of fishes were found to occur in the two streams, with the fauna of the Big Nemaha showing greater diversity than the fauna of the Little Nemaha River.

In the Big Nemaha River, 34 species were found, six of which were not collected from the Little Nemaha River. However, the lack of large-river forms, such as *Ictiobus cyprinellus* and *Aplodinotus gruinniens,* may reflect inadequate sampling of the downstream waters of the Little Nemaha River as both species are known to occur in the Missouri Rover (Larry A. Morris, personal communication). The occurrence of three species, *Rhinichthys atratulus, Campostoma anomalum* and *Noturus flavus* in only the Big Nemaha system can be attributed to ecological differences that exist between the two river systems. These species were normally found in streams that offered substrates of gravel or rubble and clear continuously flowing waters. Such habitat occurred most commonly in the southern portion of the Big Nemaha Drainage. Seemingly similar habitat was also found in portions of the Little Nemaha system. However, these habitats were widely separated and small in extent. *Lepomis humilis* was taken at only three collecting sites in the Big Nemaha Drainage. Its scarcity in the Big Nemaha River collections and its absence from the Little Nemaha River collections are difficult to explain. Cross (1967) stated that this species seems indifferent to bottom type, turbidity and fluctuation of water level.

Twenty-eight species were taken in the Little Nemaha system, only one of which (*Hybognathus hankinsoni*) was not taken from the Big Nemaha as well.

Johnson reported two species, *Carpiodes carpio* and *Noturus gyrinus,* from the Nemaha Basin that were not taken in this survey. On the other hand, 18 species were collected by us that were not reported by Johnson. The occurrence or apparently increased abundance of three of these, *Micropterus salmoides, Pomoxis annularis* and *Lepomis machrochirus,* may be attributed to recent introductions by man into the lentic waters of the basin. The absence of several large-river forms from Johnson's collections (namely, *Lepisosteus osseus, Hiodon alosoides, Ictiobus cyprinellus, Hybopsis storerianus, Notropis atherinoides* and *Pylodictus olivaris*) may reflect decreased stream flows during the time of his survey or inadequate sampling of lower, mainstream waters. During periods of high water, those species common to the Missouri River probably enter the lower reaches of the Nemahas and their major tributaries. Other species, such as *Hybopsis aestivalis, Rhinichthys atratulus, Noturus flavus,* and *Etheostoma nigrum* being generally specific in their habitat selection, may have been overlooked by Johnson.

Acknowledgments

I am grateful to Messrs. Rich Lemon, Leonard H. Sisson, William J. Ihm, Glen E. Dappen, Larry A. Morris and Jerry W. Morris for assistance in the collection of field data. Mr. Earl R. Kendle, in addition to providing aid in the collection of specimens, gave helpful suggestions on the design of the study and provided editorial assistance. Mr. C. Phillip Agee offered suggestions on the manuscript.

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