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The Unionid Mollusks of the Big and Little Nemaha River Basins of Southeastern Nebraska and Northeastern Kansas

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ABSTRACT

A qualitative survey of the unionid mollusks of the Nemaha basins resulted in the recovery of twenty-seven taxa and the confirmation of one additional taxon through museum records. The channelization of the basins, combined with siltation and possibly the impacts of various pollutants, have severely impacted the bivalve fauna of the region, eliminating of as many as 61 percent of the documented unionid taxa of the basins.

† † †

THE NEMAHA RIVER BASINS

The Big and Little Nemaha rivers drain all or portions of Richardson, Nemaha, Otoe, Pawnee, Gage, Johnson, and Lancaster counties in southeastern Nebraska and Brown, Nemaha and Marshall counties in northeastern Kansas. With a combined basin of approximately 7,167 km^2, they form the only drainage system of any size between the Kansas and Platte river basins (Map 1). The unionid distributions of this region are poorly known, and published material on them is limited to a list of species reported for the Nemaha by Aughey (1877) and a second species list for the Turkey Creek Basin, a tributary syatem (Evans et al., 1979).

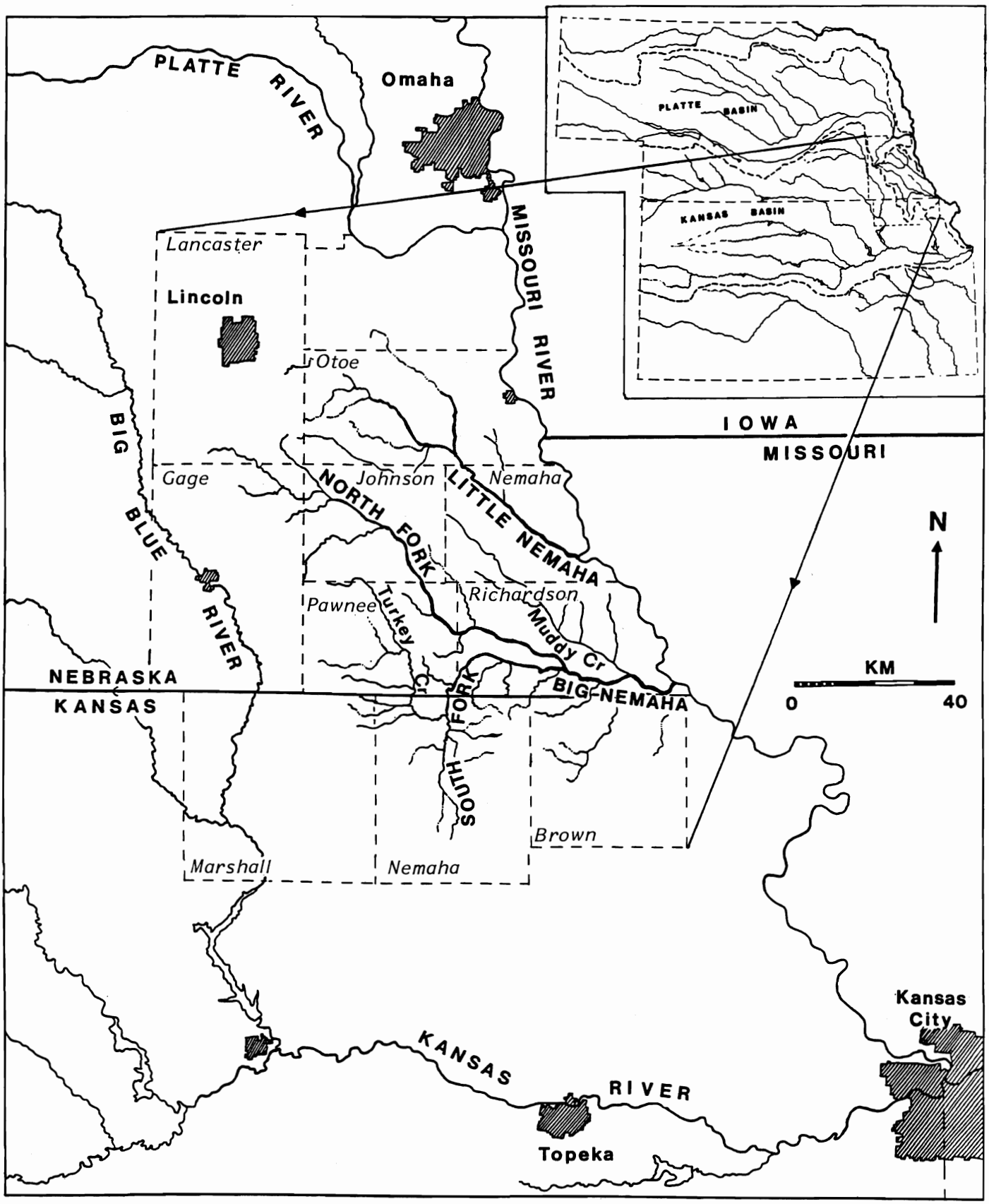
GOALS AND METHODS

This study was initiated as a part of a larger project to document and understand the distributions of unionid mollusks in Nebraska and northern Kansas. The primary goal was to collect records to document the unionid fauna of the Nemaha basins and develop a model to explain the distributions noted and any changes in the fauna which might be observable on the basis of an analysis of the living unionids and empty shells collected in this survey.

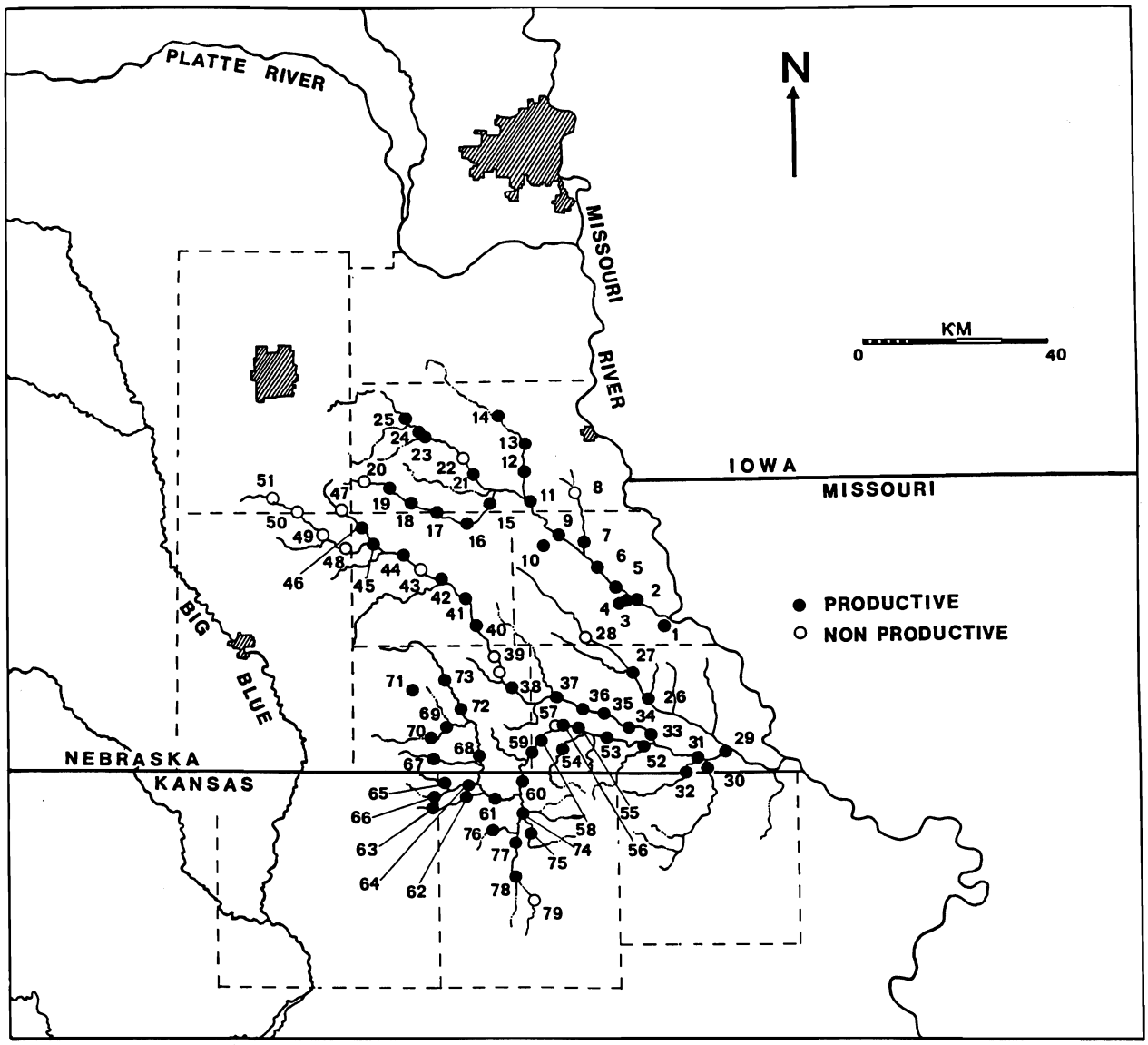
Collection activities took place between 1976 and 1995, but most collections were made in 1981 and 1995. Sites were selected at 5- to 8-mile intervals along all of the major rivers in the region, with the exception of the lower ten miles of the Big Nemaha and the Little Nemaha, which were not collected. Those areas are subject to the annual rise in the Missouri River caused by release of water at the Gavin's Point Dam to support barge traffic and were too deep to collect when visited. In addition, small creek and reservoir habitats were also investigated in an effort to gain a representative sample of the fauna of the region. Pond habitats were not sampled due to the difficulty of obtaining access. Extensive efforts were made to collect relic shells in an attempt to record taxa no longer present as living populations in the area. Sites were sampled under low-water conditions by hand or with a garden rake.

Notes on collecting conditions at each site were written in field journals, with particular emphasis placed upon factors influencing unionids. In addition, a photographic record was made at most sites. Locations of collection sites were recorded on U.S.G.S. maps with a scale of 1:250,000. A collection sheet was completed for each productive site, and specimens collected were identified as to species and condition of shell and noted on the appropriate sheet. Live specimens were generally retained only when fresh shells were unavailable at a given collection site. All specimens collected have been or will be deposited at the Ohio State University Museum of Biological Diversity in Columbus, Ohio.

Colleges and universities in the region were contacted in 1980 to determine the location of any previously collected records. In addition, in 1976 a questionnaire was distributed to conservation officers in the region, requesting information on the location of any populations in the area, and all locations mentioned by



Map 1. The Nemaha basins in perspective.



Map 2. Collection sites in the Nemaha River basins.

respondents were investigated.

Names of taxa reported from the region by Aughey (1877) have been converted into currently recognized names through listings of synonomies contained in Burch (1975) and supplemented by Dr. David H. Stansbery of the Ohio State University Museum of Biological Diversity in Columbus, Ohio. The nomenclature employed in this paper is that utilized by the Ohio State University Museum of Biological Diversity.

RESULTS

A total of 79 sites were sampled in this survey of the Nemaha basins (Map 2), and 66 of them or 84% of the total produced living unionids or empty shells. Evidence of unionids was most abundant on the Big Nemaha mainstem and along the South Fork of the Big Nemaha in the southeastern portion of the study area. Twenty-seven taxa were documented for the region in this survey (Table 1). One additional taxon, *Alasmidonta marginata*, was confirmed through examination of specimens at the University of Nebraska State Museum in Lincoln, Nebraska, and may represent one of Aughey's (1877) original records.

The most significant finding from the survey was the general absence of live specimens or fresh shells. Though 66 sites produced specimens, only 15 produced live specimens or fresh or recent shells. Further, none of the seven species of bivalves collected live or as fresh shells was particularly common. *Uniomerus tetralasmus* was the most widespread, occurring live or as fresh empty shells at six sites. *Quadrula quadrula* was collected in this condition at only four sites. Other bivalves collected live or as fresh shells and the number of sites so collected include *Leptodea fragilis* (3); *Lampsilis t. teres* (2); and *Lasmigona complanata*,

Table 1. Unionid mollusks collected from the Nemaha River Basins by collection site. L = live; F = fresh shell; R = recent shell; D = dry shell; WD = weathered dry shell; S = subfossil or chalky shell. Arrangement of taxa follows Stansbery and Borror (1983).

	LITTLE NEMAHA BASIN							
	Little Nemaha River							Whiskey Run
Collection sites:	2	6	9	11	21	23	24	1
Year(s) collected:	1981	1981	1981	1981	1981	1973	1976	1995
Taxa collected								
1. *Anodonta (Utterbackia) imbecillis* Say, 1829	–	–	–	–	–	–	–	–
2. *Anodonta (Pyganodon) grandis grandis* Say, 1829	–	–	–	S	–	WD	–	–
3. *Anodontoides ferussacianus* (Lea, 1834)	–	–	–	–	–	–	–	–
4. *Strophitus undulatus undulatus* (Say, 1817)	–	–	–	–	–	–	–	–
5. *Arcidens confragosus* (Say, 1829)	–	–	–	–	–	–	–	–
6. *Lasmigona complanata* (Barnes, 1823)	–	–	–	–	–	–	–	–
7. *Lasmigona compressa* (Lea, 1829)	–	–	–	–	–	–	–	–
8. *Tritogonia verrucosa* (Rafinesque, 1820)	–	–	–	–	–	–	–	–
9. *Quadrula quadrula* (Rafinesque, 1820)	–	–	–	–	–	–	–	–
10. *Quadrula pustulosa pustulosa* (Lea, 1831)	–	S	–	–	–	–	–	–
11. *Amblema plicata plicata* (Say, 1817)	–	S	S	–	S	–	–	S
12. *Fusconaia flava* (Rafinesque, 1820)	–	–	–	–	–	–	–	–
13. *Uniomerus tetralasmus* (Say, 1831)	–	L	–	–	WD	D	L	–
14. *Actinonaias ligamentina carinata* (Barnes, 1823)	–	–	–	–	–	–	–	–
15. *Obovaria olivaria* (Rafinesque, 1820)	–	–	–	–	–	–	–	–
16. *Truncilla truncata* (Rafinesque, 1820)	–	–	–	–	–	–	–	–
17. *Truncilla donaciformis* (Lea, 1827)	–	–	–	–	–	–	–	–
18. *Leptodea fragilis* (Rafinesque, 1820)	–	–	–	–	–	–	–	–
19. *Potamilus alatus* (Say, 1817)	–	–	–	–	–	–	–	–
20. *Potamilus ohiensis* (Rafinesque, 1820)	L	–	–	–	WD	D	–	–
21. *Toxolasma parvus* (Barnes, 1823)	–	–	–	–	–	–	–	–
22. *Ligumia recta* (Lamarck, 1819)	–	–	–	–	–	–	–	–
23. *Ligumia subrostrata* (Say, 1831)	–	–	–	–	–	–	WD	–
24. *Lampsilis teres* f. *teres* (Rafinesque, 1820)	–	WD	–	–	–	–	–	–
25. *Lampsilis teres* f. *anodontoides* (Lea, 1831)	–	–	–	–	–	–	–	–
26. *Lampsilis radiata luteola* (Lamarck, 1819)	–	–	–	–	–	–	–	–
27. *Lampsilis ventricosa* (Barnes, 1823)	–	–	–	–	–	–	–	–
28. Unidentifiable unionids	–	–	–	–	–	–	–	–
Total taxa collected:	1	4	1	1	3	3	2	1

Quadrula p. pustulosa, *Potamilus ohiensis*, and *Ligumia subrostrata* at one site each.

Though not represented in survey collections as live records, *Anodonta g. grandis*, *A. imbecillis*, and *Toxolasma parvus* are probably present in area pond and reservoir habitats, which were not extensively sampled. The remaining seventeen unionids were represented in survey collections solely by empty shells generally in weathered or chalky condition, suggesting a decrease of as much as 61% of the living unionid fauna of the region. The most widely distributed bivalves collected were *Amblema p. plicata*, *Fusconaia flava*, *Strophitus u. undulatus*, and *Ligumia subrostrata*. With one exception, all of these were weathered shells only. A single specimen of *L. subrostrata* was collected as a fresh empty shell at a single location.

Table 2 summarizes the survey results by river basin and type of environment. Species diversity, as indicated primarily by empty shells, was formerly concentrated in the major rivers of the Nemaha basins. Generally, there is a greater variety of both habitat and host fish in larger rivers, and the Nemaha rivers at one time conformed to this pattern. This is a normal distribution pattern for unionids, but it contrasts with that of the Elkhorn and Platte basins of Nebraska. In those basins, substrates of the larger rivers are primarily

Table 1. Continued.

	LITTLE NEMAHA BASIN, continued													
	Indian Creek		Hughes Creek	Rock Creek	Houchen Creek	North Fork Little Nemaha R.			South Fork Little Nemaha River					Hooper Creek
Sites:	3	4	5	7	10	12	13	14	15	16	17	18	19	25
Year(s):	1981	1995	1995	1995	1995	1995	1976	1995	1995	1995	1995	1995	1995	1990
1.	–	–	–	–	–	–	–	–	–	–	–	–	–	–
2.	–	–	–	–	–	–	–	–	–	–	–	–	–	–
3.	–	–	–	–	S	–	–	–	–	–	–	–	–	–
4.	–	–	–	–	–	–	–	–	S	–	–	S	S	–
5.	–	–	–	–	–	–	–	–	–	–	–	–	–	–
6.	–	–	–	–	–	–	–	–	–	–	–	–	–	–
7.	–	–	–	–	–	–	–	–	–	–	–	–	–	–
8.	–	–	–	–	–	–	–	–	S	–	–	–	–	–
9.	–	–	–	–	–	–	–	–	–	–	S	–	–	–
10.	–	–	–	–	–	–	–	–	–	–	–	–	–	–
11.	WD	WD	–	S	–	S	–	S	S	–	–	–	WD	S
12.	–	–	–	–	–	–	–	–	S	–	–	S	S	–
13.	L	–	–	–	–	S	WD	D		–	–	–	D	–
14.	–	–	–	–	–	–	–	–	–	–	–	–	–	–
15.	–	–	–	–	–	–	–	–	–	–	–	–	–	–
16.	–	–	–	–	–	–	–	–	–	–	–	–	–	–
17.	–	–	–	–	–	–	–	–	–	–	–	–	–	–
18.	–	–	–	–	–	–	–	–	–	–	–	–	–	–
19.	–	–	–	–	–	–	–	–	–	–	–	–	–	–
20.	–	–	–	–	–	–	D	–	–	–	–	–	–	–
21.	–	–	–	–	–	–	–	–	–	–	–	–	–	–
22.	–	–	–	–	–	–	–	–	–	–	–	–	–	–
23.	–	–	–	–	S	–	–	–	–	–	–	S	S	–
24.	–	–	–	–	S	–	–	–	–	–	–	–	–	–
25.	–	–	–	–	–	–	–	–	–	–	–	–	–	–
26.	–	–	–	–	–	–	–	–	–	–	–	S	–	–
27.	–	–	–	–	–	–	–	–	–	–	–	–	–	–
28.	–	–	WD	–	–	–	–	–	–	S	–	–	–	–
Tot. taxa:	2	1	1	1	3	2	2	2	4	1	1	4	5	1

shifting sand and bivalves are largely absent except in the more biologically rich creeks and creeklike habitats (Hoke, 1994, 1995).

Species diversity at productive collection sites was low, averaging 4.2 species per site, but included in this total are the lower portion of the Big Nemaha and the South Fork of the Big Nemaha, which were the most biologically diverse areas of the study region. Excluding these areas, the average diversity for productive sites in the region was just 2.8 species per site. Within the Little Nemaha basin it was even lower at 2.1 species per site.

DISTRIBUTIONS

The species collected in the survey are discussed in detail below and cross referenced to the accompanying maps. Collection sites are denoted on the maps by circles and triangles. Closed circles or triangles indicate sites at which a given taxon was collected, while open circles indicate other collection sites. All sites were collected by the author.

Anodonta g. grandis (Map 3) was collected at sixteen sites throughout the basin, but it was not collected live at any site. It appears to have been extirpated from the rivers of the region, but the lower 10 miles of the

Table 1. Continued.

	BIG NEMAHA BASIN													
	Big Nemaha River		Muddy Cr.	W. Fork Muddy Cr.	Walnut Cr.	Pony Creek	North Fork Big Nemaha River →							
Sites:	29	31	26	27	30	32	33	34	35	36	37	38	40	41
Year(s):	1995	1995	1980	1976	1995	1995	1995	1981	1995	1981	1995 1981	1995 1976	1981	1981
1.	–	–	–	–	–	–	–	–	–	–	–	–	–	–
2.	–	S	–	–	–	S	S	–	–	–	–	–	–	–
3.	–	–	–	–	–	–	–	–	–	–	–	–	–	–
4.	S	S	–	–	–	S	–	–	–	–	S	–	–	S
5.	–	–	–	–	–	–	–	–	–	–	–	–	–	–
6.	–	S	–	–	–	–	–	–	–	–	–	L	–	S
7.	–	–	–	–	–	–	–	–	–	–	–	–	–	–
8.	S	S	–	–	–	–	–	–	–	–	–	–	–	–
9.	WD	–	–	–	L	L	–	–	–	–	–	L	–	–
10.	WD	S	–	–	–	L	–	S	–	S	–	–	–	–
11.	–	S	–	–	–	WD	S	S	S	–	WD	S	–	S
12.	S	WD	–	–	–	S	S	S	WD	–	S	S	–	S
13.	–	–	–	L	–	WD	–	–	–	–	–	–	–	–
14.	–	–	–	–	–	–	–	–	–	–	–	–	–	–
15.	–	–	–	–	–	–	–	–	–	–	–	–	–	–
16.	S	S	–	–	–	–	–	–	–	–	–	–	–	–
17.	S	–	–	–	–	–	–	–	–	–	–	–	–	–
18.	R	–	–	–	R	–	–	–	–	–	–	–	–	–
19.	WD	S	–	–	–	–	–	–	–	–	–	–	–	–
20.	D	S	–	–	–	–	–	–	–	–	–	WD	–	–
21.	–	–	–	–	–	–	–	–	–	–	–	–	–	–
22.	–	–	–	–	–	–	–	–	–	–	–	–	–	–
23.	S	S	–	–	–	S	–	–	–	–	–	S	–	–
24.	S	S	–	–	–	–	–	–	–	L	–	–	–	–
25.	–	–	–	–	–	–	–	–	–	–	–	–	–	–
26.	–	S	–	–	–	–	–	–	–	–	–	–	–	–
27.	S	S	–	–	–	–	–	–	–	–	–	–	–	–
28.	–	–	S	–	–	–	–	–	–	–	–	–	S	–
Tot. taxa:	13	14	1	1	2	8	3	3	2	2	3	6	1	4

Big and Little Nemaha were not collected and may yield live specimens in the future. The demise of *Anodonta grandis* from the Nemaha system may be more apparent than real. It is probable that area ponds contain populations, and these habitats were not sampled in this study.

Anodonta imbecillis (Map 3) was located at only one site in this study. A weathered individual was retrieved from Burchard Lake, however, like *Anodonta grandis*, it is probably much more common in the area than indicated by this survey. Its preferred habitat, quiet waters of ponds and lakes, was not extensively sampled.

Specimens of *Anodontoides ferussacianus* (Map 4) were recovered at seven sites in the Nemaha basins. They were found in the upper portions of the basins along small tributaries. A similar distribution pattern has also been reported for this taxon for the Elkhorn basin (Hoke, 1994) and the Platte River basin (Hoke, 1995). All specimens found were either subfossil or highly weathered single valves, and it is doubtful that live populations survive in the basins at the present time.

Strophitus u. undulatus (Map 5) was one of the most widely distributed unionids recovered in the survey. Despite its abundance in survey collections, it is

Table 1. Continued.

	BIG NEMAHA BASIN, continued														
	N. Fork Big Nemaha R.				South Fork Big Nemaha River									Rock Creek	Fourmile Creek
Sites:	42	44	45	46	53	55	56	58	59	60	74	77	78	52	54
Year(s):	1981	1981	1995	1995	1995	1995	1995	1981	1995	1995	1995	1985	1995	1995 1990	1995
1.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
2.	–	–	–	–	–	–	–	–	–	WD	S	–	S	–	–
3.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
4.	–	–	S	–	–	S	–	–	S	S	S	S	S	S	S
5.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
6.	–	–	S	–	WD	–	–	–	S	S	S	S	–	–	–
7.	–	–	–	–	–	–	–	–	–	–	S	–	–	–	–
8.	–	–	–	–	–	WD	–	–	–	–	–	–	–	WD	–
9.	–	–	–	–	S	WD	–	S	D	WD	–	–	–	–	–
10.	–	–	–	–	S	D	–	S	–	WD	–	–	–	WD	–
11.	–	–	–	–	WD	WD	S	S	S	WD	S	WD	S	WD	WD
12.	–	–	–	–	WD	S	S	S	S	WD	S	WD	S	WD	WD
13.	–	–	–	–	–	–	–	–	–	WD	S	WD	S?	–	–
14.	–	–	–	–	–	–	S	–	–	–	–	–	–	–	–
15.	–	–	–	–	S	–	S?	–	–	–	–	–	–	–	–
16.	–	–	–	–	–	–	–	S	–	S	–	–	–	–	–
17.	–	–	–	–	–	–	S	–	–	–	–	–	–	–	–
18.	–	–	–	–	D	D	R	S	–	–	–	–	–	–	–
19.	–	–	–	–	–	S	–	S	S	–	–	–	–	–	–
20.	–	–	–	–	–	WD?	D	S	WD	–	–	–	–	–	–
21.	–	–	–	–	–	–	–	–	–	–	–	–	S	–	–
22.	–	–	–	–	–	–	S?	S	S	–	–	–	–	S	–
23.	–	–	–	–	–	S	D	–	S	S	S	F	S	–	–
24.	–	–	S	–	–	S	F	S	–	S	–	–	S?	–	S
25.	–	–	–	–	WD	S	S	–	–	–	–	–	–	–	–
26.	–	–	–	–	–	S	–	S	S	S	–	–	–	WD	–
27.	–	–	–	–	WD	S	S	S	S	S	–	–	–	–	–
28.	S	S	–	S	–	–	–	–	–	–	–	–	–	–	–
Tot.taxa:	1	1	3	1	9	14	12	12	11	13	8	6	8	7	4

not represented by a single fresh shell. *Strophitus u. undulatus* was collected only as weathered or chalky empty shells, and in no instance were both valves of a single individual recovered. It has been collected in Nebraska only as a documented live record in the canals of the Platte basin in west-central Nebraska (Payton and Maher, 1995). Although formerly present in the eastern part of the state, the species is represented in recent collections only by weathered shells (Hoke 1994, 1995). It has probably been extirpated from the Nemaha basins.

Arcidens confragosus (Map 6) was represented at one site by several weathered valves. In Kansas this species is listed as threatened. It appears always to have been rare in Nebraska, having been reported from only one other site in the state (Hoke, 1994), and it is extremely doubtful that any live populations remain in the Nemaha basins.

Lasmigona complanata (Map 6) was found at numerous sites in the Big Nemaha basin but it was recovered live from only one site. A single live individual was collected at site 38 in a sand substrate at a depth of three inches. It was one of only two live mussels recovered at that site, which was collected when the river was nearly dry. This mussel may be present in the extreme lower 10 miles of the Big and Little Nemaha

Table 1. Continued.

	BIG NEMAHA BASIN, continued														
	Turkey Creek Basin														
	Turkey Creek					Clear Creek		Manley Creek		Pole Cr.	John-son Cr.	W. Br. Turkey C.	Burch-ard Lk.	Harris Cr.	Wild-cat Cr.
Sites:	61	68	69	72	73	62	63	64	66	65	67	70	71	75	76
Year(s):	1995	1995	1995	1995	1980	1995	1995	1995	1995	1995	1995	1995	1980	1995	1995
1.	–	–	–	–	–	–	–	–	–	–	–	–	WD	–	–
2.	S	–	S	S	S	–	–	S	S	S	–	S	–	–	S
3.	S	–	S	–	–	–	–	–	S	S	–	–	–	S	–
4.	S	S	S	–	–	–	–	S	–	–	–	–	–	S	S
5.	–	–	–	–	–	–	–	–	–	S	–	–	–	–	–
6.	–	–	–	WD	–	–	–	–	–	–	–	–	–	S	–
7.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
8.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
9.	–	R	–	–	–	–	–	–	–	–	–	–	–	–	–
10.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
11.	–	–	D	WD	–	–	–	S	–	S	–	–	–	WD	S
12.	–	S	D	S	–	–	–	S	S	–	–	–	–	S	S
13.	–	S	D	–	–	–	–	–	–	–	–	–	L	S	R
14.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
15.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
16.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
17.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
18.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
19.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
20.	WD	–	–	–	–	–	–	–	–	–	–	–	–	–	–
21.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
22.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
23.	S	WD	D	–	–	–	S	S	S	S	–	S	–	S	WD
24.	–	–	–	–	–	–	–	S?	–	–	–	–	–	–	–
25.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
26.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
27.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
28.	–	–	–	–	–	S	–	–	–	–	S	–	–	–	–
Tot. taxa:	5	5	7	4	1	1	1	6	4	5	1	2	2	7	6

basins, which were not collected in this survey. *Lasmigona complanata* is an extremely hardy species and is widely distributed in eastern and central Nebraska. Its apparent rarity in the Nemaha basins was not expected.

Lasmigona compressa (Map 7) was found at only one site on the South Fork of the Big Nemaha River. It appears to have been uncommon in the region and has only been reported in Nebraska as weathered records from one site in the Elkhorn basin (Hoke, 1994). It is now probably extinct in the Nemaha basins.

Tritogonia verrucosa (Map 7) was collected primarily from the lower portion of the Big Nemaha and South Fork Big Nemaha rivers. In all cases, it was recovered as highly weathered empty shells. This species seems once to have been infrequent but widespread in southeastern Nebraska and northeastern Kansas, but it now appears to be absent from the region. It has probably been extirpated from the Nemaha basins.

The maple leaf mussel, *Quadrula quadrula* (Map 8), is still present in the Nemaha basins, but it was comparatively uncommon. Site 38 yielded one live specimen, and small populations were noted at sites 30 and 32. All other occurrences were as weathered shells

Table 2. Unionid mollusks collected by environment by best condition. L = live; F = fresh shell; R = recent shell; D = dry shell; WD = weathered dry shell; S = subfossil or chalky shell; M = museum specimen. Arrangement of taxa follows Stansbery and Borror (1983). Nomenclatural citations are in Table 1.

	Best Species Condition						
	Little Nemaha Basin			Big Nemaha Basin			Nemaha River basins
	Creeks	Rivers	Total	Creeks, reservoir	Rivers	Total	
Anodonta (Utterbackia) imbecillis	–	–	–	WD	–	WD	WD
Anodonta (Pyganodon) grandis grandis	–	WD	WD	S	WD	WD	WD
Anodontoides ferussacianus	S	–	S	S	–	S	S
Strophitus undulatus undulatus	–	S	S	S	S	S	S
Alasmidonta marginata	–	–	–	–	–	–	M
Arcidens confragosus	–	–	–	S	–	S	S
Lasmigona complanata	–	–	–	WD	L	L	L
Lasmigona compressa	–	–	–	–	S	S	S
Tritogonia verrucosa	–	S	S	WD	WD	WD	WD
Quadrula quadrula	–	S	S	L	L	L	L
Quadrula pustulosa pustulosa	–	S	S	L	D	L	L
Amblema plicata plicata	WD	WD	WD	D	WD	D	D
Fusconaia flava	–	S	S	D	WD	D	D
Uniomerus tetralasmus	L	L	L	L	WD	L	L
Actinonaias ligamentina carinata	–	–	–	–	S	S	S
Obovaria olivaria	–	–	–	–	S	S	S
Truncilla truncata	–	–	–	–	S	S	S
Truncilla donaciformis	–	–	–	–	S	S	S
Leptodea fragilis	–	–	–	R	R	R	R
Potamilus alatus	–	–	–	–	WD	WD	WD
Potamilus ohiensis	–	L	L	WD	D	D	L
Toxolasma parvus	–	–	–	–	S	S	S
Ligumia recta	–	–	–	S	S	S	S
Ligumia subrostrata	S	WD	WD	D	F	F	F
Lampsilis teres f. *teres*	S	WD	WD	S	L	L	L
Lampsilis teres f. *anodontoides*	–	–	–	–	WD	WD	WD
Lampsilis radiata luteola	–	S	S	WD	S	WD	WD
Lampsilis ventricosa	–	–	–	–	WD	WD	WD
Total taxa collected	**5**	**12**	**13**	**18**	**24**	**27**	**28**
Productive Sites	**7**	**15**	**22**	**21**	**23**	**44**	**66**

only. The general absence of live populations is unusual, for this mussel is among the hardiest and most widespread bivalves in eastern and central Nebraska and northeastern Kansas.

Shells of *Quadrula p. pustulosa* (Map 9) were scattered along the lower portion of the South Fork Big Nemaha, and the mussel was well distributed through the region, but specimens were largely weathered shells. Site 32 was the only location at which live individuals were discovered. This parallels its status in other parts of Nebraska, where published records are limited to two specimens, one in the Elkhorn basin (Clausen and Havlik, 1984) and the second in the lower Platte basin (Hoke, 1995). This bivalve appears to be less adaptable to current conditions than *Quadrula quadrula* and is generally declining throughout its range in the central plains.

The most numerous bivalve encountered in the survey was *Amblema plicata plicata* (Map 10). It appears once to have been quite plentiful in the region in the larger rivers as well as the small tributaries. It was found at 37 of the 66 productive collection sites, but all specimens recovered were either highly weathered or subfossil. Further, in only one instance were both valves of a single specimen recovered, and these were badly weathered. It is now probably absent from the Nemaha basins.

Fusconaia flava (Map 11) was the second most widespread unionid collected in the survey, with twenty-

Table 3. Summary of unionid mollusks collected from the Turkey Creek Basin. L = live; F = fresh shell; R = recent shell; D = dry shell; WD = weathered dry shell; S = subfossil or chalky shell. Arrangement of taxa follows Stansbery and Borror (1983).

	Hoke (1996)	**Evans et al. (1979)**
Anodonta (Utterbackia) imbecillis	WD	–
Anodonta (Pyganodon) g. grandis	S	X
Anodontoides ferussacianus	S	X
Strophitus undulatus undulatus	S	X
Arcidens confragosus	S	–
Lasmigona complanata	WD	X
Quadrula quadrula	R	X
Amblema plicata plicata	D	X
Fusconaia flava	D	X
Uniomerus tetralasmus	L	X
Potamilus ohiensis	WD	X
Toxolasma parvus	–	X
Ligumia subrostrata	D	X
Lampsilis teres f. teres	S	–
Total taxa collected	**13**	**11**

nine occurrences, but it was represented only by unmatched weathered or chalky valves. This mussel was once present in eastern Nebraska and northeastern Kansas but now appears to be largely absent. In Kansas, it is currently listed as a species in need of conservation. *Fusconaia flava* has probably been extirpated from the Nemaha basins.

Uniomerus tetralasmus (Map 12) was the most widespread living mollusk collected in the Nemaha basins. Specimens were generally collected from mud substrates in shallow water. It can be quite numerous in eastern Kansas in the quiet waters of ponds (Murray and Leonard, 1962). Its relative abundance in survey results may be attributable to its well documented ability to survive under adverse conditions.

A single fragmentary subfossil valve of *Actinonaias ligamentina carinata* was recovered during the survey (Map 12). This is only the second report of this bivalve from the region in recent times. A similarly worn valve has been collected from the Elkhorn basin in Nebraska (Hoke, 1994). This unionid is now probably absent from the Nemaha basins.

Obovaria olivaria (Map 13) was collected as a subfossil valve at two sites along the South Fork of the Big Nemaha River. This species has also been reported as a weathered record from the Elkhorn River basin (Hoke, 1994) where it was also rare. The presence of live populations in the Nemaha basins is extremely doubtful.

Truncilla truncata (Map 13) was limited in its distribution to the Big Nemaha and South Fork Big Nemaha rivers, where it was collected only as weathered empty shells. It has been reported for Nebraska in the Elkhorn basin (Hoke, 1994) and is found infrequently in the Missouri River adjacent to Nebraska (Hoke, 1983). It has probably been extirpated from the Nemaha basins.

The distribution of *Truncilla donaciformis* (Map 14) was also limited to the Big Nemaha and South Fork Big Nemaha rivers. It has been reported from the Elkhorn basin (Hoke, 1994) and Missouri River bordering Nebraska (Hoke, 1983), but it has not been reported live from the interior of Nebraska, nor is it so reported here. Recovered solely as subfossil unpaired valves, this mussel is now probably absent from the Nemaha basins.

Leptodea fragilis (Map 15) was collected from six sites in the Big Nemaha and South Fork Big Nemaha basins. It was present in small creeks as well as larger rivers and was generally found in regions with substrates consisting of soft mud. *Leptodea fragilis* is common in the Missouri River bordering Nebraska (Hoke, 1983).

The distribution of *Potamilus alatus* (Map 16) was also found in this study to be restricted to the Big Nemaha and the lower portion of the South Fork Big Nemaha rivers. This species was not collected as a fresh shell during the survey, but the existence of live populations in the Big and Little Nemaha rivers cannot be entirely dismissed. *Potamilus alatus* has been found live in the adjacent Missouri River (Hoke, 1983), and the lower portions of the Big and Little Nemaha rivers were not collected in this study due to depth.

Potamilus ohiensis (Map 17) was represented in both the Big and Little Nemaha drainages by live specimens. It was found deeply embedded in sand or mud substrates in water up to 3 feet in depth. This bivalve is also present in the adjacent Missouri River (Hoke, 1983)

Toxolasma parvus (Map 14) was collected at one site in the upper South Fork Big Nemaha river. It is probably more numerous in the study area than indicated from the survey, as it is frequently found in small ponds, a habitat not sampled in this survey. *Toxolasma parvus* has been collected live from the Platte system (Hoke, 1995; Peyton and Maher, 1995) and as a fresh shell from the Elkhorn basin (Hoke, 1994).

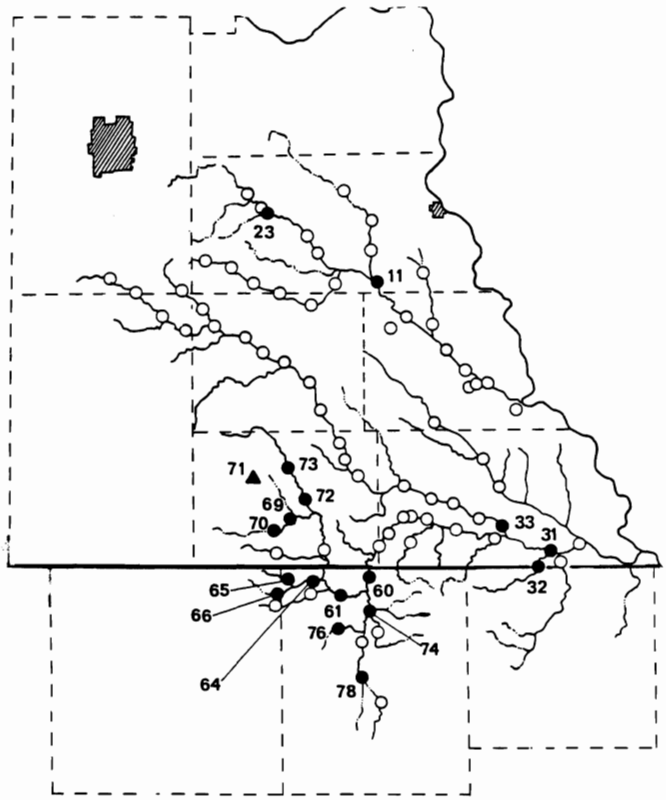
Subfossil specimens of *Ligumia recta* (Map 18) were collected from four sites along the lower portion of the South Fork Big Nemaha River and its tributaries. There

Table 4. Taxa reported for the Nemaha River Basins in Nebraska by Aughey (1877). The names reported by Aughey (1877) are given unchanged from his original report and in his arrangement.

Aughey (1877)	Currently recognized name
Unio anodontoides, Lea	*Lampsilis teres* f. *anodontoides* (Lea, 1831)
Unio alatus, Say	*Potamilus alatus* (Say, 1817)
Unio asperrimus, Say	*Quadrula quadrula* (Rafinesque, 1820)
Unio blandingianus?, Lea	*Uniomerus obesus* (Lea, 1831)
Unio camptodon, Say	*Uniomerus tetralasmus* (Say, 1831)
Unio circulus, Lea	*Obovaria subrotunda* (Rafinesque, 1820)
Unio clavus, Lamarck	*Pleurobema clava* (Lamarck, 1819)
Unio coccinus, Lea	*Pleurobema sintoxia* (Rafinesque, 1820)
Unio congaraeus?, Lea	*Elliptio congaraea* (Lea, 1831)
Unio cornutus, Bar.	*Obliquaria reflexa* (Rafinesque, 1820)
Unio cylindricus, Say	*Quadrula c. cylindrica* (Say, 1817)
Unio elegans, Lea	*Truncilla truncata* (Rafinesque, 1820)
Unio gibbosus, Bar.	*Elliptio dilatata* (Rafinesque, 1820)
Unio hebetatus, Con.	*Fusconaia flava* (Rafinesque, 1820)
Unio higginsi, Lea	*Lampsilis higginsi* (Lea, 1857)
Unio latecostatus, Lea	*Megalonaias nervosa* (Rafinesque, 1820)
Unio lacrymosus, Lea	*Quadrula quadrula* (Rafinesque, 1820)
Unio laevissimus, Lea	*Potamilus ohiensis* (Rafinesque, 1820)
Unio ligamentinus, Lam.	*Actinonaias ligamenina carinata* (Barnes, 1823)
Unio metanevrus, Raf.	*Quadrula metanevra* (Rafinesque, 1820)
Unio mississippiensis, Con.	*Ligumia subrostrata* (Say, 1831)
Unio multiradiatus, Lea	*Lampsilis fasciola* Rafinesque, 1820
Unio mytiloides, Raf.	*Pleurobema clava* (Lamarck, 1819)
Unio nigerrimus, Lea	*Villosa lienosa* (Conrad, 1834)
Unio ochraecus, Say	*Leptodea ochracea* (Say, 1817)
Unio patulus, Lea	*Pleurobema clava* (Lamarck, 1819)
Unio perdix, Lea	*Actinonaias pectorosa* (Conrad, 1834)
Unio perplexus, Lea	*Epioblasma t. torulosa* (Rafinesque, 1820)
Unio plicatus, Lesueur	*Amblema p. plicata* (Say, 1817)
Unio pressus, Lea	*Lasmigona compressa* (Lea, 1829)
Unio purpuratus, Lam.	*Potamilus purpuratus* (Lamarck, 1819)
Unio radiatus, Lam.	*Lampsilis radiata luteola* (Lamarck , 1819)
Unio rectus, Lam.	*Ligumia recta* (Lamarck, 1819)
Unio rotundatus, Lam.	*Glegula rotundata* (Lamarck, 1819)
Unio rubiginosus?, Lea	*Fusconaia flava* (Rafinesque, 1820)
Unio rutersvillensis, Lea	*Ligumia subrostrata* (Say, 1831)
Unio subinflatus, Con.	*Elliptio complanata* (Lightfoot, 1786)
Unio subovatus, Lea	*Lampsilis ventricosa* (Barnes, 1823)
Unio sulcatus?, Lea	*Epioblasma o. obliquata* (Rafinesque, 1820)
Unio tenuissimus, Lea	*Leptodea leptodon* (Rafinesque, 1820)
Unio triangularis, Bar.	*Epioblasma triquetra* (Rafinesque, 1820)
Unio tuberculatus, Bar.	*Tritogonia verrucosa* (Rafinesque, 1820)
Unio undulatus, Bar.	*Megalonaias nervosa* (Rafinesque, 1820)
Unio ventricosus, Bar	*Lampsilis ventricosa* (Barnes, 1823)
Margaritana complanata, Lea	*Lasmigona complanata* (Barnes, 1823)
Margaritana marginata, Say	*Alasmidonta marginata* Say, 1818
Anodonta danielsi, Lea	*Anodonta g. grandis* Say, 1829
Anodonta decora, Lea	*Anodonta g. grandis* Say, 1829
Anodonta edentula, Say	*Strophitus u. undulatus* (Say, 1817)
Anodonta ferussaciana, Lea	*Anodontoides ferussacianus* (Lea, 1834)
Anodonta grandis, Say	*Anodonta g. grandis* Say, 1829
Anodonta imbecilis, Say	*Anodonta imbecillis* Say, 1829
Anodonta ovata?, Lea	*Anodonta g. grandis* Say, 1829
Anodonta plana, Lea	*Anodonta g. grandis* Say, 1829
Anodonta undulata, Say	*Strophitus u. undulata* (Say, 1819)

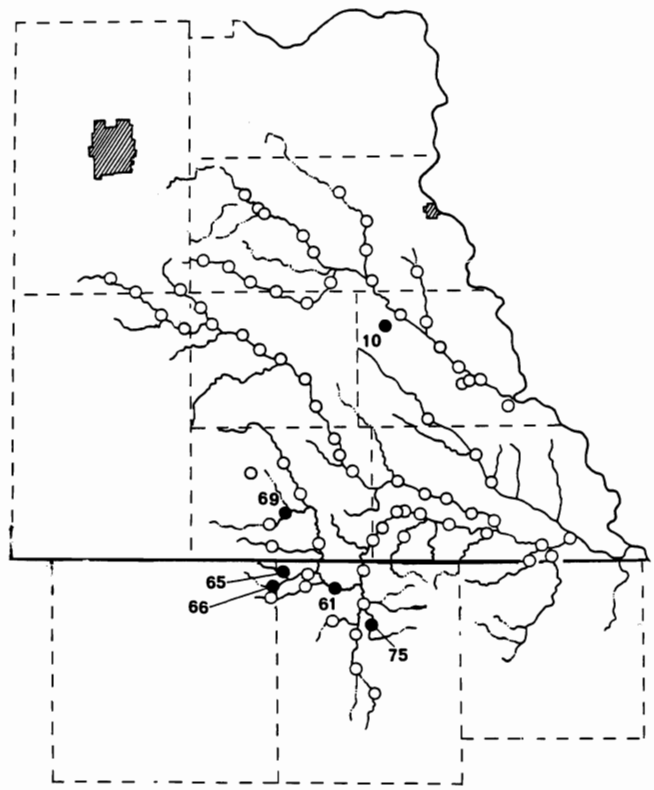
was nothing recovered during the course of the survey to suggest the presence of live populations, and the species probably has been extirpated from the Nemaha basins. *Ligumia recta* has also been reported for the Elkhorn basin in Nebraska (Hoke, 1994), where its status is similarly dismal.

The third most frequently collected unionid was *Ligumia subrostrata* (Map 19), which was recovered at 24 sites in the survey area, usually as a weathered specimen. Despite its evident historical distribution in the area, only one fresh specimen was collected. Murray and Leonard (1962) report *L. subrostrata* as common in eastern Kansas, but the only recent live collection in Nebraska was the recovery of one individual from the Elkhorn basin (Clausen and Havlik, 1994). It is pos-

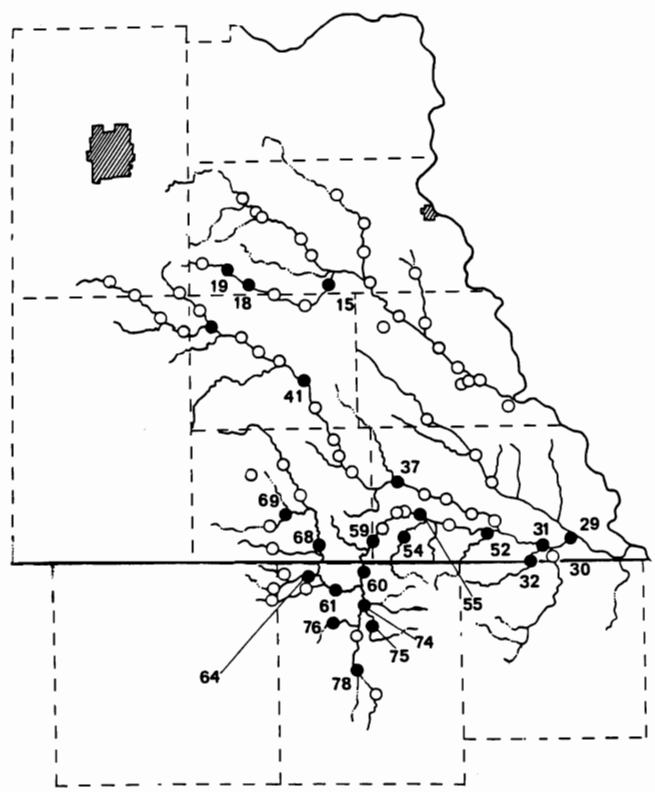


3 ● ANODONTA (UTTERBACKIA) IMBECILLIS

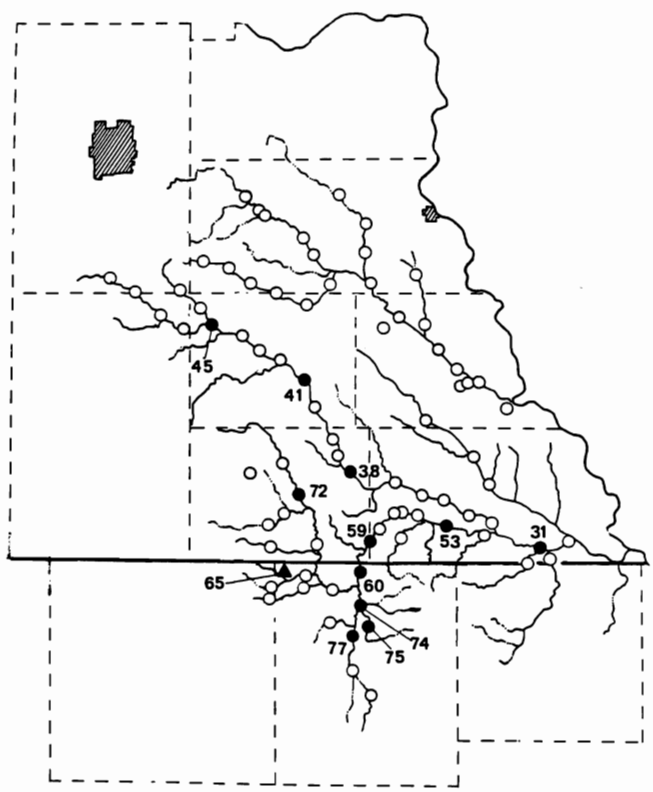
▲ ANODONTA (PYGANODON) GRANDIS GRANDIS



4 ● ANODONTOIDES FERUSSACIANUS



5 ● STROPHITUS UNDULATUS UNDULATUS



6 ▲ ARCIDENS CONFRAGOSUS

● LASMIGONA COMPLANATA

Table 5. Summary of unionid taxa reported for the Nemaha River Basins. X = reported; L = live; F = fresh shell; D = dry shell; WD = weathered dry shell; S = subfossil or chalky shell; M = museum specimen. Arrangement of taxa follows Stansbery and Borror (1983).

Taxa Reported	Study		
	Hoke (1996)	Evans et al. (1979)	Aughey (1877)
Confirmed:			
Anodonta imbecillis	WD	–	X
Anodonta g. grandis	L	X	X
Anodontoides ferussacianus	S	X	X
Strophitus u. undulatus	S	X	X
Alasmidonta marginata	M	–	X
Arcidens confragosus	S	–	–
Lasmigona complanata	L	X	X
Lasmigona compressa	S	–	X
Tritogonia verrucosa	S	–	X
Quadrula quadrula	L	X	X
Quadrula p. pustulosa	WD	–	–
Amblema p. plicata	S	X	X
Fusconaia flava	WD	X	X
Uniomerus tetralasmus	L	X	X
Actinonaias ligamentina carinata	S	–	X
Obovaria olivaria	S	–	–
Truncilla truncata	S	–	X
Truncilla donaciformis	S	–	–
Leptodea fragilis	F	–	X
Potamilus alatus	WD	–	X
Potamilus ohiensis	D	X	X
Toxolasma parvus	S	X	–
Ligumia recta	S	–	X
Ligumia subrostrata	F	X	X
Lampsilis teres f. *teres*	L	–	–
Lampsilis teres f. *anodontoides*	S	–	X
Lampsilis radiata luteola	WD	–	X
Lampsilis ventricosa	S	–	X
Total	**28**	**11**	**22**
Unconfirmed:			
Megalonaias nervosa	–	–	X
Quadrula c. cylindrica	–	–	X
Quadrula metanevra	–	–	X
Elliptio dilatata	–	–	X
Obliquaria reflexa	–	–	X
Leptodea leptodon	–	–	X
Potamilus purpuratus	–	–	X
Lampsilis higginsi	–	–	X
Epioblasma triquetra	–	–	X
Total	**–**	**–**	**9**
Probable misidentifications:			
Pleurobema clava	–	–	X
Pleurobema sintoxia	–	–	X
Elliptio congaraea	–	–	X
Elliptio complanata	–	–	X
Uniomerus obesus	–	–	X
Glebula rotundata	–	–	X
Actinonaias pectorosa	–	–	X
Obovaria subrotunda	–	–	X
Villosa lienosa	–	–	X
Lampsilis fasciola	–	–	X
Leptodea ochracea	–	–	X
Epioblasma o. obliquata	–	–	X
Epioblasma t. torulosa	–	–	X
Total	**–**	**–**	**13**
Total taxa reported	**28**	**11**	**44**

sible this unionid exists in basin ponds, which were not sampled in this survey.

Lampsilis teres f. *teres* (Map 20) was collected live or as a fresh empty shell in both the Big and Little Nemaha basins. Live specimens were collected from shallow water in rock and clay riffle areas. This mussel has also been reported from the Elkhorn (Hoke, 1994) and Platte (Hoke, 1995) basins in eastern Nebraska.

Specimens of *Lampsilis teres* f. *anodontoides* (Map 21) were collected only from the South Fork Big Nemaha. All specimens collected were represented by weathered single valves, and there is no indication in this survey to suggest the presence of extant populations.

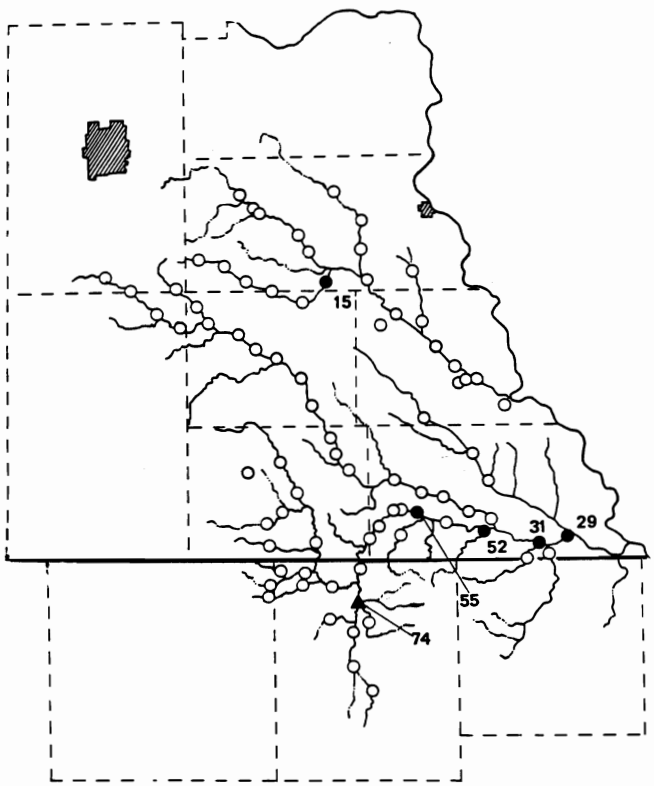
Lampsilis radiata luteola (Map 22) was collected in both the Big and Little Nemaha basins but was uncommon in the latter. It was generally found in weathered or subfossil condition. This unionid appears to have been extirpated from the Nebraska portion of the river but may still be present in portions of the South Fork Big Nemaha River in Kansas. It has also been reported for the Elkhorn (Hoke, 1994) and Platte (Hoke, 1995) basins but only as empty shells.

The distribution of *Lampsilis ventricosa* (Map 23) was similarly limited to the Big Nemaha and the South Fork Big Nemaha rivers. All specimens recovered were weathered, and it is probable that this mussel has been extirpated from the Nemaha basins. This bivalve has been recently reported as a live record only from the upper Elkhorn River basin (Clausen and Havlik, 1994; Hoke, 1994).

LITERATURE REVIEW

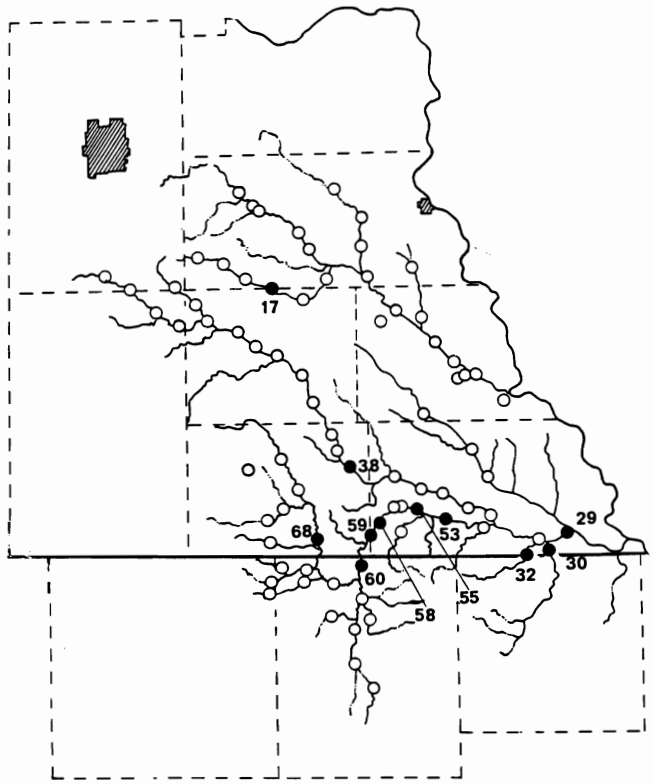
The literature on the bivalves of the Nemaha basins is extremely limited. The only recent study is that of Evans et al. (1979), who recovered eleven taxa from the Turkey Creek Basin of the South Fork Big Nemaha River. A comparison of the taxa recovered for this area is presented in Table 3. Only one of Evans' taxa, *Toxolasma parvus*, is unrepresented in the current study, while three new taxa, *Anodonta imbecillis*, *Arcidens confragosus*, and *Lampsilis t. teres*, are first reported for the Turkey Creek Basin in this study.

The only other article on the unionids of the Nemaha basin is a species list contained in Aughey (1877), which lists 55 taxa for the region. Eleven of these are synonomies, and thus the actual figure for the Nemaha basin includes only 44 valid modern (Table 4). It is difficult to compare the work of Aughey with that of the current study. Aughey did not record his collection locations specifically, and all were recorded as "Nemaha," so it is not possible to determine whether a

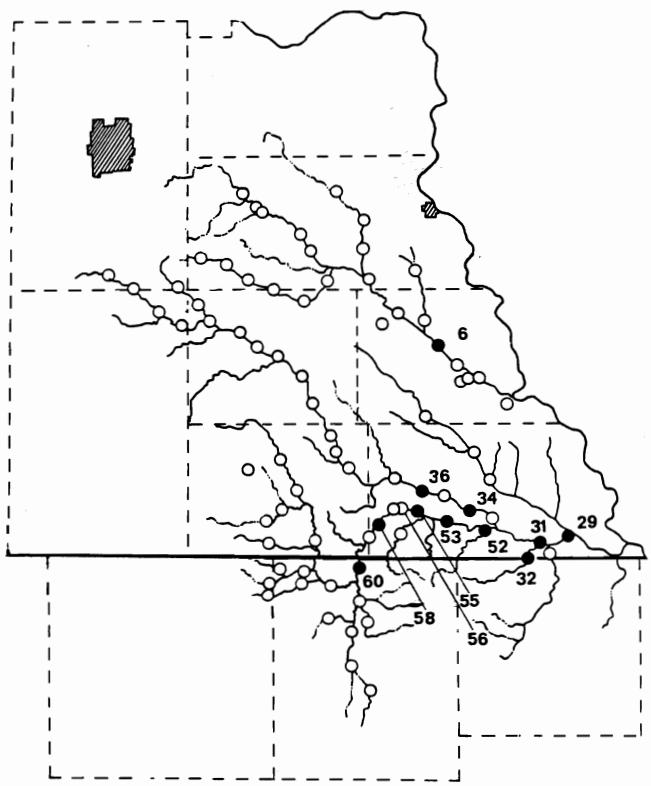


7 ▲ **LASMIGONA COMPRESSA**

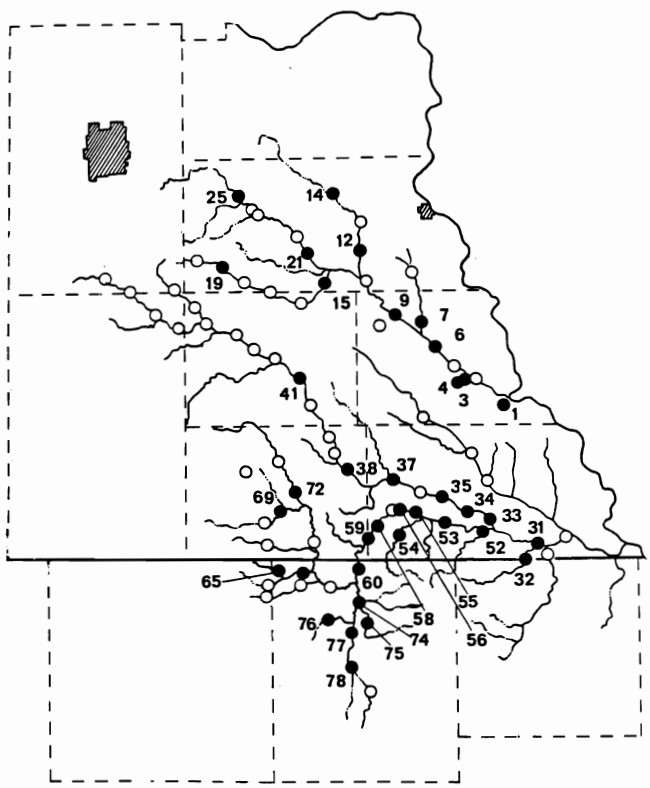
● **TRITOGONIA VERRUCOSA**



8 ● **QUADRULA QUADRULA**



9 ● **QUADRULA PUSTULOSA PUSTULOSA**



10 ● **AMBLEMA PLICATA PLICATA**

given taxon was collected in the Little Nemaha, the Big Nemaha, or both. In addition, some taxa reported by Aughey are far out of range and, in the absence of voucher specimens, it is not possible to determine whether these are misidentified or if they were actually present in the pre-channelized rivers.

Aughey's collections were probably deposited at the University of Nebraska State Museum in Lincoln, but attempts to locate his specimens have been largely unproductive. The catalogue at the Museum indicates that collection data for these early specimens was apparently placed on slips of paper, which were then placed under the object to which they related. Over time, most specimens became separated from the related data. In 1887, specimens lacking data at the Nebraska State Museum were intentionally destroyed. Consequently, it appears probable that most of the specimens supporting Aughey's paper were destroyed. It is unfortunate that these specimens were not saved, for even without locales they might have thrown some light upon the unusual species he reported in his manuscript.

The results of this study can be compared with those reported by Aughey in Table 5. Survey collections resulted in the confirmation of 21 of these taxa. One, *Alasmidonta marginata*, was verified through examination of a specimen at the University of Nebraska State Museum. Five taxa, *Arcidens confragosus*, *Quadrula p. pustolosa*, *Obovaria olivaria*, *Truncilla donaciformis*, and *Lampsilis t. teres*, are reported from the study area for the first time. One additional taxon, *Toxolasma parvus*, not reported by Aughey, has been collected by Evans et al. (1979) and in the current study. Aughey's remaining 22 taxa have been divided into two categories–unconfirmed and misidentified–based upon known distributions in the Missouri River Basin. Table 5 groups nine of these unionids into the former category, as they are possibly native to the Nemaha basins, based upon distributional records from the surrounding region. *Leptodea leptodon* has been collected recently as a fresh dead shell from the Missouri River above the collection area (Hoke, 1983). *Potamilus purpuratus* has been collected as a weathered empty shell from the Elkhorn basin of Nebraska (Hoke, 1994), and a specimen of *Lampsilis higginsi*, collected from the same area before 1900, has been located at the U. S. National Museum (Havlik, 1980). One taxon, *Epioblasma triquetra*, has been collected from the Kansas River basin (Murray and Leonard, 1962), and Burch (1975) lists *Quadrula c. cylindrica* for Nebraska, although a source is not given. Four unionids have been reported for the Missouri River basin in Missouri by Oesch (1984). Two of these, *Megalonias nervosa* and *Elliptio dilatata*, were collected prior to 1920, while *Obliquaria reflexa* and *Quadrula metanevra* have been collected more recently. Aughey's remaining 13 taxa are far out of their known ranges and are probably misidentified.

ANALYSIS

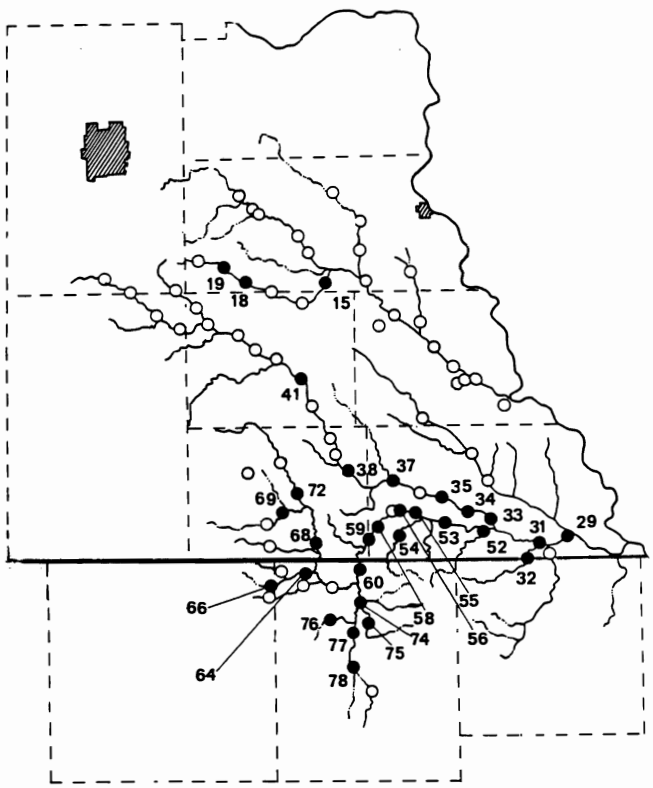
The most striking aspect of this survey was the general absence of live specimens and fresh shells. Only 10 sites produced any live records and these were usually rare. In fact, with the exception of the South Fork Big Nemaha and the Big Nemaha, shells in any condition were comparatively uncommon throughout the basin. Further, specimens were often fragmentary or in very poor condition. Only 44 of the 652 specimens collected in the survey were complete with both valves of a single bivalve represented. Many records are documented on the basis of shell fragments, usually only umbos. The general impression from survey results is that of a decimated fauna.

The unionid distributions of the Nemaha River basins are the product of both natural and manmade parameters. Clearly, there has been a decline in the unionids of the Nemaha River basins. The reasons for this decline almost certainly relate to the manner in which this area was developed. Three man-made parameters which exert a significant impact upon unionids were identified during the course of the study: channelization, siltation, and pollution.

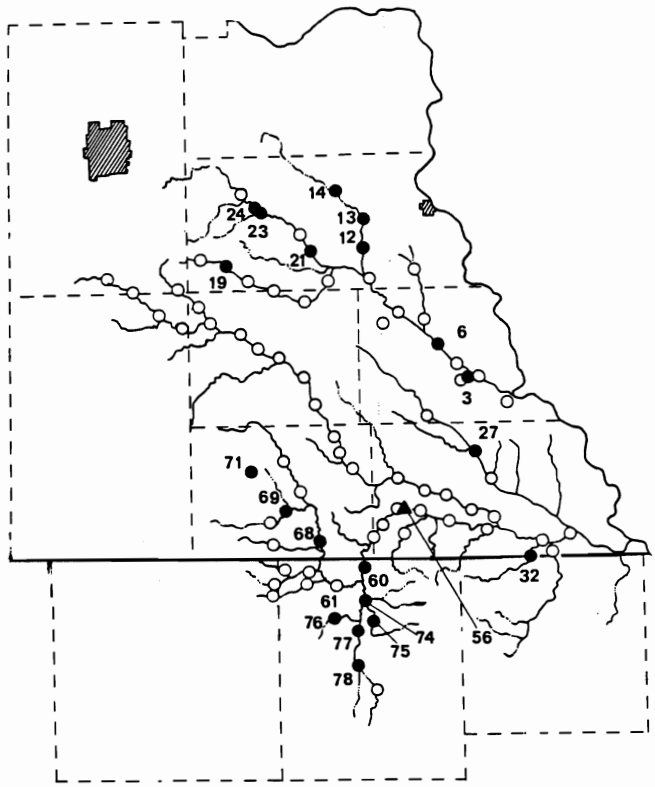
Following a series of floods in the region around the beginning of the Twentieth Century, the Nemaha basins were subjected to extensive channelization, with the majority of the work concentrated in the major rivers (Delich, 1983). Utilizing aerial photography, Bliss and Schainost (1973) estimated a minimum loss of 164 miles or 11.3 percent of the total pre-development stream mileage in the basin.

The direct impact of channelization upon unionids is through the elimination of riparian habitat, which is detrimental both to unionids and to their host fish. In the Nemaha basins, the formerly meandering rivers with their slow currents and deep pools were converted into linear ditches, and pool and riffle areas were largely destroyed. Oxbow lakes which were once present along the rivers gradually filled in, and no new lakes were created by the channelized rivers to take their place.

The habitat created by channelization is highly adverse to the establishment and support of bivalve populations. Substrates in the channelized rivers often consist of shifting sand, which is detrimental to unionids. In addition, with the exception of the lower portion of the Big Nemaha and the South Fork Big Nemaha and lower ten miles of the Little Nemaha, water depth in channelized sectors of the basins was seldom over 16

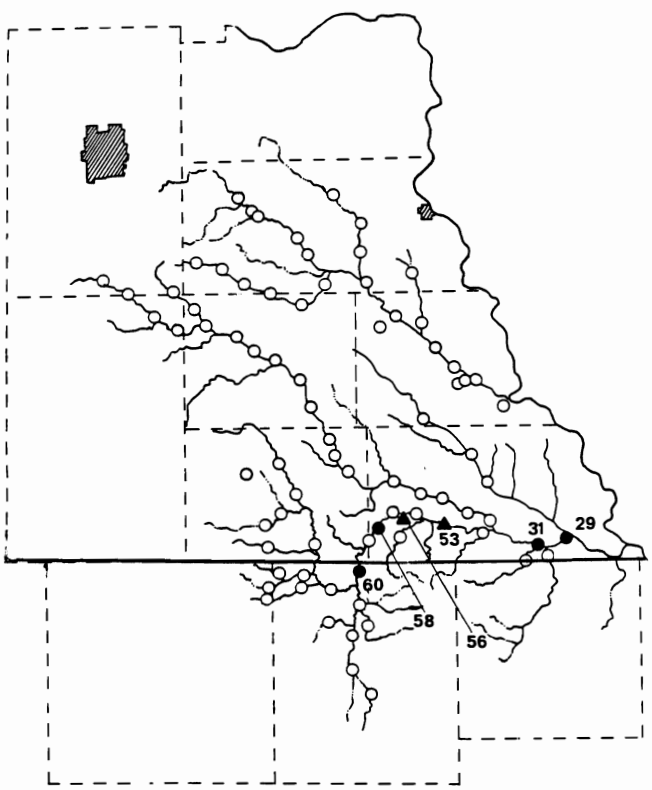


11 ● FUSCONAIA FLAVA



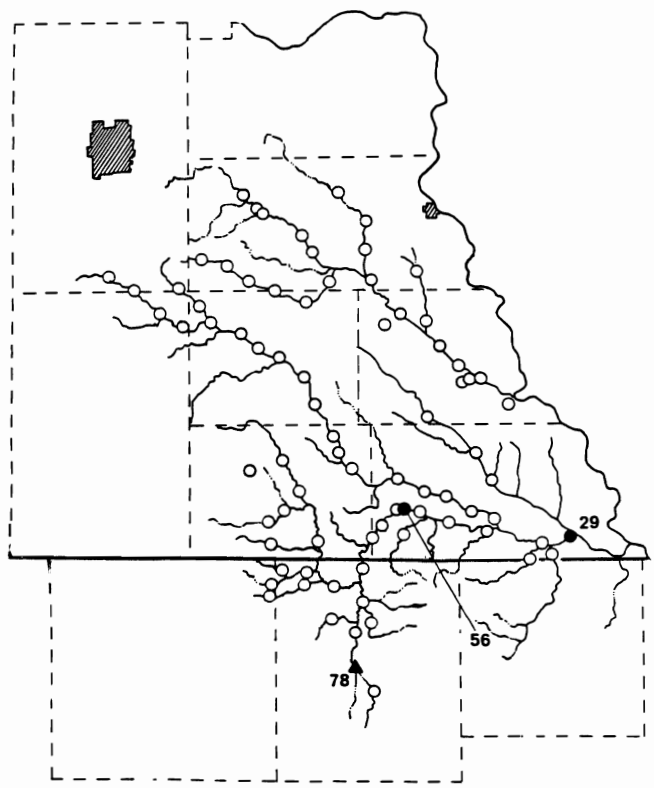
12 ● UNIOMERUS TETRALASMUS

▲ ACTINONAIAS LIGAMENTINA CARINATA



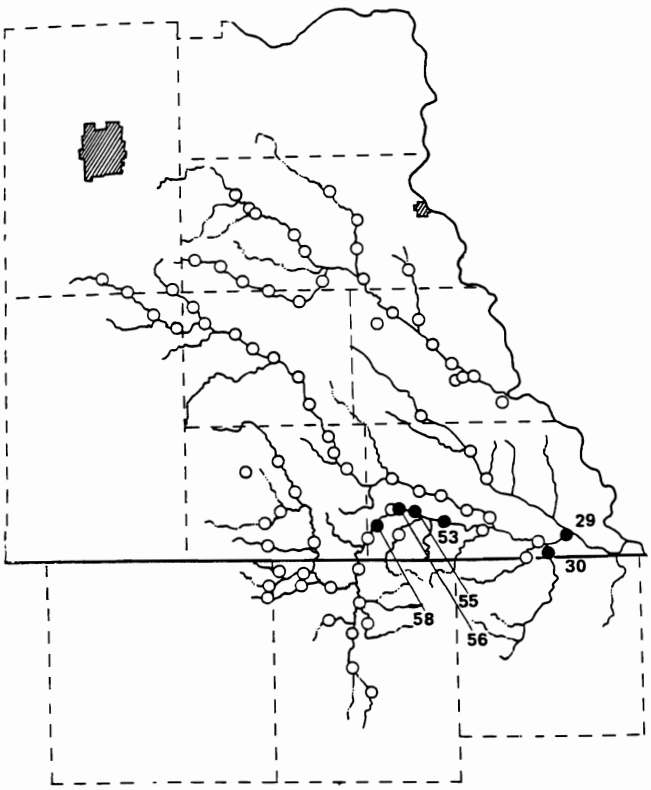
13 ▲ OBOVARIA OLIVARIA

● TRUNCILLA TRUNCATA

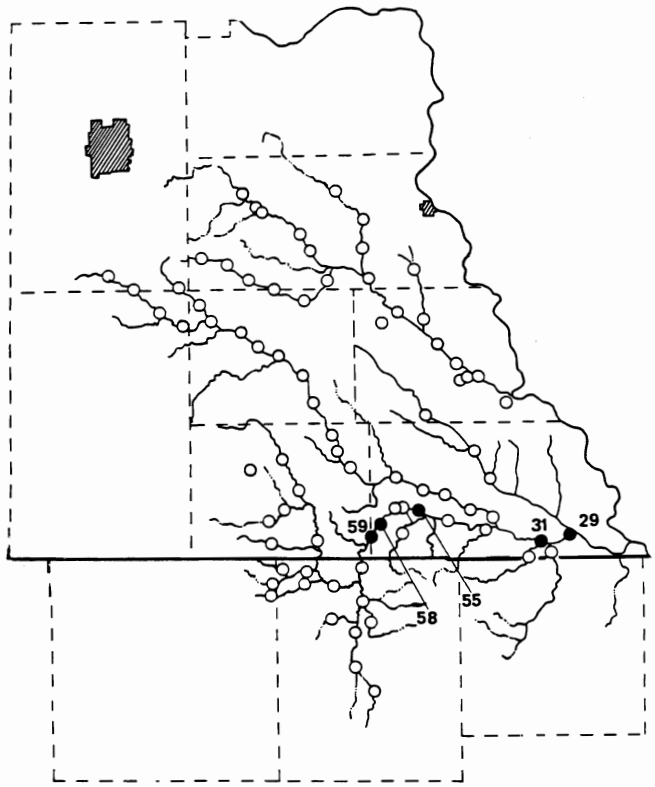


14 ● TRUNCILLA DONACIFORMIS

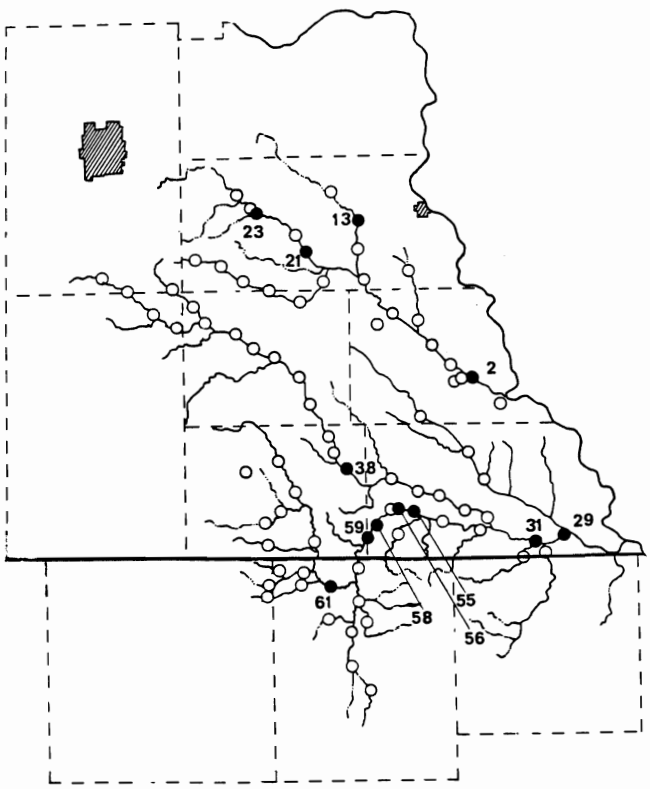
▲ TOXOLASMA PARVUS



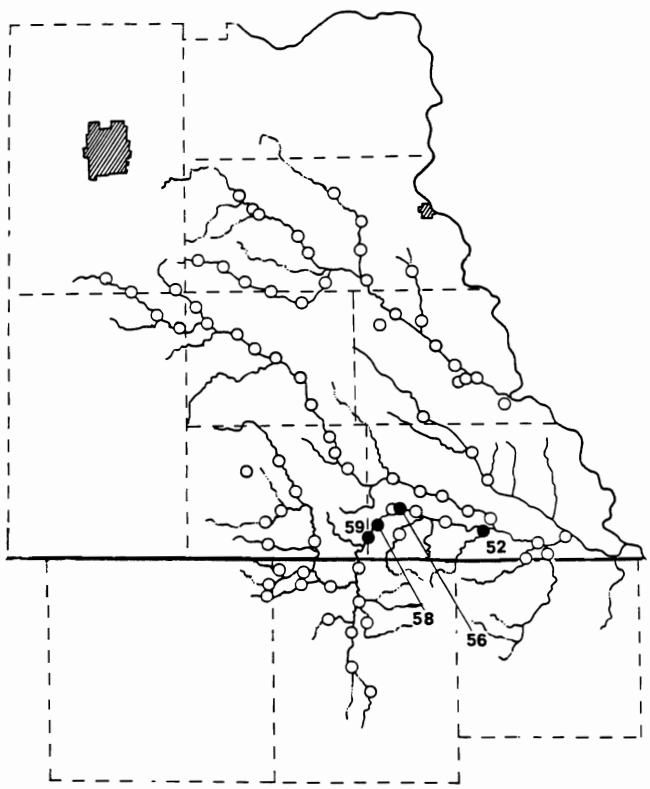
15 ● **LEPTODEA FRAGILIS**



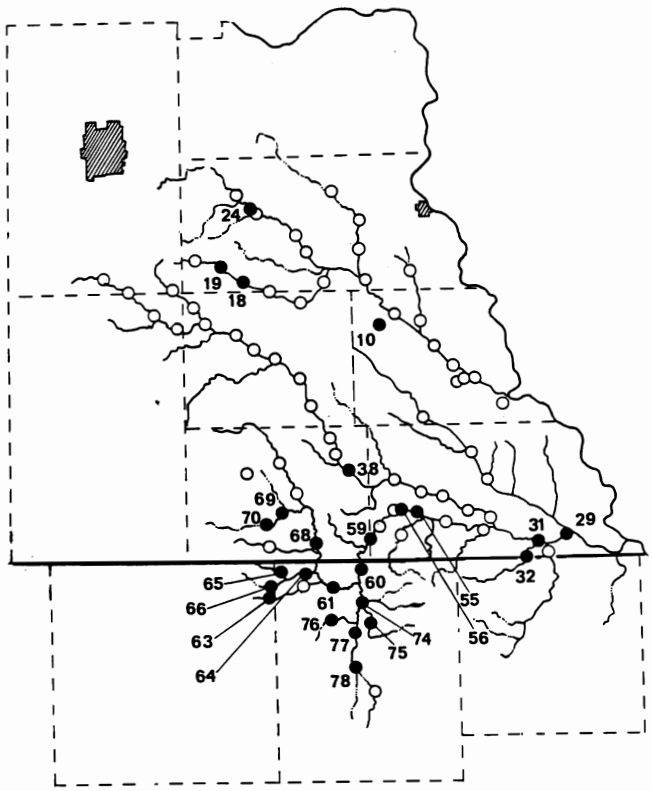
16 ● **POTAMILUS ALATUS**



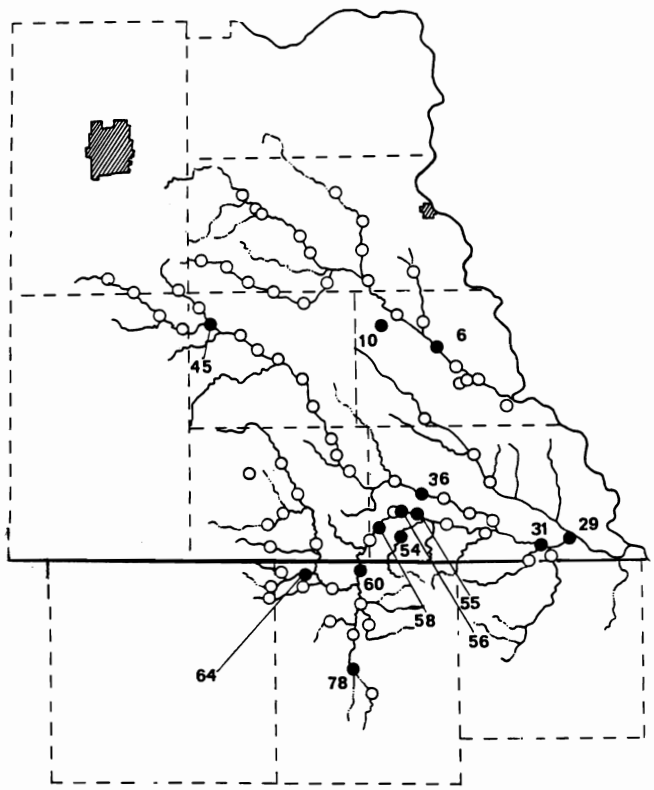
17 ● **POTAMILUS OHIENSIS**



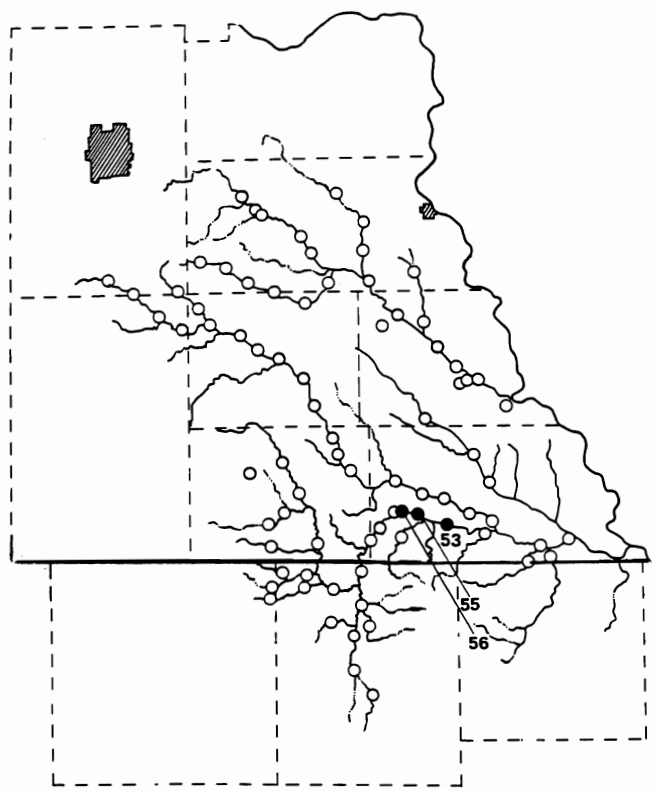
18 ● **LIGUMIA RECTA**



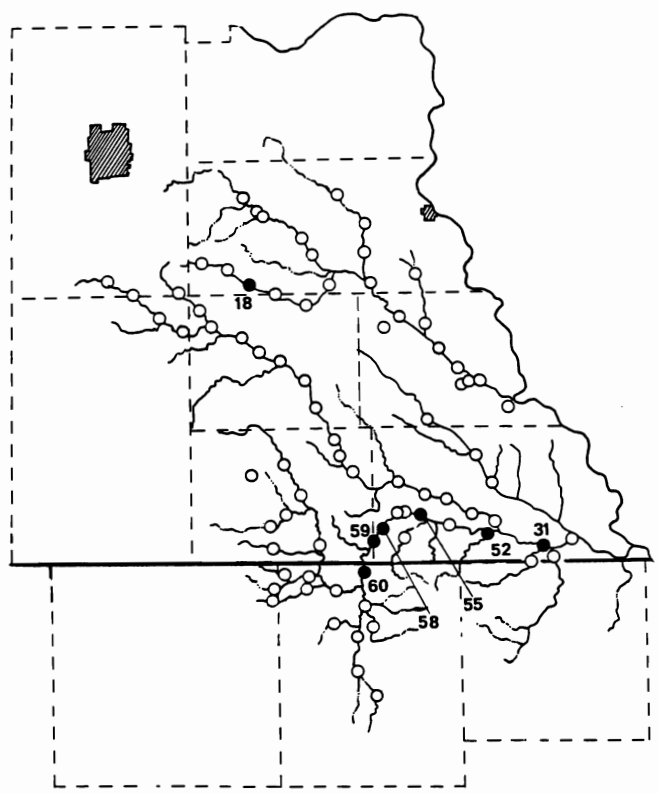
19 ● **LIGUMIA SUBROSTRATA**



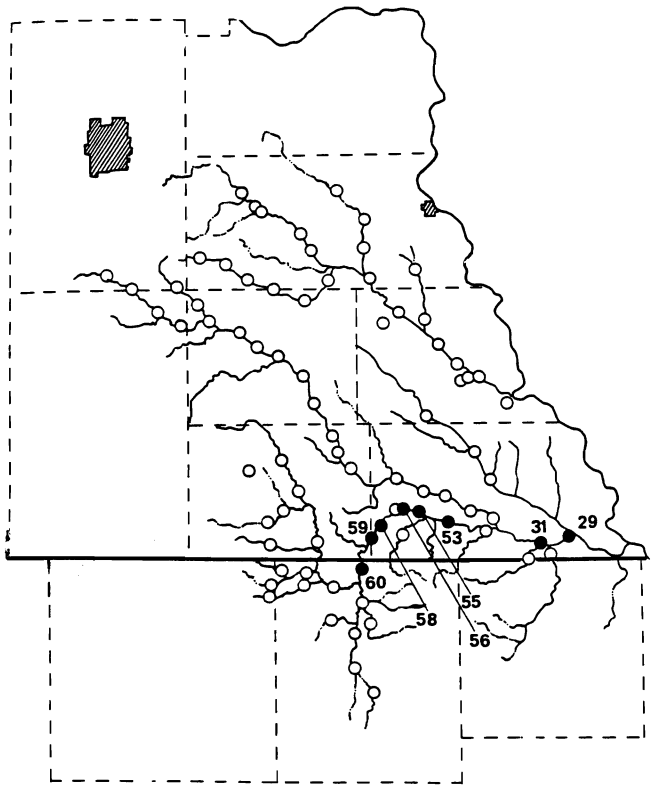
20 ● **LAMPSILIS TERES f. TERES**



21 ● **LAMPSILIS TERES f. ANODONTOIDES**



22 ● **LAMPSILIS RADIATA LUTEOLA**



23 ● **LAMPSILIS VENTRICOSA**

inches during the summer, although the channels were quite wide. In these sectors of the basins' rivers, water temperature was often relatively high, reflecting the shallow depth as well as the fact that the width of the channelized sectors is such that the water is often unshaded by vegetation and thus exposed to direct sunlight for much of the day.

Less obvious is the manner in which channelization interacts with the local geology. Originally, precipitation ran off slowly as it flowed through the many loops in the basins' rivers. In addition, oxbow lakes further aided retention of surface moisture. This conservation of surface water is especially critical, given the geology of the basins. The Nebraska Natural Resources Commission (1976) reports the soils of the region as relatively impermeable, and most of the precipitation which falls in the basins runs off. In fact, in the upper portion of the basins, flows from groundwater are often low to non-existent (NNRC, 1976). Rapid runoff of precipitation is a product of channelization and has doubtlessly had an impact upon conservation of flow in the basin. It is probable that areas in the mid- and upper portions of the study area may once have supported unionids but do not now have sufficient flow to support bivalves and/or their host fish.

Another problem for unionids in the region is siltation. The soils of the Nemaha basins are highly erodible (Bliss and Schainost, 1973), and area agricultural practices, which include farming up to the very edge of river banks, exacerbate the natural erosion process. The resulting siltation prevents the establishment of pools by filling in the naturally occurring holes in the river. This also affects the production of the local fishery, and Bliss and Schainost (1973) note that the composition of the local fishery consists primarily of carp and suckers. Host fish for many unionids are now uncommon or absent from the region.

Pollution in the basin doubtlessly effects bivalves, however it was not possible to definitively document its impact. At least one creek in the basin has been declared biologically degraded by the Nebraska Natural Resources Commission (1976) due to feedlot runoff. The effects of pesticide, herbicide and other chemical pollutants from agricultural field runoff may be severe, given the agricultural practices used in the region.

A primary goal of this study was to develop a model which would explain the distributions observed and take into account the records available. Prior to development of the region, bivalves were probably relatively abundant. The meandering rivers of the basins no doubt provided a wider diversity of habitat and host fish than exists at present. The pre-channelized Nemaha basin probably contained a number of species not represented in survey collections. Only one such bivalve, *Alasmidonta marginata*, is documented with vouchers. Others may have included some or all of the unconfirmed unionids reported by Aughey (1877), as well as possible additional bivalves which may have been misidentified by Aughey. The channelization of the Nemaha basins after 1900 may have led to the extirpation of those species as well as to a general decline in abundance of unionids. In any event, many species have not been reported from the basin in the past 119 years.

The Big Nemaha and the South Fork Big Nemaha in Nebraska were subject to perhaps the greatest loss of habitat in the region. Bliss and Schainost (1973) report the loss of river miles in these sectors at 48.4% and 38.6% respectively. Shells recovered in these sectors must either have washed into these reaches subsequent to the channelization of the area or they must date after channelization. Since the shells collected in these reaches were more numerous and exhibited more species diversity than upstream locations it appears doubtful that they originated upstream. The shells recovered along these sectors must date after the channelization of the rivers. Thus it appears that subsequent to the channelization of the rivers, unionids repopulated at least some portions of the channelized

rivers. Further, they were most abundant in the Big Nemaha and the South Fork Big Nemaha, two of the most heavily channelized portions of the Nemaha basins. The average diversity per productive site in this region was 10.9, the highest in the study.

In contrast, other heavily channelized portions of the Nemaha Rivers do not exhibit significant evidence of a post channelization repopulation. Species diversity on the North Fork Big Nemaha, Little Nemaha, North Fork Little Nemaha, and South Fork Little Nemaha averaged only 2.4 species per productive site. Further, shells were often in a poor state of preservation, and were frequently represented by fragmentary valves. The difference between these areas and the Big Nemaha and South Fork Big Nemaha in terms of bivalve habitat may be the fact that the former reaches carry more water than do the later. Also, at least at the present time, the rivers in the latter reaches are more sinuous and contain a more stable bottom than do those in the other areas mentioned.

Subsequent to the apparent repopulation of portions of the channelized rivers, most of the bivalves disappeared from the region. The demise of the post-channelization unionid populations is an unresolved problem. While *Amblema p. plicata*, *Fusconaia flava*, *Strophitus u. undulatus*, and *Ligumia subrostrata* appear to have been well established after the channelization of the basin, all but *L. subrostrata* have since disappeared. Further, these species have disappeared not only from the channelized rivers but from area creeks as well. There appears to be an unknown but general factor causing their extirpation. It is not a localized phenomenon, for these species have largely disappeared from their ranges in the Kansas River basin as well. The disappearance of these unionids from their natural ranges may be the result of siltation or the effects of pollutants upon unionid reproduction. In 1981, a number of local residents reported having seen fresh shells several years before, along portions of the basin which are now devoid of live specimens, and added that they had not seen any bivalves for some time. It is possible the bivalve shells reported were aged adults at the end of their life spans. This would be consistent with an interruption of the unionid reproductive cycle.

At the present time, there is little evidence of extant reproducing bivalve populations in the basins' major rivers. Most live specimens recovered in these rivers were relatively isolated individuals. The recovery of a number of fresh shells of *Leptodea fragilis*, *Potamilus ohiensis*, and *Lampsilis t. teres* from the lower portion of the Nemaha rivers may indicate the existence of reproducing populations in these rivers, but it is also possible that they result from glochidia dropped from fish which have swum upstream from the Missouri River. Each of these species is found in favorable habitats in the Missouri River (Hoke, 1983). Live unionids now appear to be largely restricted to area creek, reservoir, and, probably, pond habitats and the diversity and abundance of the area's unionid fauna is much reduced from former levels.

CONCLUSION

The unionid fauna of the Nemaha basins once consisted of at least 28 species. During or following the channelization of the basins after 1900, at least 27 species repopulated or were still present in the region. Unionids once were most abundant on the South Fork of the Big Nemaha and the Big Nemaha and in area creeks. Since the repopulation of the area, most species have been extirpated and unionids presently exist primarily as scattered populations or individuals. While a few bivalves remain in the rivers of the basins, in this study they were found to be uncommon. There is little evidence of reproducing populations with the exception of the creek, reservoir, and, possibly, pond habitats.

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