Section 8.3

Streams and Watersheds Tactical Plan Appendices

Section 8.3.1

Ohio Department of Natural Resources Candidate Streams and Watersheds

ODNR
Candidate Streams
For
Protection & Restoration

Introduction

While many of Ohio's historically degraded streams have received considerable funding and restoration efforts for improved water quality, many of the state's high quality (i.e., least impacted) streams have received less funding and attention. The objective of this study was to list and prioritize high quality streams on a statewide basis using a multi-metric approach towards a statewide analysis using stream monitoring results from four categories - physical habitat, biological integrity, biological diversity, and recreational opportunity. With limited funding dedicated to stream protection, the primary need for such a list is to prioritize streams to make sure such funding is well directed. It is less expensive to protect healthy streams and their faunas than to try and restore them later.

Study Area and Methods

The state of Ohio has approximately 61,532 total miles of streams. Of the 4,223 named streams, more than 1,588 have had fish and or aquatic macroinvertebrate assemblages sampled. The majority of biological data collected from Ohio streams is stored in Ohio ECOS, a statewide multi-agency biological database maintained by the Ohio Environmental Protection Agency. Although less than half of all Ohio streams have been sampled, virtually all of the unassessed streams are small headwater streams many of which have drainage areas of less than 20 square miles.

A total of 17 stream attributes within four categories (physical habitat, biological diversity, biological integrity, and recreational opportunities) were used to rank Ohio streams. A brief overview of each attribute is listed I Table 1. The total list of streams developed from these 17 attributes was created by adding a new stream to the list based on the criteria used for each attribute (e.g. all streams with a State Scenic River Designation were added to the list). In Excel, a spreadsheet was then created listing all streams with a "x" placed under each attribute. Streams were then ranked by the total number of attributes with an "x".

Results and Measurable Objectives

As the result of this study, a list of 196 Ohio streams (Table 2 – see attached spreadsheet) was compiled from the analysis of statewide data for 17 stream related attributes based on criteria listed in Table 1. Streams that scored fourteen to three of the criteria are illustrated in Figure 1.

During the five year period from July 1, 2001 through June 30, 2006, the ODNR Division of Wildlife sets the following objectives for their Stream Conservation Program and related Projects.

For the streams (and their watersheds) listed in Table 2:

- Protect and restore 250 miles of streamside forests,
- Remove (or provide fish passage) 5 dams,
- Sample fish assemblages and assess aquatic habitat in 200 currently non-assessed tributaries,
- Monitor the distribution and spread of nonnative aquatic species,
- Attend and actively collaborate with 10 different watershed partnerships,
- Conduct 50 stream related demonstrations or presentations to schools, watershed groups, and the general public.

Table 1. Scoring categories, attributes, and criteria for selection of ODNR candidate streams for protection and restoration.

Category
Attribute: Criteria

Physical Habitat:

Scenic: All streams with a State Scenic, Wild, and Recreational River Designation.

QHEI: A list of streams with Qualitative Habitat Evaluation Index (QHEI) scores ranging from 100 to 90 was created from a database query of sampled (fish) streams in Ohio ECOS. This range of scores is generally indicative of Exceptional Warmwater Habitat.

Gorge: All known streams with well defined bedrock gorges and adjacent outcrops were listed. This category was included esthetic and scenic qualities.

Biological Integrity:

IBI: Streams with the high biotic Index of Biotic Integrity (IBI) were listed from a chart ranking based on the 75th percentile IBI scores (Ohio EPA data). The IBI is one of two fish indices used as biocriteria (state water quality standards) by Ohio EPA. The IBI consists of 12 metrics which assess fish assemblages based on species richness and composition, trophic composition, abundance, and health. It is used to measure the degree of environmental disturbance as compared to reference or least impacted sites.

MIwb: Streams with Modified Index of well-being (MIwb) scores from 10.0 to 11.4 were listed based on a database query of Ohio ECOS. The MIwb is the other fish index used as biocriteria (state water quality standards) by Ohio EPA. The MIwb is a measure of the fish community based on calculation using relative number, biomass, and the Shannon Diversity Index (based on numbers and weight) from which highly tolerant and exotic fishes are removed from numbers and biomass calculations. It is also used to measure the degree of environmental disturbance.

ICI: Streams with the highest Invertebrate Community Index (ICI) scores were listed based on an Ohio ECOS database query for scores greater than or equal to 56. The ICI is similar to the IBI, but evaluates aquatic insect assemblages. Scores included the top 1.2 percent of the database.

CSHQ: Streams were selected from Ohio EPA's List of Candidates for Superior High Quality Waters with scores from 50 to 100.

DOW: Streams were listed from the ODNR Division of Wildlife's Priority List For High Aquatic Diversity, Endangered Species, and Sport Fishing.

Biological Diversity:

Fish: Streams with the most diverse fish assemblages were listed from an Ohio ECOS database query of sites with a species richness greater than or equal to 35.

Macr: Streams with the most diverse aquatic insect assemblages were listed from an Ohio ECOS database query of sites with a taxa richness greater than or equal to 90. Scores included the top 0.8 percent of the database.

Mbed: Streams were with the best and most significant mussel beds were listed under this attribute through consultation with malocologist experts (Dr. G. Thomas Watters and Dr. Michael Hoggarth).

Emus: The streams with the best populations of each endangered mussel species was listed through consultation with malocology experts (Dr. G. Thomas Watters and Dr. Michael Hoggarth).

Efish: The streams with the best populations of each endangered fish species was listed through consultation with stream ichthyology experts (Randy Sanders and Dan Rice).

Eoth: The streams with the best populations of stream related endangered bird, mammals, and herp species were listed (Dan Rice and Randy Sanders).

Recreational Opportunity:

Sfish: Streams with the highest relative number of sport fish species were listed based on an Ohio ECOS database query by species.

Boat: Ohio's most popular canoeing and boating streams were listed (Steve Goodwin, Dan Rice, and Randy Sanders).

Slake: Streams draining into ODNR State Park Lakes were listed.

Table 2: Stream scores

Stream Name	*SCORE*	*Scenic*	*QHEI*	*Gorge*	*IBI*	*ICI*	*Miwb*	*CSHQ*	*DOWs*	*Fish*	*Macr*	*MBeds*	*Emus*	*Sfish*	*Boat*	*Slake*	*Efish*	*Eoth*	*Length*	*D.Area*
Maumee River*(in OH)	**6**	**X**	**X**			**X**								**X**	**X**	**X**			**105.4**	**4856.2**
Tiffin River (in OH)	1				X														59.2	553.5
Mill Creek* (to Bean Cr.)	1															X			15.5	32
St. Joseph River (in OH)	3								X			X	X						44.3	238
Fish Creek (in OH)	5				X	X		X					X	X					4.7	17.3
West Branch (in OH)	2								X				X						11	15.8
St. Marys River (in OH)	1																X		59.1	457.7
Auglaize River	4						X		X					X			X		101.9	2341.6
Blanchard River (upper)	3								X			X	X						91	762.4
Ottawa River	1		X																52.7	372.7
Portage River	**1**													**X**					**60.6**	**601.8**
M. Branch Portage	1																X		27.8	219.4
Sandusky River*	**6**	**X**					**X**		**X**			**X**		**X**				**X**	**130.2**	**1420.7**
Sugar Creek	1		X																10.4	14.3
Huron River	**2**		**X**											**X**					**59.7**	**403.4**
W. Branch Huron River	1					X													46	261
Vermilion River	**3**		**X**		**X**			**X**											**58.7**	**271.7**
SW Branch Vermillion River	1										X								10.4	32.8
Buck Creek	1		X																8.3	22.3
E. Branch Black River	**1**		**X**																**56.7**	**215.9**
Rocky River	**2**							**X**						**X**					**48**	**293.8**
E. Branch Rocky River	2				X	X													34.5	80.4
W. Branch Rocky River	1				X														36.2	188.3
Wellington Creek*	1															X			?	?
Cuyahoga River (upper)	**8**	**X**			**X**		**X**		**X**		**X**		**X**	**X**				**X**	**100.1**	**813.3**
Breakneck Creek	1													X					?	?
Tare Creek	1					X													8	12.2
Chagrin River	**4**	**X**			**X**									**X**				**X**	**47.9**	**267**
Aurora Branch	3	X			X	X													16.1	57.6
Smith Creek	1		X																?	
East Branch	1	X																	19.4	50.8
Spring Brook	1																X		1	?
Woodie Brook	1																X		1	?
Silver Creek	2					X					X								6.2	13.4
Grand River	**11**	**X**	**X**		**X**		**X**		**X**	**X**	**X**	**X**		**X**			**X**	**X**	**102.7**	**712.1**
Mill Creek	2		X														X		13	20.2
Big Creek	2		X														X		15.6	37
Cemetary Creek	2		X														X		?	?
Swine Creek	2					X											X		14.1	30.8
Baughman Creek	1																X		9.8	20.9

Stream Name	*SCORE*	*Scenic*	*QHEI*	*Gorge*	*IBI*	*ICI*	*Miwb*	*CSHQ*	*DOWs*	*Fish*	*Macr*	*MBeds*	*Emus*	*Sfish*	*Boat*	*Slake*	*Efish*	*Eoth*	*Length*	*D.Area*
Trumbull Creek	1																X		12.2	20.6
Crooked Creek	1																X		5.2	18.5
Hoskins Creek	1																X		7.4	26.8
Indian Creek	1																X		5.2	6.3
Phelps Creek	1																X		13	29.6
Andrews Creek	1																X		5.3	8.7
Dead Branch	1																X		9	23.8
Conneaut Creek (in OH)	**3**		**X**								**X**			**X**					**22.3**	**37.7**
Ohio River (in OH)	**8**				**X**		**X**		**X**			**X**	**X**	**X**	**X**		**X**		**451**	**29547.9**
Beaver Creek (to Wabash R.)*	1															X			13	55.9
Great Miami River*	**10**		**X**		**X**	**X**	**X**	**X**	**X**	**X**				**X**		**X**	**X**		**170**	**3947.9**
McKee Creek (to Stony Cr.)	1							X											10.2	17.8
Loramie Creek*	1															X			36.5	268.5
Stillwater River*	6	X	X		X		X	X					X						67.2	673.2
Greenville Creek* (in OH)	5	X	X		X	X		X											34.1	166.8
Painter Creek	1					X													13.5	48
Lost Creek	2						X	X											17.4	59.3
Honey Creek	1							X											18.6	91.6
Mad River (lower)	5		X		X		X				X			X					60.2	656
Macochee Creek(Logan Co)	3					X		X						X					8.2	18.8
Kings Creek	1													X					9	41.8
Buck Creek*	2													X		X			15.5	141.1
Twin Creek	5		X		X		X	X			X								46.2	315
Little Twin Creek	1					X													7.8	22.6
Bantas Fork	4		X			X		X			X								16.8	35.4
Elk Creek	3		X				X	X											12.6	48
Fourmile Creek (in OH)*	6		X		X		X	X						X		X			38.2	301.4
Mosquito Creek*	1															X			11.5	27.6
Sevenmile Creek	3				X		X	X											32.5	138.4
Spring Creek	1																X		12.4	26.4
Indian Creek (in OH)	1						X												22.9	71.6
Whitewater River (in OH)	7		X			X	X	X	X	X				X					7.3	143
Little Miami River(LMR)*	**14**	**X**	**X**	**X**	**X**	**X**	**X**		**X**		**X**	**X**	**X**	**X**	**X**	**X**	**X**		**105.5**	**1755.3**
N. Fork LMR*	1	X																	13.2	37.7
Yellow Springs Creek	2							X			X								2.5	11.5
Massies Creek	1										X								9.5	86.6
Caesar Creek*	3		X					X								X			33.9	238.6
Anderson Fork*	2						X									X			28.3	93.3

Stream Name	*SCORE*	*Scenic*	*QHEI*	*Gorge*	*IBI*	*ICI*	*Miwb*	*CSHQ*	*DOWs*	*Fish*	*Macr*	*MBeds*	*Emus*	*Sfish*	*Boat*	*Slake*	*Efish*	*Eoth*	*Length*	*D.Area*
Cowan Ck (to Todd Fk)*	1															X			22.4	54.9
Turtle Creek	2						X							X					12	65.5
O'Bannon Creek	1							X											12	58.5
E. Fork LMR*	10		X		X	X	X	X	X	X	X			X		X			81.7	500.7
Stonelick Creek*	3						X			X						X			22.9	77.6
Whiteoak Creek (inc. E. Fk.)	**3**						**X**				**X**			**X**					**49.3**	**234.3**
E. Fork Whiteoak Creek	3						X	X			X								22	80.8
Ohio Brush Creek	**8**		**X**		**X**		**X**	**X**	**X**	**X**	**X**		**X**						**57.1**	**435**
W. Fork Ohio Brush	3				X		X	X											21.5	134.4
M. Fork Baker Fork	1						X												7	20.6
Lick Creek*	1															X			7.6	31.2
Turkey Creek*	**1**															**X**			**13.4**	**48.1**
Scioto River	**11**		**X**		**X**	**X**	**X**	**X**	**X**	**X**	**X**			**X**			**X**	**X**	**230.8**	**6509.9**
Taylor Creek	2					X					X								7.8	32.1
Mill Creek	3		X		X									X					37.8	185.5
Olentangy River*	8	X	X		X	X	X	X						X		X			88.5	536.3
Whetstone Creek*	6		X		X		X	X			X					X			35	113.7
Big Walnut Creek	5				X		X	X		X									74.2	556.7
Alum Creek*	3							X						X		X			55.8	200.7
Blacklick Creek	1		X																25.5	61.3
Rocky Fork	3		X					X									X		13	28.1
Walnut Creek (Little)	1						X												49.8	280.7
Big Darby Creek*	13	X	X		X	X	X	X	X	X	X	X	X	X			X		78.7	556.6
Little Darby*	10	X	X		X	X	X	X	X		X	X	X						69.1	176
Spring Fork	3		X				X	X											12	38.3
Pleasant Run	1							X											8	9.48
Spain Creek (L. Darby)	1							X											4.5	7.2
Hargus Creek*	1															X			6.6	20.2
Yellowbud Creek	1									X									10.6	35.2
Scippo Creek	3				X		X	X											17.5	52.8
Deer Creek*	8					X	X	X	X	X	X			X		X			67.1	408.4
Paint Creek*	11		X	X	X	X	X	X	X	X	X			X		X			94.7	1142.7
N. Fork Paint	3						X	X		X									46.6	236.2
Compton Creek	3					`	X	X		X									19.9	61
Rocky Fork*	4		X	X	X											X			27.5	144.7
Clear Creek*	3					X		X											11.9	46
Salt Creek	9			X	X	X	X	X	X	X	X		X						45.4	553.4
Laurel Run	1							X											12.9	55
M. Fork Laurel Run	1							X											6.2	11.4
Queer Creek	1							X											9	35
E. Fork Queer Ck	1							X											5.5	13.7

Stream Name	*SCORE*	*Scenic*	*QHEI*	*Gorge*	*IBI*	*ICI*	*Miwb*	*CSHQ*	*DOWs*	*Fish*	*Macr*	*MBeds*	*Emus*	*Sfish*	*Boat*	*Slake*	*Efish*	*Eoth*	*Length*	*D.Area*
Beech Fork	1						X												?	?
Peepee Creek*	1															X			14.5	79.4
Sunfish Creek	3		X		X		X												26.5	144.6
Scioto Brush Creek	6			X			X	X		X			X				X		36	273.5
Mill Creek	1							X											5	17.5
Rarden Creek	1							X											6.6	18.4
S. Fork Scioto Brush	1							X											18.2	112.6
Little Scioto River	**3**								**X**				**X**					**X**	**41.3**	**232.6**
Symmes Creek	**1**												**X**						**70**	**355.7**
Black Fork*	1															X			17	62.8
Pine Creek	**2**									**X**			**X**						**48**	**184.7**
Raccoon Creek*	**1**															**X**			**109**	**683.5**
Little Raccoon Ck*	1															X			36.5	157.8
Forked Run*	**1**															**X**			**8.4**	**9.1**
Hocking River	**4**				**X**	**X**	**X**							**X**					**94.9**	**1200**
Hunters Run	1					X													7.5	10.4
Clear Creek	1								X										23	91.3
Clear Fork (to Scotts Cr.)*	1															X			7.4	15.9
Duck Creek*	1															X			4.7	8.3
Sunday Creek*	1															X			27.2	138.5
Stroud Run*	1															X			4.5	7.3
Federal Creek	1							X											23.8	144.9
Pawpaw Creek (E.Fk. Duck Cr.)	1						X												11.6	23.5
Muskingum River*	**11**		**X**		**X**		**X**	**X**	**X**			**X**	**X**	**X**	**X**	**X**	**X**		**111.9**	**8037.6**
Tuscarawas River (lower)	5		X		X	X		X						X					129.9	2589.7
Craborchard Creek	1					X													6.7	11.5
Sugar Creek	1		X																45	356.2
Nimishillen Creek (Sandy)	1		X																24.5	186.8
Walhonding River	9		X		X	X	X	X	X	X		X	X						23.5	2252
Kokosing River*	9	X	X		X		X	X	X		X						X	X	57.2	482
N. Branch Kokosing*	2	X						X											18.3	96.7
Little Jelloway Creek	1							X											10.5	19.5
Schenck Creek	1							X											12.1	41.8
Killbuck Creek (lower)	4								X			X	X	X					81.7	612.9
Doughty Creek	2					X		X											20.1	60.2
Mohican River (inc. Clear Fk)	2					X									X				64.2	998.7
Lang Creek (Jerome Fk.)	2					X		X											9.3	32.7
Redhaw Creek (Muddy Fk)	1					X													3.5	11.8
Clear Fork*	4		X	X										X		X			36.6	218.5
Black Fork*	2													X		X			?	?

Stream Name	*SCORE*	*Scenic*	*QHEI*	*Gorge*	*IBI*	*ICI*	*Miwb*	*CSHQ*	*DOWs*	*Fish*	*Macr*	*MBeds*	*Emus*	*Sfish*	*Boat*	*Slake*	*Efish*	*Eoth*	*Length*	*D.Area*
Black Fork (to Moxahala Cr.)	1		X																7.7	28.3
Wakatomika Creek	6		X		X		X	X	X	X									42.6	233.9
Winding Fork	1							X											8	21.3
Sugartree Fork (Salt Fk.)*	3					X					X					X			13.4	62.8
Turkey Run	3		X			X		X											2.3	8.5
Brushy Fork (Salt Fk.)*	1															X			7.5	38.2
West Branch Wolf Creek	1							X											45	144.2
Licking River (inc. N. Fk)*	3				X									X		X			67.5	780.5
Reservoir Feeder*	1															X			?	?
S. Fork Licking River	4				X		X				X			X					33.9	288
Raccoon Creek	1						X												27.5	103.8
N. Fork Licking River	2				X		X												38.4	239
Rocky Fork	1							X											20.2	79.6
Long Run	2						X	X											5.3	6.1
Lost Run	1							X											10.2	23.5
Manns Fork (to Salt Cr.)*	1															X			7.5	19.9
Olive Green Creek	1							X											22	82.7
Wolf Run (W. Fk. Duck Cr.)*	1															X			4	6.4
Little Muskingum River	**4**				**X**				**X**								**X**	**X**	**69.7**	**314.5**
Leith Run	2							X						X					8.4	10.2
Sunfish Creek	**4**						**X**	**X**	**X**					**X**					**31.4**	**113.8**
Captina Creek (inc. S. Fk)	**5**				**X**		**X**	**X**	**X**	**X**									**38.6**	**180.8**
N. Fork Captina Creek	2						X	X											10.5	33
S. Fork Captina Creek	1							X											14	36.2
Bend Fork	1							X											13	27.1
Barkcamp Creek (McMah)*	1															X			4.3	5
Yellow Creek	**1**				**X**														**34**	**240.1**
Elkhorn Creek	1							X											8.9	34.3
Shenango River(in OH)*	**1**															**X**			**1**	**283.7**
Pymatuning Creek (in OH)	2												X	X					28.2	148.9
Mahoning River(up. in OH)*	**3**						**X**							**X**		**X**			**97.1**	**1077.6**
Mosquito Creek*	3						X							X		X			33.7	139.2
West Branch*	1															X			29.2	108.6
Little Beaver Creek (in OH)*	**7**	**X**				**X**	**X**	**X**	**X**							**X**		**X**	**49.5**	**407.8**
W. Fork L. Beaver*	6	X	X		X		X		X							X			25.2	111.7
N. Fork L. Beaver (in OH*	3	X	X				X												14.1	107
M. Fork L. Beaver	4	X	X					X											36.2	147.4

Section 8.3.2

Trends in Mussel Abundance in the Grand River

Trends in Freshwater Mussel Populations in the Grand River System (OH): A GIS Approach

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Summary

A comparison of pre- and post-1980 mussel data for the Grand River system shows that mussel diversity has remained unchanged or has increased through time. Comprehensive surveys were made prior to 1980, giving us adequate baseline data with which to compare more recent work. In particular, mussel diversity has increased in the lower third of the mainstem while remaining constant in the upper two-thirds. There is virtually no mussel information on any of the tributaries.

Most species are widespread along the entire mainstem. The dam at Harpersfield is limiting the upstream distribution of mussel species using freshwater drum as their host: Fragile Papershell and Pink Heelsplitter. Other species also seem to be influenced by the dam, although not known to use drum as a host: Elktoe and Snuffbox (OH endangered), for example.

Maximum mussel species richness occurs within or just downstream of parks, wildlife areas, and nature preserves. Diversity in these areas has increased since 1980. Mussel diversity was roughly correlated with QHEI, IBI, and ICI metrics in the downstream reach, but no metrics were available for comparison in the upstream reach. Mussel diversity was not related to any of the very few NPDES point sources on the mainstem except for the extreme downstream reach.

Host distribution does not appear to be a factor in mussel distribution. Presumed hosts, in nearly every case, have a broader distribution in the system than do their mussel parasites.

There is a lack of mussel surveys on any of the tributaries. However, based on EPA metrics and fish distributions, these tributaries may harbor a healthy mussel fauna. These areas should be investigated.

Introduction

The purpose of this study was to examine trends in freshwater mussel populations in the Grand River system using existing datasets on a geographical information system (GIS). Datasets would include mussel distributional data, fish distributional data, water quality, and land use datasets. Abiotic data are compared with mussel distributional data across 40 years of collecting records.

Materials and Methods

Themes used frequently throughout layouts	
Theme	**Source and Information**
Watershed Boundary	The Ohio Chapter of The Nature Conservancy
Streams	The Ohio Chapter of The Nature Conservancy
County lines	The Ohio Chapter of The Nature Conservancy

Watershed Information		
Layout	**Theme**	**Source and information**
Watershed Location in Ohio	1. Ohio Counties	Created from the USGS 1:100,000 digital line graphs. They were appended and edgematched at ODNR. Courtesy of Steve Lewis, ODNR.
Counties	2. Full Counties	The Ohio Chapter of The Nature Conservancy
Townships	3. Townships	The Ohio Chapter of The Nature Conservancy
The Big Darby Creek System and its Major Tributaries	4. Streams	The Ohio Chapter of The Nature Conservancy. Labeled streams are the ones we have mussel survey or collection data from.
Local Urban Areas and Watershed Towns	5. Urban Areas	From U.S. Census Bureau - TIGER. Contains Urban Areas from the 2000 census, as defined by the Census Bureau.
	6. Watershed Towns	The Ohio Chapter of The Nature Conservancy
1994 Landuse	7. 1994 Landuse	Ohio Department of Natural Resources
Major Roads	8. Major Roads	The Ohio Chapter of The Nature Conservancy
Roads	9. Roads	The Ohio Chapter of The Nature Conservancy.
Parks, Wildlife Areas, and Nature Preserves	10. Parks, Wildlife Areas, and Nature Preserves	The Ohio Chapter of The Nature Conservancy. Includes such things as State and Metro Parks, Wildlife Areas, and Nature Preserves.
	Mussel Species Richness	See Theme # 14 below.
Dams	11. Dams	The Ohio Chapter of The Nature Conservancy.

Mussel/Fish Sites		
Layout/Table	**Theme**	**Source and Information**
Sites Sampled for Freshwater Mussels	12. Mussel Sample Sites	Shows locations of actual freshwater mussel surveys/collections in each two time periods, before 1980 and 1980-2002.
Sites Sampled for Fish	13. Fish Sample Sites	Shows the sites sampled for fish by the Ohio EPA.

Mussel Species Accounts
Species accounts show the locations where each mussel species was found alive or fresh dead in each of two time periods, Before 1980 and 1980-2002. Mussel data come from the OSU Museum of Biological Diversity Bivalve Collection Database, ODNR's Natural Heritage database, Martin K. Huehner's surveys of the Grand River from the late 1990s, and ESI's South Grand River Dredging Project Survey.

Mussel/Host Maps	
Shows a comparison between locations of endangered (Ohio or Federal) mussels and their known fish hosts in each of the last two decades.	
Data	**Source**
Mussel species accounts	See "Mussel Species Accounts" section above. Shown for 1982-2000, the same time period as the EPA's fish sampling data used for the Host Locations.
Host locations	Ohio EPA
Mussel/Host Relationships	Mussel Host relationships were taken from the OSUM Molluscs division's Host database. For further information, please contact Tom Watters.

Mussel Trends		
Layout/Charts	**Theme**	**Source and Information**
Mussel Species Richness	14. Mussel Species Richness	Mussel collection/survey data were grouped into sites and sorted by time period (Before 1980 and 1980-2002). The Mussel Species Richness indicates the number of freshwater mussel species found alive or fresh dead at each site in each time period. Data were classified using equal intervals. Very few sites were sampled more than once, so comparison between time periods is not possible.
Grand River Mainstem Species Richness by River Mile		A longitudinal plot of Mussel Species Richness (1980-2002) in the Grand River mainstem by River Mile, made using Excel. There were a few sites where the locality description was not detailed enough to assign a specific River Mile (for example, the description may have been given as "near Harpersfield"). These sites are not plotted on this chart, even though they are plotted on Theme #14, the Mussel Species Richness map.
River Miles (Grand River)	15. River Miles, Grand River	This theme is included for reference, to help when reading the previous chart.

Metrics		
Layout	**Theme**	**Source/Information**
Index of Biotic Integrity (IBI)	16. Average IBI	Data from Ohio EPA. The IBI is a biological water quality index that examines the abundance, quality, and diversity of fish. We averaged the IBI score for each site for each of the last two decades using ArcView's summarize function. Data were classified using natural breaks. IBI distribution is shown next to mussel species richness for comparison. See Theme # 14 above.
Qualitative Habitat Evaluation Index (QHEI)	17. Average QHEI.	Data from Ohio EPA. The QHEI is a biological water quality index that examines various habitat quality factors. We averaged the QHEI score for each site for each of the last two decades using ArcView's summarize function. Data were classified using natural breaks. QHEI distribution is shown next to mussel species richness for comparison. See Theme # 14 above
Invertebrate Community Index (ICI)	18. Average ICI	Data from Ohio EPA. The ICI is a biological water quality index that examines the abundance, quality, and diversity of macroinvertebrates. We averaged the ICI score for each site for each of the last two decadesusing ArcView's summarize function. Data were classified using natural breaks. ICI distribution is shown next to mussel species richness for comparison. See Theme # 14 above

NPDES		
Layout	**Theme**	**Source and Information**
Location of NPDES Point Sources	19. NPDES Point Sources	Data from EPA's Envirofacts Warehouse, 11 Dec. 2003. NPDES Point Source locations are shown next to musel species richness for comparison. See Theme # 14 above.

General methods

We used ArcView 3.1 to produce all maps. Numerical data are classified by either equal intervals or natural breaks. In equal interval classifications, all classes within a theme are the same size. Natural breaks are determined by ArcView using a statistical formula

(Jenk's optimization) that looks for natural groupings in the data and assigns classes accordingly. All maps display only live and fresh dead mussel specimens.

Results and conclusions

Comparison of mussel survey results before and after 1980 clearly show an increase in the ranges of nearly all species. It is tempting to dismiss this as an artifact of collecting – post-1980 surveys were probably more thorough than pre-1980 studies. However, examination of those earlier surveys reveals that they were largely made by Dr. David Stansbery, Curator Emeritus of the Mollusk Division at Ohio State University. There is no doubt that these were not the casual efforts of weekend naturalists and shell collectors, but a genuine snapshot of the system at that time. Although post-1980 surveys examined more sites, the overall distribution of sites both pre- and post-1980 are similar. We believe the increase in mussel diversity illustrated by the distribution maps is a real phenomenon. In particular, mussel diversity has increased in the lower third of the mainstem while remaining constant in the upper two-thirds.

Most species are surprisingly widespread along the entire mainstem in both pre- and post-1980 surveys. Species rare before 1980 remain rare today. These include: Cylindrical Papershell, Wavy-rayed Lampmussel, Creek Heelsplitter, Lilliput, and others. Many species have apparently increased their ranges: Fragile Papershell, Pink Heelsplitter, Spike, Snuffbox (OH endangered), Wabash Pigtoe, and others.

The dam at Harpersfield is limiting the upstream distribution of mussel species using freshwater drum as their host, noticeably Fragile Papershell and Pink Heelsplitter. Several species using Drum are too rare in the system to show a relation to the dam, but these mussels have been shown to affected by dams elsewhere. Other species also seem to be influenced by the dam, although not known to use drum as a host: Elktoe and Snuffbox (OH endangered), for example.

Clearly maximum mussel species richness occurs within or just downstream of parks, wildlife areas, and nature preserves. Indeed, diversity in these areas has increased since 1980. This strongly suggests the benefits of environmentally managed land on mussels and the aquatic ecosystem in general. These benefits include riparian corridors, a general lack of point and non-point discharges, and absence of in-stream activities. It is no coincidence that the most mussel rich area in the Big Darby Creek system is also within a park. In addition to these protections, the Grand River is a State Wild and Scenic River from the dam to 23 miles downstream. It is a State Scenic River from the dam to 33 miles upstream.

Mussel diversity was roughly correlated with QHEI, IBI, and ICI metrics in the downstream reach. QHEI values were consistently high in the lower reach (except for the last 5 miles), as was mussel diversity. Although there was a decline in QHEI values for upstream sites, these were too few in number for comparison with the numerous mussel sites there. IBI and ICI sites were more widespread, and like mussel diversity, they were

consistently high. All scores and mussel diversity were depressed in the lower five miles of the mainstem.

The Grand River has virtually no population centers on its mainstem. The mouth flows through Painesville and it is there that we see mussel diversity noticeably lower than elsewhere in the river. EPA metrics are also lower here. Elsewhere the system is strategically placed between Ashtabula, Youngstown, and Chardon without being directly influenced by any of them. NPDES point sources are rare on the mainstem, comprised mostly of sewer outfalls.

Elsewhere, land use is a patchwork of forest and agriculture. However, the mainstem is largely bounded by forest and wetlands. Nonpoint source numbers are probably at a minimum in comparison to most Ohio river systems.

Host fish species for Grand River mussels are widespread. In nearly every case, hosts have a broader distribution in the system than do their mussel parasites. As mentioned, the dam on the mainstem at Harpersfield influences the distribution of drum and its mussel parasites. The low water quality at the mouth in Painesville may also interfere with fish entering the river from Lake Erie.

There is a lack of mussel surveys on any of the tributaries. However, based on EPA metrics and fish distributions, these tributaries may harbor a healthy mussel fauna. These areas should be investigated.

Sources

Division of Mollucs, the Ohio State University Museum of Biological Diversity. 2002. Bivalve database, Host database.

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Enviroscience, Inc. 2002. South Grand River Dredging Project Draft: Freshwater Mussel Population Survey Report.

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Huehner, Martin K. [1999]. Final Report: Mussel Survey of Grand River Headwaters and Distribution of the Clubshell in Pymatuning Creek.

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Ohio Department of Natural Resources, Natural Heritage Database. 2002.

Tetzloff, John. 2000. 2000 Survey of the Freshwater Mussels of the Lower Big Darby Creek. Final Report to the Division of Wildlife, the Ohio Department of Natural Resources.

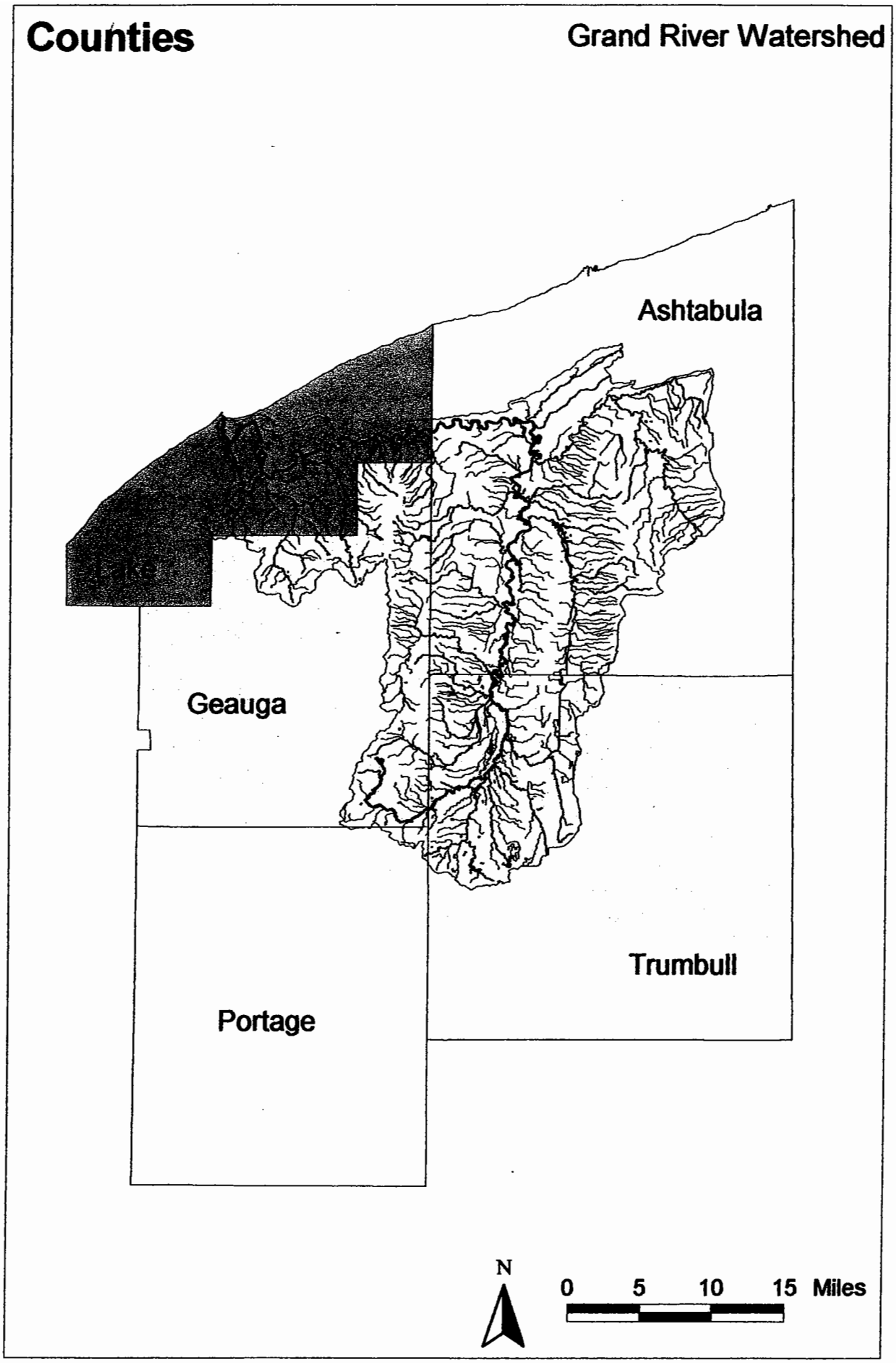
U.S. Census Bureau. TIGER Database. 2003.

Acknowledgements

This project was supported by the Ohio Division of Wildlife, The Ohio Chapter of the Nature Conservancy, and the Ohio Division of Natural Areas and Preserves. We would also like to thank Ed Moore, and Dennis Mishne of the Ohio EPA, the staff at the Natural Heritage Database, Steve Lewis of ODNR, and Jason Taylor of the Nature Conservancy for helping us to obtain the data and overlays we needed.

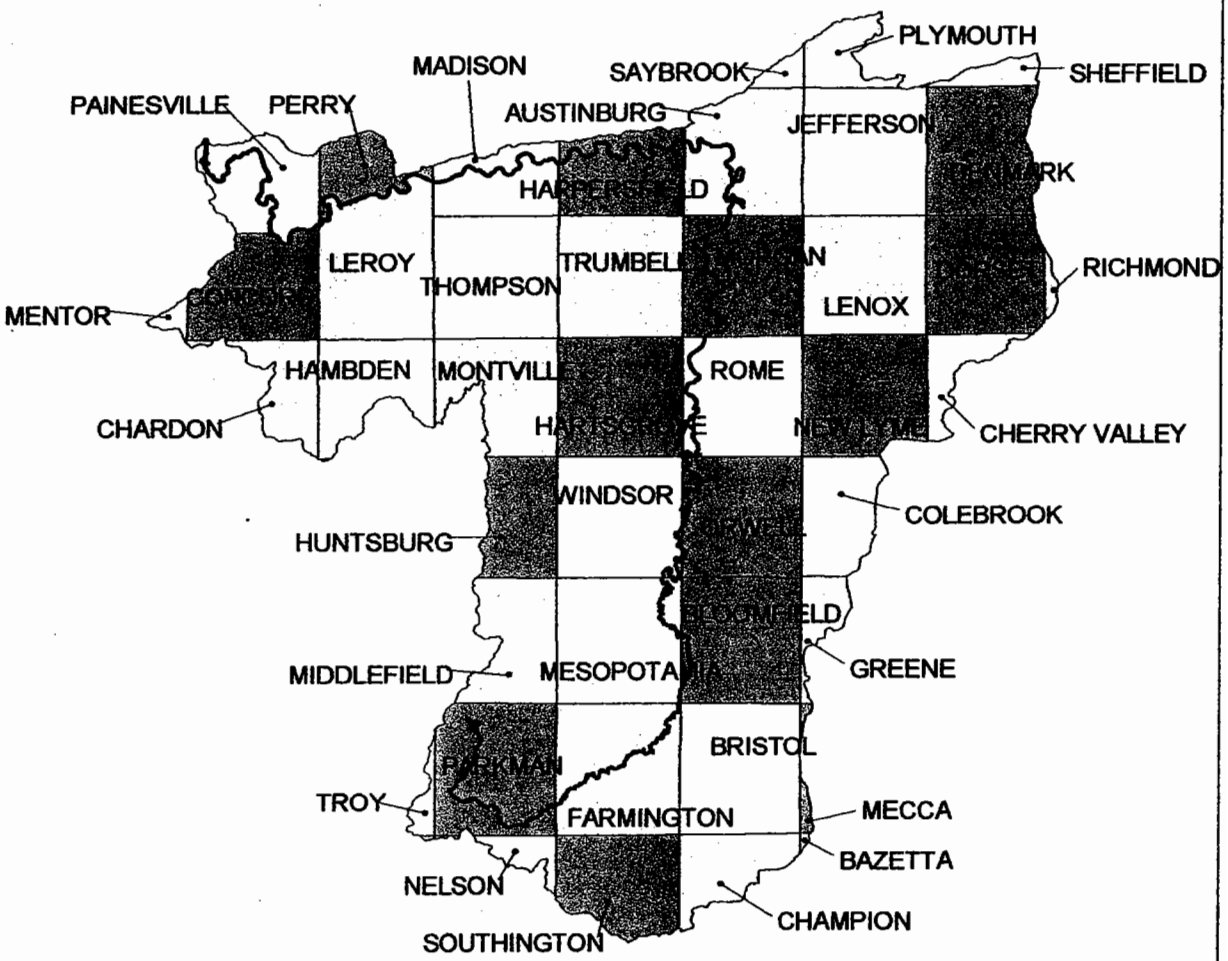
Watershed location in Ohio

Grand River Watershed


Counties
Grand River Watershed
Ashtabula
Geauga
Trumbull
Portage
N
0 5 10 15 Miles

Townships

Grand River Watershed

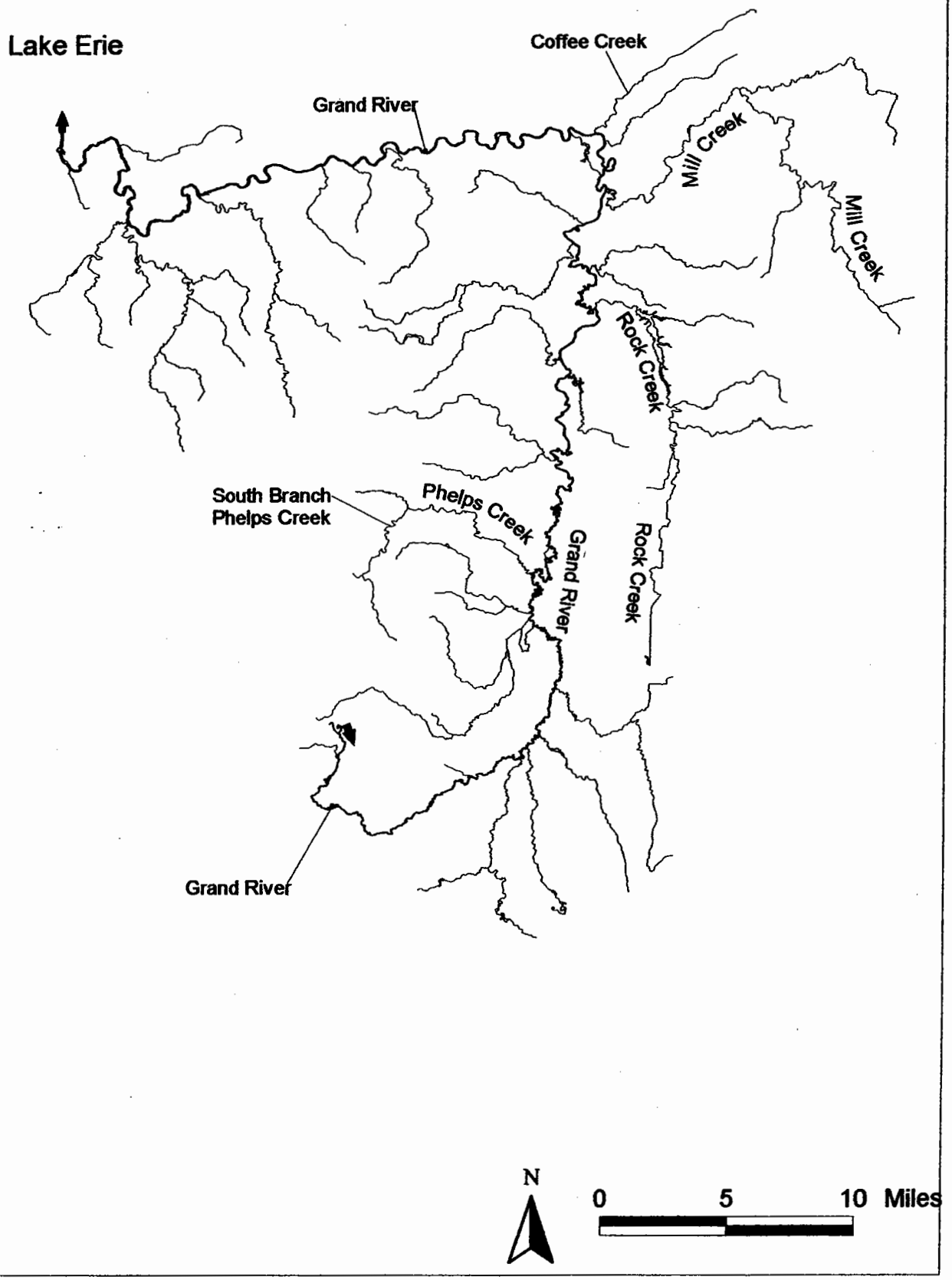


N

0 5 10 Miles

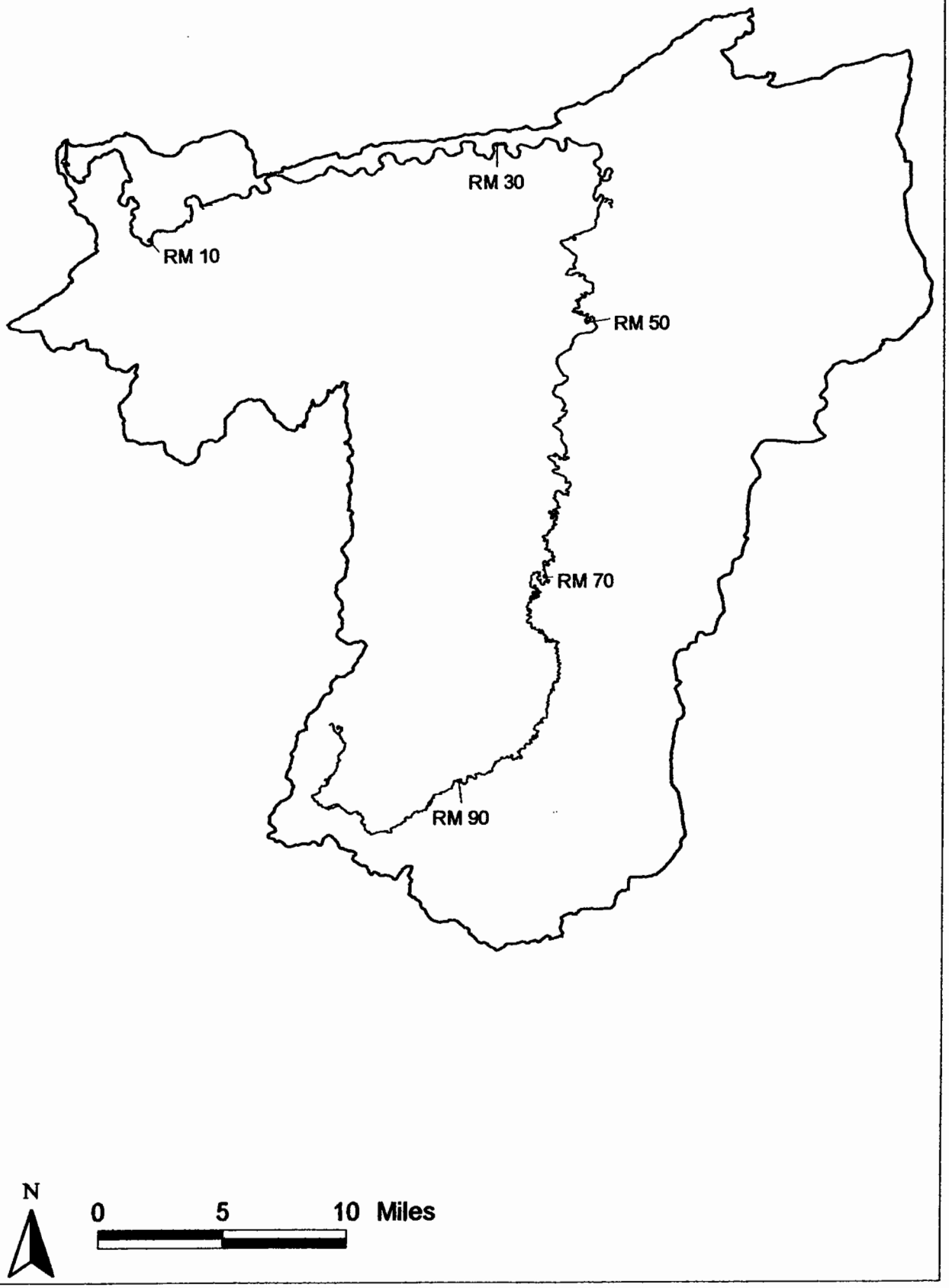
Grand River and Major Tributaries

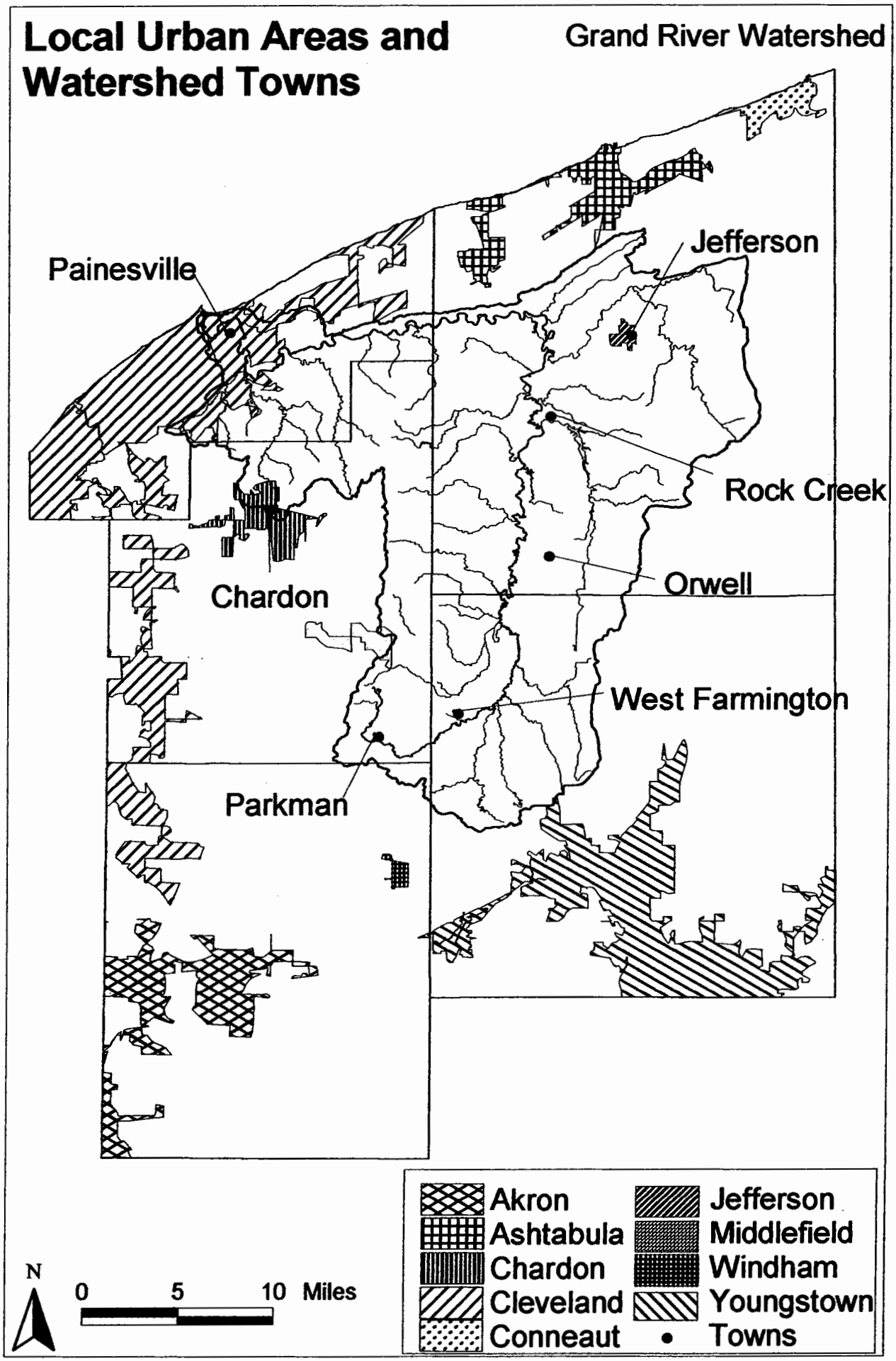
Grand River Watershed



River Miles (Grand River)

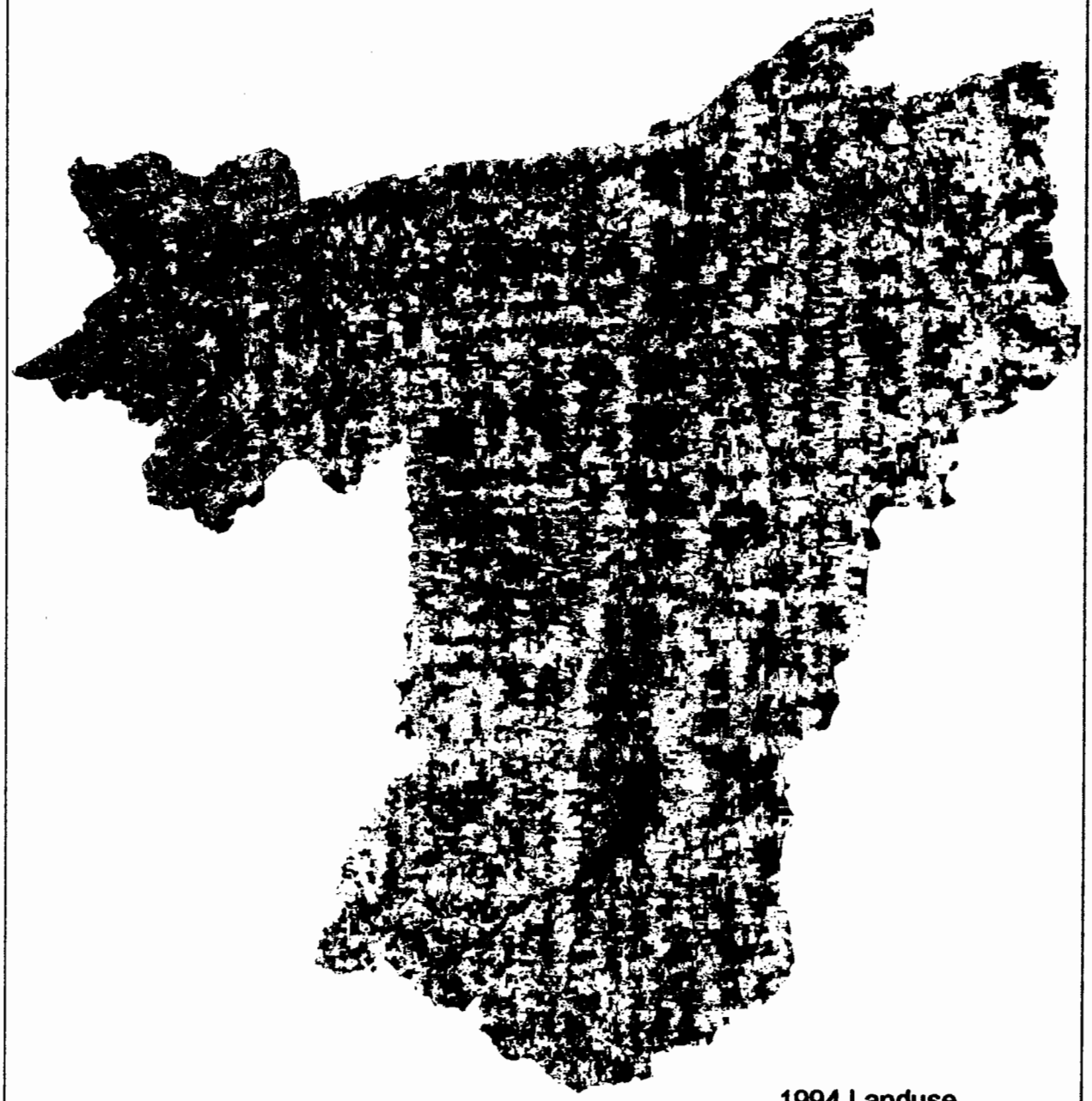
Grand River Watershed




Local Urban Areas and Watershed Towns
Grand River Watershed
Painesville
Jefferson
Rock Creek
Orwell
Chardon
West Farmington
Parkman
Akron
Ashtabula
Chardon
Cleveland
Conneaut
Jefferson
Middlefield
Windham
Youngstown
Towns
N
0
5
10 Miles

1994 Landuse

Grand River Watershed



1994 Landuse

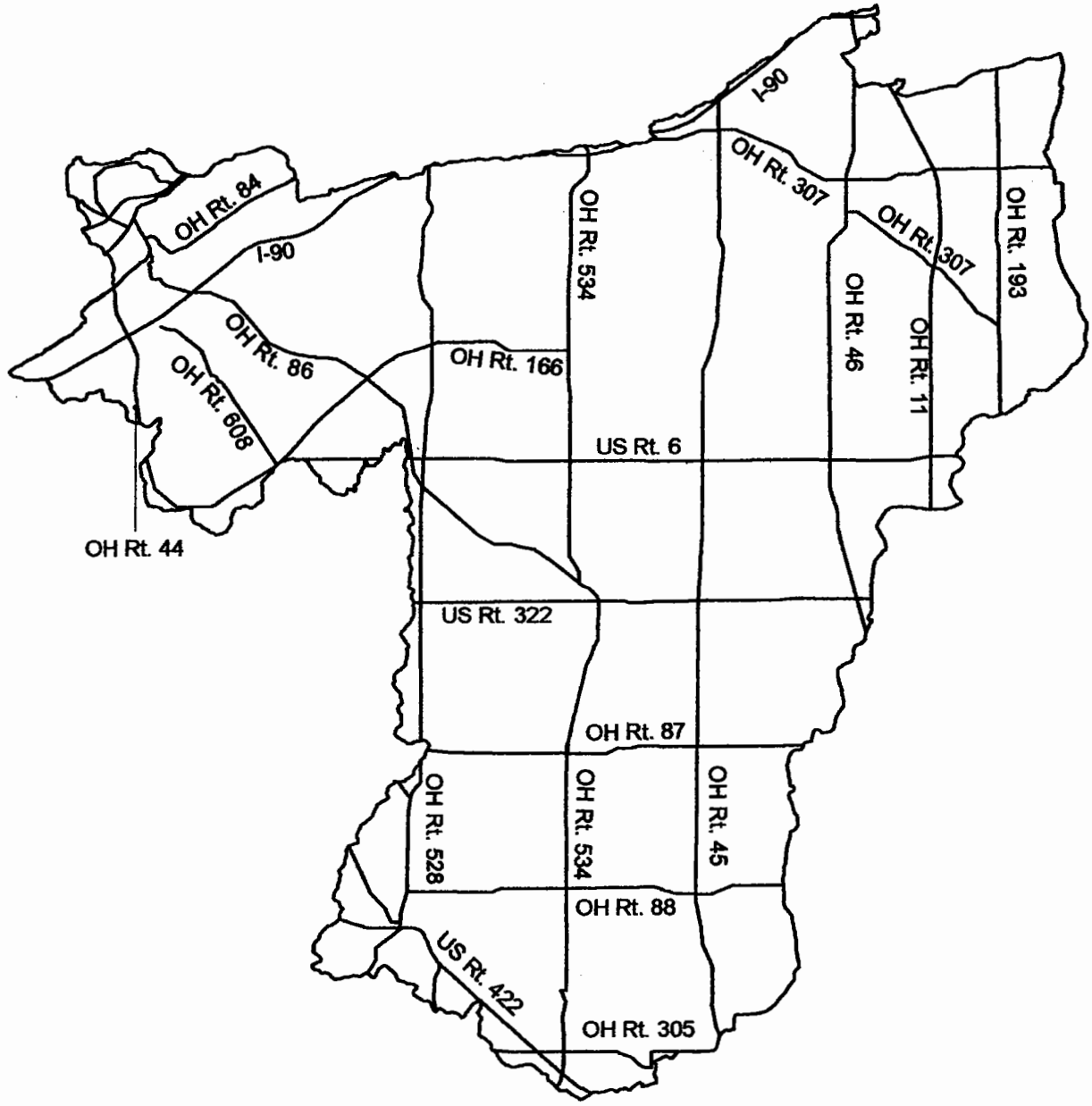
- Urban
- Agricultural
- Shrub/Scrub
- Forest
- Water
- Non-forested wetland
- Barren

N

0 5 10 Miles

Major Roads

Grand River Watershed

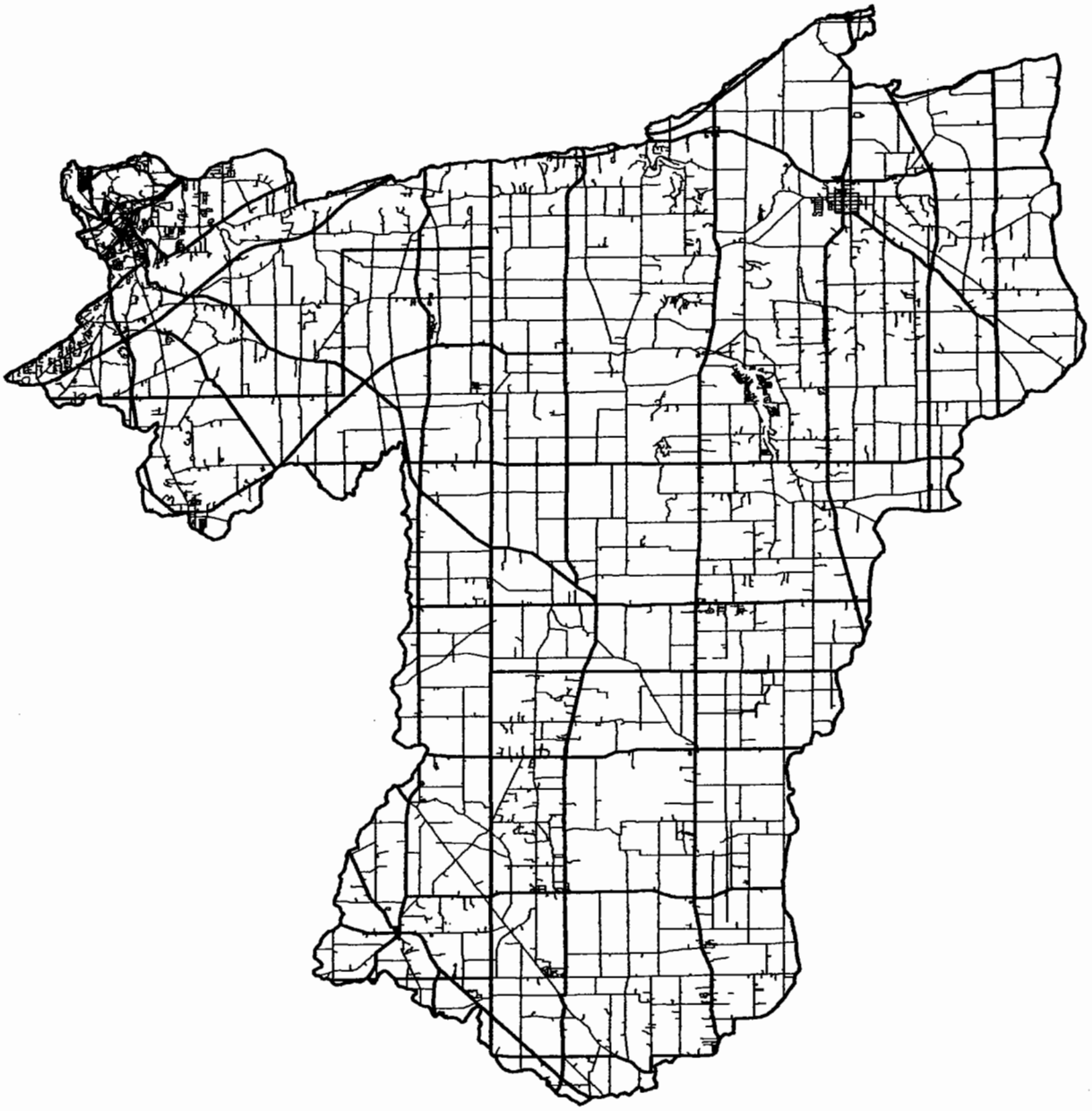


N

0 5 10 Miles

Roads

Grand River Watershed

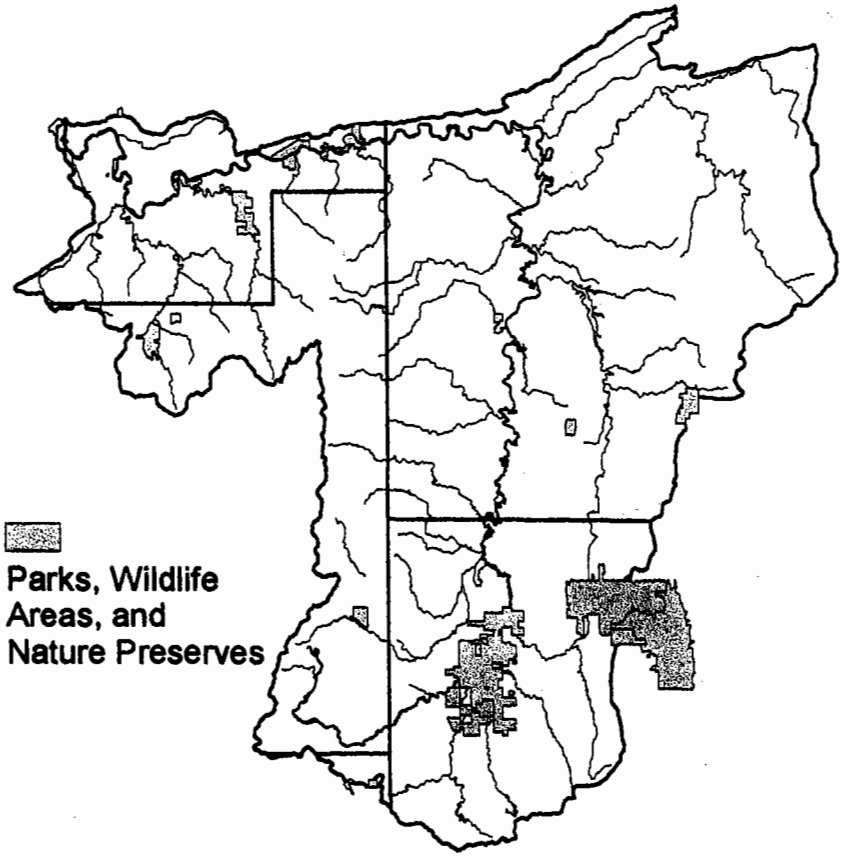


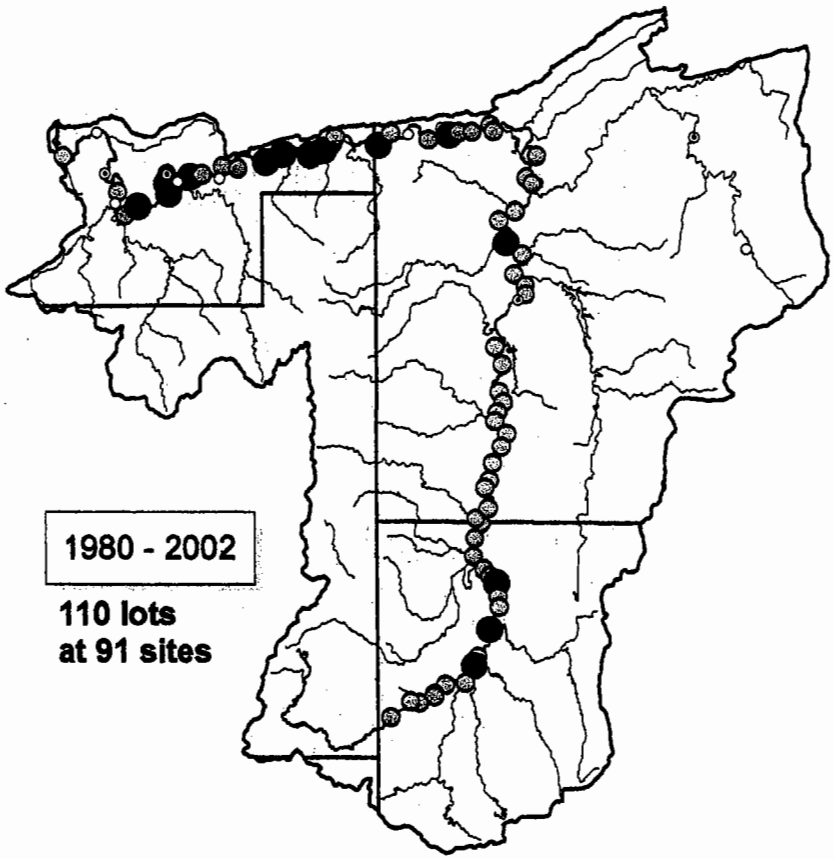
N

0 5 10 Miles

Parks, Wildlife Areas, and Nature Preserves

Grand River Watershed





N

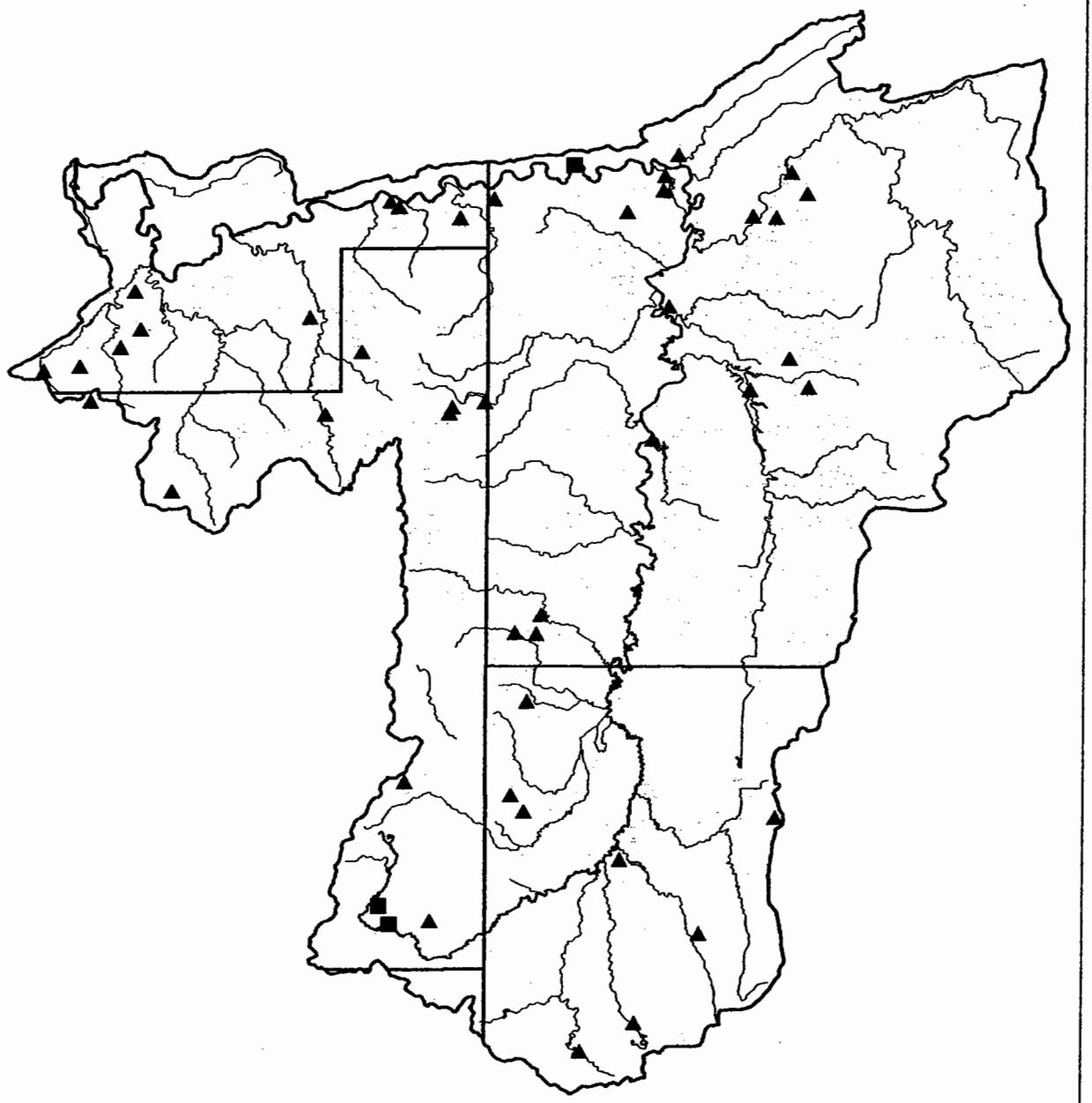
0 5 10 Miles

Mussel Species Richness (live/fresh dead only)

- 0 species
- 1 - 5 species
- 6 - 11 species
- 12 - 17 species

Dams

Grand River Watershed



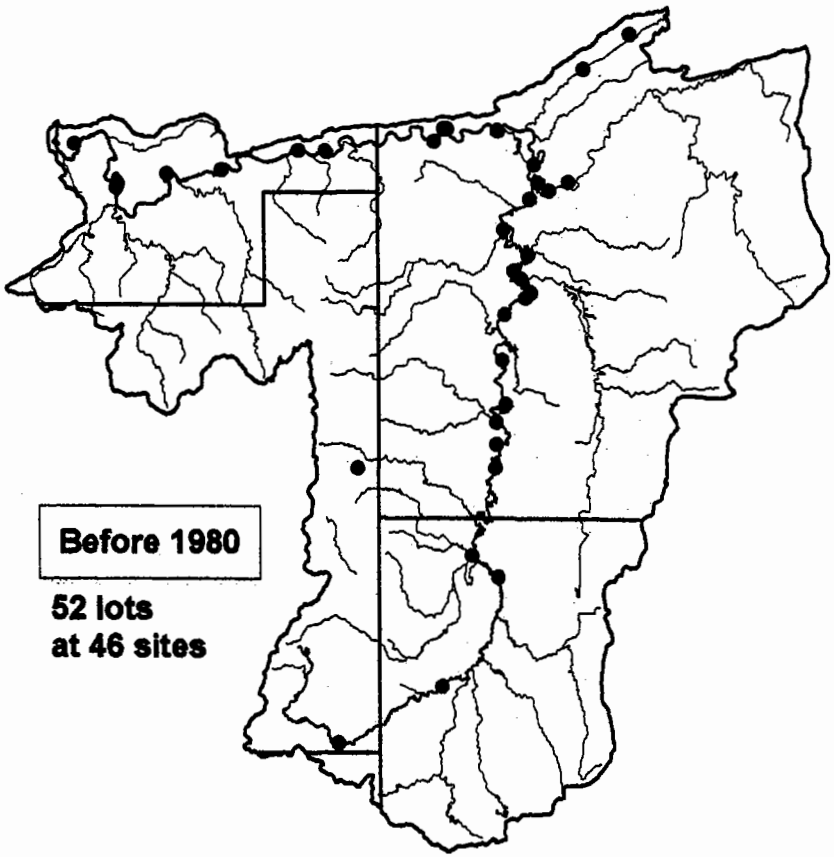
■ Dams on Grand River (3 total)
▲ Dams on Tributaries

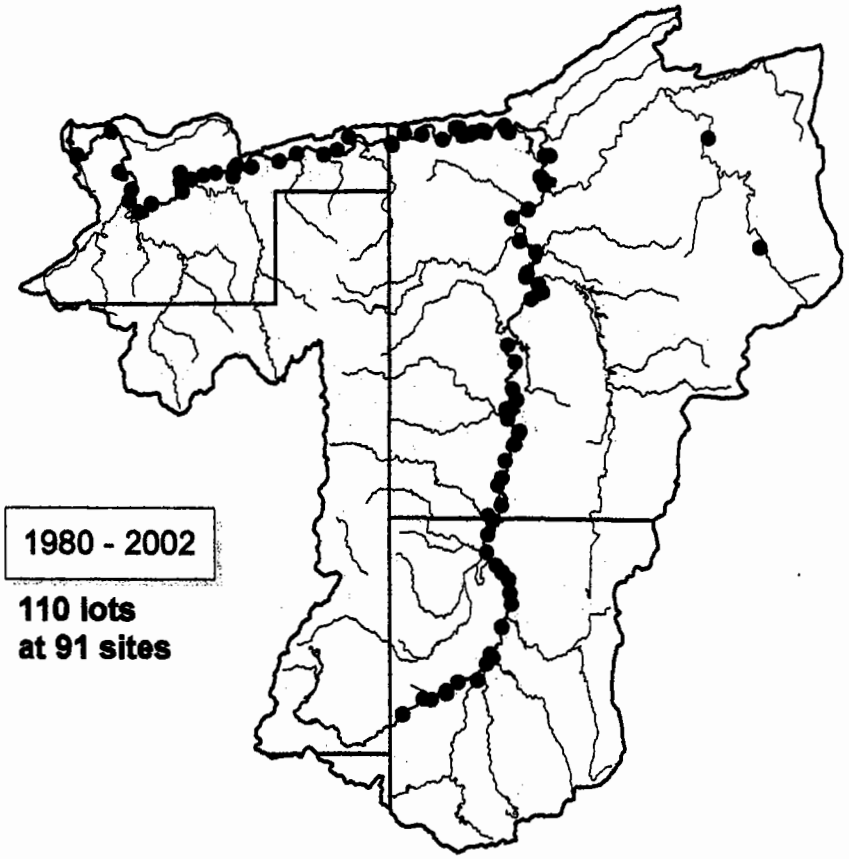
N

0 5 10 Miles

Sites sampled for Freshwater Mussels

Grand River Watershed





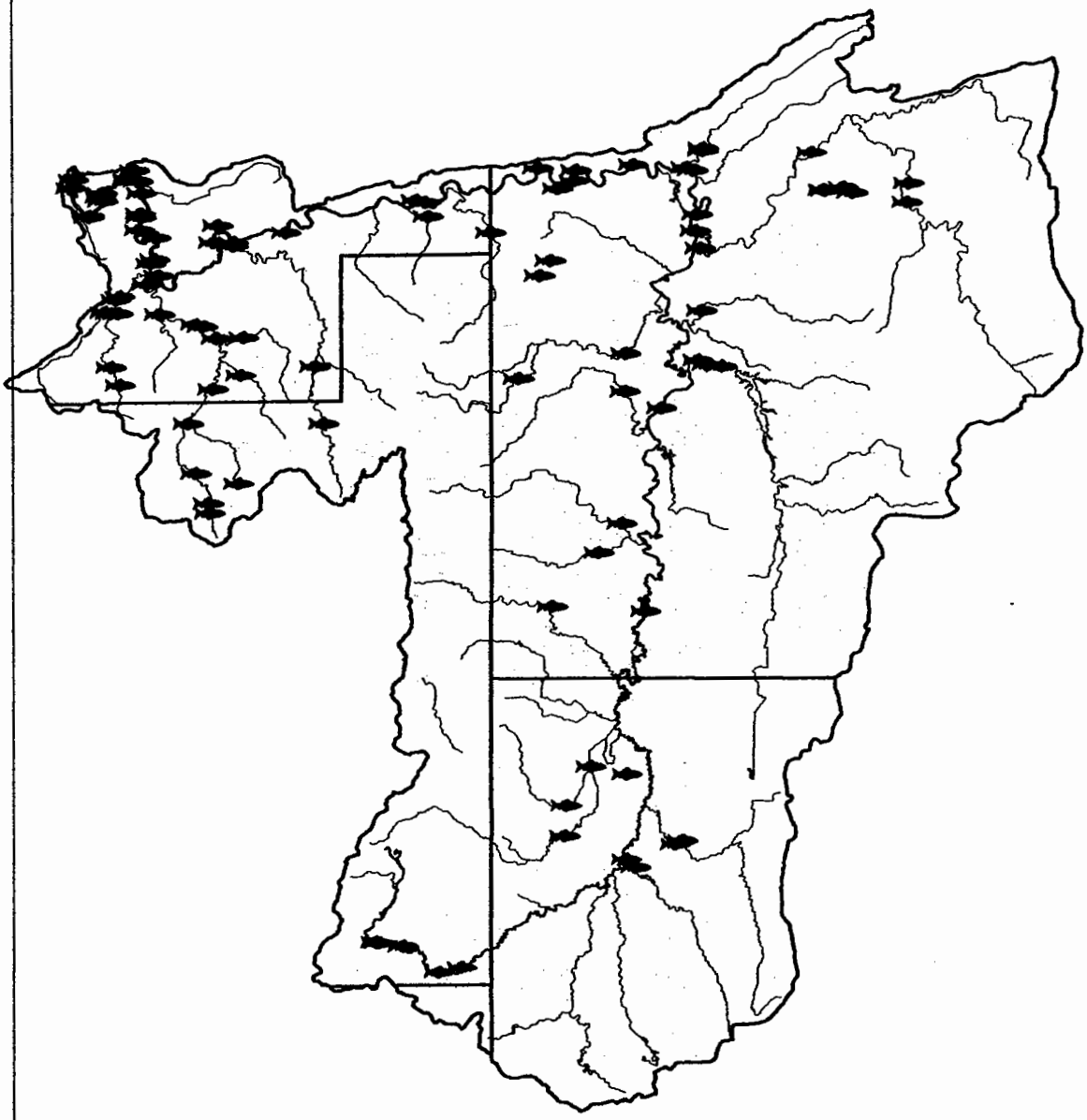
N

0 5 10 Miles

• Location sampled

Sites Sampled for Fish

Grand River Watershed



Site sampled by Ohio EPA for fish, 1982-2000

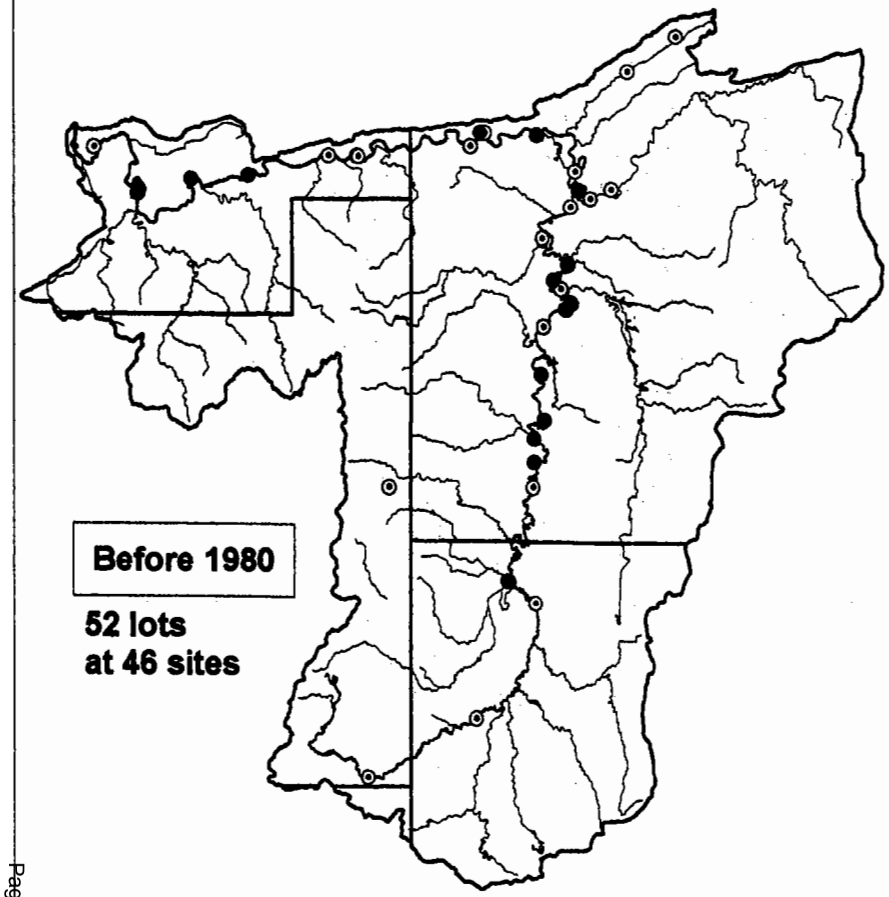
N

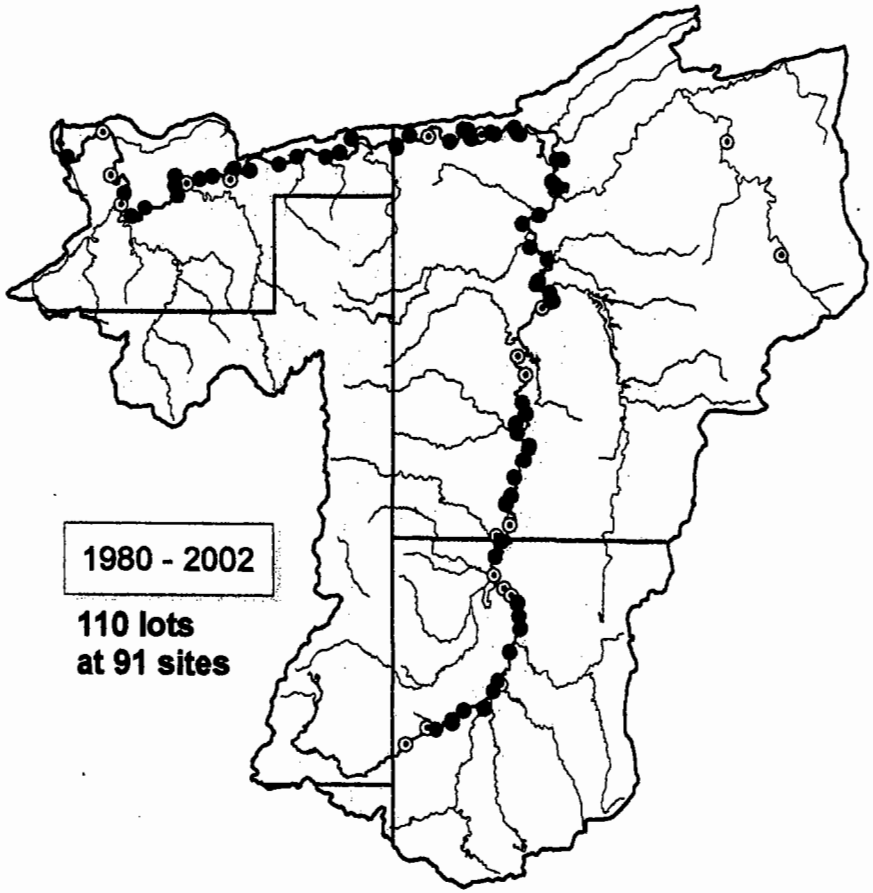
0 5 10 Miles

Mucket

Grand River Watershed

Actinonaias ligamentina carinata (Barnes, 1923).





N

0 5 10 Miles

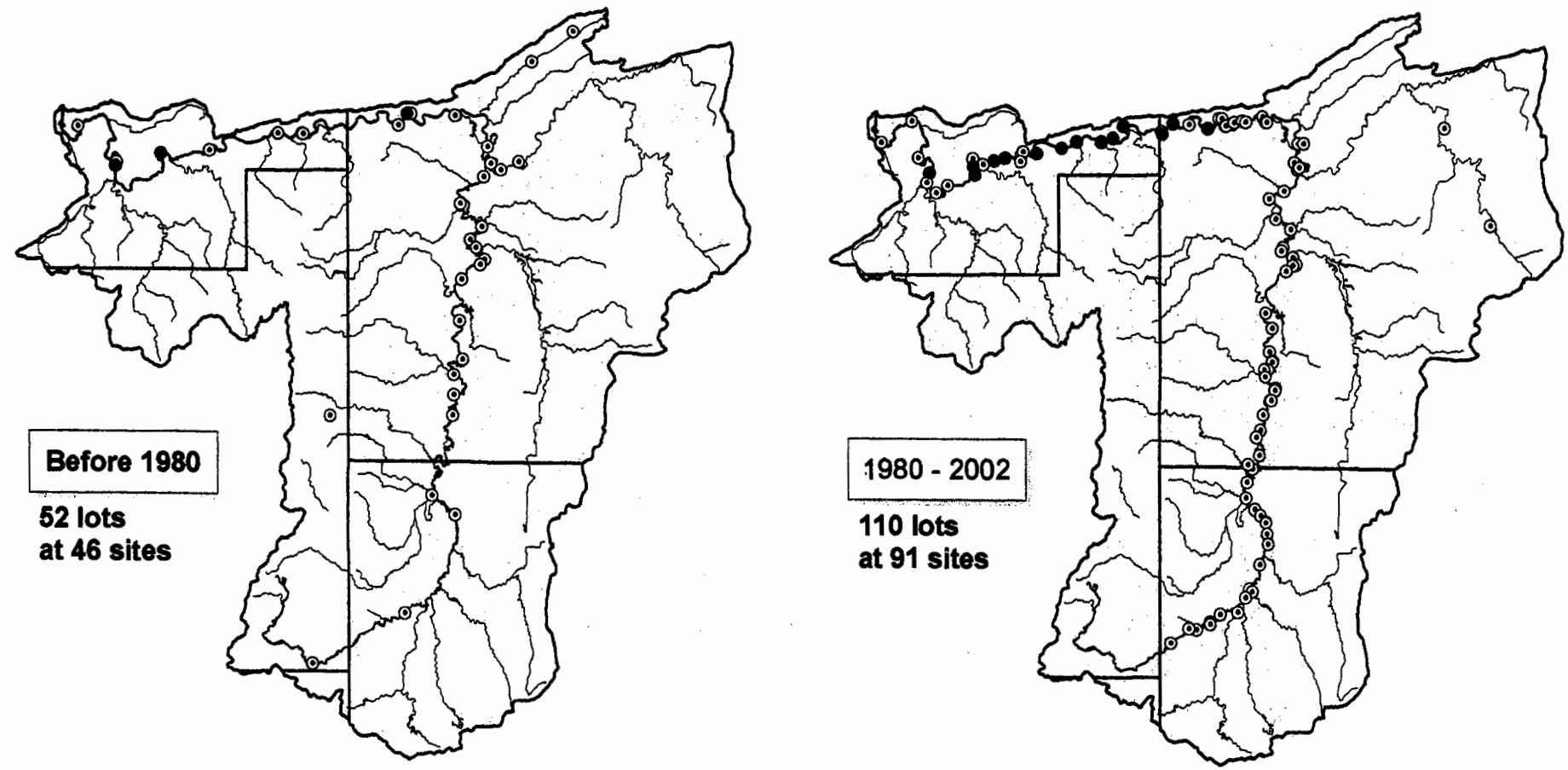
• Alive or fresh dead

⊙ Location surveyed, but this species not found

Elktoe

Alasmidonta marginata Say, 1818.

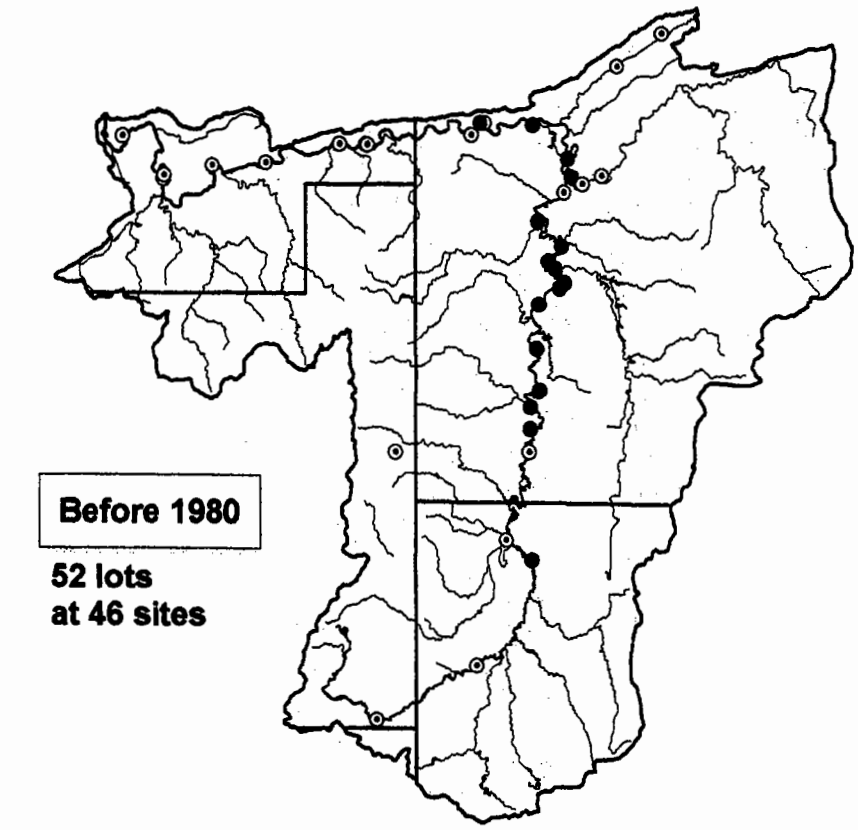
Grand River Watershed

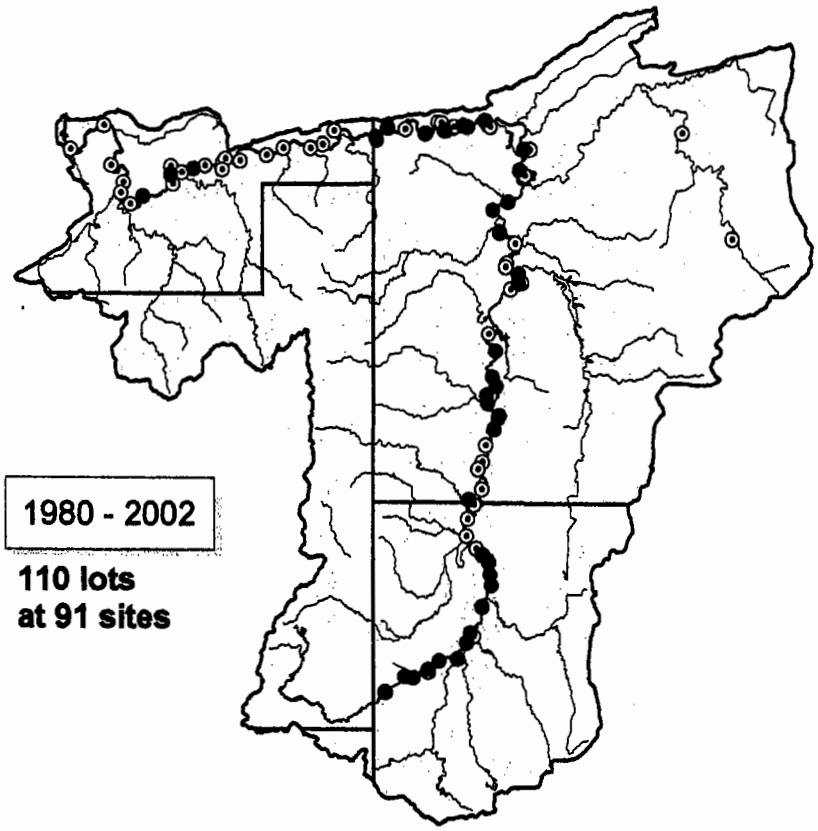


Threeridge

Amblema plicata plicata (Say, 1817).

Grand River Watershed





N

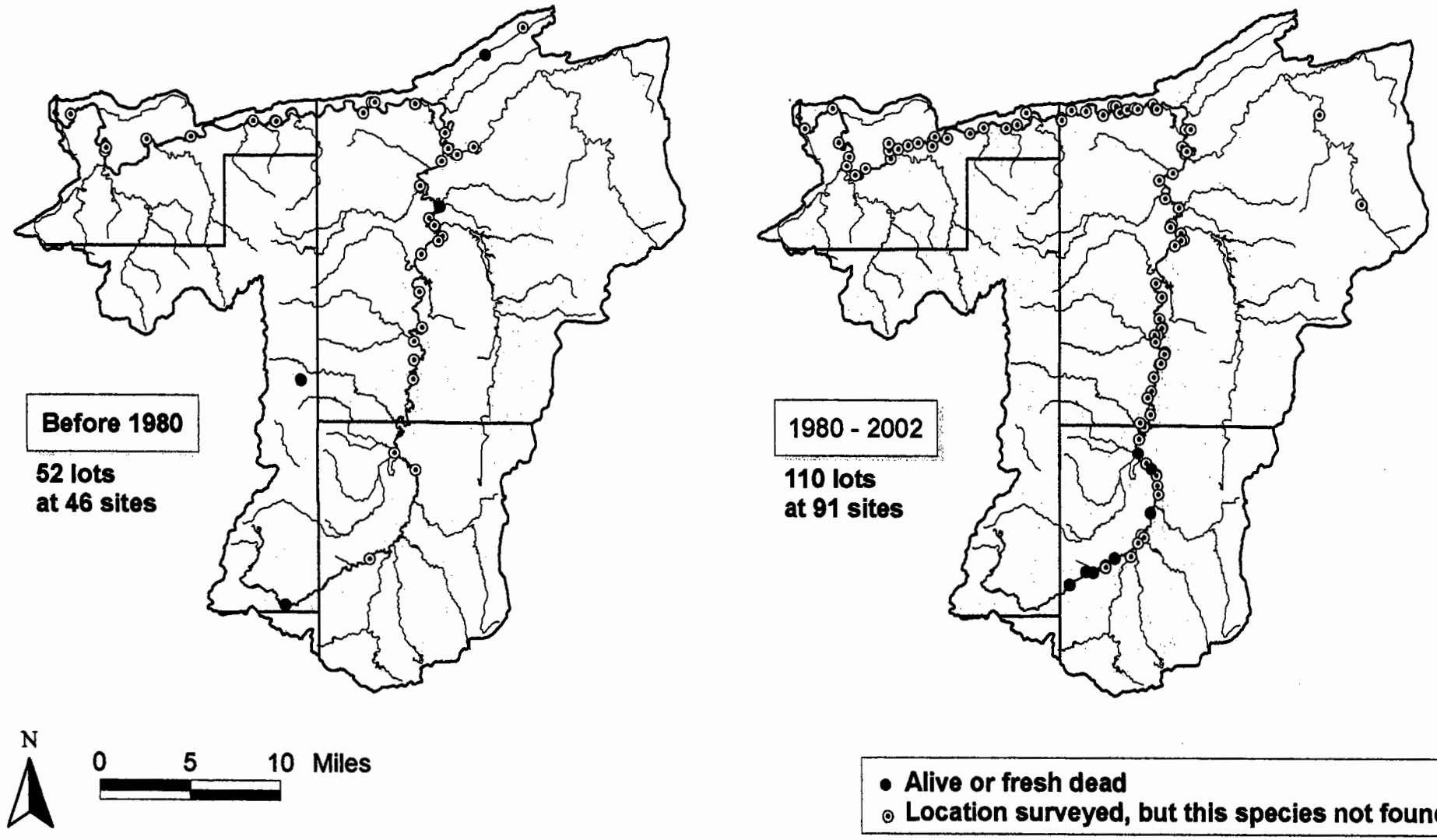
0 5 10 Miles

- Alive or fresh dead
- Location surveyed, but this species not found

Cylindrical papershell

Anodontoides ferussacianus (Lea, 1834).

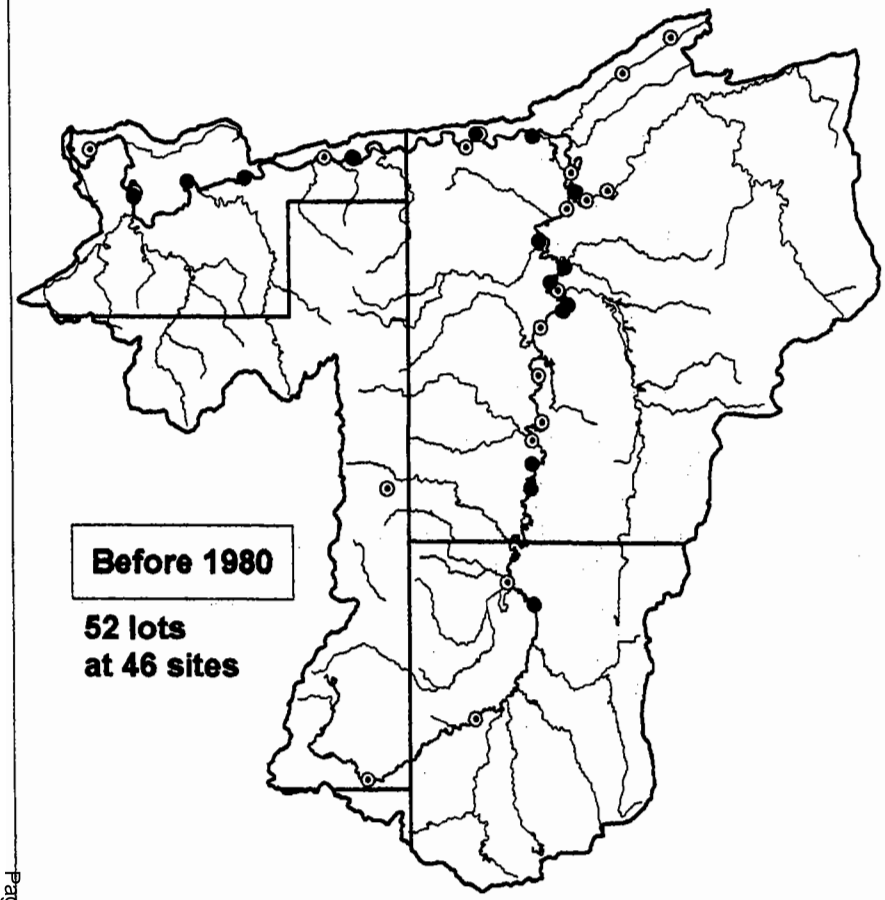
Grand River Watershed

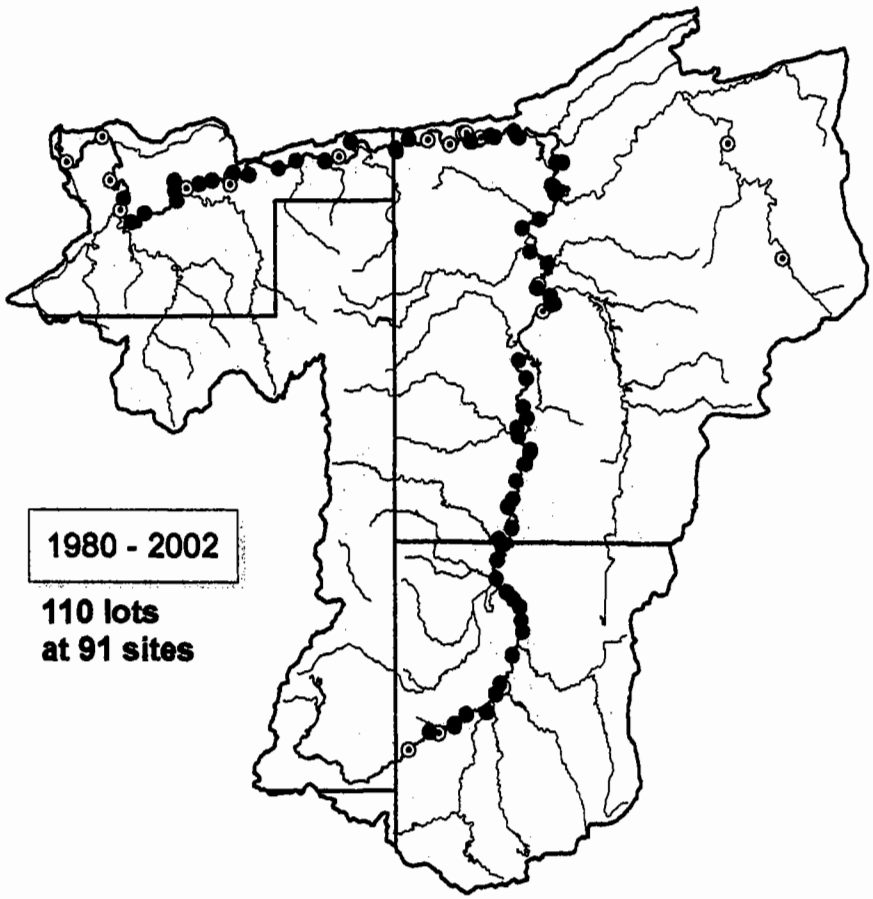


Spike

Elliptio dilatata (Rafinesque, 1820).

Grand River Watershed





N

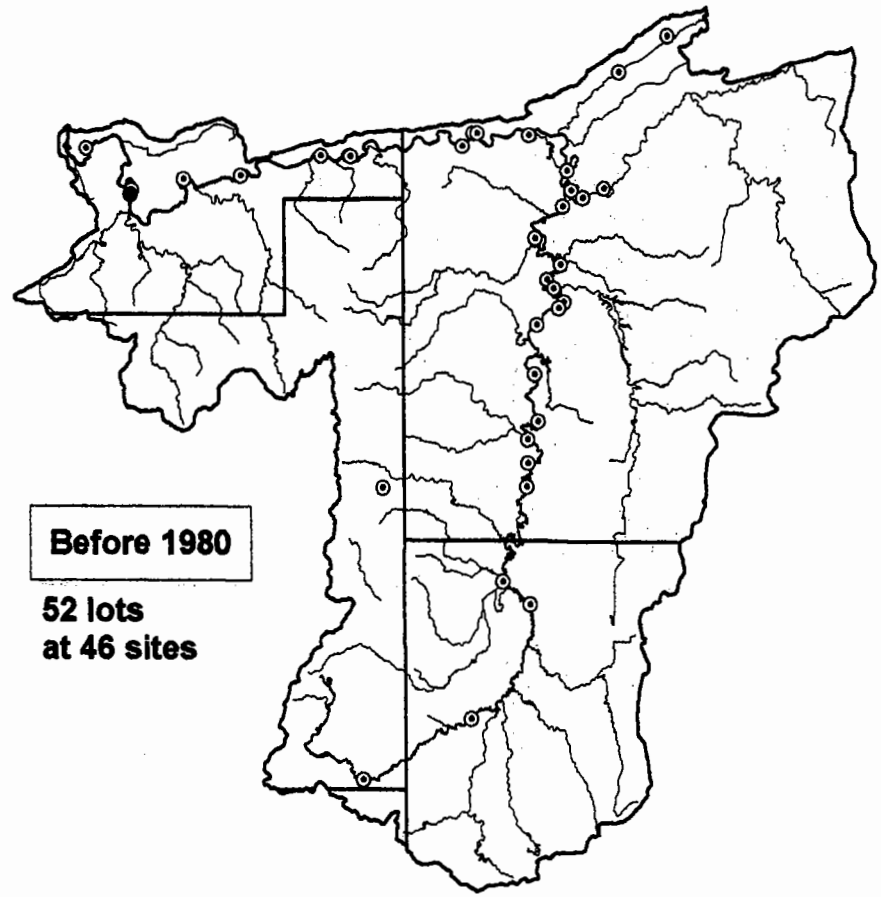
0 5 10 Miles

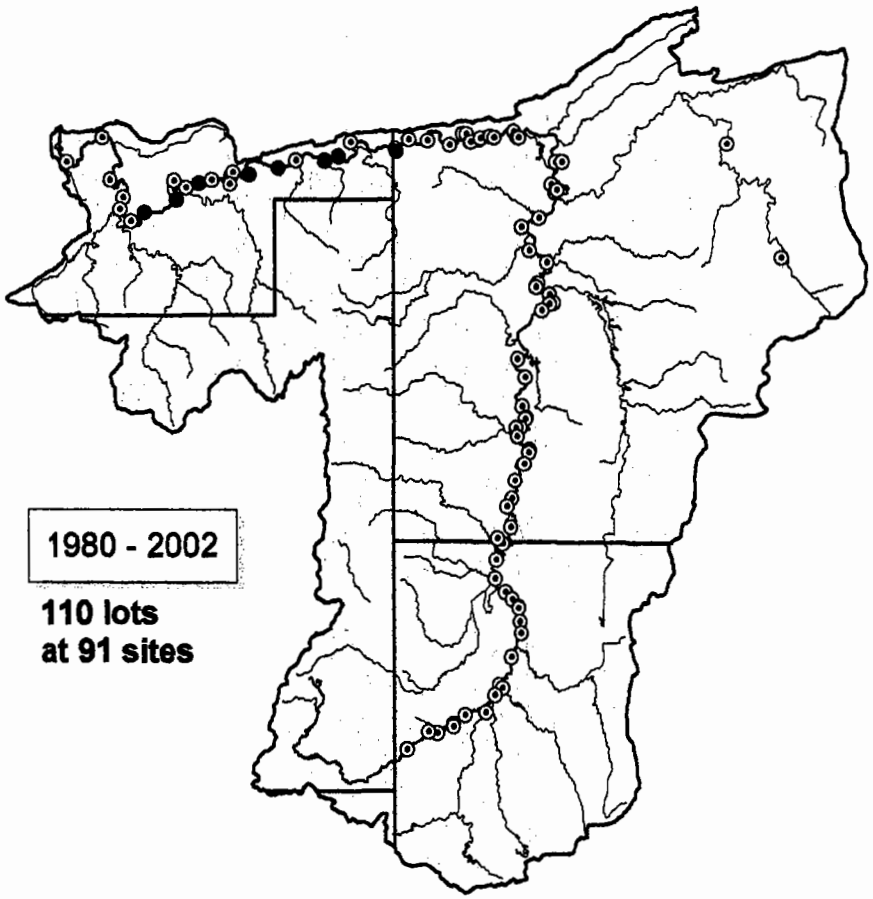
- Alive or fresh dead
- Location surveyed, but this species not found

Snuffbox

Epioblasma triquetra (Rafinesque, 1820).

Grand River Watershed





N

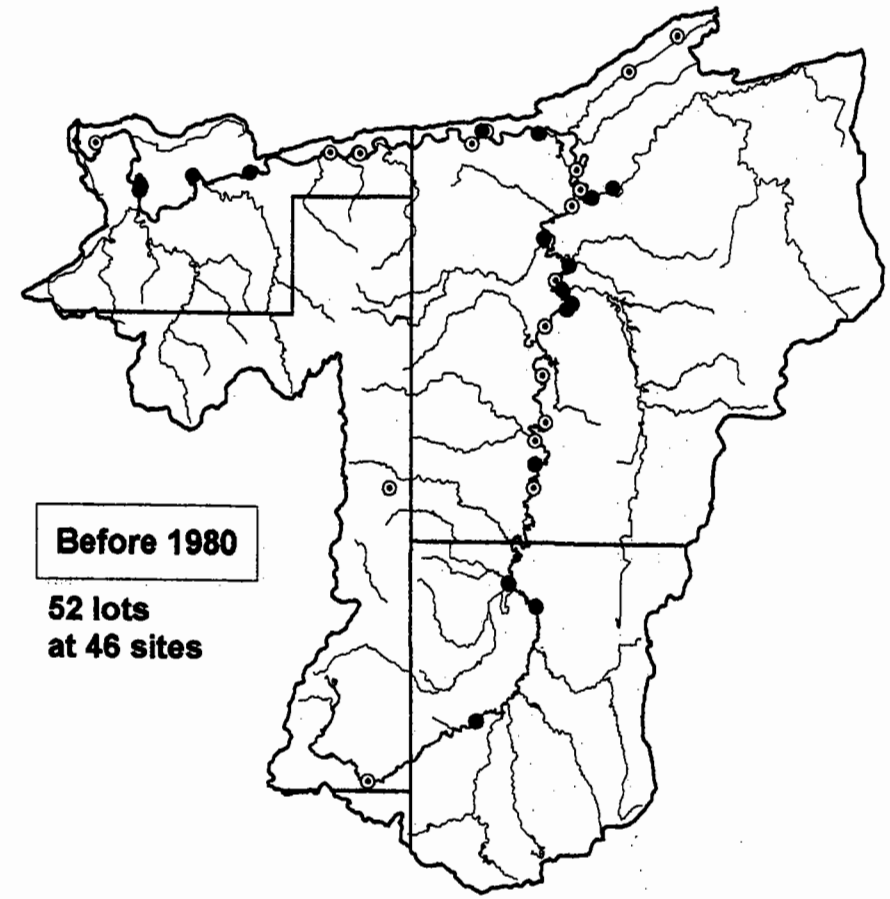
0 5 10 Miles

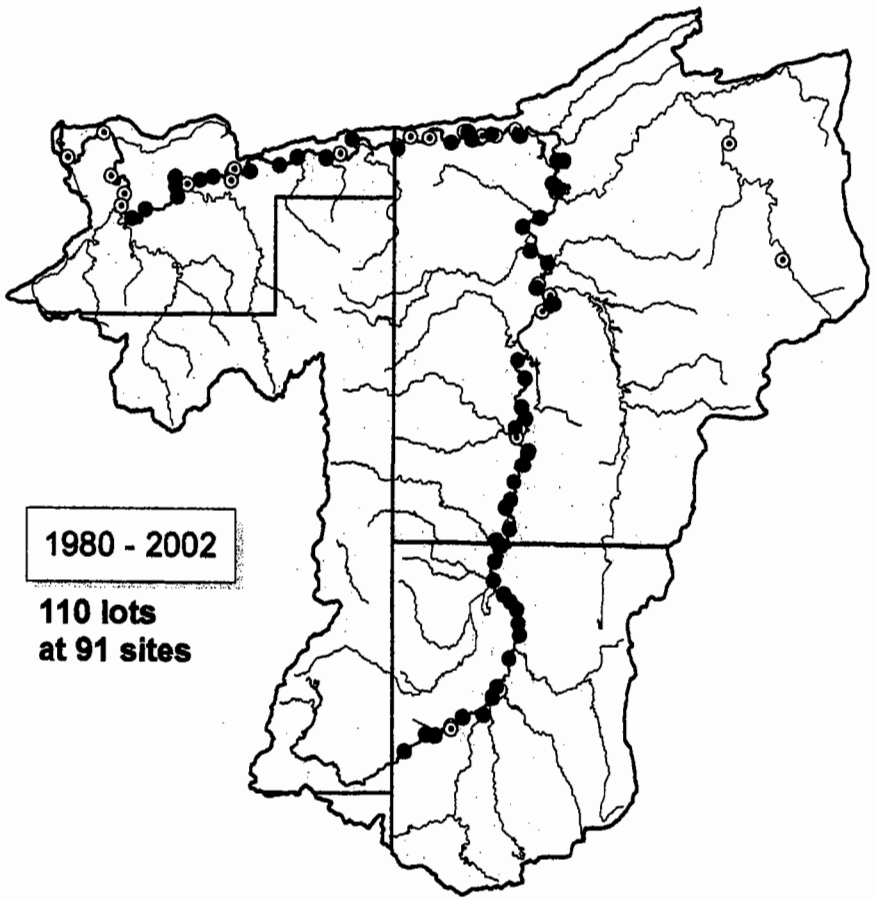
- Alive or fresh dead
- Location surveyed, but this species not found

Wabash pigtoe

Fusconaia flava (Rafinesque, 1820).

Grand River Watershed





N

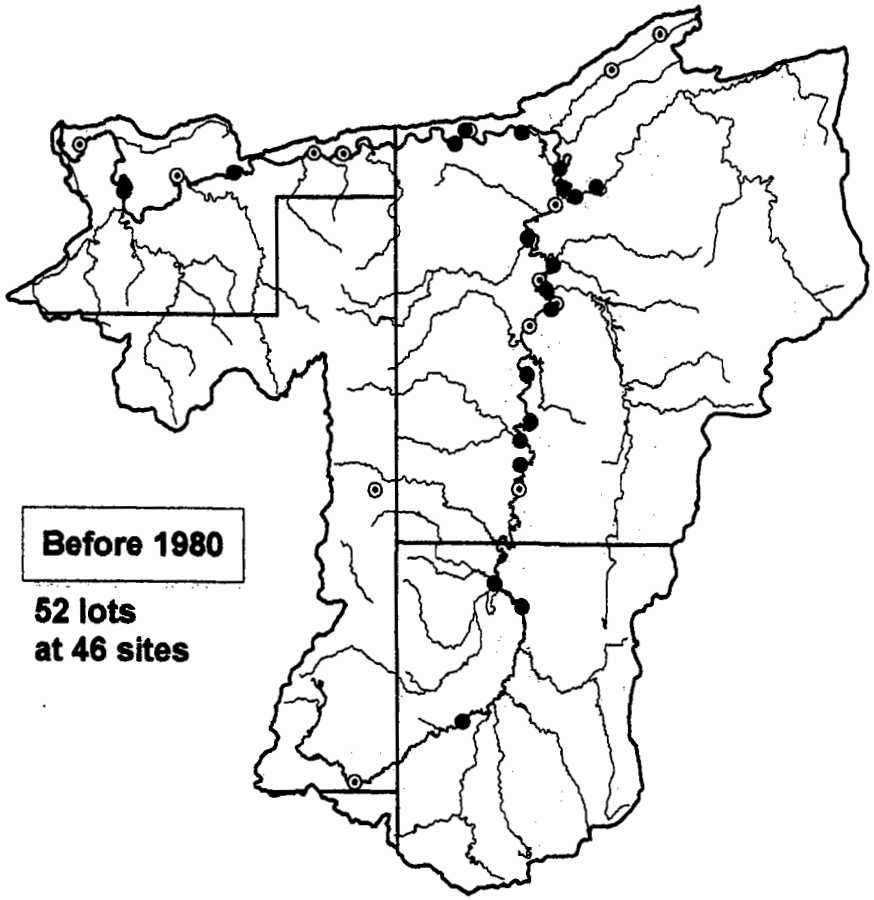
0 5 10 Miles

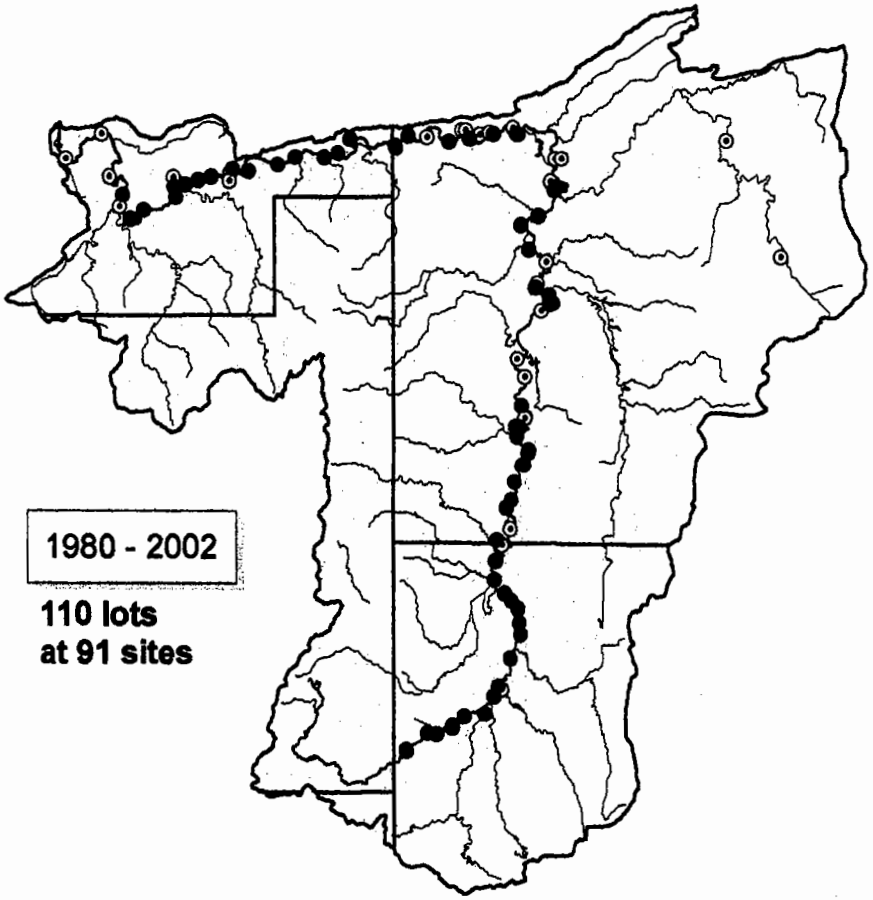
- Alive or fresh dead
- Location surveyed, but this species not found

Plain pocketbook

Lampsilis cardium (Rafinesque, 1820).

Grand River Watershed





N

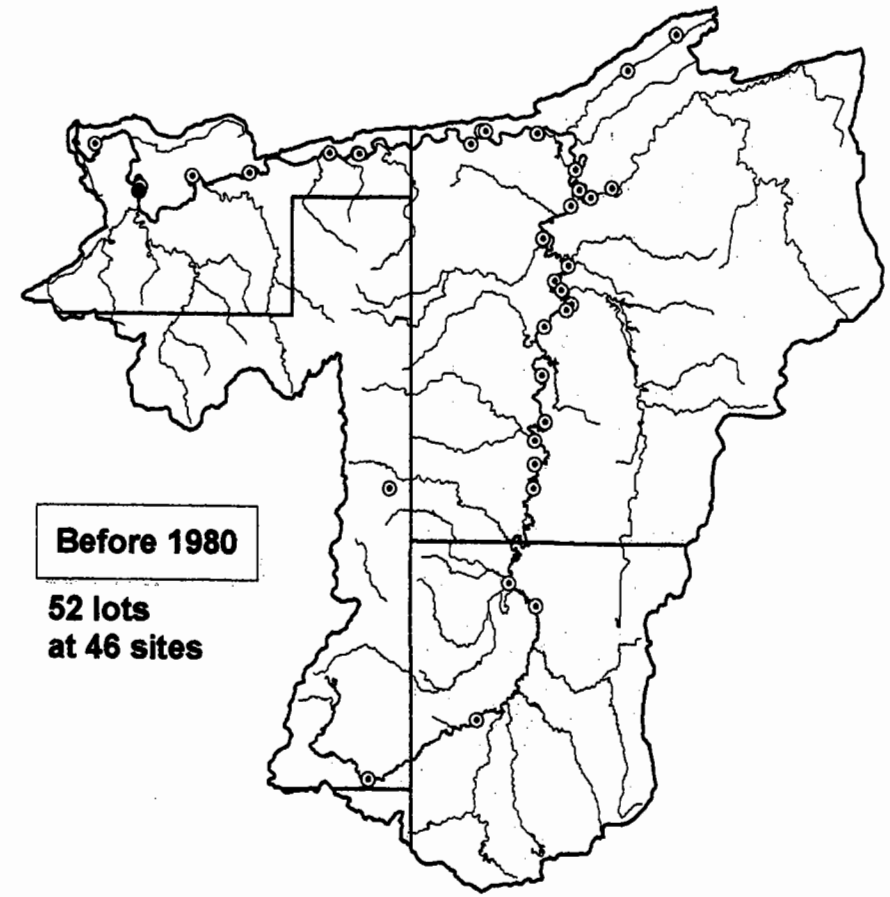
0 5 10 Miles

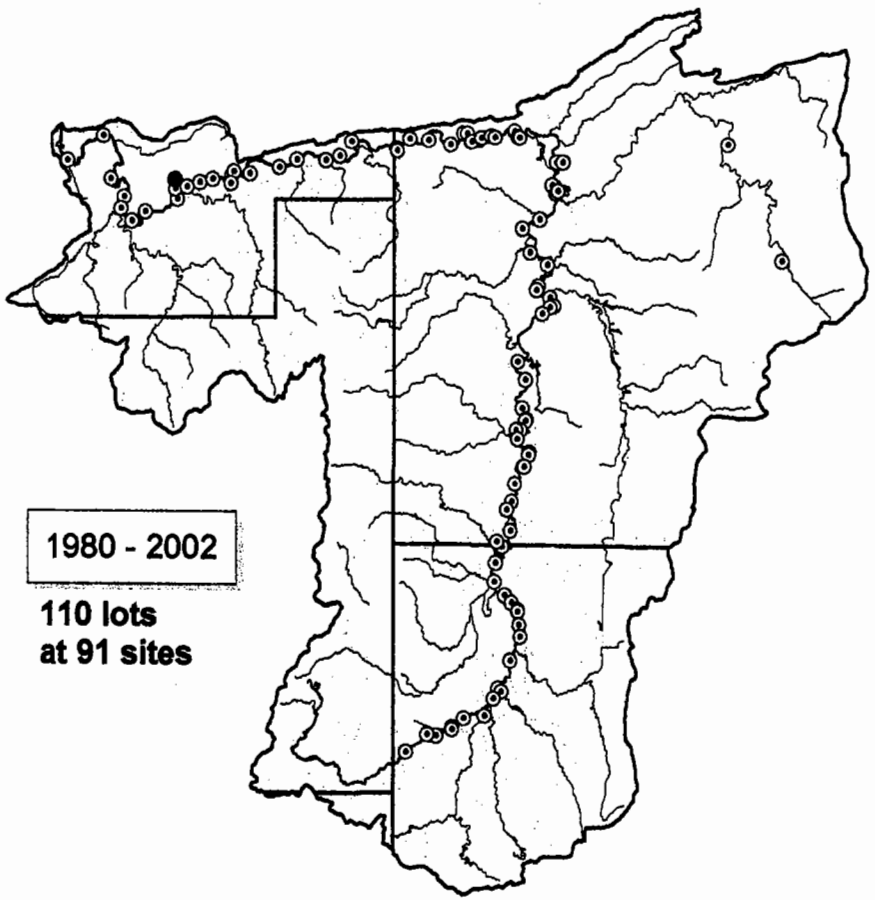
- Alive or fresh dead
- Location surveyed, but this species not found

Wavy-rayed lampmussel

Lampsilis fasciola Rafinesque, 1820.

Grand River Watershed





N

0 5 10 Miles

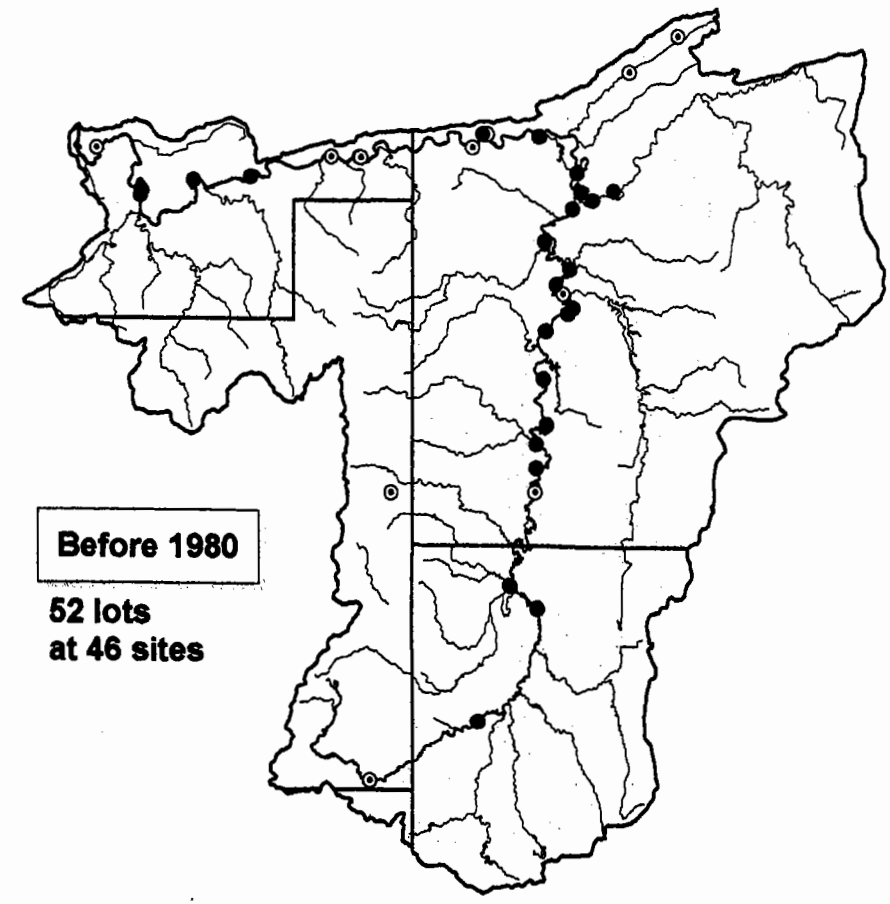
• Alive or fresh dead

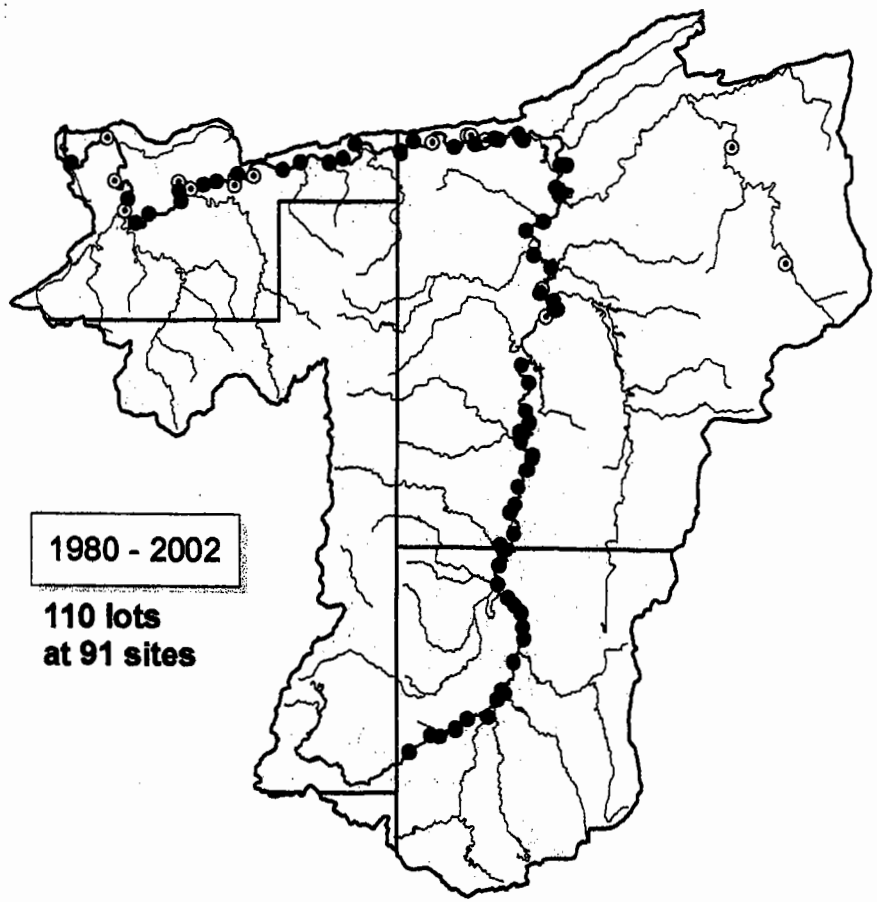
⊙ Location surveyed, but this species not found

Fatmucket

Grand River Watershed

Lampsilis radiata luteola (Lamarck, 1819).





N

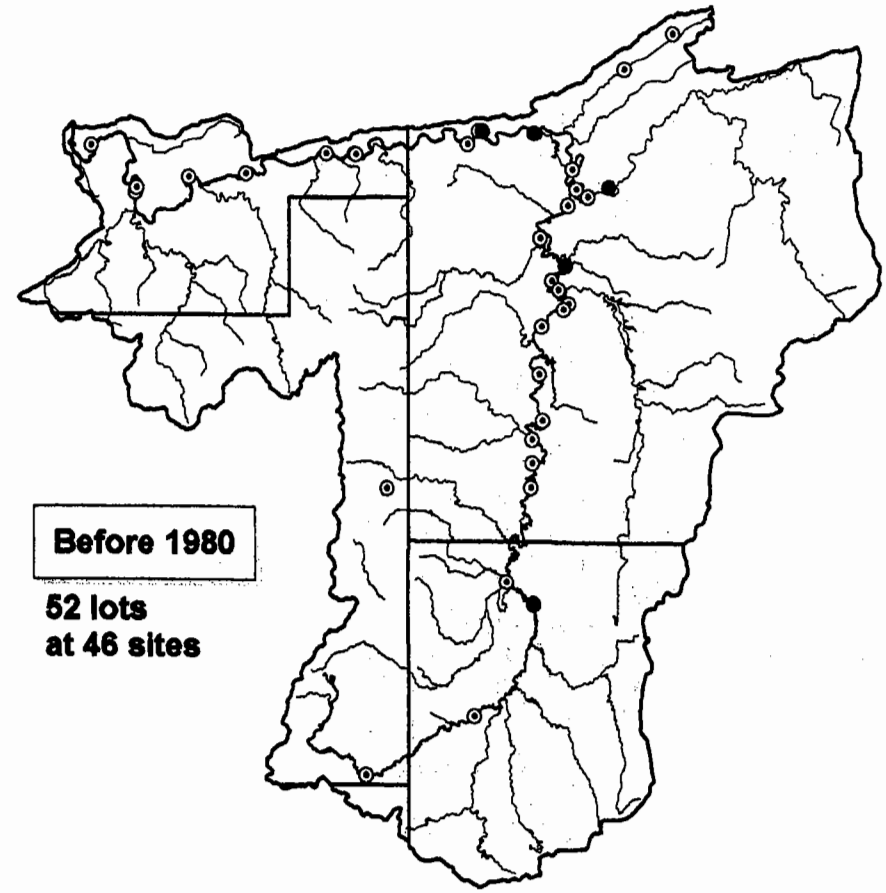
0 5 10 Miles

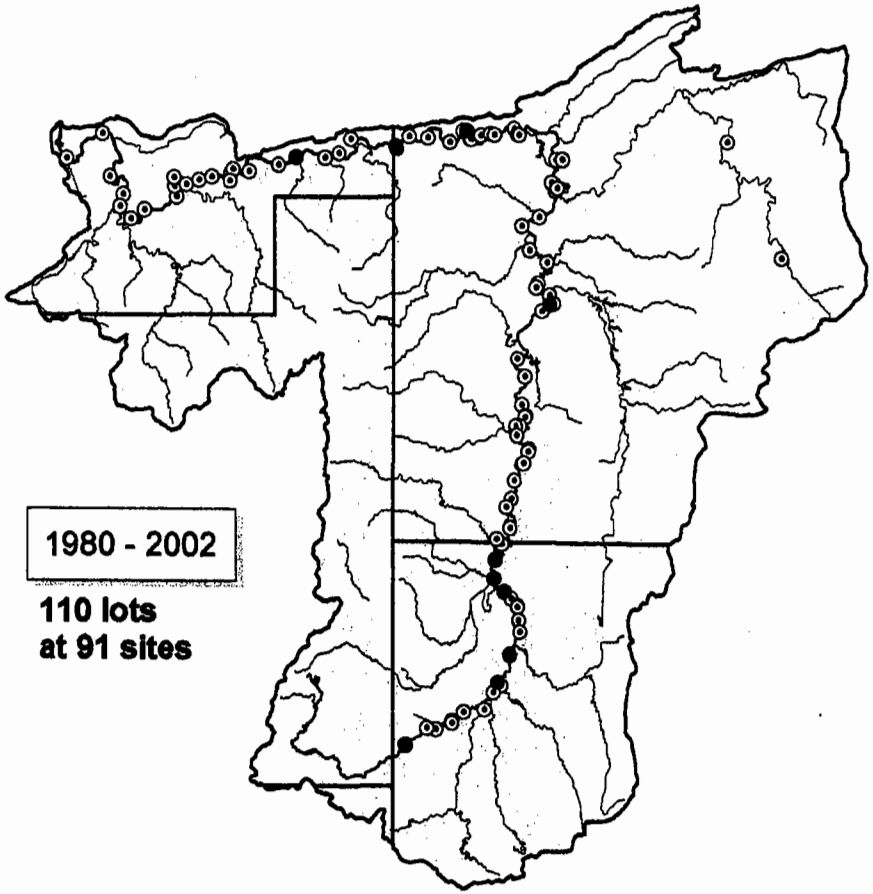
- Alive or fresh dead
- Location surveyed, but this species not found

Creek heelsplitter

Lasmigona compressa (Lea, 1829).

Grand River Watershed





N

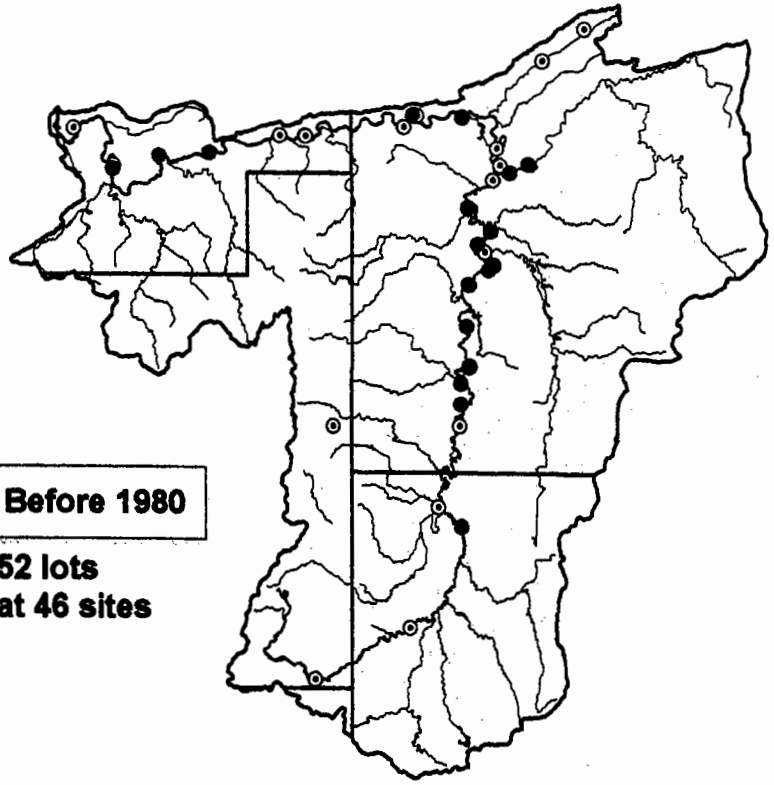
0 5 10 Miles

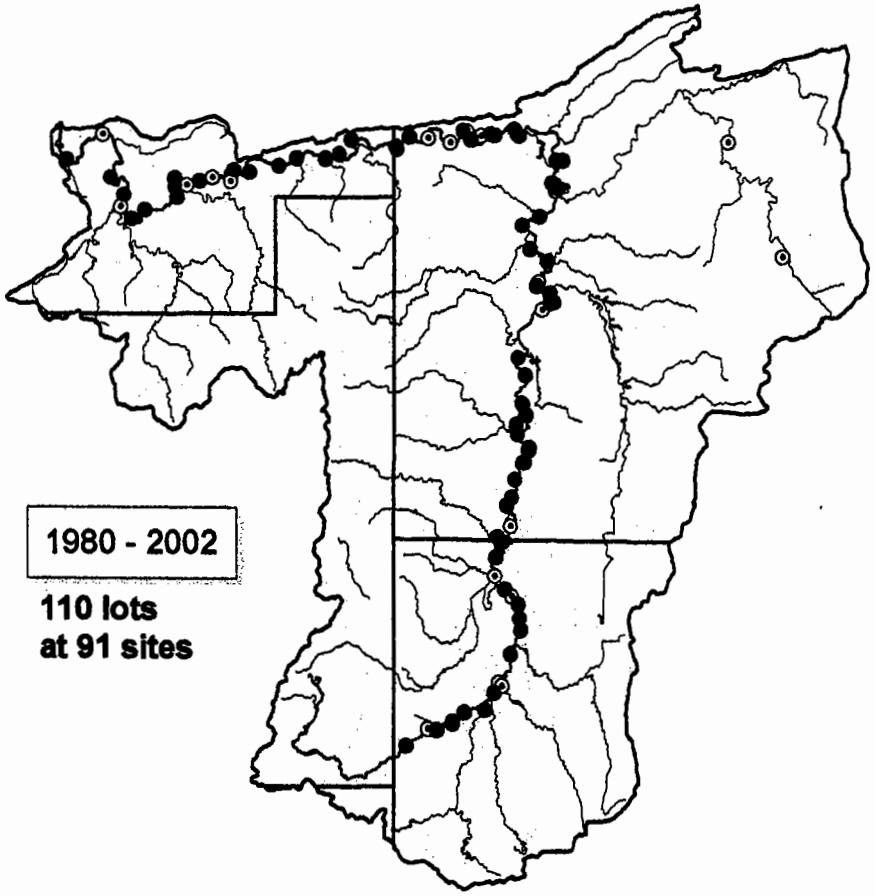
• Alive or fresh dead
⊙ Location surveyed, but this species not found

Fluted-shell

Lasmigona costata (Rafinesque, 1820).

Grand River Watershed





N

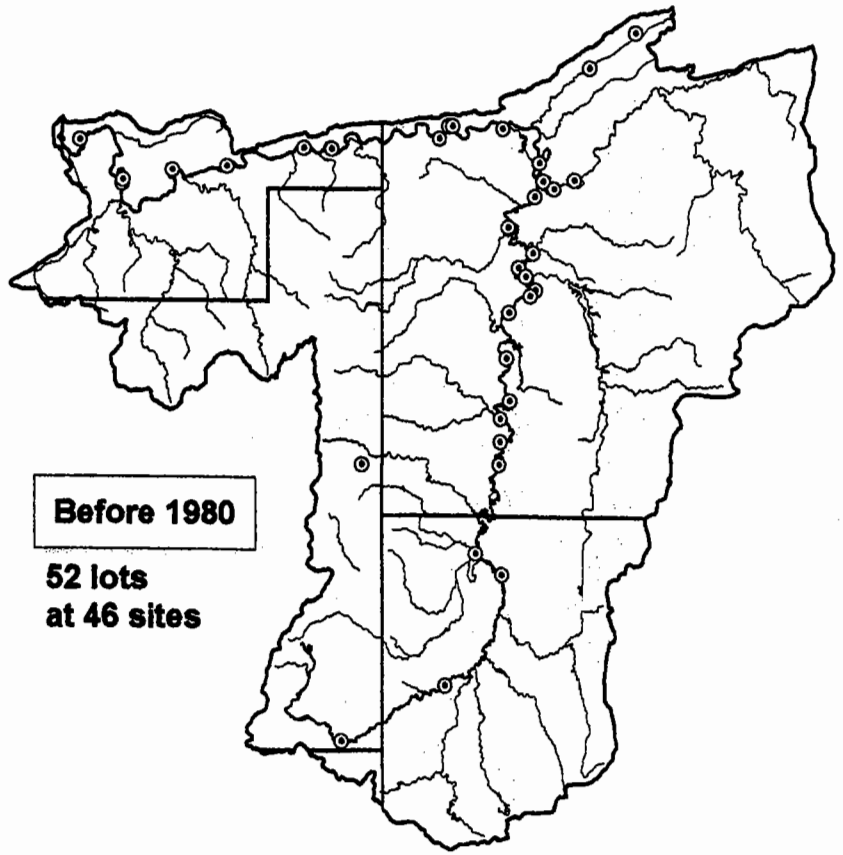
0 6 12 Miles

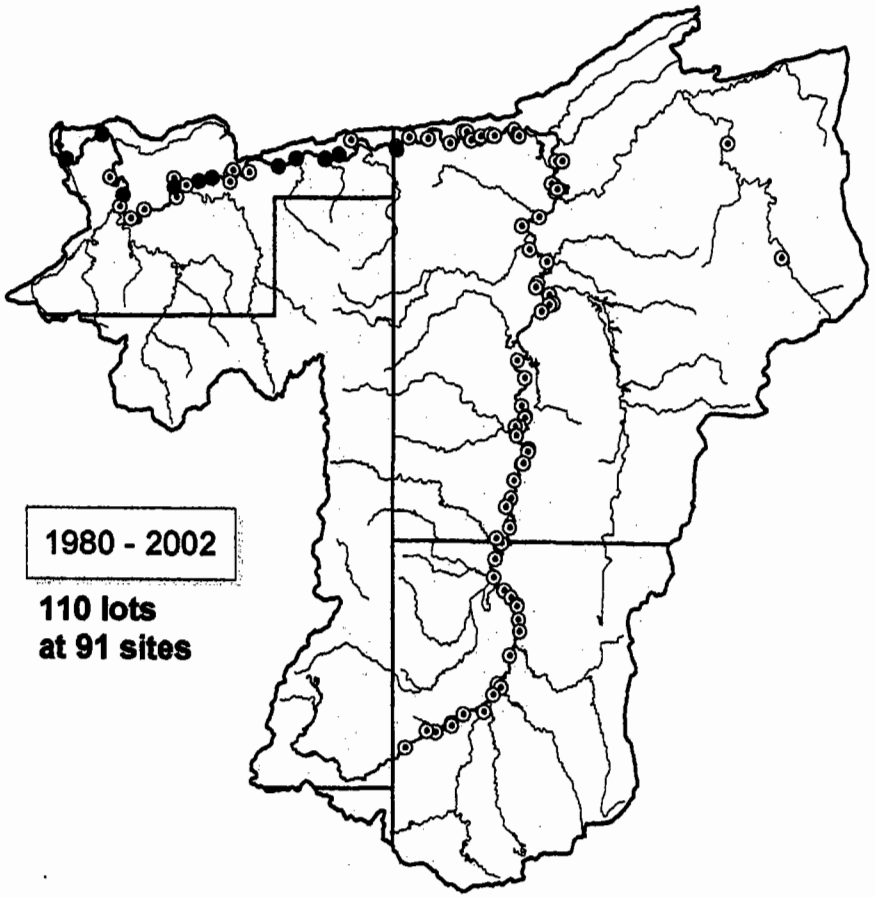
• Alive or fresh dead
⊙ Location surveyed, but this species not found

Fragile papershell

Leptodea fragilis (Lamarck, 1819).

Grand River Watershed





N

0 5 10 Miles

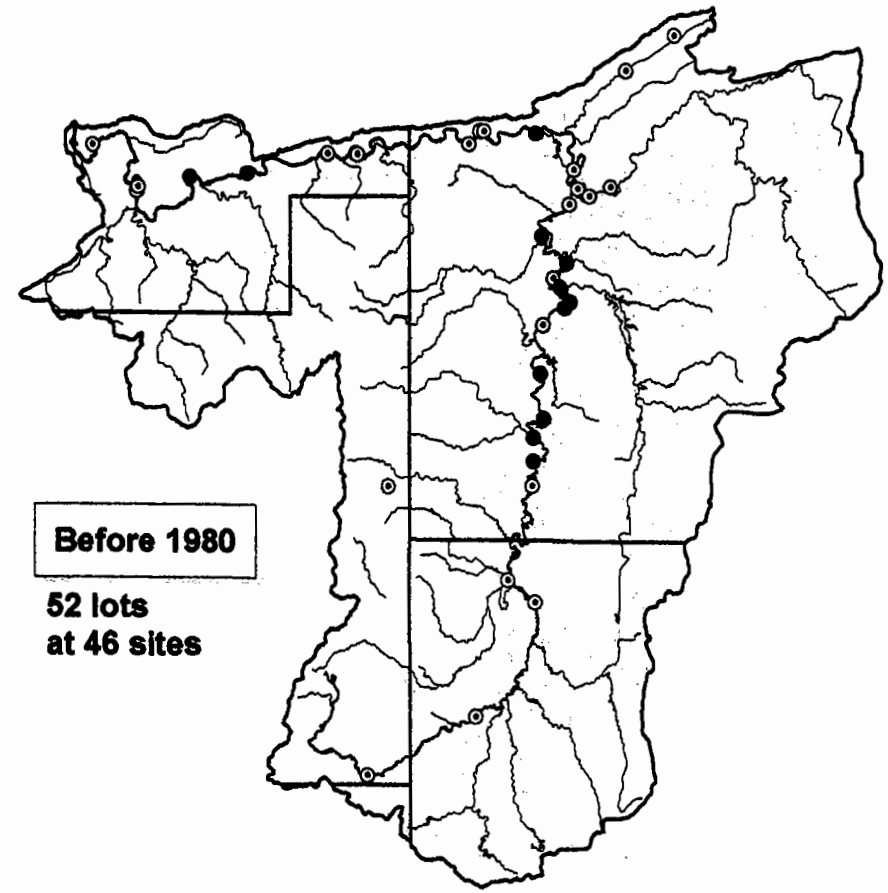
• Alive or fresh dead

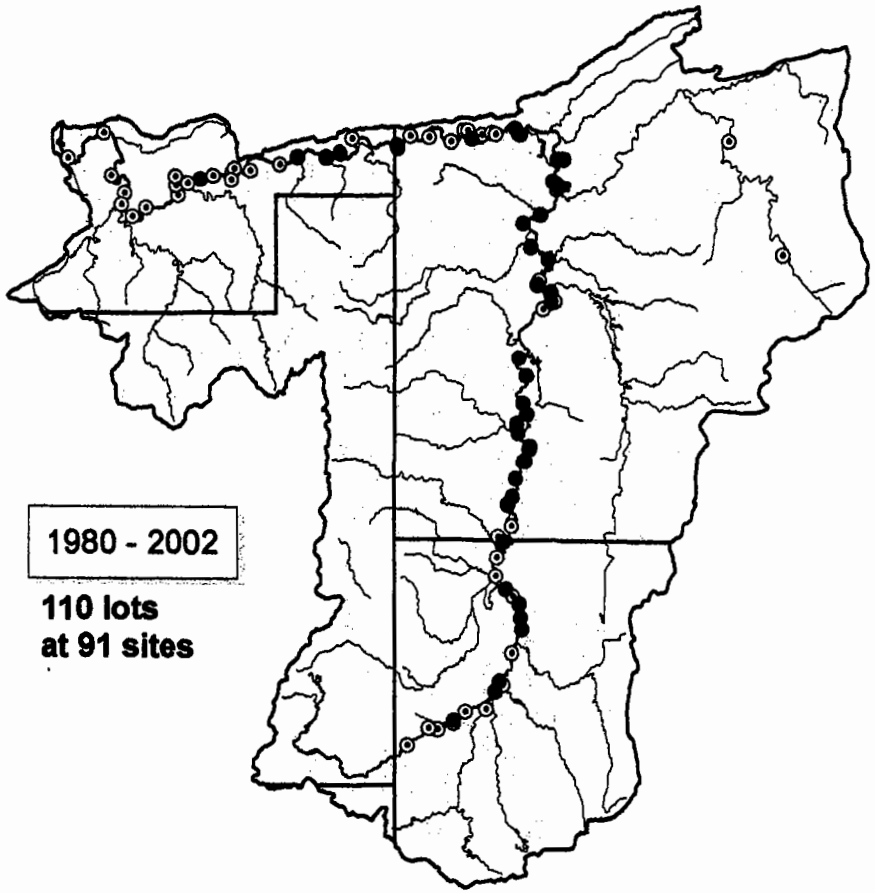
⊙ Location surveyed, but this species not found

Black sandshell

Ligumia recta (Lamarck, 1819).

Grand River Watershed





N

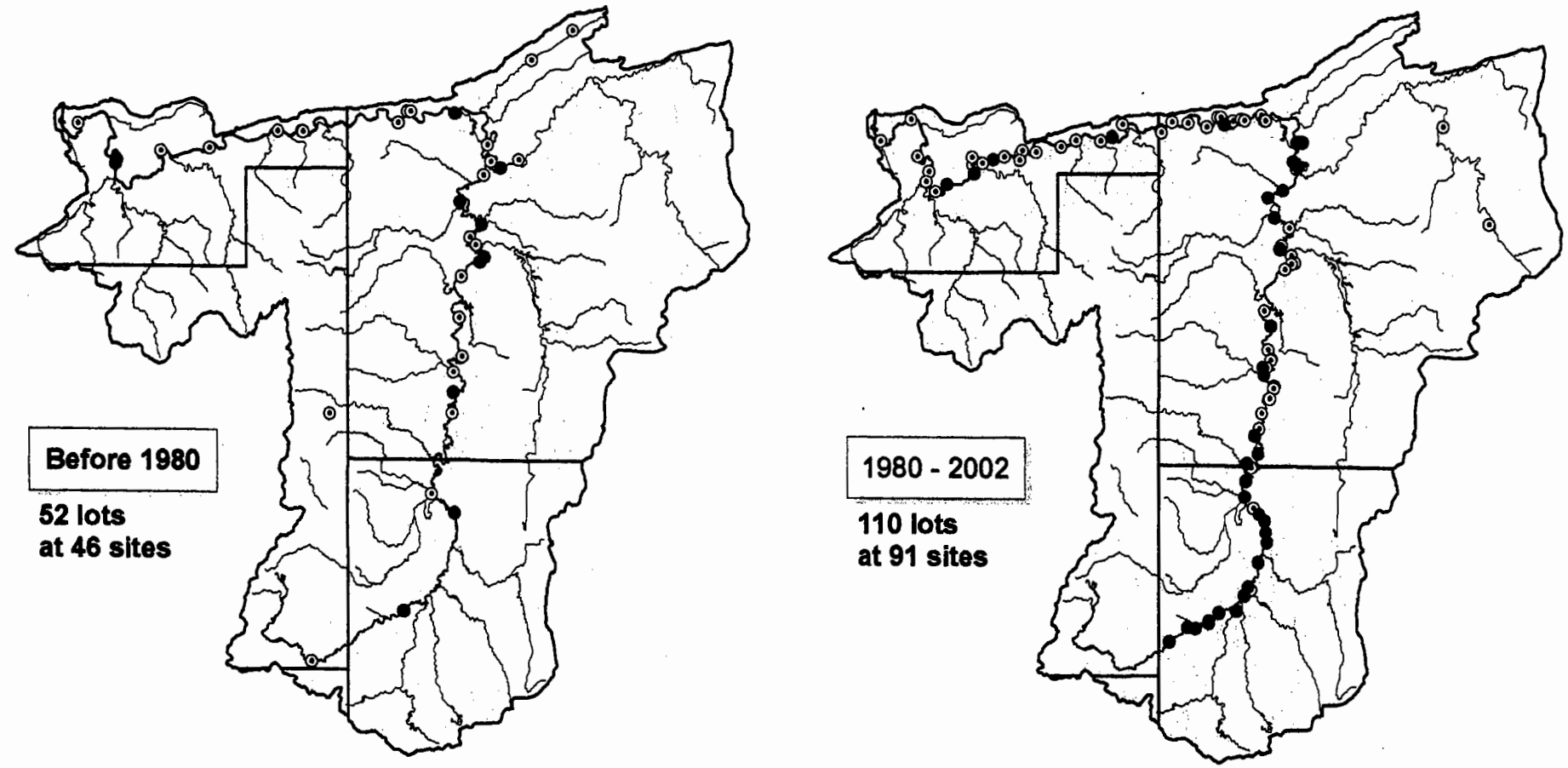
0 5 10 Miles

- Alive or fresh dead
- Location surveyed, but this species not found

Round hickorynut

Obovaria subrotunda (Rafinesque, 1820).

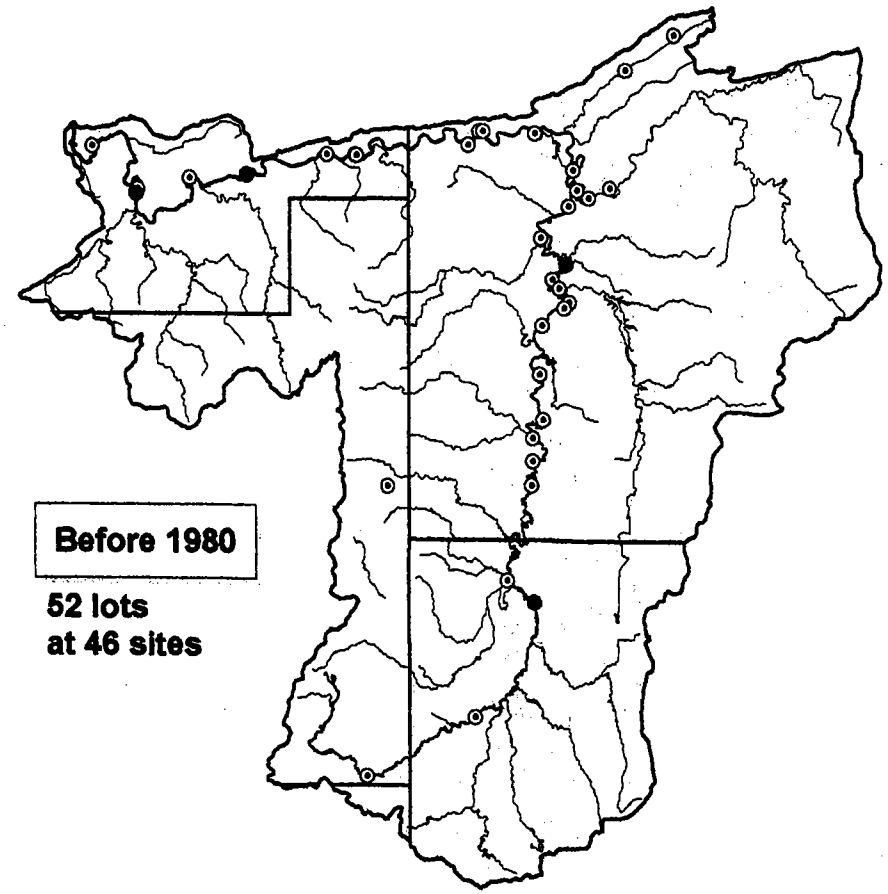
Grand River Watershed

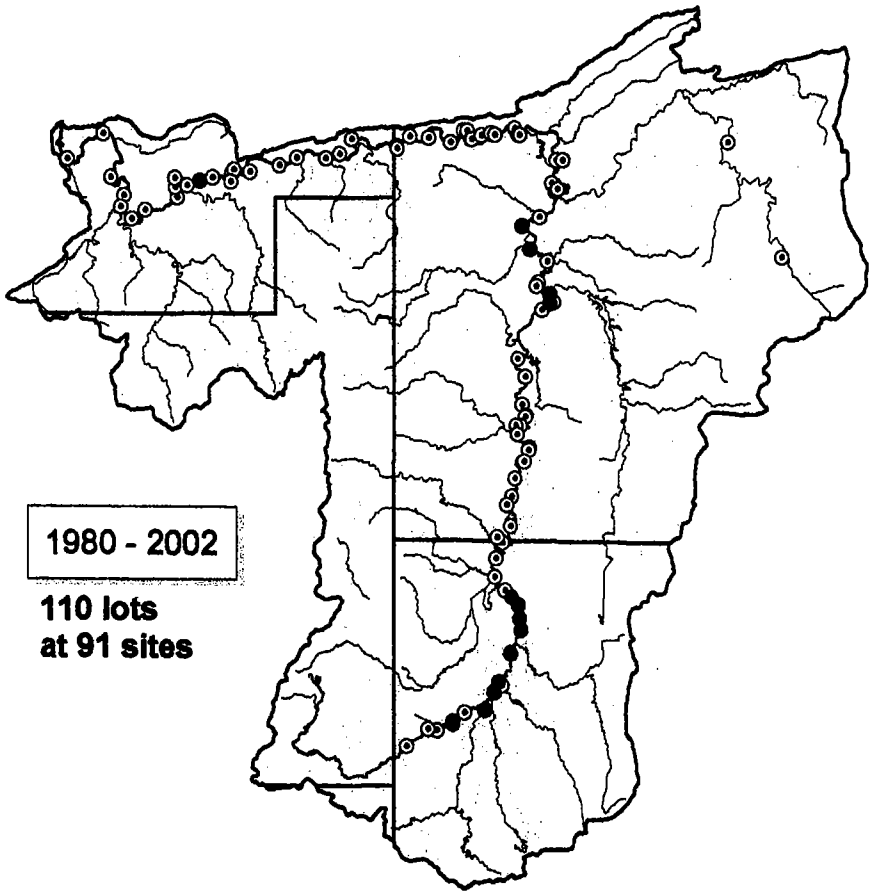


Round pigtoe

Pleurobema sintoxia (Rafinesque, 1820).

Grand River Watershed





N

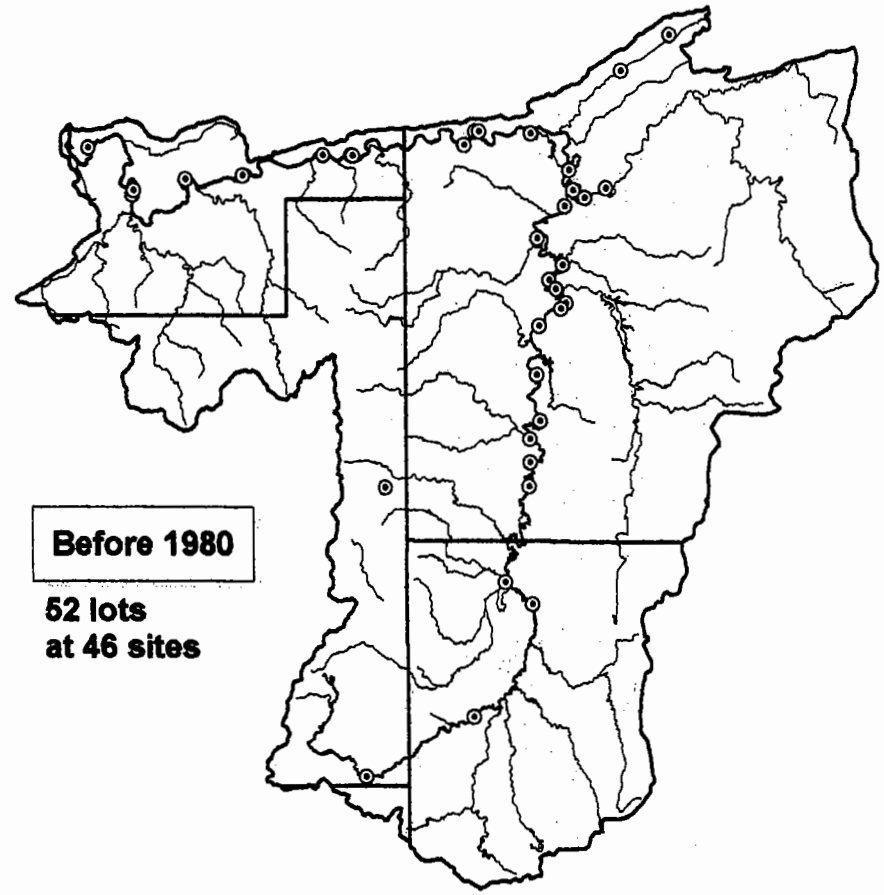
0 5 10 Miles

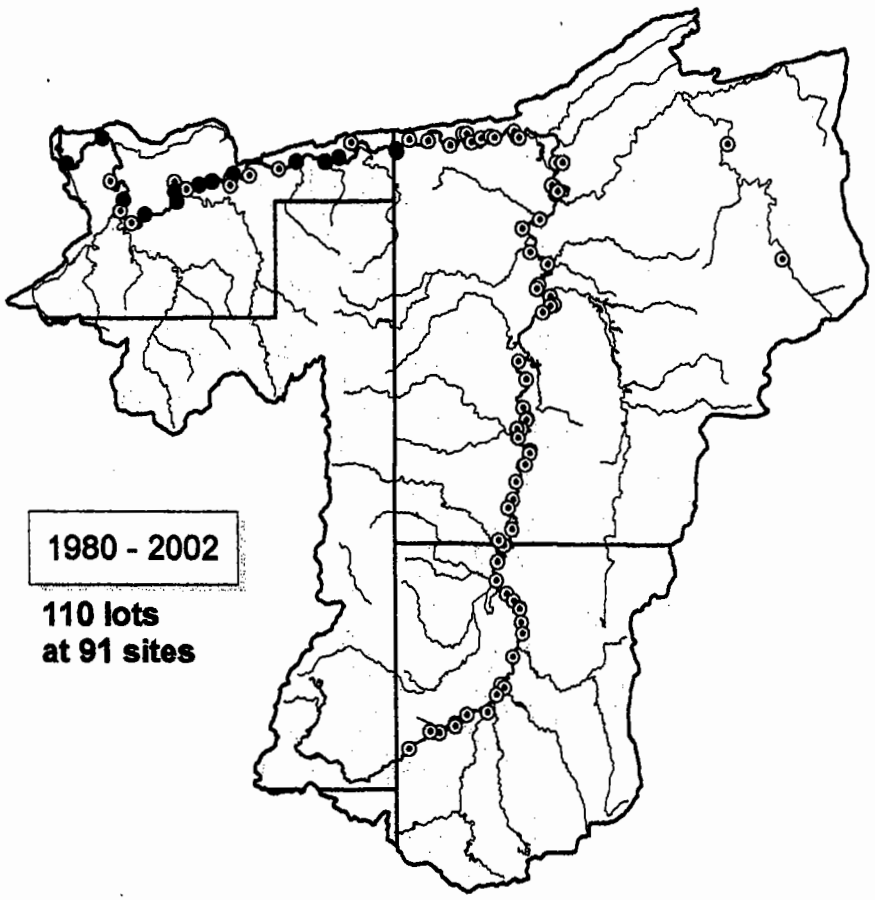
- Alive or fresh dead
- Location surveyed, but this species not found

Pink heelsplitter

Potamilus alatus (Say, 1817).

Grand River Watershed





N

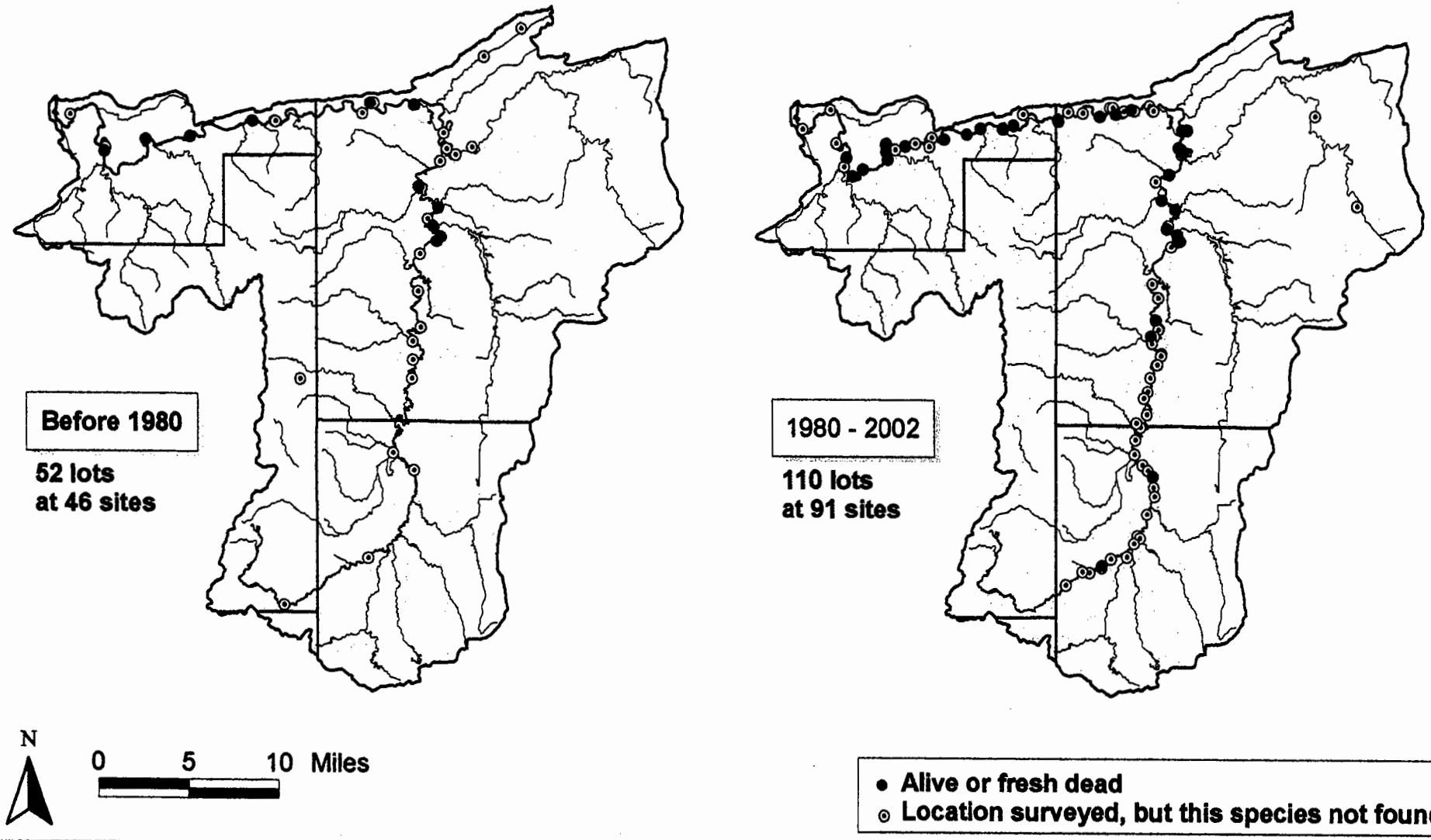
0 5 10 Miles

- Alive or fresh dead
- Location surveyed, but this species not found

Kidneyshell

Ptychobranchus fasciolaris (Rafinesque, 1820).

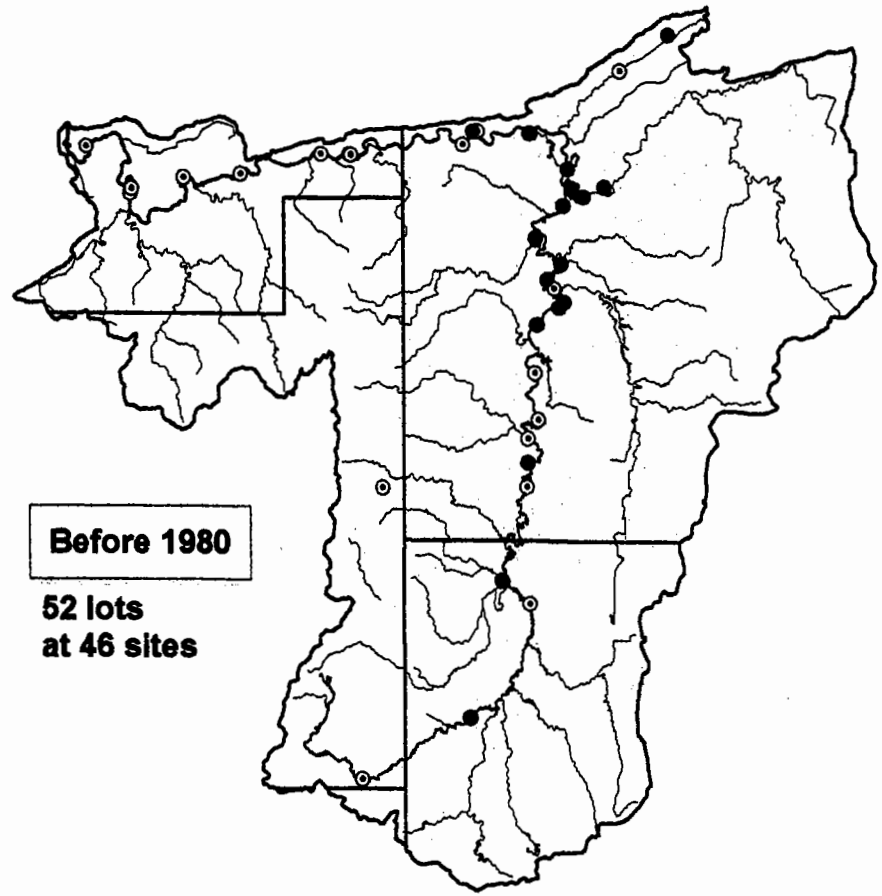
Grand River Watershed

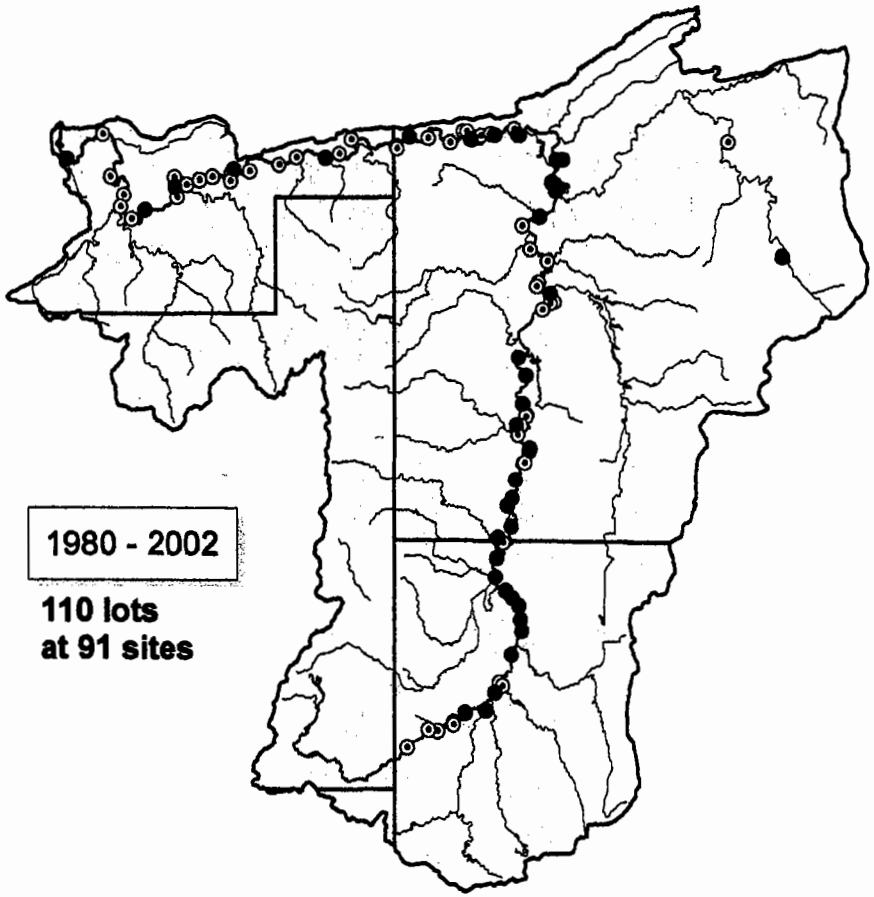


Giant Floater

Pyganodon grandis (Say, 1829).

Grand River Watershed





N

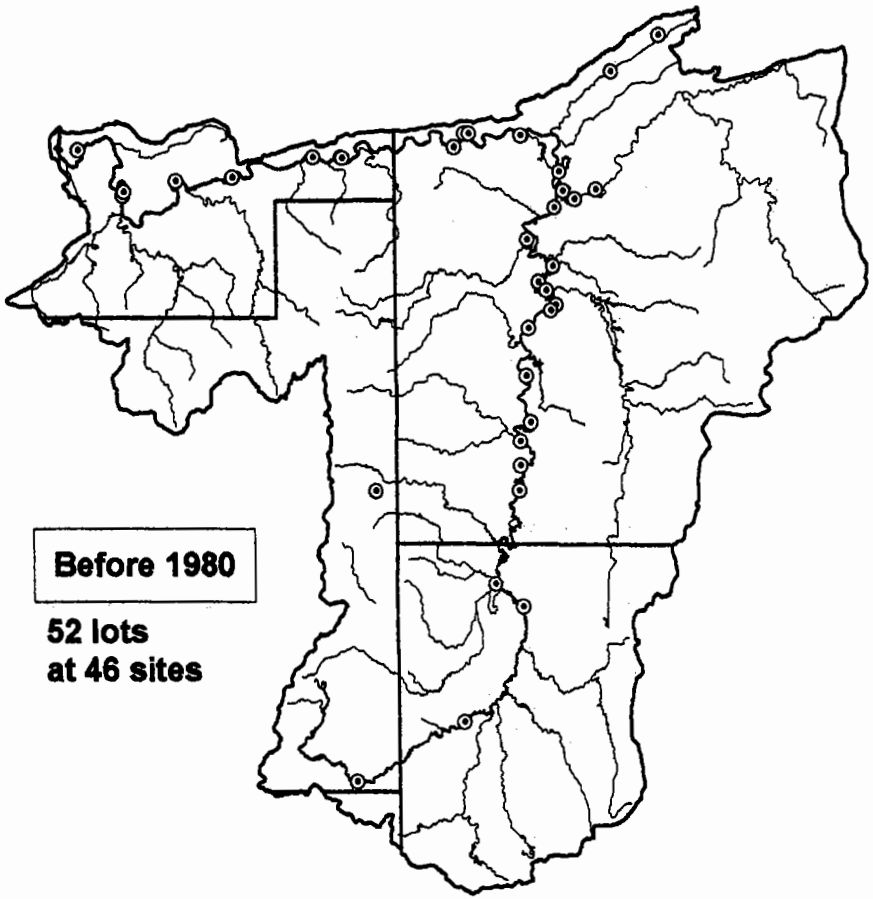
0 5 10 Miles

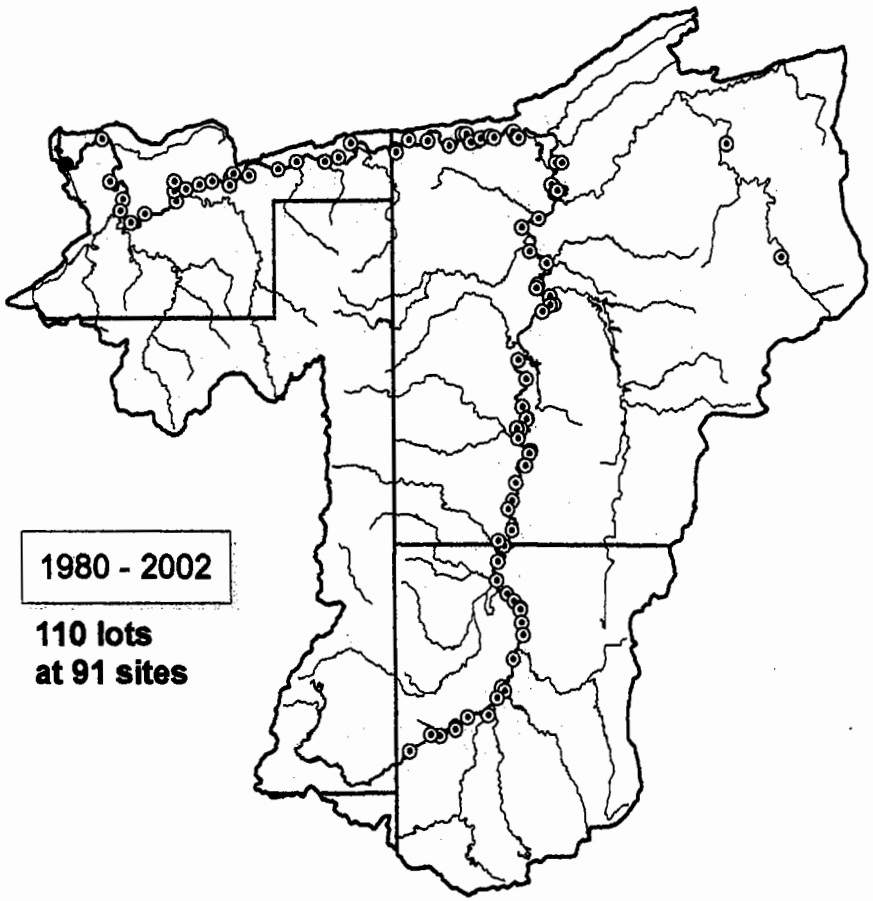
- Alive or fresh dead
- Location surveyed, but this species not found

Mapleleaf

Quadrula quadrula (Rafinesque, 1820).

Grand River Watershed





N

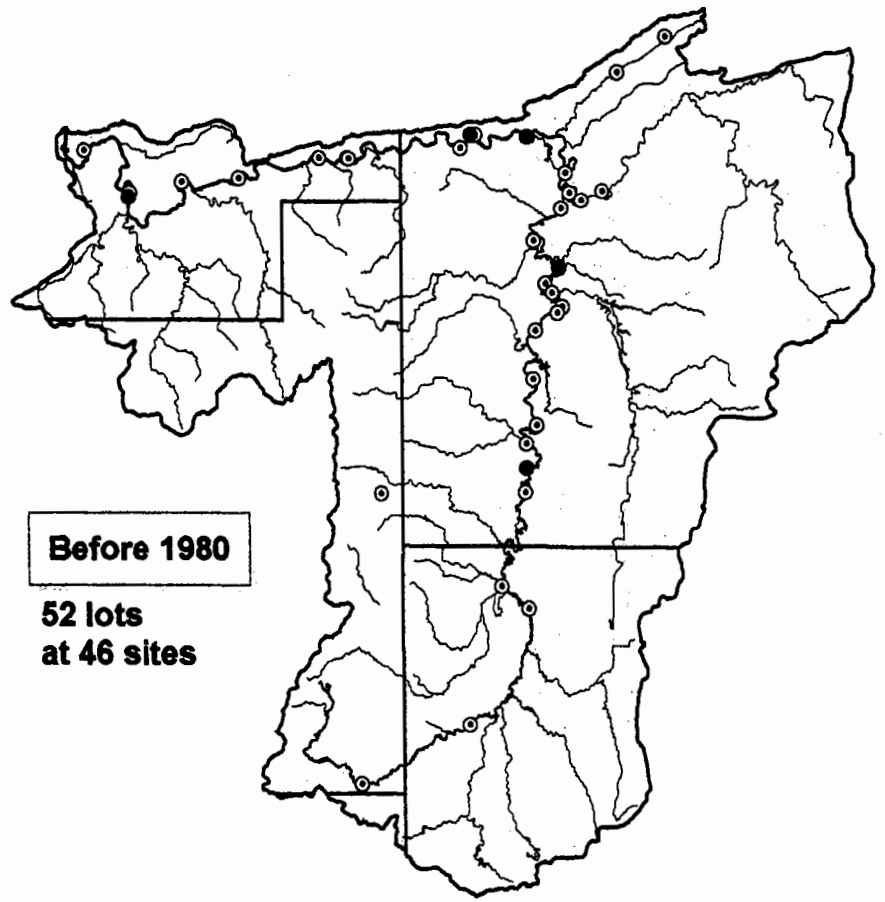
0 5 10 Miles

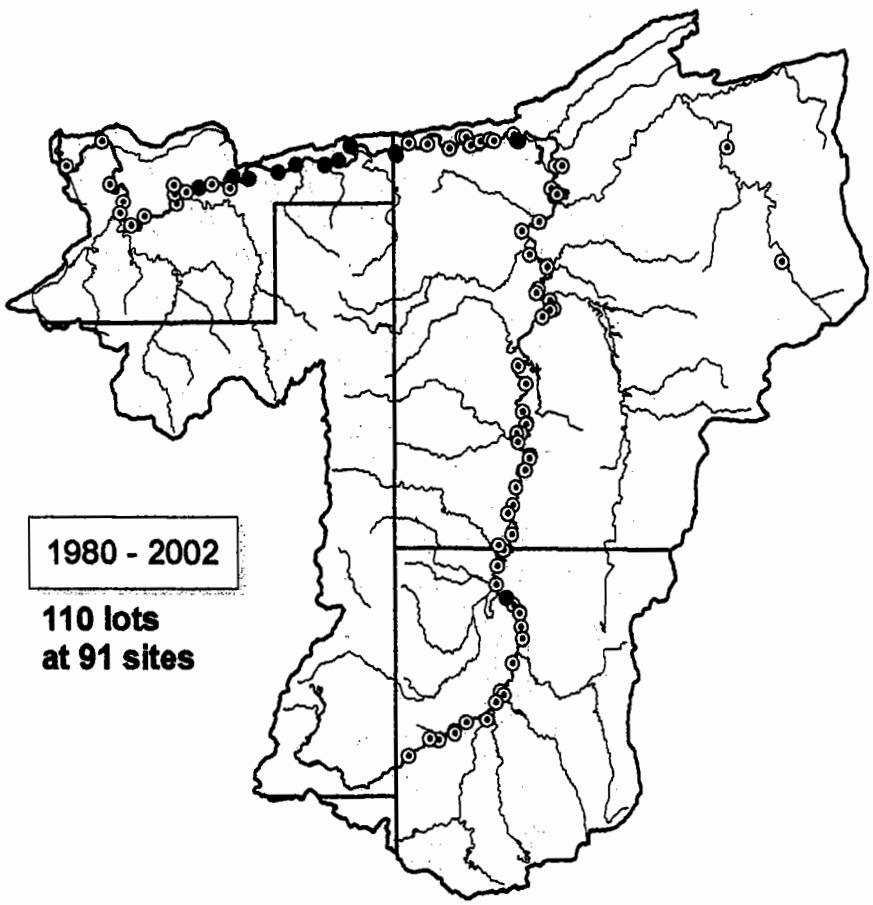
- Alive or fresh dead
- Location surveyed, but this species not found

Salamander Mussel

Simpsonaias ambigua (Say, 1825).

Grand River Watershed





N

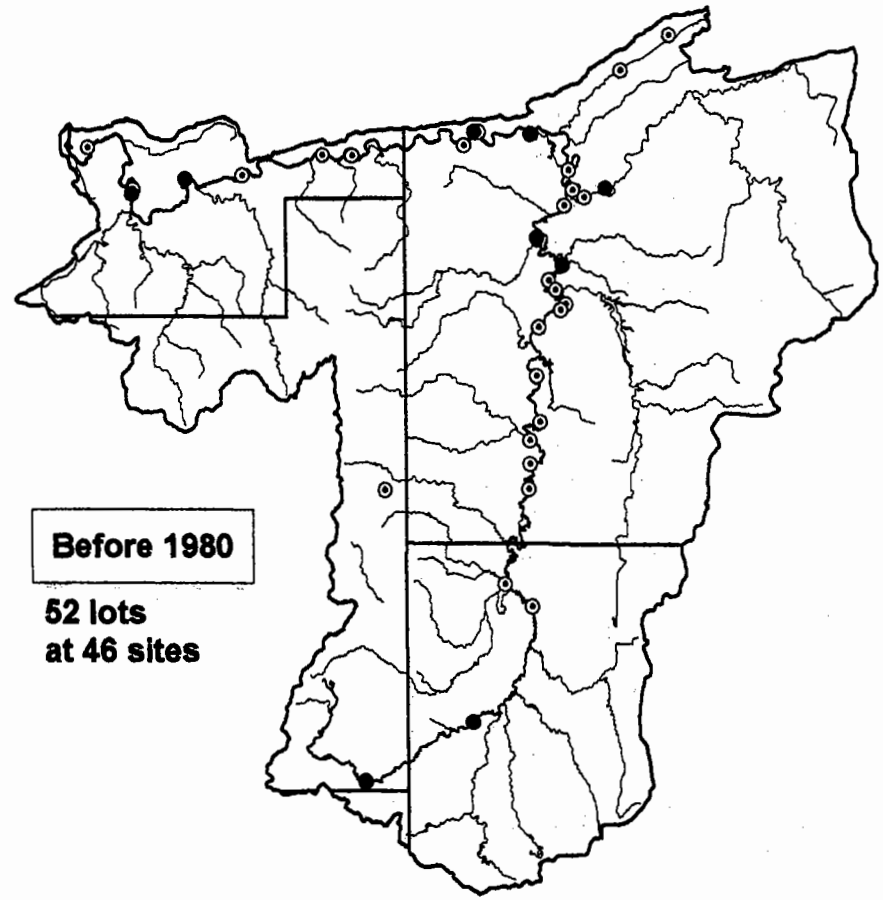
0 5 10 Miles

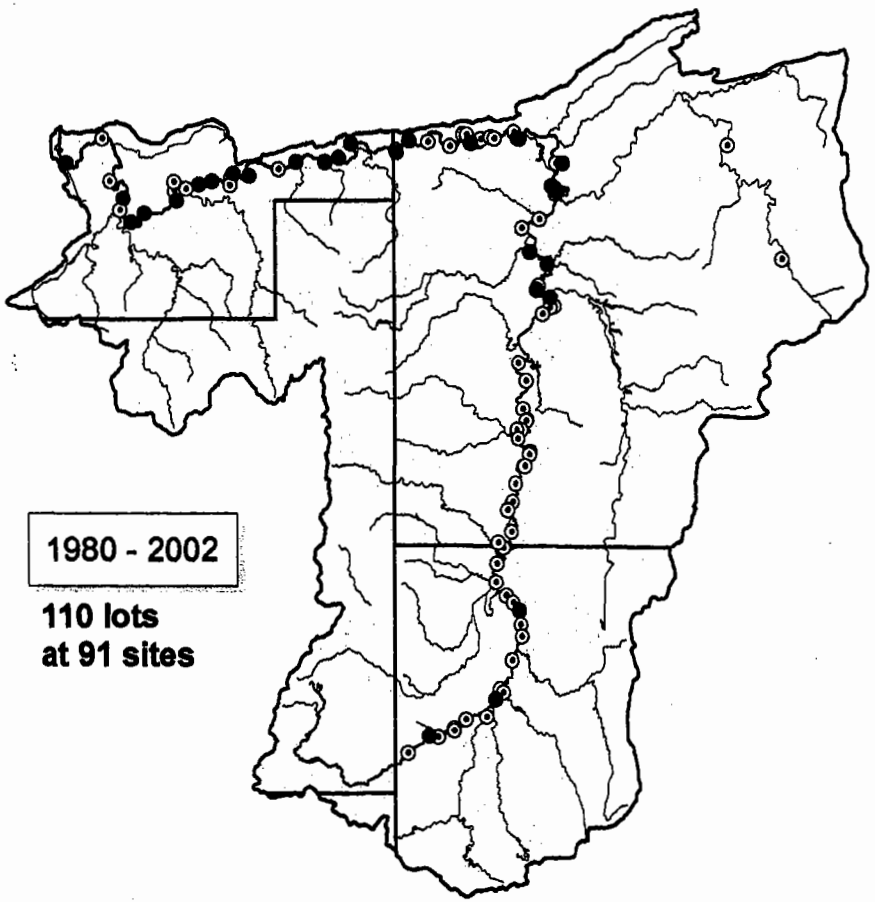
- Alive or fresh dead
- Location surveyed, but this species not found

Creeper

Strophitus undulatus (Say, 1817).

Grand River Watershed





N

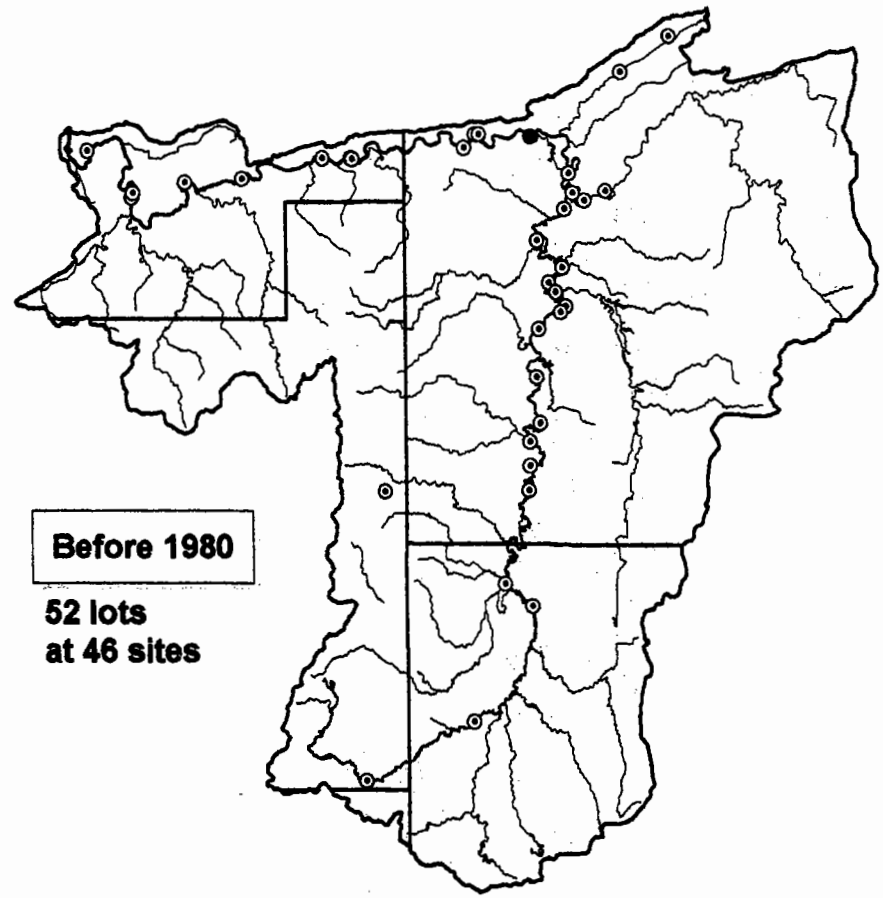
0 5 10 Miles

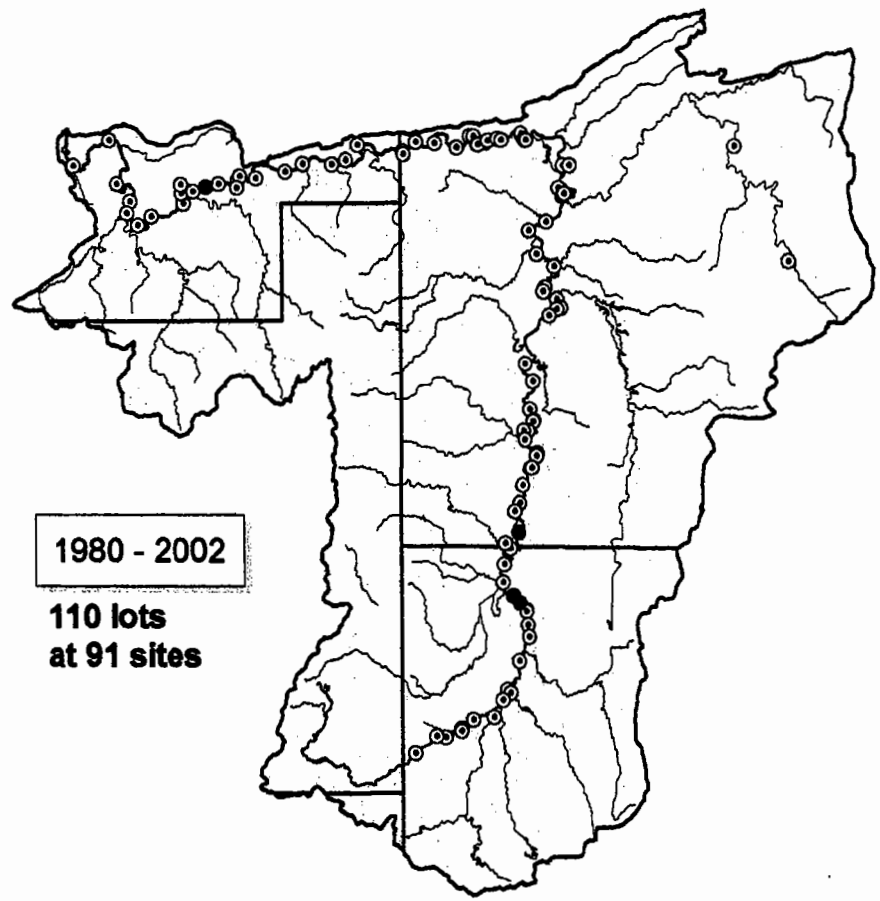
- Alive or fresh dead
- Location surveyed, but this species not found

Lilliput

Toxolasma parvus (Barnes, 1823).

Grand River Watershed





N

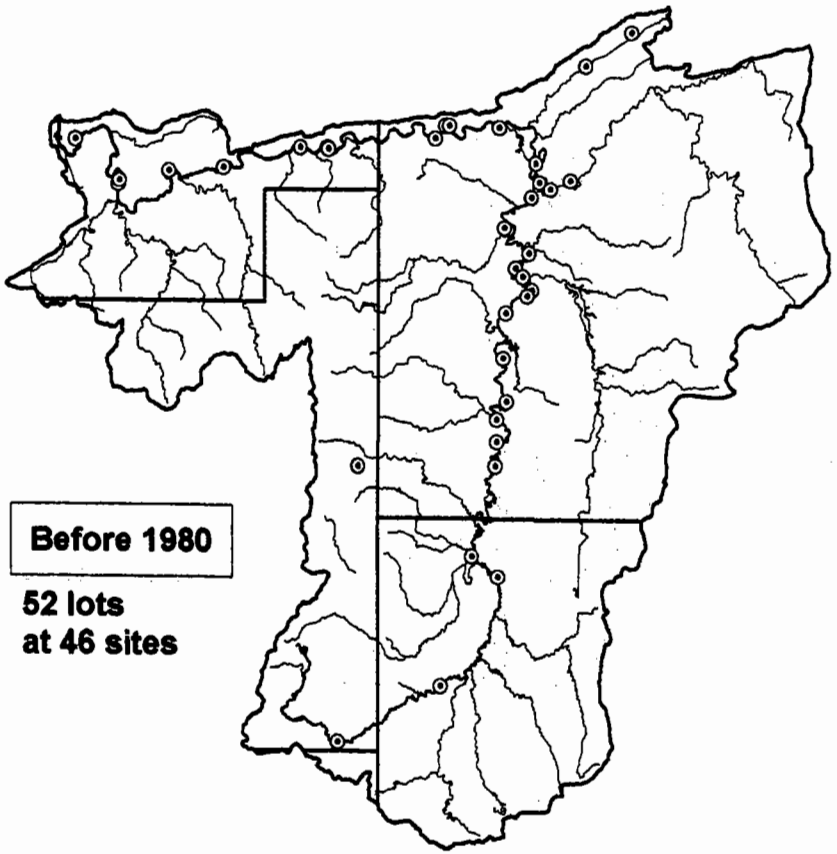
0 5 10 Miles

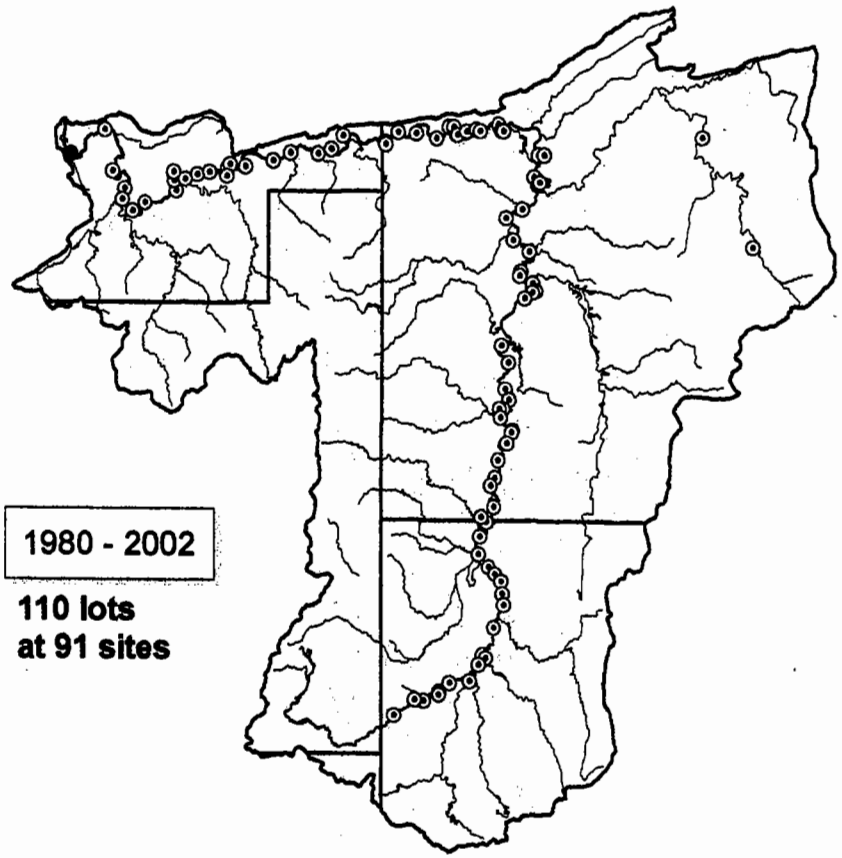
- Alive or fresh dead
- Location surveyed, but this species not found

Fawnsfoot

Truncilla donaciformis (Lea, 1827).

Grand River Watershed





N

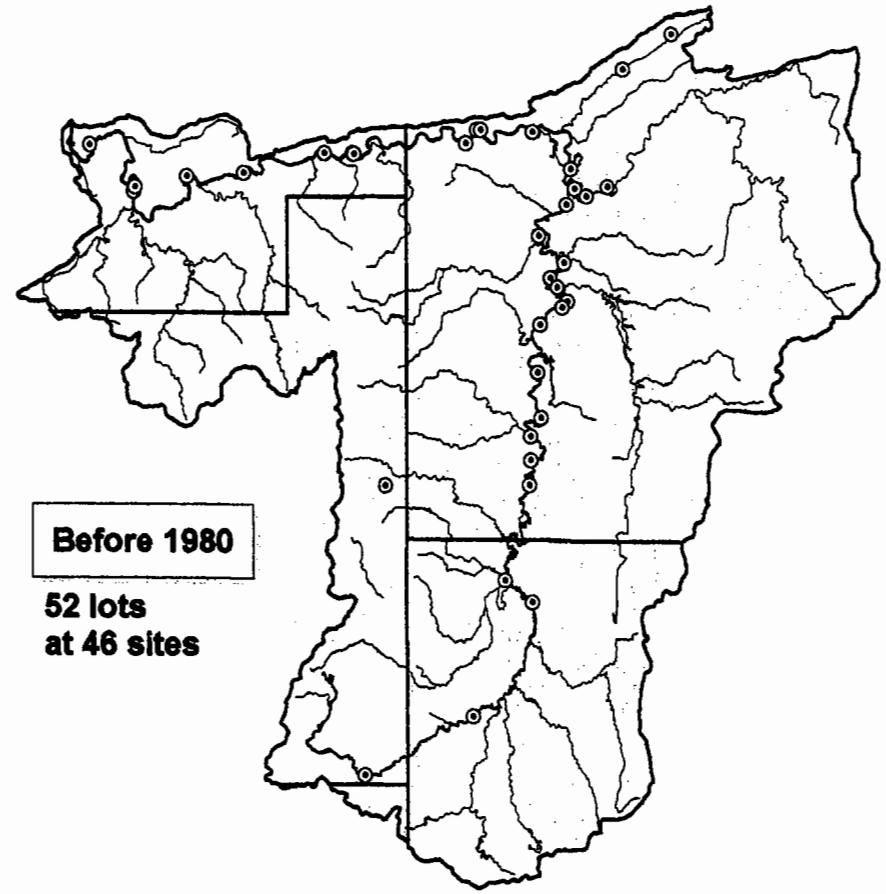
0 5 10 Miles

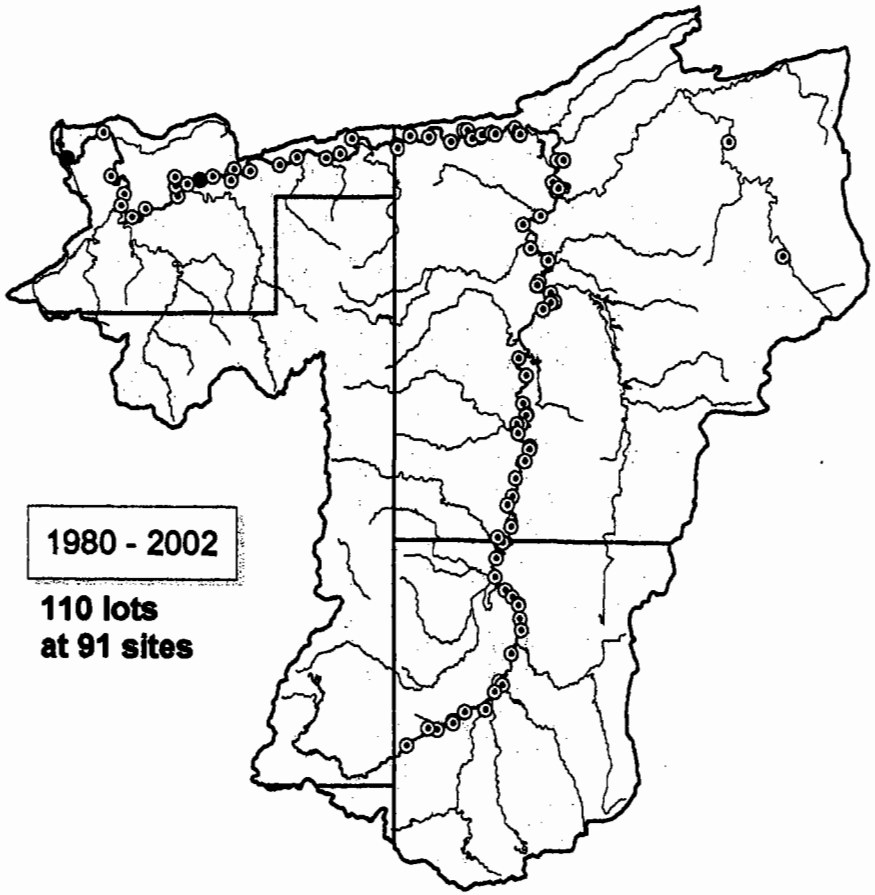
• Alive or fresh dead
⊙ Location surveyed, but this species not found

Deertoe

Truncilla truncata Rafinesque, 1820.

Grand River Watershed





N

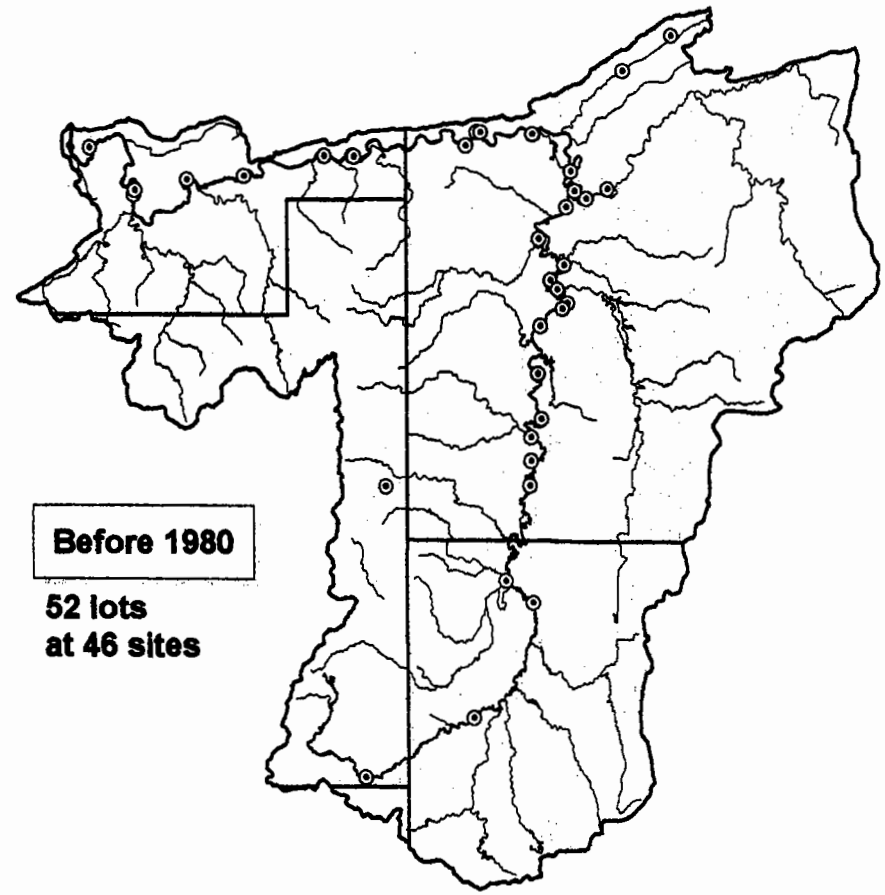
0 5 10 Miles

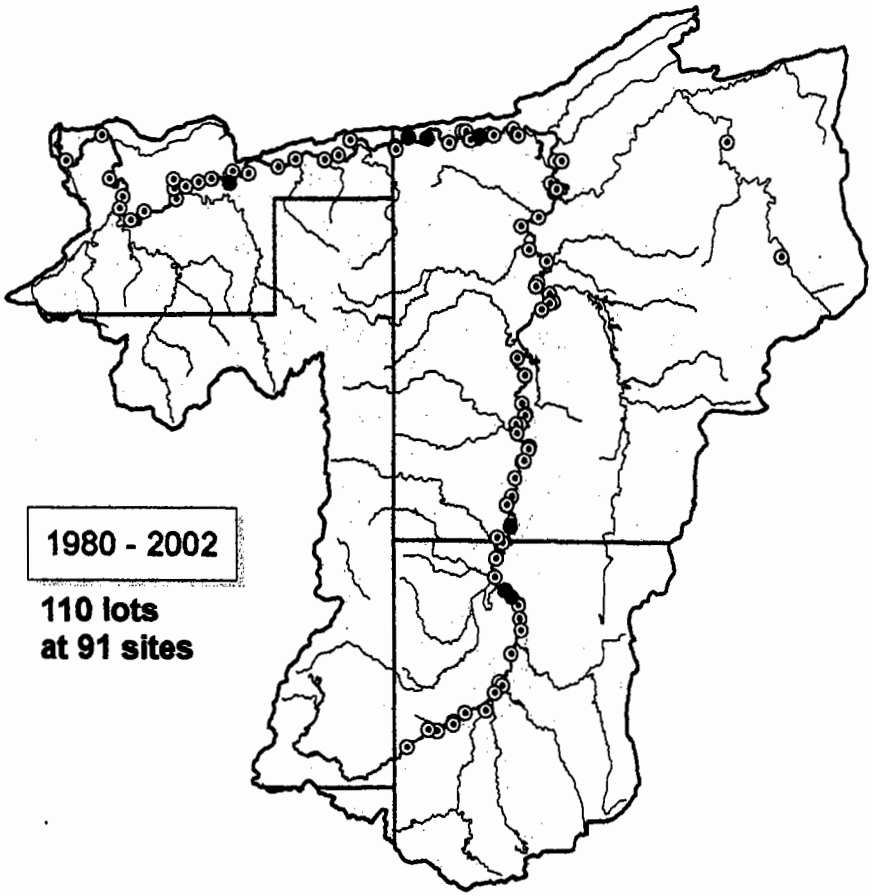
- Alive or fresh dead
- Location surveyed, but this species not found

Paper pondshell

Utterbackia imbecillis (Say, 1829).

Grand River Watershed





N

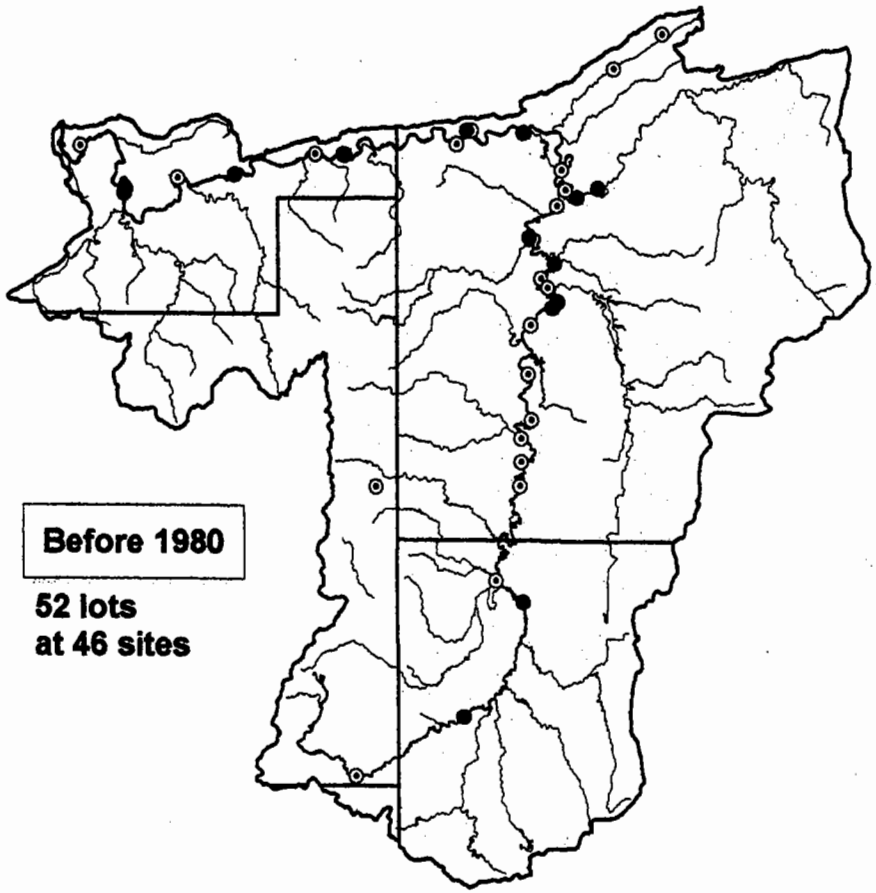
0 5 10 Miles

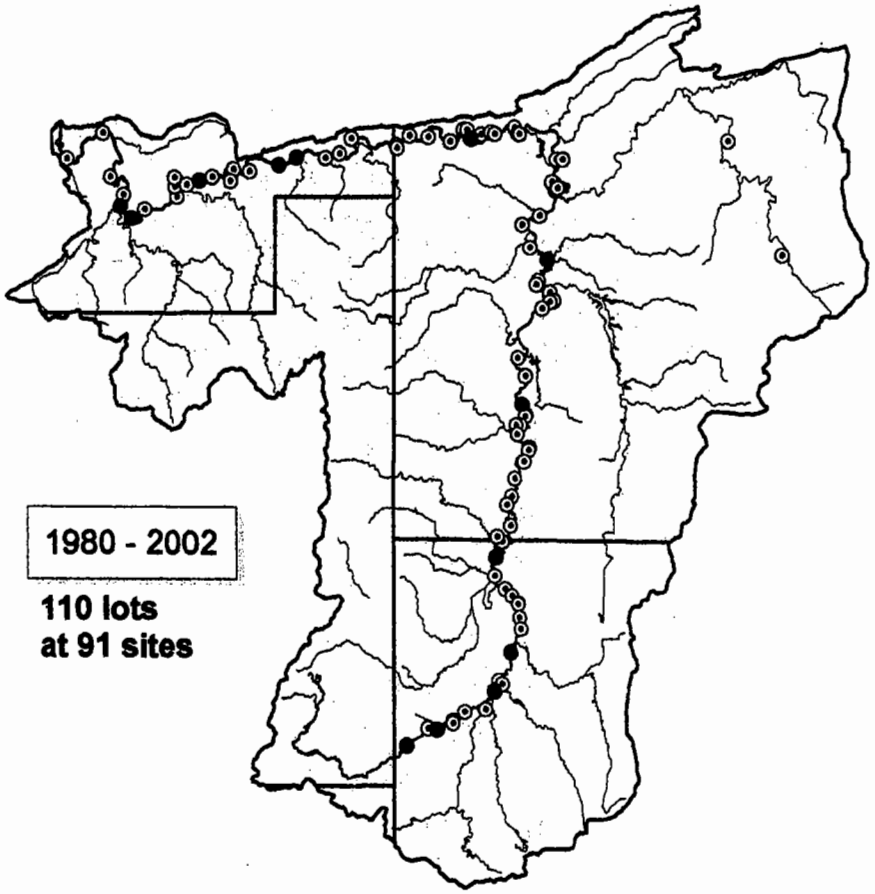
- Alive or fresh dead
- Location surveyed, but this species not found

Rainbow

Villosa iris (Lea, 1829).

Grand River Watershed





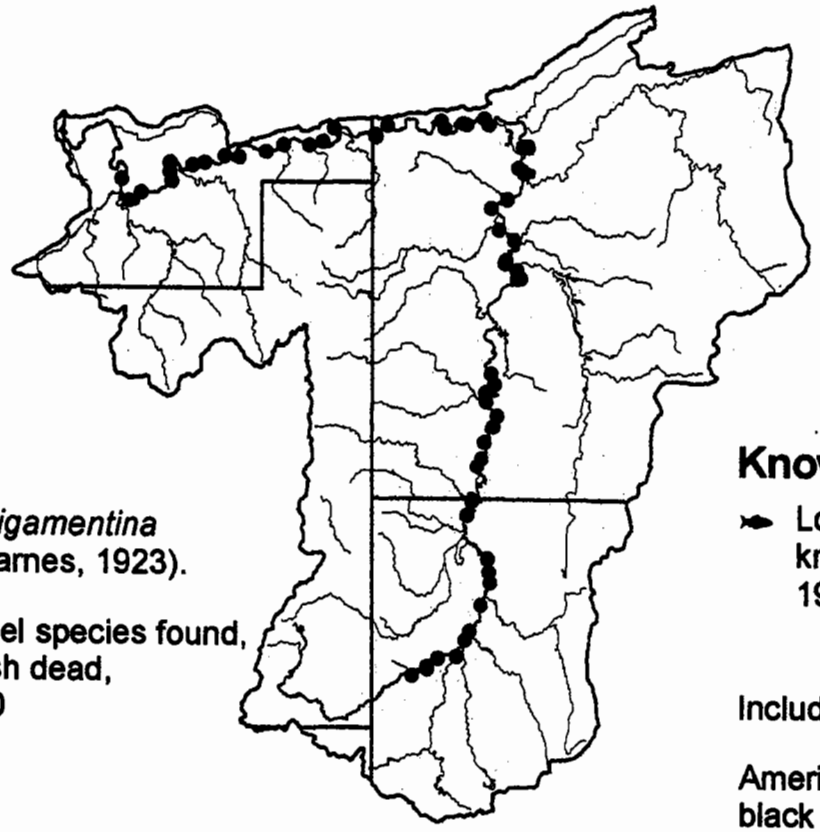
N

0 5 10 Miles

- Alive or fresh dead
- Location surveyed, but this species not found

Mussel/Host Range Comparison, 1982-2000

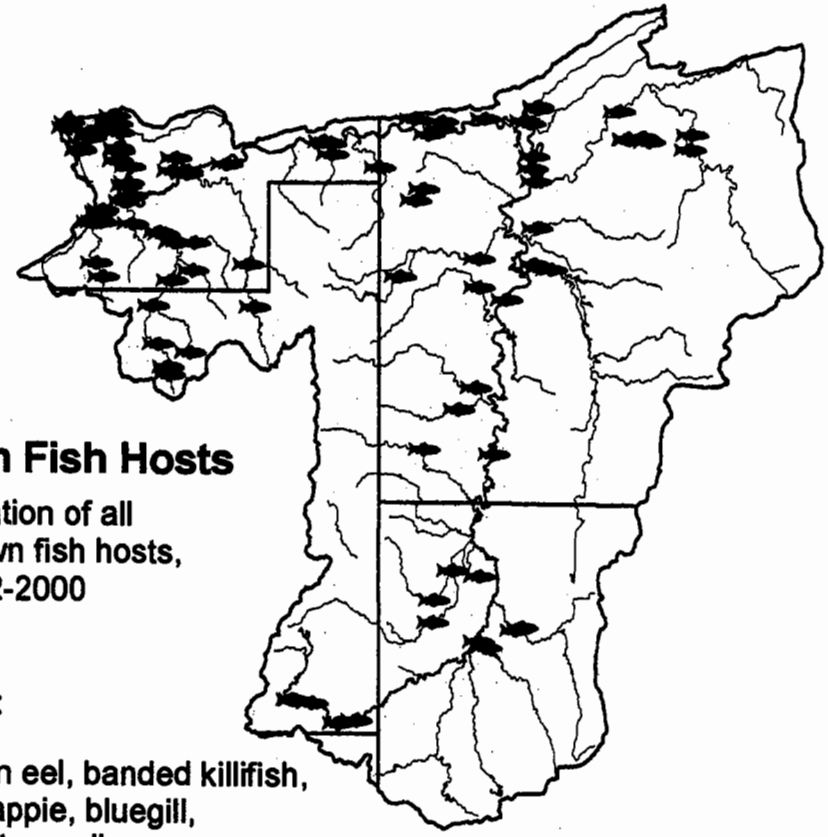
Grand River Watershed



Mucket

Actinonaias ligamentina carinata (Barnes, 1923).

- This mussel species found, live or fresh dead, 1982-2000



Known Fish Hosts

Location of all known fish hosts, 1982-2000

Includes:

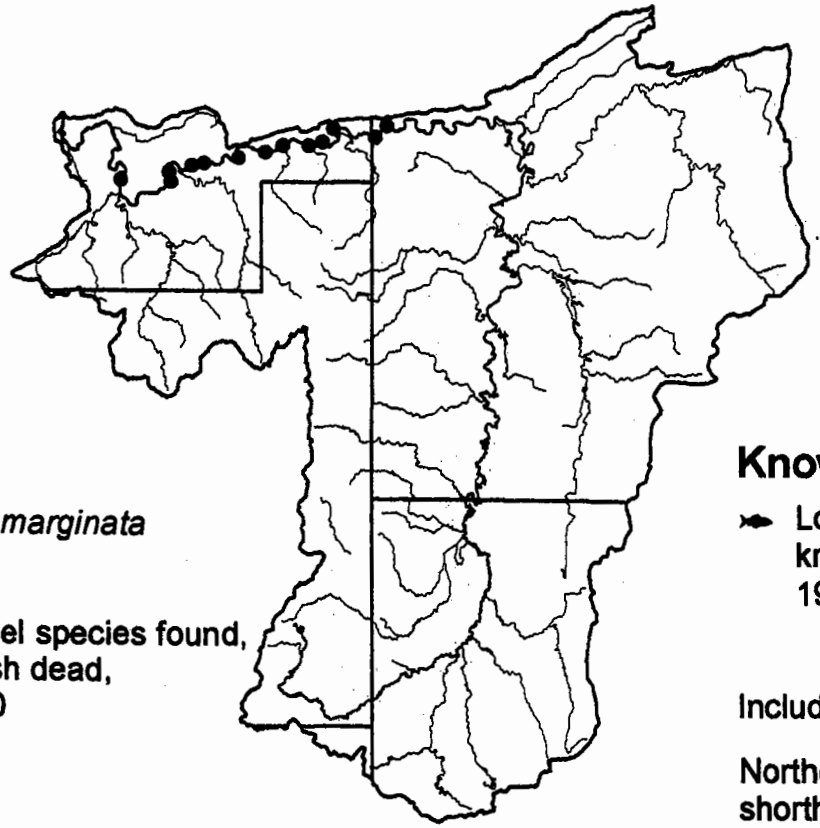
American eel, banded killifish, black crappie, bluegill, central stoneroller, common carp, green sunfish, largemouth bass, orangespotted sunfish, roach, rock bass, sauger, silverjaw minnow, smallmouth bass, tippecanoe darter, white bass, white crappie

N

0 5 10 Miles

Mussel/Host Range Comparison, 1982-2000

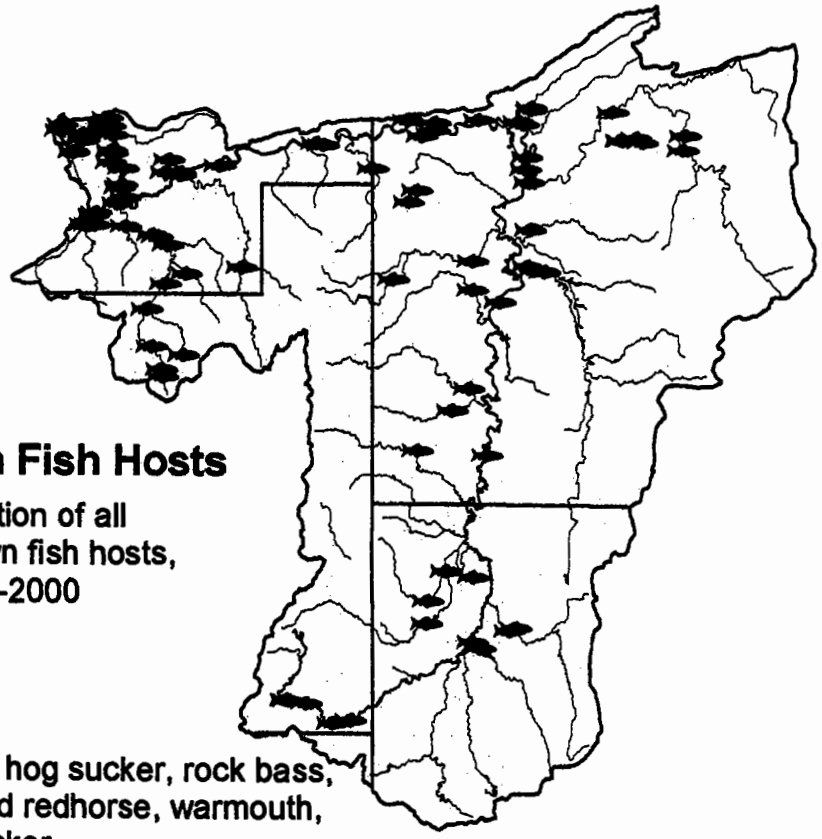
Grand River Watershed



Elktoe

Alasmidonta marginata
Say, 1818.

- This mussel species found, live or fresh dead, 1982-2000



Known Fish Hosts

Location of all known fish hosts, 1982-2000

Includes:

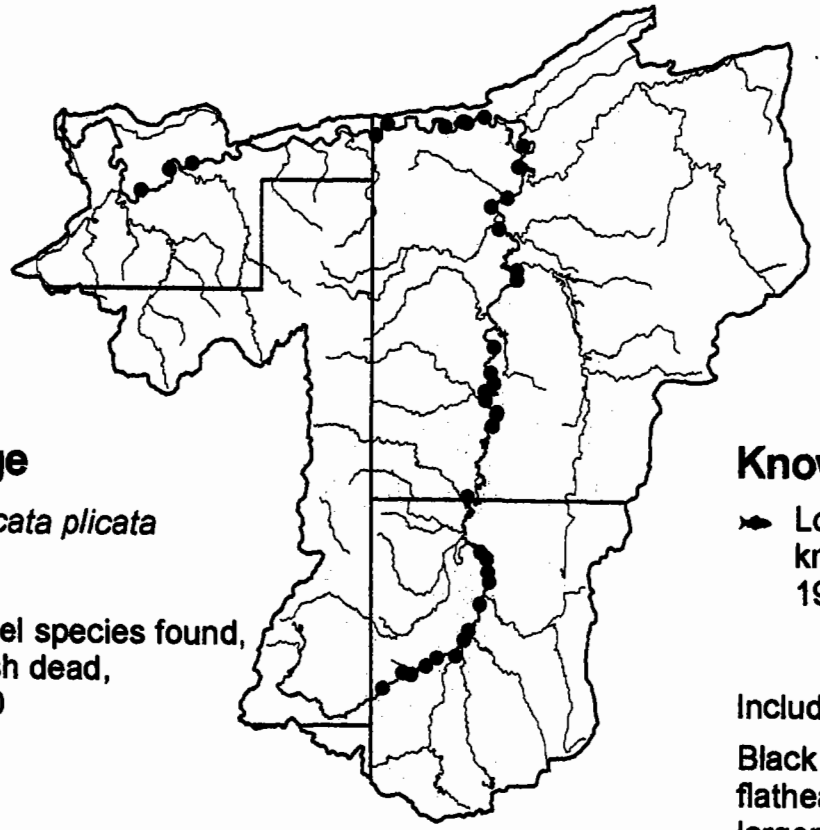
Northern hog sucker, rock bass, shorthead redhorse, warmouth, white sucker

N

0 5 10 Miles

Mussel/Host Range Comparison, 1982-2000

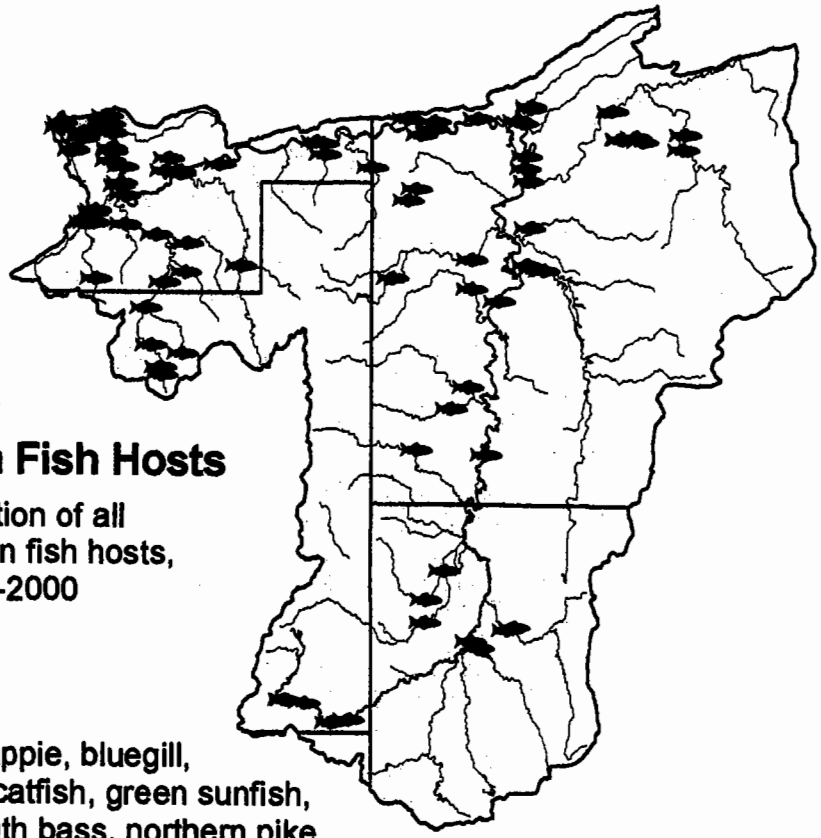
Grand River Watershed



Threeridge

Amblema plicata plicata
(Say, 1817).

- This mussel species found, live or fresh dead, 1982-2000



Known Fish Hosts

Location of all known fish hosts, 1982-2000

Includes:

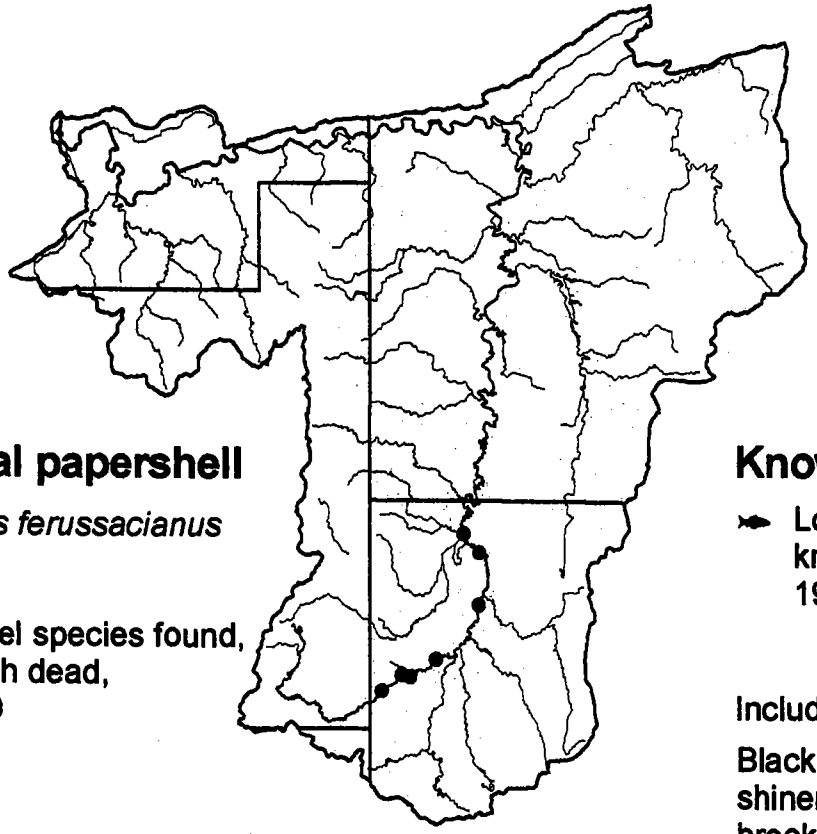
Black crappie, bluegill, flathead catfish, green sunfish, largemouth bass, northern pike, pumpkinseed sunfish, rock bass, sauger, shortnose gar, warmouth, white bass, white crappie, yellow perch

N

0 5 10 Miles

Mussel/Host Range Comparison, 1982-2000

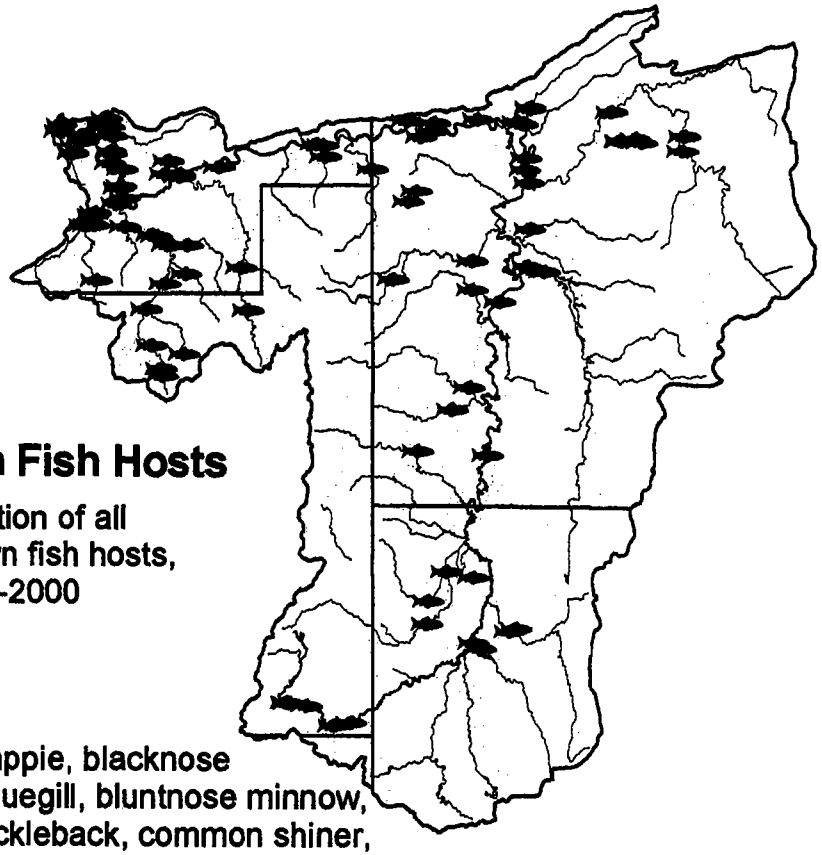
Grand River Watershed



Cylindrical papershell

Anodontoides ferussacianus (Lea, 1834).

- This mussel species found, live or fresh dead, 1982-2000



Known Fish Hosts

- Location of all known fish hosts, 1982-2000

Includes:

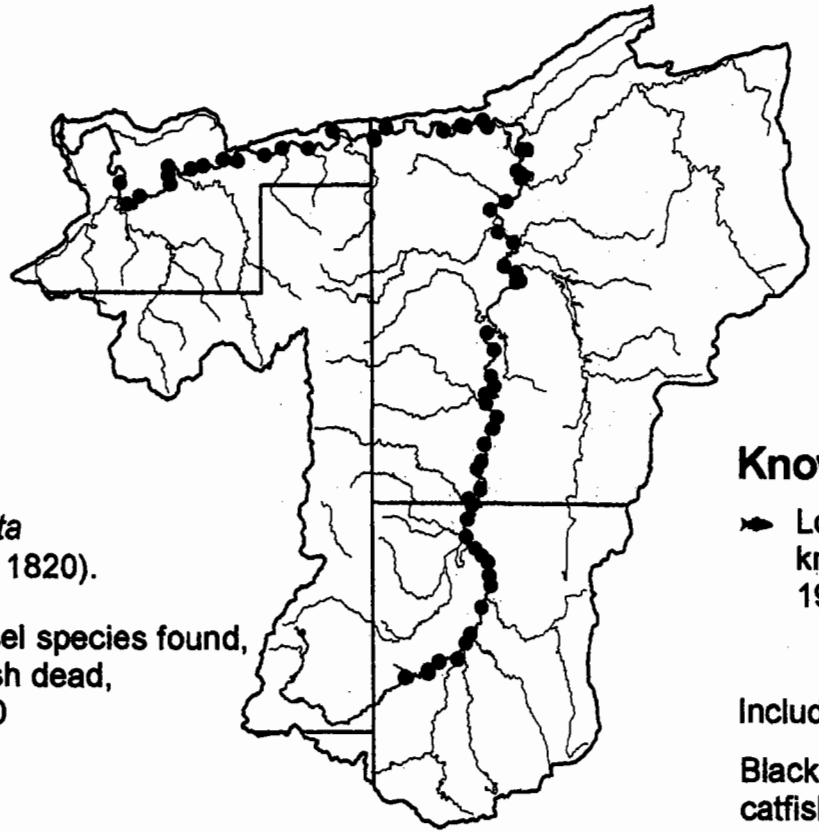
Black crappie, blacknose shiner, bluegill, bluntnose minnow, brook stickleback, common shiner, fathead minnow, Iowa darter, largemouth bass, mottled sculpin, sea lamprey, spotfin shiner, Tippecanoe darter, white sucker

N

0 5 10 Miles

Mussel/Host Range Comparison, 1982-2000

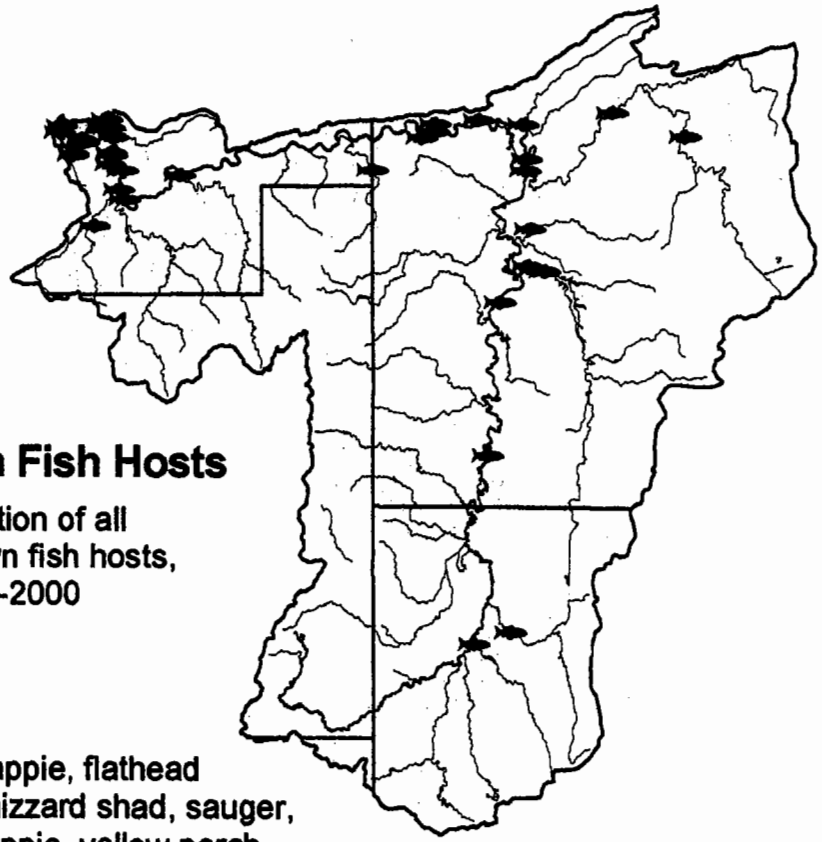
Grand River Watershed



Spike

Elliptio dilatata
(Rafinesque, 1820).

- This mussel species found, live or fresh dead, 1982-2000



Known Fish Hosts

Location of all known fish hosts, 1982-2000

Includes:

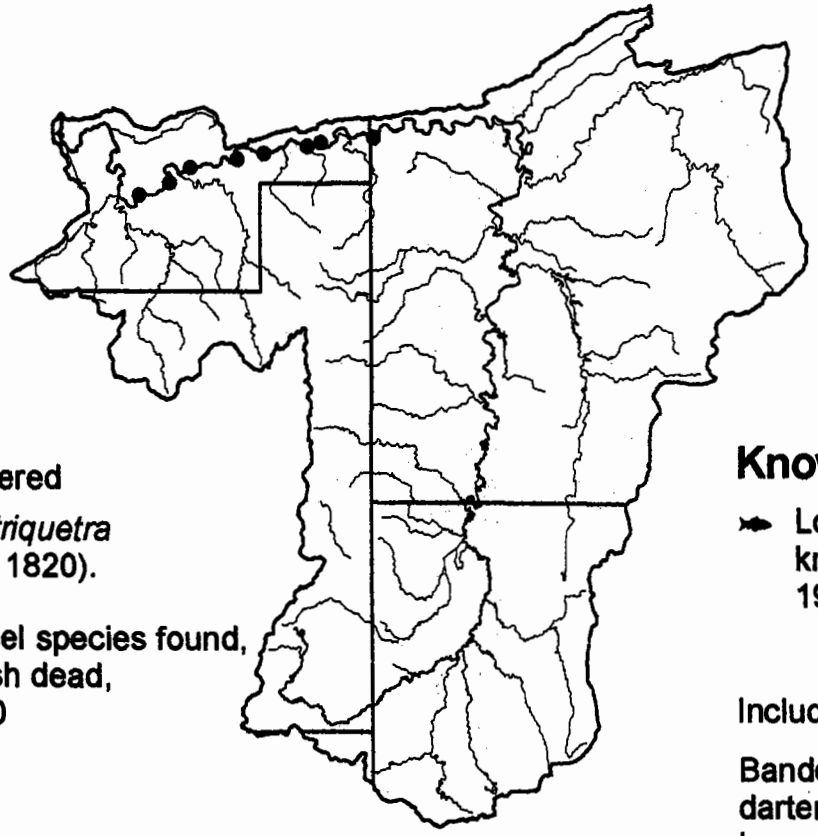
Black crappie, flathead catfish, gizzard shad, sauger, white crappie, yellow perch

N

0 5 10 Miles

Mussel/Host Range Comparison, 1982-2000

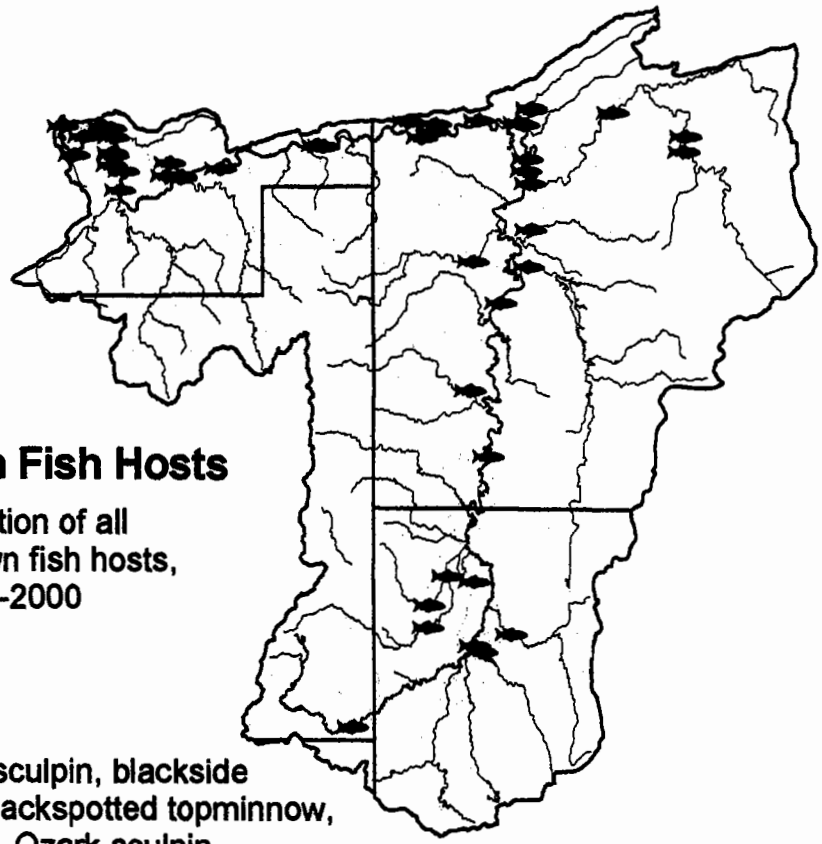
Grand River Watershed



Snuffbox
Ohio endangered

Epioblasma triquetra
(Rafinesque, 1820).

- This mussel species found, live or fresh dead, 1982-2000



Known Fish Hosts

Location of all known fish hosts, 1982-2000

Includes:

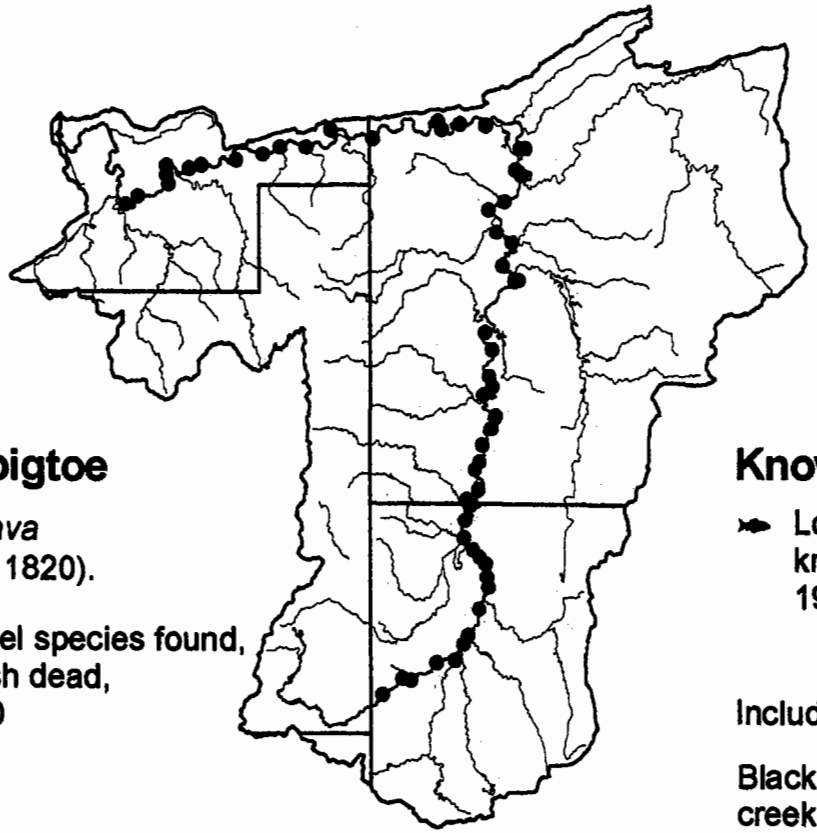
Banded sculpin, blackside darter, blackspotted topminnow, logperch, Ozark sculpin

N

0 5 10 Miles

Mussel/Host Range Comparison, 1982-2000

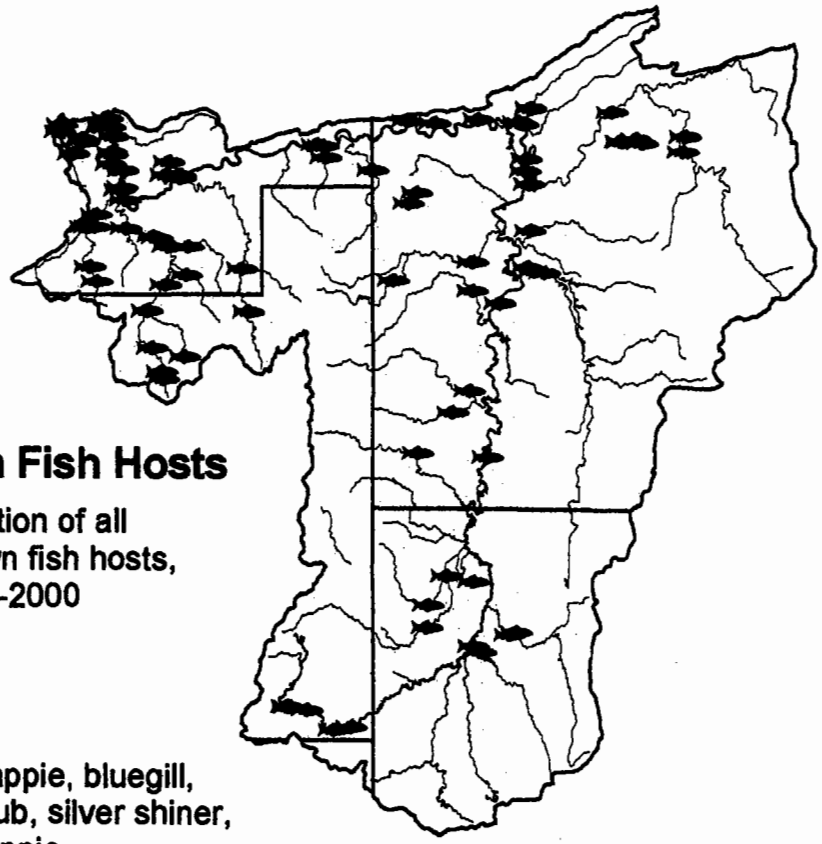
Grand River Watershed



Wabash pigtoe

Fusconaia flava
(Rafinesque, 1820).

- This mussel species found, live or fresh dead, 1982-2000



Known Fish Hosts

Location of all known fish hosts, 1982-2000

Includes:

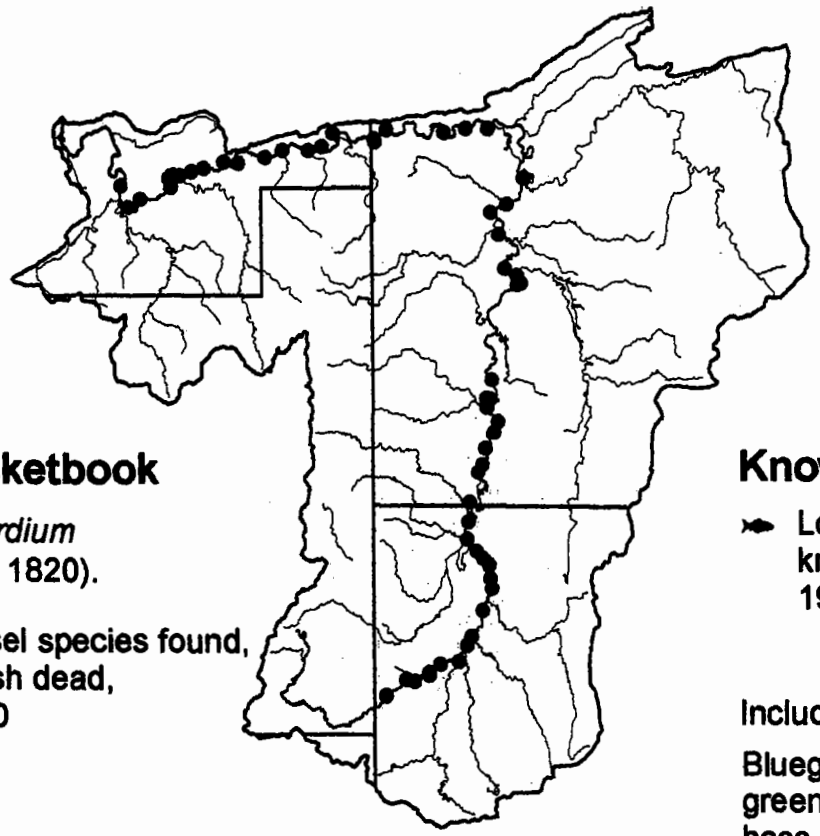
Black crappie, bluegill, creek chub, silver shiner, white crappie

N

0 5 10 Miles

Mussel/Host Range Comparison, 1982-2000

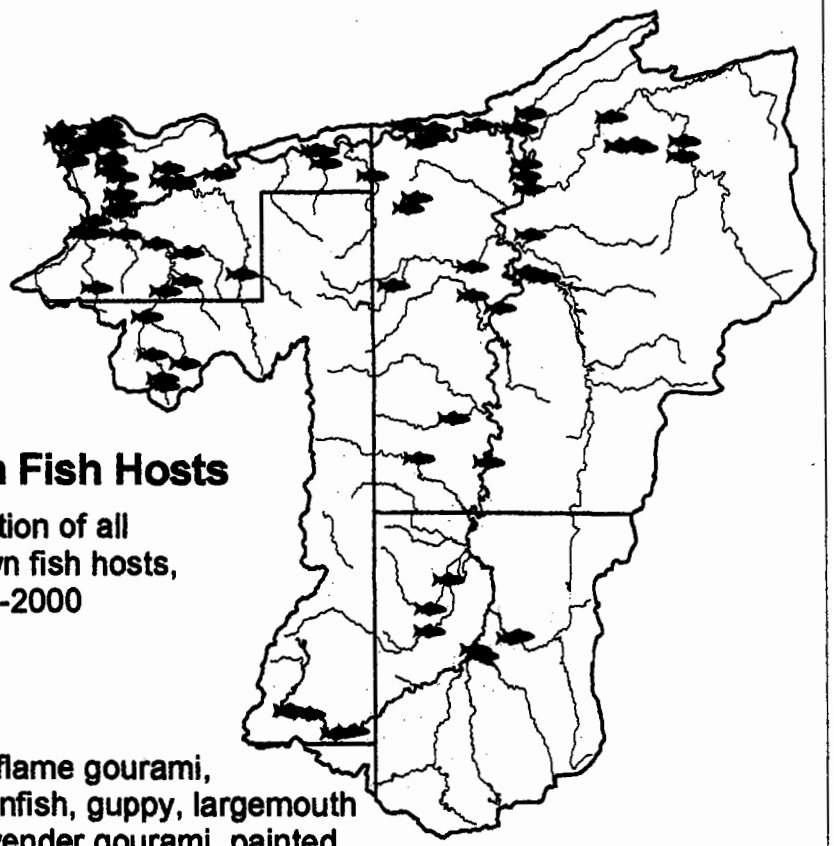
Grand River Watershed



Plain pocketbook

Lampsilis cardium
(Rafinesque, 1820).

- This mussel species found, live or fresh dead, 1982-2000



Known Fish Hosts

Location of all known fish hosts, 1982-2000

Includes:

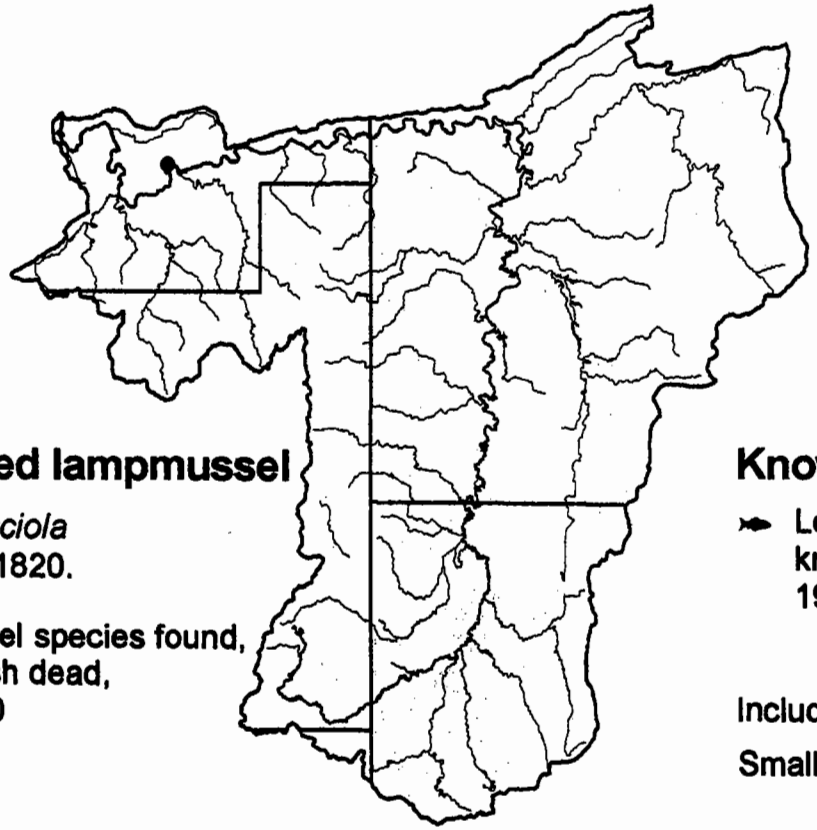
Bluegill, flame gourami, green sunfish, guppy, largemouth bass, lavender gourami, painted sword, panchax killifish, sauger, Siamese fighting fish, smallmouth bass, walleye, white crappie, yellow perch

N

0 5 10 Miles

Mussel/Host Range Comparison, 1982-2000

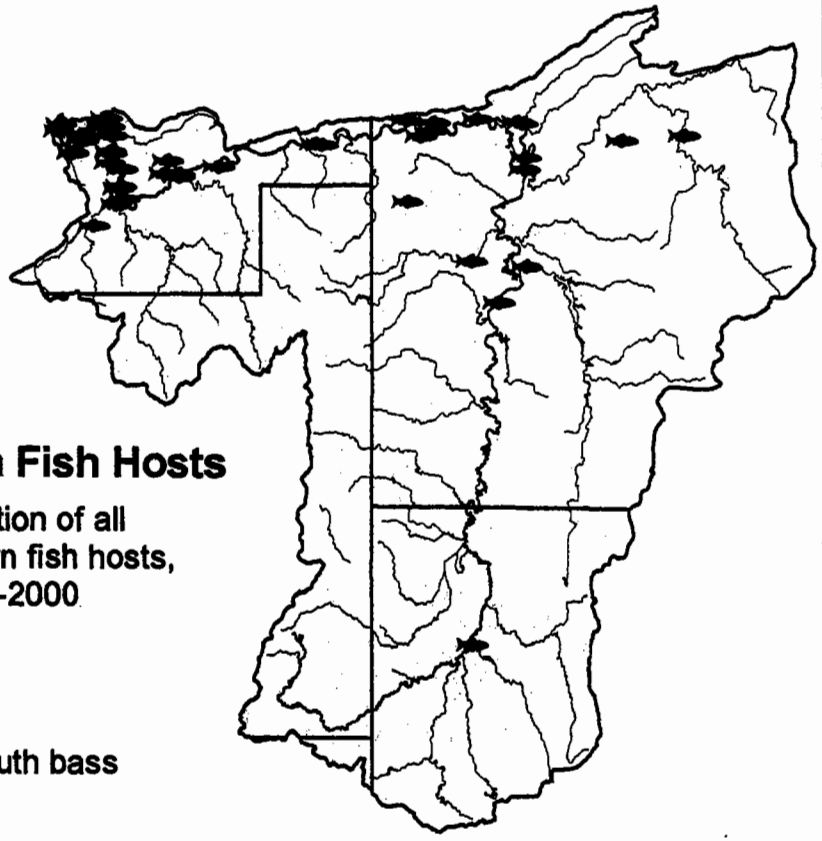
Grand River Watershed



Wavy-rayed lampmussel

Lampsilis fasciola
Rafinesque, 1820.

- This mussel species found, live or fresh dead, 1982-2000



Known Fish Hosts

Location of all known fish hosts, 1982-2000

Includes:

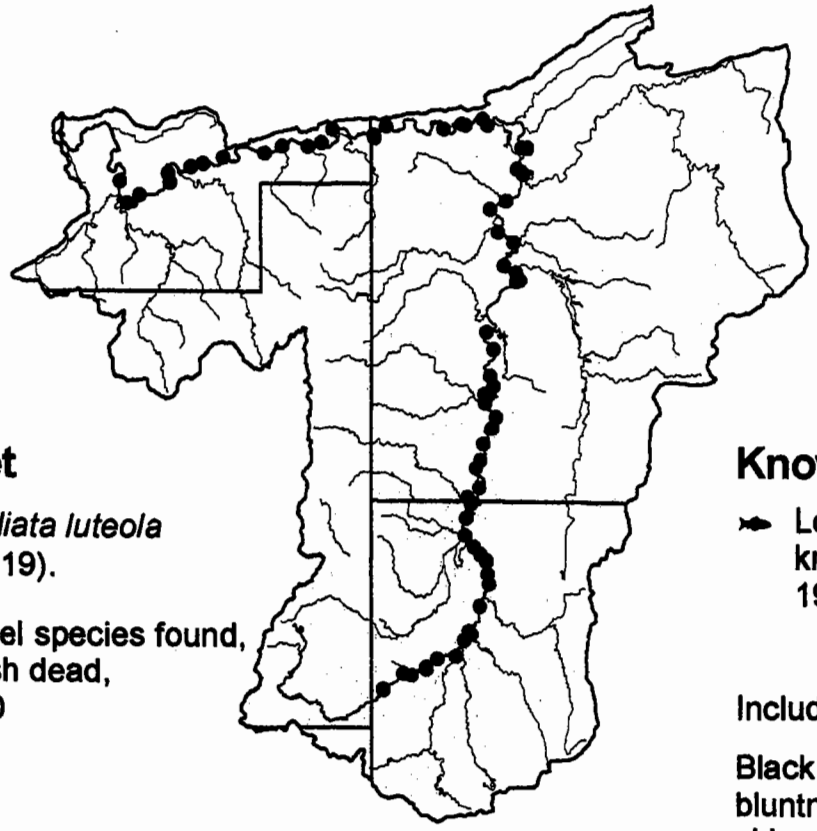
Smallmouth bass

N

0 5 10 Miles

Mussel/Host Range Comparison, 1982-2000

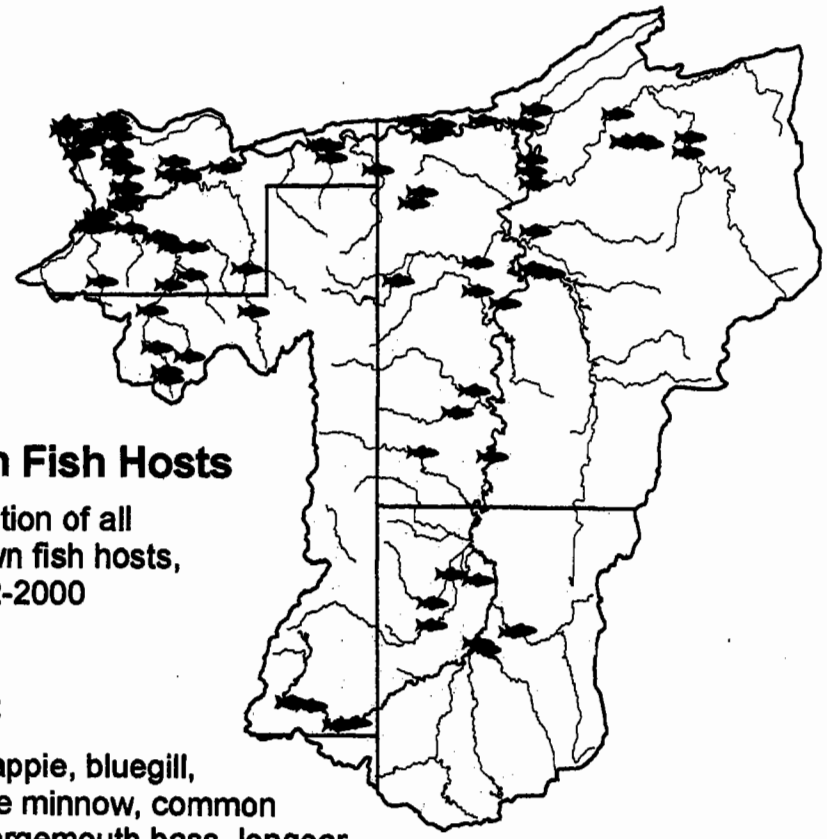
Grand River Watershed



Fatmucket

Lampsilis radiata luteola
(Lamarck, 1819).

- This mussel species found, live or fresh dead, 1982-2000



Known Fish Hosts

Location of all known fish hosts, 1982-2000

Includes:

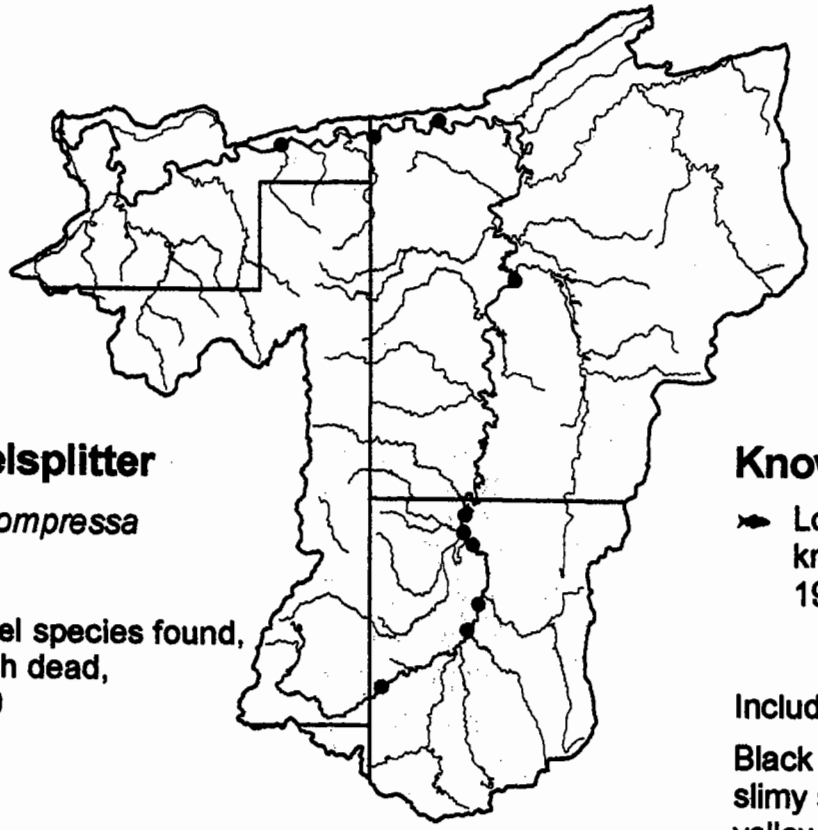
Black crappie, bluegill, bluntnose minnow, common shiner, largemouth bass, longear sunfish, pumpkinseed, rock bass, sand shiner, sauger, mallmouth bass, tadpole madtom, walleye, warmouth, white bass, white crappie, white sucker, yellow perch

N

0 5 10 Miles

Mussel/Host Range Comparison, 1982-2000

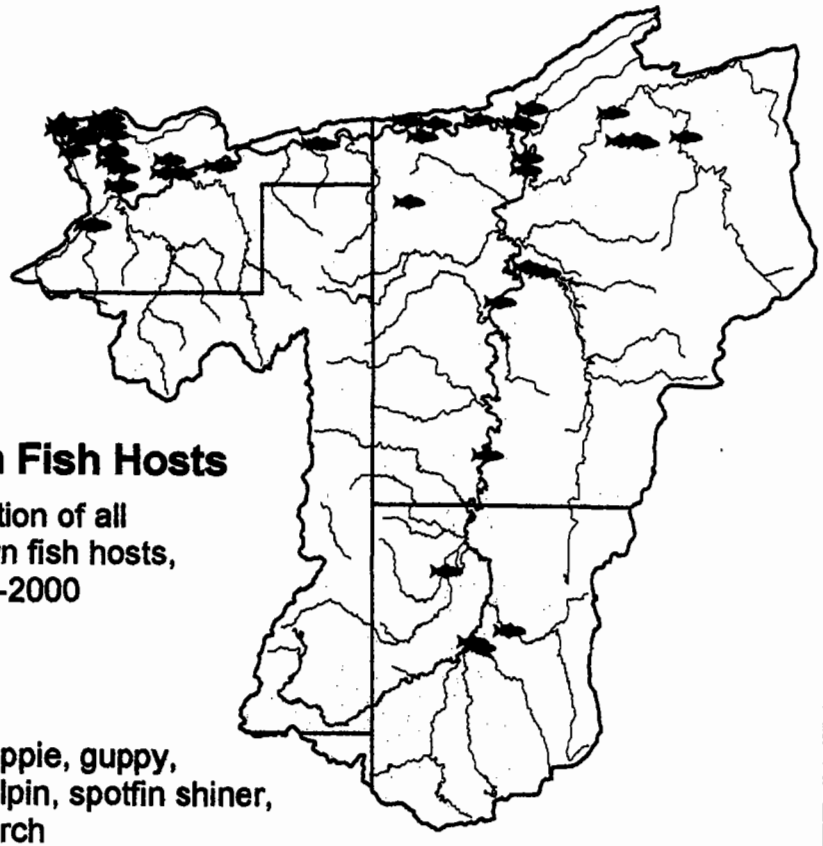
Grand River Watershed



Creek heelsplitter

Lasmigona compressa
(Lea, 1829).

- This mussel species found, live or fresh dead, 1982-2000



Known Fish Hosts

Location of all known fish hosts, 1982-2000

Includes:

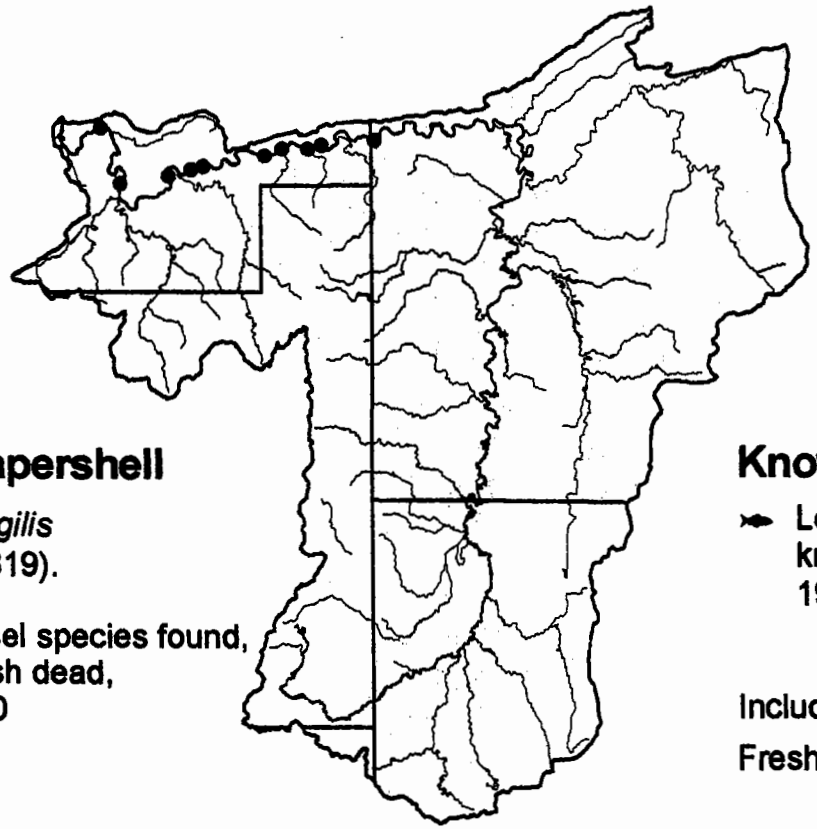
Black crappie, guppy, slimy sculpin, spotfin shiner, yellow perch

N

0 5 10 Miles

Mussel/Host Range Comparison, 1982-2000

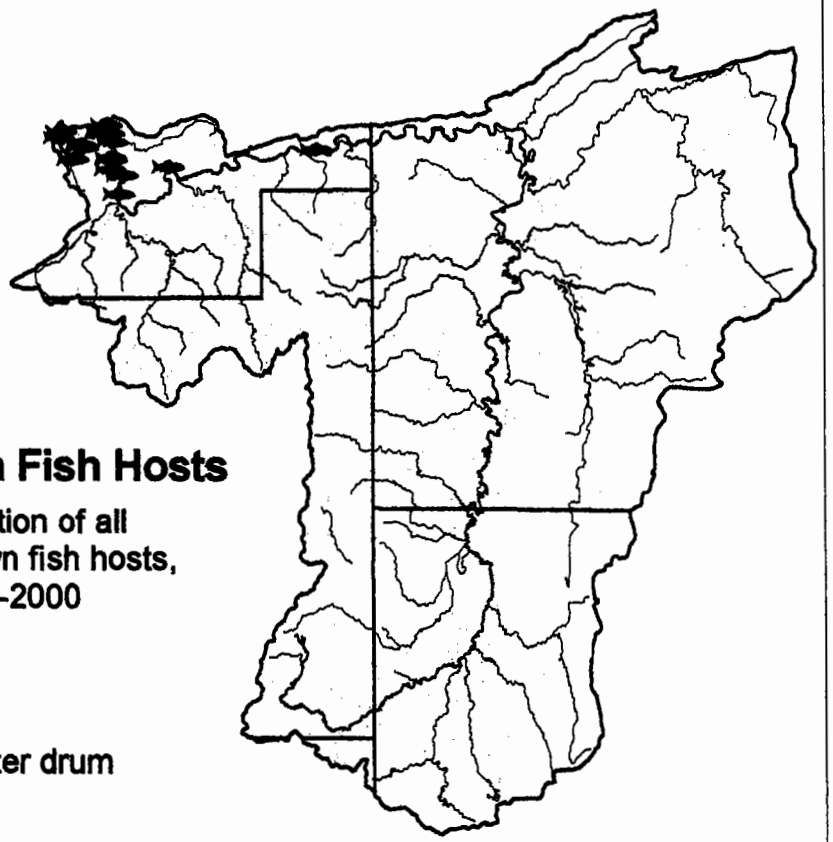
Grand River Watershed



Fragile papershell

Leptodea fragilis
(Lamarck, 1819).

- This mussel species found, live or fresh dead, 1982-2000



Known Fish Hosts

- Location of all known fish hosts, 1982-2000

Includes:

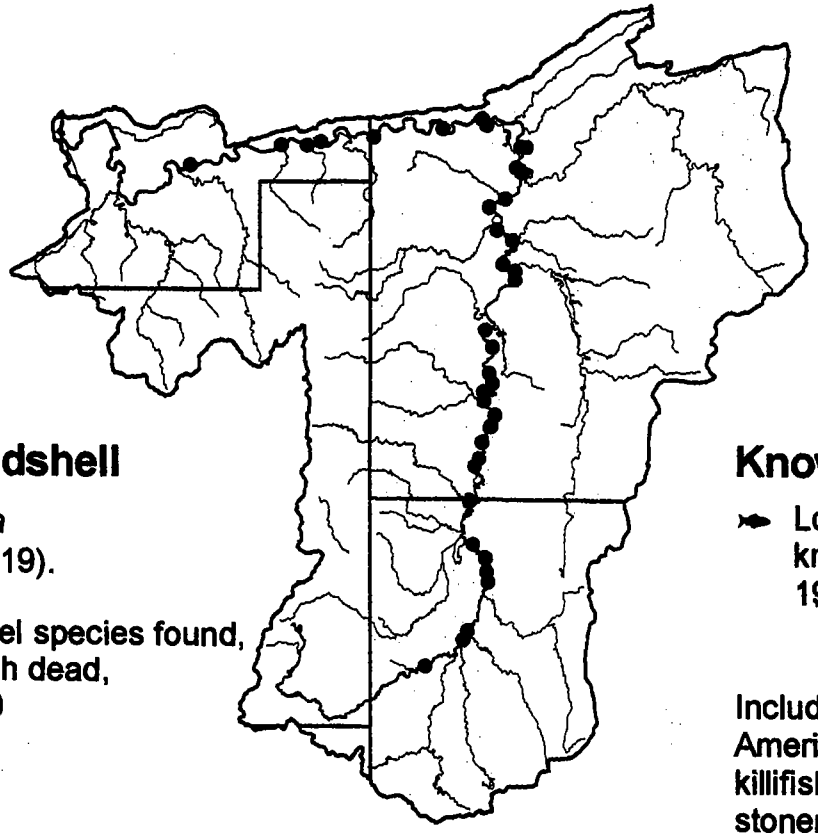
Freshwater drum

N

0 5 10 Miles

Mussel/Host Range Comparison, 1982-2000

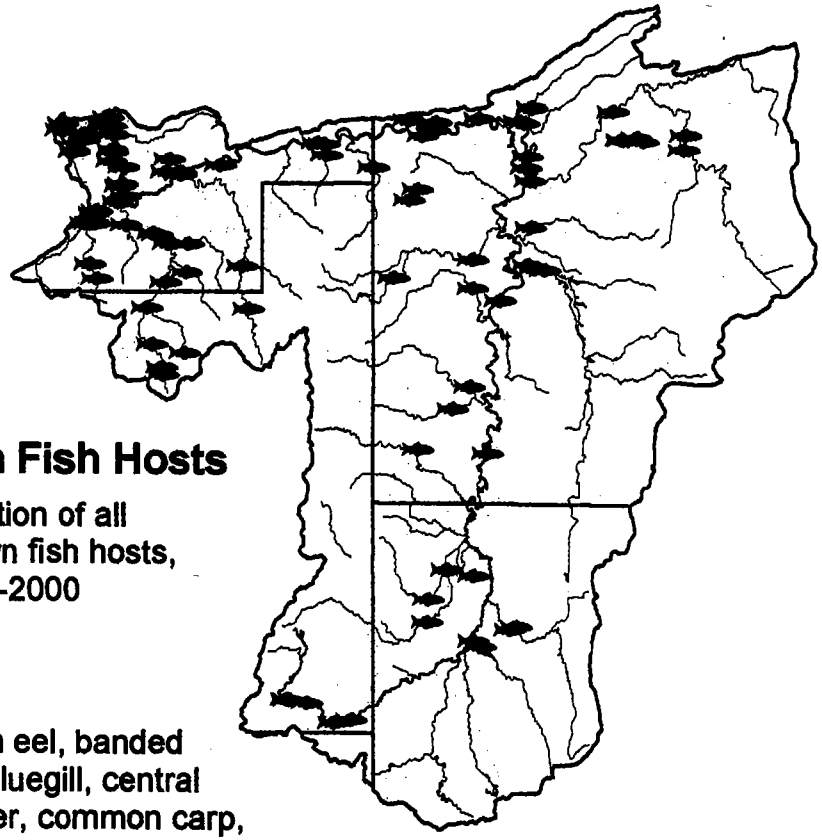
Grand River Watershed



Black sandshell

Ligumia recta
(Lamarck, 1819).

- This mussel species found, live or fresh dead, 1982-2000



Known Fish Hosts

Location of all known fish hosts, 1982-2000

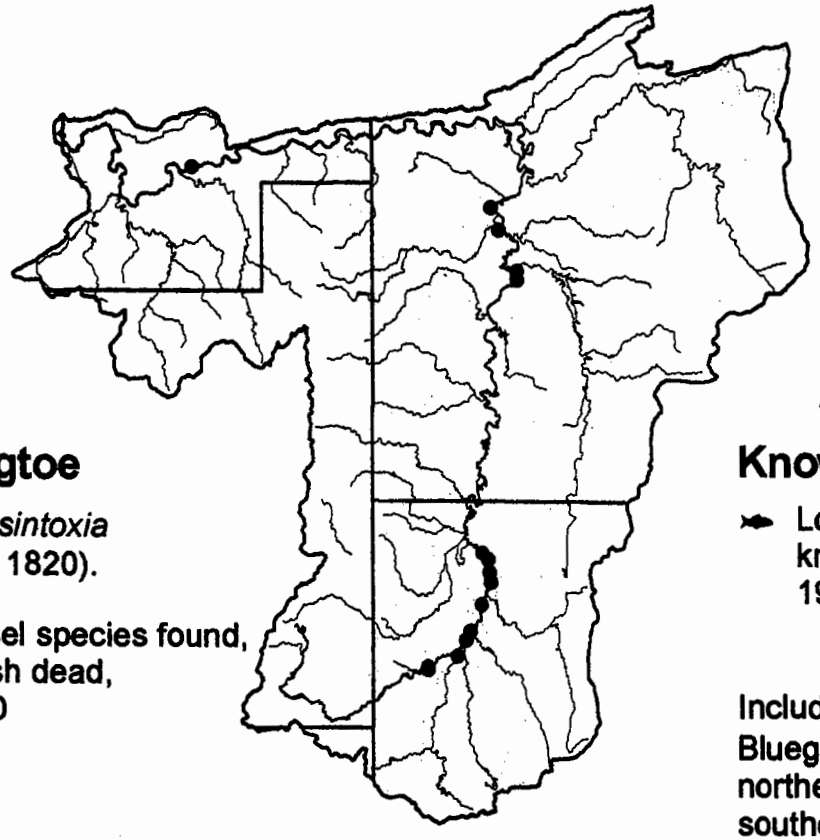
Includes:
American eel, banded killifish, bluegill, central stoneroller, common carp, convict cichlid, green sunfish, largemouth bass, longear sunfish, orangespotted sunfish, platy, pumpkinseed sunfish, redbreast sunfish, roach, rock bass, rosyface shiner, sauger, walleye, white crappie, white perch, yellow perch

N

0 5 10 Miles

Mussel/Host Range Comparison, 1982-2000

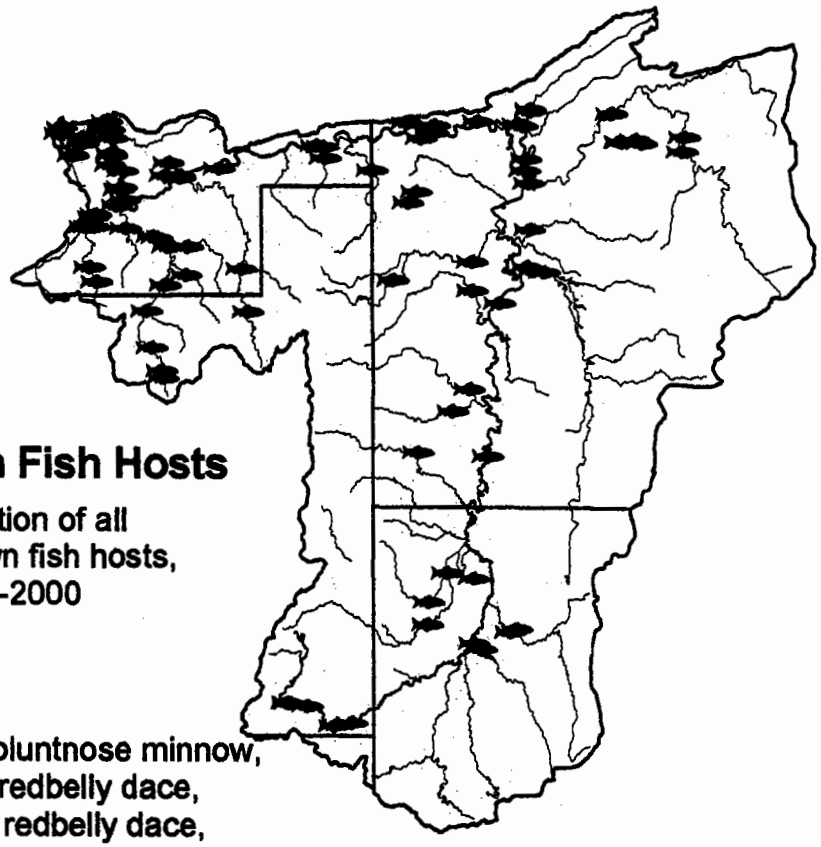
Grand River Watershed



Round Pigtoe

Pleurobema sintoxia
(Rafinesque, 1820).

- This mussel species found, live or fresh dead, 1982-2000



Known Fish Hosts

Location of all known fish hosts, 1982-2000

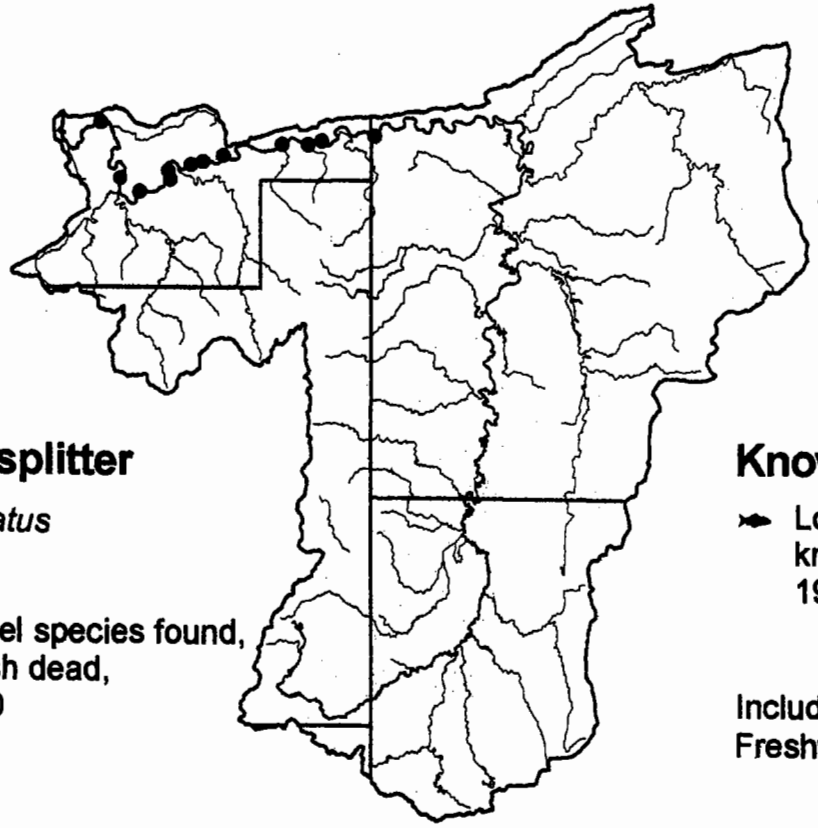
Includes:
Bluegill, bluntnose minnow, northern redbelly dace, southern redbelly dace, spotfin shiner

N

0 5 10 Miles

Mussel/Host Range Comparison, 1982-2000

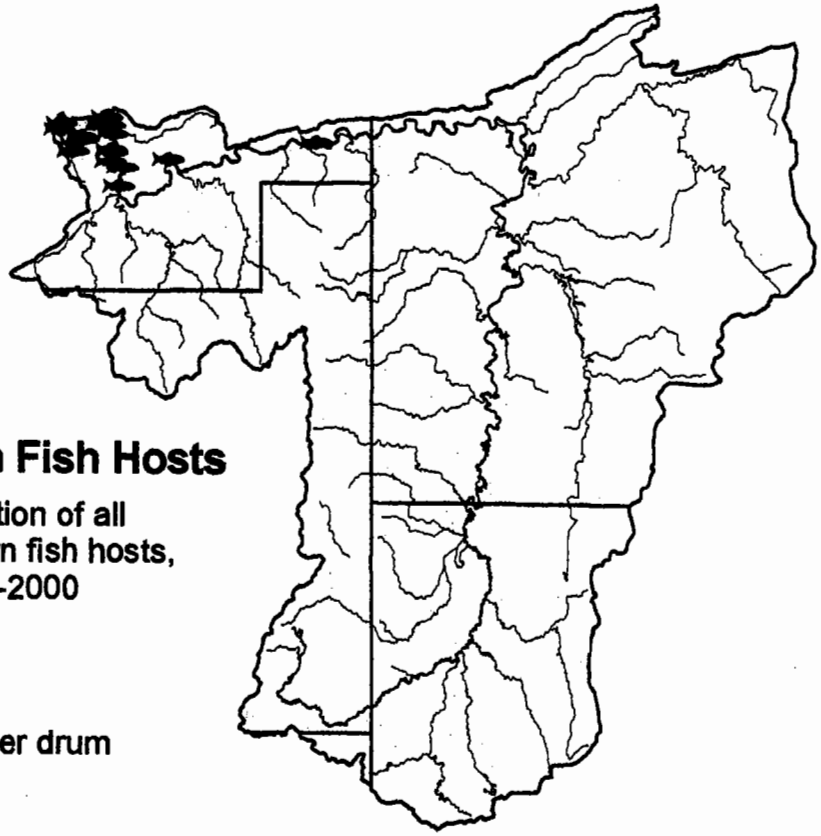
Grand River Watershed



Pink Heelsplitter

Potamilus alatus
(Say, 1817).

- This mussel species found, live or fresh dead, 1982-2000



Known Fish Hosts

Location of all known fish hosts, 1982-2000

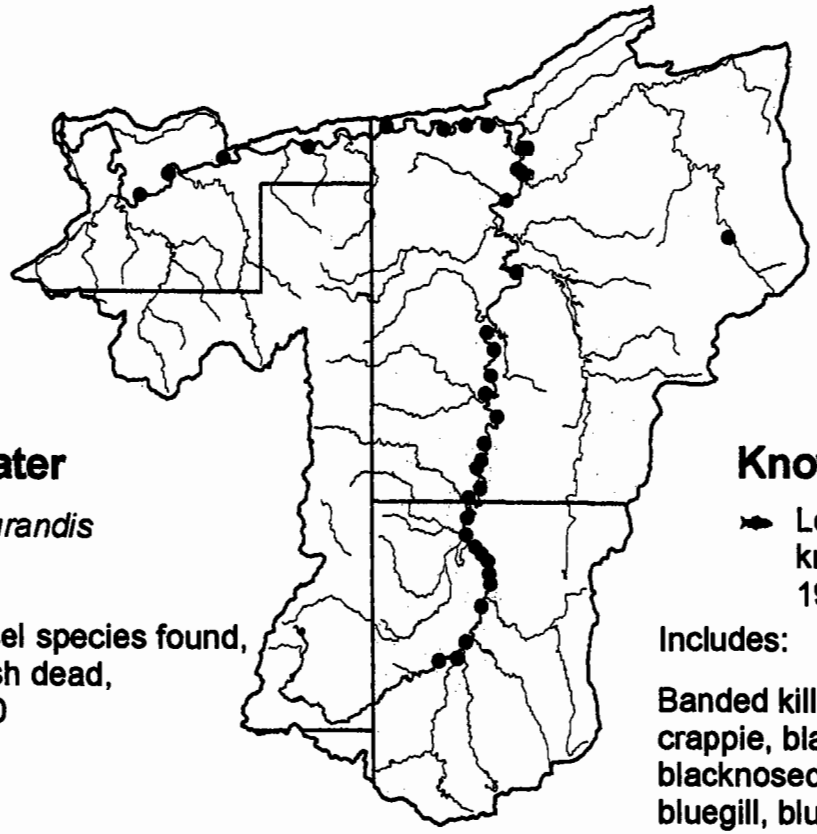
Includes:
Freshwater drum

N

0 5 10 Miles

Mussel/Host Range Comparison, 1982-2000

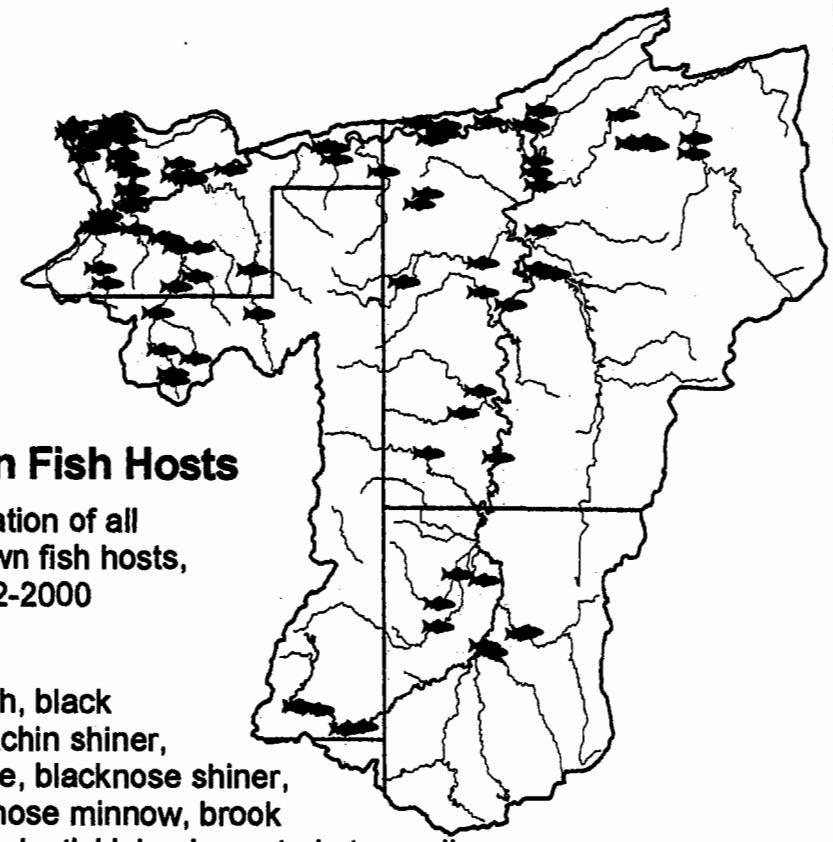
Grand River Watershed



Giant Floater

Pyganodon grandis
(Say, 1829).

- This mussel species found, live or fresh dead, 1982-2000



Known Fish Hosts

- Location of all known fish hosts, 1982-2000

Includes:

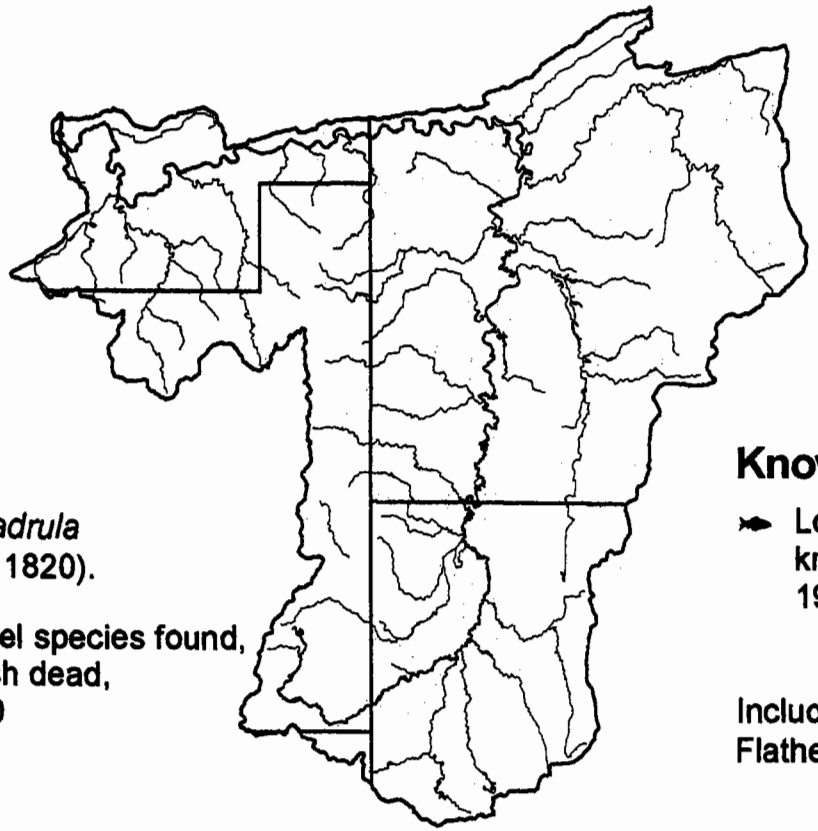
Banded killifish, black crappie, blackchin shiner, blacknosedace, blacknose shiner, bluegill, bluntnose minnow, brook silverside, brook stickleback, central stoneroller, common carp, commo shiner, creek chub, freshwater drum, gizzard shad, golden shiner, golde topminnow, green sunfish, Iowa darter, Johnny darter, largemouth bass longear sunfish, longnose gar, orangespotted sunfish, pearl dace, pumpkinseed, rainbow darter, redfin shiner, Rio Grande cichlid, river carpsucker, roach, rock bass, skipjack herring, striped shiner, white bass, white crappie, white sucker, yellow bullhead, yellow perch

N

0 5 10 Miles

Mussel/Host Range Comparison, 1982-2000

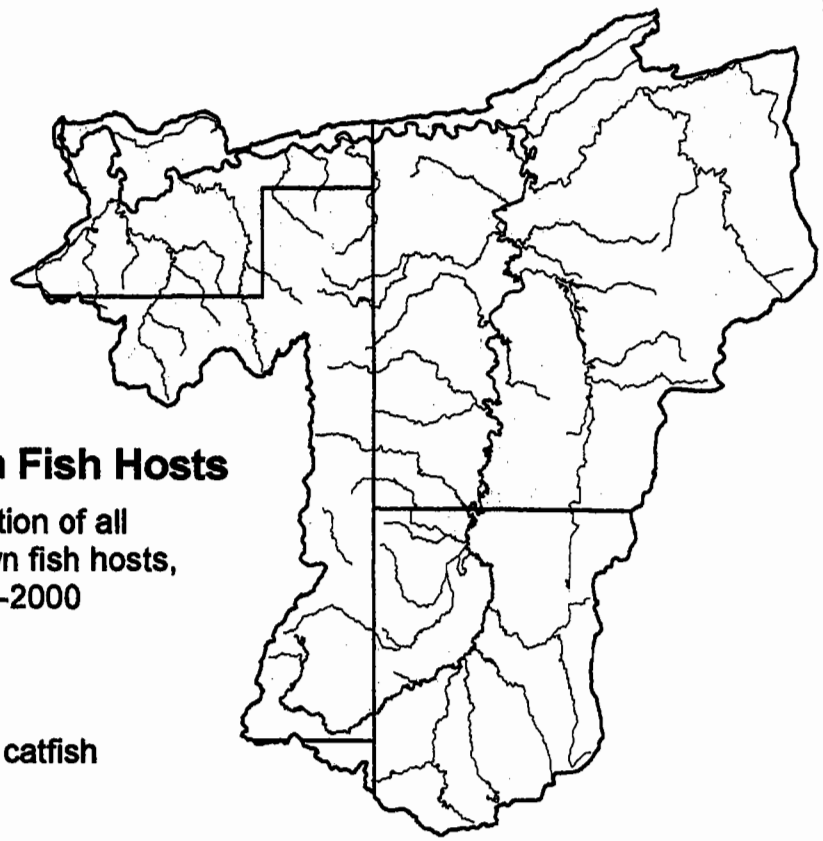
Grand River Watershed



Mapleleaf

Quadrula quadrula
(Rafinesque, 1820).

- This mussel species found, live or fresh dead, 1982-2000



Known Fish Hosts

- Location of all known fish hosts, 1982-2000

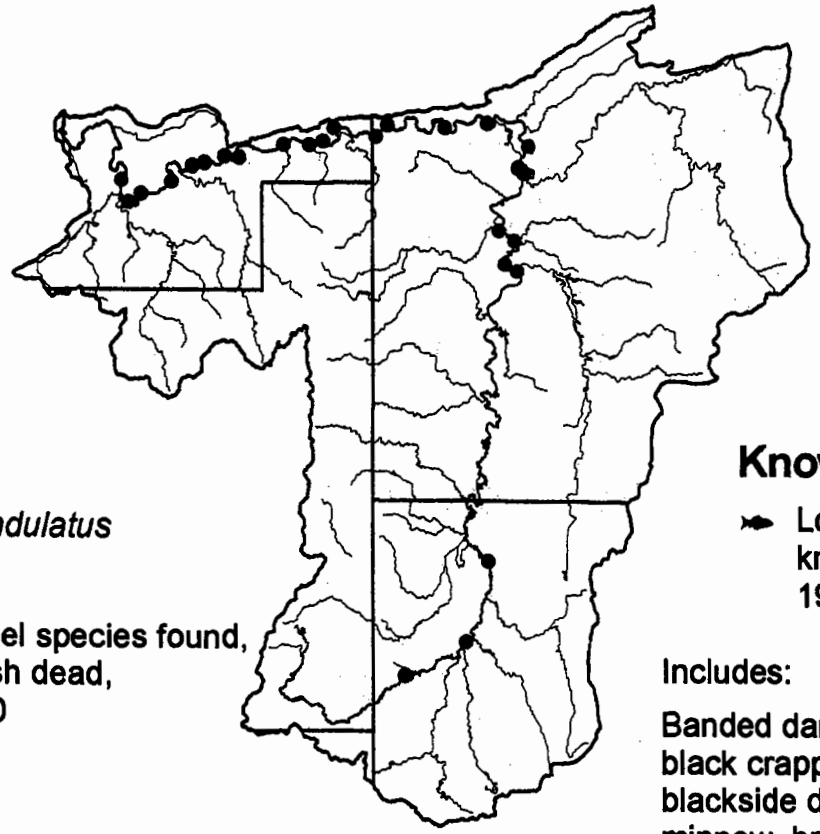
Includes:
Flathead catfish

N

0 5 10 Miles

Mussel/Host Range Comparison, 1982-2000

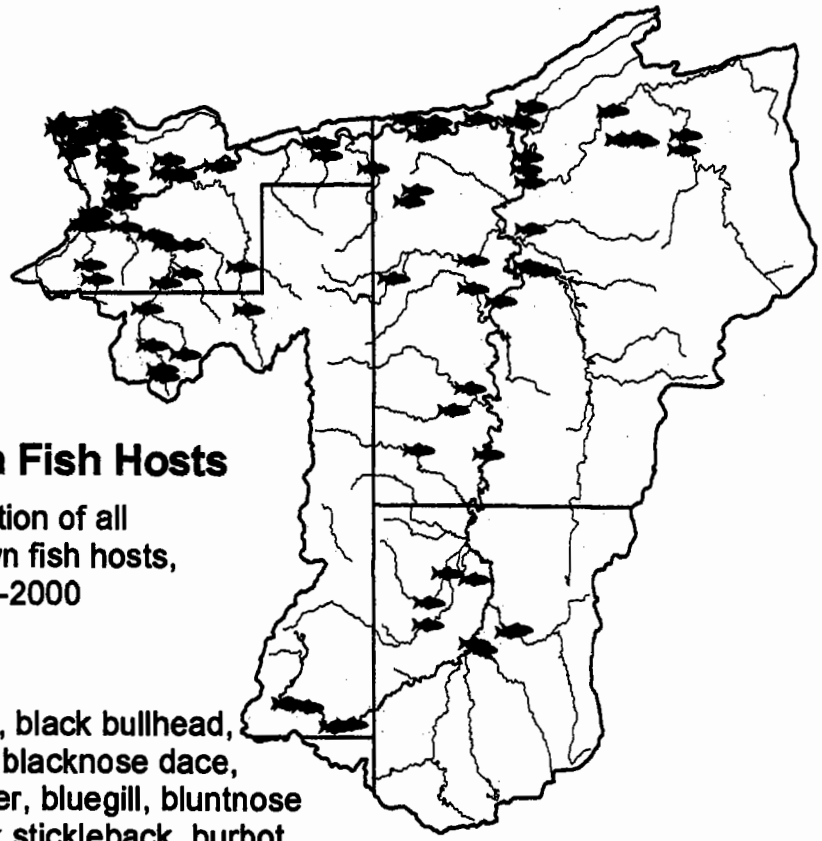
Grand River Watershed



Creeper

Strophitus undulatus
(Say, 1817).

- This mussel species found, live or fresh dead, 1982-2000



Known Fish Hosts

Location of all known fish hosts, 1982-2000

Includes:

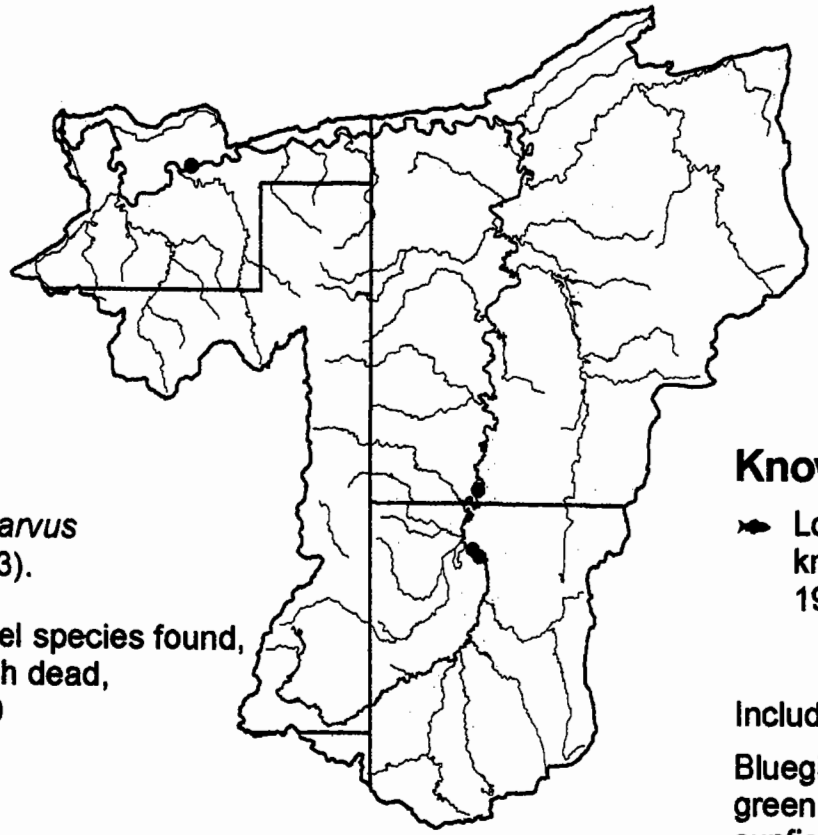
Banded darter, black bullhead, black crappie, blacknose dace, blackside darter, bluegill, bluntnose minnow, brook stickleback, burbot, central mudminnow, channel catfish, common shiner, creek chub, fantail darter, fathead minnow, green sunfish, Iowa darter, Johnny darter, largemouth bass, logperch, longnose dace, northern redbelly dace, plains killifish, pumpkinseed, rainbow darter, river chub, rock bass, sand shiner, slenderhead darter, smallmouth bass, spotfin shiner, stoneroller, walleye, white crappie, yellow bullhead, yellow perch

N

0 5 10 Miles

Mussel/Host Range Comparison, 1982-2000

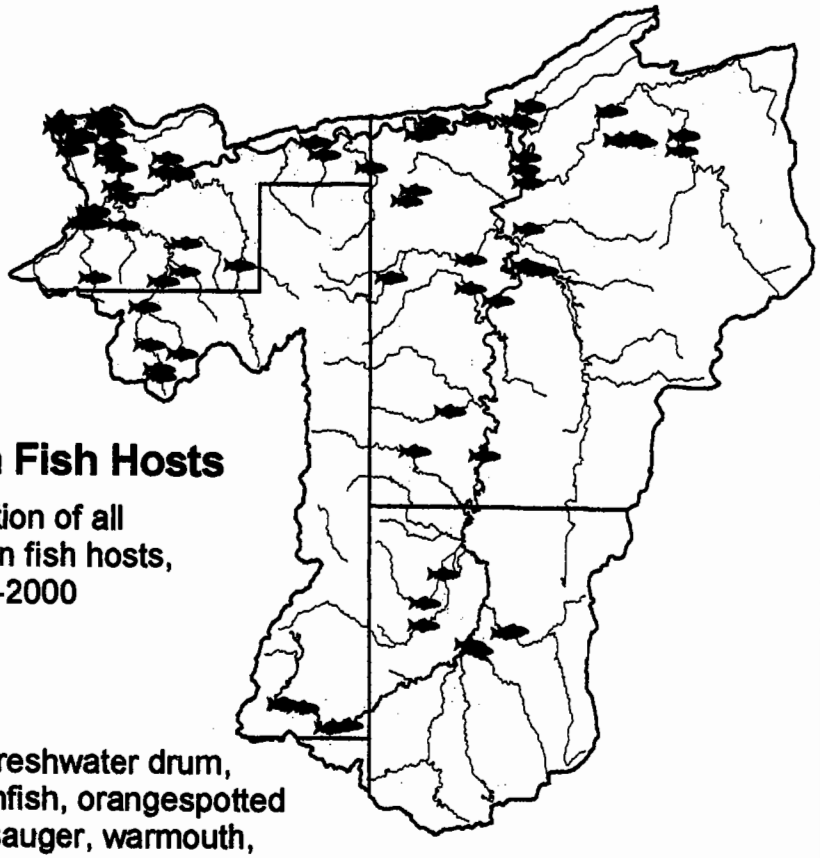
Grand River Watershed



Lilliput

Toxolasma parvus
(Barnes, 1823).

- This mussel species found, live or fresh dead, 1982-2000



Known Fish Hosts

Location of all known fish hosts, 1982-2000

Includes:

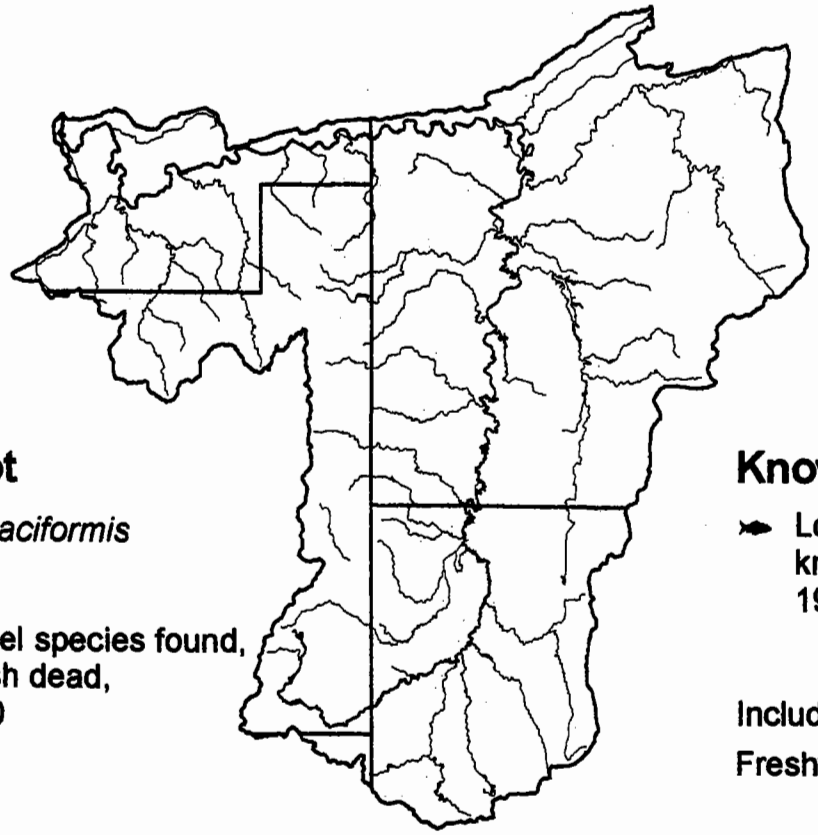
Bluegill, freshwater drum, green sunfish, orangespotted sunfish, sauger, warmouth, white crappie

N

0 5 10 Miles

Mussel/Host Range Comparison, 1982-2000

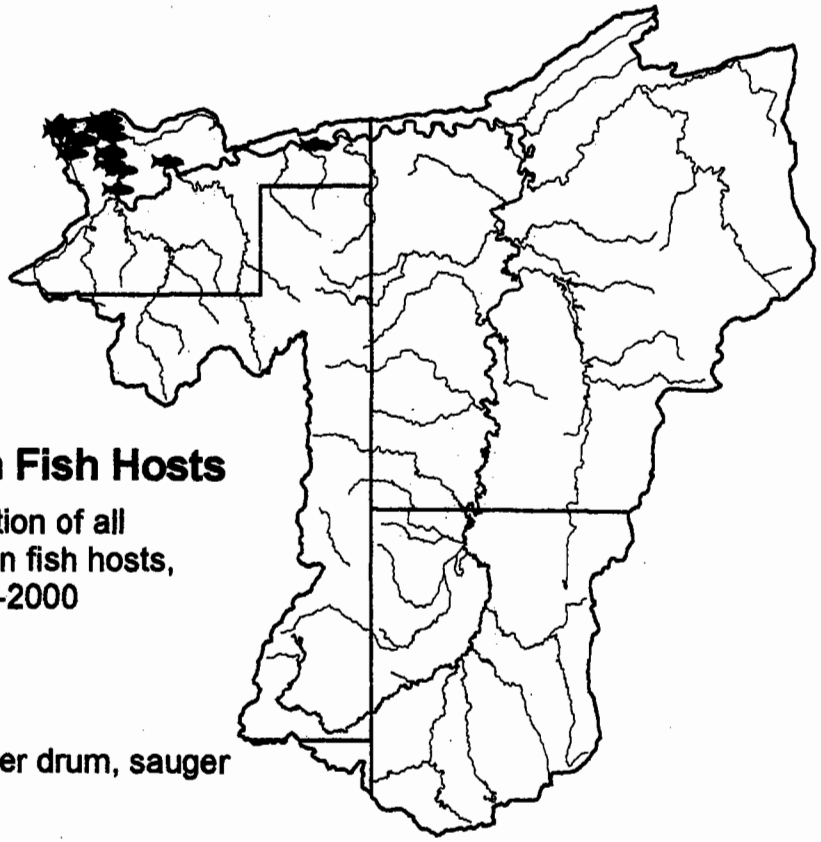
Grand River Watershed



Fawnsfoot

Truncilla donaciformis
(Lea, 1827).

- This mussel species found, live or fresh dead, 1982-2000



Known Fish Hosts

- Location of all known fish hosts, 1982-2000

Includes:

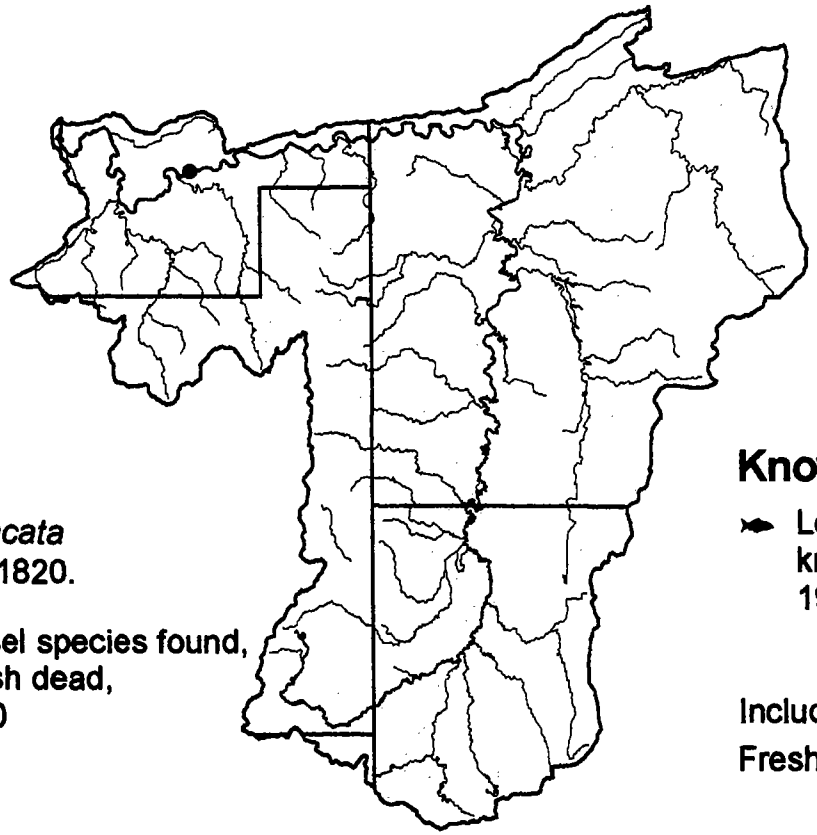
Freshwater drum, sauger

N

0 5 10 Miles

Mussel/Host Range Comparison, 1982-2000

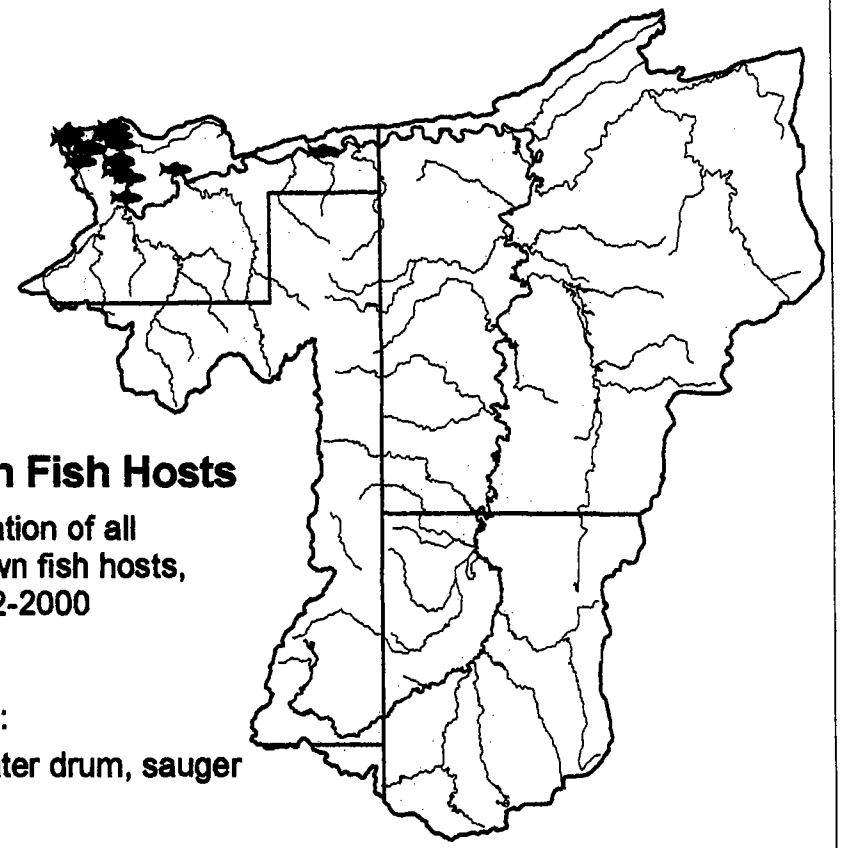
Grand River Watershed



Deertoe

Truncilla truncata
Rafinesque, 1820.

- This mussel species found, live or fresh dead, 1982-2000



Known Fish Hosts

- Location of all known fish hosts, 1982-2000

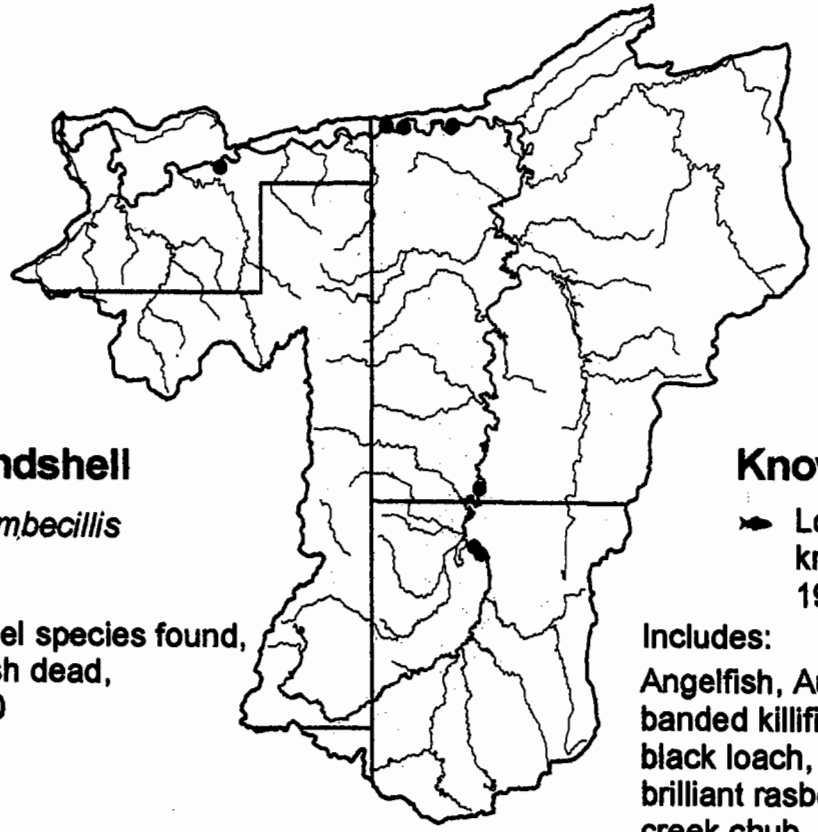
Includes:
Freshwater drum, sauger

N

0 5 10 Miles

Mussel/Host Range Comparison, 1982-2000

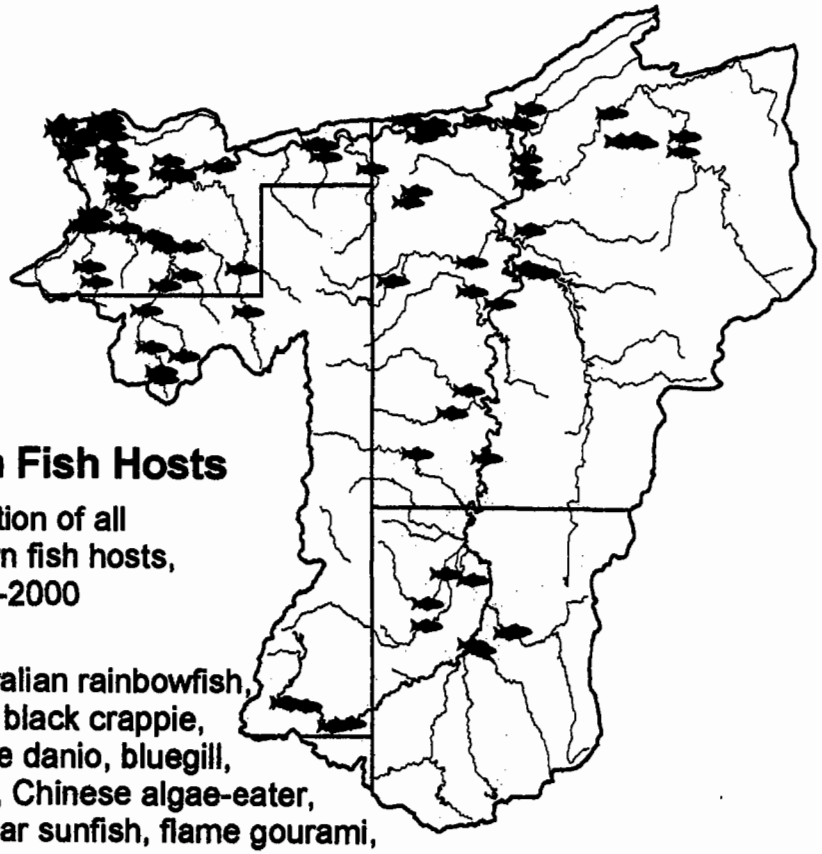
Grand River Watershed



Paper pondshell

Utterbackia imbecillis
(Say, 1829).

- This mussel species found, live or fresh dead, 1982-2000



Known Fish Hosts

Location of all known fish hosts, 1982-2000

Includes:

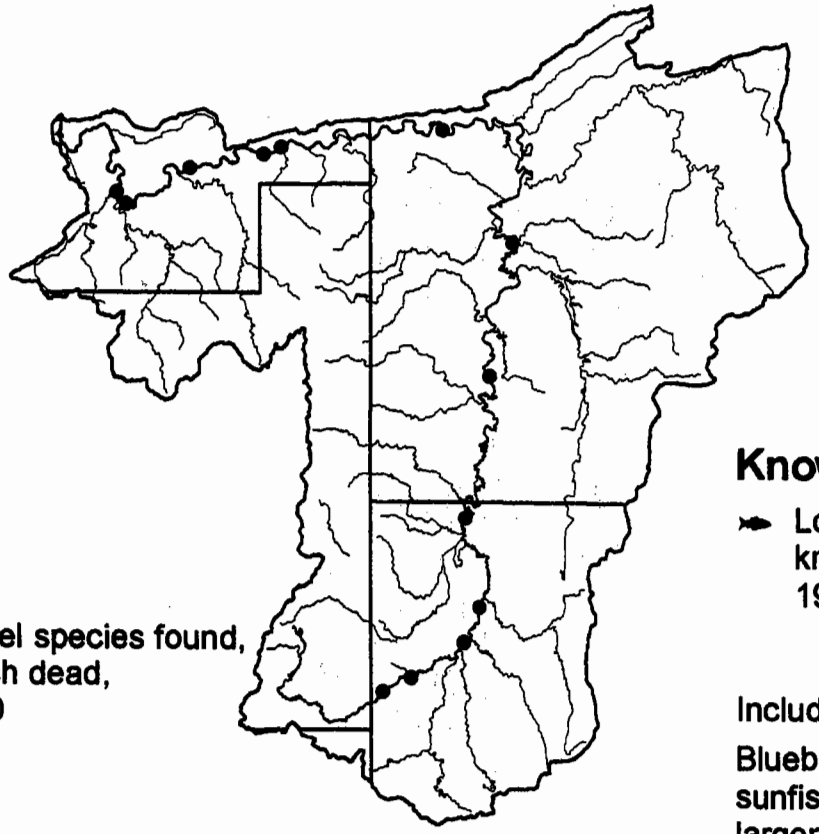
Angelfish, Australian rainbowfish, banded killifish, black crappie, black loach, blue danio, bluegill, brilliant rasbora, Chinese algae-eater, creek chub, dollar sunfish, flame gourami, giant danio, guppy, glass knifefish, glowlight tetra, golden barb, goldfish, green sunfish, greenthroat darter, largemouth bass, lavender gourami, longear sunfish, marbled cichlid, mosquitofish, painted sword, panchax killifish, pangasius catfish, peacock cichlid, pearl gourami, pumpkinseed, redeye tetra, rock bass, siamese fighting fish, silver dollar, silvertip tetra, spotfin shiner, Von Rio tetra, warmouth, yellow perch, zebra malwi chichli

N

0 5 10 Miles

Mussel/Host Range Comparison, 1982-2000

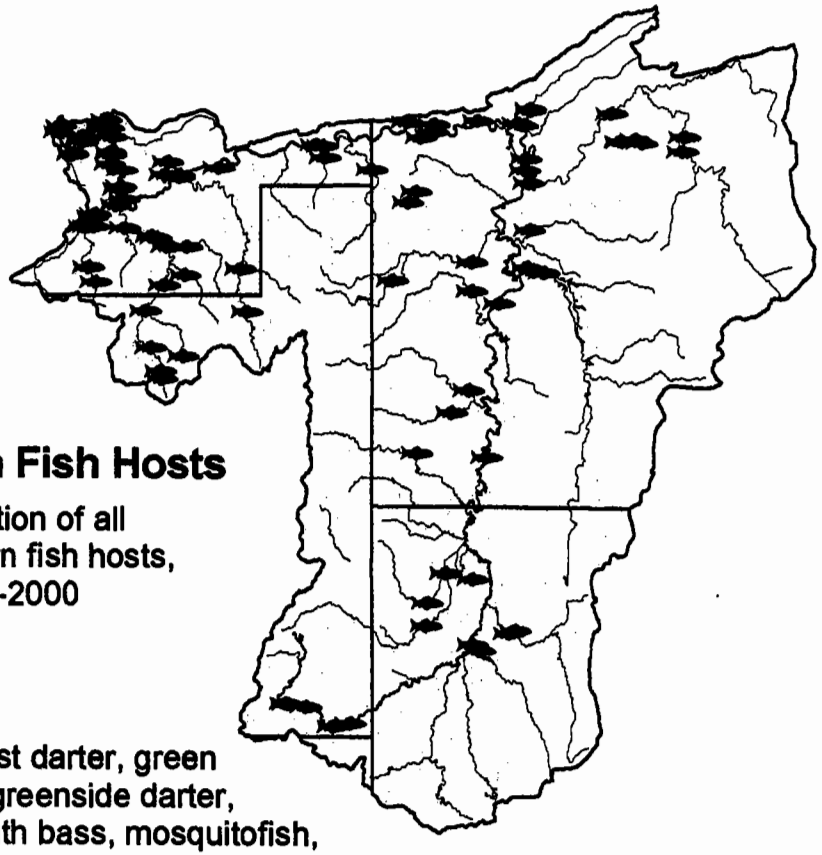
Grand River Watershed



Rainbow

Villosa iris
(Lea, 1829).

- This mussel species found, live or fresh dead, 1982-2000



Known Fish Hosts

Location of all known fish hosts, 1982-2000

Includes:

Bluebreast darter, green sunfish, greenside darter, largemouth bass, mosquitofish, rainbow darter, rock bass, Siamese fighting fish, smallmouth bass, spotted bass, streamline chub, Suwannee bass, striped shiner, yellow perch

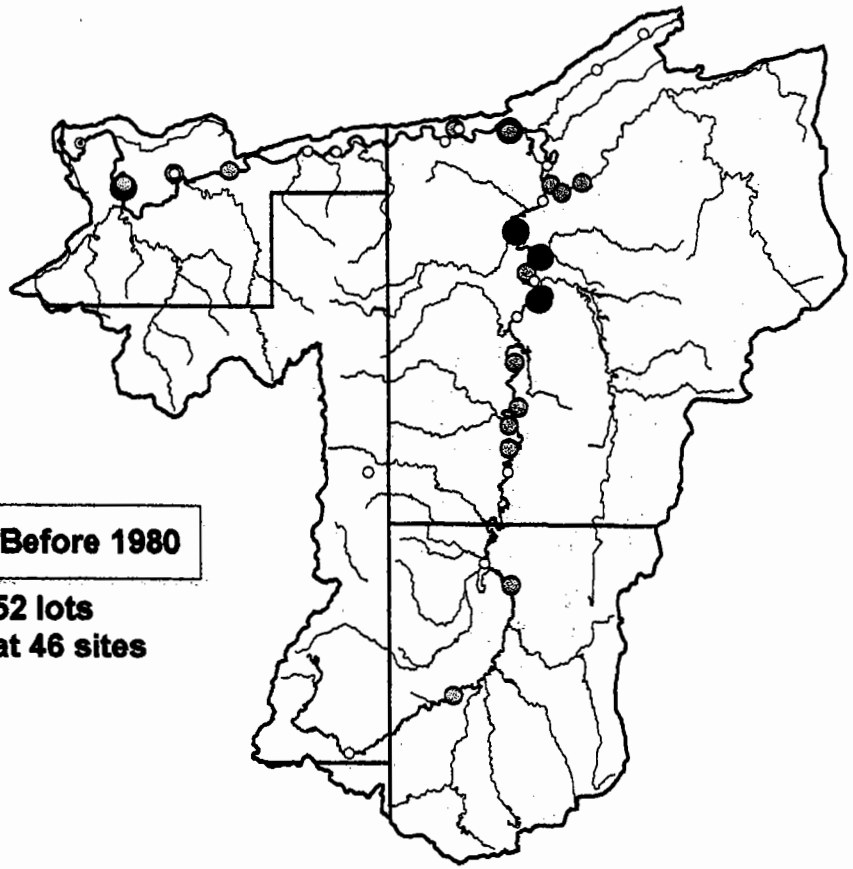
N

0 5 10 Miles

Mussel Species Richness

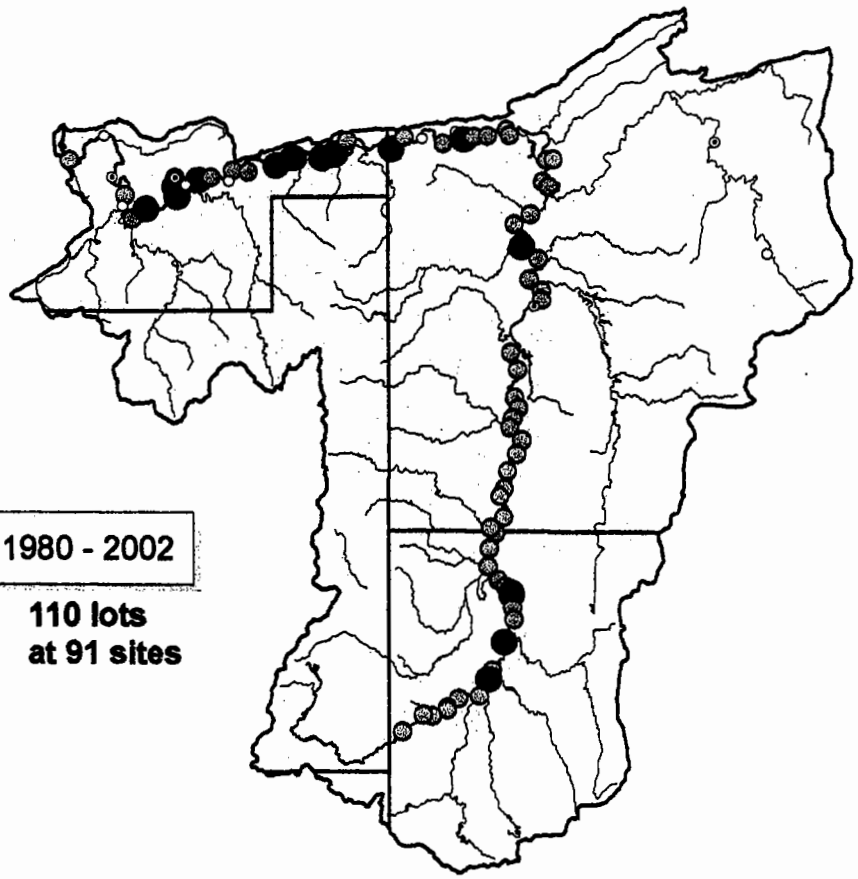
(Live or Fresh Dead only)

Grand River Watershed



Before 1980

52 lots
at 46 sites



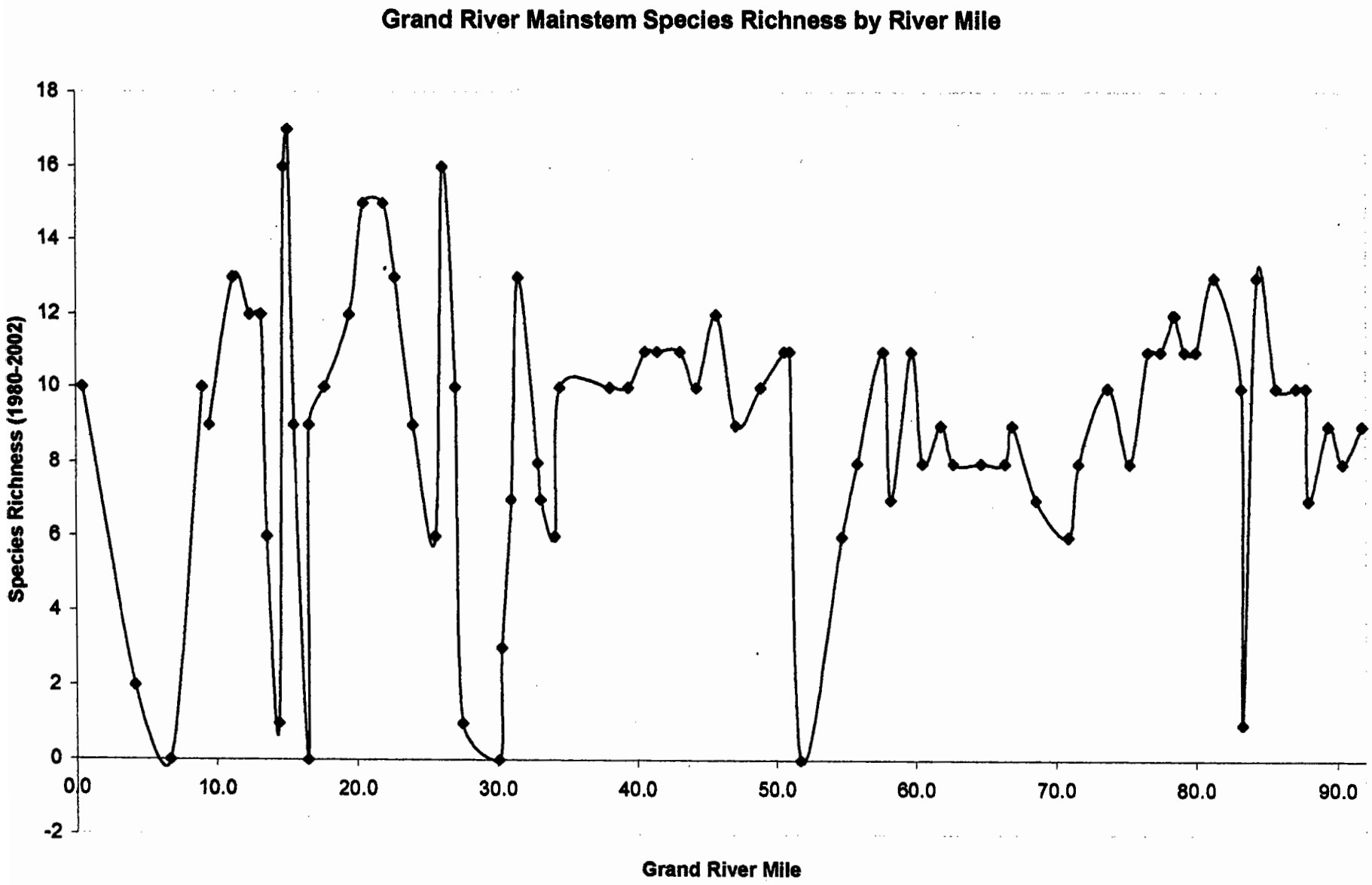
1980 - 2002

110 lots
at 91 sites

N

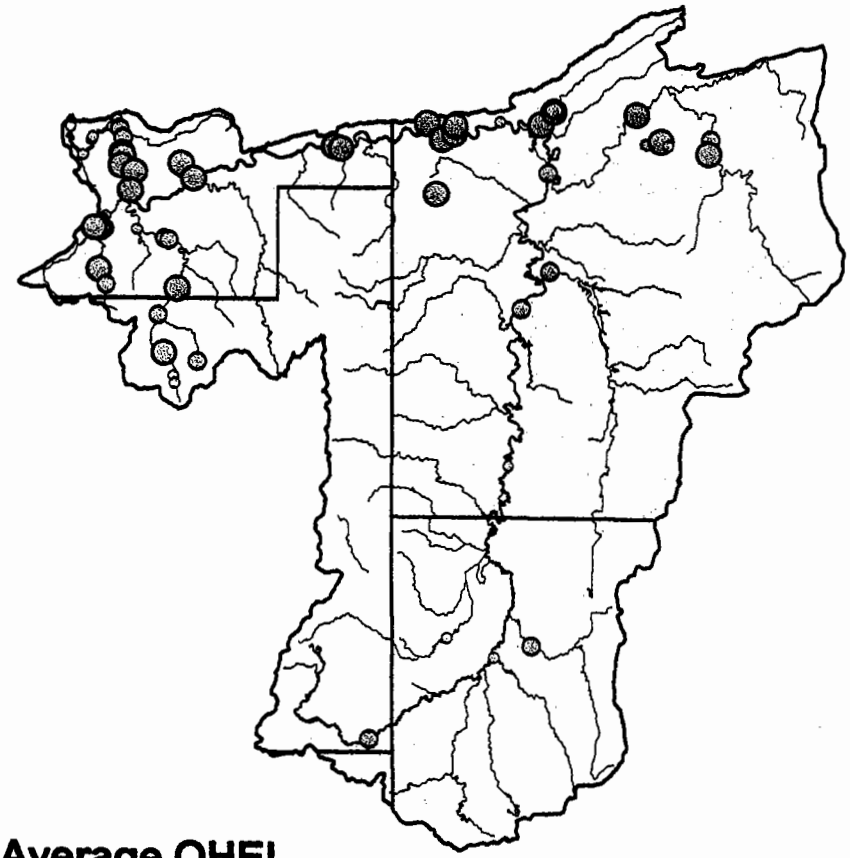
0 5 10 Miles

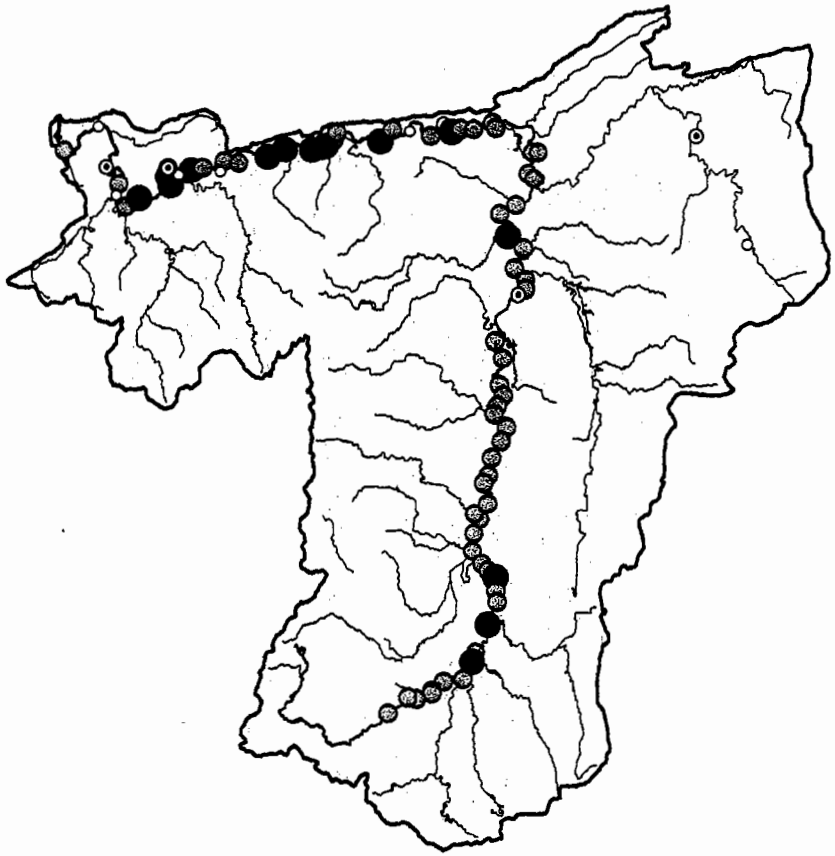
- 0 species
- 1 - 5 species
- 6 - 11 species
- 12 - 17 species


Grand River Mainstem Species Richness by River Mile
Species Richness (1980-2002)
18
16
14
12
10
8
6
4
2
0
-2
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
90.0
Grand River Mile

Qualitative Habitat Evaluation Index (QHEI)

Grand River Watershed





Average QHEI
1983 - 2000

- 42 - 60
- 60 - 73.5
- 73.5 - 90.5

(On a scale of 0 to 100, with 100 indicating the highest quality)

N

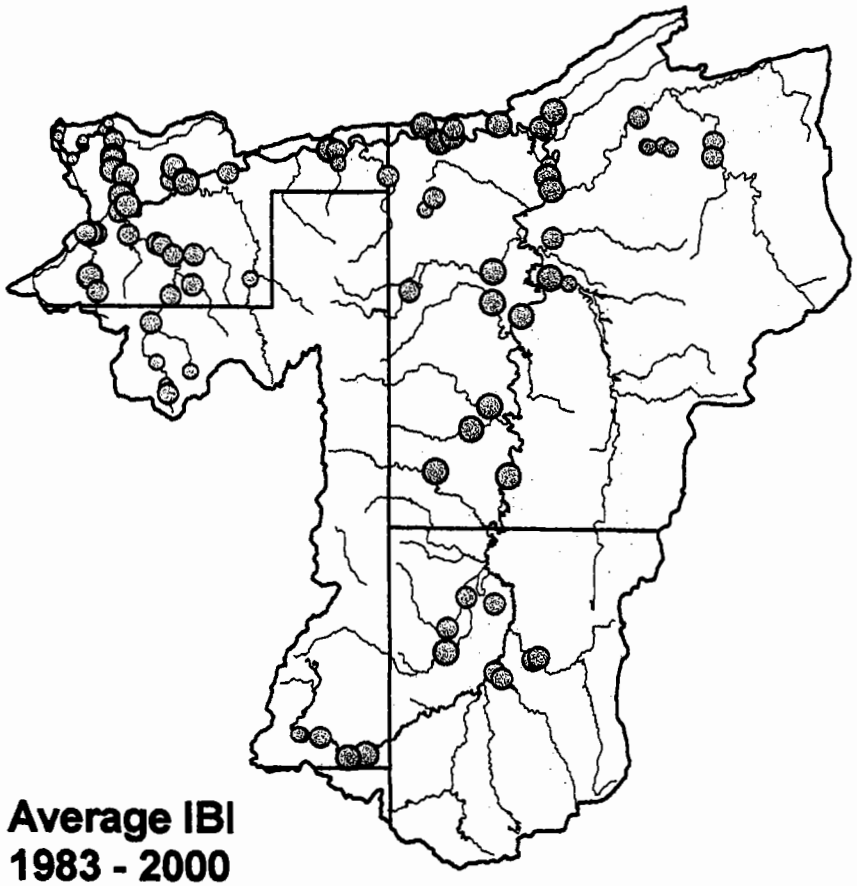
0 5 10 Miles

Mussel Species Richness
1980 - 2002 (live/fresh dead only)

- 0 species
- 1 - 5 species
- 6 - 11 species
- 12 - 17 species

Index of Biological Integrity (IBI)

Grand River Watershed



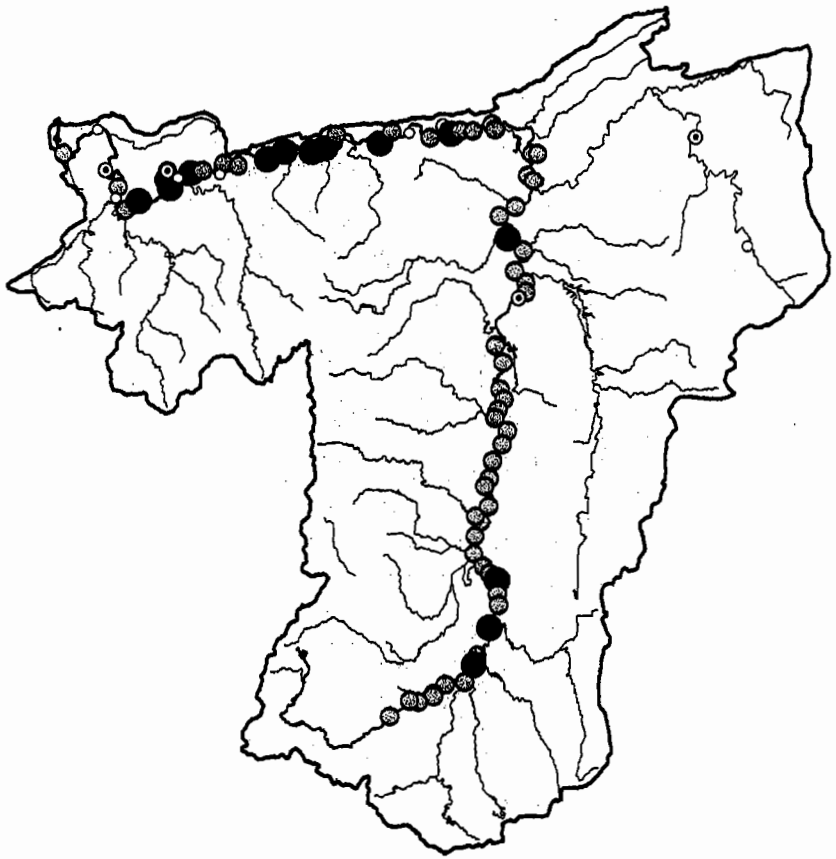
Average IBI
1983 - 2000

- 0
- 0 - 34
- 34 - 44
- 44 - 56

(On a scale of 0 to 60, with 60 indicating the highest quality)

N

0 5 10 Miles

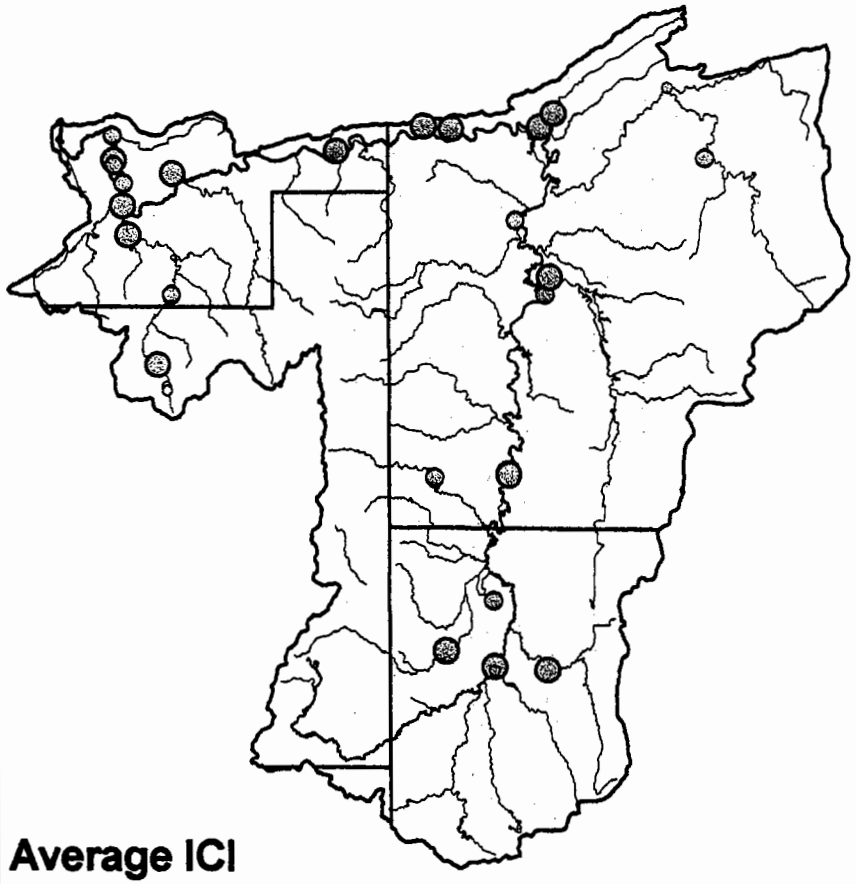


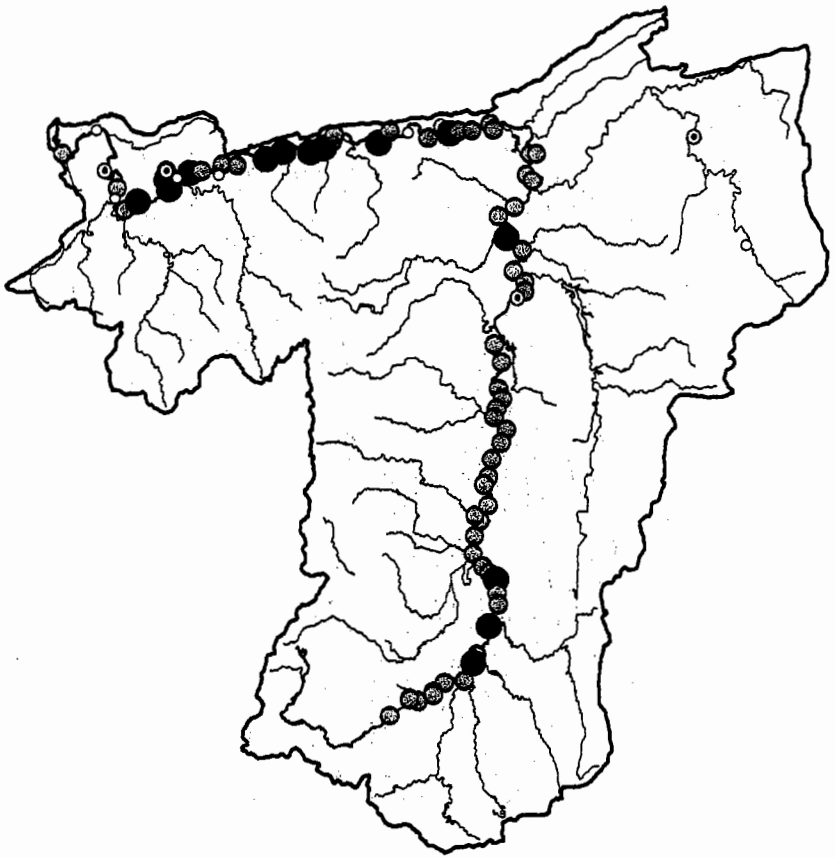
Mussel Species Richness
1980 - 2002 (live/fresh dead only)

- 0 species
- 1 - 5 species
- 6 - 11 species
- 12 - 17 species

Invertebrate Community Index (ICI)

Grand River Watershed





Average ICI
1979 - 2000

- 12 - 24
- 24 - 42
- 42 - 56

(On a scale of 0 to 60, with 60 indicating the highest quality)

N

0 5 10 Miles

Mussel Species Richness
1980 - 2002 (live/fresh dead only)

- 0 species
- 1 - 5 species
- 6 - 11 species
- 12 - 17 species