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THE EFFECTS OF SEDIMENTATION ON AQUATIC LIFE OF THE KANKAKEE RIVER

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Quantitative Studies and Threatened, Endangered, and Rare Species

by

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Illinois Natural History Survey

Project No. 20.118

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NOTE

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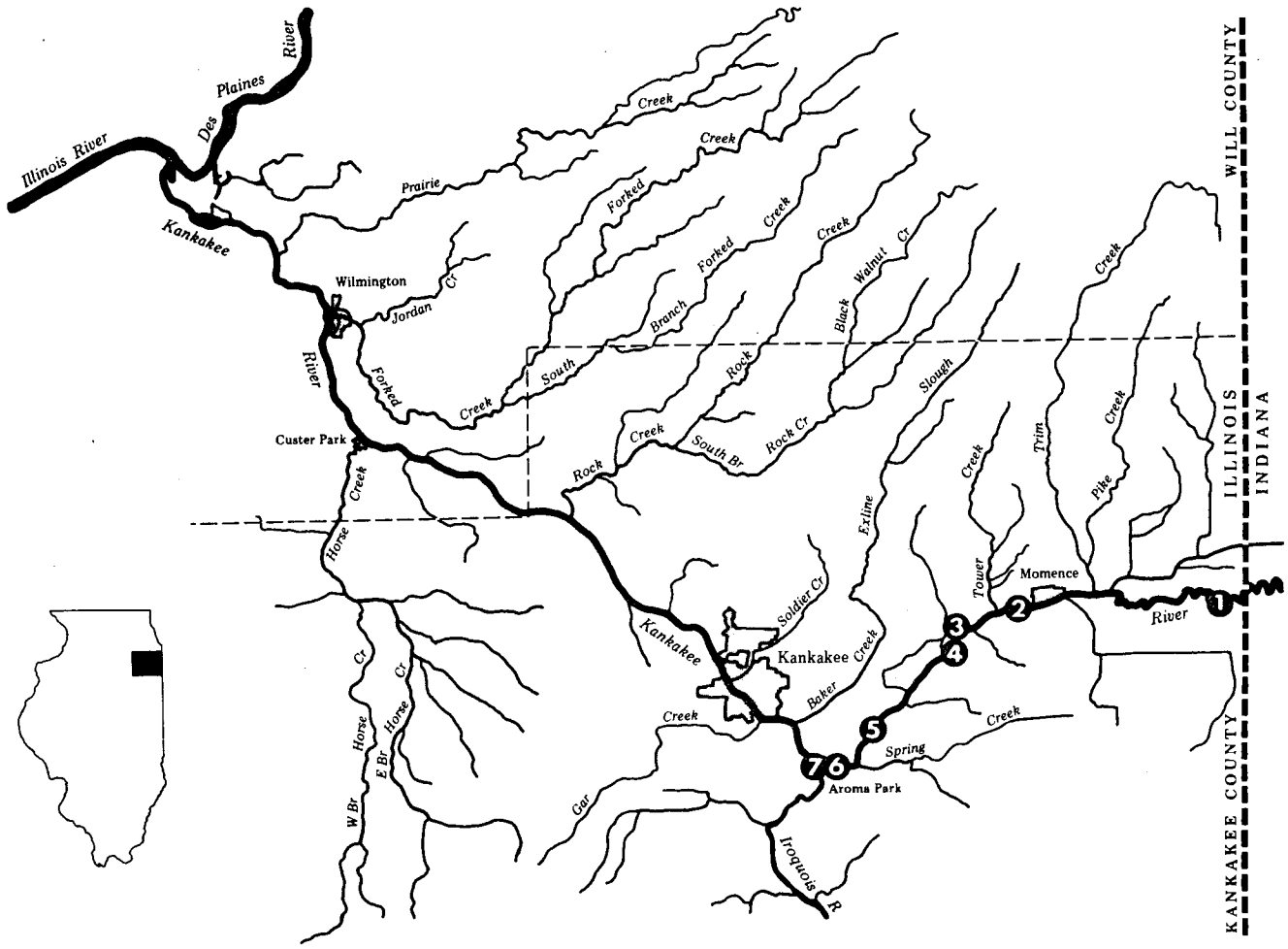

Figure 1. The Kankakee River in Illinois, showing the locations of the 1979 sampling stations.

THE EFFECTS OF SEDIMENTATION ON AQUATIC LIFE OF THE KANKAKEE RIVER. PHASE II: Quantitative Studies and Threatened, Endangered, and Rare Species.

Allison R. Brigham, Liane B. Suloway, and Lawrence M. Page

During early settlement the Kankakee Basin was a vast wet prairie called the Grand Marsh. In the early 1900's, portions of the river in Indiana, where most of the basin lies, were channelized to increase flow and thereby further facilitate drainage of the land. The result was a fast-flowing drainage ditch in Indiana that slowed when it reached the Illinois border. Concern exists among Illinois citizens that sediments, especially sand, washed into the Kankakee River in Indiana are deposited as they reach the slower-moving Illinois portion of the river and that these deposits have detrimental effects, including a reduction in diversity and abundance of aquatic life. Sedimentation adversely affects the aquatic life of a stream through loss of habitat, direct mortality, injury, and growth suppression. The degree of damage is positively correlated with the amount of sediment deposited in the river.

BACKGROUND

The objectives of the Illinois Natural History Survey Phase I study of the Kankakee River were (1) to determine the present diversity and distribution of fishes, mussels, midges, caddisflies, and water beetles in the Kankakee River and (2) to relate the diversity and distribution of these organisms to the distribution of substrates in the Kankakee River. Samples were collected and analyzed from 13 sites along the river from the Illinois-Indiana border to its confluence with the Des Plaines River. Special attention was given to determining if any long-term faunal changes had occurred and, if so, were they attributable to sedimentation, in particular, or a reflection of a general decline, as from urbanization or agricultural nonpoint pollution. Results of this 1978 inventory of the Kankakee River were reported in Page, *et al.*, *The Effects of Sedimentation on Aquatic Life of the Kankakee River, Phase I*, and are summarized below.

Seventy-eight species of fishes were collected in the Kankakee River in 1978. In addition to these, only nine other species have ever been collected in the river, all since 1950. Presumably, all 87 species of fishes known from the river in historical times still occur there. Because of habitat preferences, some fishes were found only upstream in sand habitats and others only downstream where rock habitats predominate. Even so, no up- or downstream trends in numbers of species were found, nor was there a sharp contrast in diversity between the upstream stations where sand predominated and the downstream stations where rock predominated. The large expanse of sand in the Kankakee River between Momence and Indiana was not correlated with a low diversity of fishes. In fact, presumably because of better collecting methods, the diversity of fishes found in 1978 was higher throughout the river than it was found to be in prior surveys. Based upon present diversity and historical comparisons, a detrimental effect of large deposits of sand upstream was not demonstrated.

The sand-associated fish fauna in the upper Kankakee River is among the most unusual in Illinois. Populations in the upper Kankakee system are widely separated from the nearest populations of the same species and obviously have been in the upper Kankakee system a long time. These fishes have not invaded the area recently and replaced other fishes.

Several specimens of *Notropis amnis*, the pallid shiner, were found in 1978 in the Kankakee River at Custer Park. This species was thought to be extirpated from Illinois, but is now being considered for the Illinois list of threatened and endangered species because of its presence in the Kankakee River.

The mussels of the Kankakee River have been studied intermittently for over 100 years and 37 species have been reported to occur in the river. In 1978, only 20 species were found. Six species reported in 1906 were not collected in 1978. In fact, 12 of the 16 were last recorded in 1909, indicating that the mussel fauna of the Kankakee River has undergone a drastic reduction in the 1900's. *Lampsilis orbiculata*, one of the nine species not present after 1909, is listed as a federally endangered species. Another, *Cumberlandia monodonta*, is considered to be endangered in the United States.

In 1978, fewer species of mussels were present at each site than were present at the same or nearby sites in 1909, 1953-1955, or 1960. In both upstream and downstream sites, the river has experienced decreases in the number of species. The general decline in the mussel fauna of the Kankakee River over the past 100 years is dramatic, but similar to that documented for other Illinois rivers, including the Illinois, Kaskaskia, Rock, and Vermilion Rivers. Pollution, overharvesting, and habitat destruction, including that caused by sedimentation, probably all have contributed to decreases in mussel populations in Illinois streams, but there is no evidence that sand deposits in the upper Kankakee River have resulted in more drastic reductions than have occurred elsewhere in Illinois. In the Kankakee River, small populations of mussels were observed at sites with sand substrates (between Momence and Indiana) in 1909, indicating that these sites have not been suitable for large mussel populations at least since the early 1900's.

Twenty-seven species of midge flies, 62 species of caddisflies, and 64 species of water beetles were collected in 1978 in the Kankakee River. Ten more species of caddisflies were previously recorded for the river and 52 more species of water beetles are considered likely to occur in the river, giving totals of 72 caddisflies and 116 water beetles.

Five species of midges were common and occurred at seven or more stations. The other 22 species were uncom-

mon and scattered in distribution. Because of the loose, shifting sand and the resulting lack of cover in the river between Momence and Indiana, fewer midge larvae were collected there. If sand accumulates and covers more of the bottom of the Kankakee River, it is expected that a significant decrease in the abundance and diversity of midge larvae will occur. Midge larvae form an important part of the aquatic food chain and decreases in their numbers can have a detrimental effect upon organisms in higher trophic levels, particularly many species of insectivorous fishes.

Among collections of caddisflies, the largest numbers of species were found at upstream sites (Aroma Park and upstream) and the largest numbers of individuals were observed at midstream sites (between Kankakee and Custer Park). The predominance of sand between Momence and Indiana was not correlated with a low diversity or especially small populations of caddisflies. Caddisfly diversity in the Kankakee River appears to have changed since studies in the 1940's, but does not appear to be related to sand deposition. The Kankakee River caddisfly fauna remains among the most diverse and unusual in Illinois.

Prior to the 1978 inventory, 97 species of water beetles were known or likely to occur in the Illinois portion of the Kankakee River basin. The 1978 inventory found 64 species. Of these, five were known previously from the river and 35 were considered likely to occur there. Nineteen species collected in 1978 were known from Illinois, but had not been reported from the Kankakee River basin. The remaining five species collected in 1978 represented new records for Illinois. Two of these species were new to science. The total water beetle fauna known or likely to occur in the Kankakee River basin now stands at 116 species, nearly one-third more species than any comparable watershed in Illinois investigated to date.

One group of water beetles showed a sequential replacement downstream of species characteristic of depositing substrates with species characteristic of eroding substrates. Superimposed upon this trend were rare species which occurred exclusively or characteristically at a single site, more widely distributed species, and ubiquitous ones.

It is apparent that environmental factors other than sedimentation are influencing water beetle distribution in the Kankakee River. Within the total water beetle fauna, however, exists a component whose distribution does appear to be correlated with sediment. For example, the riffle beetle *Ancyronyx variegatus* was taken only from sites having a predominantly sand substrate. An investigation of the distribution of this component of the total water beetle fauna, both in the Illinois and Indiana portions of the river, would be necessary to define clearly the impacts of sedimentation upon this group of aquatic organisms.

If sand moves downstream in the Kankakee River and covers existing gravel, rubble, and bedrock, populations of many species using those habitats will be reduced; this is obviously undesirable. Likewise, if flooding increases as a result of activities in Indiana, habitats will be altered and will affect aquatic organisms detrimentally. Although no biological damage from sand deposition or other effects of stream alteration were observed in the Phase I study, the potential for damage is apparent.

PHASE II OBJECTIVES

Research proposed for the Phase II biological component study was designed (1) to assess the impact in Illinois of upstream activities which might increase sedimentation or sediment transport into the Illinois portion of the Kankakee River, especially upstream of the city of Kankakee, by providing quantitative estimates of principal macroinvertebrate populations and fishes associated with known substrate types; and (2) to combine this quantitative sampling with additional qualitative sampling in the Illinois portions of the river to assess the status of species officially classified as threatened or endangered by either state or federal agencies, or species considered rare, unique, or whose status is uncertain.

Increased sediment transport has been identified as the most serious water pollution problem in Illinois. Soil erosion from nonpoint agricultural sources probably ranks as the primary source, but erosion from such stream "improvements" as channelization, snag removal, and bank clearing may also have sizeable local impacts upon receiving streams.

Although the large expanses of sand in the river between Momence and the Indiana border have existed for thousands of years and even though the sand-associated communities have developed together, there is concern that the sand may move farther downstream, covering bedrock, boulder, rubble, and gravel substrates. If this were to occur as a result of increased sedimentation, sizeable populations of native species would be extirpated from these areas.

The Phase II study was designed to characterize the principal macroinvertebrate and fish communities in the Kankakee River upstream of the city of Kankakee by providing quantitative estimates of populations occurring in the long reaches of sand, rock, and, especially, the transition area between the two bedrock areas (downstream of Momence and upstream of Aroma Park) (Fig. 1). These quantitative data from the long reaches of sand and bedrock provide reliable estimates of community structure and standing crop characteristic of these substrates in the river. Quantitative sampling in the transition area where substrate changes occur several times per mile allow an assessment of the potential impact of moving sand upon the larger-particle substrates. These quantitative biological data, combined with physical and geological data, provide realistic quantitative estimates of the potential impact of increased sediment transport upon biological communities in the Kankakee River in Illinois.

The status of species officially classified as threatened or endangered by either state or federal agencies, or species whose status is uncertain were assessed by additional qualitative sampling. Although Illinois does not presently have an official list of threatened or endangered mussels, there is an understanding of the uniqueness of these popula-

tions which should be protected. For example, of 37 species of mussels reported from the Kankakee River in Illinois since 1906, nine of them are recognized as threatened or endangered in Indiana and three are either federally endangered, proposed federally threatened, or recognized as rare throughout their ranges in the United States.

STUDY AREA

Emphasis in Phase II was upon quantitative biological sampling in the Kankakee River upstream of the city of Kankakee. Additional sampling was done as necessary throughout the Illinois portion of the river to assess the status of threatened, endangered, or rare species.

Seven river sites were selected to represent three general substrate types: (1) sand of indeterminate depth (upstream of Momence and between Aroma Park and the city of Kankakee, stations 1 and 7, respectively); (2) rock (the vicinity of Momence and upstream of Aroma Park, stations 2 and 6, respectively); and (3) a transition or ecotone area (rock and shallow to deep sand areas in rapid succession rather than in long expanses, stations 3, 4, 5) (Table 1).

Table 1. Estimated substrate composition (%) at sampling stations in the Kankakee River.

Substrate Type	Station 1	2	3	4	5	6	7
Silt	20	.....	10	30	10	10	.....
Debris	10	.....	.....	.....	.....	.....	.....
Sand	70	20	10	40	20	20	100
Gravel	.....	60	30	10	50	40	.....
Cobble	.....	20	40	20	10	20	.....
Bedrock	.....	.....	10	.....	10	10	.....

These sites, illustrated in Figure 1, were located as follows:

1. 1.0 mi SE Illiana Heights
   T31N, R15E, NW/4, NE/4, SE/4, NE/4, Sec. 19

2. 0.8 mi WSW Momence
   T31N, R13E, NW/4, NE/4, SW/4, NW/4, Sec. 24

3. 3.6 mi SW Momence
   T31N, R13E, NE/4, SW/4, SE/4, NE/4, Sec. 28

4. 4.4 mi SW Momence
   T31N, R13E, SW/4, NW/4, NW/4, Sec. 33

5. 2.4 mi NE Aroma Park
   T30N, R13W, NE/4, NE/4, SE/4, NE/4, Sec. 12

6. 0.3 mi SE Aroma Park
   T30N, R13W, SE/4, NE/4, NW/4, Sec. 23

7. 0.6 mi WSW Aroma Park
   T30N, R13W, N/2, NW/4, NE/4, Sec. 22.

METHODS

Fishes were sampled by minnow seining and electrofishing at each of the seven stations in the Kankakee River. Minnow seining was done on 12-14 October 1979 and electrofishing on 28-29 November 1979. Each station was seined for 30 minutes; the area sampled varied from 180 to 250 m^2. Each station was electrofished for 15 minutes over an area of approximately 1000 m^2.

Minnow-seine collections were preserved in the field in 10 percent formalin and returned to the laboratory to be identified, enumerated, and weighed. Electrofishing samples were identified, counted, and weighed as captured, and returned to the river alive.

Samples obtained by the two methods were pooled and results tabulated as (1) numbers of individuals collected per 100 m^2, (2) grams collected per 100 m^2, (3) number of individuals collected per 0.5 hour, and (4) grams collected per 0.5 hour.

Mussels were quantitatively sampled at each of the seven stations by handpicking 10, 1-m^2 quadrats. A 1-m^2 frame constructed from a concrete reinforcing rod was randomly placed at a site in water up to 1 m deep and searched to a depth of 15 cm. Stations 1 and 7 were also sampled using a boat and 1.5-m brail. Specimens were identified in the field and returned to the river. Samples were collected on 19, 23, and 24 October 1979. Results are expressed as number of individuals per 10 m^2.

Benthic macroinvertebrates were sampled quantitatively at each station along a transect or transects extending from bank to bank. A PONAR grab sampler with an effective sampling area of 0.023 m^2 was used to sample four or five transects at each site having a predominantly sand substrate (stations 1 and 7). Twenty samples were collected at each of these sites. PONAR grab samples were washed in the field using a bucket fitted with a No. 30 mesh screen bottom to reduce the volume before preservation in 15 percent formalin. A Surber swift-water net with an effective sampling area of 0.093 m^2 was used at sites having coarse substrates (stations 2 through 6). Ten Surber samples were taken at each of these sites. Surber samples were preserved in the field with 95 percent ethanol. A total of 90 quantitative samples was collected between mid-October and mid-November 1979. In addition, qualitative samples were taken from each site to obtain representatives of species not easily taken by quantitative sampling techniques. Species collected only in qualitative samples are indicated in summary tables by a plus (+). Results are expressed by station as mean numbers of individuals per m^2.

Fish, mussel, and benthic macroinvertebrate data were examined for patterns of similarity among the the various sampling sites. The method, summarized in Page, *et al.*, *The Effects of Sedimentation on Aquatic Life of the*

Kankakee River, Phase I, could not be used for mussels as the densities were too low. However, clusters were obtained for fishes and macroinvertebrates.

FISHES

Forty-four species of fishes were collected (Table 2). Sites where sand or sand-silt substrates predominated supported fewer species (mean of 12 per station), fewer individuals (approximately 38 per 100 m^2), and lower biomass (approximately 460 g per 100 m^2) than sites where coarser substrates occurred (mean of 21 species per station, 135 individuals per 100 m^2, and approximately 3850 g per 100 m^2). The transition area supported about the same number of species (mean of 20 per station) and biomass (approximately 3250 g per 100 m^2) as sites where coarser substrates predominated, but there were fewer individuals (approximately 64 per 100 m^2) (Tables 2 through 6).

The sites sampled in the Kankakee River clustered into three general categories based upon the species composition and relative abundance (as number per ha): (1) sites at which sand constitutes only 10 to 20 percent of the substrate (stations 2, 3, 5, and 6); (2) sites where sand predominates (stations 1 and 7); and (3) a single site where sand and silt predominate (station 4) (Fig. 2).

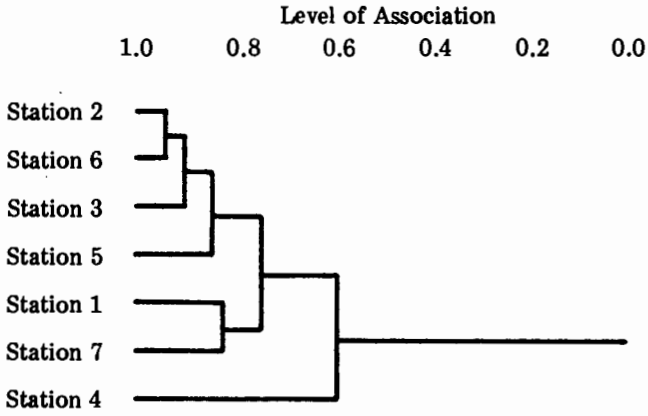

Figure 2. Dendrogram illustrating the results of a cluster analysis for fishes in the Kankakee River.

In the Kankakee River, the conversion of areas where coarse substrates predominate to areas chiefly composed of sand will reduce the number of fish species present by about 30 percent, reduce the number of individuals by approximately 70 percent, and reduce biomass by about 85 percent (Tables 2 through 6).

Fishes present in the upper Kankakee River and dependent upon rock substrates include *Campostoma anomalum* (stoneroller), *Nocomis biguttatus* (hornyhead chub), *Notropis chrysocephalus* (striped shiner), *Notropis rubellus* (rosyface shiner), *Phenacobius mirabilis* (suckermouth minnow), *Moxostoma carinatum* (river redhorse), *Etheostoma caeruleum* (rainbow darter), *Etheostoma flabellare* (fantail darter), and *Percina phoxocephala* (slenderhead darter). These species will be eliminated from any area of the river now occupied if that area is covered with sand. Many other fishes in the upper Kankakee River prefer rock substrates although they are not restricted to it, and will be adversely affected by a transition to sand substrates. These include *Notropis spilopterus* (spotfin shiner), *Pimephales notatus* (bluntnose minnow), *Carpiodes cyprinus* (quillback), *Hypentelium nigricans* (northern hogsucker), *Moxostoma anisurum* (silver redhorse), *Moxostoma erythrurum* (golden redhorse), *Moxostoma macrolepidotum* (shorthead redhorse), *Noturus flavus* (stonecat), *Micropterus dolomieui* (smallmouth bass), *Percina caprodes* (logperch), and *Stizostedion vitreum* (walleye).

Endangered, Threatened, and Rare Fishes

Efforts were made throughout the Illinois portion of t

Table 2. Number of fishes collected per 100 m^2 in the Kankak River in 1979.

Species	Station 1	2	3	4	5	6
Esox americanus	.....	.....	0.5	0.6	0.5	.....
E. lucius	.....	0.2	.....	0.4	1.5	0.4
Campostoma anomalum	.....	.....	.....	.....	.....	0.4
Cyprinus carpio	.....	.....	.....	0.2	0.8	.....
Nocomis biguttatus	.....	1.0	1.0	.....	.....	2.0
Notemigonus crysoleucas	2.0	.....	0.5	.....	.....	.....
Notropis atherinoides	.....	.....	.....	.....	.....	.....
N. chalybaeus	.....	.....	1.0	.....	.....	.....
N. chrysocephalus	.....	27.6	3.5	0.8	1.1	5.6
N. rubellus	.....	0.4	.....	.....	.....	.....
N. spilopterus	12.0	6.8	1.5	.....	13.9	87.2
N. stramineus	3.5	22.5	0.5	.....	.....	7.2
N. umbratilis	.....	1.5	.....	.....	.....	0.4
Pimephales notatus	8.0	17.2	39.0	4.8	28.9	53.2
P. vigilax	.....	.....	.....	.....	.....	.....
Carpiodes cyprinus	.....	1.4	0.6	0.6	6.6	.....
Catostomus commersoni	.....	0.4	.....	.....	.....	0.6
Hypentelium nigricans	.....	.....	0.5	.....	0.2	0.6
Ictiobus cyprinellus	.....	.....	.....	0.2	.....	.....
Minytrema melanops	.....	.....	.....	.....	0.5	.....
Moxostoma erythrurum	.....	.....	1.0	.....	.....	.....
M. macrolepidotum	0.5	2.4	1.6	.....	1.0	3.8
Noturus flavus	.....	0.4	.....	.....	.....	1.2
N. gyrinus	.....	.....	.....	.....	.....	0.4
Aphredoderus sayanus	.....	.....	.....	0.4	.....	.....
Fundulus dispar	.....	.....	.....	4.8	0.5	.....
F. notatus	.....	0.4	3.5	.....	2.2	1.2
Labidesthes sicculus	.....	.....	.....	.....	0.5	2.0
Ambloplites rupestris	1.5	2.8	3.4	0.4	1.1	1.0
Lepomis cyanellus	.....	.....	0.5	.....	1.7	0.4
L. gibbosus	.....	.....	.....	.....	2.8	.....
L. humilis	.....	.....	.....	.....	0.5	.....
L. macrochirus	0.5	0.4	.....	.....	3.3	2.4
L. megalotis	.....	.....	3.5	0.4	0.5	0.4
Micropterus dolomieui	.....	.....	0.5	.....	0.2	.....
M. salmoides	1.0	0.8	0.5	0.4	0.5	0.4
Pomoxis annularis	.....	.....	.....	.....	.....	.....
Etheostoma caeruleum	.....	.....	.....	0.8	2.2	.....
E. flabellare	.....	.....	.....	0.8	.....	.....
E. microperca	.....	0.4	.....	.....	0.5	.....
E. nigrum	2.0	3.6	14.0	14.4	4.5	.....
E. zonale	.....	5.0	0.5	4.0	4.5	6.0
Percina caprodes	.....	.....	.....	.....	.....	0.4
P. maculata	0.5	.....	1.0	.....	.....	0.4

Table 3. Number of fishes collected per 0.5 hour in the Kankakee River in 1979.

Species	Station 1	2	3	4	5	6	7
Esox americanus	....	....	1	3	1	....	....
E. lucius	....	2	....	1	6	4	2
Campostoma anomalum	....	....	....	....	....	1	....
Cyprinus carpio	....	....	....	2	8	....	4
Nocomis biguttatus	....	2	2	....	....	5	....
Notemigonus crysoleucas	4	....	1	....	....	....	....
Notropis atherinoides	....	....	....	....	....	....	2
N. chalybaeus	....	....	2	....	....	....	....
N. chrysocephalus	....	69	7	2	2	14	....
N. rubellus	....	1	....	....	....	....	1
N. spilopterus	24	17	3	....	25	218	64
N. stramineus	7	45	1	....	....	18	7
N. umbratilis	....	3	....	....	....	1	....
Pimephales notatus	16	43	78	12	52	13	13
P. vigilax	....	....	....	....	....	....	5
Carpiodes cyprinus	....	14	6	6	66	....	6
Catostomus commersoni	....	4	....	....	....	6	....
Hypentelium nigricans	....	....	1	....	2	6	....
Ictiobus cyprinellus	....	....	....	2	....	....	....
Minytrema melanops	....	....	....	....	1	....	1
Moxostoma erythrurum	....	....	2	....	....	....	....
M. macrolepidotum	1	21	16	....	10	35	....
Noturus flavus	....	1	....	....	....	3	....
N. gyrinus	....	....	....	....	....	1	....
Aphredoderus sayanus	....	....	....	1	....	....	....
Fundulus dispar	....	....	....	....	1	....	....
F. notatus	....	1	7	12	4	3	....
Labidesthes sicculus	....	....	....	....	1	5	....
Ambloplites rupestris	3	7	10	1	2	4	....
Lepomis cyanellus	....	....	1	....	3	1	....
L. gibbosus	....	....	....	....	5	....	....
L. humilis	....	....	....	....	1	....	6
L. macrochirus	1	1	....	....	6	6	....
L. megalotis	....	....	7	1	1	1	....
Micropterus dolomieui	....	....	1	....	2	....	....
M. salmoides	2	2	1	1	1	1	....
Pomoxis annularis	....	....	....	....	....	....	12
Etheostoma caeruleum	....	....	....	2	4	....	....
E. flabellare	....	....	....	2	....	....	....
E. microperca	....	1	2	....	1	....	....
E. nigrum	4	9	28	36	8	....	2
E. zonale	....	10	1	10	8	15	....
Percina caprodes	....	....	....	....	....	1	....
P. maculata	1	....	....	....	....	1	3

Kankakee River in 1978 and 1979 to locate additional populations of endangered, threatened, and rare fishes. Habitats considered to be most promising were sampled.

Pallid Shiner. *Notropis amnis*, the pallid shiner, occurs in the upper Mississippi River system, eastern Oklahoma, western Arkansas, and eastern Texas. The pallid shiner was thought to be extirpated in Illinois until 1978 when populations were discovered in the Mississippi River in Carroll County and in the Kankakee River at Custer Park in Will County. Re-examination of museum specimens identified as *Notropis heterolepis* revealed a previously misidentified series of *Notropis amnis* collected in the Kankakee River at the Will-Kankakee County line in 1963. Custer Park and the Will-Kankakee County line are the only localities in the Kankakee River where pallid shiners have been found.

The pallid shiner lives among emergent stands of vegetation along gravel bars in large, clear, clean rivers. Pflieger (1975) noted that it had disappeared from Missouri since 1941 and suggested that increased siltation and changing land-use patterns were responsible. Hine, *et al.* (1973) declared it a species of changing status in Wisconsin. In east Texas, the pallid shiner is less severely decimated than elsewhere, but appears to be uncommon and sporadically distributed.

The pallid shiner has not been listed officially as either endangered or threatened in Illinois because it was believed extirpated. It is now being considered for legal protection as an endangered species. The population remaining in the Kankakee River persists because of high water quality and clear, rocky habitats. Increased sand deposition and turbidity in the Kankakee River would be detrimental.

Blacknose Shiner. *Notropis heterolepis*, the blacknose shiner, is a northern minnow that ranges from Saskatchewan to Nova Scotia, and persists in disjunct relict populations as far south as Illinois, Indiana, Missouri, and Ohio. The species formerly occurred in Kansas (Cross 1967) and was much more widespread in Illinois (Smith 1979), Missouri (Pflieger 1975), and Ohio (Trautman 1957).

The only extant Illinois populations of the blacknose shiner are in glacial lakes and tributaries of the Fox River in

Table 4. Biomass (g) of fishes collected per 100 m^2 in the Kankakee River in 1979.

Species	Station 1	2	3	4	5	6	7
Esox americanus	.....	.....	9.8	20.6	6.3	.....	.....
E. lucius	.....	35.0	.....	36.6	164.3	2498.0	97.0
Campostoma anomalum	.....	.....	.....	.....	.....	1.3	.....
Cyprinus carpio	.....	.....	.....	682.0	1390.0	.....	324.0
Nocomis biguttatus	.....	0.8	0.6	.....	.....	1.4	.....
Notemigonus crysoleucas	1.1	.....	2.6	.....	.....	.....	.....
Notropis atherinoides	.....	.....	.....	.....	.....	.....	0.2
N. chalybaeus	.....	.....	0.2	.....	.....	.....	.....
N. chrysocephalus	.....	14.2	1.5	0.6	0.3	3.6	.....
N. rubellus	.....	0.6	.....	.....	.....	.....	0.1
N. spilopterus	2.1	4.4	0.7	.....	2.7	20.6	4.9
N. stramineus	0.6	13.9	0.7	.....	.....	2.4	0.4
N. umbratilis	.....	0.1	.....	.....	.....	0.1	.....
Pimephales notatus	1.4	9.2	7.9	1.5	28.9	1.2	0.8
P. vigilax	.....	.....	.....	.....	.....	.....	0.5
Carpiodes cyprinus	.....	1039.0	444.0	408.0	4355.0	.....	398.0
Catostomus commersoni	.....	168.0	.....	.....	.....	261.0	.....
Hypentelium nigricans	.....	.....	2.0	.....	99.0	460.0	.....
Ictiobus cyprinellus	.....	.....	.....	427.0	.....	.....	.....
Minytrema melanops	.....	.....	.....	.....	3.1	.....	0.7
Moxostoma erythrurum	.....	.....	39.3	.....	.....	.....	.....
M. macrolepidotum	1.6	1084.4	791.0	.....	539.0	1770.2	.....
Noturus flavus	.....	0.6	.....	.....	.....	1.7	.....
N. gyrinus	.....	.....	.....	.....	.....	0.3	.....
Aphredoderus sayanus	.....	.....	.....	1.8	.....	.....	.....
Fundulus dispar	.....	.....	.....	.....	0.1	.....	.....
F. notatus	.....	0.7	1.7	2.5	0.7	0.6	.....
Labidesthes sicculus	.....	.....	.....	.....	0.6	1.6	.....
Ambloplites rupestris	1.7	116.7	126.1	0.3	4.6	142.0	.....
Lepomis cyanellus	.....	.....	0.5	.....	45.4	9.3	.....
L. gibbosus	.....	.....	.....	.....	1.1	.....	.....
L. humilis	.....	.....	.....	.....	0.2	.....	12.0
L. macrochirus	0.4	0.1	.....	.....	1.6	1.2	.....
L. megalotis	.....	.....	4.9	5.8	0.5	0.5	.....
Micropterus dolomieui	.....	.....	24.0	.....	1.4	.....	.....
M. salmoides	5.0	4.0	1.4	1.4	1.8	4.1	.....
Pomoxis annularis	.....	.....	.....	.....	.....	.....	57.6
Etheostoma caeruleum	.....	.....	.....	0.6	3.6	.....	.....
E. flabellare	.....	.....	.....	0.8	.....	.....	.....
E. microperca	.....	0.1	.....	.....	0.1	.....	.....
E. nigrum	1.9	3.0	8.9	9.5	3.5	.....	0.8
E. zonale	.....	4.0	0.1	2.8	2.2	7.2	.....
Percina caprodes	.....	.....	.....	.....	.....	9.4	.....
P. maculata	1.0	.....	1.8	.....	.....	1.0	4.5

Table 5. Biomass (g) of fishes collected per 0.5 hour in the Kankakee River in 1979.

Species	Station 1	2	3	4	5	6	7
Esox americanus	.....	.....	20.4	171.6	11.4	.....	.....
E. lucius	.....	350.0	.....	91.6	1181.4	2498.0	970.0
Campostoma anomalum	.....	.....	.....	.....	.....	3.2	.....
Cyprinus carpio	.....	.....	.....	6818.2	13900.0	.....	3240.0
Nocomis biguttatus	.....	1.9	1.2	.....	.....	3.6	.....
Notemigonus crysoleucas	2.1	.....	5.1	.....	.....	.....	.....
Notropis atherinoides	.....	.....	.....	.....	.....	.....	0.4
N. chalybaeus	.....	.....	0.4	.....	.....	.....	.....
N. chrysocephalus	.....	35.5	3.0	1.5	0.6	8.9	.....
N. rubellus	.....	1.4	.....	.....	.....	.....	0.2
N. spilopterus	4.2	11.0	1.4	.....	4.9	51.4	11.8
N. stramineus	1.1	34.8	1.4	.....	.....	6.0	0.9
N. umbratilis	.....	0.3	.....	.....	.....	0.2	.....
Pimephales notatus	2.8	23.0	15.8	3.7	8.9	3.0	1.9
P. vigilax	.....	.....	.....	.....	.....	.....	1.2
Carpiodes cyprinus	.....	10390.0	444.0	408.0	43550.0	.....	3980.0
Catostomus commersoni	.....	1680.0	.....	.....	.....	2610.0	.....
Hypentelium nigricans	.....	.....	3.9	.....	990.0	4600.0	.....
Ictiobus cyprinellus	.....	.....	.....	4270.0	.....	.....	.....
Minytrema melanops	.....	.....	.....	.....	5.5	.....	1.6
Moxostoma erythrurum	.....	.....	78.6	.....	.....	.....	.....
M. macrolepidotum	3.1	10830.0	7910.0	.....	5390.0	17693.1	.....
Noturus flavus	.....	1.4	.....	.....	.....	4.3	.....
N. gyrinus	.....	.....	.....	.....	.....	0.7	.....
Aphredoderus sayanus	.....	.....	.....	4.4	.....	.....	.....
Fundulus dispar	.....	.....	.....	.....	0.1	.....	.....
F. notatus	.....	0.4	3.3	6.3	1.3	1.5	.....
Labidesthes sicculus	.....	.....	.....	.....	0.1	4.1	.....
Ambloplites rupestris	3.3	291.8	404.1	0.8	8.2	722.6	.....
Lepomis cyanellus	.....	.....	1.0	.....	81.5	23.3	.....
L. gibbosus	.....	.....	.....	.....	1.9	.....	.....
L. humilis	.....	.....	.....	.....	0.3	.....	61.2
L. macrochirus	0.8	0.3	.....	.....	2.9	3.0	.....
L. megalotis	.....	.....	9.8	14.5	0.8	1.2	.....
Micropterus dolomieui	.....	.....	48.0	.....	14.0	.....	.....
M. salmoides	9.9	10.1	2.7	3.4	3.2	10.3	.....
Pomoxis annularis	.....	.....	.....	.....	.....	.....	576.0
Etheostoma caeruleum	.....	.....	.....	1.5	6.5	.....	.....
E. flabellare	.....	.....	.....	1.9	.....	.....	.....
E. microperca	.....	0.2	.....	.....	0.2	.....	.....
E. nigrum	3.8	7.5	17.7	23.7	6.3	.....	1.8
E. zonale	.....	10.1	0.2	7.0	3.9	17.9	.....
Percina caprodes	.....	.....	.....	.....	.....	23.6	.....
P. maculata	2.0	.....	3.6	.....	.....	2.5	10.7

Table 6. Summary of collections of fishes in the Kankakee River in 1979.

Total	Station 1	2	3	4	5	6	7
Number of Species	10	19	21	16	25	23	14
Individuals per 100 m^2	31.5	95.2	78.6	34.0	80.5	177.6	44.1
Individuals per 0.5 hour	63	253	178	94	221	363	128
Biomass per 100 m^2	16.8	2498.8	1469.7	1601.8	6655.9	5198.7	901.5
Biomass per 0.5 hour	33.1	23679.7	8975.6	11828.1	65173.9	28292.4	8857.7

Lake and McHenry Counties; in the Green River system in Bureau County; in the Kankakee River system in Iroquois, Kankakee, and Will Counties; and in the Rock River system in Boone, McHenry, and Whiteside Counties. At the turn of the century, Forbes and Richardson (1908) found the blacknose shiner distributed throughout the northern two-thirds of the state and in Clear Creek in Union County.

The blacknose shiner lives in clear, vegetated lakes and in vegetated pools of clear streams. Increased turbidity and the disappearance of aquatic vegetation have probably been the major factors causing the decline of the blacknose shiner (Trautman 1957, Pflieger 1975, Smith 1979). Its decline in Illinois has been among the most dramatic of any Illinois fish.

The blacknose shiner is restricted primarily to tributaries in the Illinois portion of the Kankakee River and the species is seldom found in the river mainstream. It does well in, and in fact prefers, sand substrate. Consequently, increased sand deposition would probably not have a significant detrimental effect upon the blacknose shiner, although the total consequences of habitat and trophic alterations in the river as a result of increased sand deposition are unknown. The alterations may affect all populations to at least a small degree; even a small change could be serious for a species already suffering a decline.

Northern Brook Lamprey. *Ichthyomyzon fossor*, the northern brook lamprey, was found in the Kankakee River in Kankakee County in the early 1960's, and has since been found at two additional sites in the river (Smith 1979). Northeastern Illinois, northern Indiana, and the northern half of Ohio are on the southern periphery of its range, and distribution of this lamprey is sporadic. In Illinois, it is restricted to the Kankakee River.

Ironcolor Shiner. *Notropis chalybaeus*, the ironcolor shiner, is restricted to the sand-bottom creeks in Iroquois and Kankakee Counties, where it is common, and Mason and Tazewell Counties, where it is uncommon and sporadic in occurrence. It once was found in the Des Plaines River in Cook County. It is also relictual in Indiana (Gerking 1945) and Missouri (Pflieger 1975), but is generally distributed and apparently common in most of the southern states.

Weed Shiner. All but two of the known Illinois records for *Notropis texanus*, the weed shiner, are from the sand areas of Iroquois and Kankakee Counties, where it is a common creek fish. While never abundant in Illinois, it was formerly more widely distributed in the northern and central parts of the state. It has extremely restricted distributions in Indiana (Gerking 1945) and Missouri (Pflieger 1975), but is widely distributed in the southern states. It is regarded as a species of changing status in Wisconsin (Hine, *et al.*, 1973).

River Redhorse. *Moxostoma carinatum*, the river redhorse, is known in Illinois from the Fox, Kankakee, and Vermilion of the Wabash River systems. The largest population appears to be in the Kankakee. There are too few early records to make inferences about its former distribution and abundance. It is rare in Indiana (Gerking 1945) and is classified as a species of changing status in Wisconsin (Hine, *et al.*, 1973). It is uncommon in Missouri, but there is no strong evidence of decimation (Pflieger 1975).

MUSSELS

Thirteen species of mussels were collected in 1979 (Table 7). No mussels were found at sites with sand substrates either by handpicking or by brailing while the greatest number of species was observed at sites with

predominantly coarse substrates. The mean number of species per site was 0.0 in sand substrates (stations 1 and 7), 5.3 at sites with transitional substrates (stations 3, 4, and 5), and 5.5 for rock substrates (stations 2 and 6). Mean densities (number of individuals per m^2) ranged from 0.0 at stations 1 and 7 to 2.6 at station 2 (Fig. 3). Mean densities found at each substrate type were 0.0, 1.2, and 1.8 for sand, transitional, and rock substrates, respectively.

Table 7. Number of mussels collected in 10 m^2 in the Kankakee River in 1979.

Species	Station 1	2	3	4	5	6	7
Actinonais carinata	....	13	13	1	....	5	....
A. ellipsiformis	....	1	1	....	....	....	....
Alasmidonta marginata	....	2	3	1	....	....	....
Anodonta grandis	....	....	....	1	....	....	....
Elliptio dilatata	....	2	....	2	....	....	....
Lampsilis ovata	....	....	....	....	....	1	....
L. radiata siliquoidea	....	....	....	....	1	2	....
Lasmigona complanata	....	....	1	....	4	....	....
L. costata	....	3	....	1	....	....	....
Ligumia recta	....	....	1	....	....	....	....
Quadrula metanevra	....	3	2	....	....	....	....
Q. pustulosa	....	2	1	1	....	1	....
Q. quadrula	....	....	....	....	1	....	....
Total	0	26	22	7	6	9	0

Density and number of species sometimes varied among similar substrate types (*e.g.*, stations 2 and 6). While substrate plays an important role in the size and location of mussel communities, other factors, such as fish hosts or water quality, are also important.

If sedimentation by sand were severe enough to produce rolling sand (as observed upstream of Momence or downstream of Aroma Park) over present rock substrates, few, if any, mussels would be found (Murray and Leonard 1962). Since the results of the 1979 study indicate that mussels occur at various densities throughout the upstream portion of the Kankakee River in Illinois, sedimentation of the present non-sand areas would destroy some part of the mussel fauna. The 1978 inventory of the Kankakee River revealed that two large and diverse mussel beds exist upstream at Momence and Aroma Park. If these areas were covered by deep, rolling sand, destruction of a significant portion of the mussel fauna of the Kankakee River would be assured.

Damage to the fauna of the Kankakee River could be significant in terms of the mussel fauna of Illinois. At present, the Kankakee River supports one of the finest populations in the state. Twice as many individuals per sample hour were collected in the Kankakee in 1978 than were collected in similar studies of the Kaskaskia, Little Wabash, or Vermilion Rivers in recent years. Several species of mussels that are endangered, threatened, or rare in Illinois and the United States, in some instances, are or have been collected in the Kankakee River in Illinois.

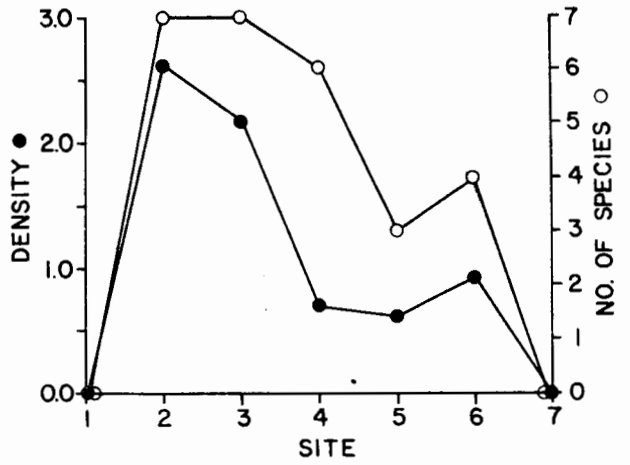

Figure 3. Density (number per m^2) and number of species of mussels in the Kankakee River in 1979.

Endangered, Threatened, and Rare Mussels

Approximately 50 percent of the known species of freshwater mussels in the world occur in eastern North America (Stansbery 1970), achieving their greatest diversity in the Mississippi River basin (Johnson 1970). A special case can be made for the protection of mussels in general in the United States because of the uniqueness of this fauna. A drastic depletion in both numbers of individuals and species has occurred in the past century throughout the country and has been documented for river systems such as the Ohio (Stansbery 1971), Tennessee (Stansbery 1971), and Wabash (Krumholz, *et al.*, 1970). Mussels in several Illinois rivers have suffered similar declines. Since 1900, 21 of the 44 species originally present in the Illinois River were apparently extirpated from that river. The Rock River in Illinois supported 30 species in 1926 and 21 in 1970 (Miller 1972); the Vermilion River (Wabash drainage) supported 29 species in 1918-1920 and 19 in 1975; the Kaskaskia River had 32 species in 1956 and 24 in 1979; and the Kankakee River supported 29 species in 1906 and 20 in 1978. A statewide survey by M. R. Matteson in the 1950's indicated that several species were rare in Illinois: in his collection of over 20,000 individuals and 50 species, 22 species were represented by fewer than 100 individuals.

The decline in the mussel fauna has prompted federal and state governments to provide protection for several species. The federal government currently lists 23 species of mussels found in the United States as endangered under the Endangered Species Act of 1973. Several states, including Indiana, Kentucky, Missouri, and Ohio, have established lists of endangered, threatened, or rare mussel species (McGaugh and Genoways 1976, Babcock 1977). Van der Schalie (1975) lists several species as endangered or rare in Michigan. To date, Illinois has not established such a list.

Of 37 mussel species reported from the Kankakee River in Illinois since 1906, one is on the federal endangered species list, two others are considered by specialists to be

endangered in the United States, and 18 are listed as endangered, threatened, or rare in various states (Indiana, Kentucky, Michigan, Missouri, or Ohio). Based upon current or historical information on the status of mussels in Illinois streams, 12 species found in the Kankakee River in Illinois deserve special consideration for protection because they are presently uncommon or possibly threatened with extirpation in Illinois.

Species considered in the following discussion were selected on the basis of the federal list of endangered species, listing by specialists of species in danger of extinction in the United States, and past and present information about the species in Illinois. Assessment of the status of a species in Illinois is difficult because many rivers, such as the Des Plaines, Du Page, Embarras, Fox, Mackinaw, Sangamon, and Spoon, have not been surveyed for mussels since the 1950's. Several rivers, however, have been recently surveyed, including the Illinois (1966-1969), Kankakee (1978-1979), Kaskaskia (1979), Little Wabash (1979), Mississippi (1977), Rock (1970), Vermilion (1975), and Wabash (1966-1967).

Several species are rare or becoming reduced in abundance and/or distribution in Illinois and probably deserve protection. Some of these species are or have been found in the Kankakee River in Illinois. The following discussion divides the endangered, threatened, or rare species reported in the Kankakee River into two categories: (1) those found prior to, but not in 1978; and (2) those found in 1978.

Seven species are included in the first category: *Cumberlandia monodonta*, *Dysnomia triquetra*, *Ellipsaria lineolata*, *Lampsilis higginsi*, *Plethobasus cyphyus*, *Simpsoniconcha ambigua*, and *Villosa iris*. These species may have been extirpated from the river or are so rare that collecting one is a matter of chance. *Cumberlandia monodonta*, *Ellipsaria lineolata*, and *Lampsilis higginsi* are usually found in large rivers and may have strayed into the Kankakee from the Illinois River. These three and *Simpsoniconcha ambigua* were last reported from the Kankakee in 1906. *Dysnomia triquetra* was last reported from the Kankakee River in 1955, and *Villosa iris* in 1960.

Five species are included in the second category. *Anodonta imbecillis*, *Cyclonaias tuberculata*, *Lasmigona compressa*, *Ligumia recta*, and *Quadrula metanevra* were found in 1978 in the Kankakee River in Illinois.

Damage to these 12 species by sand sedimentation depends upon the degree of coverage of the substrate by sand and the location of the sedimentation. Deep, rolling sand would eliminate most or all mussels, including the rare ones. Certain species could be eliminated from the fauna if the areas of sedimentation were localized. Rare species in the area upstream of Kankakee, and thus those affected by sedimentation in this area, include *Lampsilis compressa*, *Ligumia recta*, and *Quadrula metanevra*, and if they still occur, *Plethobasus cyphyus* and *Villosa iris*. *Anodonta imbecillis*, *Cyclonaias tuberculata*, *Lasmigona compressa*, *Ligumia recta*, and *Quadrula metanevra* could be affected by sedimentation in the downstream area (from the city of Kankakee to the mouth of the river), as would *Cumberlandia monodonta*, *Dysnomia triquetra*, *Ellipsaria lineolata*, *Lampsilis higginsi*, and *Simpsoniconcha ambigua*, if they have not yet been extirpated from the river. Sedimentation of riffle areas could destroy populations of riffle-associated species such as *Cyclonaias tuberculata*, *Dysnomia triquetra*, *Lasmigona compressa*, *Ligumia recta*, *Plethobasus cyphyus*, *Quadrula metanevra*, and *Villosa iris*. These coarse-substrate species could be affected by destruction of gravel substrates.

Anodonta imbecillis. *Anodonta imbecillis* has a large range in the United States (Fuller 1978). In Illinois, this species was widespread, but not abundant in the 1950's (only 42 individuals collected, Matteson collection). In addition to the Kankakee, this species occurs in small numbers in the Illinois, Kaskaskia, and Rock Rivers, in moderate numbers in the Mississippi River, but has not been observed in recent surveys of the Little Wabash, Vermilion (Wabash drainage), or Wabash Rivers.

Two individuals were collected in the Kankakee River in a pool 2.5 km northwest of Custer Park in 1978. *Anodonta imbecillis* had been reported from the river in 1906. The preferred habitat is soft-bottom, backwater areas.

Cumberlandia monodonta. Once a widespread species in the Mississippi River basin (Fuller 1978), *Cumberlandia monodonta* is in danger of extinction in the United States (Stansbery 1971) and has been proposed for federal listing as an endangered species (Fuller 1978). It is considered endangered, threatened, or rare in Kentucky and Missouri.

In Illinois, this species has been reported from the Illinois (1906, 1912), Kankakee (1906), Mississippi (1906, 1977), and Wabash (1944) Rivers. It has recently been collected in very small numbers only in the Mississippi River. *Cumberlandia monodonta*, which was reported from Will County, has not been collected in the Kankakee River since 1906.

Cumberlandia monodonta prefers rocky areas, good current, and deep water (Fuller 1978) and is found chiefly in large rivers.

Cyclonaias tuberculata. This species is widespread in the Mississippi River basin, but is becoming less common (Fuller 1978). It is considered endangered or rare in Indiana and Michigan.

In the 1950's, Matteson collected *Cyclonaias tuberculata* in the Fox, Kankakee, and, especially, the Vermilion (Wabash drainage) Rivers. It has recently been taken in the Kankakee and Vermilion Rivers, and also in the Rock and Ohio Rivers in Illinois, but is apparently gone from the Des Plaines, Illinois, and Spoon Rivers. *Cyclonaias tuberculata* is uncommon and possibly extirpated in the upper Mississippi River.

Cyclonaias tuberculata occurs in riffles in small and large rivers. In 1978, two individuals were collected in the Kankakee River, one each at the mouth of Davis Creek and at Warner Bridge. This species has been reported from the Kankakee River in 1906, 1909, 1955, 1960, 1976, and 1978.

Dysnomia triquetra. Although considered widespread in the upper Mississippi and St. Lawrence River basins, *Dysnomia triquetra* is considered endangered, threatened, or rare in Indiana, Michigan, and Missouri.

In Illinois, *Dysnomia triquetra* is rare and becoming reduced in distribution. Historical records indicate that this species occurred in the Embarras (1956), Illinois (1874, 1906, 1911), Kankakee (1906, 1955), Kaskaskia (1956), and Wabash (1906) Rivers. Matteson's statewide collection in the 1950's produced 23 specimens from the Embarras and Kaskaskia Rivers. It has not been found in subsequent collections of any river in Illinois, including the Illinois, Kankakee, Kaskaskia, and Wabash Rivers.

The Kankakee River records of *Dysnomia triquetra* are from Will County (1906) and at Lorenzo, Will County (1955). Riffles, its preferred habitat, are still available in the Kankakee River.

Ellipsaria lineolata. The distribution of *Ellipsaria lineolata* in the Mississippi River basin, apparently the only basin in which it occurs, has been curtailed (Fuller 1978). It is considered an endangered species in Ohio.

This species has been reported in Illinois from the Illinois (pre-1900, 1912, 1914), Kankakee (1906), Kaskaskia (1906), Mississippi (1906, 1931, 1977), Ohio (1906), and Wabash (1906) Rivers. *Ellipsaria lineolata* was once fairly common and widespread in the Illinois River (Starrett 1971). This species has apparently been extirpated from these rivers (except the Mississippi) as it has not been collected in subsequent surveys. Recently, it is known only from the Mississippi where it is rare (Fuller 1978).

Ellipsaria lineolata was last reported from the Kankakee River in 1906 in Will County. It is a large-river species usually found in sand (especially sand bars), gravel, and mud substrates (Baker 1928).

Lampsilis higginsi. This species is federally endangered, in danger of extinction throughout its entire range. Missouri also considers it an endangered species.

Lampsilis higginsi has been reported in Illinois from the Illinois (1870's, 1906, 1912), Kankakee (1906), Mississippi (1906), and Rock (1926) Rivers. An uncommon but widespread species in the Illinois River, *Lampsilis higginsi* was eliminated from this river before 1930 (Starrett 1971). Three populations have recently been found in the Mississippi River basin in Wisconsin (Fuller 1978).

The last documented occurrence of *Lampsilis higginsi* in the Kankakee River was in 1906 in Will County. It is apparently a large-river species (Baker 1928) and little is known of its habitat requirements (Parmalee 1967).

Lasmigona compressa. This is another species found rarely (19 individuals) in the 1950's by Matteson, who found it primarily in the Illinois River basin. It has recently been collected in the Kankakee, Vermilion (Wabash drainage), and Wabash Rivers.

Lasmigona compressa is a small-stream species usually observed below riffles (Baker 1928). Two specimens, one at Aroma Park and the other 2.5 km northwest of Custer Park, were collected in 1978. The only other report of this species in the Kankakee River was in 1960 when one individual was collected at Momence.

Ligumia recta. Ligumia recta is widely distributed in the United States (Fuller 1978), but considered to be endangered and rare in Indiana.

In the 1950's, this species was rare (46 individuals) and not widely distributed in Illinois. Matteson collected it from the Fox and Kankakee Rivers and the Rock River basin. It has recently been recollected from the Kankakee and Rock Rivers and has also been observed in the Mississippi (where it is rare) and Ohio Rivers in Illinois. Although once common in the Illinois River, it is apparently extirpated there, as well as from the Kaskaskia and Spoon Rivers.

Ligumia recta prefers strong current in coarse substrates. Fourteen individuals were taken in the Kankakee River in 1978 from eight of the 13 sites collected. Records of this species in the Kankakee River exist for 1906, 1909, 1955, 1960, 1976, 1978, and 1979.

Plethobasus cyphyus. This species is an example of a species whose range and numbers have been greatly reduced in the upper Mississippi River drainage (Fuller 1978). *Plethobasus cyphyus* is an endangered species in Missouri and Ohio and should be protected in Illinois.

Illinois records include the Fox (1906), Illinois (1870's, 1906), Kankakee (1906, 1909, 1960), Kaskaskia (1906, 1954, 1956), Mississippi (1906, 1931), Ohio (1906), Rock (1906, 1928), Spoon (1906), and Wabash (1906, 1944, 1967). This species has not been found in subsequent collections of any of the rivers (except for the Wabash for which there is no collection after 1967). It has been taken recently only in the Wabash River where it is rare (Krumholz, *et al.*, 1970). *Plethobasus cyphyus* was once widespread and abundant in the Illinois River (Starrett 1971). Although an important element of the mussel fauna of the upper Mississippi River at one time, declining populations have threatened *Plethobasus cyphyus* with extirpation there (Fuller 1978). Sixteen specimens were collected in the Matteson survey of Illinois streams in the 1950's; none was found in recent collections of the same sites.

Plethobasus cyphyus has been reported from the Kankakee River from Will County (1906), Momence (1909, 1960), and 9 km east of Kankakee (1960). This species may still exist in the river where it would most likely occur in areas of strong current or riffles (Baker 1928).

Quadrula metanevra. This is a widespread but uncommon species in the United States (Fuller 1978). Ohio lists it as an endangered species. Matteson found only 34 individuals of this species, primarily in the Kankakee River and in small numbers in the Embarras, Rock, Sangamon, and Spoon Rivers. Recent collections of *Quadrula metanevra* have been made in the Kankakee, Kaskaskia, Mississippi, Rock, Vermilion, and Wabash Rivers in Illinois. It has not

been recollected in the Illinois River. It is never abundant where it occurs.

Quadrula metanevra is usually found on gravel in current. In 1978, 13 specimens were collected from five sites between Momence and Custer Park. Kankakee River records for this species exist for 1906, 1909, 1960, 1976, 1978, and 1979.

Simpsoniconcha ambigua. Once a widespread species in the Mississippi River basin, *Simpsoniconcha ambigua* is now nearly extinct (Fuller 1978). It was considered endangered and rare in the United States by Stansbery (1971) and endangered in Michigan and Ohio.

In Illinois, *Simpsoniconcha ambigua* was reported from the Kankakee (1906), Spoon (1906), and Wabash (1906) Rivers. No specimens have been collected in subsequent surveys of these rivers.

It was collected in the Kankakee River in Will County. *Simpsoniconcha ambigua* prefers rocky habitats.

Villosa iris. This species is present rarely and becoming more restricted in distribution in Illinois. It has been reported from the Du Page (1906), Embarras (1956), Fox (1906, 1950's), Illinois (1870's), Kankakee (1906, 1909, 1955, 1960), Sangamon (1960), Spoon (1906), Vermilion (Illinois River drainage) (1874), Vermilion (Wabash River drainage) (1955, 1958, 1966), and Wabash (1944) Rivers. Subsequent collections, which have been made in all these rivers except the Embarras and Sangamon, have failed to report this species. Only nine specimens were collected in Illinois during Matteson's survey in the 1950's.

Collections from the Kankakee River document its occurrence in Will County in 1906, at Custer Park in 1909, at Lorenzo in 1955, and at Momence in 1960. As the preferred habitat (riffles) of *Villosa iris* is still available in the Kankakee River, it is possible that this species may still occur there.

BENTHIC MACROINVERTEBRATES

One hundred forty-three taxa of benthic macroinvertebrates were collected (Table 8). Their diversity increased with increasing microhabitat diversity: sites with progressively more complex substrates supported more taxa. Sites where sand or sand-silt substrates predominated supported fewer taxa than sites with substrates composed of varying amounts of silt, sand, gravel, cobble, and bedrock (Tables 1 and 8, Fig. 4). For example, in the predominantly sand areas upstream of Momence and downstream of Aroma Park, only 25 to 28 taxa were collected; in the transition or ecotone area (where bedrock and shallow to deep sand areas occur in rapid succession), 44 to 50 taxa were collected; and at sites with the most complex substrates of silt, sand, gravel, cobble, and bedrock, 70 to 80 taxa were found.

The sites sampled in the Kankakee River clustered into two general categories based upon the species composition and relative abundance (as mean number per m^2): (1) sites at which sand constitutes 10 to 40 percent of the substrate (stations 2 through 6); and (2) sites where sand predomi-

Table 8. Benthic macroinvertebrates (mean number per m^2) collected in the Kankakee River in 1979.

Species	Station 1	2	3	4	5	6	7
COELENTERATA							
Hydra	.....	.....	1	.....	.....	.....	.....
PLATYHELMINTHES							
Planariidae	.....	2	.....	+	3	7	.....
NEMATODA	9	41	7	1	.....	14	.....
NEMATOMORPHA	.....	+	.....	.....	.....	.....	.....
MOLLUSCA							
Gastropoda							
Ancylidae							
Ferrissia	.....	.....	.....	3	26	+	.....
Bulimidae							
Amnicola	.....	.....	.....	.....	2	.....	.....
Physidae							
Physa anatina	.....	17	.....	2	.....	1	.....
Pleuroceridae							
Goniobasis	.....	63	3	1	45	.....	.....
Pleurocera	.....	10	.....	.....	3	1	.....
Pelecypoda							
Sphaeriidae							
Pisidium	.....	6	6	8	3	.....	.....
Sphaerium	.....	22	3	1	2	53	2
ANNELIDA							
Hirudinea	.....	.....	.....	.....	2	.....	.....
Oligochaeta							
Enchytraeidae	.....	.....	.....	.....	.....	.....	4
Lumbriculidae	.....	.....	.....	.....	.....	2	.....
Naididae	+	550	8	3	30	1	4
Chaetogaster	.....	1	.....	.....	4	+	.....
Dero digitata	.....	2	.....	+	25	.....	.....
Dero	.....	.....	.....	.....	1	.....	.....
Nais bretscheri	.....	2	3	+	.....	.....	.....
N. pardalis	.....	.....	.....	3	.....	.....	.....
N. pseudobtusa	13	80	.....	+	.....	2	22
N. simplex	.....	1	.....	.....	.....	.....	.....
Nais	4	+	15	17	.....	9	9
Paranais frici	28	2	1	.....	55	+	22
Pristina leidyi	.....	.....	.....	.....	1	+	.....
Pristina	.....	.....	.....	.....	.....	.....	2
Slavina appendiculata	.....	.....	.....	.....	11	.....	.....
Stylaria lacustris	.....	1	.....	.....	4	.....	.....
Tubificidae							
Aulodrilus pigueti	2	.....	.....	1	1	.....	166
Aulodrilus	.....	.....	1	.....	.....	.....	.....
Branchiura sowerbyi	15	1	.....	1	.....	2	43
Limnodrilus cervix	+	.....	2	.....	1	.....	37
L. cervix (variant)	+	.....	.....	.....	.....	.....	.....
L. claparedeianus	.....	.....	.....	.....	.....	.....	13
L. hoffmeisteri	13	3	.....	.....	.....	.....	.....
L. maumeensis	+	.....	.....	.....	.....	.....	.....
L. udekemianus	+	.....	.....	.....	.....	.....	.....
Peloscolex multisetosus	+	.....	1	3	10	.....	.....
Tubifex tubifex	+	.....	.....	.....	.....	.....	.....
UIW/O capilliform setae	172	44	43	23	19	3	249
UIW/capilliform setae	19	1	3	3	10	2	26
ARTHROPODA							
Parasitengona	.....	1	.....	.....	.....	.....	.....
Crustacea							
Amphipoda							
Gammaridae							
Crangonyx	2	+	.....	+	.....	+	.....
Gammarus	+	.....	2	2	.....	+	.....
Hyalellidae							
Hyalella azteca	.....	3	3	4	39	1	.....
Decapoda							
Astacidae							
Orconectes	.....	+	.....	1	.....	1	.....
Isopoda							
Asellidae							
Asellus	.....	3	1	4	.....	+	.....
Insecta							
Ephemeroptera							
Baetidae							
Baetis propinquus	.....	.....	2	1	.....	.....	.....
Baetiscidae							
Baetisca bajkovi	11	2	25	19	3	7	.....
Baetisca	.....	4	.....	.....	.....	1	4
Caenidae							
Caenis	.....	.....	1	1	.....	7	.....
Ephemerellidae							
Serratella frisoni	.....	.....	.....	2	.....	6	.....
Ephemeridae							
Hexagenia limbata	.....	.....	.....	.....	17	.....	54
Hexagenia	.....	1	4	.....	.....	1	13
Heptageniidae							
Heptagenia marginalis	.....	.....	.....	.....	.....	+	.....
Stenonema luteum	.....	.....	6	.....	.....	.....	.....
S. pulchella	.....	.....	.....	.....	.....	8	.....
S. terminatus	.....	.....	2	1	1	6	.....
S. vicarium	9	1	.....	.....	.....	.....	.....
Stenonema	.....	37	15	21	3	114	.....
Oligoneuriidae							
Isonychia	.....	4	1	1	.....	55	43
Potamanthidae							
Potamanthus	.....	10	28	21	.....	2	.....
Tricorythidae							
Tricorythodes	.....	8	10	.....	.....	4	.....
Odonata							
Aeshnidae							
Aeshna verticalis	.....	.....	.....	.....	.....	1	.....
Calopterygidae							
Calopteryx	.....	.....	.....	.....	.....	1	.....
Hetaerina	.....	1	.....	.....	.....	1	.....
Coenagrionidae							
Argia tibialis	.....	.....	.....	.....	.....	1	.....

Table 8. (continued).

Species	Station 1	2	3	4	5	6	7
Chromagrion	.....	1	.....	.....	.....	1	.....
Enallagma	.....	+	.....	.....	3	.....	.....
Ischnura	.....	1	.....	.....	.....	.....	.....
Gomphidae							
Erpetogomphus designatus	.....	.....	.....	.....	.....	1	.....
Gomphus	.....	.....	1	.....	.....	.....	.....
Plecoptera							
Taeniopterygidae							
Taeniopteryx	.....	2	2	2	.....	31	.....
Heteroptera							
Belostomatidae							
Belostoma fluminea	.....	+	.....	.....	.....	.....	.....
Corixidae	.....	7	6	307	262	.....	.....
Megaloptera							
Corydalidae							
Corydalus cornutus	.....	.....	.....	.....	.....	.....	4
Coleoptera							
Dytiscidae							
Coptotomus loticus	.....	.....	.....	.....	.....	+	.....
Hydroporus undulatus	+	.....	.....	+	.....	.....	.....
Hydroporus	.....	.....	.....	+	.....	.....	.....
Laccophilus proximus	.....	.....	.....	+	.....	.....	.....
Elmidae							
Dubiraphia vittata	.....	1	.....	.....	.....	.....	.....
Dubiraphia	13	12	14	45	64	.....	.....
Macronychus glabratus	9	.....	.....	.....	.....	.....	.....
Optioservus	.....	.....	.....	.....	.....	8	.....
Stenelmis vittipennis	.....	.....	1	.....	.....	4	.....
Stenelmis	.....	9	7	11	2	42	.....
Haliplidae							
Peltodytes duodecimpunctatus	.....	+	.....	.....	.....	.....	.....
P. edentulus	.....	+	.....	.....	.....	+	.....
Hydrophilidae							
Berosus	.....	1	.....	.....	.....	.....	.....
Gyrinidae							
Dineutus assimilis	.....	.....	.....	.....	.....	+	.....
Gyrinus aeneolus	.....	.....	.....	.....	.....	+	.....
G. analis	.....	.....	.....	.....	.....	+	.....
G. maculiventris	.....	.....	.....	.....	.....	+	.....
Psephenidae							
Psephenus herricki	.....	29	.....	.....	1	.....	.....
Trichoptera							
Brachycentridae							
Brachycentrus numerosus	.....	2	.....	.....	.....	.....	.....
Micrasema rusticum	.....	1	.....	.....	.....	.....	.....
Glossosomatidae							
Protoptila	.....	.....	.....	.....	.....	1	.....
Helicopsychidae							
Helicopsyche borealis	.....	3	.....	.....	.....	1	.....
Hydropsychidae							
Cheumatopsyche	.....	17	1	.....	6	222	.....
Hydropsyche aerata	.....	.....	.....	.....	.....	18	.....
H. frisoni	.....	4	.....	.....	.....	3	.....
H. phalerata	.....	6	.....	.....	.....	8	.....
H. simulans	.....	6	.....	.....	.....	.....	.....
Macronema zebratum	.....	3	.....	.....	.....	30	.....
Symphitopsyche	.....	2	.....	.....	.....	1	.....
Hydroptilidae							
Hydroptila albicornis	.....	12	.....	3	.....	20	.....
H. grandiosa	.....	.....	.....	.....	.....	3	.....
H. waubesiana	.....	18	1	3	15	158	.....
Oxyethira	.....	.....	.....	.....	1	.....	.....
Leptoceridae							
Nectopsyche candida	.....	.....	1	.....	.....	.....	.....
Limnephilidae							
Hydatophylax argus	.....	+	.....	1	.....	.....	.....
Polycentropididae							
Polycentropus cinereus	.....	1	.....	.....	.....	1	.....
Lepidoptera							
Pyralidae							
Petrophila	.....	1	.....	.....	.....	11	.....
Diptera							
Ceratopogonidae							
Palpomyia complex	11	.....	.....	2	.....	.....	.....
Chaoboridae							
Chaoborus	.....	.....	.....	.....	.....	.....	2
Chironomidae							
Chaetocladius	.....	33	3	.....	.....	3	.....
Cricotopus	.....	1	.....	.....	.....	1	.....
Eukiefferiella	.....	9	.....	.....	.....	15	.....
Orthocladius	2	54	14	2	2	87	.....
Psectrocladius	.....	2	.....	.....	1	.....	.....
Thienemanniella	82	1	1	.....	.....	.....	.....
Orthocladiinae--A	9	179	6	1	3	28	.....
Orthocladiinae	.....	13	4	1	1	3	.....
Chironomus	2	15	19	75	62	1	484
Cryptochironomus	.....	10	3	2	1	1	13
Dicrotendipes	.....	4	1	.....	12	1	2
Glyptotendipes	.....	2	.....	.....	22	.....	.....
Harnischia complex	13	.....	.....	1	.....	.....	2
Microtendipes	.....	.....	1	.....	.....	.....	.....
Paralauterborniella	.....	.....	.....	.....	.....	.....	2
Phaenopsectra	2	.....	1	1	2	.....	.....
Polypedilum	43	8	10	6	3	.....	11
Stenochironomus	.....	.....	8	.....	.....	.....	.....
Stictochironomus	.....	1	43	4	.....	.....	4
Cladotanytarsus	.....	3	1	.....	.....	.....	.....
Rheotanytarsus	.....	430	10	1	1	85	.....
Tanytarsus	.....	1	3	.....	.....	.....	.....
Ablabesmyia	.....	1	.....	.....	1	.....	.....
Labrundinia	.....	.....	.....	1	.....	.....	.....
Larsia	.....	.....	2	.....	.....	.....	.....
Pentaneurini	.....	1	.....	.....	.....	7	13
Procladius	.....	1	1	.....	3	.....	7

Table 8. (concluded).

Species	Station 1	2	3	4	5	6	7
Tanypodinae	.....	.....	.....	.....	1	.....	.....
Thienemannimyia	.....	1	.....	.....	.....	.....	.....
Simuliidae	.....	1	.....	.....	.....	35	.....
Total Number of Taxa	28	80	50	50	44	70	25
Total Number of Individuals per m^2	483	1834	362	617	790	1146	1257

nates (stations 1 and 7) (Fig. 5). The first cluster of sites further subdivided into two categories: (1) sites with long expanses of coarse substrate (stations 2 and 6); and (2) the transition or ecotone area (stations 3, 4, and 5).

In the Kankakee River, the conversion of areas where coarse substrates predominate to areas chiefly composed of sand (as a result of erosion from snag removal or bank clearing upstream) will reduce the number of invertebrate taxa, a generally recognized phenomenon. From the quantitative samples taken in the river in 1979, it is apparent that the number of taxa will be reduced approximately 36 percent if moderate increases in the transport of sand sediment occur and create conditions comparable to those observed in the transition area. If increased sand were to move downstream in the Kankakee River to cover existing gravel, rubble, and bedrock with deep, rolling sand, the number of taxa will be reduced approximately 65 percent. Although the density of invertebrates occurring among different substrate types varied, in general, coarse substrates supported greater mean numbers per m^2 (Fig. 4).

The character of the substrate may be the primary physical factor influencing the distribution and abundance of benthic macroinvertebrates in the Kankakee River. Thus, any variable that effects the nature of the riverbed will produce a corresponding effect upon the invertebrates inhabiting it. Although the large expanses of sand in the Kankakee River between Momence and the Indiana border

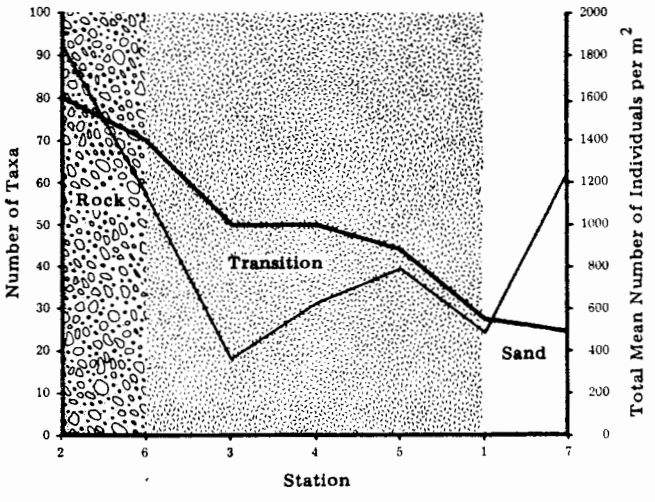

Figure 4. The number of taxa (heavy line) and density (total mean number per m^2) (fine line) of benthic macroinvertebrates in the Kankakee River in 1979.

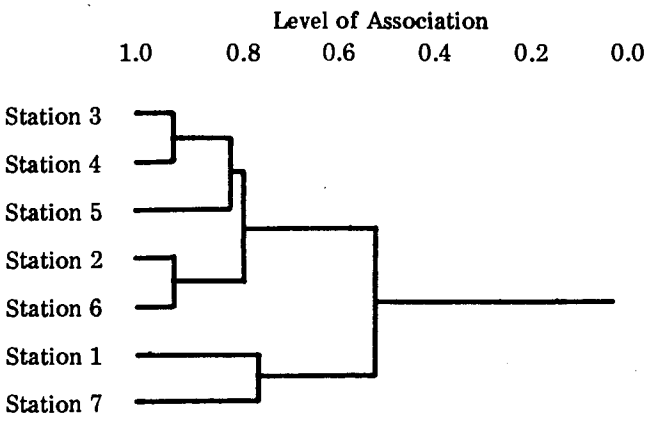

Figure 5. Dendrogram illustrating the results of a cluster analysis for benthic macroinvertebrates in the Kankakee River.

and downstream of Aroma Park have existed for a long time, the movement of sand farther downstream to cover exposed gravel, rubble, and bedrock substrates will have a significant impact upon benthic macroinvertebrates.

Recently, McClelland and Brusven (1980) observed the effect of increased sediment loading upon the behavior and distribution of selected mayflies (Ephemeroptera), stoneflies (Plecoptera), and caddisflies (Trichoptera) in a laboratory stream. Their observations are especially pertinent to an assessment of the impact of possible increased sediment transport in the Kankakee River because (1) the substrate in their experimental stream corresponds to that occurring in the Kankakee River at Momence and Aroma Park; (2) fine sand was used as their test sediment; and (3) their test organisms represent groups abundant in the Kankakee River at sites having coarse substrates.

McClelland and Brusven (1980) observed that most species tested responded negatively to increased sediment loading so that more of the experimental substrate became uninhabited as sediment loading increased. As would be expected, although sensitivity varied among species, all species preferred unsedimented to heavily sedimented substrates. Non-burrowing species were unable to get under large rocks when fine sediments filled the interstices.

The authors concluded: (1) Increased sediment will reduce insect densities by reducing the "effective" size of substrate particles by clogging the spaces between rocks and by prohibiting penetration by non-burrowing species. (2) Fine sediments eliminate the critical static-water areas around rocks, exposing insects to the effects of current. The zero-velocity areas of the rock-water interface and downstream from and beneath rocks are important to riffle insects for maintenance of position against the current. (3) Increased sediment may interfere with leaf- and detritus-processing and limit periphyton growth by covering these important food sources, making them unavailable to stream insects.

The principal effects of sediment movement upon benthic macroinvertebrates have been documented many times. They include: (1) increased emigration and drift to avoid adverse effects; (2) increased mortality from physiological effects, burial/abrasion, or physical destruction; (3) reduction of reproductive rates from loss of suitable substrates, destruction of early life stages, or physiological stress; and (4) modifications in growth and/or production rates through habitat modification and/or food availability (Farnworth, *et al.* 1979). Although one could expect rapid repopulation of benthic macroinvertebrates following short-term sediment load stress (such as following spring floods), long periods of sediment stress could drastically reduce the benthic fauna (White and Gammon 1976). The probable impact of increased sediment transport in the Kankakee River has been demonstrated vividly by the quantitative sampling done in 1979. From 36 to 65 percent of the taxa could be eliminated from areas of the river where sand does not presently exceed 40 percent of the substrate.

SUMMARY

Biological sampling in 1979 in the Kankakee River was intended to (1) assess the impact in Illinois of upstream activities which might increase sedimentation or sediment transport into the Illinois portion of the Kankakee River, especially upstream of the city of Kankakee, by providing quantitative estimates of principal macroinvertebrate populations and fishes associated with known substrate types; and (2) to combine this quantitative sampling with additional qualitative sampling in the Illinois portions of the river to assess the status of species officially classified as threatened or endangered by either state or federal agencies, or species considered rare or unique, or whose status is uncertain.

Fishes. Forty-four species of fishes were collected in 1979. Sites where sand or silt-sand substrates predominated supported fewer species, fewer individuals, and lower biomass than sites where coarser substrates occurred. The transition area supported about the same number of species and biomass as sites where coarser substrates predominated, but there were fewer individuals.

The sites sampled in the Kankakee River in 1979 clustered into three general categories based upon species composition and relative abundance: (1) sites at which sand constitutes only 10 to 20 percent of the substrate; (2) sites where sand predominates; and (3) a single site where sand and silt predominate.

In the Kankakee River, the conversion of areas where coarse substrates predominate to areas chiefly composed of sand will reduce the number of fish species present by about 30 percent, reduce the number of individuals by approximately 70 percent, and reduce biomass by about 85 percent.

The status of the pallid shiner, blacknose shiner, northern brook lamprey, ironcolor shiner, weed shiner, and river redhorse in the Kankakee River was reviewed. These species are considered to be endangered, threatened, or rare in

Illinois.

Mussels. Thirteen species of mussels were collected in 1979. Predominantly sand substrates such as those found upstream of Momence and downstream of Aroma Park support few, if any, mussels. Density and number of species varied at sites with substrates other than predominantly sand. While substrate is an important factor in the distribution and size of mussel communities, other factors, such as presence or absence of fish hosts, are also important.

Since mussels occur at various densities throughout the upstream portion of the Kankakee River in Illinois, sedimentation of the present non-sand areas would destroy some part of the mussel fauna. Two large and diverse mussel beds exist upstream at Momence and Aroma Park. If these areas were covered by deep, rolling sand, destruction of a significant portion of the mussel fauna of the Kankakee River would be assured.

Among the past and present mussel fauna of the Kankakee River in Illinois, several species are rare and/or threatened with extirpation from Illinois and, in some cases, extinction. These species include *Anodonta imbecillis*, *Cumberlandia monodonta*, *Cyclonaias tuberculata*, *Dysnomia triquetra*, *Ellipsaria lineolata*, *Lampsilis higginsi*, *Lasmigona compressa*, *Ligumia recta*, *Plethobasus cyphyus*, *Quadrula metanevra*, *Simpsoniconcha ambigua*, and *Villosa iris*. Damage by sedimentation to endangered, threatened, or rare species would depend upon the degree and location of the sedimentation.

Benthic Macroinvertebrates. One hundred forty-three taxa of benthic macroinvertebrates were collected in 1979. Their diversity increased with increasing microhabitat diversity: sites with progressively more complex substrates supported more taxa. Sites where sand or sand-silt substrates predominated supported fewer taxa than sites with substrates composed of varying amounts of silt, sand, gravel, cobble, and bedrock.

The sites sampled in the Kankakee River in 1979 clustered into two general categories based upon species composition and relative abundance of the benthos: (1) sites at which sand constitutes 10 to 40 percent of the substrate; and (2) sites where sand predominates. The first cluster of sites further subdivided into categories: (1) sites with long expanses of coarse substrates; and (2) the transition or ecotone area.

In the Kankakee River, the conversion of areas where coarse substrates predominate to areas chiefly composed of sand will reduce the number of invertebrate taxa. The number of taxa will be reduced approximately 36 percent if moderate increases in the transport of sand sediment occur and create conditions comparable to those observed in the transition area. If increased sand were to move downstream in the Kankakee River to cover existing coarse substrates with deep, rolling sand, the number of taxa will be reduced approximately 65 percent.

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