VIRGINIA COOPERATIVE FISH AND WILDLIFE RESEARCH UNIT DEPARTMENT OF FISHERIES & WILDLIFE SCIENCES 106 CHEATHAM HALL, VIRGINIA TECH BLACKSBURG, VA 24061 BICIALL A. CARLO **UMRCC Fisheries** Compendium

A COMPENDIUM OF FISHERY INFORMATION

ON THE

UPPER MISSISSIPPI RIVER

Jerry L. Rasmussen

Editor

A Contribution of the Upper Mississippi River Conservation Committee

Second Edition - 1979

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A SURVEY OF UPPER MISSISSIPPI RIVER MUSSELS

Ъу

Edward W. Perry

INTRODUCTION

The UMRCC mussel survey began in 1975 when biologists became concerned that dredging, poor water quality, hydraulic filling, levee construction, channel maintenance activities and over-fishing were seriously depleting mussel stocks in the Upper Mississippi River. The last intensive survey of Upper Mississippi River mussels was conducted by Ellis ½ in 1931. Since that time the river has undergone considerable modification (i.e. the navigation dams have been constructed and the nine-foot navigation channel has been established and maintained). The information provided in this Compendium attempts to begin the process of increasing and updating knowledge of Upper Mississippi River mussel distribution and abundance.

In the late 1800's, commercial mussel fishing was a prosperous business on the Upper Mississippi. Approximately 1,000 mussel fishermen worked the river between Fort Madison and Sabula, Iowa with over 100 fishermen located at Muscatine, Iowa. The industry was thus centered around Muscatine, which was known as the "pearl button capitol of the United States." The beds in this reach were extremely productive. One bed near New Boston, Illinois (20 miles downstream from Muscatine) yielded 10,000 tons of shells in three years. Another bed, two miles long and a quarter mile wide yielded 500 tons of shells in one year. 2/

Unfortunately, the size of the mussel fishery was exceeded only by the speed with which it collapsed. By 1900, eleven years after initation of extensive mussel fishing, the beds were already showing signs of depletion. Smith's survey of 1898 2 showed that a large bed adjacent to Muscatine could not withstand another year's fishing. As the Muscatine beds became depleted the fishery moved north to Prairie du Chien and La Crosse, Wisconsin. One reason for the decline is rather simple; harvest rates exceeded the rate at which mussels could grow to harvestable size.

Various methods were devised to rejuvenate the fishery, but none were permanently successful. In the early 1900's, scientists at the Fairport Biological Station (near Muscatine, Iowa) attempted to reseed the river by artificially infecting fish with larval mussels (glochidia). 4/ These efforts were reasonably successful, and at one time over 500,000 fat muckets were produced at the Fairport station. However, propagation efforts could not offset high harvest rates. Another management technique devised by Dr. R. E. Coker, Director of the Fairport Laboratory, involved closing alternate reaches of the Mississippi to mussel fishing for five year periods. This method was also successful but did not become a permanent management tool. Carlander 2/ provides an informative historical perspective of the early beginnings of Upper Mississippi River mussel fishing.

In recent years Upper Mississippi River commercial mussel fishing has been rejuvenated. This time, however, clammers harvest shells for the cultured pearl industry, rather than for production of pearl buttons. Lopinot 5/ provides an interesting account of mussel fishing and how fresh-water mussels are used to produce cultured pearls.

Annual reports submitted by mussel exporters in Illinois reflect recent trends in mussel harvest and species sought. From 1965-67, 95% of the mussels purchased by exporters in Illinois were washboard (75-80%) and three ridge (15-20%). Total tonnage exported from Illinois was 181 in 1965, 1,245 in 1966, and 74 in 1967. 6/ A decade later, washboard (55-85%) and three ridge (15-45%) still dominate. Total tonnage exported from Illinois was 150 in 1975, 471 in 1976, and 585 in 1977. Maple leafs comprise most of the remaining tonnage.

Although freshwater mussels play an important role in the river environment, their ecology remains poorly understood by both layman and professional biologist. Therefore, data for this Compendium have been compiled and summarized in a style usable by both the professional and the non-professional. Genera are listed in alphabetical order and common names are used wherever possible (Table 19). Hopefully, this format will enhance the understanding and stimulate an interest in this generally unappreciated and poorly understood part of the river's ecosystem.

METHODS AND MATERIALS

Since the UMRCC Mussel Survey was not a full-time research effort, collections were usually made incidental to other field work. Hence, sampling was not conducted uniformly using standard times or distances, nor were sampling efforts evenly divided between pools. Therefore, comparisons of data between pools and samples must be made with caution. Sample sites were usually selected at random at various locations along the river without prior knowledge as to whether or not mussels would actually be taken. Three techniques were used for mussel collections: (1) dragging a crowfoot bar (also called a brail) along the river bed; (2) hand picking in shallow water; or (3) gathering shells from dredged spoil sites.

Upper Mississippi River mussel collections recorded by species, collection site and pool. River mile of collection site and other supplemental information are recorded on Table 20.

SCIENTIFIC NAME CONNON NAME (in parenthesis)	COLLECTION	COLLECTION SITE REFERENCE	R NUMBER AND POOL DESIGNATION	GRATION			
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0. quadrula (Maple Leaf)	×	×	×		***************************************	××	x x x x x x
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Tritogonia verrucosa (Pistol Grip) Truncilla donaciformis (Favn's Poot)			Ŷ	×	×		× × ×
T. truncata (Neer Yoe)		×	×	×	×	×	X X X X X

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	Lasmigona complanata (White Heel Splitter)										<
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TOTAL SPECIES COLLECTED

This survey's initial sampling efforts were directed towards Corps of Engineers' dredged spoil sites. Hydraulic dredging conducted by the Corps to maintain a nine-foot navigation channel removes accumulated bottom sediments and pumps them to spoil piles on nearby shores. Mussel shells are often included in the dredged spoil. Occasionally, sub-fossil shells were collected from these piles that were not collected by any other method. Sample site 52 (Table 20) provides a good example.

The crowfoot bar (brail) eventually replaced hand picking on shore and in shallow water (called polliwogging by commercial clammers) as the principal collection method. A brail consists of a wooden bar or metal pipe with crowfoot hooks attached to short lengths of chain or rope spaced at four to eight inch intervals along the bar. Commercial brails are about 16 feet long, however, the bars used in this survey were only eight feet long. A rope is attached to the bar and this contraption is pulled downstream along the bottom. Commercial clammers use an underwater sail constructed of canvas (called a mule) that uses the current to pull the boat and the bar downstream. However, since UMRCC biologists often sampled during low flow conditions and in backwaters where strong currents were lacking, a motor was needed to pull the bar downstream. The bar's efficiency relies on the fact that the mussels partially bury themselves in the substrate with the open portion of their valves pointing upstream. As the bar is pulled along the bottom, a hook enters the mussel's partially opened valves; the mussel then clamps its valve shut on the hook and is pulled from the substrate. Lopinot 5/ provides a detailed description of crowfoot bar clamming techniques.

Hand picking (either by wading or with scuba gear) is an excellent means of obtaining a greater number of species. Furthermore, it is probably the only way of obtaining a statistically valid population estimate. Poor visability in the usually turbid Mississippi does not hamper sampling efficiency. With practice, it is relatively simple to differentiate mussels from rocks, cans or other imbedded bottom materials. After completing a sampling run with the crowfoot bar, we were usually able to collect additional species by hand picking over the same area. After two years of use, it is now apparent that the crowfoot bar is a more convenient rather than efficient sampling device.

Since commercial clammers are often reluctant to divulge mussel bed locations, we located most beds by taking random samples. Sampling efforts were usually concentrated in areas that had not been dredged, were not subject to extreme sediment deposition and were influenced by a good current flow. After locating a bed we made a few runs with the crowfoot bar and representative specimens of each species were collected. These specimens and those that were difficult to identify were sent to Dr. David Stansbery at Ohio State University for verification. In most instances, biologists made no attempt to delineate bed size or collect every species possible. However, regardless of our success, precise locations of sampling efforts were recorded on navigation charts (See Appendix C).

Table 20.

Upper Mississippi River mussel collection sites sampled by UMRCC biologists or reported by commercial clammers and amateur naturalists. River miles begin at 0 at the mouth of the Ohio River and increase upstream. Left and right banks are recorded facing downstream.

Site Reference Number <u>a/</u>	River Mile	Date	Sample Status (Alive/Dead)	Supplemental Information
1	673.1	- ,		Bed location was provided to $\ensuremath{\text{ICC}} \frac{b}{}$ biologists by commercial clammers.
2	669.0	****		Same as site No. 1
3	567.7	****		Same as site No. 1
4	664.8			Winneshiek Slough Same as site No. 1
5	663.0	7-14-75	Alive	Collected by John Spinner, ICC.
6	643.0	western .	<u> </u>	Same as site No. 1
7	637.8			Same as site No. 1
8	632.0			West Channel - Same as site No. 1
9	632.3	***		East Channel - Same as site No. 1
10	617.0	7-3-75	Alive	Collected by Gary Ackerman, ICC.
11	611.0			Same as site No. 1
12	610.0			Bluff Slough - Same as site No. 1
13	607.6	7-24-77	Alive	Collected by Gary Ackerman, ICC at the Mouth of Turkey River.
14	606.0	******		Same as site No. 1
15	604.2			Jack Oak Slough - Same as site No. 1
16	603.0	***		Same as site No. 1
17	598.5	7-2-75	Dead	Collected by Ed Perry, USFWS $\frac{c/}{}$, at dredged spoil site.
18	596.2			Same as site No. 1
19	596.0	7-2-75	Dead	Same as site No. 17
20	581.2	7-25-75	Alive	Crowfoot bar dragged 75 ft. off left bank from government light at River Mile 581.2 to River Mile 580.7. Collection made by Ed Perry, USFWS, and Gary Ackerman, ICC. Commercial bed.
21	576.0		<u>.</u>	Mussel sampling site for USFWS pesticide monitoring program.
22	571.5			Same as site No. 1
23	567.1		24.50	Same as site No. 1
24	563.3			Same as site No. 1
25	558.1	5-10-77	Alive	Crowfoot bar dragged 100 ft. off right bank in the main channel. Collections made by Ed Perry, USFWS, and Gary Ackerman, ICC.
26	556.3	8-4-75	Alive	Collected by Don Helms, ICC.
27	554.0	8-4-75	Alive	Same as site No. 26
28	550.2	8-4-75	Alive	Same as site No. 26
29	540.6-541.4		WES MESS	Same as site No. 1
30	536.8	8-4-77		Three 400 ft. long crowfoot bar drags, 50, 100 and 200 ft. off left bank. All drags started at River Mile 536.9. No mussels collected. Bottom composition sand mixed with some silt. Sampling conducted by Ed Perry, USFWS.

Number coincides to numbers used on Table 19, in the text and on the figures. ICC = Iowa Conservation Commission USFWS = U.S. Fish and Wildlife Service

a/ b/ o/d/ e/f/ COE = Corps of Engineers
MDC = Missouri Department of Conservation
IDC = Illinois Department of Conservation

Site Reference Number	River Mile	<u>Date</u>	Sample Status (Alive/Dead)	Supplemental Information
31	535.4			Same as site No. 1
32	531.2	7-1-75	Dead	Collected on an island by Teresa DeBates, USFWS.
33	520.0	8-4-77		Crowfoot bar dragged 150 ft. off left bank from River Mile 522.3 to River Mile 518.0 along a red buoy line in main channel. No mussels collected. Sampling conducted by Ed Perry, USFWS, and Rick Breitenbach, USFWS.
34	516.0	5-10-76		Crowfoot bar dragged a total distance of 500 ft. parallel to and 100 ft. off left bank of Cattail Slough. No mussels collected. Sampling conducted by Ed Perry, USFWS, and Al Mueller, USFWS.
35	515.5	7-14-75	Alive	Same as site No. 26
36	515.2	9-2-75	Dead	Collected on left shoreline by Ed Perry, USFWS.
37	510.2	8-14-77	Alive	Same as site No. 26
38	510.0	2-18-77	Dead	Collected by Ed Perry, USFWS, from two mounds of spoil material adjacent to main channel. Spoil was from a pipeline crossing. The contractor placed backfill material on and partially excavated a commercial mussel bed.
39	509.5	5-10-76	Alive	Crowfoot bar dragged 75 ft. off left bank by Ed Perry, USFWS, and Al Mueller, USFWS. Good bed, although not commercially important. Mussels abundant in river reach from River Mile 509.0 (3M plant outfall pipe) to 509.9, 75 ft. off left bank. Mussel distribution is not uniform.
40	508.1	9-28-76	Alive	Collected by NALCO Environmental Sciences, Northbrook, IL.
41	508.0	6-30-76	Dead	Collected by Ed Perry, USFWS, on Adams Island.
4:2	506.8	9-28-76	Alive	Same as site No. 40
43	504.5	9-29-76	Alive	Same as site No. 40
44	504.0	6-30-75	Dead	Collected by Gary Wege, USFWS, on an island along right bank.
45	503.5	6-30-75	Dead	Collected by Ed Perry, USFWS, on small island in left main channel border.
46	503.4	9-30-76	Alive	Same as site No. 40
47	502.5	5-10-76	Alive	Crowfoot bar dragged 75 ft. off right bank adjacent to small rock jetty. Commercially fished bed. Sample collected by Ed Perry, USFWS, and Al Mueller, USFWS.
48	495.8	5-17-77		Crowfoot bar dragged 75 ft. off left bank starting at River Mile 495.8 and ending at I-80 bridge. The few mussels collected were not recorded. Sampling was conducted by Ed Perry, USFWS, and Rick Breitenbach, USFWS.
49	492.0	8-14-75	Alive	Same as site No. 26
50	48 5.5	6-15/16-77	Alive	Commercially fished bed. Collected by Don Helms, Ecology Consultants, INC., Bellevue, Iowa.
51	482.6	9-1-77	-	Three 500 ft. long crowfoot bar drags (25, 50 and 100 ft. off right bank of Sylvan Slough) starting at Moline Arsenal Island Bridge. No mussels collected. Site located below hydropower dam. Sampling conducted by Ed Perry, USFWS, Rick Breitenbach, USFWS, and Steve Waters, ICC.
52	481.6	8-23-76	Dead	Collected by Ed Perry, USFWS, from Corps' dredged spoil pile along Illinois shore.
53	481.2	8-23-76	Alive	Eight crowfoot bar drags made between wing dams along Iowa shore from River Mile 481.2 to 480.1. Mussel scattered throughout this reach although not considered a mussel bed. Collections made by Ed Perry, USFWS, and Al Kniep, private citizen.
54	478.3	5-31-76	Alive	Numerous collections made by Ed Perry, USFWS, and Al Mueller, USFWS, over a two year period (1975-76). Mussels were abundant along the right main channel border from the I-280 bridge to River Mile 477.6. The commercially fished bed extends into the main channel at River Mile 477.6.
55	473.8	8 - 19 - 75	Alive	Crowfoot bar dragged 1,000 ft. along left edge of main channel. Collected by Ed Perry, USFWS, and Don Kline, ICC.

Site Reference Number	River Mile	Date	Sample Status (Alive/Dead)	Supplemental Information
56	471.9	8-19-75	Alive	Crowfoot bar dragged a distance of 1,000 ft. parallel and 50 ft. off of Towhead Island in the main channel. Collected by Ed Perry, USFWS, and Don Kline, ICC.
57	471.6	8-19-75	Alive	Collected by Ed Perry, USFWS, and Don Kline, ICC, along right main channel border.
58	470.5	8-19-75	Alive	Same as site No. 57
59	467.0	8-19-75	Alive	Collected by Ed Perry, USFWS, and Don Kline, ICC, in center of Andalusia Slough Channel.
60	462.3	8-19-75	Alive	Collected by Ed Perry, USFWS, and Don Kline, ICC, in center of main channel.
61	460.1	8-19-75	Alive	Collected by Ed Perry, USFWS, and Don Kline, ICC, 25 ft. off right bank of Wyoming Slough just above the mouth of Sweetland Creek.
62	455.0	8-6-76	Alive	Commercially fished bed begins at McKee Button Company (red brick building on Iowa shore) and ends abruptly at outfall pipe adjacent to Kent Feeds at River Mile 453.7. Sampling conducted by Ed Perry, USFWS, Steve Waters, ICC, and Al Mueller, USFWS.
63	453.4	7-22-76	AND BOOK	Crowfoot bar drag started 100 ft. off right bank at River Mile 453.4 and ended 200 ft. off right bank at River Mile 453.2. No mussels collected. Collector was Ed Perry, USFWS.
64	453.0	7-22-76	water	Crowfoot bar drag started at Muscatine Power and Water conveyor in center of main channel and ended 1,000 ft. downstream. No mussels collected. Collector was Ed Perry, USFWS.
65	452.4	7-22-76		Crowfoot bar drag started at government light along left edge of main channel and ended 500 ft. downstream at first island south of government light. No mussels collected. Collector was Ed Perry, USFWS.
66	452.3	8-21-75	Dead	Collected by Don Kline, ICC, on Island No. 336.
67	451.5	72276	de an	Crowfoot bar drag started at government light 75 ft. off right bank and ended 500 ft. downstream. No mussels collected. Collector was Ed Perry, USFWS.
68	451.0	7-22-76	Alive	Small bed 50 ft. off right bank just upstream from wastewater canal. Collected by Ed Perry, USFWS.
69	449.9	7-22-76	antinos.	Crowfoot bar drag started at government daymark 50 ft. off right bank and ended 1,000 ft. downstream. No mussels collected. Collector was Ed Perry, USFWS.
70	448.6	6-16-76	Alive	Small commercial bed. Collections made by Ed Perry, USFWS, and Steve Waters, ICC. Separate collections made by Don Kline, ICC, on 8-21-75.
71	448.5	6-23-76	Dead	Collected by Don Kline, ICC, on Bass Island.
72	447.0	8-21-75	Dead	Collected by Don Kline, ICC, on Kilpeck Island.
73	445.0	8-21-75	Alive	Same as site No. 1. Collections also made by Don Kline, ICC.
74	437.0	8-28-75	Alive	Mussel bed just below Lock and Dam No. 17. Probably not commercially fished. Collections made by Ed Perry, USFWS, and Don Kline, ICC.
75	436.6	8-28-75	****	Crowfoot bar drag started at wing dam at lower end of Otter Tail Island and ended 500 ft. downstream. No mussels collected. Collectors were Ed Perry, USFWS, and Don Kline, ICC.
76	435.6	8-25-75	_	Crowfoot bar drag started in center of channel behind Keg Island and ended 500 ft. downstream. No mussels collected. Collectors were Ed Perry, USFWS, and Don Kline, ICC.
77	434.5	82575	Alive	Crowfoot bar drag started at boat launching ramp 50 ft. off right bank and ended 1,000 ft. downstream. Commercially fished bed. Collections made by Ed Perry, USFWS, and Don Kline, ICC.
78	434.3	6-23-75	Dead	Collected by Ed Perry, USFWS, on an island.
79	434.1	8-24-76		Two crowfoot bar drags parallel to Illinois shore starting at red buoy across from mouth of Iowa River and ended at government light. First run 200 ft. off left bank (main channel border) and second run in main channel along red buoy line. No mussels collected. Collected by Ed Perry, USFWS, and Lou George, COE—

Site Reference			Sample Status	. A 1 to Completion
Number	River Mile	Date	(Alive/Dead)	Supplemental Information
80	432.9	8-28-75		Two 500 ft. long crowfoot bar drags in right main channel border. No mussels collected. Collectors were Ed Perry, USFWS, and Don Kline, ICC.
81	432.0	8-24-76	va v-	Two parallel crowfoot bar drags 1,000 ft. long in right main channel border. No mussels collected. Collectors were Ed Perry, USFWS, and Lou George, COE.
82	429.2	8-28-75	and them	One 500 ft. long crowfoot bar drag along right main channel border. No mussels collected. Collectors were Ed Perry, USFWS, and Don Kline, ICC.
83	426.5	82875	ada tan	One 500 ft. crowfoot bar drag 25 ft. off left bank of Mapes Island starting at government light. No mussels collected. Collectors were Ed Perry, USFWS, and Don Kline, ICC.
84	425.7	6-23-75.	Dead	Collected by Ed Perry, USFWS, on Willow Bar Island.
85	425.3	8 ⊷28−7 5		One 500 ft. long crowfoot bar drag 30 ft. off right bank of Huron Island. No mussels collected. Collectors were Ed Perry, USFWS, and Don Kline, ICC.
86	424.5	6-23-75	Dead	Collected by Ed Perry, USFWS, on Snipe Island.
87	423.3	8-28-75	Alive	One 500 ft. long crowfoot bar drag 25 ft. off left bank at government daymark. The few mussels collected were not recorded. Collectors were Ed Perry, USFWS, and Don Kline, ICC.
88	421,4	8-28-75	Alive	Crowfoot bar drag 25 ft. off right bank of Johnson Island. The few mussels collected were not recorded. Collectors were Ed Perry, USFWS, and Don Kline, ICC.
89	410.3	9-4-75	Alive	Excellent bed located just below Lock and Dam No. 18. Not commercially fished. Collectors were Ed Perry, USFWS, and Don Kline, ICC.
90	409.2	9-4-75	Alive	Crowfoot bar drag 100 ft. off right bank of Otter Island. Few mussels collected were not recorded. Collectors were Ed Perry, USFWS, and Don Kline, ICC.
91	408.5	9-4-75	Alive	One 500 ft. crowfoot bar drag 25 ft. off right bank of island adjacent to Otter Island. Few mussels collected were not recorded. Collectors were Ed Perry, USFWS, and Don Kline, ICC.
92	406.5	6-23-75	Dead	Collected by Ed Perry, USFWS, on Big Rush Island.
93	405.1	7-24-75	Alive	One 500 ft. long crowfoot bar drag in center of O'Connel Slough adjacent to commercial dock. Few mussels collected were not recorded. Collectors were Ed Perry, USFWS, and Al Mueller, USFWS.
94	399.9	9-4-75	Alive	Commercially fished bed 40 ft. off right bank. Many Amblema plicata (Three-ridge) collected. Collectors were Ed Perry, USFWS, and Don Kline, ICC.
95	399.5	6-24-75	Dead	Collected by Ed Perry, USFWS, on Craigel Island.
96	398.2	9-4-75	Alive	One 500 ft. crowfoot bar drag 25 ft. off right bank at government light - daymark. Good mussel bed with many Quadrula nodulata (warty-back). Collectors were Ed Perry, USFWS, and Don Kline, ICC.
97	396.8	9-4-75	Dead	Collected by Ed Perry, USFWS, on right bank.
98	383.4	6-22-76		Four crowfoot bar drags immediately above a productive bed varying from 100 to 500 ft. off right bank. No mussels collected. Collectors were Ed Perry, USFWS, and Steve Waters, ICC.
99	382.6	6-22-76	Alive	One crowfoot bar drag 500 ft. above Crandon Paper Mill Co. and adjacent to Shaeffer water tower. Commercially fished bed. Collectors were Ed Perry, USFWS, and Steve Waters, ICC.
100	373.7	9-4-75	Alive	Few mussels collected about 300 ft. off right bank. Water depth was 24 ft. Bottom composition was silt mixed with gravel. Collectors were Ed Perry, USFWS, and Don Kline, ICC.
101	371.5	9-4-75	-	One crowfoot bar drag 1,000 ft. upstream from Iowa Gateway docking facility 50 ft. off left bank. Few mussels collected. Collectors were Ed Perry, USFWS, and Don Kline, ICC.
102	371.1	9-4-75	- '	One 1,000 crowfoot bar drag started at Iowa Gateway docking facility 100 ft. off right bank. Water depth was 20 ft. and bottom composition was silt. No mussels collected, but mayflies and fingernail clams were common. Collectors were Ed Perry, USFWS, and Don Kline, ICC.

Site Reference Number	River Mile	Date	Sample Status (Alive/Dead)	Supplemental Information
				The state of the s
103	358.3	8-13-76		One 1,000 ft. crowfoot bar drag started at head of Fox Island 75 ft. off right bank in main channel. Bottom composition was large gravel and rubble. No mussels collected. Collectors were Ed Perry, USFWS, and Dave Parsons, USFWS.
104	357.5	8-13-76		One 500 ft. crowfoot bar drag started at government light/daymark 75 ft. off right bank in right main channel border. Bottom composition was sand. No mussels collected. Collectors were Ed Perry, USFWS, and Dave Parsons, USFWS.
105	356.9	8-13-76	-	One 500 ft. crowfoot bar drag 75 ft. off left bank. Bottom composition was sand. No mussels collected. Collectors were Ed Perry, USFWS, and Dave Parsons, USFWS.
106	356.5	8-13-76	Alive	One 1,500 ft. crowfoot bar drag 75 ft. off left bank. Bottom composition was mixed gravel and sand. Small bed not commercially important. Collectors were Ed Perry, USFWS, and Dave Parsons, USFWS.
107	354.6	6-24-75	Dead	Collected by Ed Perry, USFWS, on Hackney Island.
108	350.0	8-11-76		Two crowfoot bar drags 100 ft. and 300 ft. off right bank of Buzzard Island, 500 ft. and 1,000 ft. long respectively. Bottom composition was sand. No mussels collected. Collectors were Ed Perry, USFWS, and Dave Parsons, USFWS.
109	349.3	6-24-75	Dead	Collected by Ed Perry, USFWS, Gus Artus, MDC $^{\mbox{e}/}$ and Bill Dieffenbach, MDC, on Buzzard Island.
110	348.7	8-11-76	Alive	Crowfoot bar drag started at government light 75 ft. off right bank. Few mussels collected. Collectors were Ed Perry, USFWS, and Dave Parsons, USFWS.
111	346.4	8-12-76	Alive	Few mussels collected adjacent to Polly Island. Collectors were Ed Perry, USFWS, and Dave Parsons, USFWS.
112	341.0	8-21-75		Crowfoot bar dragged from River Mile 341.0 to 335 in Canton Chute. No mussels collected. Bottom composition was sand. Collectors were Ed Perry, USFWS, and Bob Dunn, IDC ²⁷ .
113	340.8	8-12-76	Alive	One 1,000 ft. crowfoot bar drag 75 ft. off right bank. Three mussels collected but not recorded. Bottom composition was gravel. Collectors were Ed Perry, USFWS, and Dave Parsons, USFWS.
114	339.8	8-12-76	*****	One 1,000 ft. run 75 ft. off right bank starting at government light. Bottom composition was fine and large gravel. No mussels collected. Collectors were Ed Perry, USFWS, and Dave Parsons, USFWS.
115	339.5	8-12-76		Two parallel crowfoot bar drags 100 and 200 ft. off left bank of little Ladrange Island. No mussels collected. Bottom composition was sand and fine gravel. Collectors were Ed Perry, USFWS, and Dave Parsons, USFWS.
116	339.3	8-12-76		Crowfoot bar drag 100 ft. off right bank ending at River Mile 339.0 No mussels collected. Bottom composition was rubble and probably interfered with sampling gear's effectiveness. Collectors were Ed Perry, USFWS, and Dave Parsons, USFWS.
117	339.0	8-12-76		Crowfoot bar dragged 100 ft. off right bank ending at government light. No mussels collected. Bottom composition was gravel. Collectors were Ed Perry, USFWS, and Dave Parsons, USFWS.
118	339.0	8-12-76		Crowfoot bar dragged in center of main channel. Bottom composition was sand. No mussels collected. Collectors were Ed Perry, USFWS, and Dave Parsons, USFWS.
119	338.4	8-12-76		One 4,000 ft. crowfoot bar drag 75 ft. off left bank of Long Island ending at government light (River Mile 337.5). No mussels collected. Bottom composition was variable sand and gravel. Collectors were Ed Perry, USFWS, and Dave Parsons, USFWS.
120	338.0	10-10-75	Dead	Collected by Gordon Farabee, MDC, on right bank.
121	336.9	8-12-76	Alive	Crowfoot bar drag started at government light 75 ft. off left bank of LaGrange Island and ended at first wing dam downstream (River Mile 336.2). Few mussels collected. Bottom composition was variable sand and fine gravel. Collectors were Ed Perry, USFWS, and Dave Parsons, USFWS.
122	335.5	8-12-76	Alive	Crowfoot bar drag started at government light 75 ft. off right bank and ending at River Mile 334.6. Few mussels collected. Bottom composition was gravel. Collectors were Ed Perry, USFWS, and Dave Parsons, USFWS.

Site Reference Number	River Mile	<u>Date</u>	Sample Status (Alive/Bead)	Supplemental Information
123	335.3	6-24-75	Dead	Collected by Ed Perry, USFWS, and Bill Dieffenbach, MDC, on LaGrange Island.
124	332.6	8-11-76		Crowfoot bar drag started at government light buoy 300 ft. off left bank of Willow Island. No mussels collected. Collectors were Ed Perry, USFWS, and Dave Parsons, USFWS.
125	332.3	8-12-76		Crowfoot bar drag started in chute between Teal and Hogback Island. No mussels collected. Bottom composition was sand. Collectors were Ed Perry, USFWS, and Dave Parsons, USFWS.
126	331.7	8-11-76	and grown	Crowfoot bar dragged 100 ft. off right bank and ended at submerged pipeline (River Mile 331.3). Bottom composition was sand and fine gravel. No mussels collected. Collectors were Ed Perry, USFWS, and Dave Parsons, USFWS.
127	330.6	8-11-76	Walling	Crowfoot bar dragged for distance of 1,000 ft. approximately 900 ft. off left bank. Bottom composition was sand and fine gravel. No mussels collected. Collectors were Ed Perry, USFWS, and Dave Parsons, USFWS.
128	328.7	8-11-76		One 300 ft. crowfoot bar drag conducted 75 ft. off left bank. Bottom composition was sand. No mussels collected. Collectors were Ed Perry, USFWS, and Dave Parsons, USFWS.
129	323.6	8-10-76		One 1,300 ft. crowfoot bar drag 75 ft. off right bank of Orton Island. Bottom composition was rubble. No mussels collected. Collectors were Ed Perry, USFWS, and Dave Parsons, USFWS.
130	319.3	8-10-76	Alive	One 300 ft. crowfoot bar drag 75 ft. off right bank. The two mussels collected were not recorded. Collectors were Ed Perry, USFWS, and Dave Parsons, USFWS.
131	316.0	8-10-76	Alive	Crowfoot bar dragged 75 ft. off left bank and ended at River Mile 315.1. Mussel bed begins abruptly at government light (River Mile 316.0). It appears that sand is drifting downstream and covering portions of the bed. The bottom composition changes abruptly from sand (upstream of government light) to rubble (downstream of light). Although this bed has a high species diversity, it is not commercially important. Water depth is about 20 ft. Collectors were Ed Perry, USFWS, and Dave Parsons, USFWS.
132	314.0	8-10-76	and the	Crowfoot bar drag started at government light at left edge of main channel. Bottom composition was gravel. No mussels collected. Collectors were Ed Perry, USFWS, and Dave Parsons, USFWS.
133	311.8	8-10-76	- Account	Crowfoot bar dragged 100 ft. off left bank of Turtle Island for distance of 1,500 ft. Bottom composition was sand. No mussels collected. Collectors were Ed Perry, USFWS, and Dave Parsons, USFWS.
134	310.7	8-10-76	Alive	Crowfoot bar dragged 200 ft. off right bank. Bottom composition was gravel. Four mussels collected. Collectors were Ed Perry, USFWS, and Dave Parsons, USFWS.
135	308.0	8-10-76	Alive	Collected by Ed Perry, USFWS, on Glasscox Island.
136	306.9	8-10-76	Alive	One 3,500 ft. crowfoot bar drag 200 ft. off right bank. Five mussels collected. Collectors were Ed Perry, USFWS, and Dave Parsons, USFWS.
137	305.3	8-10-76		One 2,500 ft. crowfoot bar drag 100 ft. off left bank of Harris Island. Bottom composition was sand. No mussels collected. Collectors were Ed Perry, USFWS, and Dave Parsons, USFWS.
138	304.1	8-10-77	287-tum	One 500 ft. crowfoot bar drag at light buoy. No mussels collected. Collectors were Ed.Perry, USFWS, and Dave Parsons, USFWS.
139	303.5	8-10-76		One 300 ft. crowfoot bar drag at right edge of main channel. No mussels collected. Collectors were Ed Perry, USFWS, and Rick Breitenbach, USFWS.
140	302 . 7	****		One 500 ft. crowfoot bar drag at right edge of main channel. Bottom composition was sand. No mussels collected. Collectors were Ed Perry, USFWS, and Dave Parsons, USFWS.
141	299.8	9-11-75	Dead	Collected by Gordon Farabee, MDC, along the right bank.
142	287.0	9-25-76	Dead	Collected and identified by Ron Oesch, #9 Hill Dr., St. Louis, MO. 63122, along right bank. Collections also made on 8-28-76. The specimen of <u>Potamilus capax</u> has been verified by Dr. David Stansbery, Ohio State University.
143	255.0	9-1-76	******	Five crowfoot bar drags were conducted in Westport Chute from River Miles 254.1 to 255.0 No mussels were collected. Collectors were Al Mueller, USFWS, and Steve Hensley, COE.

Site				· · · · · · · · · · · · · · · · · · ·
Reference Number	River Mile	Date	Sample Status (Alive/Dead)	Supplemental Information
144	241.5	10-23-75	Dead	Collected by Al Mueller, USFWS, and Bill Overholtz, USFWS, just along right bank below Lock and Dam No. 25.
145	240.2	9-1-76	Alive	Collected by Al Mueller, USFWS, and Steve Hensley, COE, along the left main channel border.
146	217.4	11-8-76	Dead	Collected by Al Mueller, USFWS, along the right bank.
147	212.5	12-24-75	Dead	Collected by Al Mueller, USFWS, along the right bank.
148	147.5	8-17-76	Dead	Collected by Al Mueller, USFWS, in side channel adjacent to Illinois shoreline.
149	147.4	8-17-76		One 500 ft. crowfoot bar drag between wing dams in left main channel border. No mussels collected. Collectors were Al Mueller, USFWS, and Tom Johnson, IDC.
150	144.9	8-17-76	Dead	Collected by Al Mueller, USFWS, and Bill Dieffenbach, MDC, in cut-off side channel adjacent to Illinois shoreline.
151	141.7	8-17-76	Dead	Collected by Al Mueller, USFWS, in cut-off side channel adjacent to Missouri shoreline.
152	135.9	8-17-76		One 500 ft. crowfoot bar drag in right main channel border. No mussels collected. Collectors were Ed Perry, USFWS, and Al Mueller, USFWS.
153	135.4	6-12-76	Dead	Collected and identified by Ron Oesch, #9 Hill Dr., St. Louis, Mo., 63122. Mr. Oesch also collected at this site on 9-11-76.
154	132.3	8-18-76	Dead	Collected by Al Mueller, USFWS, in Fort Chartres Chute.
155	131.0	8-18-76	Dead	Collected by Al Mueller, USFWS, in Establishment Chute.
156	120.1	8-18-76	Dead	Collected by Al Mueller, USFWS, in Moro Chute.
157	117.0	8-18-76	Dead	Collected by Al Mueller, USFWS, in Kaskaskia Side Channel.
158	102.2	8-18-76		Crowfoot bar dragged for 500 ft. in Liberty Chute. No mussels collected. Collectors were Al Mueller, USFWS, and Tom Johnson, IDC.
159	93.0	9-18-76	Dead	Collected and identified by Ron Oesch, #9 Hill Dr., St. Louis, MO., 63122. River Mile given is approximate.
160	72.0	8-19-76	Dead	Collected by Al Mueller, USFWS, and Bill Dieffenbach, MDC, in Crawford Chute.
161	66.4	8-19-76		One 500 ft. crowfoot bar drag along right bank. No mussels collected. Collectors were Al Mueller, USFWS, and Tom Johnson, IDC.
162	64.2	9-3-76	Dead	Collected and identified by Ron Oesch, #9 Hill Dr., St. Louis, MO., 63122. Mr. Oesch also collected at this site on 9-22-74 and 2-15-76.
163	60.6	8-19-76	Alive	Hand picked by Al Mueller, USFWS, in Picayune Chute.
164	50.7	10 - 75		One 500 ft. crowfoot bar drag in left main channel border. No mussels collected. Collectors were Al Mueller, USFWS, and Bill Overholtz, USFWS.
165	39.4	8-20-76	Dead	Collected by Al Mueller, USFWS, in Santa Fe Chute.

RESULTS

Thirty-nine species of mussels and one true clam (Corbicula leana) were collected at 165 sites from river miles 39.0 to 674.0. Forty-two of these were shore collections, 104 were crowfoot bar collections, and the remaining 19 sites were historic mussel beds whose locations were provided by commercial clammers. No collections were made at the latter 19 sites (Table 20).

The three ridge, pimple back, pigtoe, maple leaf and hickory nut were the most commonly collected species, while Higgin's eye, fat pocketbook, spectacle case, purple warty back, pistol grip, ebony shell, purple shell mussel and Lasmigona compressa were collected only at a few locations (Table 21).

Except for Pools 12, 13 and 15, sampling efforts were fairly evenly divided between pools 14, 16, 17, 18, 19, 20, 21 and 22. Pools 24, 25, 26 and 26B were sampled infrequently, therefore, these latter four pools will not be discussed in this report. Sampling frequency ranged from a high 0.94 (Pool 21) to a low of 0.19 (Pool 13) sample sites per mile. Although the collections per mile were far greater in Pool 21 than in Pools 12, 13 and 15, each of these three pools yielded more species than Pool 21 (Table 22). Upon further examination of Table 22, it is apparent that mussels are relatively scarce in the lower pools (i.e. below Pool 19).

DISCUSSION

As mentioned earlier, the UMRCC survey began by collecting mussels from Corps of Engineer's dredged spoil piles. From these early collections, it appeared that species diversity decreased as sampling moved downstream. Ordinarily species diversity should increase in the downstream direction as food becomes more plentiful and habitats more diverse. Additional sampling fortified this initial observation, especially below Pool 19 (river mile 364.5). The only two mussel beds below Pool 19 (Figures 44 and 52, Appendix C) are of poor quality compared to beds further upstream. In August, 1976 we sampled more than 20 miles in pools 20, 21, and 22, yet collected fewer than 100 mussels. One 3,500 foot run (Figure 54, Appendix C, sample 136) in Pool 22 yielded only five mussels. In upstream reaches, this collection would not have been recorded. However, in the lower pools mussels were uncommon and all specimens collected were recorded.

Contrary to popular opinion, the Upper Mississippi River bed is not blanketed with mussels shore to shore. Mussel beds are not nearly as common as in the "good old days". Random sampling efforts produced relatively few mussel beds, although this may be partly related to site selection. One factor affecting sampling success is that the boundaries of mussel beds are sharply delineated and do not usually taper off gradually over long distances. Thus, it is possible to sample within a few feet of a large bed and miss it. If the UMRCC survey continues, all known

Table 21. A checklist of mussels collected during the UMRCC Survey, their common names, total number of occurrence and frequency of occurrence in 86 successful crowfoot bar and share collections.*

	Total Number of Occurrence	Frequency of Occurrence (%)
Actinonaias ligamentina carinata (Mucket) Amblema plicata plicata (Three Ridge) Anodonta grandis grandis (Floater) Anodonta grandis corpulenta (Stout Floater) Anodonta imbecillis (Paper Pond Shell) Anodonta suborbiculata (Heel Splitter) Arcidens confragosus (Rock Pocketbook) Corbicula leana (Asiatic Clam) Cumberlandia monodonta (Spectacle Case) Cyclonaias tuberculata (Purple Warty Back) Elliptio dilatatus (Lady Finger) Fusconaia ebena (Ebony Shell) Fusconaia flava (Wabash Pig Toe) Lampsilis higginsi (Higgin's Eye) Lampsilis teres form teres (Yellow Sand Shell) Lampsilis teres form fallaciosa (Slough Sand Shell) Lampsilis teres form fallaciosa (Slough Sand Shell) Lampsilis ventricosa (Pocketbook) Lasmigona complanata (White Heel Splitter) Leptodea fragilis (Fragile Paper Shell) Ligumia recta (Black Sand Shell) Megalonaias nervosa (Washboard) Obovaria clivaria (Hickory Nut) Obliquaria reflexa (Three-Horned Warty Back) Plagiola lineolata (Butterfly) Plethobasus cyphyus (Bullhead) Potamilus alatus (Pink Heel Splitter) Potamilus capax (Fat Pocketbook) Potamilus laevissimus (Pink Paper Shell) Quadrula metanevra (Monkey Face) Quadrula nodulata (Warty Back)	of Occurrence 12 64 5 24 2 1 17 8 1 2 3 8 52 7 2 11 7 39 4 1 46 19 30 47 52 34 3 30 1 25 1 16 32	Occurrence (%) 13.9 74.4 5.8 27.9 2.3 1.1 19.7 9.3 1.1 2.3 3.4 9.3 60.4 8.1 2.3 12.8 8.1 45.3 4.6 1.1 53.4 22.1 34.8 54.6 60.5 39.5 3.4 34.8 1.1 29.1 1.1 18.6 37.2
Quadrula pustulosa (Pimple Back) Quadrula quadrula (Maple Leaf) Strophitus undulatus undulatus (Squaw Foot) Toxolasma parvus (Liliput Shell)	56 49 13 3	65.1 56.9 15.1 3.4
Tritogonia verrucosa (Pistol Grip) Truncilla donaciformis (Fawn's Foot) Truncilla truncata (Deer Toe)	1 24 39	1.1 27.9 45.3

^{*} A successful crowfoot collection included at least one specimen.

^{**} Frequency of Occurrence - Signifies the percentage of occurrence in 86 successful collections.

Table 22. A comparison of the sample sites per mile and the total number of species collected per pool.

<u>Pool</u>	Sample Sites Per Mile	Total Number of Species Collected
12	0.21	21
13	0.19	20
14	0.59	20
15	0.20	26
16	0.42	27
17	0.60	24
18	0.55	19
19	0.31	19
20	0.41	17
21	0.94	14
22	0.40	15

commercial clammers should be contacted for information on other bed locations.

Gravel mining is another factor affecting mussel bed development. Since mussels are slow growing and relatively immobile, beds develop only in areas with an extremely stable river bottom. A gravel bed provides this stability. Through hydraulic sorting, gravel armors the river's bed, thereby retarding excessive scour _// and preventing excessive sediment movement. Hence, gravel armored sand bars can serve as semi-permanent channel controls. Removing the gravel armor can lead to erosion of the river's bed with attendent increases in siltation, dredging and loss of aquatic habitat. Thus, due to its stability, a gravel armored river bottom not only serves as a channel maintenance control feature, but also develops a rich benthic fauna and can provide prime sites for mussel beds.

The 1931 Ellis Survey 8/ was the last mussel survey conducted on the Upper Mississippi of comparable scope to the UMRCC efforts. Ellis made thousands of individual collections at 254 stations from Quincy, Illinois to Point Au Sable, Minnesota. His sampling efforts consisted of hand picking and self-closing dredges that collected six square feet of river bottom. 1/ Though Ellis's survey was more intensive and his sampling methods less selective, both his and the UMRCC survey yielded the same number of species. However, there were differences in the number and abundance of species collected.

For example, Ellis collected six species that were not collected by UMRCC biologists, while there are six species listed in this survey that were not listed by Ellis.

These differences are summarized in Table 23 using Van der Schalie's 1/ analysis of Ellis's data. Van der Schalie concluded that ebony shell, monkey face, pistol grip and white heel splitter were common throughout the river in the 1930's; while purple warty back, bullhead, fat pocketbook and Higgin's eye were wide ranging but seldom occurred in large numbers. The UMRCC survey classified ebony shell, pistol grip, white heel splitter and bullhead as uncommon, while Higgin's eye and fat pocketbook are listed by the U.S. Department of the Interior as endangered species. 9/ Only two sub-fossil shells of purple warty back were collected. Dr. Van der Schalie 1/ lists 24 of the 39 species Ellis collected as common throughout the river; only 13 of the 40 species included in the UMRCC survey could be categorized as common. Of the 86 successful brail and shore collections these 13 species occurred in 35 to 75 percent of the collections (Table 21). Twenty-one other species were present in less than 15 percent of the collections. In contrast to Ellis's collections, the evidence suggests that the Mississippi River mussel fauna is now dominated by relatively few species, with a decrease in species numbers and diversity. 10/

There are a number of factors that have acted to reduce mussel populations. Erosion silt resulting from poor land use practices has smothered numerous mussel beds. 4,8,11/ Fuller 11/ blames wing dams as being "...particularly reprehensible because they set up powerful currents which shift bars, erode stream banks and increase silt". Coker, et al. 4/, and Grier 12/ described certain river reaches where mussels had thrived that had since been destroyed by wing dam construction. Although siltation has destroyed many mussel beds, a number of species can withstand a certain amount of sedimentation. For example, the UMRCC survey included collections of three ridge, pig toe and pocketbook mussels buried under six inches of silt. Other species such as paper pond shell, heel splitter and liliput shell, are typically found on silt bottoms. Excessive siltation has probably eliminated silt intolerant species and this may be one reason for the apparent decreased species diversity.

Hydraulic dredging to maintain a nine-foot navigation channel has almost certainly destroyed mussel beds. Due to increased awareness and interagency coordination, the chance of this occurring today, especially in the Rock Island Corps District, is remote. However, accidents can happen. For example, in July, 1976 the St. Paul Corps District dredged over 100,000 yds. 3/ of bottom materials from the East Channel at Prairie du Chien, Wisconsin. Unfortunately, dredged material at this site contained over 1,700 mussels representing 33 species, including 60 specimens of Higgin's eye mussel (an endangered species). 13/

Another factor, not generally considered a threat to mussels is the flood protection levees bordering the Mississippi River. Counting both river banks, over 150 miles of mainstem levees have been constructed from river miles 300 to 500 (Saverton, Missouri to Princeton, Iowa). Most of the material used to construct these levees was dredged from the river. In some instances, these levees were raised more than once resulting in repeated dredging.

Table 23. A comparison of the relative abundance of mussels collected during the Ellis Survey and the UMRCC Survey.

	* Ellis Survey	UMRCC Survey
Actinonaias ligamentina carinata (Mucket)	X	W
Amblema plicata plicata (Three Ridge)	C	Č
Anodonta grandis grandis (Floater)	N	W
Anodonta grandis corpulenta (Stout Floater)	C	W
Anodonta imbecillis (Paper Pond Shell)	С	R
Anodonta suborbiculata (Heel Splitter)	N	R
Arcidens confragosus (Rock Pocketbook)	W	W
Corbicula leana (Asiatic Clam)	${\mathbb N}$	c^{1}
Cumberlandia monodonta (Spectacle Case)	${f N}$	0
Cyclonaias tuberculata (Purple Warty Back)	W	0
Elliptio dilatatus (Lady Finger)	X	R
Fusconaia ebena (Ebony Shell)	C	R
Fusconaia flava (Wabash Pig Toe)	C	C
Lampsilis higginsi (Higgin's Eye)	W	${ m E}$
Lampsilis radiata luteola (Fat Mucket)	M	R
Lampsilis teres form teres (Yellow Sand Shell)	C	W
Lampsilis teres form fallaciosa (Slough Sand S	Shell) C	W
Lampsilis ventricosa (Pocketbook)	X	C
Lasmigona complanata (White Heel Splitter)	C	R
Lasmigona compressa (Creek Heel Splitter)	N	R
Leptodea fragilis (Fragile Paper Shell)	C	C
Ligumia recta (Black Sand Shell)	C	W
Megalonaias nervosa (Washboard)	C	C
Obovaria olivaria (Hickory Nut)	C	C
Obliquaria reflexa (Three-Horned Warty Back)	C	C
Plagiola lineolata (Butterfly)	C	C
Plethobasus cyphyus (Bullhead)	M	R
Potamilus alatus (Pink Heel Splitter)	C	C
Potamilus capax (Fat Pocketbook)	W	E
Potamilus laevissimus (Pink Paper Shell)	C	W
Potamilus purpurata (Purple Shell Mussel)	N	R
Quadrula metanevra (Monkey Face)	C	W
Quadrula nodulata (Warty Back)	C	C
Quadrula pustulosa (Pimple Back)	C	C
Quadrula quadrula (Maple Leaf)	C	C
Strophitus undulatus undulatus (Squaw Foot)	X	W
Toxolasma parvus (Liliput Shell)	${f Z}$	R
Tritogonia verrucosa (Pistol Grip)	C	R
Truncilla donaciformis (Fawn's Foot)	C	M
Truncilla truncata (Deer Toe)	C	C

^{*} Taken from Van der Schalie $\frac{1}{}$

C Common throughout the river

E Endangered

O No live specimens taken

W Species with a wide range but seldom occurring in large numbers

N Not collected by Ellis

R Rarely collected

X Species distribution limited mainly to above Prairie du Chien, Wisconsin

Z Not considered to be a regular part of the fauna

 $[\]mathbb{C}^1$ Common only in the Middle River. Rarely found in the Upper Mississippi

Although mussel surveys were not conducted prior to dredging, some of the older levees are strewn with mussel shells, providing strong evidence that mussel beds were excavated along with levee materials.

Aside from pollution and the aforementioned factors, over harvesting is probably the next greatest threat to commercially valuable mussels. Unlike their predecessors, todays clammers often use scuba or other diving gear. Although this is an efficient technique, the non-selective removal of all size ranges and species could destroy the bed's productivity for many years. When mussels were harvested for the pearl button industry, ebony shell, lady finger, pocketbook, hickory nut, butterfly and monkey face were among the most sought after shells. Today, none of these species are commercially important, only three ridges, washboards, and large maple leafs and pimple backs have shells of sufficient thickness for use in cultured pearl production. However, commercial clammers continue to take, and often discard, other species. In addition to harvesting all species, some clammers keep all size ranges. The small specimens are ground up and used for a variety of ornamental purposes while shells two and one-half inches or larger are shipped to Japan for use in the cultured pearl industry. Since mussels are slow growing (a 2.5 inch long mussel may range from 5-16 years of age), harvesting all size ranges could destroy the fishery. Experience has shown that mussels cannot withstand heavy fishing pressure, 3/ therefore, additional research is necessary to determine if harvest rates should be implemented and size limits more stringently enforced.

Besides their commercial value, mussels play an important role in the aquatic food chain by converting plankton, a food source unavailable to many aquatic species, into a readily available food source. Jude 14/ found that molluscs comprised a significant portion of the diet of larger channel catfish in Pool 19. Freshwater drum also feed heavily on molluscs; their pharyngeal arches are well suited for crushing mollusc shells. Planktivores such as gizzard shad (Dorosoma cepedianum) and paddlefish (Polyodon spathula) and bottom feeders such as sturgeon (Acipenseridae) and suckers (Catostomidae) feed on larval and juvenile mussels. 15/ A few mammals such as muskrats and raccoons also feed on mussels. 11/ Muskrats often leave piles of discarded shells (called midden) at preferred feeding stations.

Reproductive success and thus survival of certain mussel species is dependent on the survival of particular fish species since some mussels are host-specific during their intermediate, parasitic life stages. The male mussel sheds sperm into the water which is drawn into the female's incurrent siphon. Once fertilized, the eggs incubate on the female's gills for varying periods, depending on the species. Following incubation the larvae (glochidia) are discharged into the water where they become free-floating until they become attached to the gills or fins of a particular host fish. Each mussel species seems to require particular fish species or group of species as intermediate hosts. The glochidia will not infect another fish species if the particular host fish is unavailable. 4,11,16/ Since mussel larvae are not free swimming, host fish also serve as a dispersal mechanism. One possible explanation for the demise of the ebony shell may be that its host fish, the skipjack herring (Alosa chrysochloris), has not been found above Lock and Dam 19 (Keokuk, Iowa) since the mid 1920's. 2/

Additional information is needed to predict the future for Upper Mississippi River mussel fauna. The resurgence of commercial clamming reopens the possibility that mussel fauna may be seriously depleted. Commercially fished mussel beds should be mapped and sampled intensively to determine species composition, recruitment success and population densities. If appropriate, harvest should be regulated and size limits enforced. Gravel mining should also be examined much more closely than it has been in the past. Benefits derived from this seemingly harmless operation may be minuscule compared to the environmental damages and channel maintenance problems it creates. 7/Finally, a mussel survey should be a prerequisite for any dredging or filling activity in the river.

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