Proceedings of the Iowa Academy of Science

Volume 89 | Number

Article 13

1982

Factors Influencing Hoop Net Catches in Channel Habitats of Pool 9, Upper Mississippi River

Wayne A. Hubert
Iowa State University

Dennis N. Schmitt
Iowa State University

Proc. Iowa Acad. Sci. 89(2): 84-88. 1982

Factors Influencing Hoop Net Catches in Channel Habitats of Pool 9, Upper Mississippi River[1]

WAYNE A. HUBERT and DENNIS N. SCHMITT[2]

Iowa Cooperative Fishery Research Unit, Iowa State University, Ames Iowa 50011

The catch per unit of effort and species selectivity of two hoop net types fished in channel habitats of Pool 9 were described. Variation in catch was noted between the two net types, as well as between sampling areas and channel types. The total catch with bait nets was 580 fish in the main channel border and 539 in side channels, while buffalo nets captured 1,213 fish from the main channel border and 1,004 from side channels with the same amount of fishing effort. Six species comprised 93% of the bait net samples: shorthead redhorse, black crappie, freshwater drum, flathead catfish, bluegill, and channel catfish. The six most abundant species in buffalo nets were: shorthead redhorse, freshwater drum, smallmouth buffalo, mooneye, bluegill, and common carp. Species collected in greater numbers in main channel border habitats were: gizzard shad, mooneye, quillback, white sucker, smallmouth buffalo, bigmouth buffalo, channel catfish, flathead catfish, and black crappie. Side channels produced greater numbers of common carp, shorthead redhorse, and bluegill. Multiple regression analysis showed that variation in water temperature, current velocity, turbidity, dissolved oxygen, channel type, and sampling area accounted for variation in the catch of several fish species. Turbidity was the most common variable to be related to catch and tended to have a negative relationship.

INDEX DESCRIPTORS: fish, Mississippi River, Pool 9, hoop net, catch.

Few gears are available to adequately sample fish in the strong currents of large river channels. One usable gear is the hoop net. Hoop nets rely on fish movement for self entrapment and any factor that accelerates movement can also increase catch per unit of effort (CPUE) (Mayhew 1972). Although CPUE of hoop nets, like that of other fish sampling gears, can be proportional to fish abundance (Gulland 1973), several biological, environmental, and mechanical factors also influence CPUE.

Hoop nets are selective for certain species and sizes of fish depending on net construction, mesh size, and bait (Carter 1954, Harrison 1954, Starrett and Barnickol 1955, Mayhew 1973). The CPUE with a particular net construction and bait is further influenced in streams by numerous environmental factors including season, water temperature, river stage, turbidity, and net location in a river (Muncy 1957, Funk 1957, 1958).

Few data on CPUE of hoop nets in the Mississippi River are available. The classic study of the efficiency and selectivity of commercial fishing devices used on the Mississippi River by Starrett and Barnickol (1955) described the catch with unbaited, 2.5- and 6.5-cm-square mesh hoop nets in two reaches of the river, without consideration of habitat types or environmental variables.

The purpose of this study was to derive basic information on the selectivity and CPUE of two hoop net types in Mississippi River channels, as well as the influence of environmental variables on CPUE of each type. Variables of interest were water temperature, turbidity, current velocity, dissolved oxygen, channel type, and sampling location.

METHODS

Three Upper Mississippi River reaches of Pool 9 were sampled in 1980 (Figure 1). The three reaches were in the Battle Slough, Winneshiek Slough, and Big Slough areas. Each study reach consisted of a main channel and flowing side channel. Study reaches were selected so that environmental variables (water temperature, turbidity, current velocity, and dissolved oxygen) in the side channels and main channel would be similar. The main channel border was defined as the zone between the navigation channel and the main river bank, and side channels were designated as departures from the main channel in which there is current during normal river stage (Rasmussen 1979).

Two types of hoop nets were used, "bait nets" and "buffalo nets". Bait nets were constructed of 3.8-cm-mesh (bar measure) netting with seven hoops ranging from 0.9m in diameter at the mouth to 0.6m in diameter at the cod end. Bait nets had two finger throats and were baited with cheese. Buffalo nets were made of 7.6- to 4.4-cm-mesh netting from mouth to cod end with hoop diameters declining from 1.2 to 1.0 m over the length of the net. Buffalo nets were constructed with two square throats and were baited with soybean cake. The two net types were set in tandem at each sampling location, with the bait net 25 m downstream from the buffalo net.

Ten netting locations were selected along the main channel border and in the side channel of the three study reaches. Sampling rotated weekly from Battle Slough to Winneshiek Slough to Big Slough from July through October, resulting in five sampling periods per area. Five locations in each channel type were randomly selected in each sampling period. Nets were set for three consecutive days and the catch was removed daily. Current velocity, turbidity, water temperature, and dissolved oxygen were measured in midchannel of both main and side channel areas on each sampling day.

Chi-square was used to compare catch between the two net types and between main channel border and side channel locations. Analysis of variance (ANOVA) was utilized to evaluate variation in measured environmental variables and CPUE resulting from sampling location, channel type, and sampling period; while stepwise multiple regression was used to determine possible associations between selected environmental variables and CPUE of the most abundant species captured with each type of hoop net. All decisions to reject null hypotheses were at a 0.10 level of sampling probability.

RESULTS

Environmental Variables

Mean values of environmentl variables measured in main channel and side channel sampling areas for all river reaches were graphically portrayed (Figure 2). Water temperature from July through October declined from 24 to 4 C, and dissolved oxygen rose from 6 to 11 mg/1. Turbidity ranged from 28 to 178 Jackson Turbidity Units.

[1]Journal Paper No. J-10235 of the Iowa Agriculture and Home Economics Experiment Station, Ames, Iowa. Project No. 2458. Financed by a grant from the Upper Mississippi River Basin Commission and made available through the U. S. Fish and Wildlife Service to the Iowa Cooperative Fishery Research Unit.

[2]The Unit is jointly supported by Iowa State University, the Iowa State Conservation Commission, and the U. S. Fish and Wildlife Service.

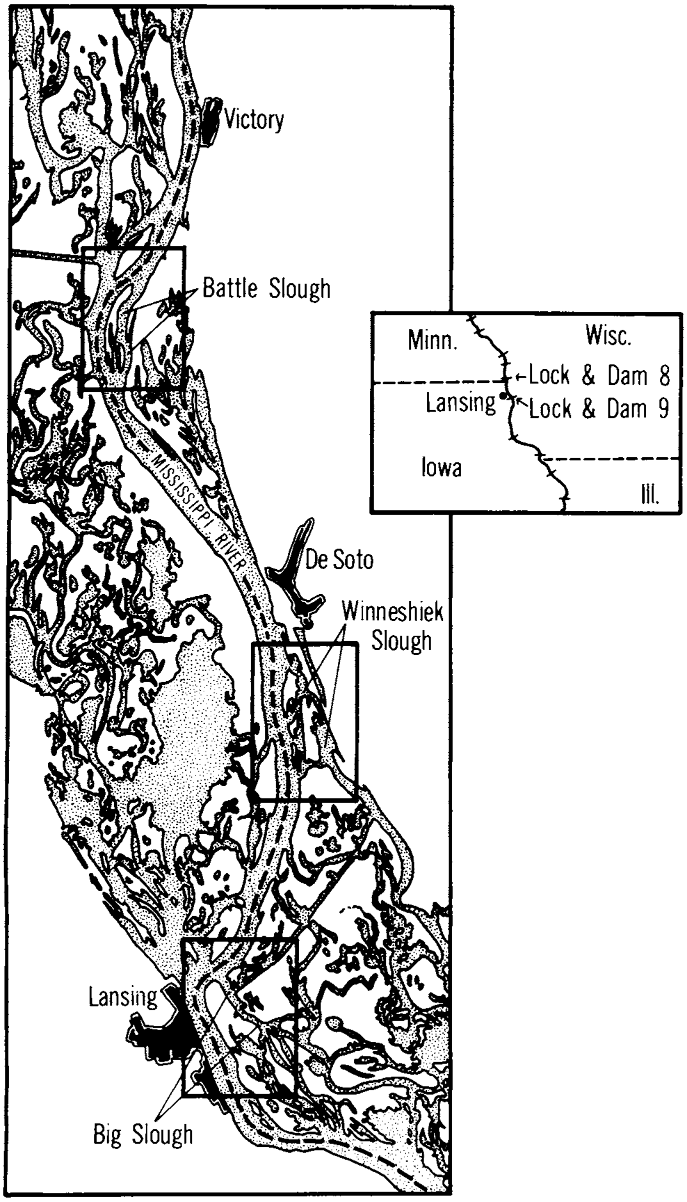

Figure 1. Location of the three hoop net sampling areas in Pool 9, Upper Mississippi River.

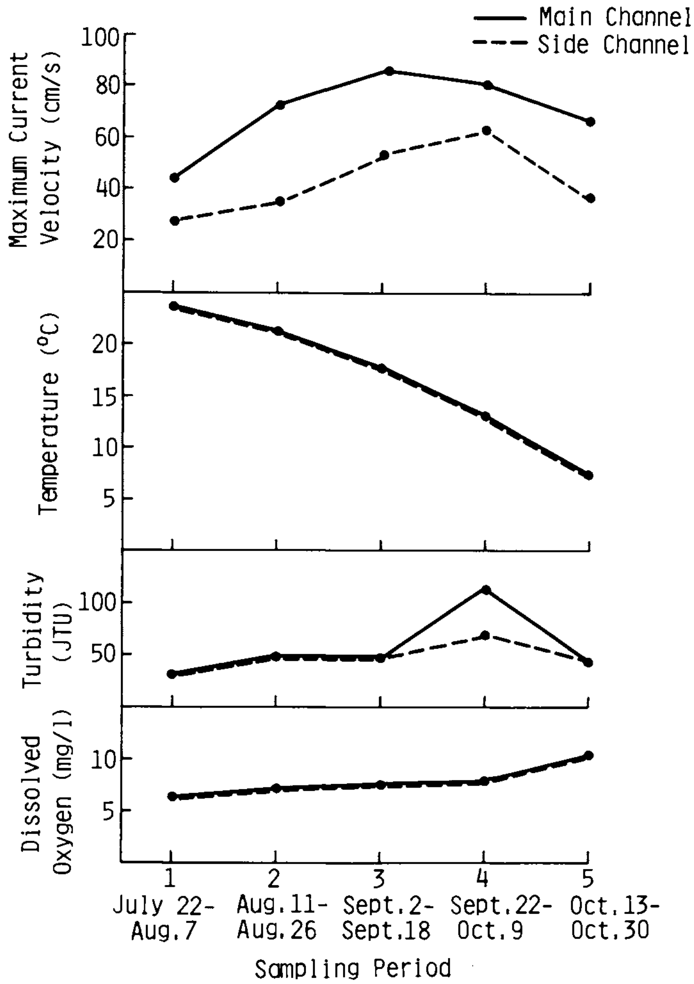

Figure 2. Mean values of measured environmental variables in main channel and side channel habitats of Pool 9, Upper Mississippi, for each sampling period.

The only significant difference between main channel and side channel locations indicated by ANOVA was in current velocities, which were consistently higher in the main channel than in side channel areas. Current velocities (cm/second) ranged from 17 to 105. They averaged 69 in the main channel and 42 in the side channels. Current velocities also varied significantly among the three side channels, tending to be higher at Battle Slough and Winneshiek Slough than at Big Slough.

Species Composition

Thirty-three species of fish were captured with the two hoop net types, 24 species with bait nets and 31 species with buffalo nets (Table 1). With equal sampling effort, bait nets took 1,119 fish, buffalo nets 2,217. Chi-square testing of total catches indicated significant numerical differences in catch between the two gears for several species (Table 1). Buffalo nets captured 14 species in significantly larger numbers. Only 4 species were significantly more numerous in the bait net catch: shortnose gar, channel catfish, flathead catfish, and rock bass.

Six species comprised 93% of the bait net samples: shorthead redhorse (48% of total sample), black crappie (21%), freshwater drum (11%), flathead catfish (6%), bluegill (5%), and channel catfish (2%).

The 10 most abundant species in the buffalo net samples comprised 94% of the catch: black crappie (28% of the total sample), shorthead redhorse (24%), freshwater drum (16%), smallmouth buffalo (13%), mooneye (4%), bluegill (3%), common carp (2%), quillback (2%), silver redhorse (1%) and walleye (1%).

Chi-square analysis indicated significant numerical differences in catch between the main channel border and side channels for six species captured in bait nets and for nine species in buffalo nets. Species collected in significantly greater numbers from main channel border habitats with at least one hoop net type were gizzard shad, mooneye, quillback, white sucker, smallmouth buffalo, bigmouth

Table. 1. **Catch with two types of hoop nets in main channel border (main) and side channel (side) habitats of Pool 9, Upper Mississippi River, 1980 (225 net days per channel type with each gear).**

	Bait Net		Buffalo Net	
Species	Main	Side	Main	Side
Shortnose gar, *Lepisosteus spatula*	3	5	1	—
Bowfin, *Amia calva*	—	—	—	1
Gizzard shad, *Dorosoma cepedianum*	—	—	5	2
Mooneye, *Hiodon tergisus*	4	3	57	40
Northern pike, *Esox lucius*	—	—	4	3
Common Carp, *Cyprinus carpio*	3	2	11	32
River carpsucker, *Carpiodes carpio*	—	—	3	5
Quillback carpsucker, *Carpiodes cyprinus*	—	—	34	6
Highfin carpsucker, *Carpiodes velifer*	—	—	2	—
White sucker, *Catostomus commersoni*	4	—	9	1
Blue sucker, *Cycleptus elongatus*	—	1	—	2
Smallmouth buffalo, *Ictiobus bubalus*	6	5	168	126
Bigmouth buffalo, *Ictiobus cyprinellus*	—	—	10	1
Black buffalo, *Ictiobus niger*	—	—	—	1
Spotted Sucker, *Minytrema melanops*	1	—	7	5
Silver redhorse, *Moxostoma anisurum*	—	1	16	9
Golden redhorse, *Moxostoma erythrurum*	8	5	10	8
Shorthead redhorse, *Moxostoma macropedidotum*	253	295	271	258
Black bullhead, *Ictalurus melas*	1	—	—	—
Yellow bullhead, *Ictalurus natalis*	1	2	2	—
Channel catfish, *Ictalurus punctatus*	13	5	1	1
Flathead catfish, *Pylodictis olivaris*	39	23	10	10
White bass, *Morone chrysops*	2	—	1	7
Rock bass, *Ambloplites rupestris*	10	5	2	—
Orangespotted sunfish, *Lepomis humilis*	—	1	—	—
Bluegill, *Lepomis macrochirus*	11	46	10	59
Smallmouth bass, *Micropterus dolomieui*	2	—	—	—
White crappie, *Pomoxis annularis*	—	—	—	1
Black crappie, *Pomoxis nigromaculatus*	139	91	383	241
Yellow perch, *Perca flavescens*	1	—	1	—
Sauger, *Stizostedion canadense*	3	2	3	1
Walleye, *Stizostedion vitreum vitreum*	2	1	13	8
Freshwater drum, *Aplodinotus grunniens*	74	46	179	176
Total	580	539	1,213	1,004

buffalo, channel catfish, flathead catfish, and black crappie. Side channels produced significantly greater numbers of common carp, shorthead redhorse, and bluegill. The total catch with bait nets was 580 fish in the main channel border and 539 in side channels. Buffalo nets captured 1,213 fish from the main channel border and 1,004 from the side channels with the same amount of effort.

Catch per unit of effort

The mean number of fish caught per unit of effort (one net day) was about 2.5 with bait nets and 5.0 with buffalo nets, but the rate varied widely. Inasmuch as the two hoop net types were fished in tandem at the same location, each may have influenced the catch in the other to some degree. The influence of sampling reach, channel type, and sampling period on mean CPUE within a 3-day sampling interval was assessed by analysis of variance. Among the three variable classes for the 6 most abundant species in bait net samples and the 10 most abundant species in buffalo samples, statistically significant variation in CPUE due to sampling area or sampling period was noted for several. The CPUE of black crappie, shorthead redhorse, bluegill, quillback, and common carp were significantly different among sampling areas for at least one type of hoop net. Channel type had a significant influence on CPUE of only one species, the quillback. Catch rate of quillback was higher in main channel border areas than in side channels. Sampling period significantly influenced the CPUE of black crappie, freshwater drum, flathead catfish, smallmouth buffalo, and shorthead redhorse in at least one gear type.

Stepwise multiple regression analysis indicated environmental variables can account for variance in the CPUE of individual species and total catch (Table 2). The independent variables were mean values of current velocity, turbidity, water temperature, and dissolved oxygen measured in a sampling area over a 3-day sampling interval, as well as sampling area and channel type. Sampling areas were coded 1, 2, and 3 in progression downstream. Channel type was coded as a dichotomous variable. The dependent variable was the mean CPUE of a species in a sampling area over the 3-day interval. The CPUE of several species were significantly related to one or more environmental variables; however, the maximum accounted-for variance attributed to environmental variables was about 52%. The most frequent environmental variable to influence CPUE was turbidity. Turbidity had a negative relationship to the catch of shorthead redhorse in bait nets and the catch of quillback, shorthead redhorse, bluegill, and freshwater drum in buffalo nets; and a positive relationship to the catch of flathead catfish in bait nets. Turbidity also showed a negative influence on the total catch rate of both bait nets and buffalo nets.

Current velocity had a negative relationship to catch of freshwater drum in bait nets and to common carp in buffalo nets. In buffalo nets, CPUE of bluegill and crappie, as well as total catch, was positively correlated to current velocity. Water temperature negatively influenced CPUE of common carp, shorthead redhorse, and walleye in buffalo nets, but was positively correlated with CPUE for smallmouth buffalo. Dissolved oxygen, channel type, and sampling area were also related to CPUE of some species.

DISCUSSION

Main channel border and flowing side channel habitats generally differ. Often the major differences are that the main channel border is modified by channel training devices (e.g., wing dams, closing dams, rip-rap), the main channel border is vulnerable to turbulence and wave action created by barge traffic, and is generally associated with a deeper, wider, and faster flowing channel. The influence of channel type on hoop net catch was assessed by Ragland (1974), who compared fish samples from three side channels to the main channel border of the Middle Mississippi River, 30 to 100 km downstream from St. Louis, Missouri. Significantly greater numbers of fish were captured in side channels than in the main channels of the Middle Mississippi River study areas, but the number of species in main channel border and side channel areas were similar. In the Pool 9 investigation, the total catch and specis composition of the catch were similar in main channel and side channel areas, but individual species tended to vary in abundance in the two channel types.

A comparison of the fish communities in three successional stages of side channels of Pools 20, 21, and 22 of the Upper Mississippi River showed differences in hoop net catch, with transition from riverine to lacustrine conditions (Ellis et al. 1979). Hoop netting in a

Table 2. Statistically significant regression equations relating variation in mean CPUE (catch per net day) over a 3-day sampling period to variation in the mean of measured environmental variables over the same sampling period for abundant fish species in Pool 9 hoop net catches ($P \leq 0.10$).

Species	Equation[a]	R^2
Bait Nets		
Shorthead redhorse	$CPUE = 2.89 - 0.012T - 0.549A$	0.37
Channel catfish	No significant variables	—
Flathead catfish	$CPUE = -0.01 + 0.003T$	0.39
Bluegill	No significant variables	—
Black crappie	No significant variables	—
Freshwater drum	$CPUE = 1.07 - 0.00000074\ V^2 - 0.357C$	0.47
Total catch	$CPUE = 8.54 - 3.697 \log_{10}T$	0.10
Buffalo Nets		
Mooneye	No significant variables	—
Common carp	$CPUE = 0.97 - 0.00027\ V - 0.609 \log_{10}H$	0.36
Quillback carpsucker	$CPUE = 0.824 - 0.233 \log_{10}T - 0.134C - 0.074A$	0.52
Smallmouth buffalo	$CPUE = -11.3 + 8.44 \log_{10}D + 3.78 \log_{10}H$	0.29
Silver redhorse	No significant variables	—
Shorthead redhorse	$CPUE = 4.16 - 0.013T - 1.29 \log_{10}H - 0.432A$	0.35
Bluegill	$CPUE = 0.09 + 0.0017V - 1.03 \log_{10}T + 6.65C$	0.43
Black crappie	$CPUE = -0.11 + 0.000004\ V^2$	0.11
Walleye	$CPUE = 0.19 - 0.122 \log_{10}H$	0.11
Freshwater drum	$CPUE = 3.19 - 1.46 \log_{10}T$	0.15
Total catch	$CPUE = 2.01 + 0.0069V - 0.00024\ T^2$	0.19

[a]Abbreviations: A = sampling; C = channel type (main or side); D = dissolved oxygen (mg/ℓ); H = water temperature (°C); T = turbidity (Jackson Turbidity Units); and V = current velocity (cm/second).

riverine side channel of Pool 20, which was similar to the side channels of Pool 9, yielded 17 species in 74 net days of effort with unbaited 2.5-cm-mesh hoop nets. Two species were captured in Pool 20 that were not caught in Pool 9, American eel (*Anquilla rostrata*) and green sunfish (*Lepomis cynaellus*). The riverine side channel catch in Pool 20 was dominated by white bass, common carp, white crappie, black crappie, and flathead catfish. The most abundant fish in the riverine side channel samples from Pool 9 were shorthead redhorse, black crappie, freshwater drum, and smallmouth buffalo. The observed difference between Pool 9 and Pool 20 may be due to differeing hoop net types and gear selectivity, not differences in community structure.

The influence of sampling location and sampling period on CPUE with hoop nets in rivers has been observed previously. Hoop nets in four distinct areas of Tennessee River channel within Wheeler Reservoir varied in CPUE and catch composition (Miller 1943). Mayhew (1973) found significant variation in channel catfish CPUE between sampling locations in the Des Moines River, as well as significant variation in common carp CPUE between sampling month from June through September. Helms (1973) observed significant differences in channel catfish CPUE between sampling stations within Mississippi River pools and between sampling months, April through October. In this investigation, statistically significant variation in CPUE was noted between sampling locations and between sampling periods for some species, but the patterns were different for the two hoop net types and for various species.

Environmental variables have been shown to influence CPUE in rivers. Mayhew (1972) postulated that the most important factors influencing hoop net CPUE in a river were flow, water temperature, and turbidity. Using multiple regression analysis, he found water temperature and turbidity to significantly account for variance in channel catfish CPUE in the lower Des Moines River. Catfish CPUE was influenced positively by increased temperatures and negatively by increased turbidity; however, only 3% of the variance could be attributed to variability in these two environmental factors. Helms (1973) used multiple regression analysis to evaluate water temperature and turbidity influences an CPUE of channel catfish in Pools 9, 11, 13, and 18 of the Upper Mississippi River. Neither water temperature nor turbidity significantly accounted for variation in channel catfish CPUE. Both water temperature and turbidity were related to CPUE of some species in the present study. As water temperature decreased from July through October, the catch of common carp and walleye increased in buffalo nets, but no significant relationship was observed with channel catfish. Turbidity had a negative relation to CPUE for all species where significance was observed, except for flathead catfish.

This investigation has contributed information on several aspects of fish sampling with hoop nets in riverine channels. The two hoop net types used in Pool 9 yielded catch rates and catch compositions substantially different from each other and from those reported in previous Upper Mississippi River studies. The need for standardization of gear types in surveys was made clear.

The influence of sampling location, sampling period, and environmental variables on CPUE of several species was illustrated and in some cases a substantial amount of the variability in CPUE was related to differences in these variables. Hoop nets are one of only a few gears that can be used to sample fish in channels. A better understanding of the biological, environmental, and mechanical factors influencing CPUE and catch composition could lead to the establishment of hoop net catches as a useful index of fish abundance and community structure.

ACKNOWLEDGMENTS

We thank John Verdon and William Noonan for their assistance in the field; the Iowa State Conservation Commission, in particular John Spinner, for facilities, equipment, and guidance; and Kenneth Carlander, Jim Mayhew, and John Nickum for reading the manuscript and making suggestions.

REFERENCES

CARTER, E. R. 1954. An evaluation of nine types of commercial fishing gear in Kentucky Lake. Trans. Ky. Acad. Sci. 15:56-80.

ELLIS, J. M., G. B. FARABEE, and J. B. REYNOLDS. 1979. Fish communities in three successional stages of side channels in the Upper Mississippi River. Trans. Mo. Acad. Sci. 13:5-20.

FUNK, J. L. 1957. Relative efficiency and selectivity of gear used in the study of fish populations in Missouri streams. Pages 31-44 in Carlander, K. D. (ed.), Symposium on evaluation of fish populations in warm water streams held at Iowa State College, March 25, 1957. Iowa Coop. Res. Unit, Ames.

FUNK, J. L. 1958. Relative efficiency and selectivity of gear used in the study of stream fish populations. Trans. No. Am. Wildl. Conf. 23:236-248.

GULLAND, J. A. 1973. Manual of methods for fish stock assessment. Part 1. Fish population analysis. Food, Agric. Org. United Nations, Rome. 154 p.

HARRISON, H. M. 1954. An estimation of the population of channel catfish in the Humbolt area with notes on the hoopnet as a sampling instrument. Quart. Biol. Rep. Iowa Game Fish Div. 6:21-25.

HELMS, D. R. 1973. Progress report from the first year study of sub-legal sized channel catfish on the Mississippi River. Fisheries Section, Iowa Cons. Comm. 54 p.

MAYHEW, J. 1972. Some biological characteristics of a channel catfish population in the lower Des Moines River with an evaluation of potential commercial harvest. Tech. Ser. No. 72-2. Iowa Cons. Comm. Des Moines. 49 p.

MAYHEW, J. 1973. Variations in the catch of channel catfish and carp in baited hoop nets. Proc. Iowa Acad. Sci. 80:136-139.

MILLER, L. F. 1943. A comparison of the hoop-net catches in several fish habitats of Wheeler Reservoir. Trans. Am. Fish. Soc. 72:37-40.

MUNCY, R. J. 1957. Factors affecting hoop net and trap net catches of channel catfish. Pages 23-27 in Carlander, K. D. (ed.), Symposium on evaluation of fish populations in warm water streams held at Iowa State College, March 25, 1957. Iowa Coop. Res. Unit, Ames.

RAGLAND, D. V. 1974. Evaluation of three side channels and the main channel border of the Middle Mississippi River as fish habitat. Contract Report Y-74-1. U. S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, Mississippi. 32 p.

RASMUSSEN, J. L. 1979. Description of the Upper Mississippi River. Pages 3-20 in Rasmussen, J. L. (ed.), A compendium of fishery information on the Upper Mississippi River. Upper Mississippi River Conservation Committee.

STARRETT, W. C., and P. G. BARNICKOL. 1955. Efficiency and selectivity of commercial fishing devices used on the Mississippi River. Ill. Nat. Hist. Surv. Bull. 26:325-366.