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Characteristics of Channel Catfish Populations in Streams and Rivers of Iowa with Varying Habitats

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From 1983 to 1985, more than 1,000 channel catfish (*Icatalurus punctatus*) were sampled with rotenone from 50 streams and rivers in Iowa to assess differences in population densities, standing stocks, vital statistics, age and growth, and habitat use. Catfish densities ranged from 5 fish/ha in sites on the South Skunk and Upper Iowa Rivers to more than 4,400 fish/ha at a site on the Thompson Fork of the Grand River. Standing stocks ranged from a low of 0.1 kg/ha on a site on the South Skunk River to a high of 467 kg/ha on the East Fork of the Des Moines River. In general, catfish in rivers grew at a slower rate than lake populations (taking about four years to reach 305 mm), but total annual mortality was relatively low compared to one published lake population, usually between 20 and 35% for fish age III and older. Larger catfish were usually found in streams of larger watersheds, but headwater streams were important nursery areas for fish less than age III. Mean standing stocks of channel catfish were similar between landforms ($P>0.05$), but both relative weight (W_r) of channel catfish and PSD was higher ($P<0.05$) in good vs. poor habitat. Channel catfish in the Des Moines Lobe had lower W_r than fish in the Iowan Surface or Southern Iowa Drift Plain. Restoration of lotic waters to improve habitat diversity (e.g. woody structure, improve water quality, prevent bank failure and stream sedimentation, mitigate channelized streams, and eliminate channel changes) will play a key role in future management of channel catfish.

INDEX DESCRIPTORS: Channel catfish, rivers in Iowa, and fish populations.

The channel catfish (*Ictalurus punctatus*) is the most abundant (Paragamian 1990) and most popular sport fish (IMR Systems 1986) in the stream and rivers of Iowa. The species occupies many different waters in the state, including most lakes, reservoirs, rivers and farm ponds (Harlan et al. 1987), but in rivers and streams, it occurs in both meandering and channelized reaches (Paragamian 1990) and is found over a wide variety of substrates from silt and sand to cobble and boulders.

Because of the channel catfish's importance to the river fisheries in Iowa, several research and management-oriented studies have been conducted on it in Iowa. Helms (1975) described the life history characteristics of channel catfish in four pools of the Mississippi River and proposed a 15-inch minimum length limit for commercial harvest (Helms 1969) which is presently being assessed (Pitlo 1989). In the interior rivers, Mayhew (1972) studied the population charcteristics and exploitation of channel catfish in the Des Moines River and evaluated a potential commercial harvest. Other investigations were conducted by Bailey and Harrison (1948), Harrison (1954 and 1957), Muncy (1959), Schoumacher and Ackerman (1965), and Mayhew (1971).

The objectives of this study were to: 1) characterize and compare the densities, standing stocks, annual mortality rates, age structures, growth rates, and condition factors (Carlander 1969) of channel catfish among the interior streams and rivers throughout Iowa; and, 2) to determine how substrate, woody structure, and pool depth affected the abundance and condition of the species.

Fifty sample sites with channel catfish populations were selected for this study of 69 sampled by Paragamian (1990) in the five major landform regions in Iowa (Prior 1976; Figures 1 and 2). One site was within the Paleozoic Plateau, 11 sites were in the Iowan Surface, 16 sites in the Des Moines Lobe, three sites in the Northwest Iowa Plains, and 20 sites within the Southern Iowa Drift Plain. These landform regions are distinguishable from each other by streambed gradient, drainage pattern, degree of weathering, exposure of bedrock, amount of glacial deposition, and soil origin (Prior 1976). General physical characteristics of rivers within these landforms as well as precise locations of sample sites are described in Paragamian (1990).

Selection of sample sites was based on several factors. Access was most important followed by U.S. Geological Survey (U.S.G.S.) gauging stations, Management Section requests for fish population data, and Iowa Environmental Protection Division Water Quality Monitoring Stations.

METHODS AND PROCEDURES

Sampling Procedures

Channel catfish and other fish populations were sampled with rotenone, electrofishing, and net gear. Sites sampled ranged from 90 to 198 m in length. At each site block nets (25 mm bar mesh) were placed across the streams at upstream and downstream ends of the site — typically at riffles. Below the lower block net, two small (1 m^2 frame) nets of 6 mm bar mesh web were randomly positioned with their openings facing upstream. These smaller nets were used to subsample small fish from the study site that were too small to be caught in the larger meshed block nets.

At each site rotenone was applied at a rate of 5 mg/l of discharge. Discharge was estimated by measuring flow rate at a transect with a Gurley No. 622-F flow meter along with measurements of width and mean depth. The rotenone was applied immediately above the upper block net for 10 to 20 minutes. The toxicant was spread on the water surface and a weighted perforated 16 mm hose was used to apply it below the surface. The natural riffles located at the upper end of most sites aided in the mixing of the rotenone. Additional rotenone was also applied to brush piles and backwater areas within the sample site.

In order to detoxify the rotenone, potassium permanganate ($KMnO_4$) was applied at 10 mg/l and mixed below the lower block net. Jugs that contained $KMnO_4$ were evenly spaced and suspended in the water column from the float line of the downstream block net. The chemical was also applied manually along the upper margin of the lower block net.

Population Estimates

In order to estimate sampling efficiency of the rotenone, fish were captured prior to rotenone application with electrofishing gear, marked, and released into the study reach. The proportion of these fish re-captured provided an estimate of total fish within the reach. This method did not incorporate confidence intervals. When electrofishing was not feasible, stressed fish were captured shortly after chemical application, fin clipped and released into the site. Capture and marking was confined to the upper ¼ of the reach.

Fish stressed by the rotenone were collected whenever possible

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with dip nets, but most fish were carried by stream currents into the lower block net. Channel catfish and sport fish were placed in a tub of untreated water when possible in anticipation of recovery and live release.

Channel catfish were counted, weighed, measured in total length (TL), and pectoral spines were collected for age determination from 50 fish or the entire sample when it was less. Total numbers of small channel catfish were determined by multiplying the number of small fish caught in small mesh nets by the ratio of total stream cross section to stream cross section covered by the small mesh nets. Biomass estimates of small fish were calculated by the product of mean weight and density (fish/ha). Total numbers and weight of large fish were determined by expanding the catch according to estimates of sampling efficiency (recapture of marked fish) and multiplying the population estimates by the mean weights.

Population Characteristics

For determining the ages of the channel catfish, pectoral spines were sectioned and viewed on a microprojector at a magnification of 40X. Ages were verified for consistency with a second experienced person, and several measurements were taken from each spine, including total spine radius and distance from the center of the spine to each annulus. Weight-Length relationships, condition (K), and back calculations of growth (Carlander 1969) were developed with the aid of two analysis programs: SHAD (Mayhew 1973) for samples of 25 or more fish, and DISBCAL (Frie 1982) (for samples of fewer than 25). Proportional stock density (PSD) of channel catfish was used to describe size structure (Anderson and Weithman 1978). PSD is the percentage of stock-length fish ($\geq$279 mm) that are $\geq$406mm (quality-size; Gablehouse 1984). Relative weights (W_r) were also calculated (Wege and Anderson 1978) to provide a second more comparable index of condition. Total annual mortality (A) was estimated from sample age distributions of catfish age III, IV and older (Ricker 1975) when at least three age groups were represented. In some cases, the zero value of missing age groups were replaced with a value of 0.01 to facilitate computer computations. Total annual mortality of age II or age III catfish was estimated with Heincke's method (Ricker 1975) when only age II and III, or III and IV, were represented, respectively. The latter method uses the proportional decline of a younger to an older age to estimate mortality over a single season.

Physical Habitat

Information pertaining to general physical characteristics of each site were obtained from several sources. Drainage area for each site was taken from the Iowa Highway Research Board Bulletin No. 7 (Larimer 1957). Gradient for each site was calculated from U.S.G.S. topographic maps, while mean discharge was obtained from data in a U.S.G.S. Water Resource Data Book (Melcher et al. 1985).

Field grade maps were developed on site to include length of each bank, five to ten measurements of width, maximum pool depth, and distribution of various substrates (silt, sand, gravel, cobble, and boulders) and woody structure.

A subjective habitat classification system was developed to compare general physical characteristics of sample sites to respective fish populations (Paragamian 1990).

The importance of each substrate type and amount of woody structure was ranked as: dominant, abundant, moderate, scarce, and/or absent. The instream habitat classification system used was as follows (Paragamian 1990): 1) poor habitat (P) — pools poorly defined or absent, absence of cobble or boulder substrate and dominance of sand, and absence of woody structure; 2) fair habitat (F) — pools up to 0.7 m deep, cobble or boulder substrate moderate or scarce and moderate sand, and/or woody structure moderate or scarce; 3) good habitat (G) — pools over 0.7 m deep, cobble or boulder substrate dominant or abundant with moderate gravel but sand moderate or scarce, and/or woody structure abundant or moderate. Habitat classification for streams in the Southern Iowa Drift Plain were dependent primarily on abundance of woody structure and pool depth since gravel and cobble substrates were uncommon.

Population Analysis

Analysis of variance testing (ANOVA) and regression analysis were used to compare standing stocks by landform and by drainage area, and standing stocks by habitat quality and W_r by habitat. Regression analysis was used to compare standing stocks among different landforms and to relate total standing stocks in a river with W_r values for that river. The Wilcoxin two sample test was used to compare paired sets of PSD's from good, fair, and poor habitats.

RESULTS

Population Densities

In all, more than 1,000 channel catfish were sampled from 50 streams and rivers (Figure 1; Table 1). The mean recapture rate of marked channel catfish with rotenone was 70%. Estimates of channel catfish densities ranged from 5/ha at a site on the Upper Iowa River and another site on the South Skunk River to 4,402/ha for a site on the Thompson Fork of the Grand River (Table 1). The overall mean density of channel catfish was 699 fish/ha (Table 1), but the means for the different landforms varied greatly: 5 fish/ha for the Paleozoic Plateau; 333 fish/ha for the Northwest Iowa Plains; 514 fish/ha for the Des Moines Lobe; 797 fish/ha for the Iowan Surface; and 832 fish/ha for the Southern Iowa Drift Plain (Table 1).

Standing Stocks

Standing stocks of channel catfish ranged from 0.1 kg/ha at a site on the South Skunk River to 466.5 kg/ha at the East Fork of the Des Moines River (Table 1). The mean was 83.2 kg/ha, while the means by landform were: Paleozoic Plateau 5.9; Northwest Iowa Plains 42.8; Iowan Surface 78.8; Des Moines Lobe 82.0; and the Southern Iowa Drift Plain 96.5 kg/ha.

Body Condition Factors

Weight-length relationships and condition factors were calculated for catfish from 24 stream sites (Table 2). Mean K-factors ranged from 0.66 for fish at a site on the North Raccoon River to 1.35 for a site on the Middle Raccoon River. Relative weights (W_r) for fish from 39 streams ranged from 20 for fish in the Little Rock River to 116 for fish in Black Hawk Creek (Table 2).

Growth, Total Annual Mortality and PSD

Growth of channel catfish varied greatly among sites; three-year-old fish ranged from 170 mm TL at a site on the North Raccoon River to 333 mm TL at a site on the Upper Iowa River (Table 3). Mean length at age III was lowest for channel catfish within the Des Moines Lobe, achieving a mean of 218 mm TL at age III; whereas fish within the Northwest Iowa Plains attained 285 mm TL by the same age (Table 3).

Seven hundred forty channel catfish were aged and total annual mortality was estimated for ages III and older for 26 populations (Table 4). Total annual mortality ranged from 17% for fish in Beaver Creek to 55% for catfish in a site on the Thompson Fork of the Grand River and one on the Middle Raccoon River (Table 4). Ten estimates ranged from 30 to 40%. For example, it was 32% for catfish on the Iowa River, 35% for fish at a site on the West Nishnabotna, and a mean of 38% for fish in the North Skunk.

Proportional stock density ranged from 0% for 18 streams to 69% for East Fork of the Des Moines River (Table 4). PSD generally ranged from 20 to 35%, but fish over 406 mm were relatively uncommon. Large fish were found in the East Fork of rhe Des Moines River, Wapsipinicon River, North Skunk River, and West Fork of the Cedar River.

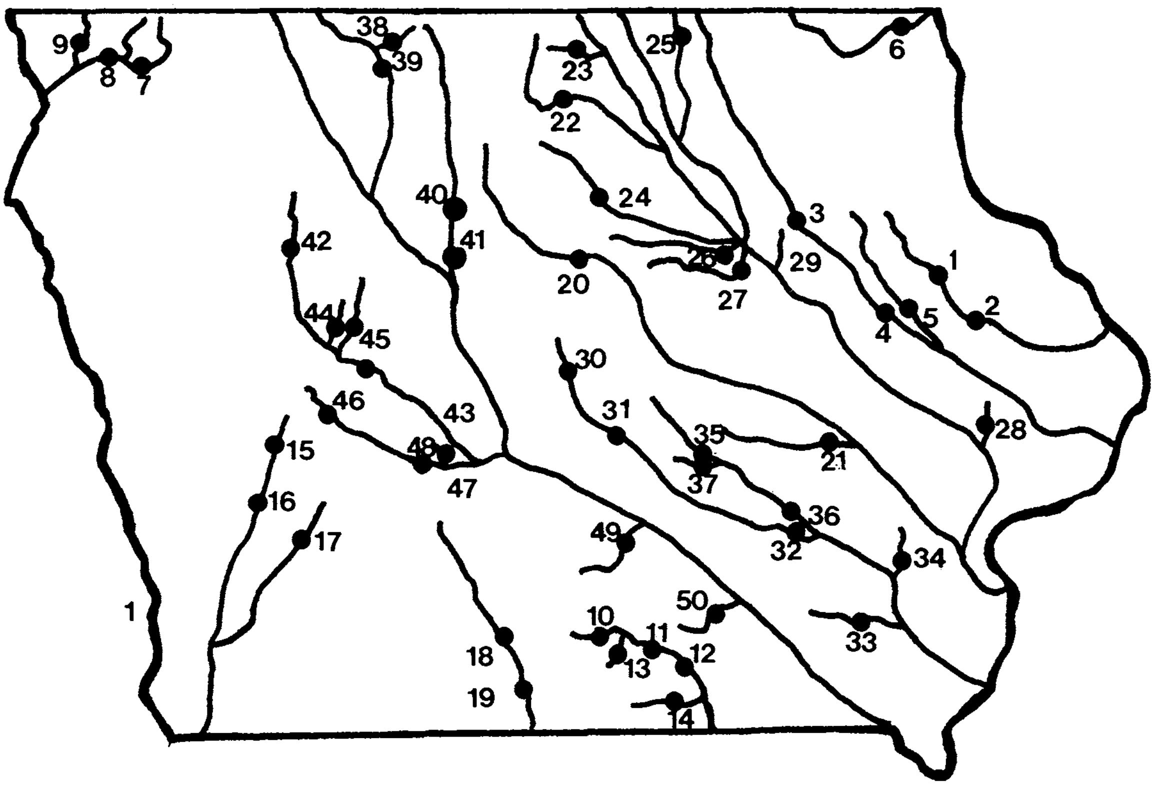

Figure 1. Location of channel catfish sample sites in Iowa, 1983 through 1985.

1. Maquoketa River - B
2. Maquoketa River - C
3. Wapsipinicon River - B
4. Wapsipinicon River - C
5. Buffalo Creek
6. Upper Iowa River - B
7. Otter Creek
8. Little Rock River
9. Rock River
10. Chariton River - A
11. Chariton River - B
12. Chariton River - C
13. Wolf Creek
14. Cooper Creek
15. West Nishnabotna River - A
16. West Nishnabotna River - B
17. Walnut Creek
18. Thompson Fork - A
19. Thompson Fork - B
20. Iowa River B
21. English River
22. Winnebago River
23. Elk Creek
24. West Fork Cedar River
25. Little Cedar River
26. Beaver Creek
27. Black Hawk Creek
28. Rock Creek
29. Lime Creek
30. South Skunk River - A
31. South Skunk River - B
32. South Skunk River - C
33. Big Cedar Creek
34. West Fork Crooked Creek
35. North Skunk River - B
36. North Skunk River - C
37. Middle Creek
38. East Fork Des Moines River
39. Buffalo Creek
40. Boone River - A
41. Boone River - B
42. North Raccoon River - A
43. North Raccoon River - B
44. Camp Creek
45. Cedar Creek
46. Middle Raccoon River - A
47. Middle Raccoon River - B
48. Willow Creek
49. Whitebreast Creek
50. South Fork Avery Creek

Habitat

Good habitat was assessed for 32% of the streams, 52% fair and 16% poor. Sixty-four percent of the Iowan Surface sites were classified as good habitat; as were 27% of the Des Moines Lobe sites and 25% of the Southern Iowa Drift Plain sites (Table 1). The one site located within the Paleozoic Plateau was fair habitat (Upper Iowa site B). None of the sites within the Northwest Iowa Plains were good habitat, but two of the three were classifed as fair.

Many small streams sampled in this study contained catfish of all ages. Twenty-eight percent of the streams with channel catfish populations were less than 400 km^2 (Table 1) while 35% of the streams within the Southern Iowa Drift Plain fell into this category. Many of these southern streams were probably nursery streams because they were inhabited by young of the year, age I, and age II fish. These streams included Rock, Wolf, Willow, Walnut, Cooper, and South Avery Creeks.

Statistical Analysis

Statistical comparisons indicated there was no significant difference ($P>0.05$) between standing stocks of channel catfish among landforms. Channel catfish standing stock averaged 120 kg/ha in good habitat, 79 kg/ha in fair habitat, and 21 kg/ha in poor habitat. Testing of standing stocks of channel catfish among the habitat classes of good, fair, and poor indicated significant differences existed ($P<0.05$), but testing between paired groups were non-significant, mainly due to the fact the variance for standing stocks in good habitat was so high. Testing further indicated there were no differences ($P>0.05$) in standing stocks of channel catfish and drainage areas of <194 sq km, $\geq 194 < 1{,}554$ sq km, and $\geq 1{,}554$ sq km.

Significant differences existed between the W_r of channel catfish of three landforms. Relative weights of fish within the Iowan Surface (mean = 95) and Southern Iowa Drift Plain (mean = 91) were similar ($P>0.05$) but were significantly higher ($P<0.05$) than those for

Table 1. Mean ($\bar{x}$) discharge (m^3/s), drainage area (km^2), and habitat status of 50 streams within five landforms sampled with rotenone and respective estimates of standing stocks and densities (means and Standard Deviations - SD) of channel catfish, 1983-1985. Habitat status is Good (G), Fair (F), and Poor (P).

	Sample Site Parameters			Channel Catfish Abundance	
Landform Stream or River	$\bar{X}$ Discharge (m^3/s)	Drainage Area (km^2)	Habitat Status	Standing Stock (kg/ha)	Density (fish/ha)
Paleozoic Plateau					
Upper Iowa River - B	13.7	1,994	F	5.9	5
Iowan Surface					
Elk Creek	0.7	117	G	2.8	10
Lime Creek	0.6	109	F	48.9	299
Maquoketa River - B	6.5	899	G	17.3	133
Maquoketa River - C	12.6	1,746	F	52.9	254
Wapsipinicon River - B	9.0	1,432	G	132.7	4,384
Wapsipinicon River - C	19.2	3,056	F	61.8	2,102
Buffalo Creek	2.6	368	F	17.0	37
Little Cedar River	2.2	285	G	97.9	222
Beaver Creek	6.3	1,013	G	158.2	1,057
Black Hawk Creek	4.8	785	G	39.8	329
West Fork Cedar River	12.2	1,901	G	237.7	778
Mean				78.8	797
SD				71.8	1,270
Des Moines Lobe					
Winnebago River	6.0	1,109	F	6.7	12
North Raccoon River - A	4.5	743	F	257.1	1,709
North Raccoon River - B	19.8	4,027	F	35.2	2,267
Middle Raccoon River - A	4.0	565	F	168.8	664
Middle Raccoon River - B	8.6	1,243	G	4.7	62
South Skunk River - A	3.7	793	F	0.1	5
South Skunk River - B	8.8	1,632	F	0.3	12
Buffalo Creek	2.6	435	P	12.6	17
Boone River - A	5.8	816	G	37.7	69
Boone River - B	7.4	1,326	F	32.5	119
Camp Creek	2.1	365	F	39.5	281
Cedar Creek	1.6	329	F	55.9	375
Willow Creek	2.0	259	P	31.3	973
Iowa River - B	9.8	1,759	G	80.9	247
East Fork River Des Moines River	10.3	1,803	G	466.5	904
Mean				82.0	514
SD				127.4	687
Northwest Iowa Plains					
Little Rock River	9.0	1,197	F	74.8	306
Otter Creek	2.2	544	F	12.4	37
Rock River	9.0	2,251	P	41.2	657
Mean				42.8	333
SD				31.2	311
Southern Iowa Drift Plain					
Rock Creek	0.9	145	F	20.5	793
Wolf Creek	0.2	47	F	208.5	329
Cooper Creek	—	124	F	47.6	212
Walnut Creek	0.7	158	F	224.3	751
Middle Creek	0.9	104	F	122.1	383
South Avery Creek	0.9	130	F	95.9	741
Chariton River - A	3.2	471	P	1.2	52
Chariton River - B	3.7	534	G	50.1	392
Chariton River - C	3.9	570	G	340.7	716
West Nishnabotna River - A	3.9	808	P	16.8	54
West Nishnabotna River - B	4.4	907	F	94.1	375
Thompson Fork of Grand River - A	3.7	632	G	122.3	4,402

Table 1 (continued)

Thompson Fork of Grand River - B	10.1	1,748	P	51.1	721
Big Cedar Creek	8.3	987	P	8.2	148
West Fork Crooked Creek	2.7	303	P	5.8	89
North Skunk River - B	10.4	1,370	F	190.2	1,707
North Skunk River - C	12.6	1,588	G	136.7	1,077
Whitebreast Creek	6.6	940	F	4.5	215
English River	10.5	1,331	F	80.1	1,766
South Skunk River - C	28.8	4,403	F	110.1	1,719
Mean				96.5	832
SD				89.7	1,003

Table 2. Weight-length relationship (a = intercept, b = slope, and S_b = standard error of slope), condition, and Relative Weight (W_r) of channel catfish collected from stream sites in Iowa, 1983-1985.

Landform	Weight-length Relationship			K-factor		W_r	
Stream or River	a	b	S_b	Range	$\bar{X}$	$\bar{X}$	S
Iowan Surface							
Wapsipinicon River - B	−5.54	3.19	0.04	0.82-1.28	0.93	97	9
Wapsipinicon River - C	−5.09	2.99	0.07	0.71-1.04	0.81	89	10
Maquoketa River - C	−6.20	3.41	0.13	0.71-1.04	0.77	77	18
West Fork Cedar River	−4.85	2.92	0.11	0.74-1.03	0.88	101	78
Little Cedar River	−5.98	3.35	0.08	0.72-1.09	0.84	87	88
Beaver Creek	−4.91	2.94	0.04	0.78-1.09	0.93	107	30
Black Hawk Creek	−4.40	2.75	0.13	0.81-1.35	0.98	116	42
Iowa River - B	−3.76	2.48	0.17	0.80-1.57	0.90	101	54
Lime Creek	−6.06	3.37	0.12	0.52-0.89	0.70	79	12
Buffalo Creek	—	—	—	—	—	27	1
Des Moines Lobe							
East Fork Des Moines River	−7.53	3.92	0.09	0.27-1.17	0.71	67	21
Boone River - A	—	—	—	—	—	35	38
Boone River - B	—	—	—	—	—	30	13
North Raccoon River - A	−3.76	2.42	0.23	0.61-0.96	0.75	77	23
North Raccoon River - B	−5.05	2.94	0.10	0.53-1.11	0.66	77	24
Camp Creek	−6.14	3.36	0.28	0.36-0.98	0.68	61	23
Middle Raccoon River - A	−7.47	3.90	0.14	0.21-1.07	0.67	68	18
Middle Raccoon River - B	−4.47	2.84	0.10	1.16-1.54	1.35	85	36
Willow Creek	—	—	—	—	—	109	84
Southern Iowa Drift Plain							
South Skunk River - C	—	—	—	—	—	113	189
North Skunk River - B	−5.64	3.20	0.09	0.56-1.02	0.73	79	11
North Skunk River - C	−5.74	3.24	0.08	0.52-0.99	0.73	80	16
Whitebreast Creek	—	—	—	—	—	89	42
Rock Creek	−5.79	3.27	0.16	0.58-1.06	0.73	84	20
English River	−5.18	3.00	0.07	0.49-0.92	0.73	82	21
South Avery Creek	—	—	—	—	—	75	56
Chariton River - C	−5.25	3.08	0.06	0.69-1.20	0.89	105	19
West Nishnabotna River - A	—	—	—	—	—	52	45
West Nishnabotna River - B	−5.40	3.13	0.06	0.50-1.19	0.88	99	22
Wolf Creek	—	—	—	—	—	32	29
Walnut Creek	−5.25	3.08	0.05	0.70-1.02	0.88	110	47
Cedar Creek	—	—	—	—	—	62	35
Thompson Fork of the Grand River - A	−5.20	3.04	0.08	0.59-1.05	0.78	95	27
Thompson Fork of the Grand River - B	−4.89	2.91	0.12	0.70-1.76	0.83	86	22
West Fork Crooked Creek	—	—	—	—	—	57	7
Paleozoic Plateau							
Upper Iowa River - B	—	—	—	—	—	29	14
Northwest Iowa Plains							
Rock River	—	—	—	—	—	36	11
Little Rock River	—	—	—	—	—	20	3
Otter Creek	—	—	—	—	—	31	7

Table 3. Grand average total length (mm) for channel catfish from 44 sample sites of five landforms in Iowa, 1983-1985.

Landform Site	Total Number	Age I	II	III	IV	V	VI	VII	VIII	IX	X
Paleozoic Plateau											
Upper Iowa River - B	3	198	269	333	450	493	526	569	617		
Iowan Surface											
Maquoketa River - B	13	51	163	216	249						
Maquoketa River - C	48	74	157	231	297	333	356	437			
Wapsipinicon River - B	55	114	201	274	340	409	450	480	503	549	
Wapsipinicon River - C	51	56	132	206	267	320					
Buffalo Creek	3	134	216	269	310						
West Fork Cedar River	55	132	206	272	323	381	429	450	516		
Little Cedar River	28	142	211	264	307	345	384	450	564		
Beaver Creek	51	107	183	239	290	338	386	429	437	447	
Black Hawk Creek	28	91	165	231	279	335	389				
Lime Creek	52	117	183	226	262	297	320				
Grand Mean		102	182	243	292	345	388	449	505	498	
Des Moines Lobe											
East Fork Des Moines River	35	53	102	180	246	330	373	427	447	462	516
Boone River - A	4	97	163	251	287	356	404	478			
Boone River - B	14	94	178	226	284	345					
Iowa River - B	41	74	132	208	274	320	345				
North Raccoon River - A	50	61	104	170	257	356	409	437	462		
North Raccoon River - B	57	84	147	221							
Camp Creek	51	102	170	229	290	345					
Big Cedar Creek	24	81	155	216	269	312	348				
Middle Raccoon River - A	32	124	191	244	297	325	340				
Middle Raccoon River - B	6	79	178								
Willow Creek	17	76	145	231	249	305	338	394			
Grand Mean		84	290	218	273	333	365	434	455	462	516
Northwest Iowa Plains											
Rock River	13	147	206	259	320	381					
Little Rock River	6	198	267	315	348	371	391				
Otter Creek	3	165	226	282							
Grand Mean		170	233	285	334	376	391				
Southern Iowa Drift Plain											
Chariton River - B	19	76	145	213	290	315	373	417			
Chariton River - C	40	114	208	287	381	432	452	480	572		
Wolf Creek	9	157	226	292	348	427	513				
Cooper Creek	8	76	170	264	318	366	417	442			
West Nishnabotna River - A	9	84	178	226	330						
West Nishnabotna River - B	32	79	163	246	330	417	478	500			
Walnut Creek	43	127	213	292	348	409	462				
Thompson Fork -	49	91	163	224	277	330	414				
Thompson Fork -	49	102	180	213	259	297	322	371	417	457	
English River	50	107	178	234	287	325	343				
Rock Creek	26	99	180	279							
South Skunk River - C	9	112	198	272	328						
Whitebreast Creek	18	61	147	244	312						
South Avery Creek	20	91	160	323	277						
Big Cedar Creek	12	81	152	211							
West Fork Crooked Creek	3	91	152	203							
North Skunk River - B	49	117	201	267	323	366					
North Skunk River - C	51	127	185	241	287	325	381	455			
Middle Creek	14	109	218	302	378	432					
Grand Mean		153	180	251	317	370	416	444	495	457	

Table 4. Proportional stock density (PSD) and sample size of stock-length catfish (N), total annual mortality (A), respective age distribution, and multiple r of regression for channel catfish from 50 stream sites in Iowa, 1983-1985.

Landform	Size Structure		Mortalilty and Age Structure		
Stream or River	PSD (%)	N≥279 mm	A (%)	Ages	r
Paleozoic Plateau					
Upper Iowa River - B	33	3	—	—	—
Iowan Surface					
Wapsipinicon River - B	33	27	17	III-IX	0.19
Wapsipinicon River - C	8	26	—	—	—
Maquoketa River - B	0	3	87	III-IV	—
Maquoketa River - C	16	31	43	III-VII	0.94
Buffalo Creek	0	3	—	—	—
West Fork Cedar River	36	45	29	III-VIII	0.87
Little Cedar River	21	24	27	III-IX	0.75
Beaver Creek	58	36	17	III-VI	0.87
Black Hawk Creek	29	14	18	III-VII	0.68
Iowa River - B	11	37	36	III-VI	0.92
Lime Creek	4	24	32	III-VI	0.96
Elk Creek	0	1	—	—	—
Des Moines Lobe					
East Fork Des Moines River	69	16	20	III-X	0.21
Buffalo Creek	0	0	—	—	—
North Raccoon River - A	21	10	54	III-VIII	0.76
North Raccoon River - B	0	12	45	II-III	—
Camp Creek	19	16	32	III-VI	1.00
Cedar Creek	0	9	—	—	—
Willow Creek	33	3	—	—	—
Boone River - A	67	3	—	—	—
Boone River - B	18	11	—	—	—
Eagle Creek	0	0	—	—	—
Middle Raccoon River - A	20	20	55	III-VIII	0.62
Middle Raccoon River - B	0	0	—	—	—
Winnebago River	0	3	—	—	—
South Skunk - A	0	0	—	—	—
South Skunk - B	0	0	—	—	—
Northwest Iowa Plains					
Rock River	11	9	24	III-V	0.69
Otter Creek	0	3	—	—	—
Little Rock River	33	6	—	—	—
Southern Iowa Drift Plain					
North Skunk River - B	11	26	37	III-VI	0.81
North Skunk River - C	17	36	39	III-VII	0.92
Middle Creek	60	5	13	III-V	0.87
English River	17	24	23	III-VI	0.76
Chariton River - A	0	0	—	—	—
Chariton River - B	50	4	59[a]	III-IV	—
Chariton River - C	44	9	31	III-VIII	0.35
Wolf Creek	38	8	—	—	—
Cooper Creek	50	2	—	—	—
West Nishnabotna River - A	33	6	—	—	—
West Nishnabotna River - B	25	16	35	III-VII	0.87
Walnut Creek	36	22	33	III-VI	0.98
Thompson Fork of the Grand River - A	13	15	33	III-VI	0.97
Thompson Fork of the Grand River - B	13	38	55	III-IX	0.76
South Skunk - C	0	5	—	—	—
Big Cedar Creek	0	0	23	III-VI	0.72
West Fork Crooked Creek	0	0	—	—	—
South Fork Avery Creek	0	8	40	III-IV	—
Whitebreast Creek	0	2	—	—	—
Rock Creek	0	3	—	—	—

[a] Mean A of ages II and III.

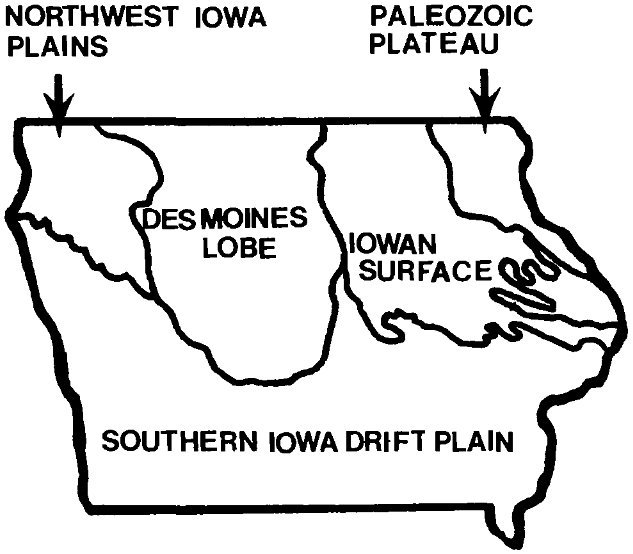

Figure 2. Five major landforms in Iowa from which channel catfish were sampled.

populations within the Des Moines Lobe (mean = 72). Regression analysis of W_r and standing stocks of channel catfish in the Iowan Surface, Des Moines Lobe, and Southern Iowa Drift Plain was nonsignificant. Catfish within good habitat of the Iowan Surface and the Southern Iowa Drift Plain each had a significantly higher W_r ($P<0.05$) than in poor habitat of the respective regions. PSD of channel catfish were significantly higher ($P<0.05$) in good and fair habitat than poor habitat.

DISCUSSION

Habitat quality was a key factor in the abundance of channel catfish in streams and rivers throughout Iowa. The best stream reaches for channel catfish offered a variety of depths, cobble/boulder substrates or woody structure, and variations in current, similar to that reported by Bailey and Harrison (1948), for the Des Moines River, Iowa. Standing stocks of catfish were significantly different among stream reaches of good, fair and poor habitat. Sixty percent of the sample sites with at least 130 kg/ha of channel catfish were classified as good habitat; whereas the remainder were fair. Further analysis of habitat classes vs. the standing stocks of channel catfish was affected by the high degree of variability in standing stocks of channel catfish, particularly in good habitat. That even some channelized sites had a few catfish is indicative of this species' adaptability to extreme differences in habitat within streams and rivers in Iowa. However, Paragamian (1987) noted that natural stream reaches of the Southern Iowa Drift Plain had significantly higher standing stocks of catfish than channelized reaches and he noted that Iowa has annually lost an estimated three million catfish to stream channelization (Paragamian 1990).

Woody structure was an important component of habitat to channel catfish in streams throughout the state, but was particularly important to streams within the Southern Iowa Drift Plain. Streams in southern Iowa seldom had rock or boulder substrates that could add to habitat diversity. However, fallen trees, root wads, and brushpiles were common. Channelized streams were often barren of instream cover, but when trees and parts of trees were present, they added habitat diversity by creating cover and scour pockets. Two good examples of these improved channelized streams include the West Nishnabotna River and Whitebreast Creek. The importance of woody structure to channel catfish as shelter and food production for a reach of the Des Moines River also was noted by Bailey and Harrison (1948). Woody structure could be an important mitigative measure, but further research is needed for proper placement and size.

Relative weights of channel catfish varied greatly between landforms as well as within stream sites. Some of the variation between landforms was related to habitat differences, but it was not due to density or standing stock. The better habitat was probably favorable to greater food production and high W_r of catfish. Hansen (1971) found greater numbers of invertebrates in unchannelized vs. channelized reaches of streams in Iowa. The catfish with the best average W_r were found within the Iowan Surface and Southern Iowa Drift Plain, while the lowest were fish within the Des Moines Lobe and the Northwest Iowa Plains. Relative weight was not associated with a north-south change that Pitlo (1989) found with catfish in the Mississippi River.

Some factors could have interacted with the sample design of this study to create variations in W_r values. Sampling of fish prior to spawning could have accounted for higher W_r, maturity, male: female ratios, time of year and water temperature or river discharge-year interaction.

Larger and older ($\geq$500 mm and age VI+) channel catfish were most common to streams with watersheds of 1,000 km^2 or larger. Examples include: Beaver Creek, the two sites at the Wapsipinicon River, Maquoketa River, East Fork Des Moines River, Iowa River, West Fork Cedar River, and North Skunk River. Several exceptions to this generality were prespawn catfish in Wolf and Walnut Creeks.

High PSD's were a function of habitat because the largest channel catfish were usually found in the best habitat. Examples included: the East Fork of the Des Moines River, PSD of 69; West Fork of the Cedar and Beaver Creek, PSD's of 36 and 58, respectively; Chariton River - B and C, PSD's of 50 and 44; and, Wapsipinicon River - B, PSD of 33. Low PSD was either a function of habitat or because the site was a nursery area with few adults. For example, channelized streams provided poor habitat but usually had low densities of young of the year and age I fish while adult fish were rare, e.g. South Skunk - B, Chariton River - A, West Fork Crooked Creek. But some small streams had good habitat for young fish and were nursery streams with many young fish, e.g. Rock Creek and Willow Creek. PSD values at five sites on four rivers in Missouri ranged form 14 to 50% with a mean of 30% (Steve Eder, Missouri Department of Conservation, Personal Communication). Three streams had their headwaters in Iowa.

Growth of channel catfish in streams and rivers in Iowa varied within the range reported for other habitats (Carlander 1969), but averaged about 245 mm after three years of growth and about 305 mm at about four years. Channel catfish in pools of the Mississippi River (Harrison 1957) and Red Rock Reservoir reportedly grow slightly faster but less rapidly than fish in Rathbun Reservoir (Paragamian 1977) — 343 mm at age IV.

Total annual mortality was usually low, ranging from 20 to 35%, indicating fishing mortality was also low. Mayhew (1972) found total annual mortality of channel catfish in the Des Moines River was about 46%, of which the sport fishery accounted for 10%. Natural mortality of channel catfish in lakes in Iowa is much higher, particularly those with cage catfish programs (Mitzner and Middendorf 1975). They found initial mortality to be low (2%), but it was 51 and 69% in succeeding years after additional fish were stocked in a study lake.

The channel catfish will continue to be the most abundant sport fish in streams and rivers of Iowa. But a conscientious effort must be directed at protecting the habitat of even the smallest streams from man's alterations and improving the habitat of those that have been changed.

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