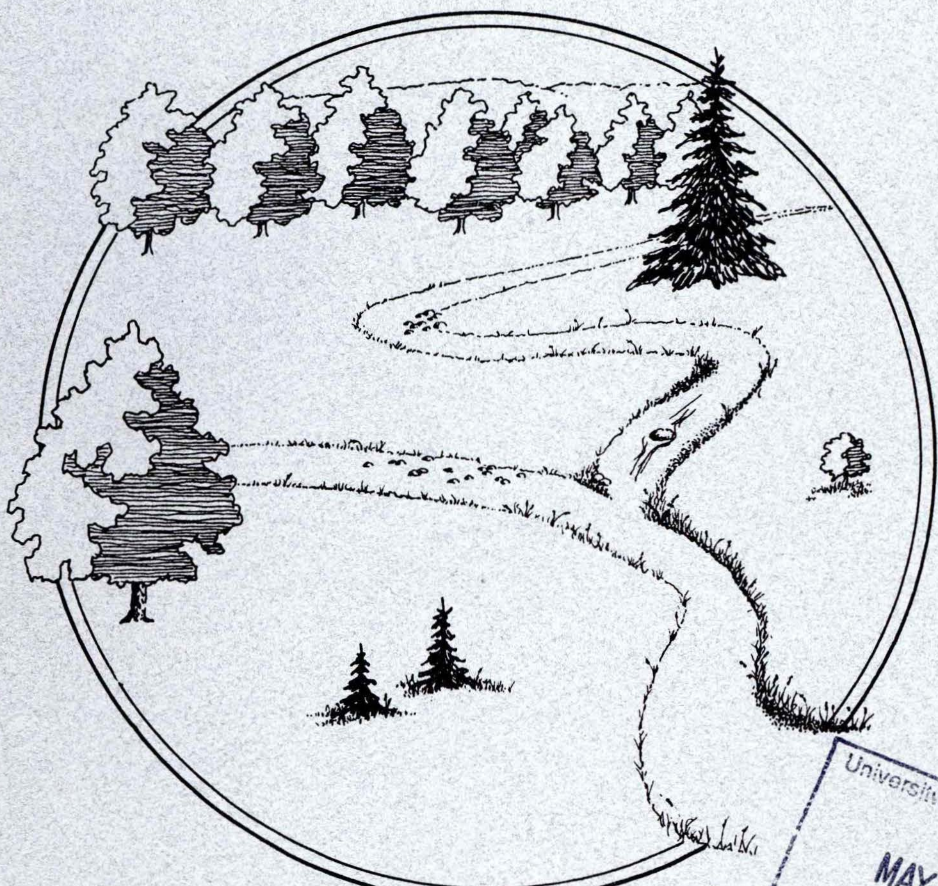
FISH POPULATIONS OF IOWA RIVERS AND STREAMS

Technical Bulletin No. 3



Iowa Department of Natural Resources
Larry J. Wilson, Director
May 1990

FISH POPULATIONS OF IOWA RIVERS AND STREAMS

Technical Bulletin No. 3

Iowa Department of Natural Resources
Larry J. Wilson, Director
May 1990

ABSTRACT

Fish populations at 69 locations on streams throughout Iowa were sampled with rotenone. The objective of this study was to determine species composition, fish densities, standing stocks, and trophic structure. The study also determined the influence of habitat on fish communities and provided direction to future management. Streams were segregated by geologic region, size of drainage area and habitat quality. Habitats were classified as poor, fair and good. Streams in the Iowan Surface region produced highest species diversity with 9 families and 59 species. Total standing stocks ranged from 10.9 lbs/ac in a channelized reach of the Chariton River (Southern Iowa Drift Plain) to almost 2,300 lbs/ac in the East Fork Des Moines River (Des Moines Lobe). Analysis of variance comparisons of the means showed habitat quality was the main factor for significant differences ($P<0.01$) between total standing stocks of fish. Further comparisons indicated there was no difference in total standing stocks of fish within and between landforms. Altered streams had significantly lower standing stocks of fish ($P<0.05$) than unaltered sites. Channel catfish was the most widely distributed and abundant sport fish. Headwater streams were important to sport fish, while habitat quality and diversity was the most important factor to fish abundance and biotic diversity.

Fish Populations of Iowa Rivers and Streams

by
Vaughn L. Paragamian

Technical Bulletin No. 3
Fish and Wildlife Division
Iowa Department of Natural Resources
Wallace State Office Bldg.
Des Moines, Iowa 50319-0034
May 1990

CONTENTS

page

LIST OF FIGURES *page*

LIST OF TABLES *page*

LIST OF APPENDIX TABLES *page*

LIST OF APPENDIX TABLES

page

INTRODUCTION

Streams are the most fished resource in Iowa and support 30% of the annual sport fishing activity of licensed anglers or about 12 million fishing days per year (Anonymous 1986). In order to manage these fisheries effectively, a comprehensive data base is essential. Previous studies of river fish populations in Iowa provide an important source of information; however, most of the early investigations were taxonomic surveys to determine species composition and distribution (Jordan and Meek 1885, Potter 1928, Aitken 1936, Bailey 1951, Harrison and Speaker 1954, and Cleary 1956). Investigations designed to analyze fish communities and relationships of the various species in those communities began in the 1940's. Harrison (1952 and 1962) determined the relative abundance of fish species in several Iowa streams, but these and similar studies (Cleary 1957, Harrison 1962, Mayhew 1965, Schwartz 1975, Middendorf 1974, Ackerman 1974, Putnam 1974, and Paragamian 1980) were enumeration inventories by design, lacked standardization in sample design, were conducted over a span of 40 years, and lacked quantitative analyses. A need existed for comparable data which will help determine impacts of environmental changes on these resources. This study was designed to provide quantitative and comparable data on Iowa's riverine fisheries. Of major importance was the documentation of densities and standing stocks of stream fish populations, and how they are affected by habitat.

STUDY AREAS

Sample sites were selected by landform (Figure 1 and Appendix A). The landforms in which fish sampling occurred were the Paleozoic Plateau, Iowan Surface, Southern Iowa Drift Plain, Des Moines Lobe, and Northwest Iowa Plains.

Streambed gradient, drainage pattern, weathering, exposure of bedrock, glacial deposition, and soil origin were the unique geologic features that distinguished between landforms (Prior 1976).

Paleozoic Plateau

This landform has been exposed to weathering and erosion longer than any other geologic region of the state. It contains deep valleys, numerous rock outcrops, artesians, and is thought by many to be untouched by the Pleistocene glaciers. Three streams were sampled in this landform (Figure 1 and Appendix A). Stream habitats within the upper reaches of the Paleozoic Plateau had high gradients and were characterized by substrates comprised of limestone bedrock, fractured cobbles, gravel and sand. Lower reaches of mainstem streams had lower gradients with silt substrates and contained debris jams. Valleys within the Paleozoic Plateau were usually forested, while the uplands and river bottoms were pastured or row-cropped.

Iowan Surface

The Iowan Surface is level to gently rolling and is transected by low gradient streams. The flood plains are often forested within the Iowan Surface, while the uplands are intensively row-cropped. Marshes are present in some stream valleys and the region shows evidence of glaciation; 18 sites were sampled in this landform (Figure 1 and Appendix A). Streams and rivers sampled in the Iowan Surface were characterized by silt and sand substrates, while occasional debris jams were also present. Stream substrates in the northern and eastern portion of the region also contained extensive reaches of boulder, cobble and gravel.

Des Moines Lobe

Impacts of the Pleistocene glaciers are most evident within the Des Moines Lobe. Sediments in this landform are glacial in origin and are often seen in terraces within river valleys. Soil drainage is slow in many portions of this landform. Prior (1976) described it as, "flat to slightly irregular, but bands of rough, knobby terrain appear abruptly"; 20 sites were sampled within this landform (Figure 1 and Appendix A). The Des Moines Lobe contained some of the richest soils in the world and this was nearly exclusively row-cropped. Water courses in the Des Moines Lobe were characterized by high stream gradients and substrates comprised primarily of cobble, gravel, sand, silt, and occasional outcrops of bedrock. Debris jams and windfalls were common in streams flowing through timbered terrain, but channelized reaches were less diversified.

Northwest Iowa Plains

This landform is barren of trees and had the lowest annual rainfall within the state (25 inches/year). The agriculturalized landscape is gently rolling and bedrock is covered by layers of glacial drift and loess soils; four streams were sampled within this region (Figure 1 and Appendix A). Streams within the Northwest Iowa Plains possess moderate gradients and were uniform in habitat. Substrates in the riffles were primarily sand and small gravel, while silt dominated the pool substrate. Intensive agriculture by row-cropping and grazing dominated the riparian zone of most streams; thus, few banks were stable.

Southern Iowa Drift Plain

Topography in the Southern Iowa Drift Plain consists of steeply rolling hills with level upland divides as well as level alluvial river bottoms. The uplands and bottoms are row-cropped or pastured, but the hill sides are usually forested. The only proof of glaciation is the hundreds of feet of glacial drift deposited on bedrock. The region also contains large deposits of loess soils. Twenty-four sites were sampled within the Southern Iowa Drift Plain; they were low gra-

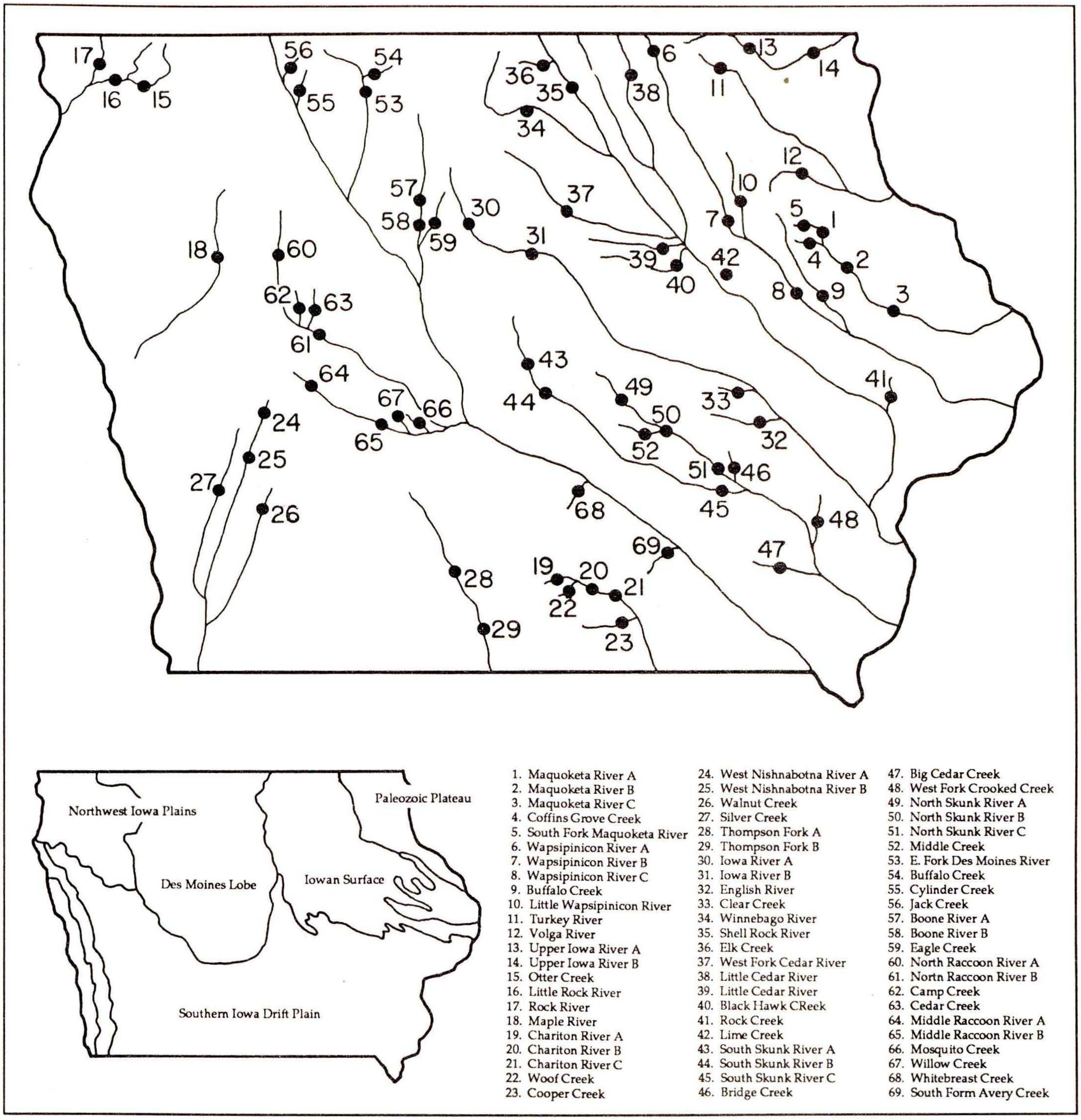


Figure 1. Location of stream and river fish populations sampled with rotenone, 1983 through 1985, and location of the 5 geologic regions in Iowa.

dient and characterized by poor development of the typical riffle-pool flow pattern found in other Iowa landforms (Figure 1 and Appendix A). Most of the streams sampled had steep banks; substrates comprised of silt, sand and clay; and cover comprised of debris jams and exposed tree roots. Nearly all of the major rivers and many headwater streams sampled in this geologic region were channelized. Channelized streams in this region were uniform in water depth, current velocity, and substrate.

METHODS

Sampling Sites

Fish collection sites were located in the upper, middle, and lower portions of all major streams and in two tributary streams. Priority was given to sites with a U.S. Geological Survey (USGS) gauging station, active Environmental Protection Division (EPD) water quality sampling site, or those recommended by Fisheries Management Biologists. Site selection was also affected by availability of access and the presence of habitat which typified the stream. Sample sites (Figure 1) were stratified by landform and were further separated by drainage area: < 75 sq mi, 75-599 sq mi and ≥ 600 sq mi.

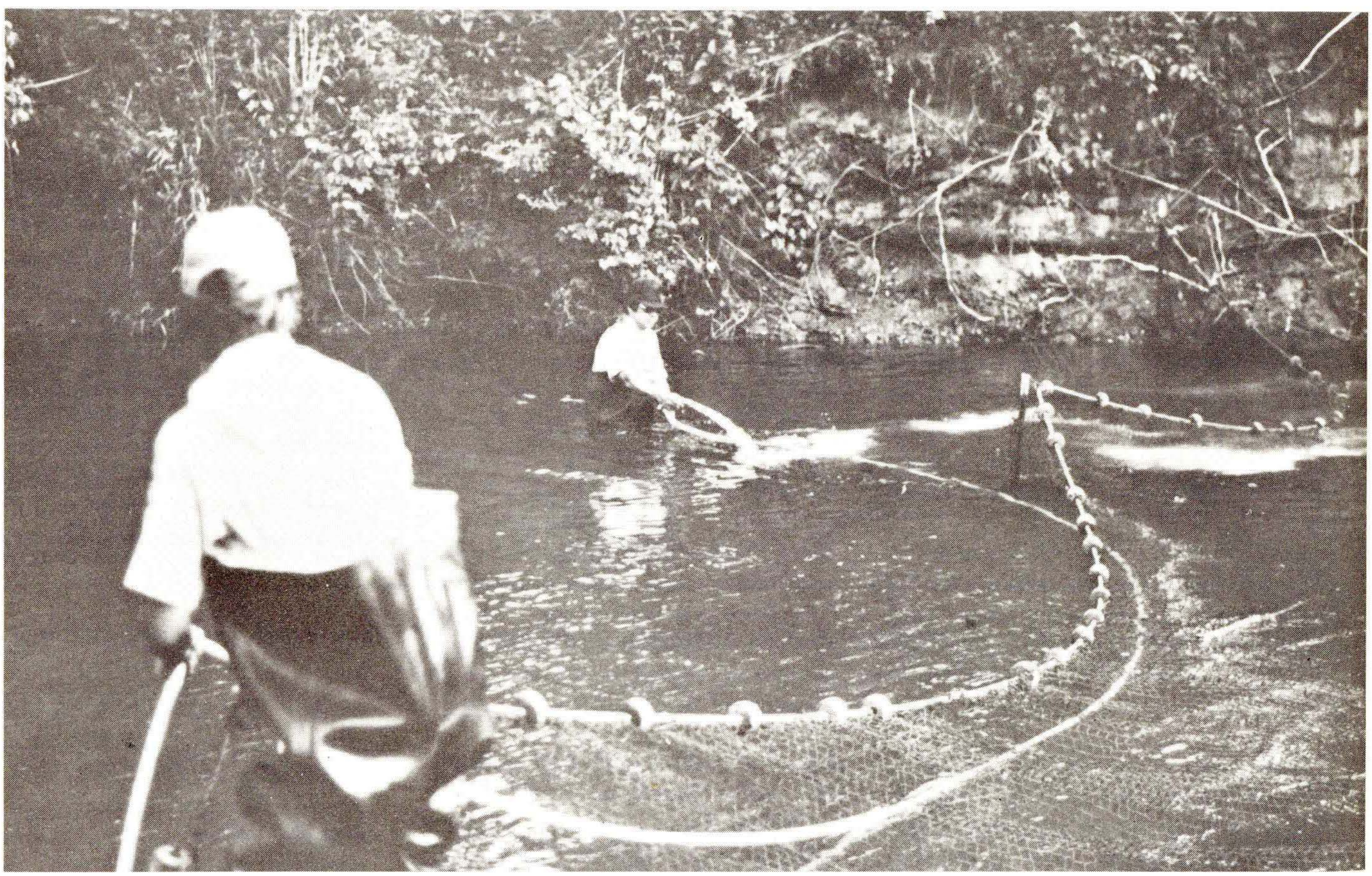
Sampling Methods

Fish were sampled with rotenone and net gear at sites 300-650 feet in length. Sites were enclosed by block nets constructed of one-inch bar mesh web. Nets were set to span the entire width and depth of the stream and used to prevent the movement of fish in an upstream or downstream direction. Riffles were often used to delineate the upper and lower boundaries of the sampling sites. Two additional nets, constructed of 1/4-inch bar measure web and a frame 39 inches x 39 inches, were positioned immediately downstream of the lower block net to obtain a sub-sample of small fish killed in the sample area but not captured in the block net.

A boat-mounted 110V AC electrofishing unit was used to capture fish prior to the application of rotenone. All fish greater than 8 inches total length were netted, identified, enumerated, fin clipped, and released into the treatment area. In most instances, fish were captured outside the treatment area, marked, and released into the sample site. When electrofishing was not feasible, however, stressed fish located in the upper 1/4 of the reach were captured shortly after chemical application, fin clipped, and released. The ratio of marked fish to unmarked fish sampled after chemical application provided an estimate of the efficiency of the capture techniques.

Stream flow, measured with a Gurley No. 622-F flow meter was used to calculate discharge in cubic feet per second (CFS), was used to determine the rate of rotenone application needed to achieve a concentration of 5ppm for a twenty-minute period. Rotenone was sprayed immediately above the upper block net and on the substrate through a weighted and perforated hose. Rotenone was applied for approximately 25 minutes in a natural riffle located at the upper end of the site and was also applied to brush piles and backwater habitats.

Potassium permanganate ($KMnO_4$) was used to detoxify the rotenone and was applied at a rate of



Rotenone application at Site A of the Maquoketa River.

10ppm below the lower block net. Evenly spaced jugs of $KMnO_4$ were suspended in the water column from the float line of the downstream block net. $KMnO_4$ was also manually applied along the margin of the net.

Large stressed fish were collected with dip nets during the treatment process; however, the majority were carried by the currents into the lower block net. Whenever possible, sport fish were placed in a tub of untreated water for recovery and live release. Collection was limited to fish large enough to be entrapped by the block net.

Large fish were identified, enumerated, and weighed while small fish collected in the sub-sample nets were weighed and preserved in 10% formalin for identification and enumeration at a later date. The ratio of the total cross- sectional area of the lower segment of the treatment site to that portion covered by the small mesh nets was used to estimate the number and biomass of small fish. The total population and biomass for each species at each site were estimated from: 1) the actual catch of large fish, and 2) the estimate of efficiency of the sample techniques.

Trophic structure (Odum 1959), within a fish community, was determined by partitioning fish species into categories with similar food habits and summing the individual standing stocks. Trophic categories were as follows: piscivore, piscivore-insectivore, insectivore, omnivore, and herbivore as identified by Karr (unpublished Iowa species list). These data, in turn, were compiled by landform, drainage area, and channelized/unaltered stream reaches. Models of trophic structure were used to show fish biomass at each trophic level, changes in trophic structures within the stream continuum, and the differences within trophic structures of altered streams.

Measurement of Environmental Parameters

Drainage area, gradient, and mean discharge of each river was obtained from the Iowa Highway Research Board Bulletin No.7, USGS Water Resources Data Book and Topographic Maps. Field grade maps were made to calculate sample area, average depth, estimate the distribution and proportion of substrates (sand, gravel, cobble, and boulder) and woody structure. The importance of each substrate type or amount of woody structure was ranked as: dominant, abundant, moderate, scarce, and absent. Instream habitat was categorized as follows: 1) poor habitat - pools absent or poorly defined, absence of cobble or boulder substrate and dominance of sand, and absence of woody structure; 2) fair habitat - pools up to two feet deep, cobble or boulder substrate moderate or scarce and moderate sand, and/or woody structure moderate or scarce; 3) good habitat - pools over two feet deep, cobble or boulder substrate dominant or abundant with moderate gravel but sand moderate or scarce, and/or woody structure abundant or moderate.

Data Analysis

Analysis of variance (ANOVA) of standing stocks were performed in a 2-way contrast within and between land forms. ANOVA was also performed in a one-way contrast to compare total standing stocks of stream fish and habitat type. All testing was at the 0.05 level of significance or higher. Comparisons were also made between fish communities inhabiting altered (channelized) and unaltered stream reaches.

RESULTS

Fish, Fauna and Landforms

Fish communities in Iowa rivers and streams varied by landform, although most species had a broader range than just a single geologic region (Appendix B). Fish communities within the Paleozoic Plateau were a mix of coldwater and warmwater forms and were of the northern Mississippi Basin fauna. The fishes of the Iowan Surface are primarily warmwater varieties and were of the eastern and central Mississippi Basin origin. Fish communities of the Des Moines lobe were of the southern and eastern Mississippi Basin fauna and were influenced by a former connection between the Little Sioux and Des Moines Rivers. The fauna of the Northwest Iowa Plains were a mixture of Mississippi Basin and Missouri Basin species and communities exhibited a distinct decline in number of species, north to south. The fish communities of the Southern Iowa Drift Plain were nearly exclusively of Missouri Basin origin. A more detailed explanation of fish fauna distribution can be found in Menzel (1987).

Fish Populations and Standing Stocks

Paleozoic Plateau - Fish communities in the streams that traverse the Paleozoic Plateau were comprised of cyprinids, catostomids and darters. Smallmouth bass and rock bass were common sport fish inhabiting upper and mid reaches, while channel catfish were commonly found in the lower portions of major streams. Rainbow and brown trout were stocked in many of the headwater streams and sometimes found in the mainstem rivers.

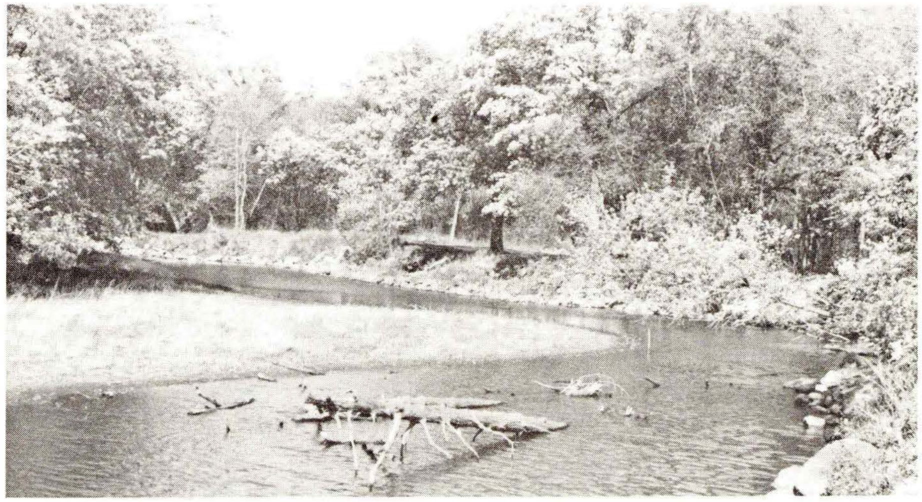
Seven families of fish represented and 37 species were identified in the four study sites (Appendix B). The most numerous species were cyprinids (18), along with the nine species of catostomids. Other families were poorly represented.

Fish density in streams within this land form ranged from 16,255 fish/mi (823/ac) in the lower reach of the Upper Iowa River to 56,420 fish/mi (5,578/ac) in the upper site of the same river. Cyprinids were the most abundant group of species found, while catostomids were the second most numerous fish group in the Volga River and upper reach of the Upper Iowa River.

Ictalurids were second at the

lower reach of the Upper Iowa River. (See Appendix C for individual listings of fish density and biomass.)

Total fish standing stock ranged from 102 lbs/ac in the lower reach of the Upper Iowa River to 363 lbs/ac in the Volga River. Catostomids dominated the biomass of fish found in the upper reaches of the Upper Iowa River and Volga River; while cyprinids, primarily common carp, dominated the standing stock of fish in the lower reaches of the Upper Iowa River. Mean standing stock of sport fish were: 20 lbs/ac carp, 5 lbs/ac channel catfish, 3 lbs/ac smallmouth bass, and 1 lb/ac for rock bass at sites from which they were sampled.



The Wapsipinicon River in the Iowan Surface contained high habitat diversity and a variety of fish, including sport fish.

Iowan Surface - Fish communities which inhabited streams that bisect the Iowan Surface were represented by nine families and 59 species (Appendix B). Twenty- one species of Cyprinidae were identified, in addition to nine catostomids, ten percids, eight centrarchids, and seven ictalurids. Smallmouth and rock bass were the most abundant sport fishes in headwater streams, but they were replaced by channel catfish and carp within lower reaches. Northern pike were common throughout most rivers, but walleye and flathead catfish were never abundant.

Total fish densities in this landform ranged from 8,805 fish/mi (643/ac) in the lower Maquoketa River to 62,743 fish/mi (27,510/ac) in the upper reaches of the Wapsipinicon. Cyprinids dominated the catch at most sample sites. Catostomids often ranked second in abundance. (See Appendices D, E, and F for individual listings of fish density and biomass.)

Total standing stock of fish ranged from 35 lbs/ac in the South Fork of the Maquoketa River to over 1,800 lbs/ac in the West Fork of the Cedar River. Suckers dominated the biomass of fish sampled from 13 of 18 sites. Standing stocks of sport fish averaged 297 lbs/ac for carp, 70 lbs/ac for channel catfish, 13 lbs/ac for walleye, 7 lbs/ac for northern pike, 3 lbs/ ac for rock bass, and 1 lb/ac for flathead catfish. These averages represent only those sites from which the species were sampled.

Des Moines Lobe - Ten families and 52 species of fish were found to inhabit streams in the Des Moines Lobe (Appendix B). Twenty-one species of cyprinids were identified, along with ten catostomids, six ictalurids, five percids, and five centrarchids. The most abundant sport fishes found in these streams were channel catfish, carp, smallmouth bass, and northern pike. Walleye and flathead catfish were uncommon.

Total fish densitites in this land form ranged from 880 fish/mi (195/ac) at Cylinder Creek (a drainage ditch) to 403,883 fish/mi (74,621/ac) at the mid- reach of the South Skunk River (a channelized reach). Cyprinids were usually the most abundant species, while catostomids usually ranked second but were occasionally surpassed by ictalurids. (See Appendices G and H for individual listings of fish density and biomass.)

Total fish standing stock in this landform ranged from 49 lbs/ac in Mosquito Creek to 2,255 lbs/ac at East Fork Des Moines River (Appendices G and H). Cyprinids dominated the biomass at 15 of 20 sample sites, while carp were most important at ten sites. Ictalurids and catostomids dominated at three sites each. Standing stock of carp averaged 286 lbs/ac, channel catfish 75 lbs/ac, northern pike 20 lbs/ac, smallmouth bass 11 lbs/ac, walleye 7 lbs/ac, and rock bass 4 lbs/ac at sites from which they were collected.

Northwest Iowa Plains - Fish communities found in streams of the Northwest Iowa Plains were represented by nine families and 25 species (Appendix B). Fish communities in these streams exhibited low species diversity and consisted of only nine species of minnows, four species of catfish and four species of suckers. The only sport fish sampled were carp and channel catfish.

Numerical population density in this landform ranged from 2,751 fish/mi (392/ac) in the Maple River to 35,078 fish/mi (4,000/ac) in the Rock River. Cyprinids were the most numerous fish at all sites, while catfish and suckers were second and third in numerical importance, respectively. (See Appendix I for individual listings of fish density and biomass.)

Total standing stock ranged from 11 lbs/ac in the Maple River to 260 lbs/ac in the Little Rock River. Suckers dominated the biomass of fish sampled at all sites. Ictalurids and cyprinids were usually second or third in importance. Channel catfish was the most important sport fish sampled at three of four sites and had an average biomass of 38 lbs/ac.

Southern Iowa Drift Plain - Nine families and 46 species of fish were identified in the Southern Iowa Drift Plain, of which seventeen were species of minnows and eight were species of catfish (Appendix B). The most important sport fish sampled were channel catfish, carp and flathead catfish.

Fish densities in unaltered stream sites of the Southern Iowa Drift Plain ranged from 2,577 fish/mi (3,680/ac) at South Avery Creek to 40,328 fish/mi (7,135/ac) at Rock Creek. Minnows dominated the density of fishes, while catfish and suckers were usually second or third in importance. (See Appendices J, K, and L for individual listings of fish density and biomass.)

Total standing stock of fish in unaltered streams ranged from 57.5 lbs/ac in Clear Creek to 1,200 lbs/ac in the middle reaches of the Chariton River. The standing stock was dominated by carp; ictalurids and catostomids often ranked second or third in importance. Average standing stocks of sport fish in unaltered streams of this landform were: 448 lbs/ac carp, 95 lbs/ac for channel catfish, 13 lbs/ac for flathead catfish, and 4.5 lbs/ac for walleye in streams from which they were sampled.

Fish densities in channelized streams ranged from 2,928 fish/mi (1,087/ac) in upper reaches of the Chariton River to 51,852 fish/mi (20,976/ac) in Walnut Creek. Cyprinids dominated the fish communities and centrarchids usually ranked second in numerical abundance. (See Appendices J, K, and L for individual listings of fish density and biomass.)

The total standing stock of fish ranged from 10.9 lbs/ac in the upper reach of the Chariton River to 609 lbs/ac in Walnut Creek. Cyprinids, principally carp, dominated the biomass; while ictalurids were usually the second most important group of

Table 1. Sample sites categorized by landform and instream habitat quality.

	Instream Habitat		
Landform	Poor	Fair	Good
Paleozoic		Upper Iowa River-B	Volga River Upper Iowa River-A
Iowan Surface	S. Fork Maquoketa Little Wapsipinicon	Wapsipinicon-A Lime Creek Coffins Grove Creek Maquoketa River-A Buffalo Creek Turkey River Wapsipinicon-C Maquoketa River-C	Elk Creek Maquoketa River-B Wapsipinicon-B Shell Rock River Little Cedar River Beaver Creek Black Hawk Creek W. Fork Cedar
Des Moines Lobe	Buffalo Creek Willow Creek Mosquito Creek Jack Creek Cylinder Creek	Eagle Creek Winnebago N. Raccoon River-A S. Skunk River-A Camp Creek Cedar Creek Middle Raccoon-A Boone River-B N. Raccoon River-B S. Skunk River-B	Iowa River-A Middle Raccoon-B Boone River-A Iowa River-B E. Fork Des Moines
Northwest Iowa Plains	Maple River Rock River	Little Rock River Otter Creek	
Southern Iowa Drift Plain	Clear Creek Silver Creek Chariton River-A W. Nishnabotna-A Big Cedar Creek W. Fork Crooked Creek N. Skunk River-A Thompson Fork Grand River-B	Rock Creek Wolf Creek Cooper Creek Middle Creek S. Avery Creek Walnut Creek Bridge Creek W. Nishnabotna-B N. Skunk River-B White Breast Creek English River S. Skunk River-C	Chariton River-B Chariton River-C Thompson Fork Grand River-A N. Skunk River-C

fishes. Average standing stocks of sport fish in channelized streams of the Southern Iowa Drift Plain, at sites from which they were sampled, were; 38 lbs/ac carp, 21 lbs/ac for channel catfish, 4 lbs/ac flathead catfish, and <1 lb/ac for walleye. The means for channel catfish and carp do not include estimates of fish in Walnut Creek.

Habitat Quality and Landform

Habitat quality values were summarized for each sample site thus each site was placed within a habitat category (Table 1). Forty-eight percent of the sample sites were classified as fair habitat, 28% were good, while 25% were poor. Two of three sites located within the Paleozoic Plateau were classified as good habitat, while 44% of the Iowan Surface sites and 25% of those in the Des Moines Lobe were in this category. Seventeen percent of the Southern Iowa Drift Plain sites were classified as good habitat, but none of those sampled in the Northwest Iowa Plain rated as good habitat. Over 50% of the channelized sites in the Southern Iowa Drift Plain were considered in the poor habitat category, while the remainder were fair (Table 1).

Quantitative Data Analysis

ANOVA indicated the total biomasses of fish were similar between landforms (P>0.05). Total biomass of fish in most rivers in Iowa ranged from 300 to 1,000 lbs/ac; those of channelized reaches were usually much lower. The streams of the Northwest Iowa Plains provided the lowest mean total fish standing stock of 116 lbs/ac. Furthermore, analysis of variance comparisons of fish standing stocks, stratified by landform type, showed no significant differences (P>0.05) regardless of the size of drainage area. However, total standing stocks of fish in unaltered sites of the Southern Iowa Drift Plain were significanty higher than those of altered sites (P<0.05), particularly for stocks of channel and flathead catfish, carp, and bullhead (Ictalurus sp.).

Statistical differences in total fish standing stocks, regardless of landform, were found when comparisons were made between habitat categories. Three ANOVA tests were made contrasting standing stocks of good (mean = 862 lbs/ac) vs. fair (mean = 400 lbs/ac) habitat, good vs. poor (mean = 99 lbs/ac) habitat and fair vs. poor habitat. Total standing stocks of fish were significantly higher (P<0.05) in good vs. fair habitat, good vs. poor habitat, and fair vs. poor habitat.

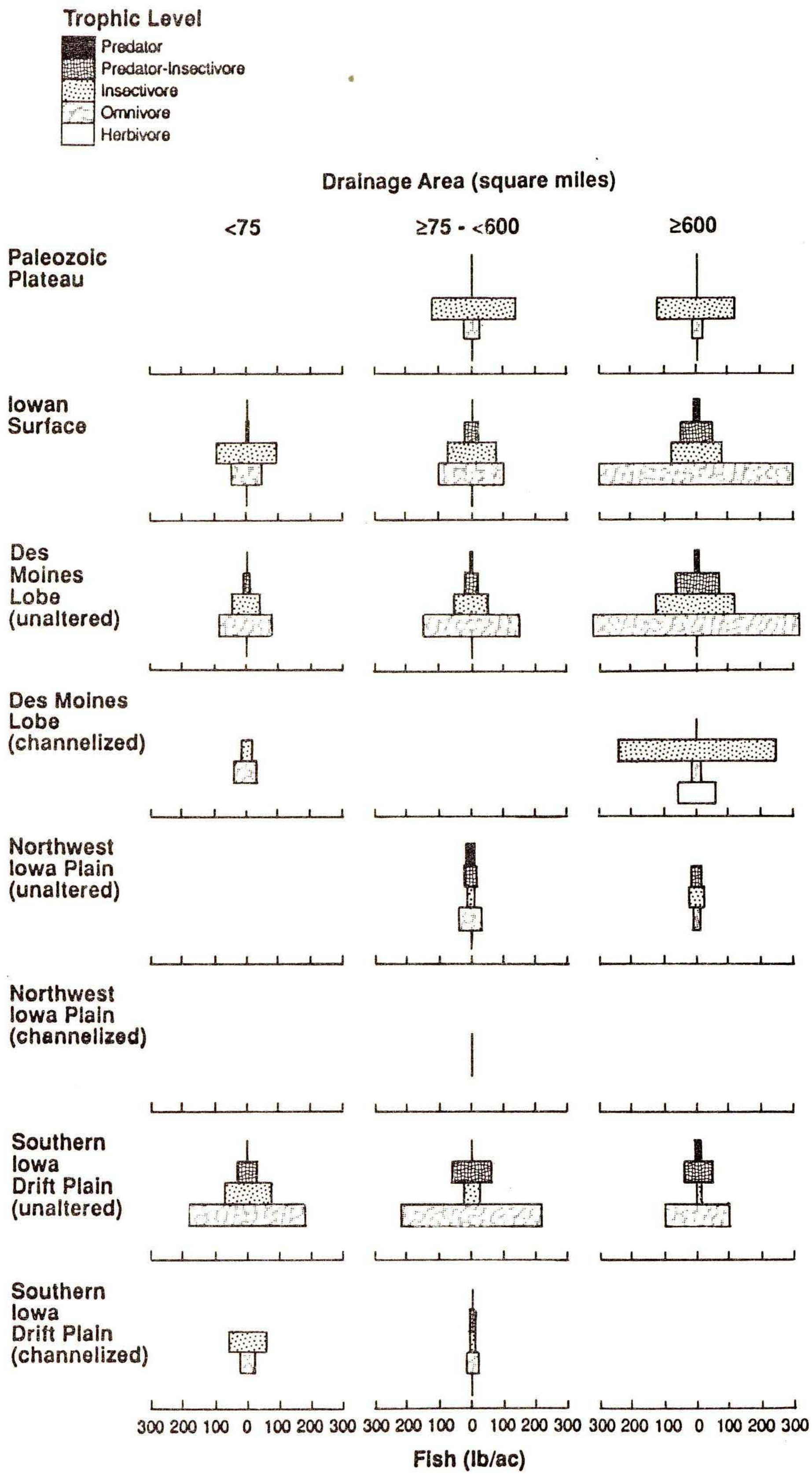


Figure 2. Mean trophic structure of fish (lb/ac) in Iowa rivers and streams.

Trophic Structure

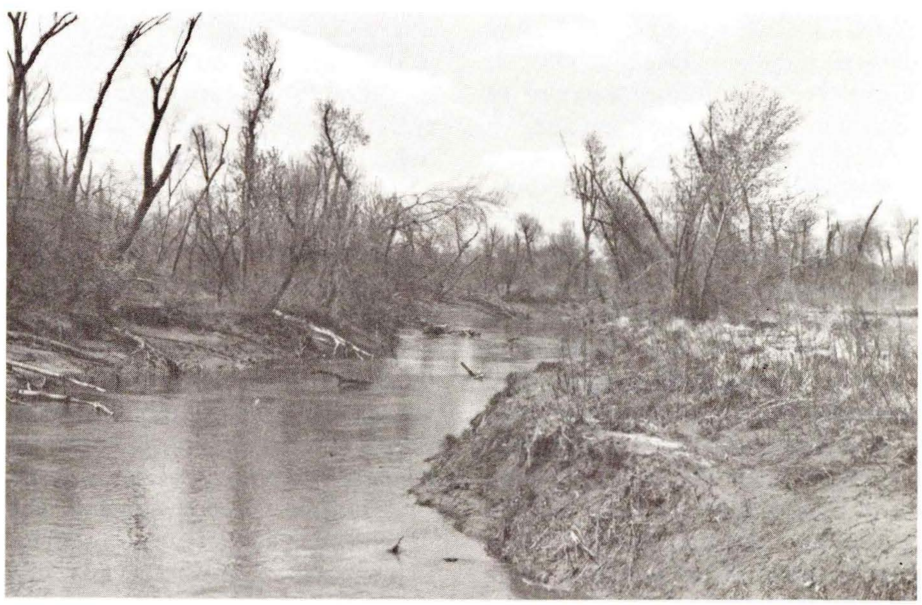
Like most waters in North America, the trophic structure of fish communities in Iowa streams was pyramid-shaped and was a function of habitat and food availability (Figure 2). The biomass of the fish community was usually dominated by omnivores (up to 656 lbs/ac in the Des Moines Lobe) followed by insectivores, piscivore-insectivores, and piscivores, while herbivores comprised a very minor proportion of the total (a maximum of 3.6 lbs/ac in the Paleozoic Plateau). The best examples of this distribution were found in the unaltered streams of the Iowan Surface, Des Moines Lobe, and Southern Iowa Drift Plain. However, insectivores dominated the biomass of the Paleozoic Plateau. Carpsuckers and carp were the dominant omnivores in all landforms, redhorse were important insectivores, while channel catfish was the dominant piscivore-insectivore (up to 416 lbs/ac in East Fork Des Moines River) in most streams and large catfish were the major predator. Smallmouth bass was the most important piscivore in the Paleozoic Plateau (about 3 lbs/ac) and also in the Iowan Surface (about 2 lbs/ac). Smallmouth bass and northern pike were important in the Des Moines Lobe while shortnose gar were dominant in the Northwest Iowa Plains. Flathead catfish was an additional predator in some unaltered rivers in the Southern Iowa Drift Plain. In general, piscivores were most abundant in streams with good habitat: middle reaches of the Maquoketa River; Middle Raccoon River; Iowa River and Wapsipinicon River; the lower reach of the North Skunk River; and Elk Creek. Trophic structure in the altered streams were severely truncated because they were nearly void of piscivores (less than 1 lb/ac) and piscivore-insectivores (about 9 lbs/ac) (Figure 2).

Trophic structure of most fish communities changed from headwater habitats to lower reaches of main river systems (Figure 2). The most obvious increase occurred in omnivore biomass as the stream size and drainage area increased, i.e. biomass increased from 30% of the total in the headwater habitat to 68% in the lower reaches of the Iowan Surface. Predator biomass also tended to increase in lower reaches but seldom comprised more than 3% of the total, although piscivore-insectivores (primarily channel catfish) continued as an important predator component. Best examples of this observation were recorded in the Iowan Surface, Des Moines Lobe, and Southern Iowa Drift Plain. As the drainage area and turbidity of rivers increased, the biomass of insectivorous fish declined.

DISCUSSION

Habitat was the major factor responsible for differences in total fish standing stocks in Iowa streams and rivers. ANOVA comparisons of the total standing stocks of fish within stream sets of good, fair, and poor habitat demonstrated highly significant differences ($P<0.01$). Streams with good habitat averaged 862 lbs/ac of fish, fair 399 lbs/ac, and poor habitat was only 99 lbs/ac of fish. A change in habitat from one bend in a river to the next was sufficient to make a substantial difference in total standing stocks. For example, sites A and B of the Thompson Fork of the Grand were not very distant from one another, yet site A was classified as good habitat and B was poor habitat. The difference in habitat quality made a 5-fold difference in total standing stocks of fish and a 2.5-fold difference in channel catfish biomass. Also, total standing stocks of smallmouth bass averaged 17.8 lbs/ac within streams of good habitat; while it was 4.6 lbs/ac in streams of fair and poor habitat. These cases reveal an important need to quantify instream habitat and to determine precisely what makes them different. Only after habitat is quantified can the complete importance of this component be fully understood.

A comparison of altered and unaltered waterways clearly showed that stream channelization reduced species diversity, and that total fish biomass was significantly lower ($P<0.05$) in channelized waters. These differences were due to the poor habitat found within channelized streams. Channelized streams are uniform in depth, current velocity, and void of instream cover. Such habitat supported numerous small fish, but the total standing stock and



Fallen trees and root wads provide ideal habitat for channel and flathead catfish in Site C of the North Skunk River.

density of sport fish including channel and flathead catfish, bullhead, and carp was significantly lower ($P<0.05$).

Channelization of streams and rivers in Iowa has resulted in a dramatic loss of channel catfish. Bulkley et al. (1976) estimated the state has lost 3,000 miles of streams to channelization. Findings in this study indicated that streams in the Southern Iowa Drift Plain with <600 sq. mi. of drainage averaged 980 channel catfish/mi. and these fish averaged .25 lbs/per fish. This equates to an annual loss of nearly 3 million catfish valued at a half-million dollars (Anonymous 1982).

A substantial improvement in the fish community of a channelized stream was noted when habitat quality and diversity were improved. Channelization of Walnut and Silver Creeks, both tributaries to the Nishnabotna River, occurred at about the same time. These streams were similar in location, physical characteristics, and water quality; however, the reach sampled on Walnut Creek included remains of an abandoned bridge. The site also contained remnants of riprap, debris, and a plunge pool created by stream flow over fallen bridge material. This habitat resulted in a standing stock of fish 30 times greater than that found in Silver Creek, which lacked similar habitat. Davis (1988), in Kentucky, found improvement of habitat in several channelized streams increased fish biomass.

Woody structure was an important instream habitat factor to streams of all landforms, but was particularly important to streams of the Southern Iowa Drift Plain and was most evident in the channelized reaches. Channelized streams were normally barren of instream structure and often fell into the poor habitat category, but when trees and parts of trees had fallen or were washed into a waterway, they provided habitat diversity. Trees would provide overhead cover and scour pockets enabling some channelized streams to be considered fair habitat, e.g. West Nishnabotna River - B, Whitebreast, and Bridge Creeks. The former two streams averaged 44 lbs/ac of channel catfish.

Cylinder Creek, a ditched stream in the Des Moines Lobe, was uniform in depth, substrate, current velocity and thus provided little habitat to fish.

Drainage ditches contained poor habitat for fish. Samples taken from Cylinder Creek and Jack Creek, drainage ditches in the Des Moines Lobe, showed these streams supported only 125 lbs/ac of fish and the streams were void of gamefish. Jack Creek contained a surprisingly large number of fish species, but this was probably due to the close proximity of the sample site to the West Fork Des Moines River. Other streams sampled in the region contained 300 or more lbs/ac of fish and smallmouth bass, rock bass, northern pike, and channel catfish were present.

The trophic structure of fish communities within waterways in Iowa demonstrated some unique differences in fish production within and between landforms. In general, as the drainage area of most streams increased, the importance of insectivores decreased and that of insectivore-piscivore and omnivores increased, while the predator biomass remained low. Each group of streams or rivers had a different potential for management. It also graphically showed the dramatic change within a fish community after a river course was physically altered.

The importance of headwater streams to sport fish populations of larger rivers is not well documented, but 86% of the smaller second and third order streams were inhabited by young-of-the-year of one or more species of sport fish important to the fisheries of larger receiving streams. These small streams appear to be important spawning and nursery sites for sport fish that may later recruit to larger streams; however, a better understanding of this relationship is needed.

Channel catfish was the most abundant and most widely distributed sport fish in streams and rivers. This species occupied a variety of habitat and was associated with all substrate types, from cobble and boulder substrate in the Wapsipinicon River to silt and sand in the Chariton and West Nishnabotna Rivers. Channel catfish also inhabited the small tributary streams like Wolf Creek, as well as the large rivers, such as East Fork Des Moines River. More specific habitat requirements were noted for other sport fish. For example, gravel and cobble substrate was associated with better populations of smallmouth and rock bass. Northern pike were most common in streams with debris jams and those that traversed through a landscape that contained flood plain oxbows and backwater marshes.

River systems in Iowa are under continuous threat of physical alteration and point and non-point pollution. These threats often become reality and result in partial or total losses in fish life. Assessment of these losses are seldom accurate and often an after-the-fact activity of Department employees. Data from this study are compiled in Appendix M and N to present an alternative method to estimate these losses. These data are quantitatively segregated by landform because of known differences in species composition and segregated by drainage areas.

This dissertation on the river and stream fisheries in Iowa is by no means complete. Many questions need to be answered and many data gaps remain. For example, many more streams in the Northwest Iowa Plains, Paleozoic Plateau and Des Moines Lobe need to be sampled, as well as more large streams in all landforms. Of particular importance is the need of comparative studies of the impact of land use on fish populations. The importance of habitat must be quantified even further to provide direction for warmwater stream habitat improvements. Streams are all dynamic environments and are most sensitive to man's activities. These streams and rivers are overlooked and have a need for fisheries improvements and management. A comprehensive statewide management strategy will ensure improved access, refined stocking strategies, protection of stream corridors, angler education, and improved chemical and physical integrity of interior rivers and streams.

MANAGEMENT CONSIDERATIONS

1. Further study is needed to provide a more precise quantification of habitat; however, work accomplished in this study provides a great deal of insight to habitat requirements of Iowa's riverine fish species.

2. Habitat should be created on an experimental basis and assessed for fisheries value. Public access to streams in some regions of Iowa is restricted primarily to channelized waters. Fishing could be enhanced at these sites by creating habitat diversity, e.g. riprap, in-stream structure, bank stabilization, and restoration of streams back to former channel configuration.

3. Routine sampling of stream fish populations should incorporate the use of rotenone.

4. Two appendix tables list fish population densities (Appendix M) and standing stocks (Appendix N) by landform and drainage area. These should be used to estimate fish loss due to kills. This will be an adequate substitute when on-site inspection is not practical or possible.

5. Spawning habitat of northern pike exists within flood plain marshes and backwaters areas. These habitats should be included in access acquistion and protected.

6. Instream flow needs have yet to be addressed adequately in Iowa.

7. A policy should be developed which requires channelized stream banks to be rip-rapped or mitigation that would enhance fisheries habitat.

8. There is a need to determine the importance of small headwater streams as spawning and nursery areas for larger receiving streams.

LITERATURE CITED

Ackerman. 1974. Turkey River investigation. Fisheries Management Completion Reports. Iowa Conservation Commission, Des Moines, Iowa, pp. 83-99.

Aitken, W. 1936. Some common fishes. Iowa State College Extension Circular 224:1-33.

Anonymous. 1982. Monetary values of freshwater fish and fish-kill counting guidelines. American Fisheries Society Special Publication No. 13. Bethesda, Maryland.

Anonymous. 1986. Fishing in Iowa. Iowa Conservation Commission, Des Moines, Iowa.

Baily, R. 1951. A checklist of fishes in Iowa, with keys for identification, pp. 195-237. In Harlan and Speaker eds. Iowa Fish and Fishing. Iowa Conservation Commission, Des Moines, Iowa.

Bulkley, R. , R. Bachmann, K. Carlander, H. Fierstine, L. King, B. Menzel, A. Witten and D. Zimmer. 1976. Warmwater stream alteration in Iowa; Extent, effects on habitat, fish, and fish food, and evaluation of stream improvement structures (Summary Report). U.S. Fish and Wildlife Service, Office of Biological Services Report FWS/OBS-76-16:39 pp.

Cleary, R. 1956. Distribution of the Iowa fishes. In Iowa Fish and Fishing. Editors J. Harlan and E. Speaker. Iowa Conservation Commission, Des Moines, Iowa. 365 pp.

Cleary, R. 1957. Catch composition of inland river trap net raises in northeast Iowa, 1949-56. Quarterly Biology Report. 9(3):20-22. Iowa Conservation Commission, Des Moines, Iowa.

Davis, W. 1988. Impacts of channel modification and habitat mitigation on the fisheries at Poor Fork Cumberland River, Caney Creek, and Right Fork Beaver Creek. Fisheries Bulletin Number 84, Kentucky Dept. of Fish and Wildlife Resources, Frankfort, Kentucky.

Harrison, H. 1952. Fish populations of Boone County for 1946 through 1951. Quarterly Biology Report. 4(1):41-49. Iowa Conservation Commission, Des Moines, Iowa.

____________. 1962. Fall fish populations by shocking. Quarterly Biology Report. 14(4) 46-51. Iowa Conservation Commission, Des Moines, Iowa.

____________, and E. Speaker. 1954. Annotated list of the fishes in the streams tributary to the Missouri River in Iowa. Proceedings of Iowa Academy of Science. 63:511-523.

Jordan, D. and S. Meek. 1885. List of fishes collected in Iowa and Missouri in August, 1884, with descriptions of three new species. Proceedings of the United States Natural History Museum.

Karr, J. 1981. Assessment of biotic integrity using fish communities. Fisheries (Bethesda) 6(6):21-27.

Karr, J. et al. 1986. Assessing biological integrity in running waters: a method and its rationale. Illinois Natural History Survey, Special Publication 5. 29 pp.

Mayhew, J. K. 1965. Pre-impoundment of the Chariton River in the vicinity of Rathbun Dam and Reservoir--Part II. Quarterly Biology Report. 17(4):4-10. Iowa Conservation Commission, Des Moines, Iowa.

Menzel, B. 1981. Iowa's waters and fishes: a century and a half of change. Proceedings Iowa Academy Science. 88(1):17-23.

__________. 1987. Fish distribution. Pp. 201-213 in J. Harland and E. Speaker with J. Mayhew. Iowa Fish and Fishing. Iowa Department of Natural Resources. Des Moines, Iowa.

Middendorf, R. 1974. Evaluation of a fishery to determine effects of the Duane Arnold Energy Center. Iowa Conservation Commission, Des Moines, Iowa, pp. 94-97.

Odum, E. 1959. Fundamentals of ecology. W.B. Saunders Company. Philadelphia, Pennsylvania. 546 pp.

Paragamian, V. 1980. Population dynamics of smallmouth bass in the Maquoketa River and other Iowa streams. Federal Aid Fish Restoration Completion Report Project No. F-89-R. Iowa Conservation Commission, Des Moines, Iowa.

__________. 1986. Diversity and standing stocks of stream fishes. Federal Aid Fish Restoration Completion Report Project No. F-99-R. Iowa Conservation Commission, Des Moines, Iowa.

Prior, J. 1976. A regional guide to Iowa landforms. Iowa Geological Survey, Education Survey 3, Iowa City, Iowa. 72 pp.

Potter, G. 1928. Compilation and revision of the fish records published for Iowa. Proceedings of the Iowa Academy of Science, 34:339-366.

Putnam, T. 1974. Pre-impoundment survey of the Des Moines River--Saylorville Reservoir. Fish Management Completion Reports. Iowa Conservaton Commission, Des Moines, Iowa.

Schwartz, J. 1975. A pre-impoundment study of Walters Creek. Fisheries Management Completion Reports. Iowa Conservation Commission, Des Moines, Iowa, pp. 138-145.

Appendix A. Fish sample sites listed by landform, drainage basin, and description, 1983-1985. Drainage basins are Northeast (NE), Iowa-Cedar (IC), Des Moines (DM), Western (W), Skunk (SK), and Southern (S).

Stream	Sample Site	Location by County & Drainage Basin	Location	Length (Miles)	Acres	Date Sampled
Paleozoic Plateau						
Volga River		Fayette	NE T93N-R8W-Sec 24	.122	.81	28 July 83
Upper Iowa River	A	Winneshiek	NE T100N-R10W-Sec 35	.087	.88	15 Sept 83
	B	Allamakee	NE T99N-R6W-Sec	.120	2.37	16 Sept 83
Iowan Surface						
Turkey River		Howard	NE T98N-R11W-Sec 2	.059	.33	20 July 83
Maquoketa River	A	Delaware	NE T90N-R6W-Sec 34	.071	.40	21 June 83
	B	Delaware	NE T88N-R4W-Sec 33	.092	.61	8 July 83
	C	Jones	NE T88N-R2W-Sec 32	.065	.89	9 Aug 83
Coffins Grove Creek		Delaware	NE T89N-R6W-Sec 27	.066	.29	24 June 83
South Fork Maquoketa River		Buchanan	NE T90N-R7W-Sec 24	.062	.22	19 Aug 83
Wapsipinicon River	A	Mitchell	NE T100N-R15W-Sec 20	.057	.13	20 July 83
	B	Black Hawk	NE T90N-R11W-Sec 4	.102	.84	24 July 83
	C	Buchanan	NE T87N-R8W-Sec 25	.120	1.78	7 Sept 83
Buffalo Creek		Linn	NE T86N-R6W-Sec 12	.055	.34	11 July 83
Little Wapsipinicon River		Fayette	NE T91N-R10W-Sec 16	.081	.47	15 July 83
Shell Rock River		Cerro Gordo	IC T97N-R19W-Sec 27	.060	.86	18 July 84
Elk Creek		Worth	IC T99W-R21W-Sec 24	.060	.45	17 July 84
West Fork Cedar River		Butler	IC T91N-R17W-Sec 23	.067	.70	1 Aug 84
Little Cedar River		Mitchell	IC T99M-R16W-Sec 36	.072	.39	7 Aug 84
Beaver Creek		Black Hawk	IC T90N-R14W-Sec 28	.078	.63	1 Aug 84
Black Hawk Creek		Black Hawk	IC T87N-R14W-Sec 6	.064	.58	2 Aug 84
Lime Creek		Benton	IC T86N-R10W-Sec 4	.081	.42	10 Aug 84
Des Moines Lobe						
East Fork Des Moines River		Kossuth	DM T96N-R28W-Sec 6	.029	.16	16 July 85
Buffalo Creek		Kossuth	DM T97N-R28W-Sec 9	.031	.16	17 July 85
Cylinder Creek		Palo Alto	DM T95N-R32W-Sec 24[a]	.071	.32	31 May 85

[a]Denotes channelized reach.

Appendix A. Continued

Stream	Sample Site	Location by County & Drainage Basin	Location	Length (Miles)	Acres	Date Sampled
Jack Creek		Palo Alto	DM T97N-R33W-Sec 22[a]	.059	.24	31 May 85
Boone River	A	Wright	DM T92N-R26W-Sec 7	.064	.28	25 June 85
	B	Wright	DM T90N-R26W-Sec 22	.073	.63	26 June 85
Eagle Creek		Wright	DM T90N-R25W-Sec 18	.066	.23	26 June 85
North Raccoon River	A	Sac	DM T89N-R36W-Sec 1	.053	.30	9 July 85
	B	Greene	DM T84W-R32W-Sec 10	.049	.44	21 Aug 85
Camp Creek		Calhoun	DM T86N-R34W-Sec 5	.040	.15	10 July 85
Cedar Creek		Calhoun	DM T86N-R32W-Sec 23	.054	.20	10 July 85
Middle Raccoon River	A	Carroll	DM T82N-R33W-Sec 18	.040	.20	10 July 85
	B	Guthrie	DM T79N-R30W-Sec 24	.043	.30	31 July 85
Mosquito Creek		Dallas	DM T79N-R29W-Sec 22	.055	.10	1 Aug 85
Willow Creek		Guthrie	DM T81N-R32W-Sec 23	.044	.15	1 Aug 85
Winnebago River		Worth	IC T98N-R22W-Sec 34	.056	.50	8 Aug 84
Iowa River	A	Wright	IC T92N-R24W-Sec 14	.040	.28	13 Sept 84
	B	Hardin	IC T89N-R20W-Sec 20	.085	.76	28 Aug 84
South Skunk River	A	Story	SK T84N-R23W-Sec 7	.064	.46	6 June 85
	B	Story	SK T82N-R23W-Sec 9[a]	.039	.21	8 Aug 85
Northwest Iowa Plains						
Otter Creek		Lyon	W T98N-R44W-Sec 21	.083	.41	2 Aug 83
Little Rock River		Lyon	W T98N-R45W-Sec 12	.069	.55	3 Aug 83
Rock River		Lyon	W T99N-R45W-Sec 15	.065	.57	3 Aug 83
Maple River		Ida	W T89N-R39W-Sec 22[a]	.057	.40	31 Aug 83
Southern Iowa Drift Plain						
Chariton River	A	Lucas	S T71N-R21W-Sec 5[a]	.052	.14	28 June 84
	B	Lucas	S T71N-R30W-Sec 19	.061	.25	28 June 84
	C	Lucas	S T71N-R20W-Sec 29	.085	.55	27 June 84
Wolf Creek		Lucas	S T71N-R21W-Sec 30	.081	.09	26 June 84
Cooper Creek		Appanoose	S T69N-R17W-Sec 30	.045	.15	27 June 84

[a]Denotes channelized reach.

Appendix A. Continued

Stream	Sample Site	Location by County & Drainage Basin	Location	Length (Miles)	Acres	Date Sampled
W. Fork Nishna-botna River	A	Shelby	S T79N-R38W-Sec 19[a]	.066	.61	11 July 84
	B	Pottawattamie	S T78N-R39W-Sec 32[a]	.062	.69	11 July 84
Walnut Creek		Pottawattamie	S T75N-R38W-Sec 15 & 16[a]	.089	.22	5 Sept 84
Silver Creek		Pottawattamie	S T75N-R41W-Sec 34[a]	.051	.15	5 Sept 84
Thompson Fork of the Grand River	A	Union	S T72N-R28W-Sec 29	.059	.33	24 July 84
	B	Decatur	S T68N-R26W-Sec 17	.095	.77	25 July 84
Clear Creek		Johnson	IC T80N-R8W-Sec 25	.098	.11	31 Aug 84
English River		Washington	IC T77N-R7W-Sec 17	.071	.47	30 Aug 84
South Skunk	C	Keokuk	SK T75N-R13W-Sec 32	.019	.09	18 June 85
Bridge Creek		Keokuk	SK T75N-R11W-Sec 7	.048	.10	18 June 85
Big Cedar Creek		Jefferson	SK T71N-R9W-Sec 33	.067	.30	17 June 85
West Fork Crooked Creek		Washington	SK T74N-R7W-Sec 11[a]	.058	.19	22 May 85
North Skunk River	A	Jasper	SK T80W-R17W-Sec 31[a]	.032	.15	6 Aug 85
	B	Mahaska	SK T76W-R14W-Sec 22	.070	.41	19 June 85
	C	Keokuk	SK T75N-R13W-Sec 8	.065	.44	22 May 85
Middle Creek		Mahaska	SK T76N-R14W-Sec 34	.044	.10	19 June 85
Whitebreast Creek		Marion	DM T75N-R20W-Sec 16[a]	.075	.42	15 May 85
South Avery Creek		Wapello	DM T72N-R15W-Sec 2	.102	.07	5 June 85
Rock Creek		Cedar	IC T79N-R3W-Sec 2	.047	.26	10 Aug 84

[a]Denotes channelized reach.

Appendix B. Species composition of fish sampled from Iowa streams traversing five geologic landforms.

LANDFORM

Paleozoic Plateau

Hiodontidae
- Mooneye
- Gizzard Shad

Catostomidae
- River Carpsucker
- Highfin Carpsucker
- Quillback Carpsucker
- Shorthead Redhorse
- Golden Redhorse
- Black Redhorse
- Silver Redhorse
- Northern Hog Sucker
- White Sucker

Cyprinidae
- Carp
- Central Stoneroller
- Largescale Stoneroller
- Blacknose Dace
- Longnose Dace
- Creek Chub
- Suckermouth Minnow
- Bluntnose Minnow
- Brassy Minnow
- Hornyhead Chub
- Gravel Chub
- Silver Chub
- Common Shiner
- Spotfin Shiner
- Rosyface Shiner
- Emerald Shiner
- Sand Shiner
- Bigmouth Shiner

Ictaluridae
- Stonecat
- Channel Catfish

Centrachidae
- Rock Bass
- Smallmouth Bass

Serranidae
- White Bass

Percidae
- Slenderhead Darter
- Fantail Darter
- Sauger

Iowan Surface

Umbridae
- Central Mudminnow

Esosidae
- Northern Pike

Catostomidae
- Bigmouth Buffalo
- Highfin Carpsucker
- Quillback Carpsucker
- Shorthead Redhorse
- Golden Redhorse
- Black Redhorse
- Silver Redhorse
- Northern Hog Sucker
- White Sucker

Cyprinidae
- Carp
- Largescale Stoneroller
- Blacknose Dace
- Longnose Dace
- Creek Chub
- Southern Redbelly Dace
- Flathead Minnow
- Redfin Shiner
- Red Shiner
- Suckermouth Minnow
- Bluntnose Minnow
- Brassy Minnow
- Hornyhead Chub
- Gravel Chub
- Silver Chub
- Common Shiner
- Spotfin Shiner
- Rosyface Shiner
- Emerald Shiner
- Sand Shiner
- Bigmouth Shiner

Ictaluridae
- Tadpole Madtom
- Slender Madtom
- Black Bullhead
- Yellow Bullhead
- Stonecat
- Channel Catfish
- Flathead Catfish

Gasterostidae
- Brook Stickleback

Centrarchidae
- Green Sunfish
- Orange Spotted Sunfish
- Green Sunfish X
- Bluegill
- White Crappie
- Black Crappie
- Rock Bass
- Smallmouth Bass
- Largemouth Bass

Des Moines Lobe

Esosidae
- Northern Pike

Catostomidae
- Bigmouth Buffalo
- Smallmouth Buffalo
- River Carpsucker
- Highfin Carpsucker
- Quillback Carpsucker
- Shorthead Redhorse
- Golden Redhorse
- Silver Redhorse
- Northern Hog Sucker
- White Sucker

Cyprinidae
- Carp
- Central Stoneroller
- Fathead Minnow
- Bluntnose Minnow
- Bullhead Minnow
- Suckermouth Minnow
- Brassy Minnow
- Creek Chub
- Hornyhead Chub
- Speckled Chub
- Topeka Shiner
- Golden Shiner
- Common Shiner
- Red Shiner
- Spotfin Shiner
- Emerald Shiner
- Sand Shiner
- Bigmouth Shiner
- Blacknose Dace
- Rosyface Shiner
- Goldfish

Ictaluridae
- Black Bullhead
- Yellow Bullhead
- Channel Catfish
- Flathead Catfish
- Stonecat
- Tadpole Madtom

Gasterostidae
- Brook Stickleback

Sciaenidae
- Freshwater Drum

Cyprinodontidae
- Banded Killifish

Serranidae
- White Bass

Centrarchidae
- Orange Spotted Sunfish
- Green Sunfish
- Bluegill
- Rock Bass

Northwest Iowan Plains

Lepisosteidae
- Shortnose Gar

Hiodontidae
- Goldeye

Catostomidae
- Quillback Carpsucker
- Golden Redhorse
- Shorthead Redhorse
- White Sucker

Cyprinidae
- Carp
- Central Stoneroller
- Creek Chub
- Fathead Minnow
- Bluntnose Minnow
- Brassy Minnow
- Red Shiner
- Sand Shiner
- Bigmouth Shiner

Ictaluridae
- Channel Catfish
- Black Bullhead
- Stonecat
- Tadpole Madtom

Sciaenidae
- Freshwater Drum

Centrarchidae
- Green Sunfish

Percidae
- Yellow Perch
- Blackside Darter
- Johnny Darter

Percopsidae
- Trout Perch

Southern Iowa Drift Plain

Lepisosteidae
- Shortnose Gar

Hiodontidae
- Mooneye
- Goldeye
- Gizzard Shad

Catostomidae
- Bigmouth Buffalo
- River Carpsucker
- Quillback Carpsucker
- Golden Redhorse
- Shorthead Redhorse
- White Sucker

Ictaluridae
- Black Bullhead
- Yellow Bullhead
- Stonecat
- Channel Catfish
- Flathead Catfish
- Freckled Madtom
- Tadpole Madtom
- Slender Madtom

Cyprinidae
- Carp
- Central Stoneroller
- Fathead Minnow
- Bluntnose Minnow
- Suckermouth Minnow
- Brassy Minnow
- Creek Chub
- Common Shiner
- Red Shiner
- Emerald Shiner
- Sand Shiner
- Bigmouth Shiner
- Plains Minnow
- Western Silver Minnow
- Silver Chub
- Flathead Chub
- Speckled Chub

Sciaenidae
- Freshwater Drum

Centrarchidae
- Black Crappie
- White Crappie
- Green Sunfish
- Bluegill
- Orange Spotted Sunfish
- Largemouth Bass

Serranidae
- Yellow Bass
- White Bass

Percidae
- Walleye
- Johnny Darter

Appendix B. Continued

LANDFORM				
Paleozoic Plateau	**Iowan Surface**	**Des Moines Lobe**	**Northwest Iowan Plains**	**Southern Iowa Drift Plain**
	Serranidae Yellow Bass Percidae Walleye Blackside Darter Slenderhead Darter Johnny Darter Banded Darter Rainbow Darter Fantail Darter Mud Darter Yellow Perch Log Perch	Smallmouth Bass Percidae Slenderhead Darter Johnny Darter Blackside Darter Fantail Darter Walleye		

Appendix C. Numerical density and standing stock of four species and six families of fish found in two streams in the Paleozoic Plateau landform.

	Upper Iowa River						Volga River[a]		
	A[a]			B[b]					
	N/mi	N/ac	lb/ac	N/mi	N/ac	lb/ac	N/mi	N/ac	lb/ac
Species									
Carp				158	8	40.5			
Channel Catfish				40	2	5.3			
Smallmouth Bass	262	26	2.1	20	1	<.1	365	55	6.7
Rock Bass	20	2	.9				60	9	1.5
Family									
Hiodontidae				1,481	75	9.7			
Catostomidae	5,098	504	231.5	1,738	88	36.8	4,488	676	327.0
Cyprinidae	44,374	4,387	50.9	6,636	336	2.1	18,112	2,728	23.9
Ictaluridae	1,517	150	1.6	6,083	308	4.3	1,979	298	4.0
Percichthyidae				40	2	1.8			
Percidae	5,149	509	2.7	59	3	1.5	153	23	.1
TOTAL	**56,420**	**5,578**	**289.7**	**16,255**	**823**	**102.1**	**25,157**	**3,789**	**363.2**

[a]River segment with drainage basin of 75-599 sq. mi.
[b]River segment with drainage basin of 600 sq. mi. or greater.

Appendix D. Numerical density and standing stock of seven species and eight families of fish found in five streams <75 sq. mi. of drainage in the Iowan Surface landform.

	South Fork Maquoketa River			Wapsipinicon River A			Elk Creek			Lime Creek			Coffins Grove Creek		
	N/mi	N/ac	lb/ac	N/mi	N/ac	lb/ac	N/mi	N/ac	lb/ac	N/mi	N/ac	lb/ac	N/mi	N/ac	lb/ac
Species															
Northern Pike							226	36	17.3	62	12	1.6			
Carp							1,343	182	286.7	26	5	1.7			
Channel Catfish							30	4	2.5	627	121	43.6			
Flathead Catfish										10	2	1.2			
Smallmouth Bass										259	50	3.6	123	28	1.9
Rock Bass										135	26	2.9	136	31	6.6
Walleye										10	2	.9			
Family															
Umbridae							221	30	.1						
Catostomidae	405	114	15.8	7,440	3,262	95.3	1,040	141	103.5	1,468	283	149.4	5,840	1,329	386.8
Cyprinidae	12,995	3,664	17.2	54,007	23,680	164.1	2,833	384	1.3	7,996	1,542	4.0	15,195	3,458	35.3
Ictaluridae	209	59	1.4	260	114	11.9	10,441	1,411	74.9	778	150	13.8	92	21	4.4
Gasterosteidae				194	85	.2									
Centrarchidae				87	38	.2	1,387	188	2.8	1,047	202	7.9	167	38	.6
Percichthyidae															
Percidae	837	236	.7	755	331	1.3	332	45	.3	270	52	.1	185	42	.1
Total	**14,446**	**4,073**	**35.1**	**62,743**	**27,510**	**273.0**	**17,893**	**2,421**	**489.4**	**12,688**	**2,447**	**230.7**	**21,738**	**4,947**	**435.7**

Appendix E. Numerical density and standing stock of six species and seven families of fish found in six streams. >75 - <600 sq. mi. of drainage in the Iowan Surface landform.

	Maquoketa River A			Maquoketa River B			Wapsipinicon River B			Buffalo Creek		
	N/mi	N/ac	lb/ac	N/mi	N/ac	lb/ac	N/mi	N/ac	lb/ac	N/mi	N/ac	lb/ac
Species												
Northern Pike							148	18	16.1			
Carp							708	86	280.0	19	3	9.9
Channel Catfish				358	54	15.4	14,618	1,775	118.4	93	15	15.2
Smallmouth Bass	242	43	11.1	2,447	369	33.9	8	1	1.8	544	88	5.8
Rock Bass				73	11	3.4	66	8	3.1	148	24	.3
Walleye												
Family												
Catostomidae	3,808	676	165.3	4,151	626	221.4	3,838	466	291.1	2,566	415	141.3
Cyprinidae	11,031	1,958	13.3	14,323	2,160	21.4	26,435	3,210	10.9	16,082	2,601	15.7
Ictaluridae	203	36	3.5	1,936	292	28.2	2,957	359	26.5	816	132	1.9
Gasterostidae												
Centrarchidae	552	98	5.4	119	18	1.1	4,875	592	8.5	254	41	.6
Percichthyidae				33	5	3.0						
Percidae				1,764	266	1.4	659	80	.4	390	63	.4
TOTAL	**15,836**	**2,811**	**198.6**	**25,204**	**3,801**	**329.2**	**54,312**	**6,595**	**756.8**	**20,912**	**3,382**	**191.1**

Appendix E. Continued

	Turkey River			Little Wapsipinicon River			Shell Rock River		
	N/mi	N/ac	lb/ac	N/mi	N/ac	lb/ac	N/mi	N/ac	lb/ac
Species									
Northern Pike							141	10	9.6
Carp				34	6	44.5	1,086	77	68.3
Channel Catfish									
Smallmouth Bass	610	109	9.6						
Rock Bass	168	30	7.3				99	7	3.1
Walleye									
Family									
Catostomidae	2,674	478	98.3	1,565	273	36.0	4,286	304	120.0
Cyprinidae	13,083	2,339	11.0	26,268	4,583	58.4	4,878	346	2.6
Ictaluridae	1,438	257	10.9	1,129	197	7.5	27,802	1,972	118.1
Gasterostidae				132	23	.1			
Centrarchidae	509	91	4.2	4,356	760	7.3	4,949	351	10.2
Percichthyidae									
Percidae	509	91	.2	825	144	.3	2,101	149	.7
TOTAL	**18,991**	**3,395**	**141.5**	**34,309**	**5,986**	**154.1**	**45,342**	**3,216**	**332.6**

Appendix E. Continued

	Little Cedar River			Beaver Creek			Black Hawk Creek		
	N/mi	N/ac	lb/ac	N/mi	N/ac	lb/ac	N/mi	N/ac	lb/ac
Species									
Northern Pike				16	2	2.6			
Carp	260	48	87.0	2,181	270	559.2	1,341	148	595.1
Channel Catfish	488	90	87.3	3,457	428	141.1	1,205	133	35.5
Smallmouth Bass	87	16	7.9	16	2	1.0			
Rock Bass									
Walleye				16	2	1.0			
Family									
Catostomidae	5,861	1,082	258.6	695	86	75.7	1,504	166	94.5
Cyprinidae	14,555	2,687	17.2	7,738	958	4.1	7,812	862	4.8
Ictaluridae				2,245	278	16.0	3,435	379	14.3
Gasterostidae									
Centrarchidae	184	34	1.0	4,749	588	19.0	308	34	.4
Percichthyidae									
Percidae	547	101	.2	388	48	.4			
TOTAL	**21,982**	**4,058**	**459.2**	**21,501**	**2,662**	**820.1**	**15,605**	**1,721**	**744.6**

Appendix F. Numerical density and standing stock of six species and five families of fish found in three streams > 600 sq. mi. of drainage in the Iowan Surface landform.

	Wapsipinicon River C			Maquoketa River C			West Fork Cedar River		
	N/mi	N/ac	lb/ac	N/mi	N/ac	lb/ac	N/mi	N/ac	lb/ac
Species									
Northern Pike	223	15	2.3				63	6	2.8
Carp	1,009	68	182.9	55	4	13.3	4,597	440	1,433.7
Channel Catfish	12,623	851	55.1	1,410	103	47.2	3,291	315	212.1
Smallmouth Bass	15	1	.3	205	15	4.6	31	3	.5
Rock Bass				55	4	.9			
Walleye	104	7	12.1	55	4	33.3	94	9	15.3
Family									
Catostomidae	5,235	353	233.6	5,546	405	244.7	2,434	233	111.5
Cyprinidae	40,065	2,701	10.2	1,301	95	.5	11,148	1,067	5.0
Ictaluridae	12,104	816	11.9	27	2	1.0	9,487	908	59.9
Centrarchidae	2,818	190	16.7	151	11	1.5	2,361	226	5.0
Percidae	5,563	375	2.7				773	74	.5
Total	**79,759**	**5,377**	**527.8**	**8,805**	**643**	**347.0**	**34,279**	**3,281**	**1,846.3**

Appendix G. Numerical density and standing stock of seven species and nine families of fish found in fourteen streams 75-599 sq. mi. of drainage in the Des Moines Lobe landform.

	Jack Creek[a]			Cylinder Creek[a]			Eagle Creek			Iowa River A		
	N/mi	N/ac	lb/ac	N/mi	N/ac	lb/ac	N/mi	N/ac	lb/ac	N/mi	N/ac	lb/ac
Species												
Northern Pike							14	4	3.1	357	51	54.8
Carp	37	9	17.2	95	21	67.2				1,596	228	709.9
Channel Catfish												
Flathead Catfish												
Smallmouth Bass							945	271	5.4			
Rock Bass							153	44	8.6			
Walleye										35	5	9.2
Family												
Catostomidae	301	74	92.4	158	35	21.8	1,889	542	80.0	2,429	347	167.2
Cyprinidae	1,704	419	1.0	257	57	.3	110,978	31,831	197.2	3,241	463	2.0
Ictaluridae	810	199	10.5	257	57	2.2	760	218	8.7	4,515	645	107.4
Gasterosteidae							77	22	<.1			
Sciaenidae												
Cyprinodontidae	85	21	.1									
Percichthyidae												
Centrarchidae	85	21	.7	50	11	.1	77	22	.3	8,127	1,161	34.6
Percidae	106	26	.3	63	14	<.1	387	111	.4	2,317	331	1.2
Total	**3,128**	**769**	**122.2**	**880**	**195**	**91.6**	**115,280**	**33,065**	**303.8**	**22,617**	**3,231**	**1,086.2**

[a] A drainage ditch.

Appendix G. Continued

	Winnebago River			North Raccoon River A			Middle Raccoon River A			Middle Raccoon River B		
	N/mi	N/ac	lb/ac	N/mi	N/ac	lb/ac	N/mi	N/ac	lb/ac	N/mi	N/ac	lb/ac
Species												
Northern Pike	18	2	.8									
Carp	563	63	109.2	617	109	237.8	1,870	374	437.5	2,916	418	524.6
Channel Catfish	45	5	6.0	3,917	692	229.4	1,345	269	150.6	174	25	4.2
Flathead Catfish												
Smallmouth Bass	63	7	8.0	28	5	.2				1,270	182	47.4
Rock Bass												
Walleye				130	23	8.6				28	4	2.5
Family												
Catostomidae	1,107	125	102.9	3,962	700	463.2				349	50	62.2
Cyprinidae	357	40	.1	11,660	2,060	9.3	4,165	833	6.8	18,384	2,635	17.4
Ictaluridae	2,223	249	11.0	1,047	185	6.6				15,167	2,174	37.8
Gasterosteidae												
Sciaenidae				51	9	4.2						
Cyprinodontidae												
Percichthyidae				28	5	.4						
Centrarchidae	661	74	1.7				40	8	1.6	4,102	588	30.0
Percidae	179	20	.3	136	24	.1				628	90	.4
Total	**5,216**	**584**	**240.0**	**21,576**	**3,812**	**959.8**	**7,420**	**1,484**	**596.5**	**43,018**	**6,166**	**726.5**

Appendix G. Continued

	South Skunk River A			Buffalo Creek			Boone River A			Camp Creek		
	N/mi	N/ac	lb/ac	N/mi	N/ac	lb/ac	N/mi	N/ac	lb/ac	N/mi	N/ac	lb/ac
Species												
Northern Pike				149	28	43.3						
Carp	158	22	48.3	784	147	295.6	473	108	290.3	431	115	150.3
Channel Catfish	14	2	.1	37	7	11.2	123	28	33.6	428	114	35.2
Flathead Catfish												
Smallmouth Bass	14	2	.1									
Rock Bass							74	17	1.0			
Walleye												
Family												
Catostomidae	7,144	994	132.1	149	28	16.7	1,173	268	84.6	3,353	894	159.0
Cyprinidae	54,977	7,649	44.3	1,781	334	.5	42,114	9,625	45.4	8,214	2,190	12.2
Ictaluridae	4,686	652	20.4	336	63	3.3	3,189	729	34.5	930	248	7.4
Gasterosteidae												
Sciaenidae												
Cyprinodontidae												
Percichthyidae												
Centrarchidae	1,746	243	8.3	891	167	2.2	3,461	791	11.5	199	53	1.9
Percidae				37	7	.7	683	156	1.1	398	106	.5
Total	**68,739**	**9,564**	**253.6**	**4,164**	**781**	**373.5**	**51,290**	**11,722**	**502.0**	**13,953**	**3,720**	**366.5**

	Cedar Creek			Mosquito Creek			Willow Creek		
	N/mi	N/ac	lb/ac	N/mi	N/ac	lb/ac	N/mi	N/ac	lb/ac
Species									
Northern Pike									
Carp	444	120	266.5				157	46	31.0
Channel Catfish	563	152	49.9				1,343	394	27.9
Flathead Catfish							89	26	<.1
Smallmouth Bass									
Rock Bass									
Walleye									
Family									
Catostomidae	378	102	4.4				392	115	24.3
Cyprinidae	14,285	3,857	22.6	28,298	15,564	43.0	4,299	1,261	3.5
Ictaluridae	3,037	820	28.3	44	24	.1	228	67	3.7
Gasterosteidae									
Sciaenidae									
Cyprinodontidae									
Percichthyidae									
Centrarchidae	167	45	2.7	436	240	5.1	413	121	7.1
Percidae	385	104	.7	131	72	.4			
Total	**19,259**	**5,200**	**375.1**	**28,909**	**15,900**	**48.6**	**6,921**	**2,030**	**97.6**

Appendix H. Numerical density and standing stock of seven species and six families of fish found in five streams ≥600 sq. mi. of drainage in the Des Moines Lobe landform.

	Iowa River B			South Skunk River[a] B			East Fork Des Moines River			Boone River B			North Raccoon River B		
	N/mi	N/ac	lb/ac	N/mi	N/ac	lb/ac	N/mi	N/ac	lb/ac	N/mi	N/ac	lb/ac	N/mi	N/ac	lb/ac
Species															
Northern Pike	143	16	10.9				55	10	11.2	78	9	13.1			
Carp	1,082	121	397.6	145	27	23.3	4,772	865	1,463.7	837	97	190.7	27	3	3.2
Channel Catfish	894	100	72.2	27	5	.3	2,019	366	416.2	414	48	29.0	8,243	918	31.4
Flathead Catfish	250	28	.1										189	21	3.3
Smallmouth Bass	125	14	17.1							78	9	1.5			
Rock Bass										319	37	2.2			
Walleye													54	6	7.6
Family															
Catostomidae	5,195	581	265.3	24,894	4,623	48.4	1,495	271	325.2	2,365	274	121.4	15,723	1,751	422.5
Ictaluridae	76,948	8,606	271.1	953	177	2.3	2,223	403	34.8	2,356	273	8.9	4,660	519	3.2
Centrarchidae	9,692	1,084	11.0	1,599	297	8.3	381	69	3.1	647	75	3.9	27	3	1.8
Percidae	1,753	196	1.9	2,687	499	1.9				173	20	.1	4,185	466	3.1
Cyprinidae	15,316	1,713	7.8	371,511	68,993	549.0	1,627	295	.8	37,852	4,386	18.7	106,094	11,815	53.4
Sciaenidae													260	29	16.1
Total	**111,398**	**12,459**	**1,055.0**	**403,883**	**74,621**	**633.5**	**12,572**	**2,279**	**2,255.0**	**45,119**	**5,228**	**379.5**	**139,462**	**15,531**	**545.6**

[a] A channelized reach.

Appendix I. Numerical density and standing stock of two species and nine families of fish found in four streams in the Northwest Iowa Plains landform.

	Little Rock River [a]			Maple River [a,c]			Otter Creek [a]			Rock River [b]		
	N/mi	N/ac	lb/ac	N/mi	N/ac	lb/ac	N/mi	N/ac	lb/ac	N/mi	N/ac	lb/ac
Species												
Carp	144	18	45.6									
Channel Catfish	988	124	66.7				74	15	11.1	2,333	266	36.8
Family												
Lepisosteidae	287	36	70.7									
Hiodontidae							25	5	3.9	79	9	7.0
Catostomidae	1,570	197	72.5	56	8	7.2	978	198	33.6	1,017	116	45.9
Cyprinidae	9,494	1,191	2.9	2,267	323	2.7	31,748	6,427	18.5	28,018	3,195	9.9
Ictaluridae	191	24	.8	428	61	.7	356	72	.8	3,061	349	11.8
Sciaenidae							25	5	9.7			
Centrarchidae	367	46	.5							386	44	2.3
Percidae	1,275	160	.3				237	48	.1			
Percopsidae										184	21	1.0
Total	**14,316**	**1,796**	**260.0**	**2,751**	**392**	**10.6**	**33,443**	**6,770**	**77.7**	**35,078**	**4,000**	**114.7**

[a] River segment with drainage basin of 75 - 599 sq. mi.
[b] River segment with drainage bsin of ≥ 600 sq. mi. or greater.
[c] A channelized reach.

Appendix J. Numerical density and standing stock of four species and eight families of fish found in nine streams <75 sq. mi. of drainage in the Southern Iowa Drift Plain landform.

	Silver Creek [a]			Clear creek			Rock Creek		
	N/mi	N/ac	lb/ac	N/mi	N/ac	lb/ac	N/mi	N/ac	lb/ac
Species									
Carp							627	111	187.0
Channel Catfish							1,814	321	18.3
Flathead Catfish									
Walleye									
Family									
Hiodontidae				1,381	1,230	43.2			
Catostomidae							774	137	105.8
Ictaluridae				171	152		3,923	694	22.0
Cyprinidae	11,862	4,033	58.2	2,099	1,870	11.7	32,794	5,802	25.5
Sciaenidae									
Centrarchidae	44	15	.6	113	101	2.0	74	13	2.3
Percichthyidae				31	28	.6			
Percidae							322	57	.2
Total	**11,906**	**4,048**	**58.8**	**3,795**	**3,381**	**57.5**	**40,328**	**7,135**	**361.1**

[a] A channelized reach.

Appendix J. Continued

	Wolf Creek			Cooper Creek			Walnut Creek [a]		
	N/mi	N/ac	lb/ac	N/mi	N/ac	lb/ac	N/mi	N/ac	lb/ac
Species									
Carp	247	222	260.0	953	286	411.4	188	76	288.0
Channel Catfish	148	133	186.1	287	86	42.5	752	304	200.1
Flathead Catfish									
Walleye									
Family									
Hiodontidae				33	10	.7			
Catostomidae	127	114	7.6	1,207	362	235.5			
Ictaluridae	3,124	2,812	188.2	1,767	530	84.7			
Cyprinidae	4,434	3,991	16.5	110	33	.2	50,912	20,596	120.9
Sciaenidae	82	74	4.7	63	19	2.5			
Centrarchidae	123	111	16.6	770	231	20.5			
Percichthyidae				33	10	.7			
Percidae									
Total	8,285	7,457	679.7	5,223	**1,567**	**798.7**	**51,852**	**20,976**	**609.0**

 [a] A channelized reach.

Appendix J. Continued

	Bridge Creek [a]			Middle Creek			South Avery Creek		
	N/mi	N/ac	lb/ac	N/mi	N/ac	lb/ac	N/mi	N/ac	lb/ac
Species									
Carp	325	156	72.2	555	244	145.5	1,013	1,447	1,028.5
Channel Catfish				352	155	108.9	210	300	85.6
Flathead Catfish									
Walleye				25	11	3.3	42	60	10.5
Family									
Hiodontidae									
Catostomidae	1,421	682	83.5	175	77	26.0	340	485	143.9
Ictaluridae	115	55	68.5	382	168	5.9	251	359	11.8
Cyprinidae	12,615	6,055	45.4	2,755	1,212	2.2	433	619	2.2
Sciaenidae							11	15	6.1
Centrarchidae				593	261	10.7	257	367	15.1
Percichthyidae									
Percidae							20	28	.04
Total	**14,476**	**6,948**	**269.6**	**4,837**	**2,128**	**302.4**	**2,577**	**3,680**	**1,303.7**

[a] A channelized reach.

Appendix K. Numerical density and standing stock of four species and seven families of fish found in eight streams 75-599 sq. mi. of drainage in the Southern Iowa Drift Plain landform.

	Chariton River								
	A [a]			B			C		
	N/mi	N/ac	lb/ac	N/mi	N/ac	lb/ac	N/mi	N/ac	lb/ac
Species									
Carp	19	7	1.7	4,984	1,216	1,041.8	4,504	696	572.1
Channel Catfish	57	21	1.1	652	159	45.2	1,877	290	304.0
Flathead Catfish									
Walleye	38	14	1.3						
Family									
Hiodontidae				361	88	8.3	1,171	181	6.0
Catostomidae	38	14	1.4	86	21	19.7	78	12	13.1
Ictaluridae	75	28	.4	3,406	831	60.6	3,319	513	53.0
Cyprinidae	2,388	887	2.3	123	30	.3	84	13	.1
Sciaenidae	19	7	1.2	258	63	8.4	1,087	168	34.4
Centrarchidae	294	109	1.5	635	155	15.8	1,553	240	29.7
Percichthyidae									
Total	**2,928**	**1,087**	**10.9**	**10,505**	**2,563**	**1,200.1**	**13,673**	**2,113**	**1,012.4**

[a] A channelized reach.

Appendix K. Continued

	West Fork Crooked Creek [a]			North Skunk River A			North Skunk River B			White Breast Creek [a]		
	N/mi	N/ac	lb/ac	N/mi	N/ac	lb/ac	N/mi	N/ac	lb/ac	N/mi	N/ac	lb/ac
Species												
Carp	154	47	4.7				347	60	93.8	325	58	82.1
Channel Catfish	118	36	5.2				3,990	691	169.7	487	87	4.0
Flathead Catfish							92	16	3.8			
Walleye							29	5	2.2			
Family												
Hiodontidae												
Catostomidae				3,127	667	4.1	116	20	11.3	101	18	7.5
Ictaluridae							797	138	4.0	3,870	691	27.3
Cyprinidae	25,408	7,756	31.6	38,911	8,301	25.5	3,944	683	4.0	2,307	412	1.2
Sciaenidae										241	43	2.7
Centrarchidae							179	31	.5	140	25	1.6
Percichthyidae										34	6	2.3
Total	**25,680**	**7,839**	**41.5**	**42,038**	**8,968**	**29.6**	**9,494**	**1,644**	**287.1**	**7,505**	**1,340**	**128.7**

[a] A channelized reach.

Appendix K. Continued

	West Nishnabotna River						Thompson Fork Grand River			Big Cedar Creek		
	A [a]			B [a]			A					
	N/mi	N/ac	lb/ac	N/mi	N/ac	lb/ac	N/mi	N/ac	lb/ac	N/mi	N/ac	lb/ac
Species												
Carp	111	12	12.8	67	6	5.3	755	135	367.3			
Channel Catfish	203	22	15.0	1,692	152	84.0	9,967	1,782	109.2	269	60	7.3
Flathead Catfish				33	3	3.5	1,169	209	2.7			
Walleye	19	2	.6									
Family												
Hiodontidae	786	85	26.7	946	85	1.2	22	4	1.7			
Catostomidae	176	19	19.0	212	19	15.9	1,538	275	115.8	175	39	11.1
Ictaluridae	647	70	1.3	223	20	.3	78	14	.4	13	3	.2
Cyprinidae	4,298	465	6.9	6,143	552	7.0	30,262	5,411	18.1	13,581	3,033	12.8
Sciaenidae				33	3	.2	6	1	2.0			
Centrarchidae	1,312	142	2.0	690	62	.6	6	1	1.3	188	42	.3
Percichthyidae												
Total	7,552	**817**	**84.3**	**10,039**	**902**	**118.0**	**43,803**	**7,832**	**618.4**	14,226	**3,177**	**31.7**

[a] A channelized reach.

Appendix L. Numerical density and standing stock of four species and nine families of fish found in four streams >600 sq. mi. of drainage in the Southern Iowa Drift Plain landform.

	Thompson Fork of the Grand -- B			English River			South Skunk River -- C			North Skunk River -- C		
	N/mi	N/ac	lb/ac	N/mi	N/ac	lb/ac	N/mi	N/ac	lb/ac	N/mi	N/ac	lb/ac
Species												
Carp	73	9	18.5	324	49	167.1	801	169	164.9	564	83	251.1
Channel Catfish	2,367	292	45.6	4,733	715	71.5	3,297	696	98.2	2,962	436	122.0
Flathead Catfish	138	17	2.1	880	133	10.8	583	123	39.4	82	12	20.6
Walleye										27	4	2.0
Family												
Lepisosteidae				60	9	9.4						
Hiodontidae	32	4	1.7	11,075	1,673	120.0						
Catostomidae	956	118	44.3	1,430	216	161.5				136	20	18.0
Ictaluridae	114	14	.4	602	91	2.0				1,278	187	2.9
Cyprinidae	11,104	1,370	4.0	6,613	999	5.8	4,467	943	3.7	2,072	305	1.3
Sciaenidae	8	1	2.0				90	19	1.7			
Centrarchidae	8	1	1.3	20	3	1.0	1,274	269	1.3	965	142	1.5
Percichthyidae				907	137	1.9						
Percidae												
Total	**14,800**	**1,826**	**119.9**	**26,644**	**4,025**	**551.0**	**10,512**	**2,219**	**309.2**	**8,086**	**1,189**	**419.4**

Appendix M. Mean density (N/mi) of fish by landform and stream drainage area. Average values for sportfish were calculated using only those data from streams in which they were sampled.

	<75 N/mi	75-599 N/mi	>600 N/mi
Paleozoic Plateau			
Northern Pike			
Carp			158
Channel Catfish			40
Flathead Catfish			
Smallmouth Bass		314	20
Rock Bass		40	
Walleye			
Others[a]		40,435	16,037
TOTAL		**40,789**	**16,255**
Iowan Surface			
Northern Pike	144	102	143
Carp	685	804	1,887
Channel Catfish	329	3,370	5,775
Flathead Catfish	10		
Smallmouth Bass	191	565	84
Rock Bass	136	111	55
Walleye	10	16	84
Others[a]	25,296	24,332	10,803
TOTAL	**26,801**	**29,300**	**18,831**
Des Moines Lobe (Unaltered)			
Northern Pike		135	92
Carp		910	1,680
Channel Catfish		799	2,893
Flathead Catfish		89	220
Smallmouth Bass		464	102
Rock Bass		114	319
Walleye		64	54
Others[a]		29,769	72,243
TOTAL		**32,344**	**77,603**
Des Moines Lobe (Channelized)			
Northern Pike			
Carp		66	145
Channel Catfish			27
Flathead Catfish			
Smallmouth Bass			
Rock Bass			
Walleye			
Others[a]		1,938	403,711
TOTAL		**2,004**	**403,883**

[a] Others includes fish species found in Appendix B.

Appendix M. Continued.

	<75 N/mi	75-599 N/mi	>600 N/mi
Northwest Iowa Plain (Unaltered)			
Northern Pike			
Carp		144	
Channel Catfish		531	2,333
Flathead Catfish			
Smallmouth Bass			
Rock Bass			
Walleye			
Others[a]		23,277	32,745
TOTAL		**23,952**	**35,078**
Northwest Iowa Plains (Channelized)			
Northern Pike			
Carp			
Channel Catfish			
Flathead Catfish			
Smallmouth Bass			
Rock Bass			
Walleye			
Others[a]		2,751	
TOTAL		**2,751**	
Southern Iowa Drift Plain (Unaltered)			
Northern Pike			
Carp	679	2,648	441
Channel Catfish	562	3,351	3,340
Flathead Catfish		631	421
Smallmouth Bass			
Rock Bass			
Walleye	34	29	27
Others[a]	9,795	12,613	10,803
TOTAL	**11,070**	**19,272**	**15,032**
Southern Iowa Drift Plain (Channelized)[b]			
Northern Pike			
Carp	257	135	
Channel Catfish	752	511	
Flathead Catfish		33	
Smallmouth Bass			
Rock Bass			
Walleye		29	
Others[a]	25,656	15,403	
TOTAL	**26,665**	**16,111**	

[b] Does not include Walnut Creek.

Appendix N. Mean standing stock (lb/mi) of fish by landform and stream drainage area. Average values for sportfish were calculated using only those data from streams in which they were sampled

	<75 lb/mi	75-599 lb/mi	>600 lb/mi
Paleozoic Plateau			
Northern Pike			
Carp			799.9
Channel Catfish			106.0
Flathead Catfish			
Smallmouth Bass		34.1	2.0
Rock Bass		8.7	
Walleye			
Others[a]		2,797.5	1,110.0
TOTAL		**2,840.3**	**2,017.9**
Iowan Surface			
Northern Pike	56.7	96.2	34.7
Carp	1,056.4	987.9	6,005.0
Channel Catfish	121.3	557.7	1,430.8
Flathead Catfish	6.0		
Smallmouth Bass	13.5	64.0	23.9
Rock Bass	22.7	23.9	12.4
Walleye	4.5	8.0	254.9
Others[a]	676.3	1,404.7	639.0
TOTAL	**1,957.4**	**3,142.4**	**8,400.7**
Des Moines Lobe (Unaltered)			
Northern Pike		162.0	92.5
Carp		1,612.5	3,179.3
Channel Catfish		259.4	1,108.7
Flathead Catfish		.3	15.3
Smallmouth Bass		60.7	82.5
Rock Bass		17.9	19.0
Walleye		40.6	68.4
Others[a]		667.1	3,463.9
TOTAL		**2,820.5**	**8,029.6**
Des Moines Lobe (Channelized)			
Northern Pike			
Carp		185.7	125.1
Channel Catfish			1.6
Flathead Catfish			
Smallmouth Bass			
Rock Bass			
Walleye			
Others[a]		268.5	3,301.1
TOTAL		**454.2**	**3,427.8**

[a] Others includes fish species found in Appendix B.

Appendix N. Continued.

	<75 lb/mi	75-599 lb/mi	>600 lb/mi
Northwest Iowa Plain (Unaltered)			
Northern Pike			
Carp		364.8	
Channel Catfish		297.2	322.8
Flathead Catfish			
Smallmouth Bass			
Rock Bass			
Walleye			
Others[a]		597.4	683.1
TOTAL		**1,259.4**	**1,005.9**
Northwest Iowa Plains (Channelized)			
Northern Pike			
Carp			
Channel Catfish			
Flathead Catfish			
Smallmouth Bass			
Rock Bass			
Walleye			
Others[a]		74.4	
TOTAL		**74.4**	
Southern Iowa Drift Plain (Unaltered)			
Northern Pike			
Carp	597.4	2,607.8	855.8
Channel Catfish	249.3	714.0	526.7
Flathead Catfish		18.2	107.7
Smallmouth Bass			
Rock Bass			
Walleye	6.6	12.8	13.5
Others[a]	452.7	454.5	639.0
TOTAL	**1,306.0**	**3,807.3**	**2,142.7**
Southern Iowa Drift Plain (Channelized)[b]			
Northern Pike			
Carp	399.0	110.7	
Channel Catfish	495.0	175.6	
Flathead Catfish		38.5	
Smallmouth Bass			
Rock Bass			
Walleye		3.4	
Others[a]	307.8	144.1	
TOTAL	**1,201.8**	**472.3**	

[b] Does not include Walnut Creek.

ACKNOWLEDGEMENTS

The author would like to thank Richard Martens and the many technicians, workers, biologists, and district supervisors that helped in field collections.

Thanks to those conservation officers who were of assistance. Special thanks to Don Bonneau, Jim Mayhew, Larry Mitzner, Don Kline, Terry Jennings, and Jud Monroe who provided editorial aid. Also, thanks to Sue O'Loughlin for typing of the ms. and to those many others for their support.

This investigation was supported in part by the Federal Aid in Fish Restoration Act (PL 81-681) under Dingell-Johnson Project F-99-R, United States Fish and Wildlife Service, and the Iowa Department of Natural Resources.

Printed on
Recycled Paper