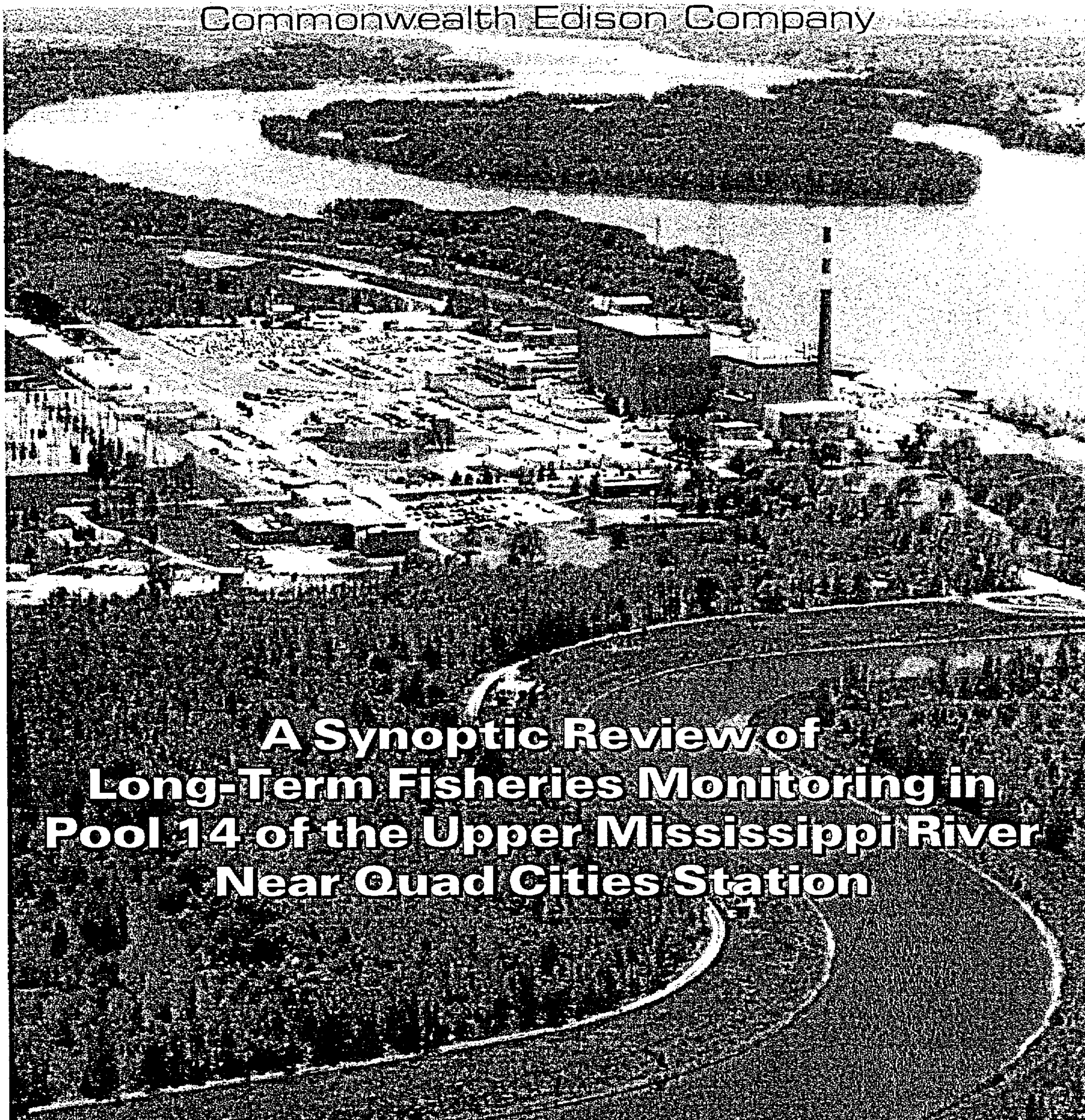
ENCLOSURE 9

Prepared for
Commonwealth Edison Company



A Synoptic Review of Long-Term Fisheries Monitoring in Pool 14 of the Upper Mississippi River Near Quad Cities Station

Prepared by

LMS Lawler, Matusky & Skelly Engineers
10207 Lucas Road • Woodstock, Illinois 60098
ENVIRONMENTAL SCIENCE & ENGINEERING CONSULTANTS

Prepared for:

COMMONWEALTH EDISON COMPANY
Chicago, Illinois

A SYNOPTIC REVIEW OF LONG-TERM FISHERIES MONITORING IN POOL 14 OF THE UPPER MISSISSIPPI RIVER NEAR QUAD CITIES STATION

October 1995

Prepared by:

Timothy W. Bowzer and Bruce L. Lippincott

LAWLER, MATUSKY & SKELLY ENGINEERS
Environmental Science & Engineering Consultants
10207 Lucas Road
Woodstock, Illinois 60098

LMSE-95/0451&453/105

Abstract

A long-term monitoring program was initiated in 1971 in conjunction with the construction and operation of Quad Cities Station located on Pool 14 of the Mississippi River. The principal objectives of this program have been aimed at determining whether Station operation has had any measurable effects upon the fish community in Pool 14. The freshwater drum was selected as an indicator species because it was believed that this species would be most likely affected by Station operation through impingement and entrainment. Freshwater drum ranked second to gizzard shad in terms of numerical contribution to annual impingement. The earliest studies considered a wide range of potential biological effects, including those on lower trophic levels. As a result, a variety of sampling methods have been utilized during the 24-year study. However, initial concerns regarding lower trophic levels were resolved by 1978 and recent sampling efforts summarized herein have focused on the fish community in Pool 14.

In reviewing this long-term data base, it became apparent that the pooled portion of the Upper Mississippi River is an extremely complex ecosystem influenced by many natural variables. This monitoring program has not identified any verifiable effects of Station operation on the fishery of Pool 14. They have, however, led to the conclusion that the physical characteristics of the river can be highly variable and subject to relatively rapid changes which do affect the fish community.

The fish community in Pool 14 is dominated by gizzard shad and freshwater drum, with emerald shiner, river shiner, bullhead minnow, carp and bluegill also being abundant. Several other species, including mooneye, river carpsucker, smallmouth buffalo, shorthead and golden redhorse, channel and flathead catfish, white bass, largemouth bass, black crappie, sauger and walleye, have been commonly collected during this monitoring effort. Walleye abundance in Pool 14 has increased measurably since 1985 due to a stocking program of fingerling fish that were reared in Quad Cities Station's inactive cooling canal. Paddlefish have become increasingly uncommon while modest numbers of lake sturgeon have been collected in recent years.

Individual fish species in Pool 14 have exhibited both long-term and short-term fluctuations in abundance. Overall, the fish population of Pool 14 is extremely dynamic and resilient. This long-term data set has afforded an opportunity to observe multiple occurrences of short-term cycles which has provided a more complete characterization of the fish community. Conversely, short-term data sets can be misleading simply because of their tenure. Therefore, resource managers and regulators who must base decisions and recommendations on short-term data sets are urged to exercise a reasonable degree of caution.

ACKNOWLEDGEMENTS

The field work and data analysis for this report were conducted by several environmental consulting firms under contract to Commonwealth Edison Company (ComEd). This 24-year review was prepared by Lawler, Matusky & Skelly Engineers (LMS) and reviewed by ComEd and members of the project's Steering Committee. Drs. William Lewis and Roy Heidinger of Southern Illinois University; Messrs James Mayhew, Thomas Boland, and John Pitlo of the Iowa Department of Natural Resources; and Messrs Bill Bertrand and Daniel Sallee of the Illinois Department of Natural Resources have all contributed to the program design and its modifications through the period of study. Messrs Lewis, Heidinger, Mayhew and Gary Mensinger have reviewed this document and their suggested changes have added to its content and clarity. Mr. Mensinger has directed the placement of hoop nets since this element was added to the program. His experience and insight to the behavior of Mississippi River fish have been essential to these studies.

Appreciation is extended to the following members of the Environmental Services Division of Commonwealth Edison Company for their support, cooperation, and assistance throughout these studies: Dr. Richard G. Monzingo; Mr. Jeffrey P. Smith; and Ms. Mary K. O'Toole.

Finally, a special debt of gratitude is owed to Mr. Larry J. LaJeone, Commonwealth Edison's program manager for these studies. His technical assistance and guidance during the preparation of this document have been invaluable and they are greatly appreciated by the authors.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES
(Continued)

Figure No.	Caption	Page No.
13	Freshwater drum (≥150 mm TL) standing crop estimates by year for Areas A-C in Pool 14 of the Upper Mississippi River near Quad Cities Station, 1983-1994	43
14	Freshwater drum average weight at 350 mm TL, 1980-1994	45
15	Channel catfish (≥280 mm TL) population estimates by year for Areas A-T in Pool 14 of the Upper Mississippi River near Quad Cities Station, 1983-1994	47
16	Flathead catfish (≥280 mm TL) population estimates by year for Areas A-T in Pool 14 of the Upper Mississippi River near Quad Cities Station, 1983-1994	48
17	Channel catfish (≥280 mm TL) standing stock estimates by year for Areas A-T in Pool 14 of the Upper Mississippi River near Quad Cities Station, 1983-1994	50
18	Flathead catfish (≥280 mm TL) standing crop estimates by year for Areas A-T in Pool 14 of the Upper Mississippi River near Quad Cities Station, 1984-1994	51
19	Estimated numbers of fish impinged at Quad Cities Station from 1973-1994	52
20	Estimated weight of fish impinged at Quad Cities Station from 1973-1994	53
21	Mean annual impingement composition at Quad Cities Station under open-cycle operation, 1984-1994	55
22	Mean monthly impingement estimates of dominant fish species at Quad Cities Station under open-cycle operation, 1984-1994	56

Introduction

A long-term fisheries monitoring program in Pool 14 of the Upper Mississippi River has been conducted in the vicinity of the Quad Cities Station from 1971 to the present. The purpose of this program has been to determine whether Station operation has had any notable effects on the fish population in the Pool. During this 24-year period, the monitoring program has not identified any measurable effects that are attributable to Station operation. However, the design and duration of the program have provided the opportunity to observe certain changes in the fishery.

This document summarizes results of the various elements of the monitoring program, identifies observed changes in the fish community that have occurred since 1971, and evaluates techniques used in this monitoring effort. It does not reexamine the selection of methodologies or provide additional analyses of specific program elements.

Virtually all of the data summarized in this report were developed by environmental consulting firms under contract to Commonwealth Edison Company (ComEd). While data developed each year are available in individual annual reports, there has been no effort to summarize the results of these annual monitoring programs since 1978. Most of the changes described herein are not apparent in the short-term (two to three years); but they become obvious when long-term data sets are examined. This review illustrates the value of using long-term data bases to evaluate the status of fisheries and serves as a caution to investigators who must make decisions based upon short-term data sets.

The Station

Quad Cities Station is a dual unit, nuclear fueled steam electric generating facility that began commercial operation in 1972. Each reactor has the capability of producing 809 megawatts (Mwe) of electrical output. Mississippi River water serves as the Station's source for condenser cooling and most of the in-house service water. Maximum cooling and service water usage is 2270 cfs (1,018,776 GPM). Condenser cooling water is warmed a maximum of 12.8° C (23.0° F) before being discharged.

The original discharge design for Quad Cities Station was an on-shore side-jet discharge along the Illinois bank of the river. However, this design was only utilized for eight months when a thermal-hydraulic study determined that this type of discharge would violate State of Illinois thermal criteria, which limits the maximum temperature rise to 2.8° C (5° F) above ambient at the edge of the 600 ft radius mixing zone.

The Station discharge design was then modified into a multi-port diffuser pipe system which transports heated condenser water out to the main channel of the river through two 16 ft diameter pipes. Condenser water is discharged through a series of 29 in. diameter diffuser ports across the top of each pipe. With this system, heated condenser water is completely mixed with river water and meets the 2.8° C criterion within 500 ft downstream of the diffuser pipes. The Station operated in an open-cycle mode (once through) on this diffuser system from August 1972 through May 1974.

Concern over the possible adverse effects of once-through cooling on the biota of the river resulted in a lawsuit brought forth by the Attorney General of the State of Illinois, the Izaak Walton League and the United Auto Workers to enjoin operation of the Station. In resolving this suit, Commonwealth Edison constructed an offstream spray canal system for cooling the condenser discharge water from the Station. The Station operated in a closed-cycle system from May 1974 through December 1983.

The cooling capacity of the spray canal system was inadequate to allow normal plant operation, particularly during the summer months. Electrical generating capacity was greatly reduced, which resulted in the use of electricity generated by more expensive burning of coal and oil. These costs were passed on to the consumer.

Concurrent with the operational history of Quad Cities Station, extensive biological monitoring of the river ecosystem has been conducted each year to assess the impacts of Station operation. Results of these studies have not demonstrated any measurable effects of Station operation on the aquatic communities of the river under either closed-cycle or open-cycle operation. In consideration of these findings, Commonwealth Edison petitioned the governing regulatory agencies and intervenors to allow Quad Cities Station to return to once-through cooling and to discontinue further use of the spray canal for cooling purposes. Following a thorough review of the data presented, a new agreement was reached with the intervenors allowing open-cycle cooling using the diffuser pipe system, contingent upon continued monitoring of the fish community. This agreement became effective in January 1984 and the Station continues to operate in accordance with the agreement.

No longer used for cooling purposes, the inactive spray canal has been converted into a game fish rearing facility. Walleye and hybrid striped bass, are raised from fry to fingerlings (two to four inches) in the canal and then stocked into the Mississippi River to enhance sport fishing opportunities.

Study Area

The Upper Mississippi River drains approximately 714,000 square miles of watershed and extends from Lake Itasca near Hastings, Minnesota to the mouth of the Ohio River near Cairo, Illinois (Interagency Floodplain Management Review Committee 1994). This portion of the Mississippi River traverses 1,366 miles and comprises an integral part of one of the largest and most productive aquatic ecosystems in the world. The Upper Mississippi River is divided longitudinally into a series of navigation pools by 28 lock-and-dam structures. Pools are numerically identified as the river flows downstream, except for the two uppermost pools (Upper St. Anthony Falls and Lower St. Anthony Falls).

Pool 14 is located at the approximate mid-point of the impounded portion of the river with the Quad Cities Station being sited near the middle of the pool at River Mile (RM) 506.3 (Figure 1). The pool is 47 km long and 4,165 hectares in area, extending from Lock and Dam 14 near LeClaire, Iowa upstream to Lock and Dam 13 near Clinton, Iowa (Rasmussen 1979). The study area encompassed by the long-term monitoring program extends from RM 503.2, just upstream from Cordova, Illinois to RM 518.8, near Clinton, Iowa.

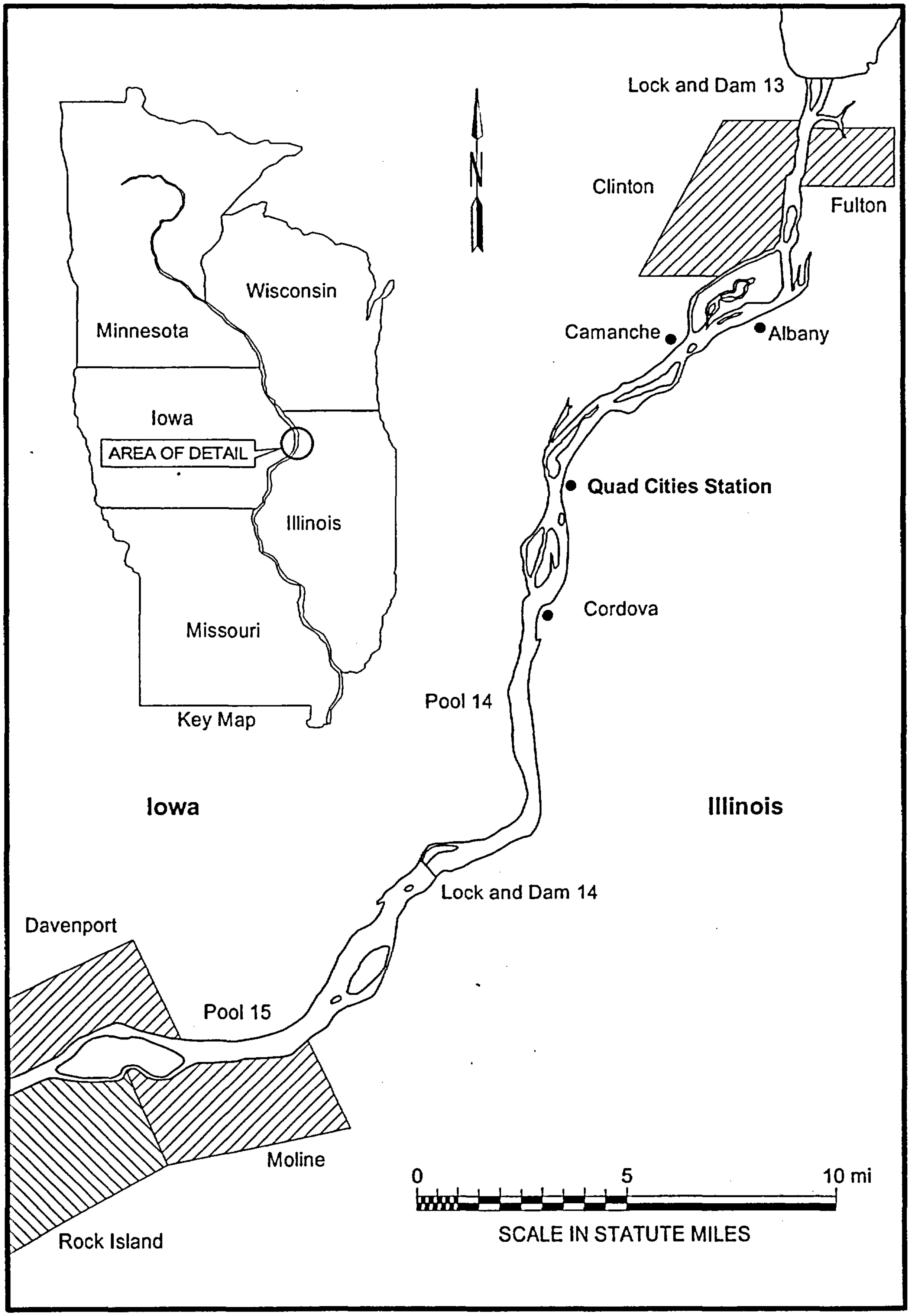


Figure 1. Pool 14 of the Mississippi River near Quad Cities Station.

Methods

Various collection techniques and sampling strategies have been utilized to evaluate several program objectives during this monitoring effort. More detailed descriptions of sampling methodologies, locations and equipment can be found in the annual reports submitted to ComEd.

Electrofishing and bottom trawling are two techniques used during all 24 years of monitoring. Both techniques use a "fixed point" sampling design in which individually timed samples are systematically collected at specified locations once per week during the first two weeks of June, July, August and September. Electrofishing is conducted for 20 minutes at each of eight locations (Figure 2) during each scheduled effort (eight fixed locations sampled eight times per season) and utilizes a high-cycle AC electroshocking unit. Habitat types that are sampled include main channel border, side channel and slough. Bottom trawl collections are made at three locations (Figure 2) each week (three fixed locations sampled eight times per season) using a 16 ft semi-balloon bottom trawl with a 0.25 inch cod-end inner liner. All bottom trawl collections are conducted for seven minutes in a downstream direction within the navigation channel of the river. Bottom trawls were towed at a constant speed of approximately 2 knots above ambient current velocity. Consequently, the distance covered by each tow varied with current velocity.

Haul seining was added to the study program in 1978 to provide relative abundance estimates for fish species not adequately sampled by electrofishing or trawling and to estimate standing crops for several species that inhabit side channel and slough habitats. Seining is conducted at four locations (Figure 3) on a weekly schedule from mid-October through mid-November (four fixed locations sampled four or five times each season) using a seine that is constructed of 1.5-inch bar mesh and measures 1000 feet by 20 feet.

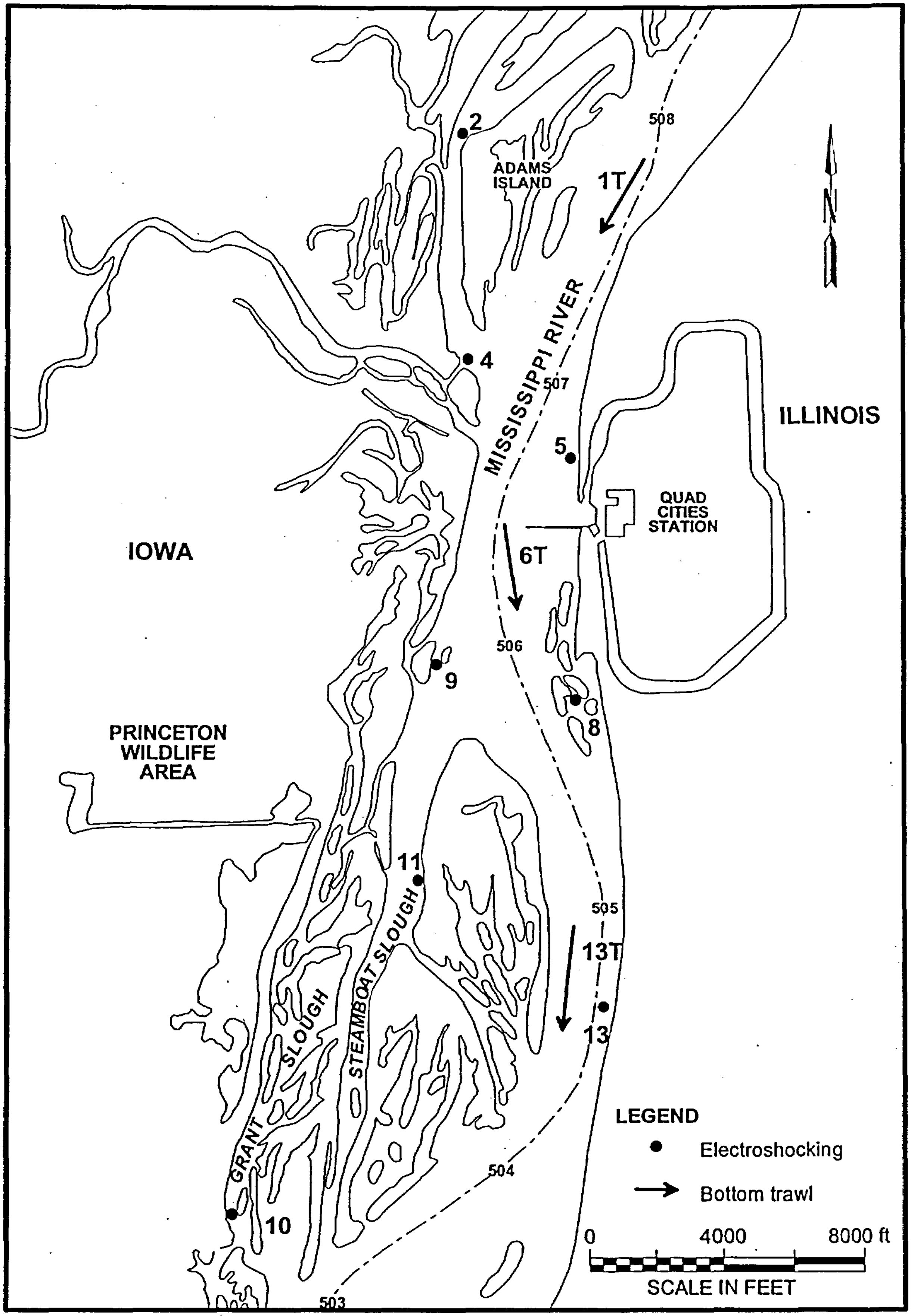


Figure 2. Electrofishing and bottom trawling locations in Pool 14 of the Mississippi River near Quad Cities Station.

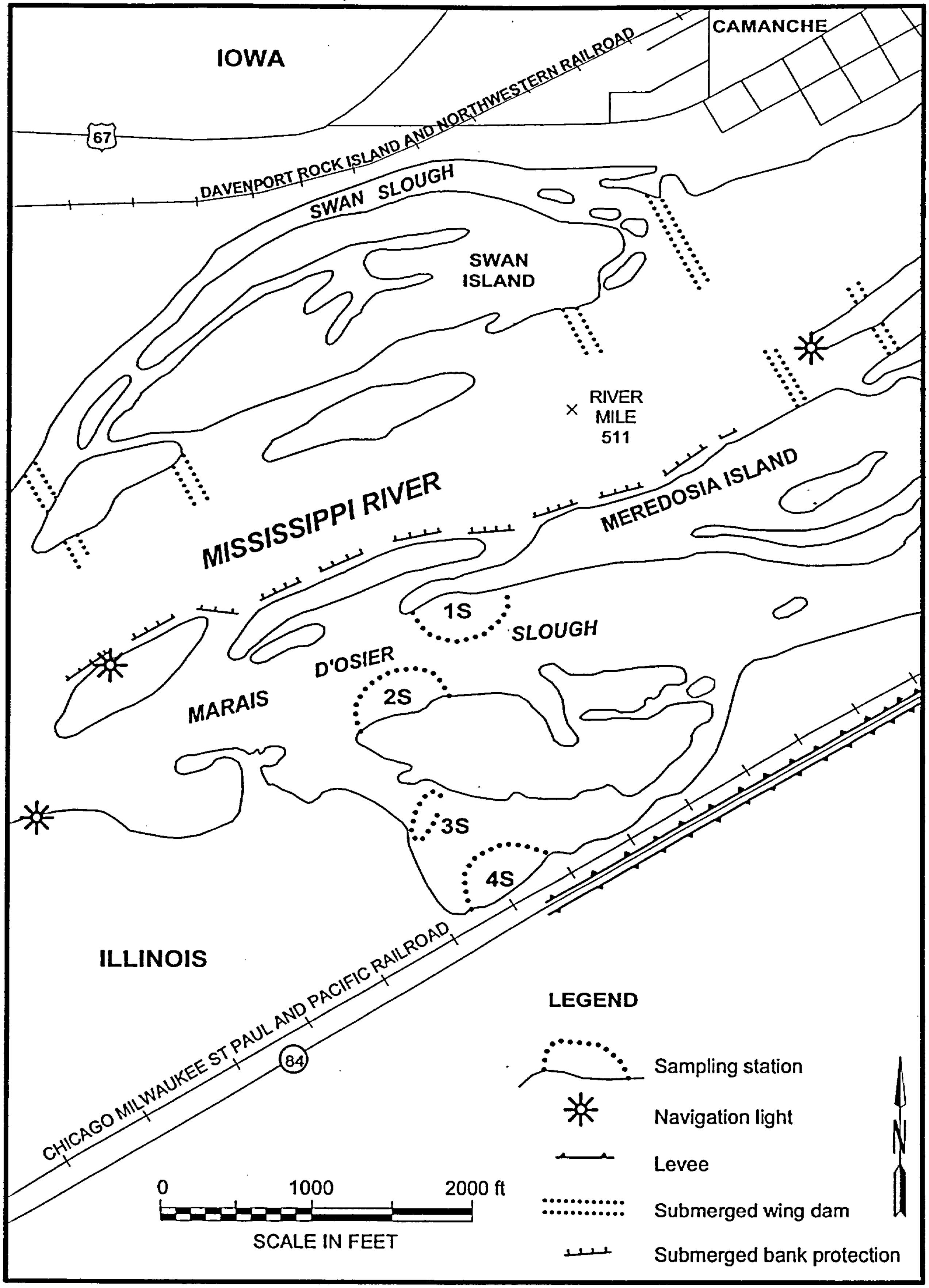


Figure 3. Haul seining locations in Pool 14 of the Mississippi River near Quad Cities Station.

Fish standing crop estimates for selected slough habitats (Figure 4) have been determined at various times during the 24-year period using a cove rotenone sampling technique. Ten cove rotenone samples were collected in Pool 14 between 1977 and 1984. As a result of public displeasure and the belief that adequate standing crop data had been collected, rotenone surveys were discontinued after 1984.

Beginning in 1978, at the request of the Illinois Department of Natural Resources (ILDNR), an intensive study of the population dynamics and life history of freshwater drum was begun. The freshwater drum was selected for additional studies based upon the belief that it was the species most likely to be affected by Station operation. During the past 17 years, freshwater drum studies have been revised and refined several times; however, comparable data are available for the past 12 years. The program consists of an intensive hoop netting effort in May and June which encompasses the entire study area (Figure 5). Seventy-two commercial hoop nets (14 nets are set in each of the five areas with the exception of Area B where 16 nets are fished) are raised and cleared of fish twice per week. Each net is constructed of 1.25-inch bar mesh nylon net that is attached to six hoops measuring 3.5 feet in diameter. The majority (80%) of freshwater drum captured are weighed, measured, tagged with a Floy FD-68B spaghetti tag, and released alive. Recaptured fish are used to monitor movement and to estimate population size using Chapman's (1952) modification of the Schnable (1938) multiple census method. The remaining 20% are sacrificed to determine age and sex. Twenty-eight hoop nets from this program (seven per day, four days per week) are randomly selected each week during May for analysis of the total catch of all species. Catch data for this component of the program have been compiled since 1982.

In 1984, there was little information regarding the movements and standing crops of channel and flathead catfish bordering Illinois and Iowa. Because large incidental catches of these species were occurring in the hoop nets set for freshwater drum,

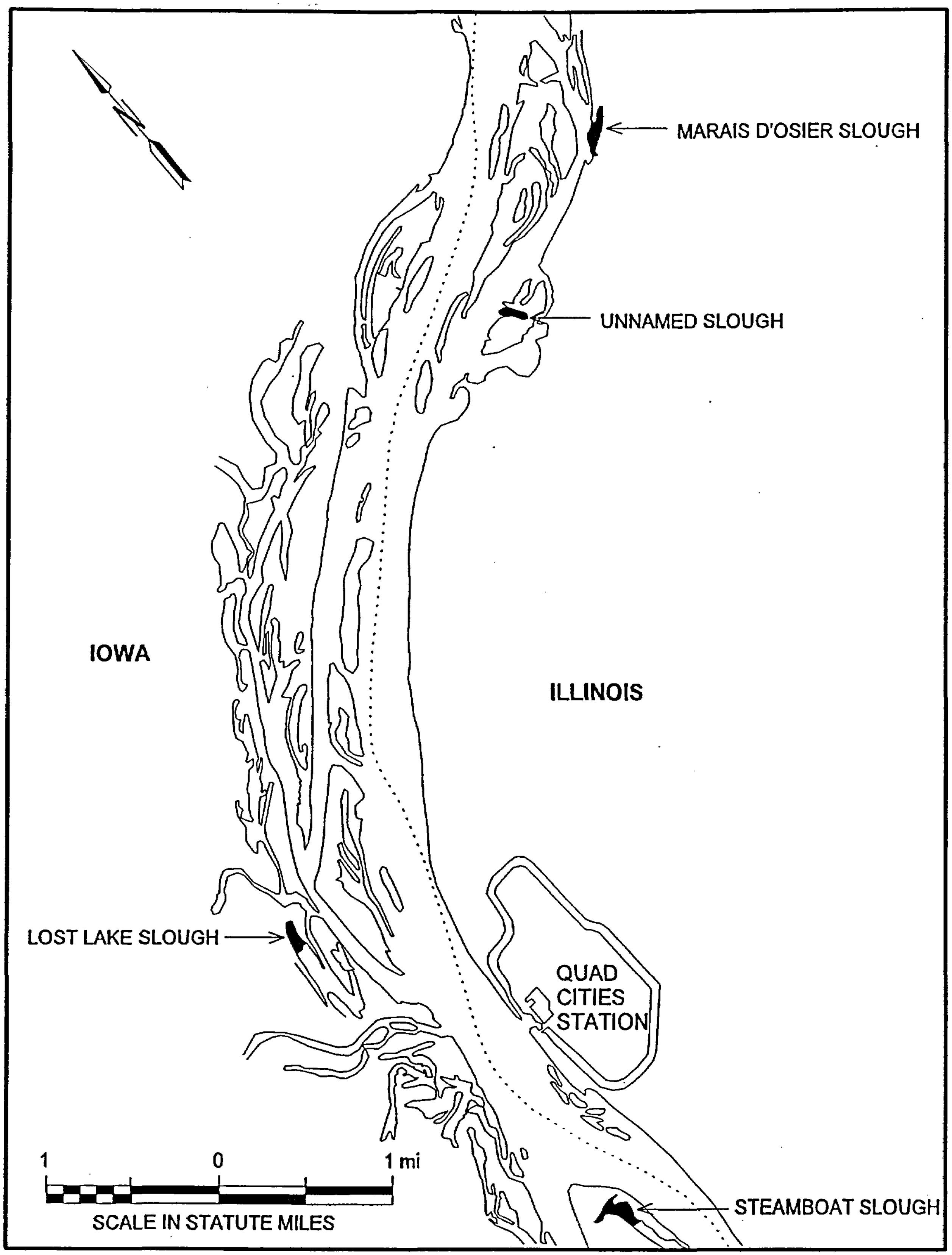


Figure 4. Cove rotenone locations in Pool 14 of the Mississippi River near Quad Cities Station.

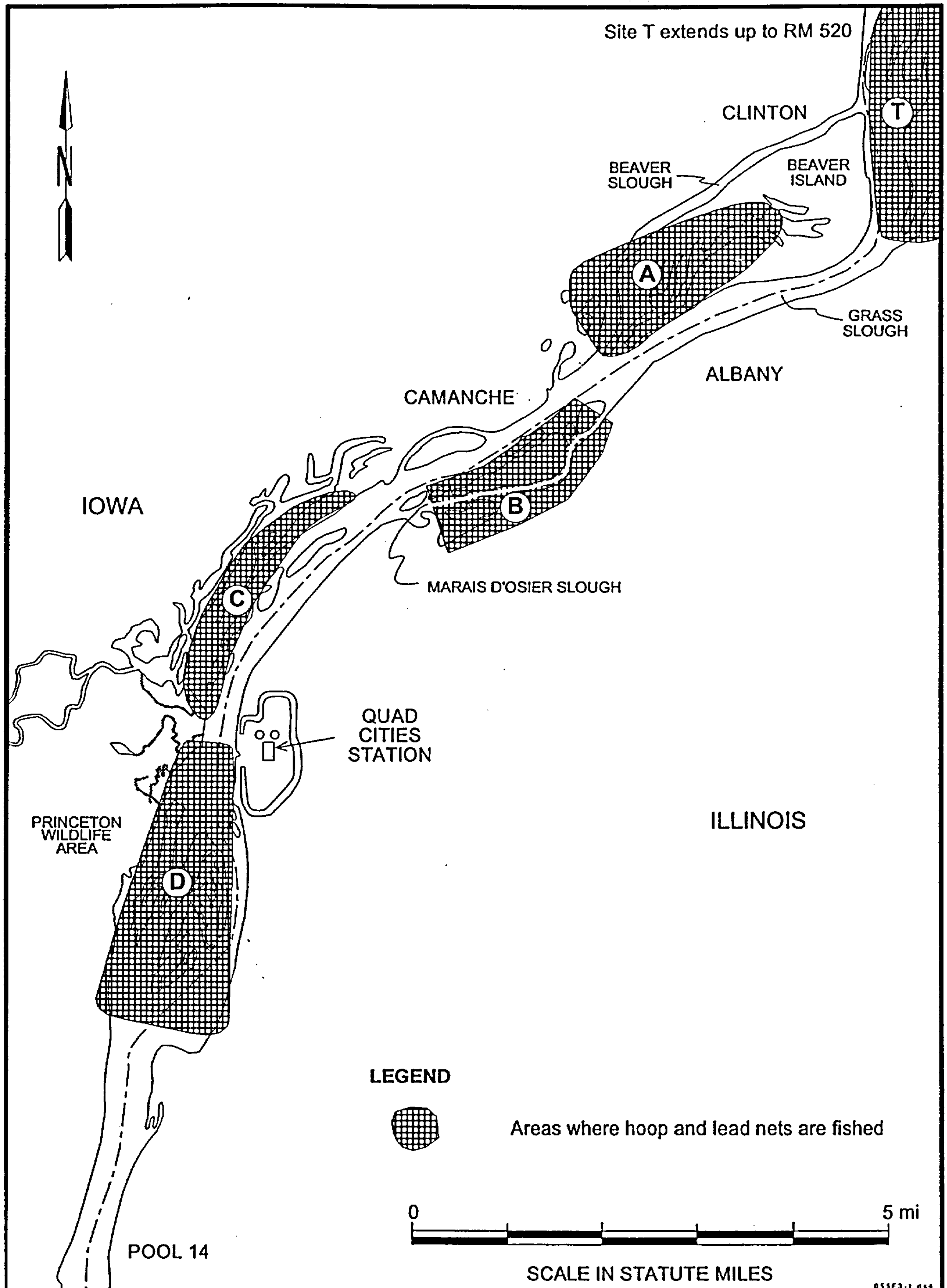


Figure 5. Hoop netting and tagging areas in Pool 14 of the Mississippi River near Quad Cities Station.

ILDNR and IDNR requested that catfish tagging studies be incorporated into the spring tagging program in 1984 to determine population and standing crop estimates for these two species. In addition, information collected during these studies could be used by both agencies to evaluate a newly imposed 15-inch commercial length limit for channel and flathead catfish. As a further supplement to the freshwater drum life history and catfish population studies, a tagging study of walleye and sauger was integrated into the spring tagging program in 1984. This was prompted by ILDNR's interest in habitat preference and utilization by walleye and sauger and by the need to develop a data base for walleye that coincided with supplemental stocking activities in Pool 14. Neither the catfish nor walleye/sauger studies were directed at assessing Station effects. They were cooperative efforts to provide useful management information to interested agencies.

Nuclear generating stations are typically operated as base-load facilities and daily changes in the operational mode are minimal. Consequently, when there are dramatic fluctuations in impingement collections from week to week or from year to year, they accurately reflect prevailing conditions in the river and changes in the fish community. Monitoring of the numbers and biomass of fish impinged on the intake screens (impingement) of Quad Cities Station is an NPDES permit requirement designed to estimate the number of fish removed from the Mississippi River during Station operation. Annual impingement projections are calculated by expanding the number of fish that accumulate on the intake screens for two 24-hour periods per week. These data are available for each year since the Station began commercial operation in 1972. Impingement sampling has been one of the most useful collection techniques for monitoring the fish community of Pool 14 for both dominant species and for the occurrence of rare and unusual species.

Results and Discussion

Ninety-one fish species representing 21 families have been collected in Pool 14 during the 24-year monitoring program at the Quad Cities Station (Table 1). Hybrid striped bass, hybrid sunfish and one carp X goldfish hybrid have also been collected. Impingement monitoring and electrofishing surveys have resulted in the collection of the largest numbers of species. Eighty species have been identified from impingement samples, while 71 species have been collected by electrofishing. Rotenone sampling, bottom trawling, hoop netting and haul seining resulted in the capture of 50, 44, 40, and 37 species, respectively. Four cyprinid species (bigmouth shiner, southern redbelly dace, pearl dace and blacknose dace) were captured by minnow seining, which was conducted during the early years of the monitoring program (prior to 1978).

One hundred fifty-six species of fish have been reported to occur in the Upper Mississippi River, which reflects the diverse fish fauna that this aquatic resource supports (Pitlo et al., 1995). Of the ninety-four species of fish that have been reported in Pool 14, five species (red shiner, silverband shiner, northern hog sucker, blue catfish, and brown bullhead) which are listed by Pitlo et al. have not been collected. Three species not listed for Pool 14 in that report have been collected during these monitoring efforts: weed shiner, central stoneroller and trout-perch (Table 2). Each of these species have been collected in other pools. Seven of the species collected are presently listed as threatened or endangered in Iowa (IDNR 1985): chestnut lamprey, skipjack herring, grass pickerel, weed shiner, and western sand darter (threatened); and pearl dace and lake sturgeon (endangered). Five of the species collected are also listed as threatened or endangered in Illinois (Illinois Endangered Species Protection Board 1990): longnose sucker and lake sturgeon (threatened); and pallid shiner, weed shiner and western sand darter (endangered).

Table 1

Fish taxa collected during 24 years of monitoring in Pool 14 of the Upper Mississippi River near Quad Cities Station, 1971-1994

TAXON	SPECIES STATUS[a]	IMPINGE-MENT	ELECTRO-FISHING	BOTTOM TRAWL	HOOP NET	HAUL SEINE	ROTENONE
Chestnut lamprey (*Ichthyomyzon castaneus*)[b]	U	X					
Silver lamprey (*Ichthyomyzon unicuspis*)	O	X	X		X	X	X
Lake sturgeon (*Acipenser fulvescens*)[b]	R				X	X	
Shovelnose sturgeon (*Scaphirhynchus platorynchus*)	O	X		X	X		
Paddlefish (*Polyodon spathula*)	O	X	X	X		X	
Longnose gar (*Lepisosteus osseus*)	C	X	X		X	X	X
Shortnose gar (*Lepisosteus platostomus*)	C	X	X		X	X	X
Bowfin (*Amia calva*)	C	X	X		X	X	X
American eel (*Anguilla rostrata*)	U	X	X		X		
Skipjack herring (*Alosa chrysochloris*)[b]	R	X	X			X	
Gizzard shad (*Dorosoma cepedianum*)	A	X	X	X	X	X	X
Goldeye (*Hiodon alosoides*)	R	X	X			X	
Mooneye (*Hiodon tergisus*)	C	X	X	X	X	X	X
Rainbow trout (*Onchorhynchus mykiss*)	X		X				
Brown trout (*Salmo trutta*)	X	X					
Lake trout (*Salvelinus namaycush*)	X	X					
Central mudminnow (*Umbra limi*)	R	X					X
Grass pickerel (*Esox americanus*)[b]	R	X	X				X
Northern pike (*Esox lucius*)	O	X	X		X	X	X
Central stoneroller (*Campostoma anomalum*)	-	X					
Common carp (*Cyprinus carpio*)	A	X	X	X	X	X	X
Grass carp (*Ctenopharyngodon idella*)	U		X				
Silvery minnow (*Hybognathus nuchalis*)	U	X	X	X			
Speckled chub (*Macrhybopsis aestivalis*)	C		X	X			
Silver chub (*Macrhybopsis storeriana*)	C	X	X	X			X
Golden shiner (*Notemigonus crysoleucas*)	O	X	X	X			X
Pallid shiner (*Notropis amnis*)[b]	R	X	X				
Emerald shiner (*Notropis atherinoides*)	A	X	X	X			X
River shiner (*Notropis blennius*)	A	X	X	X			
Ghost shiner (*Notropis buchanani*)	H		X	X			
Common shiner (*Luxilus cornutus*)	R	X					
Bigmouth shiner (*Notropis dorsalis*)[c]	R						
Pugnose minnow (*Opsopoeodus emiliae*)[b]	R	X	X				
Spottail shiner (*Notropis hudsonius*)	C	X	X	X			X
Red shiner (*Cyprinella lutrensis*)	R						
Silverband shiner (*Notropis shumardi*)[b]	X						
Spotfin shiner (*Cyprinella spiloptera*)	C	X	X	X			
Sand shiner (*Notropis stramineus*)	C	X	X				
Weed shiner (*Notropis texanus*)[b]	-	X					
Mimic shiner (*Notropis volucellus*)	R		X	X			
Suckermouth minnow (*Phenacobius mirabilis*)	R	X					
Southern redbelly dace (*Phoxinus erythrogaster*)[c]	X						
Bluntnose minnow (*Pimephales notatus*)	O	X	X				X
Fathead minnow (*Pimephales promelas*)	U	X	X	X			
Bullhead minnow (*Pimephales vigilax*)	C	X	X	X			X
Creek chub (*Semotilus atromaculatus*)	X	X					
Pearl dace (*Margariscus margarita*)[b,c]	X						
Blacknose dace (*Rhinichthys atratulus*)[c]	X						

Table 1 (Continued)

Fish taxa collected during 24 years of monitoring in Pool 14 of the Upper Mississippi River near Quad Cities Station, 1971-1994

TAXON	SPECIES STATUS[a]	IMPING-MENT	ELECTRO-FISHING	BOTTOM TRAWL	HOOP NET	HAUL SEINE	ROTENONE
River carpsucker (*Carpiodes carpio*)	C	X	X	X	X	X	X
Quillback (*Carpiodes cyprinus*)	C	X	X	X	X	X	X
Highfin carpsucker (*Carpiodes velifer*)	O	X	X	X	X	X	X
White sucker (*Catostomus commersoni*)	X	X	X		X	X	
Longnose sucker (*Catostomus catostomus*)[b]	X	X					
Blue sucker (*Cycleptus elongatus*)	U	X	X	X	X		
Northern hogsucker (*Hypentelium nigricans*)	X						
Smallmouth buffalo (*Ictiobus bubalus*)	C	X	X	X	X	X	X
Bigmouth buffalo (*Ictiobus cyprinellus*)	C	X	X	X	X	X	X
Black buffalo (*Ictiobus niger*)	U	X	X		X	X	X
Spotted sucker (*Minytrema melanops*)	O	X	X		X	X	X
Silver redhorse (*Moxostoma anisurum*)	U	X	X	X	X	X	
Golden redhorse (*Moxostoma erythrurum*)	O	X	X	X	X	X	X
Shorthead redhorse (*Moxostoma macrolepidotum*)	C	X	X	X	X	X	X
Blue catfish (*Ictalurus furcatus*)	H						
Black bullhead (*Ameiurus melas*)	O	X	X	X	X	X	X
Yellow bullhead (*Ameiurus natalis*)	O	X	X		X		X
Brown bullhead (*Ameiurus nebulosus*)	R						
Channel catfish (*Ictalurus punctatus*)	C	X	X	X	X	X	X
Stonecat (*Noturus flavus*)	U	X		X	X		
Tadpole madtom (*Noturus gyrinus*)	U	X	X	X			X
Flathead catfish (*Pylodictis olivaris*)	C	X	X	X	X	X	X
Trout-perch (*Percopsis omiscomaycus*)	-	X					
Mosquitofish (*Gambusia affinis*)	R	X	X				X
Brook silverside (*Labidesthes sicculus*)	O	X	X	X			X
White bass (*Morone chrysops*)	C	X	X	X	X	X	X
Yellow bass (*Morone mississippiensis*)	U	X	X			X	X
Rock bass (*Ambloplites rupestris*)	U	X	X		X		
Green sunfish (*Lepomis cyanellus*)	O	X	X				X
Pumpkinseed (*Lepomis gibbosus*)	C	X	X		X	X	X
Warmouth (*Lepomis gulosus*)	U	X	X		X		X
Orangespotted sunfish (*Lepomis humilis*)	O	X	X				X
Bluegill (*Lepomis macrochirus*)	A	X	X	X	X	X	X
Smallmouth bass (*Micropterus dolomieu*)	U	X	X				
Largemouth bass (*Micropterus salmoides*)	C	X	X		X	X	X
White crappie (*Pomoxis annularis*)	C	X	X	X	X	X	X
Black crappie (*Pomoxis nigromaculatus*)	C	X	X	X	X	X	X
Western sand darter (*Ammocrypta clara*)[b]	U			X			
Mud darter (*Etheostoma asprigene*)	U	X	X				X
Rainbow darter (*Etheostoma caeruleum*)	X	X					
Johnny darter (*Etheostoma nigrum*)	U	X	X	X			X
Yellow perch (*Perca flavescens*)	U	X	X		X	X	X
Logperch (*Percina caprodes*)	O	X	X	X			X
Blackside darter (*Percina maculata*)	X						
Slenderhead darter (*Percina phoxocephala*)	R	X	X	X			
River darter (*Percina shumardi*)	U	X	X	X			X
Sauger (*Stizostedion canadense*)	C	X	X	X	X	X	X
Walleye (*Stizostedion vitreum*)	C	X	X	X	X	X	X
Freshwater drum (*Aplodinotus grunniens*)	A	X	X	X	X	X	X

Table 1 (Continued)

Fish taxa collected during 24 years of monitoring in Pool 14 of the Upper Mississippi River near Quad Cities Station, 1971-1994

TAXON	SPECIES STATUS[a]	IMPINGE-MENT	ELECTRO-FISHING	BOTTOM TRAWL	HOOP NET	HAUL SEINE	ROTENONE
Hybrid striped bass (*Morone saxatilus x Morone chrysops*)	X	X	X			X	
Carp X goldfish hybrid (*Cyprinus carpio x Carassius auratus*)	-				X		
Hybrid sunfish (*Lepomis*)	-	X	X		X		X
Total Species		80	71	44	40	37	50
Total Taxa		82	73	44	42	38	51

[a]Species listed as collected in Pool 14 by Pitlo et al., (1995) and their status.

X - Probably occurs only as a stray from a tributary or inland stocking.
H - Records of occurrence are available, but no collections have been documented in the last 10 years.
R - Considered rare. Some species in this category may be on the verge of extinction.
U - Uncommon; does not ususally appear in sample ccollections.
O - Occasionally collected; not generally distributed, but local concentrations may occur.
C - Commonly taken in most sample collections; can make up a large portion of some samples.
A - Abundant; taken in all river surveys.

[b]Listed as threatened, endangered, or "undetermined" by Iowa Department of Natural Resources (1985) or Illinois Endangered Species Protection Board (1990).

[c]Collected by minnow seine only.

Table 2

Total number of threatened, endangered and unusual species collected by sampling method during 24 years of monitoring in Pool 14 of the Upper Mississippi River

TAXON	SPECIES STATUS[a]	IMPINGE-MENT	ELECTRO-FISHING	BOTTOM TRAWL	HOOP NET	HAUL SEINE	ROTENONE
Chestnut lamprey	1	10					
Lake sturgeon	2,3				4	1	
Skipjack herring	1	4	2			6	
Central stoneroller	5	5					
Grass pickerel	1	91	30				24
Pallid shiner	4	1	1				
Weed shiner	1,4,5	1					
Mimic shiner	6		1	1			
Pearl dace[b]	2						
Longnose sucker	3	1					
Trout-perch	5	9					
Mosquitofish	6	91	4				
Western sand darter	1,4			10			
Rainbow darter	6	1					
Total fish		214	38	11	4	7	24
Total species		10	5	2	1	2	1

[a] Species status:

1 - Threatened in Iowa.
2 - Endangered in Iowa.
3 - Threatened in Illinois.
4 - Endangered in Illinois.
5 - Not listed in Pool 14 by Pitlo et al., (1995).
6 - Unusual species or strays from a tributary or inland stocking.

[b] Collected by minnow seine only.

Despite occasional wide fluctuations in the abundance of some species, community composition has remained relatively stable. The fish population in Pool 14 is dominated by gizzard shad and freshwater drum, both of which are widely distributed throughout North America. Other species considered abundant in Pool 14 include the common carp, emerald shiner, river shiner and bluegill (Table 1).

Species commonly collected each year include longnose and shortnose gar, bowfin, mooneye, silver chub, spottail shiner, spotfin shiner, bullhead minnow, river carpsucker, quillback, smallmouth buffalo, shorthead redhorse, channel catfish, flathead catfish, white bass, largemouth bass, black crappie, sauger and walleye. Of the remaining 66 species, 60 fall into the categories of occasional, uncommon or rare.

Although not well supported in the data base that is described in subsequent sections of this document, some notable changes have occurred for three species. Walleye abundance has increased considerably in the past eight years due primarily to a supplemental stocking program conducted by Southern Illinois University (LaJeone et al., 1992). Paddlefish, though never commonly captured during this program, have become increasingly uncommon, with only nine specimens being collected since 1985. In contrast, modest numbers of lake sturgeon now inhabit the pool, with the first specimens being captured in 1990.

Electrofishing

A total of 80,277 fish representing 71 species, 18 families and two hybrids (hybrid sunfish and hybrid striped bass) has been collected by electrofishing since 1971. Fifteen species have been captured during each year and have been ranked according to their abundance (Table 3). The five most abundant species (including carp but excluding other cyprinids) collected over the 24-year study have been gizzard shad, bluegill, freshwater drum, carp and largemouth bass. Annual fluctuations in species

Table 3

Total number, catch-per-effort, percent composition and ranking of fish collected by electrofishing in Pool 14 of the Upper Mississippi River near Quad Cities Station, 1971-1994[a]

TAXON	No.	CPE	%[b]	RANK[d]
Silver lamprey	6	<0.1	<0.1	
Paddlefish	5	<0.1	<0.1	
Longnose gar	108	0.3	0.2	
Shortnose gar	95	0.2	0.2	
Bowfin[c]	238	0.6	0.4	21
American eel	1	<0.1	<0.1	
Skipjack herring	2	<0.1	<0.1	
Goldeye	1	<0.1	<0.1	
Mooneye[c]	367	0.9	0.6	18
Rainbow trout	1	<0.1	<0.1	
Grass pickerel	30	0.1	<0.1	
Northern pike	122	0.3	0.2	
Carp[c]	5018	11.8	8.3	4
Grass carp	1	<0.1	<0.1	
Silvery minnow	40	0.1	0.1	
Speckled chub	1	<0.1	<0.1	
Silver chub	482	1.1	0.8	
Golden shiner	207	0.5	0.3	
Emerald shiner	9117	21.4	15.1	
River shiner	971	2.3	1.6	
Ghost shiner	1	<0.1	<0.1	
Pugnose minnow	12	<0.1	<0.1	
Spottail shiner	489	1.2	0.8	
Spotfin shiner	2292	5.4	3.8	
Sand shiner	35	0.1	0.1	
Pallid shiner	1	<0.1	<0.1	
Mimic shiner	1	<0.1	<0.1	
Bluntnose minnow	2	<0.1	<0.1	
Fathead minnow	3	<0.1	<0.1	
Bullhead minnow	1285	3.0	2.1	
River carpsucker[c]	2439	5.7	4.0	6
Quillback	220	0.5	0.4	
Highfin carpsucker	135	0.3	0.2	
Carpiodes spp.	696	1.6	1.2	
White sucker	15	<0.1	<0.1	
Blue sucker	7	<0.1	<0.1	
Smallmouth buffalo[c]	737	1.7	1.3	12
Bigmouth buffalo[c]	265	0.6	0.4	19
Black buffalo	10	<0.1	<0.1	
Ictiobus spp.	11	<0.1	<0.1	
Spotted sucker	187	0.4	0.3	
Silver redhorse	99	0.2	0.2	
Golden redhorse	495	1.2	0.8	
Shorthead redhorse[c]	732	1.7	1.2	13
Moxostoma spp.	17	<0.1	<0.1	
Black bullhead	9	<0.1	<0.1	
Yellow bullhead	2	<0.1	<0.1	
Channel catfish[c]	1478	3.5	2.4	7

Table 3 (Continued)

Total number, catch-per-effort, percent composition and ranking of fish collected by electrofishing in Pool 14 of the Upper Mississippi River near Quad Cities Station, 1971-1994[a]

TAXON	No.	CPE	%[b]	RANK[d]
Tadpole madtom	3	<0.1	<0.1	
Flathead catfish	175	0.4	0.3	
Mosquitofish	4	<0.1	<0.1	
Brook silverside	185	0.4	0.3	
White bass[c]	1319	3.1	2.2	9
Yellow bass	23	0.1	<0.1	
Hybrid striped bass	62	0.1	0.1	
Rock bass	89	0.2	0.1	
Green sunfish	50	0.1	0.1	
Pumpkinseed	641	1.5	1.1	
Warmouth	71	0.2	0.1	
Orangespotted sunfish	776	1.8	1.3	
Bluegill[c]	14,522	34.2	24.0	2
Hybrid sunfish	13	<0.1	<0.1	
Smallmouth bass	8	<0.1	<0.1	
Largemouth bass[c]	4388	10.3	7.3	5
White crappie	643	1.5	1.1	
Black crappie[c]	1444	3.4	2.4	8
Mud darter	3	<0.1	<0.1	
Johnny darter	19	<0.1	<0.1	
Yellow perch	56	0.1	0.1	
Logperch	234	0.6	0.4	
Slenderhead darter	1	<0.1	<0.1	
River darter	7	<0.1	<0.1	
Sauger[c]	1141	2.7	1.9	10
Walleye	585	1.4	1.0	
Freshwater drum[c]	5566	13.1	9.2	3
Gizzard shad[c]	19,761	46.5	-	1
Total w/gizzard shad	80,277	188.8		
Total w/o gizzard shad	60,516	142.3		
Total species	71			
Total taxa	76			
Total hours effort		425.2		

[a]1980 data excluded; not comparable to other years because different electrofishing gear was used.
[b]Without gizzard shad.
[c]Species captured every year.
[d]Ranking excludes cyprinids.

composition and richness during the course of these studies have resulted primarily from the infrequent collection of taxa that are less abundant or are generally not vulnerable to electrofishing.

Electrofishing catch data (Figure 6) indicates that total catch-per-effort (CPE), excluding cyprinids and gizzard shad, declined during the early years of monitoring (1971-1976) and then increased to varying degrees in subsequent years (1977-1979 and 1981-1994). The exceptionally high CPE recorded in 1989 is attributed to strong recruitment of several dominant species during the three year drought (1987-1989). In contrast, the relatively low CPE reported in 1993 is the result of poor sampling conditions and recruitment associated with record floods. CPE data for 1980 is not included in Figure 6 because a 1981 sampling gear comparison study (ERT 1982) indicated that CPE data for 1980 were not comparable to other years due to the reduced efficiency of the electrofishing apparatus used during the 1980 surveys.

Catch data for selected species that are frequently collected by electrofishing indicates that some conspicuous shifts in relative abundance have occurred since 1971 (Figure 7). Catches of bluegill, largemouth bass, and freshwater drum were very low in the mid to late 1970's but all have increased substantially since then, particularly in the late 1980's and early 1990's. Conversely, catches of white crappie have exhibited a downward trend. Black crappie CPE was slightly higher during the first few years of sampling (1971-1974) but has remained relatively constant since 1977. Sauger catches have been cyclic, with highest CPE's occurring in 1971 and 1972. Catches of other species such as carp, river carpsucker and channel catfish have exhibited some annual fluctuations in CPE, but do not exhibit any increasing or decreasing trends when examined over the 24 years of study (LMS 1995).

Relatively low CPE's from the mid 1970's to the mid 1980's may be partially due to habitat degradation from sedimentation. One backwater electrofishing station

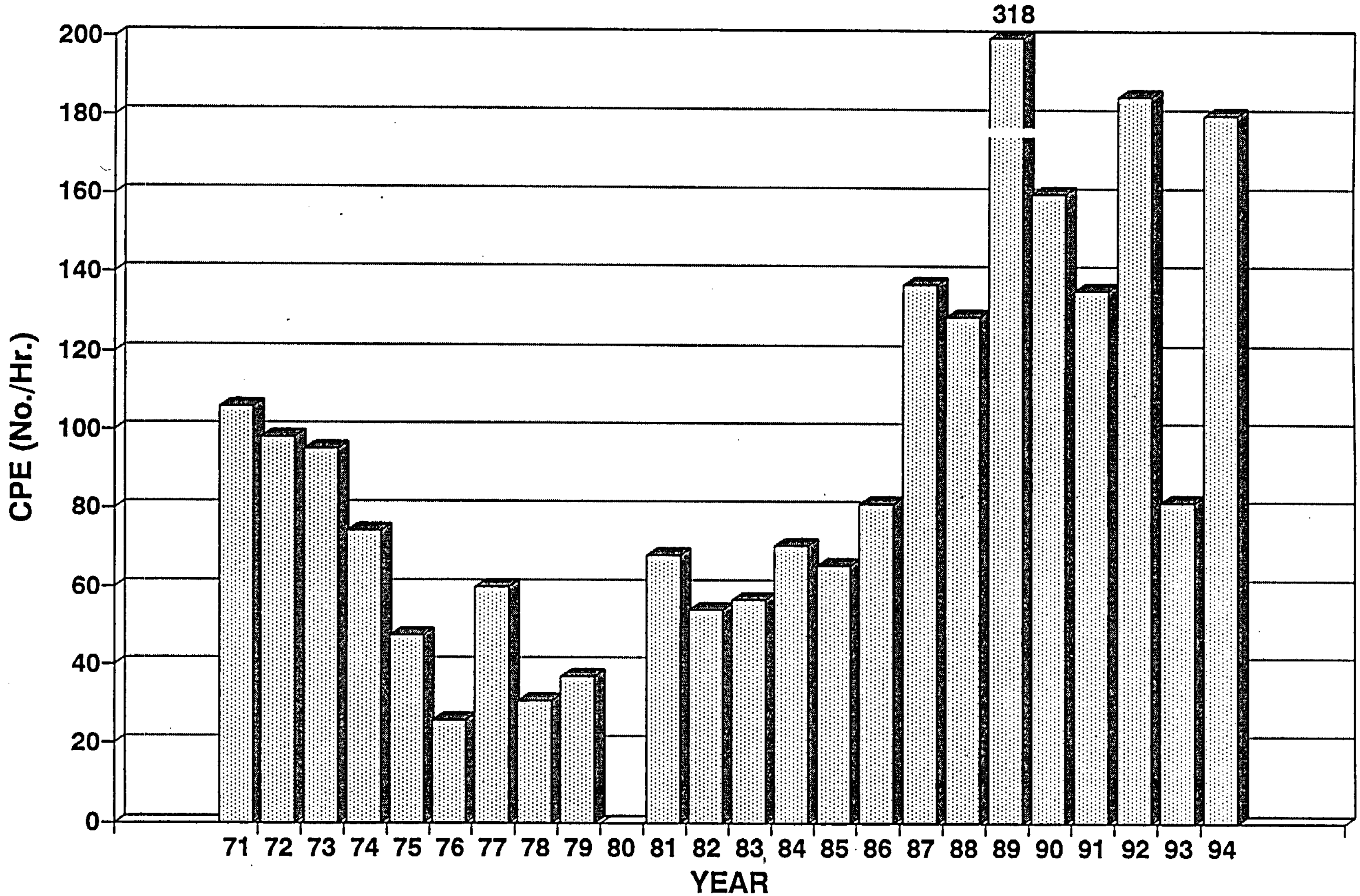


Figure 6. Electrofishing CPE (without gizzard shad and cyprinids) in Pool 14 of the Mississippi River near Quad Cities Station, 1971-1994.

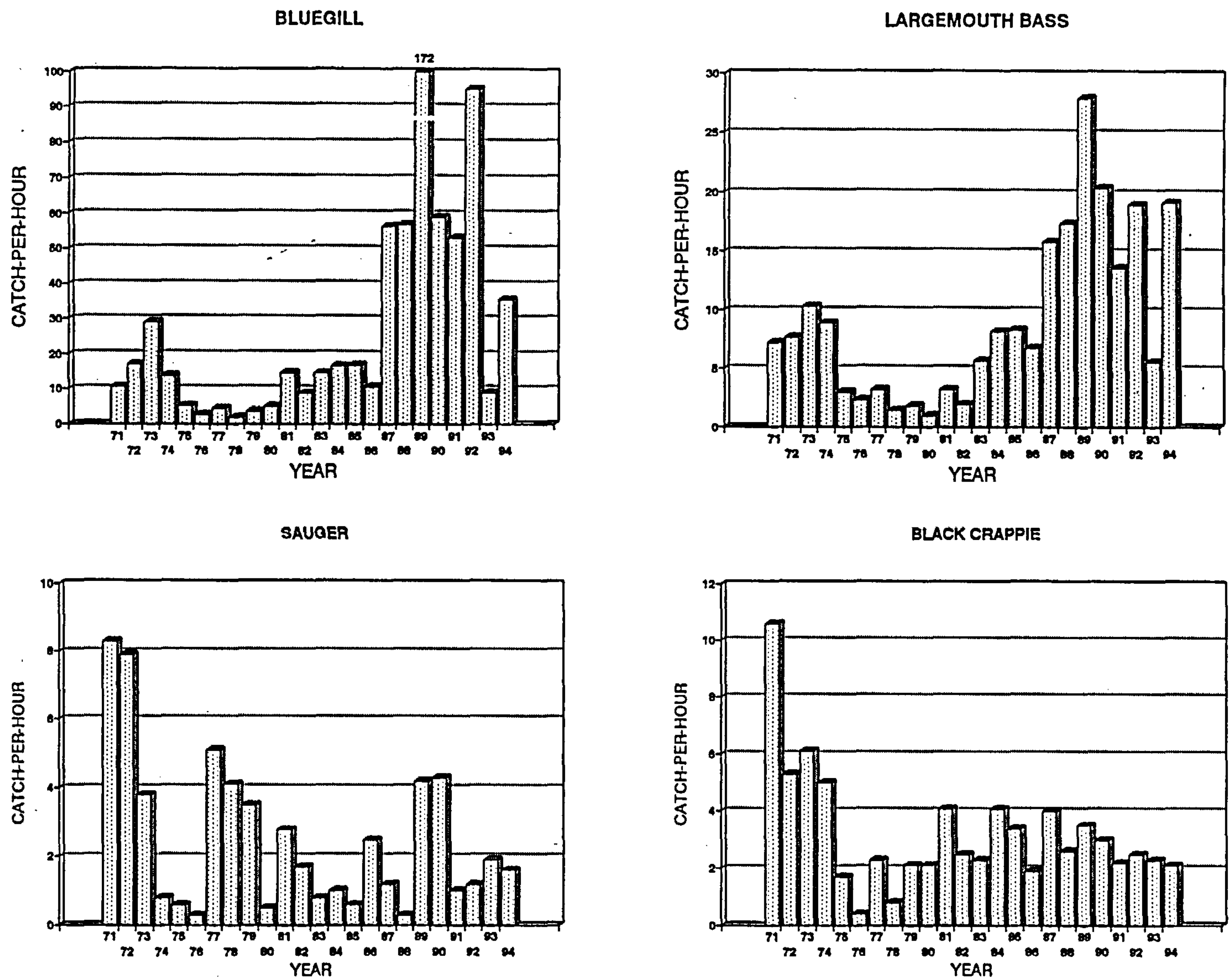


Figure 7. Electrofishing mean CPE for all locations of selected fish species collected in Pool 14 of the Mississippi River near Quad Cties Station, 1971-1994.

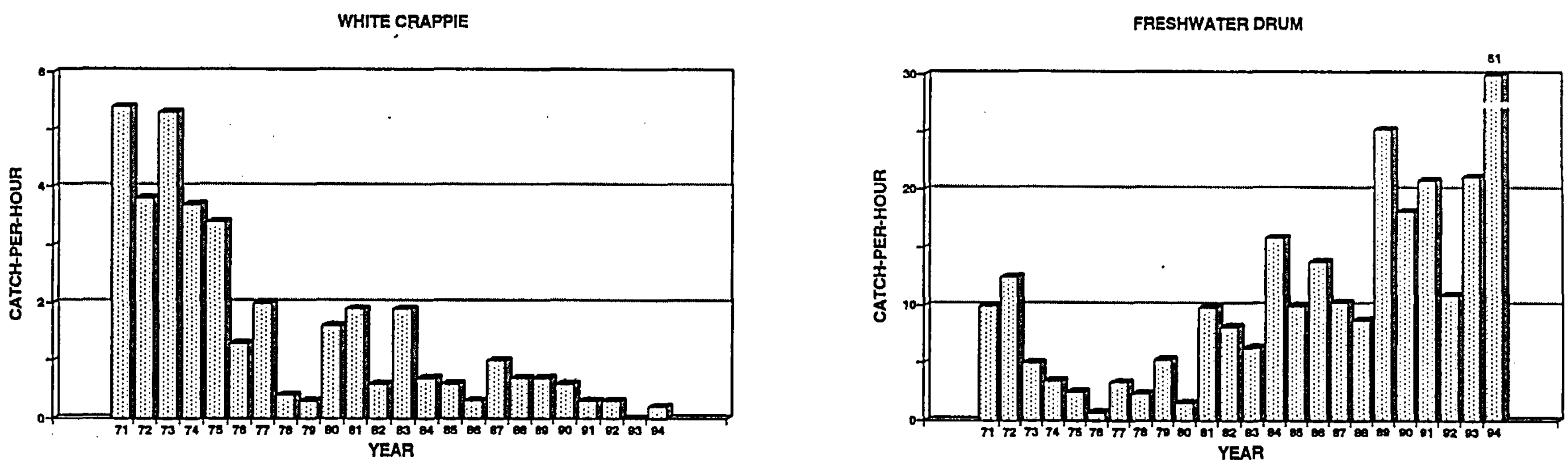


Figure 7. (Cont.) Electrofishing mean CPE for all locations of selected fish species collected in Pool 14 of the Mississippi River near Quad Cities Station, 1971-1994.

(Location 10) in Steamboat Island was replaced by nearby Grant Slough in 1989 because so much sediment had accumulated in Steamboat Slough that the sampling area was inaccessible by boat except during high river stages. McHenry (1981) reported over 110 cm of sediment was deposited in Steamboat Slough between 1954 and 1980. An additional 20 cm of sediment could have easily been deposited between 1980 and 1989. Grant Slough is much deeper and CPE's at this location have been notably higher than those from Steamboat Slough.

The increased catch rate of bluegill, largemouth bass, and freshwater drum in the late 1980's was partially due to increased recruitment during the 1987-1989 drought and the changing of the slough habitat sampling site in 1989. This change in sampling area did not improve catch rates for white crappie, however. White crappie are taken by anglers from deeper backwater complexes in the pool; but this species does not appear to regularly utilize habitats at the fixed sampling locations within the study area. The apparent decline in sauger abundance may be the result of sedimentation and/or increased angler exploitation over the past decade.

Gear selectivity and sampling bias cause great differences in the efficiency of sampling equipment used to capture fish. Electrofishing is widely viewed as the single most effective method commonly used for sampling fish assemblages in lotic habitats (Ohio EPA 1989). Electrofishing surveys provide relatively high numbers of species, a wide assortment of fish sizes, and limited mortality to captured fish. In addition, electrofishing is an effective method of sampling a variety of riverine habitats (main channel border, side channel, and slough). Throughout this monitoring program, electrofishing has been one of the most important techniques used to evaluate the status of a broad range of fish species.

Bottom Trawling

Forty-four species representing 12 families have been collected by bottom trawling since 1971 (Table 4). Ten western sand darters, which are listed as threatened in Iowa (IDNR 1985) and endangered in Illinois (Illinois Endangered Species Protection Board 1990), have been collected by bottom trawling over the 24-year monitoring period. No other threatened or endangered species have been collected by this method.

Bottom trawl samples have been dominated by young-of-year and yearling fish, with channel catfish and freshwater drum being the only species that have been captured during all years of sampling. Since 1971, channel catfish (59.7%) and freshwater drum (32.3%) have comprised 92.0% of the 19,879 fish captured (Table 4). Silver chub (1.7%), mooneye (1.4%), shovelnose sturgeon (1.1%), and speckled chub (1.0%) have been the only other species to individually comprise more than 1.0% of the catch. The remaining 38 species have been collected infrequently or rarely during the study period.

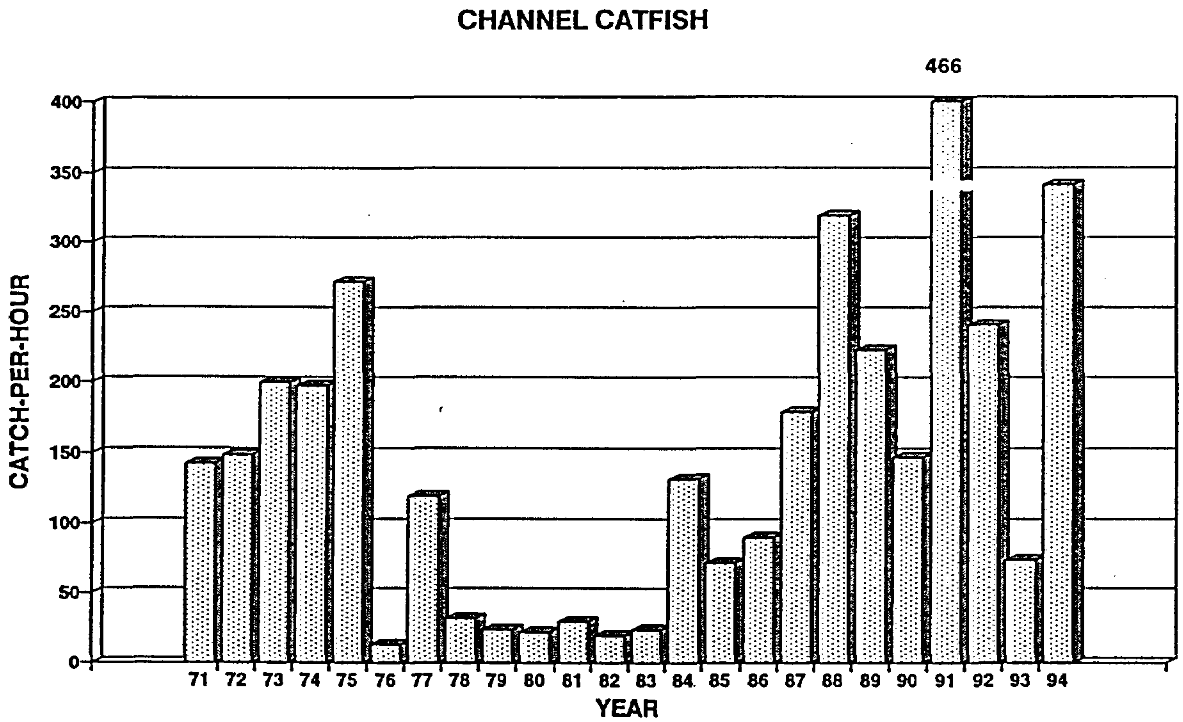
Analysis of channel catfish and freshwater drum catches over time suggests that their abundance in Pool 14 may be expanding (Figure 8). Catches of channel catfish and freshwater drum have averaged 148.1 and 80.2 fish/hr, respectively (Table 4). CPE's for both species were slightly higher during the first few years of monitoring (1971-1977) than were noted from 1978 to 1983. Since 1983, CPE's for both species have increased substantially from those observed during the 1978 through 1983 period. Examination of catch data reported during 1978 to 1983 leads to a very different conclusion then would be drawn from the data collected from either 1971 through 1977 or 1984 through 1994. This provides a clear example of how short-term data sets can be misleading.

Table 4

Total number, catch-per-effort, and percent composition of all fish collected by bottom trawling in Pool 14 of the Upper Mississippi River near Quad Cities Station, 1971-1994

TAXON	No.	CPE	%
Shovelnose sturgeon	226	2.8	1.1
Paddlefish	5	0.1	<0.1
Gizzard shad	17	0.2	0.1
Mooneye	277	3.5	1.4
Carp	95	1.2	0.5
Silvery minnow	6	0.1	<0.1
Silver chub	346	4.3	1.7
Speckled chub	193	2.4	1.0
Emerald shiner	28	0.3	0.1
River shiner	21	0.3	0.1
Ghost shiner	1	<0.1	<0.1
Spotfin shiner	3	<0.1	<0.1
Spottail shiner	12	0.1	0.1
Shiner sp.	4	<0.1	<0.1
Golden shiner	1	<0.1	<0.1
Mimic shiner	1	<0.1	<0.1
Fathead minnow	1	<0.1	<0.1
Bullhead minnow	3	<0.1	<0.1
River carpsucker	54	0.7	0.3
Quillback	14	0.2	0.1
Highfin carpsucker	6	0.1	<0.1
Carpsucker sp.	6	0.1	<0.1
Blue sucker	7	0.1	<0.1
Smallmouth buffalo	32	0.4	0.2
Bigmouth buffalo	1	<0.1	<0.1
Buffalo sp.	3	<0.1	<0.1
Silver redhorse	1	<0.1	<0.1
Golden redhorse	4	<0.1	<0.1
Shorthead redhorse	12	0.1	0.1
Redhorse sp.	2	<0.1	<0.1
Black bullhead	1	<0.1	<0.1
Channel catfish	11,862	148.1	59.7
Stonecat	51	0.6	0.3
Tadpole madtom	1	<0.1	<0.1
Flathead catfish	26	0.3	0.1
Brook silverside	2	<0.1	<0.1
White bass	13	0.2	0.1
Bluegill	20	0.2	0.1
White crappie	2	<0.1	<0.1
Black crappie	3	<0.1	<0.1
Western sand darter[a]	10	0.1	0.1
Logperch	2	<0.1	<0.1
Slenderhead darter	2	<0.1	<0.1
River darter	5	0.1	<0.1
Johnny darter	1	<0.1	<0.1
Sauger	43	0.5	0.2
Walleye	26	0.3	0.1
Freshwater drum	6427	80.2	32.3
Total	19,879	248.2	
Total Species	44		
Total Taxa	48		
Total Hours Effort		80.1	

[a]Listed as threatened in Iowa (Iowa Department of Natural Resources 1985) or Illinois (Illinois Endangered Species Protection Board 1990).



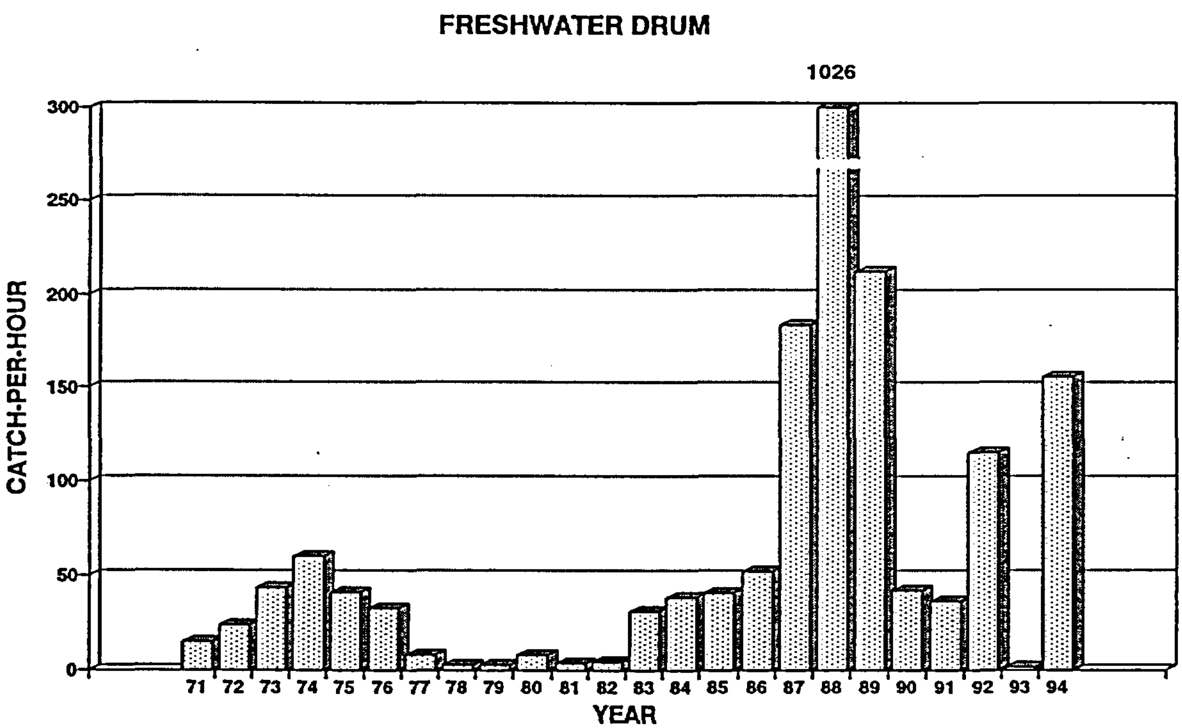


Figure 8. Mean CPE of freshwater drum and channel catfish captured by bottom trawl in Pool 14 of the Mississippi River near Quad Cities Station, 1971-1994.

Although freshwater drum and channel catfish abundance appears to be increasing based on trawl collections, caution is advised in using bottom trawl catches as predictors of year class strength. Both species have been collected more frequently since 1986, with the exception of the record flood of 1993, when sampling conditions and fish recruitment were both adversely affected by high water. This increase is particularly noteworthy for channel catfish, as increased reproductive success may have occurred in response to increasing the minimum length limit on the commercial fishery to 380 mm (15 in.) in 1985. However, attempts to associate freshwater drum young-of-year abundance in trawl catches with subsequent year class strength in hoop net and haul seine catches have been inconclusive. There is some question as to whether trawl catches of freshwater drum are truly reflective of young-of-year abundance or rather a matter of chance. It has been observed that an abundance of young-of-year fish does not always result in a strong year class of adult fish because numerous environmental factors affect survival, particularly during the first year of life.

The value of using bottom trawling data to satisfy the objectives of this long-term monitoring program is limited. This technique is qualitative and, by design, selective for juvenile fish which are unable to avoid the trawl. While trawling has provided some indications of reproductive success for channel catfish and perhaps freshwater drum, populations of these two species have been more effectively monitored by other collection methods within these studies.

Hoop Netting

Hoop net monitoring of fish populations in Pool 14 commenced in 1982 as a companion study of the freshwater drum life history study that was initiated four years earlier. Unlike the spring tagging program, which was restricted to the collection of freshwater drum, channel and flathead catfish, walleye and sauger, the objective of this program component was to evaluate the entire catch of all fish species captured in 28 randomly selected hoop nets each week during May. In addition to measuring species composition and relative abundance, catch results were also compared to other physical parameters (river discharge, velocity, temperature, and depth) to determine their effects. This effort was not directed at assessing the potential impact of Station operation on the fish community.

Thirteen years of hoop net monitoring has resulted in the capture of 11,375 fish representing 15 families and 40 species, nine of which have been captured every year (Table 5). Four lake sturgeon, listed as endangered in Iowa (IDNR 1985) and threatened in Illinois (Illinois Endangered Species Protection Board 1990), have been collected by hoop netting since 1990 (Table 2). Freshwater drum (42.6%), channel catfish (24.2%), flathead catfish (7.7%) and mooneye (5.5%) have typically dominated hoop net catches during most years of sampling. Too few individuals of any other species were captured in the remaining portion of the catch to warrant valid comparisons of the effects of physical parameters on their catch rate or relative abundance.

Comparisons of catch data to the measured physical parameters for the dominant species (freshwater drum, channel and flathead catfish) collected during these studies have exhibited no consistent relationships or trends. Such inconclusive results may be attributed to two factors. First, the Mississippi River is a complex and dynamic ecosystem in which many parameters simultaneously influence the biological community. To attempt to explain any particular observation as the result of one parameter would lead to over simplification and probable misinterpretation.

Secondly, the design of this sampling effort was not sufficient to adequately address the influences of the physical parameters on catch rates. Placement of the nets varied with prevailing river conditions in an attempt to capture as many freshwater

Table 5

Total number, catch-per-effort, and percent composition of all fish collected by hoop net in Pool 14 of the Upper Mississippi River near Quad Cities Station, 1982-1994

TAXON	No.	CPE[a]	%
Silver lamprey	5	<0.1	<0.1
Lake sturgeon	4	<0.1	<0.1
Shovelnose sturgeon	41	<0.1	0.4
Longnose gar	46	<0.1	0.4
Shortnose gar[b]	100	<0.1	0.9
Bowfin	11	<0.1	0.1
American eel	15	<0.1	0.1
Gizzard shad	150	<0.1	1.3
Mooneye	626	0.1	5.5
Northern pike	8	<0.1	0.1
Carp[b]	270	<0.1	2.4
Carp X Goldfish hybrid	1	<0.1	<0.1
River carpsucker[b]	216	<0.1	1.9
Quillback	17	<0.1	0.1
Highfin carpsucker	16	<0.1	0.1
White sucker	2	<0.1	<0.1
Blue sucker	1	<0.1	<0.1
Smallmouth buffalo[b]	274	<0.1	2.4
Bigmouth buffalo	23	<0.1	0.2
Black buffalo	6	<0.1	0.1
Spotted sucker	12	<0.1	0.1
Silver redhorse	2	<0.1	<0.1
Golden redhorse	16	<0.1	0.1
Shorthead redhorse[b]	204	<0.1	1.8
Redhorse spp.	3	<0.1	<0.1
Black bullhead	37	<0.1	0.3
Yellow bullhead	4	<0.1	<0.1
Channel catfish[b]	2756	0.4	24.2
Stonecat	1	<0.1	<0.1
Flathead catfish[b]	873	0.1	7.7
White bass	167	<0.1	1.5
Rock bass	3	<0.1	<0.1
Pumpkinseed	11	<0.1	0.1
Warmouth	1	<0.1	<0.1
Bluegill[b]	249	<0.1	2.2
Hybrid sunfish	1	<0.1	<0.1
Largemouth bass	20	<0.1	0.2
White crappie	58	<0.1	0.5
Black crappie	246	<0.1	2.2
Yellow perch	1	<0.1	<0.1
Sauger	43	<0.1	0.4
Walleye	8	<0.1	0.1
Freshwater drum[b]	4845	0.8	42.6
Total Fish	11,375		
Total Species	40		
Total Taxa	43		
Net Days	6451		
CPE		1.76	

[a]Catch-per-effort equals the number of fish per net-day.

drum as possible. Collection of freshwater drum has been the overriding goal of the spring tagging program. Consequently, during low flow periods, collection efforts were conducted primarily in main channel and side channel habitats; while during high flow periods, nets were moved into flooded island and slough habitats. Because the nets were moved and placed in response to changing river conditions, the effects of net movement cannot be separated from those of physical parameters.

Haul Seining

Relative abundance and standing crop estimates of fish inhabiting side channel and slough habitats have been monitored by haul seine since 1978. Haul seining has captured 103,497 fish representing 37 species, one hybrid (hybrid striped bass) and 15 families (Table 6). Lake sturgeon (1993) and skipjack herring (1983, 1984, 1990, and 1994) represent the only two species that have been collected during the 17 years of sampling that are presently listed as either threatened or endangered (Table 2). Numerically, gizzard shad (53.7%), freshwater drum (24.6%) and bluegill (5.3%) have comprised 83.6% of all fish sampled.

Haul seine biomass estimates have been dominated by gizzard shad ($\bar{x}$ = 40.7 lb/A), freshwater drum ($\bar{x}$ = 19.1 lb/A) and smallmouth buffalo ($\bar{x}$ = 4.8 lbs/A).. Haul seine standing crop estimates were strongly influenced by catches of gizzard shad and freshwater drum, which typically comprise a substantial portion of the catch. However, these estimates were highly variable between years in response to changing physical and biological conditions. Gizzard shad biomass estimates have ranged from 1.3 to 278.3 lb/A and freshwater drum from 2.1 to 73.9 lb/A during the 1978 to 1994 period. The overall mean standing crop of 85 lbs/A may appear less than expected for the Mississippi River; however, this estimate includes only larger fish retained by the gear. Smaller fish easily escape through the larger mesh and are not included in the estimate.

Table 6

Total number, percent composition, and standing crop estimates of all fish collected by haul seine in Pool 14 of the Upper Mississippi River near Quad Cities Station, 1978-1994

TAXON	No.	%	STANDING CROP ESTIMATES (lb/Acre) MEAN	%	RANGE
Silver lamprey	2	<0.1	-[a]	-	-
Lake sturgeon	1	<0.1	-	-	-
Paddlefish	161	0.2	-	-	-
Longnose gar	19	<0.1	-	-	-
Shortnose gar	23	<0.1	-	-	-
Bowfin	6	<0.1	-	-	-
Skipjack herring	6	<0.1	-	-	-
Gizzard shad	55,613	53.7	40.7	47.9	1.3 - 278.3
Goldeye	85	0.1	-	-	-
Mooneye	4459	4.3	2.1	2.5	0.3 - 11.8
Northern pike	265	0.3	1.9	2.2	0.3 - 7.7
Carp	737	0.7	2.2	2.6	0 - 12.6
River carpsucker	1692	1.6	2.5	2.9	0.1 - 13.3
Quillback	702	0.7	1.1	1.3	0 - 5.9
Highfin carpsucker	641	0.6	1.0	1.2	0 - 7.5
White sucker	3	<0.1	-	-	-
Smallmouth buffalo	2924	2.8	4.8	5.6	0.2 - 20.8
Bigmouth buffalo	527	0.5	1.1	1.3	0.2 - 5.0
Black buffalo	10	<0.1	-	-	-
Spotted sucker	126	0.1	0.3	0.4	0 - 1.1
Silver redhorse	15	<0.1	-	-	-
Golden redhorse	33	<0.1	-	-	-
Shorthead redhorse	54	0.1	-	-	-
Black bullhead	9	<0.1	-	-	-
Channel catfish	342	0.3	0.6	0.7	0 - 2.9
Flathead catfish	3	<0.1	-	-	-
White bass	2318	2.2	1.2	1.4	0 - 3.6
Hybrid striped bass	6	<0.1	-	-	-
Yellow bass	9	<0.1	-	-	-
Pumpkinseed	15	<0.1	-	-	-
Bluegill	5513	5.3	2.8	3.3	0.1 - 18.2
Largemouth bass	170	0.2	-	-	-
White crappie	827	0.8	0.3	0.4	0.1 - 1.7
Black crappie	237	0.2	0.1	0.1	0.1 - 0.5
Yellow perch	1	<0.1	-	-	-
Sauger	431	0.4	0.4	0.5	0.1 - 2.2
Walleye	67	0.1	0.1	-	-
Freshwater drum	25,445	24.6	19.1	22.5	2.1 - 73.9
Total Number	103,497		85.0		
Total Species	37				
Total Taxa	38				

[a]Minor contributors to the catch with values <0.1.

The total number of fish, as well as the standing crop estimates derived from these studies, have been highly variable among years. This variability should not be considered as unusual or unique to this program, but rather as typical of any long-term monitoring program of a large, riverine system influenced by broad changes in physical and biological conditions. During the autumn, fish tend to utilize the side channel habitat more extensively during periods of reduced flow and warmer temperatures. As flow increases and/or water temperature decreases, the majority of fish relocate to the backwater slough habitat (LMS 1994). In addition, droughts and severe flooding, both of which have occurred during the course of these studies, have had a pronounced effect on the biological community. Relatively high biomass estimates recorded for the 1987-1990 period reflect the effects of the drought (Figure 9). The drought resulted in low, stable river flows that were conducive to spawning, strong recruitment, and increased standing crop estimates. This was particularly true in 1988, 1989 and 1990 when large numbers of gizzard shad and freshwater drum spawned during the drought began to recruit to the gear (LMS 1992). Biomass estimates peaked in 1990 before returning to pre-drought levels in the following two years. In contrast, the flood of 1993 adversely effected spawning and recruitment of many fish species (LMS 1994). This had little effect on biomass estimates in 1993 and 1994 because none of the fish spawned in 1993 would have been vulnerable to the 1.5 inch mesh seine. The 1993 year class should be noted in haul seine collections made during the fall of 1995 or 1996 when those fish first reach sufficient size to be captured by the net.

Rotenone Sampling

Cove rotenone sampling was conducted at five locations in the late 1970's and early 1980's. Fish collected during cove rotenone studies in Pool 14 were grouped according to guild following recommendations established by the Upper Mississippi River Conservation Committee's Fisheries Technical Section (UMRCC, 1947) and

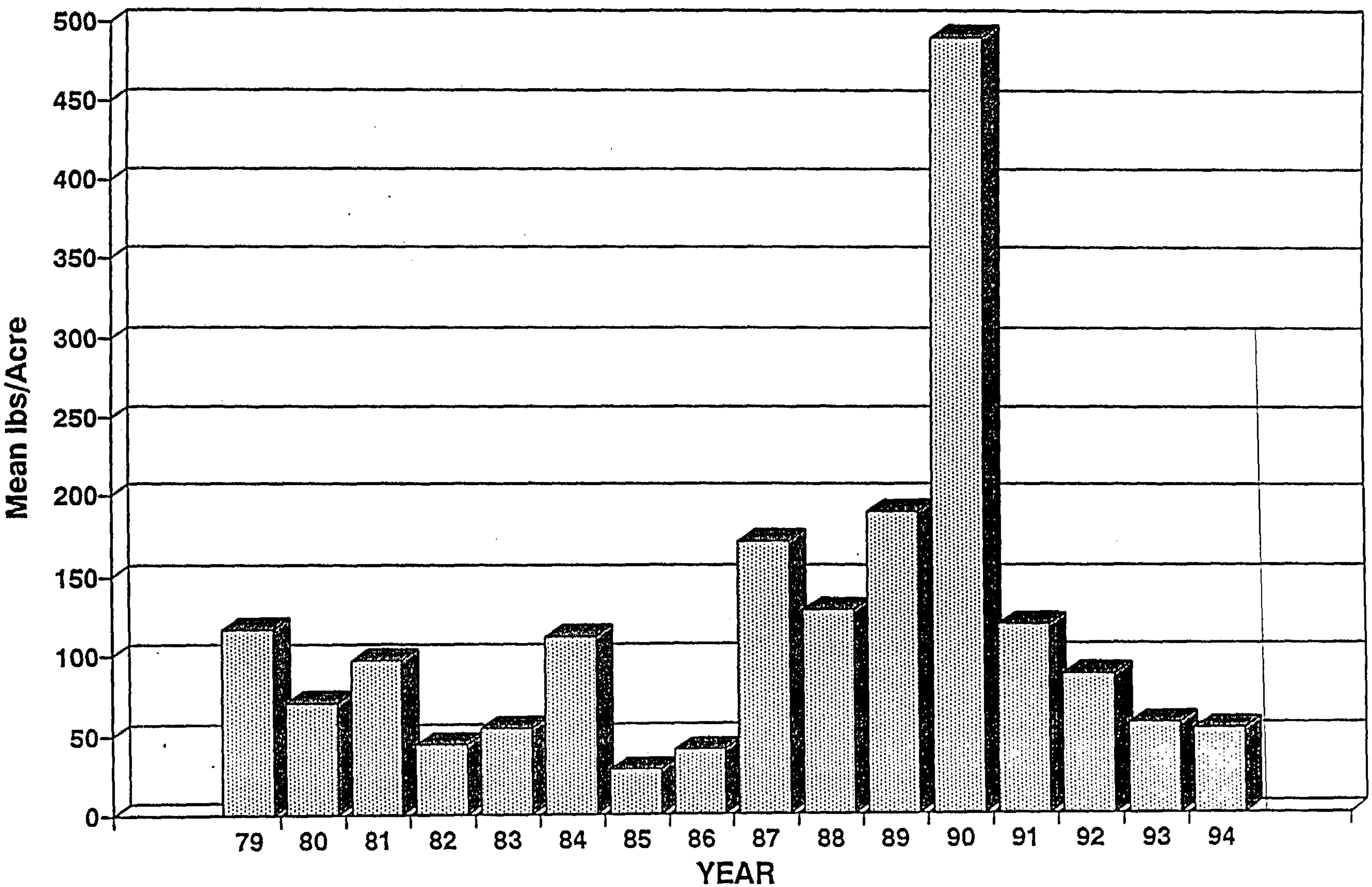


Figure 9. Mean standing crop estimates of fish collected by haul seine in Pool 14 of the Mississippi River near Quad Cities Station, 1979-1994.

Christenson and Smith (1965). These groupings include: 1) predators, 2) game fish, 3) panfish, 4) forage fish, 5) catfish and bullheads, and 6) rough fish (Table 7). The average standing crop biomass estimate of fish collected from 10 cove rotenone samples in Pool 14 has been calculated and compared to the average standing crop estimate of fish collected from several cove areas located in Pools 5, 6, 8, 13, 14, 18 and 22 of the Upper Mississippi River (Pitlo 1987).

Cove rotenone biomass estimates of fish collected in Pool 14 averaged 380 lb/A, which is slightly greater than the 320 lb/A average reported for the entire pooled portion of the Upper Mississippi River (Figure 10). This 380 lb/A biomass estimate agrees well with Jenkins' (1976) regression analysis which predicted a standing crop size of 356 lb/A for Pool 14 (Nalco Environmental Sciences 1977). In Pool 14, forage fish (35.8%) and rough fish (35.3%) dominated the catch, followed by panfish (17.4%), game fish (6.8%), predators (2.4%) and catfish (2.3%). The relative abundance of these guilds are similar to the pooled river averages described by Pitlo (1987). Pitlo reported that rough fish (38.2%) and forage fish (30.8%) comprise 69% of all fish collected by rotenone in an average backwater cove, followed by panfish (14.2%), predators (6.3%), game fish (5.7%) and catfish (4.7%).

Cove rotenone sampling provides reliable information for species that use backwater habitats; however, it does not adequately reflect standing stock estimates of species that prefer main channel and side channel habitats. Rotenone sampling is generally viewed with disfavor by the public, and has the potential to cause unwanted fish kills outside the designated study area. In addition, many of the backwater complexes throughout the Upper Mississippi River have lost habitat due to sedimentation. Many of these areas have become too shallow to support the quantity and diversity of fish species that initially developed following construction of the locks, dams and levee systems built for commercial navigation and flood control. The inference is that, as sediment accumulates, carrying capacity diminishes. The result is a reduction

Table 7

Major categories of fish species used to evaluate standing crop estimates collected during cove rotenone studies in Pool 14 of the Upper Mississippi River, 1977, 1979-1981 and 1984

Predators

- Longnose gar
- Shortnose gar
- Bowfin

Game Fish

- Grass pickerel
- Northern pike
- Smallmouth bass
- Largemouth bass
- Sauger
- Walleye

Panfish

- White bass
- Yellow bass
- Rock bass
- Green sunfish
- Pumpkinseed
- Warmouth
- Orangespotted sunfish
- Bluegill
- Sunfish hybrids
- White crappie
- Black crappie

Forage Fish

- Gizzard shad
- All cyprinids (except carp)
- Stonecat
- Trout-perch
- Mosquitofish
- Brook silverside
- All darters

Catfish and Bullhead

- Black bullhead
- Yellow bullhead
- Brown bullhead
- Channel catfish
- Flathead catfish

Rough Fish

- Paddlefish
- Shovelnose sturgeon
- Mooneye
- Carp
- Carpsucker spp.
- Buffalo spp.
- Redhorse spp.
- Freshwater drum

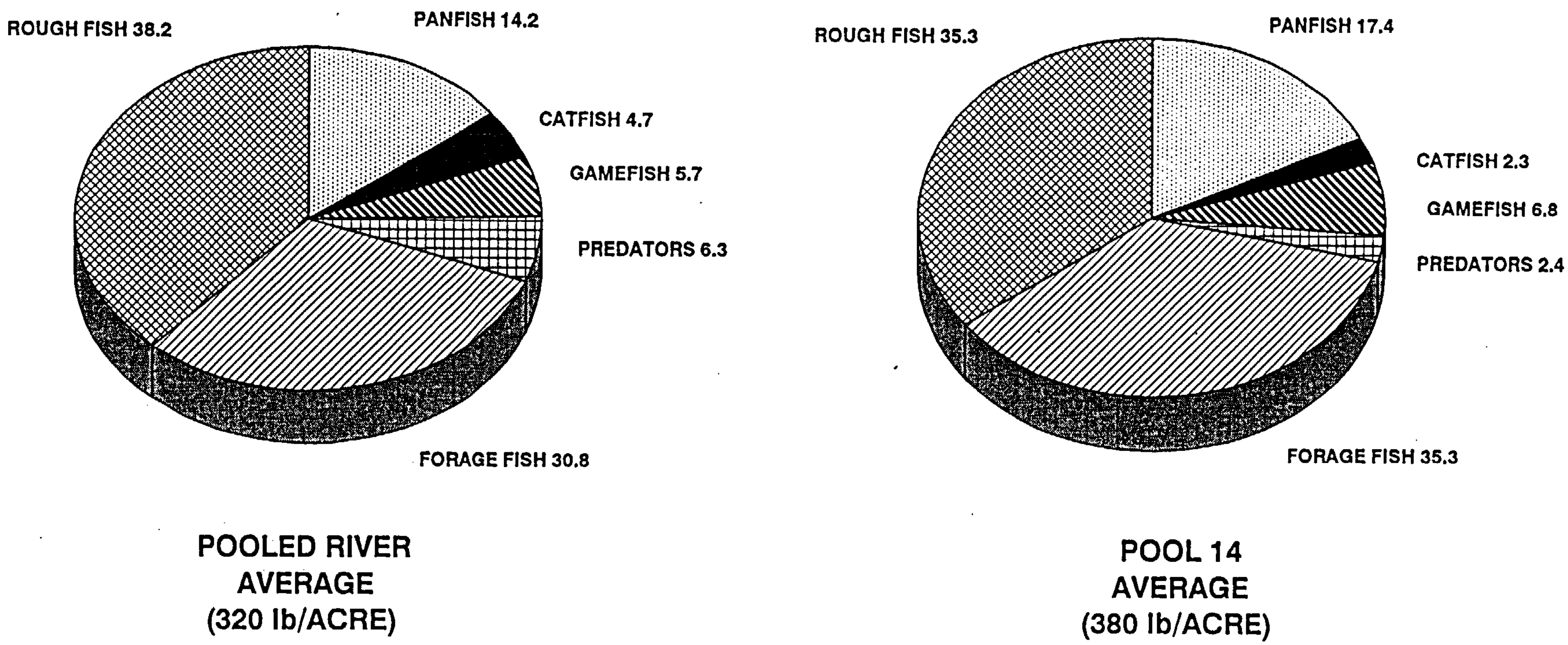


Figure 10. Comparative composition of major fish groups from backwater areas of the Upper Mississippi River as determined by rotenone samples.

of total fish biomass over time. As a result, the cove rotenone sampling program was discontinued after 1984. Use of standing crop information provided by cove rotenone studies from 1977 to 1984 may no longer be valid because it does not reflect present conditions at the locations that were sampled.

Spring Tagging

Freshwater drum. Extensive studies regarding the population dynamics and life history of freshwater drum in Pool 14 have been conducted since 1978. Freshwater drum was selected as an indicator species because of its abundance in Pool 14 and its susceptibility to larval and egg entrainment. The majority of information used to evaluate this species has been collected by hoop netting during the spring tagging program. This program element has provided useful information for evaluating Station effects on the fish community.

Mark recapture methods have been used since 1983 to estimate population size and to monitor movement of freshwater drum. Intra-pool movement of this species, based upon tag returns has supported an earlier radiotelemetry study conducted in 1981 (ERT 1982). This study found that freshwater drum movement is commonly restricted to one mile or less from the original release location. Freshwater drum population estimates are presented for Areas A-C because they represent the only locations in which sampling was conducted over the entire 11-year period. Areas A-C includes approximately 546 hectares (1349 acres), which represents 13% of the surface area of Pool 14. Numerical population estimates for freshwater drum ≥150 mm TL for the long-term monitoring area (Areas A-C) have ranged from 45,279 (95% C.I. = 23,522 - 95,324) in 1987 to 602,845 (95% C.I. = 313,166 - 1,269,147) in 1989 (Figure 11). Although considerable variation exists in these numerical estimates, only the estimates in 1985 and 1987 show differences at the 0.05 level of significance. Even then there is no significant statistical difference in the 1985 estimates and those

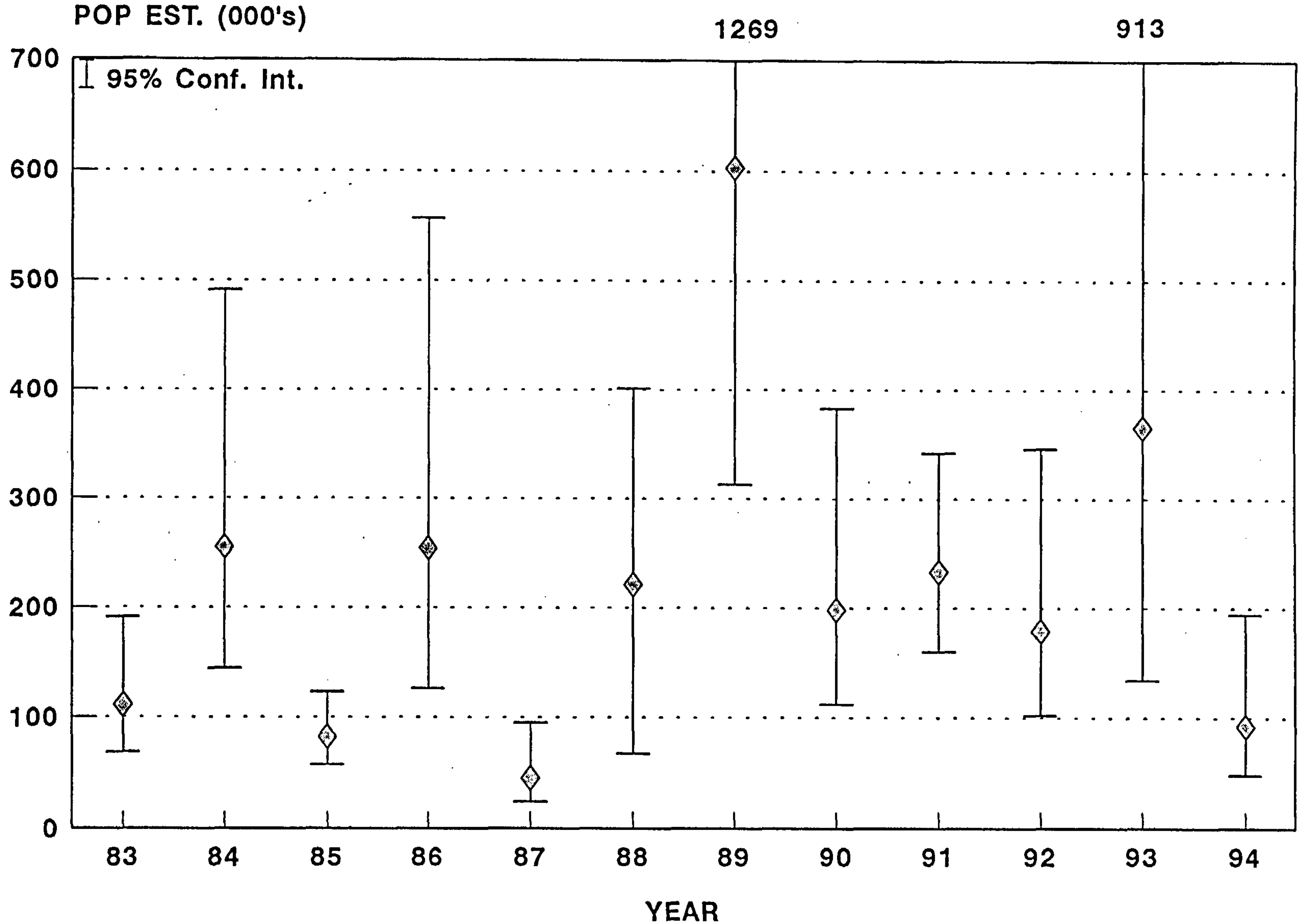


Figure 11. Freshwater drum (≥150mm TL) population estimates by year for Areas A-C in Pool 14 of the Mississippi River near Quad Cities Station, 1983-1994.

in 1983, 1988, 1990, 1992 and 1994. Likewise no significant statistical difference is noted in the estimates in 1987 with those in 1983,1988, and 1994. Recapture numbers, which drive confidence intervals for the estimates, are obviously the overwhelming mathematical factor for establishing statistical differences. Low numbers of recaptured marked fish (0.08% to 0.81%) dilutes the strength of the confidence intervals. Environmental variations such as river discharge, which influences both fish distribution and movement, are also contributing components. In addition, natural fluctuations in the drum population must be considered before drawing any conclusions from these data.

Relative abundance index values for freshwater drum (fish/net-day) ≥150 mm TL have ranged from 0.36 fish/net-day in 1983 to 1.89 fish/net-day in 1989 (Figure 12). Catches of freshwater drum for the period 1989 through 1992 were all higher than any other year. High catch rates during those years were apparently influenced by the extended drought that occurred from 1987-1989. The low stable flows that occurred throughout this period resulted in more effective capture and high recruitment of many fish species, including freshwater drum. As these fish grew and became vulnerable to the sampling gear, catches of freshwater drum increased, reflecting the strong recruitment experienced during the drought. Since 1992, CPE's have returned to pre-drought levels (1983-1988).

Standing crop estimates of freshwater drum ≥150 mm TL have been calculated for Areas A-C since 1983 (Figure 13). Biomass estimates have also been highly variable between years ranging from 21.8 lb/A in 1987 to 270.6 lb/A in 1993. As is the case with most long-term population indices, annual standing crop estimates are expected to exhibit variability. Several factors may be responsible including: 1) natural fluctuations in population cycles; 2) changing environmental conditions, such as river flow and temperature, which influence fish distribution, movement and gear efficiency; and/or 3) strength of year classes being recruited to the gear. Unusually

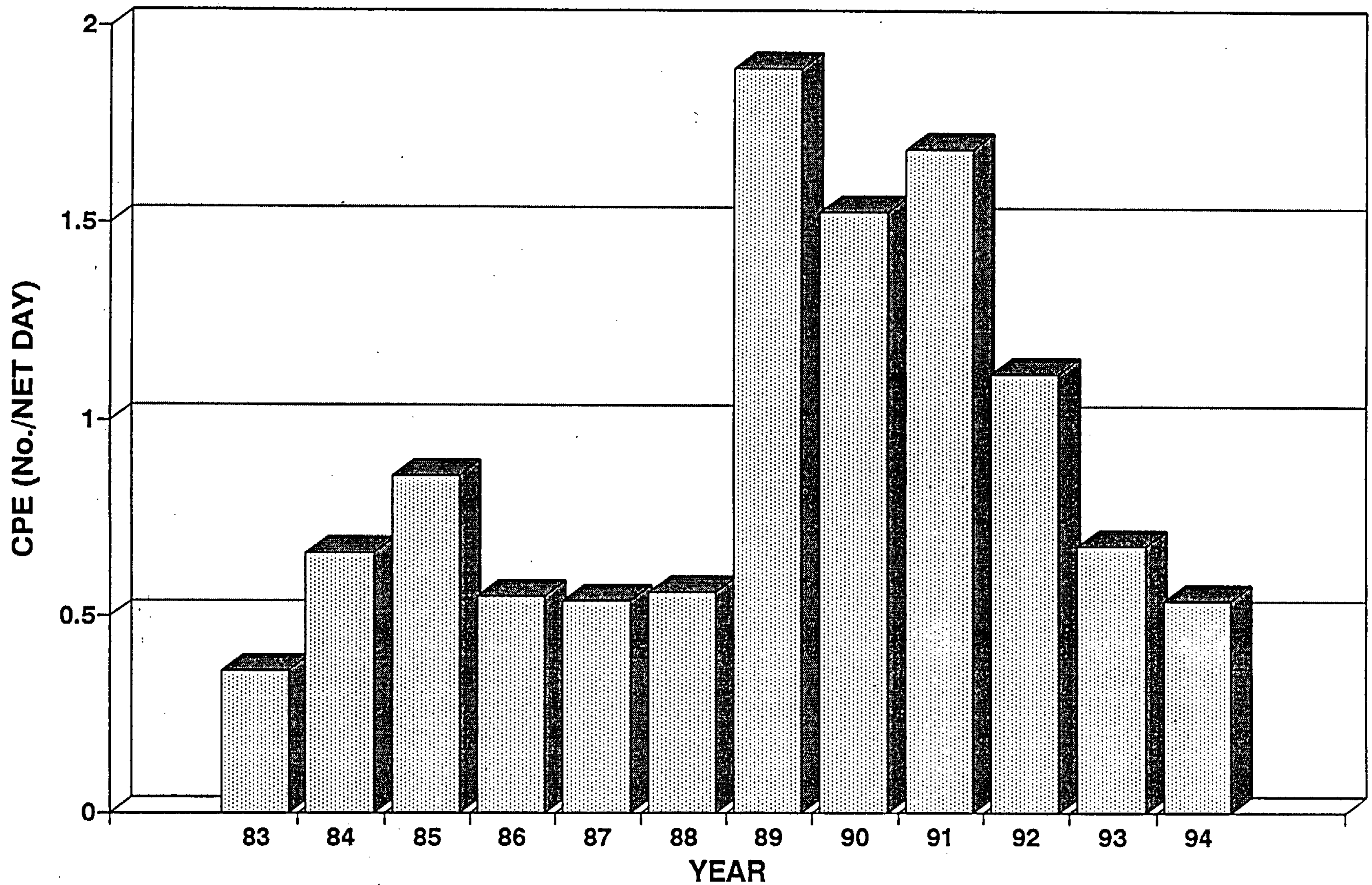


Figure 12. Freshwater drum (≥150 mm TL) mean CPE by year for Areas A-T in Pool 14 of the Upper Mississippi River near Quad Cities Station, 1983-1994.

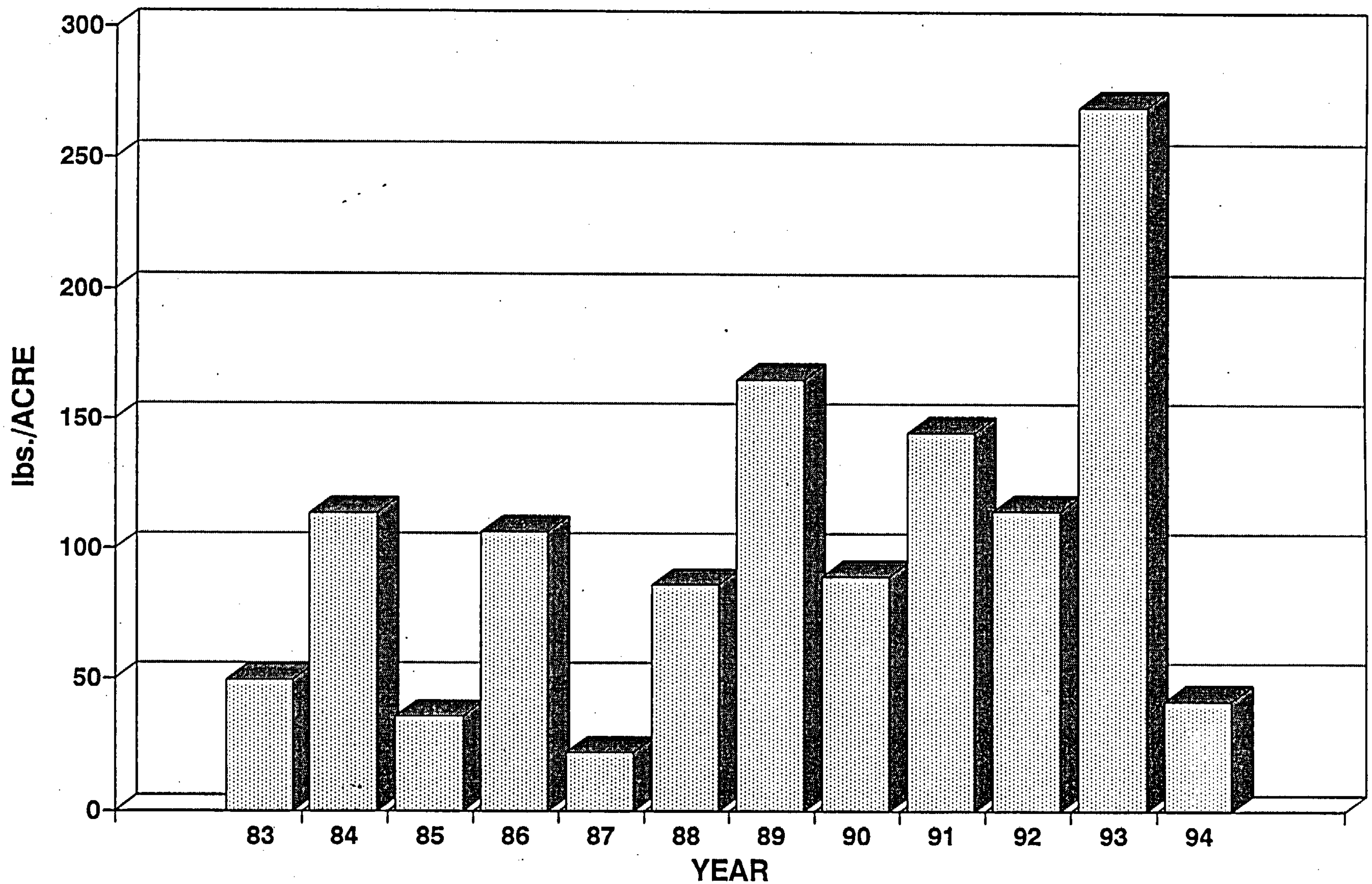


Figure 13. Freshwater drum (≥150 mm TL) standing crop estimates by year for Areas A-C in Pool 14 of the Upper Mississippi River near Quad Cities Station, 1983-1994.

high or low estimates that may occur during any sampling year should not individually be disconcerting unless a long-term and consistent trend can be identified.

A number of growth equations have been developed to measure the well-being of fish populations. As a means of making a valid comparison of the growth and the theoretical well-being of the freshwater drum population in Pool 14 over time, annual length-weight equations were used to solve for the average weight at length of freshwater drum measuring 350 mm TL (Figure 14). The average weight of a 350 mm freshwater drum has ranged from 483.3 g in 1990 to 579.4 g in 1992. Graphical analysis of these data indicates that the average weight of a 350 mm fish decreased slightly from 1980 to 1988. Mean weight of these fish dropped dramatically in 1989 and 1990, presumably in response to the prolonged drought. The dramatic reduction in the mean weight of these fish was thought to be symptomatic of an extremely dense population that was outstripping a limited food supply. Low and stable river flows associated with the drought led to increased recruitment, crowding, and competition for food. The strong recruitment of these fish, combined with under exploitation, habitat reduction, and increased competition, had a negative influence on fish condition. Following the drought, the average weight of a 350 mm fish increased dramatically in 1991 and 1992. This increase was apparently in response to the end of the drought, the return to higher flows, and an increase in food availability. Recruitment declined, mortality and habitat availability increased, and as a result, the average weight of freshwater drum increased. Average weight of these fish declined in 1993 and 1994, presumably representing a return to the levels observed before the onset of the drought. Similar results have been noted when length-weight equations were solved for fish ranging from 250-450 mm TL. Throughout these extensive studies, there has been no discernible impact upon the freshwater drum population in Pool 14 that can be attributed to Station operation.

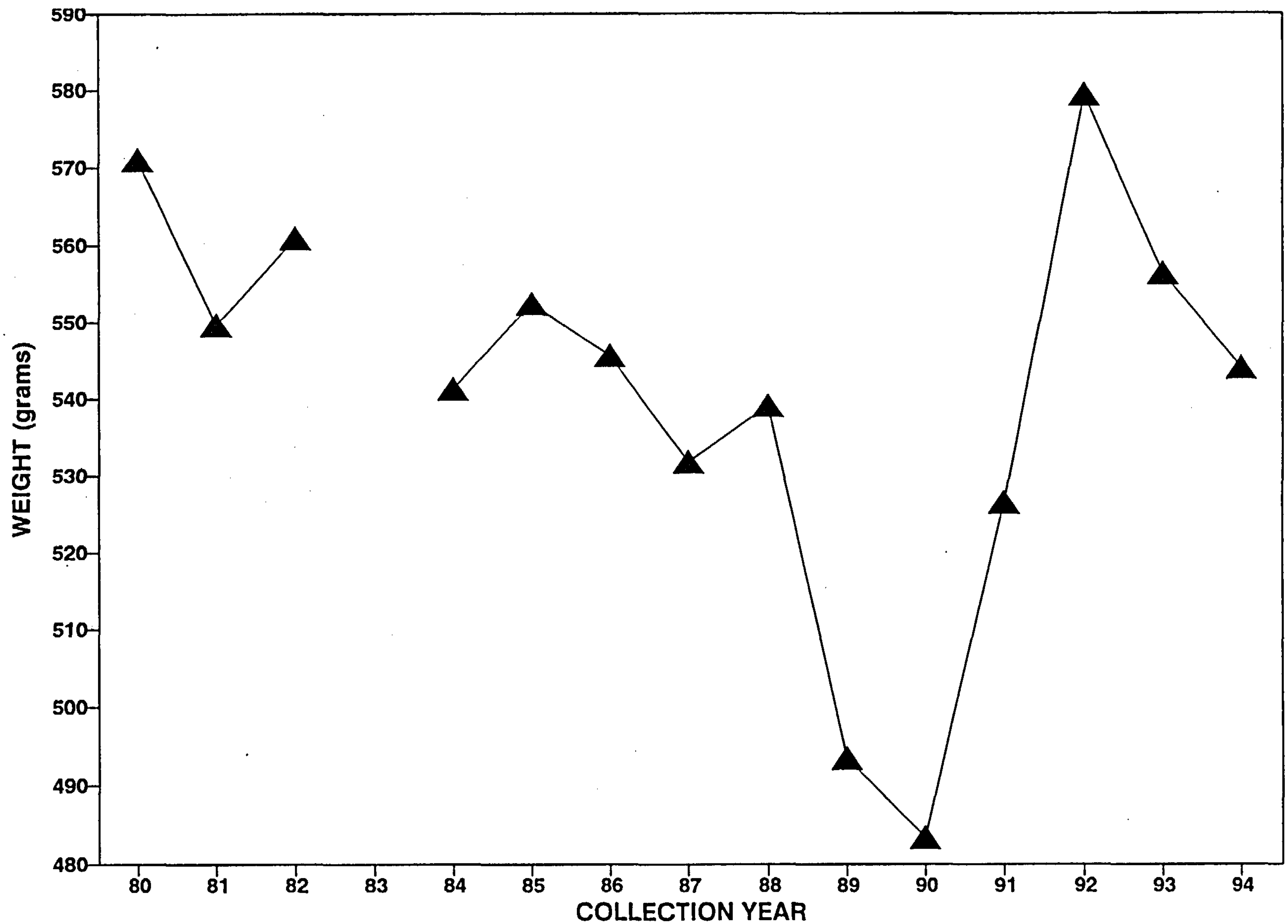


Figure 14. Freshwater drum average weight at 350 mm TL, 1980-1994.

Channel and Flathead Catfish. The fish tagging effort was expanded in 1983 to include mark/recapture population studies of channel and flathead catfish captured coincidentally in hoop nets that were set primarily for freshwater drum. As previously noted, freshwater drum was selected for intensive study because it was the species most likely to be effected by Station operation. In the case of both catfish species, there has been no concern expressed by regulatory agencies that Station operation has affected their population levels. This element of the monitoring program was added to develop population and standing crop estimates for both species as a means of evaluating any change in population levels subsequent to implementation of a 380 mm (15 inch) commercial length limit in 1985. The previous minimum length limit was 330 mm (13 inches) for all catfish species.

Estimates of population size for channel and flathead catfish ≥280 mm TL have been calculated since 1983. Population estimates for channel catfish in Areas A-T have ranged from 12,705 (95% C.I. = 5672 - 31,762) in 1987 to 300,521 fish (95% C.I. = 191,822 - 496,273) in 1993 (Figure 15). Area A-T encompasses 2556 hectares (6313 acres), or approximately 60.6% of the surface area in Pool 14. Channel catfish population estimates for Areas A-T have averaged 81,081 fish since 1984. At the 0.05 level of significance the channel catfish population estimates are statistically different only in 1987, 1993, and 1994. The estimate in 1993 is different at this level of significance in all years except 1990 and 1991. Numerical population yields in 1987 and 1994 are different at this level of significance in 1990, 1991, 1992, and 1993.

The mean flathead catfish population estimate for Areas A-T is 8692 fish. Flathead catfish population estimates have ranged from 3605 (95% C.I. = 2525 - 5334) in 1985 to 16,776 fish (95% C.I. = 10,842 -27,243) in 1989 (Figure 16). Statistical differences between years in the flathead catfish population are apparent only for 1985 and 1989. At the 0.05 level of significance, the 1985 population estimates shows a difference

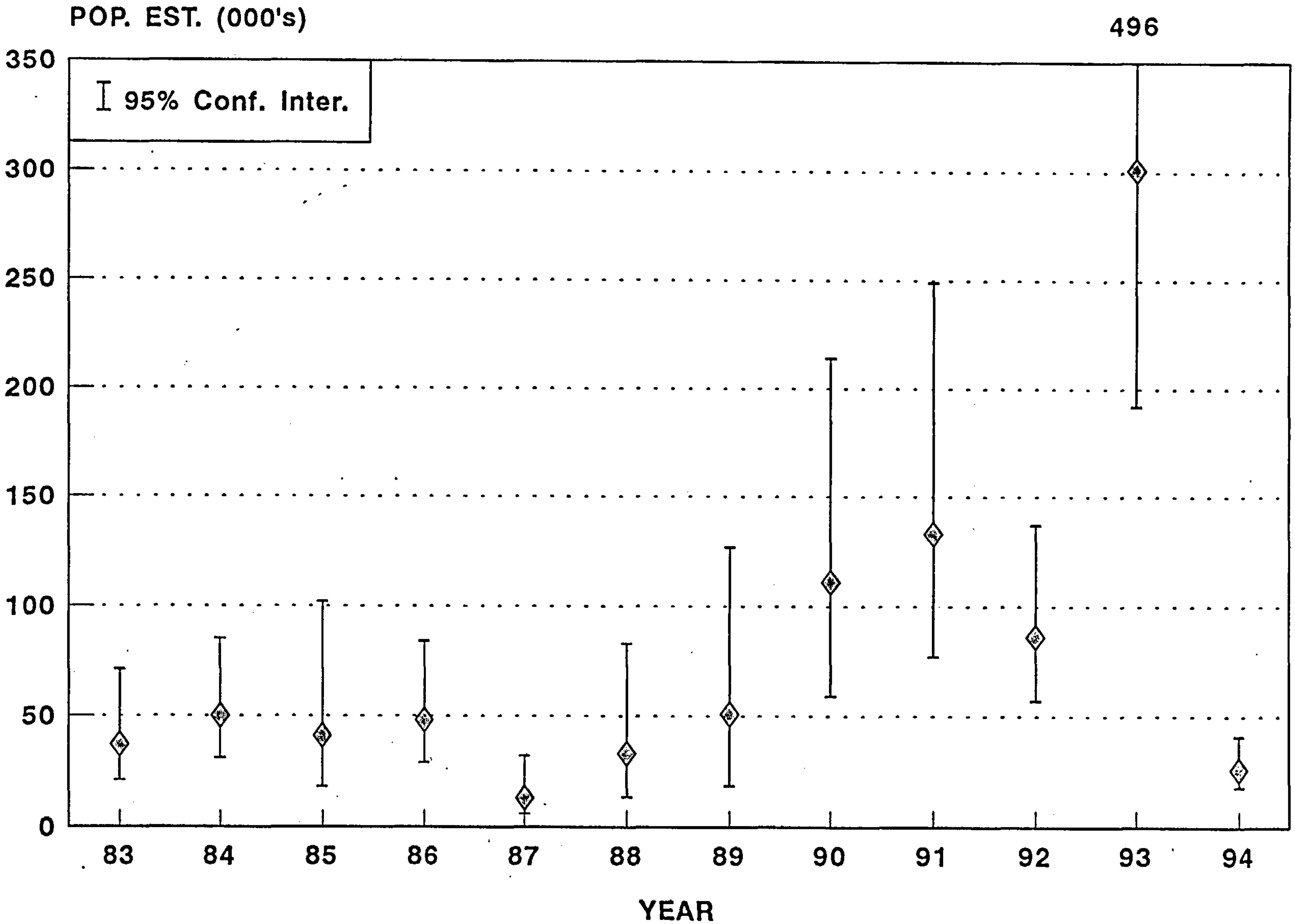


Figure 15. Channel catfish (≥280mm TL) population estimates by year for Areas A-T in Pool 14 of the Mississippi River near Quad Cities Station, 1983-1994.

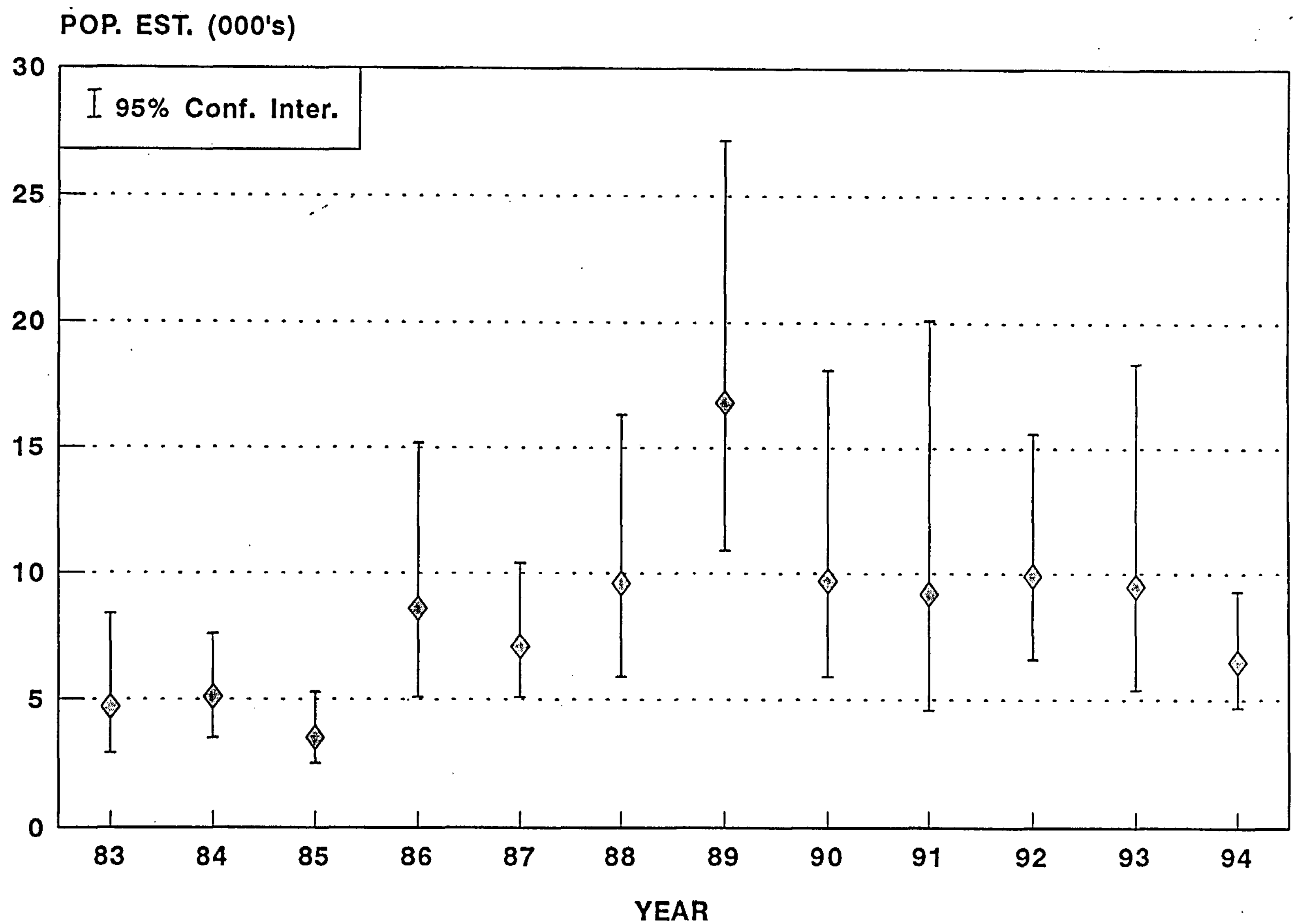


Figure 16. Flathead catfish (≥280mm TL) population estimates by year for Areas A-T in Pool 14 of the Mississippi River near Quad Cities Station, 1983-1994.

from those in 1988, 1989, 1990, and 1992. Also at this level, the 1989 estimate is significantly different from those of 1983, 1984, 1985, 1987, and 1994.

Standing crop estimates for channel and flathead catfish have generally increased during the past twelve years (Figures 17 and 18). Channel catfish standing crop estimates for fish ≥280 mm TL have varied from 3.6 to 94.9 lbs/A ($\bar{x}$ = 19.8 lb/A). Population and standing crop estimates for channel catfish have increased since 1987 when both parameters were at all-time lows. Flathead catfish standing crop estimates have been less variable between years ranging from 2.7 lb/A in 1985 to 8.9 lb/A in 1989 ($\bar{x}$ = 5.2 lb/A).

Population levels and standing crop of both catfish species have increased in Pool 14 since 1986, apparently in response to the 380 mm (15 inch) commercial harvest regulation. It is not certain that this regulation was the sole factor affecting this increase; but the desired increase in reproductive potential appears to have been achieved.

Impingement

The estimated number and weight of fish impinged at Quad Cities Station has been monitored since 1973. Gizzard shad and freshwater drum have comprised the major component of impingement collections by number and weight during all 22 years of sampling. Annual impingement estimates have ranged from 59,000 fish in 1981 to 2,989,000 fish in 1989 (Figure 19). The projected weight of fish impinged since 1973 has ranged from 1200 kg in 1981 to 153,700 kg in 1989 (Figure 20). Past studies indicate that the majority of fish impinged are young-of-year or Age 1 fish which are either dead or moribund before they reach the intake forebay (LMS 1985; Lewis and Bodensteiner 1985).

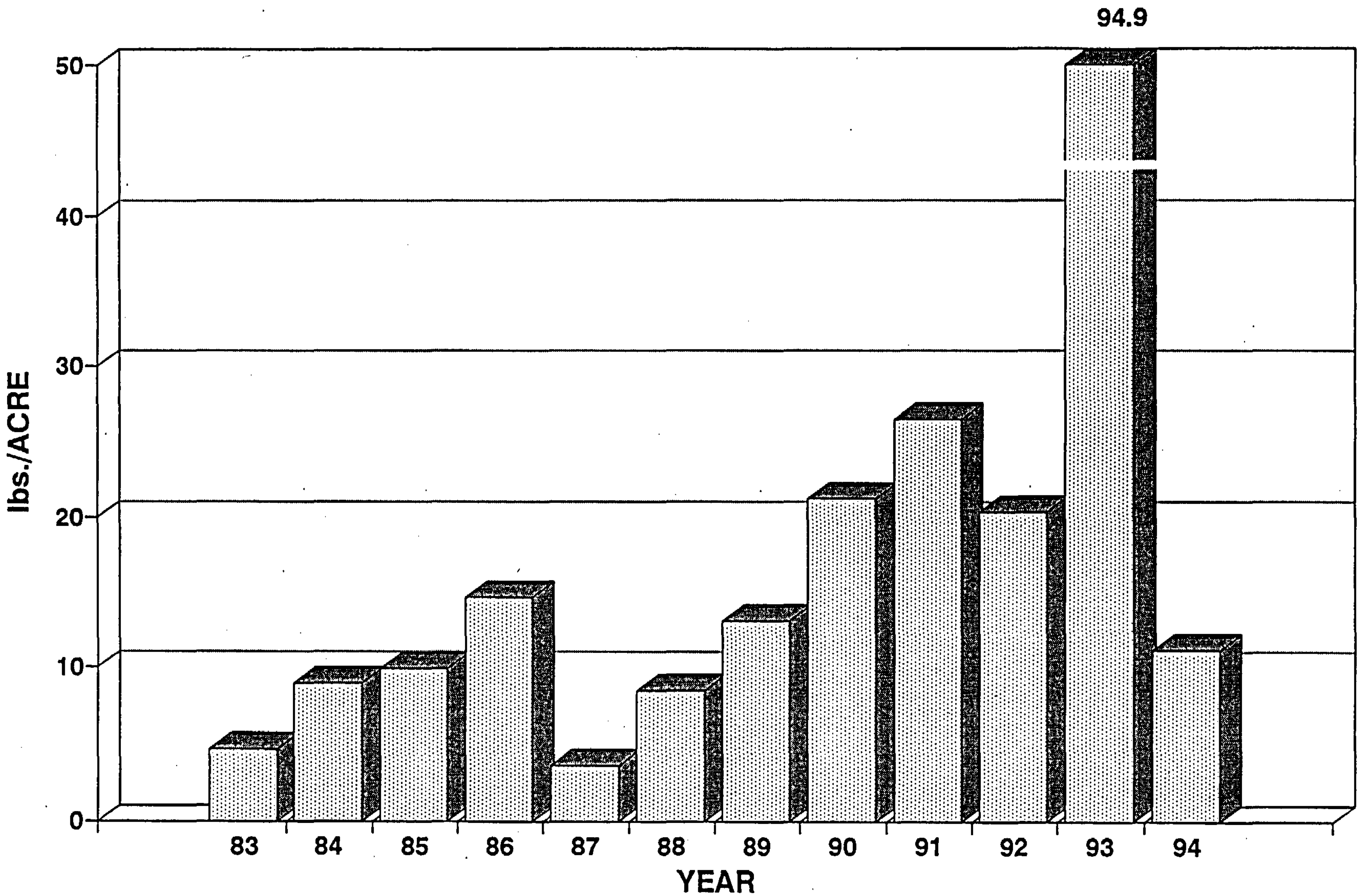


Figure 17. Channel catfish (≥280 mm TL) standing crop estimates by year for Areas A-T in Pool 14 of the Upper Mississippi River near Quad Cities Station, 1983-1994.

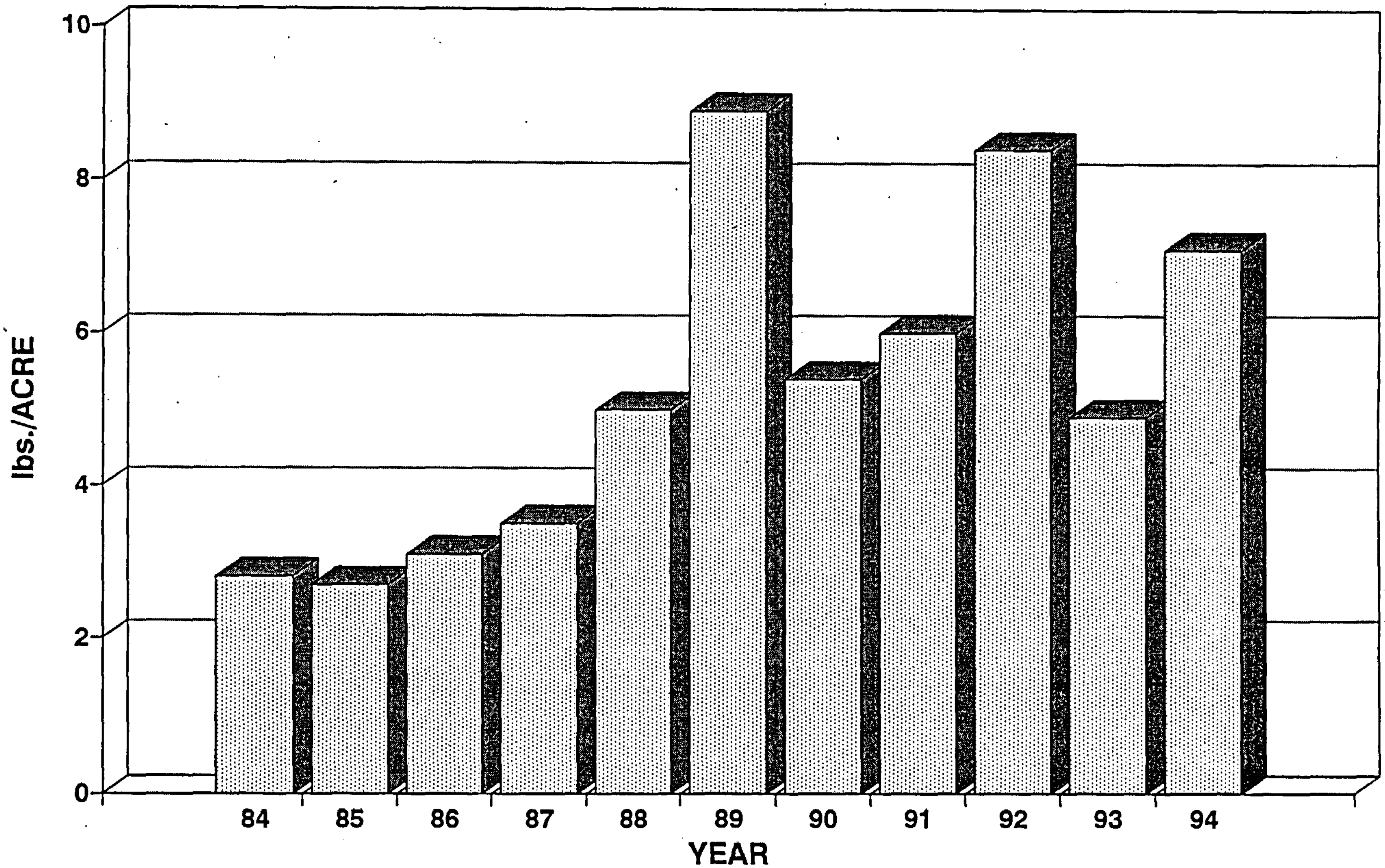


Figure 18. Flathead catfish (≥280 mm TL) standing crop estimates by year for Areas A-T in Pool 14 of the Upper Mississippi River near Quad Cities Station, 1984-1994.

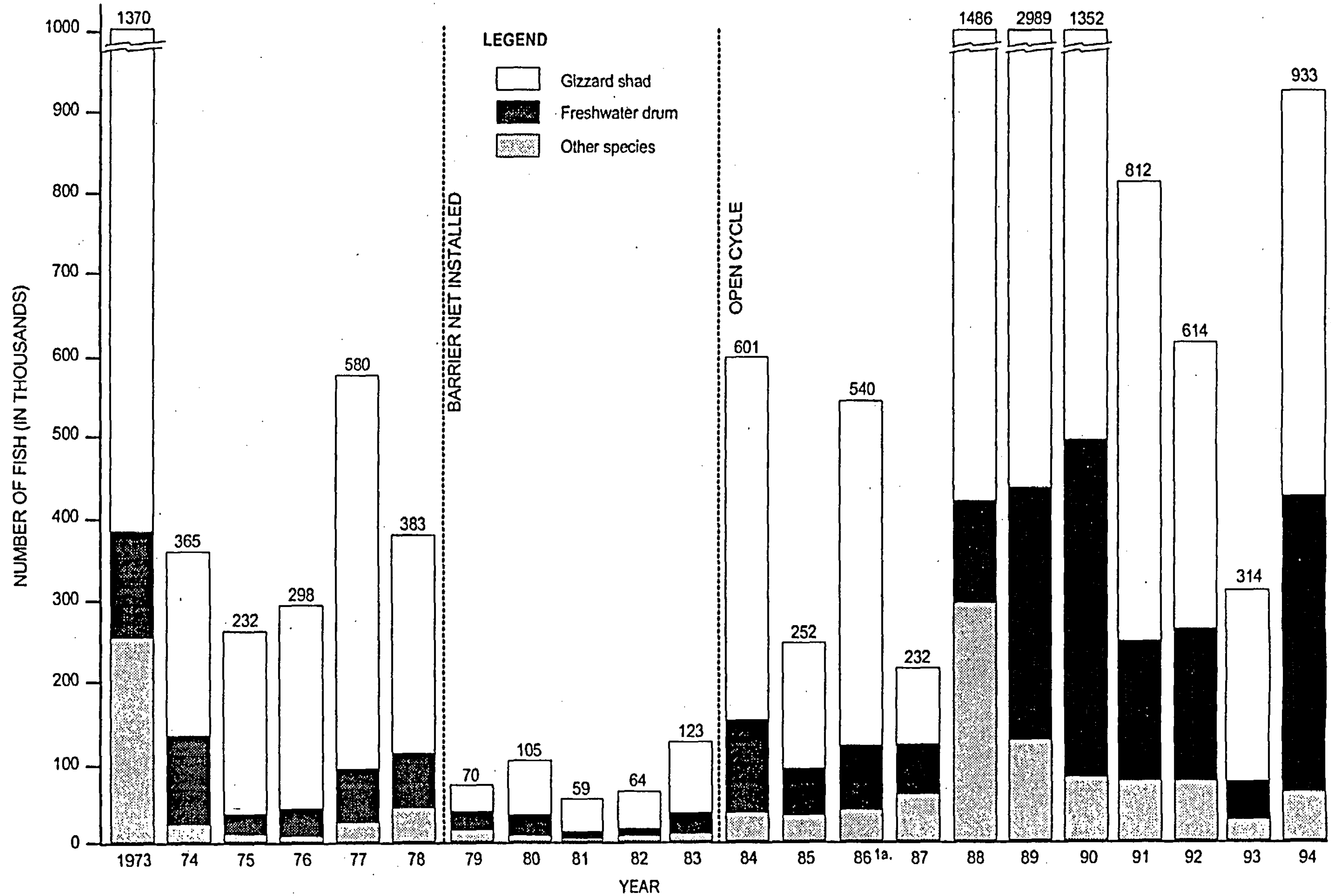


Figure 19. Estimated number of fish impinged at Quad Cities Station from 1973 through 1994.
1a. Impingement samples were not collected 1 July through 31 August.

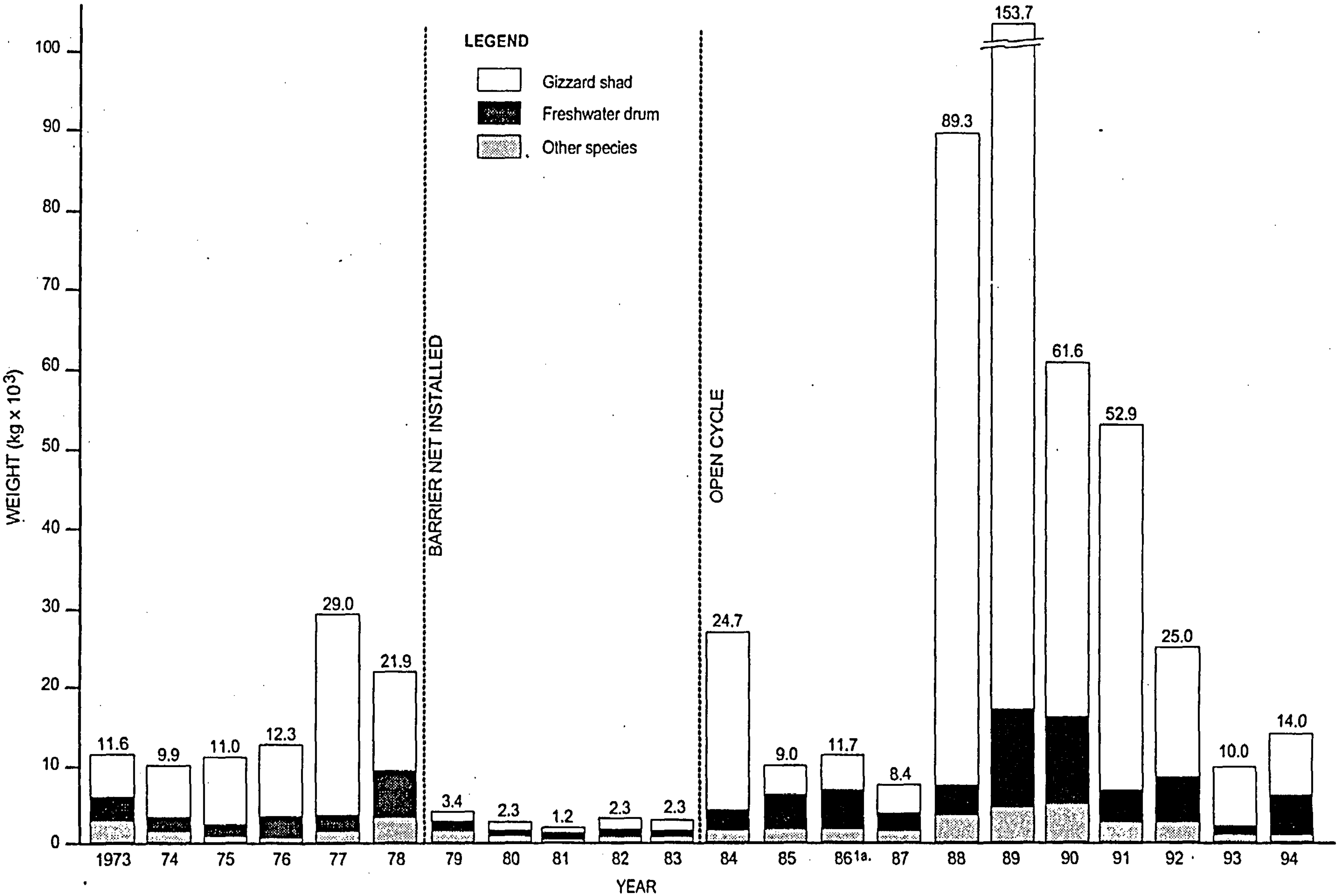


Figure 20. Estimated weight of fish impinged at Quad Cities Station from 1973 through 1994.
1a. Impingement samples were not collected 1 July through 31 August.

Quad Cities Station has operated in the open-cycle mode since 1984. Impingement collections during this period of time have been dominated by gizzard shad, which comprised 66.5% of the total catch by number and 72.9% by weight (Figure 21). Freshwater drum have comprised 20.9% of all fish impinged, followed by bluegill (4.9%), white bass (1.9%), channel catfish (1.7%) and all other species (4.1%). Freshwater drum have also constituted 17.8% of total impingement by weight, followed by bluegill (1.6%), white bass (1.2%), channel catfish (1.1%) and other species (5.5%). These five species account for the majority of fish impinged each year, although ranking among bluegill, white bass and channel catfish varies from year to year. Six species (chestnut lamprey, skipjack herring, grass pickerel, pallid shiner, weed shiner and longnose sucker) that are currently listed as threatened or endangered by Iowa and Illinois agencies (Table 2), have been collected by impingement. In addition, several other unusual species (lake trout, mosquitofish, trout-perch, central stoneroller, rainbow darter, blue sucker, American eel, silvery minnow, black buffalo and warmouth) have been captured by this method.

In most years, impingement increases in fall and remains high throughout the winter and spring regardless of Station operational mode (i.e., open-cycle or partial open-cycle). The greatest number of fish are typically impinged during the winter months with fewer fish being impinged during the May through August period (Figure 22). Impingement of gizzard shad usually peaks in January or February and coincides with freezing or near-freezing water temperatures. Freshwater drum impingement generally peaks in March or April, while impingement of bluegill, white bass and channel catfish peak in April, July, and August or September, respectively. Peak impingement of all other taxa combined occurs during early spring (April). Young fish, particularly gizzard shad and freshwater drum, cannot tolerate the near-freezing water temperatures that occur in the main channel and side channels during the winter months. Consequently, if they do not find refuge in the backwaters where water temperatures under the ice can be several degrees centigrade warmer than the

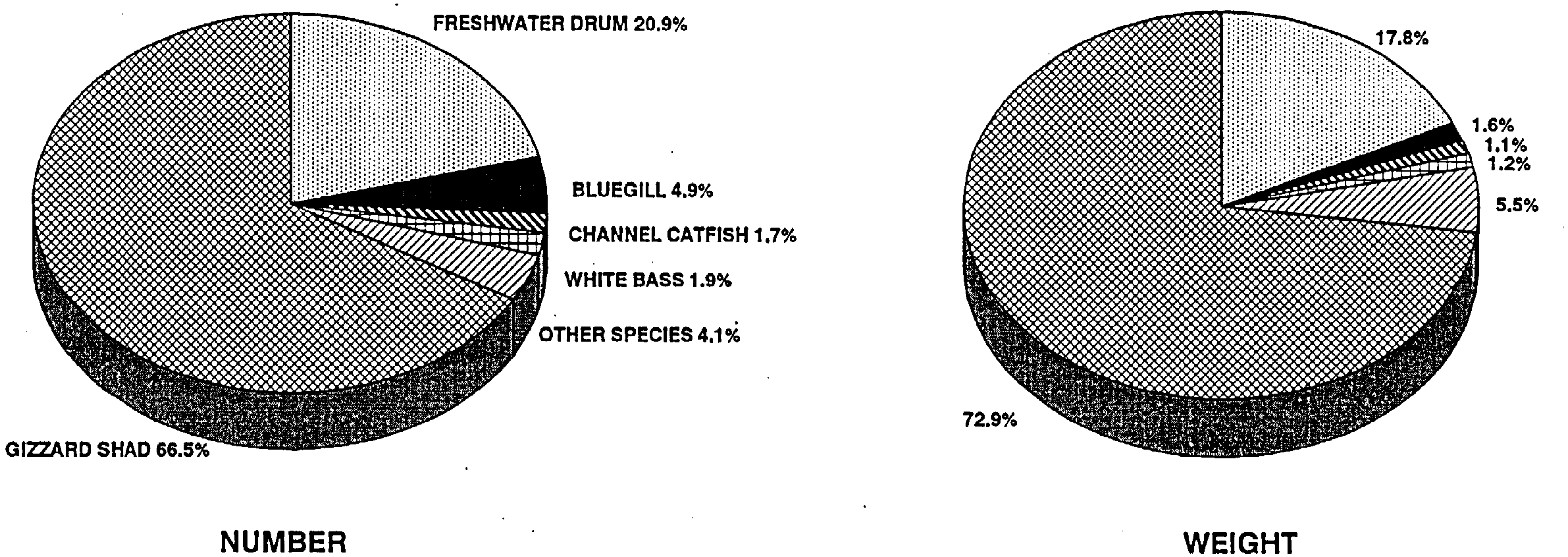
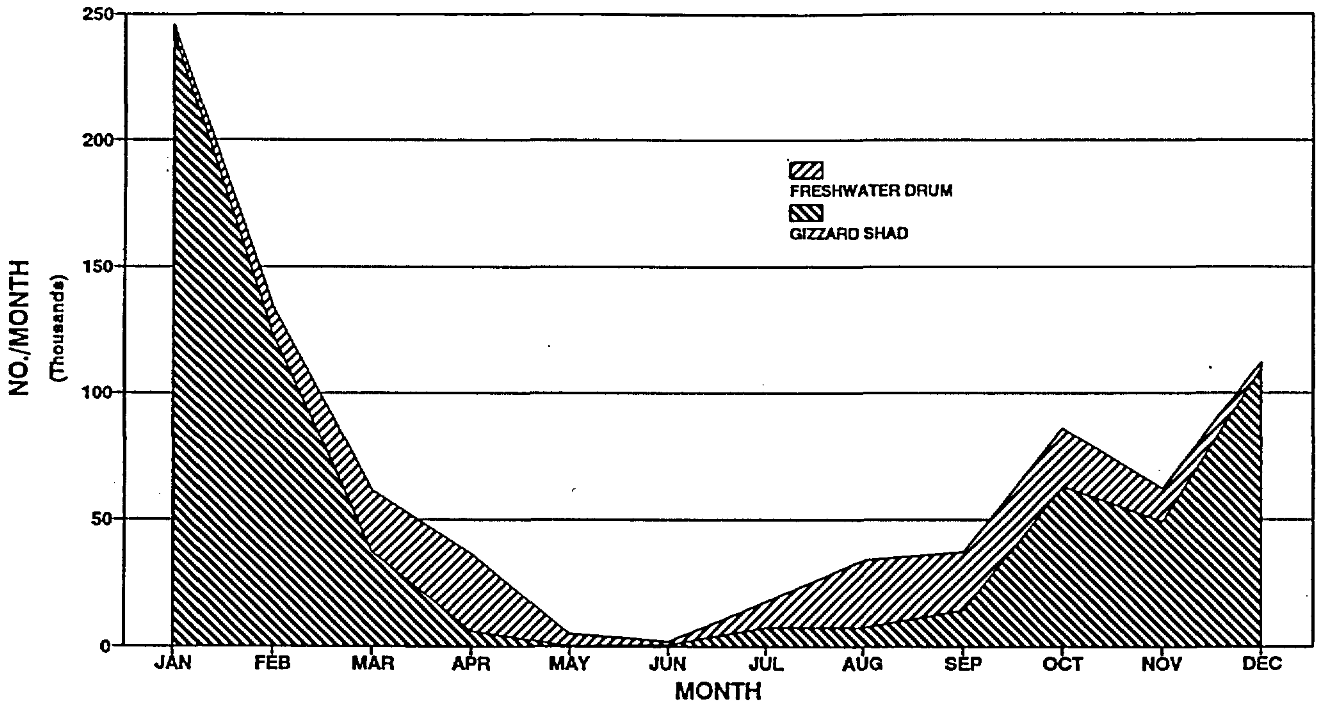


Figure 21. Mean annual impingement composition at Quad Cities Station during open-cycle operation, 1984-1994.



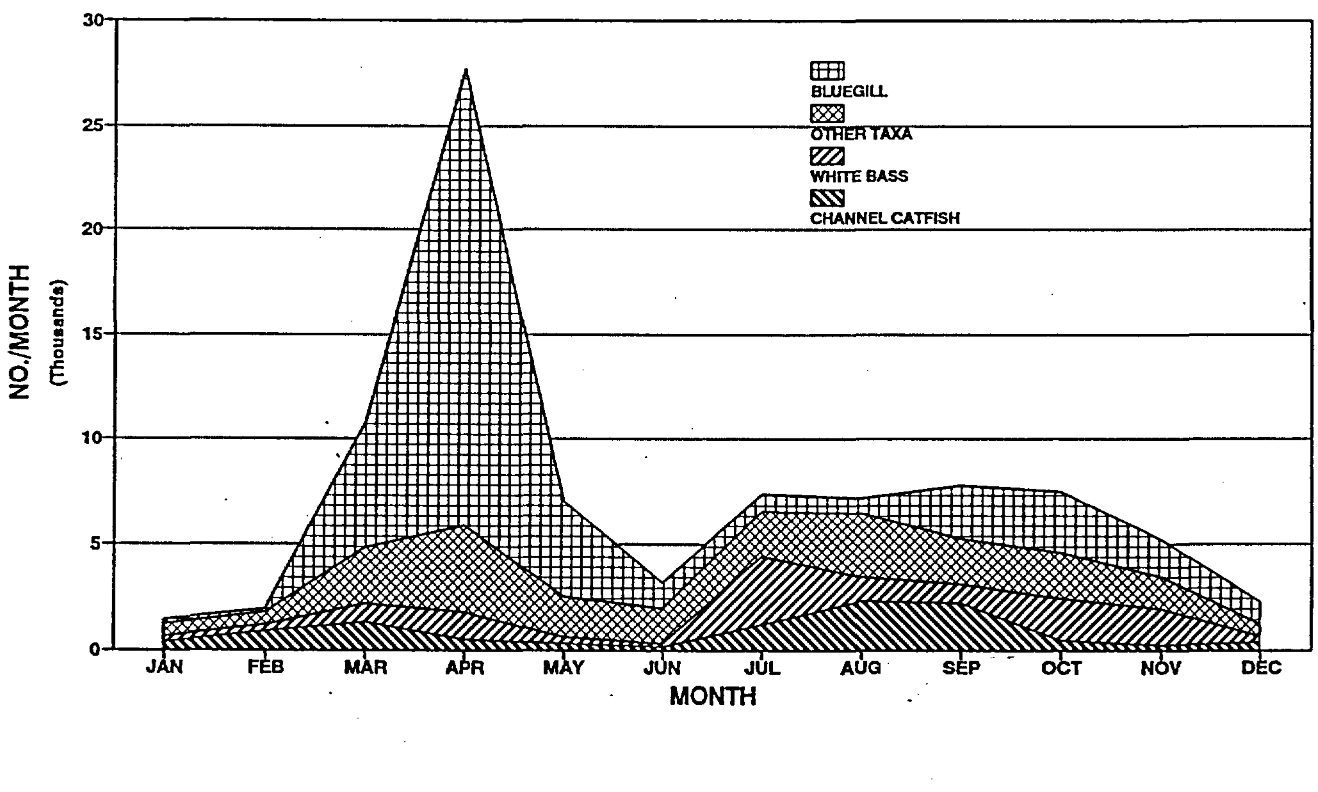


Figure 22. Mean monthly impingement estimates of dominant fish species at Quad Cities Station under open-cycle operation, 1984-1994.

main channel or side channel habitats, they drift helplessly with the currents until they expire and become vulnerable to Station intake currents.

Since the return to open-cycle operation in 1984, annual impingement projections have been extremely variable. In any year, the number of fish impinged is influenced by several factors, including the standing crops of individual species, the physical condition of the fish at the onset of winter, the severity and duration of winter weather (winter-kill), environmental disturbances such as droughts or floods, and the number of Station circulating water pumps withdrawing water from the river. For example, impingement collections were greatly affected by a record fall flood during October 1986. During that event large numbers of young-of-year carp and largemouth bass were impinged. Impingement monitoring has provided very useful information about the status of fish species inhabiting Pool 14, particularly relative to their reproductive success. When strong year classes of juvenile fish are present in the pool, they are also abundant in impingement collections. Conversely, fewer juvenile fish are collected in impingement samples when their abundance in the pool declines.

Impingement monitoring is one of the most sensitive sampling programs to changes in the biological community. Increases and decreases in the numbers of fish collected from the traveling screens often reflect actual increases and decreases in population densities. A major advantage associated with impingement monitoring is the frequency and duration of sample collection. Two 24-hour samples have been collected weekly since 1973. This schedule permits impingement samples to be sensitive to the events of an entire year rather than seasonal sampling that is characteristic of the other sampling elements in this program. Consequently, impingement monitoring has collected more fish and provided greater species diversity than any other sampling method used. Two disadvantages associated with impingement sampling are: 1) the majority of individuals captured are small fish (young-of-year or yearling) that are either moribund or dead at the time of collection (Lewis and Bodensteiner 1985, LMS 1985); and 2) Station operation may influence sample collections by the number of circulating water pumps that are in use. However, Station operation is relatively constant as compared to the high variability in environmental parameters discussed earlier. Impingement monitoring has been an important component of the long-term monitoring program.

Summary

Twenty-four years of fisheries monitoring in Pool 14 of the Upper Mississippi River have provided a number of substantive observations regarding individual species and the overall fishery. The purpose for these investigations has been to determine whether operation of Quad Cities Station has had a measurable cumulative impact on fish populations in the pool. In reviewing this long-term data base, it becomes evermore apparent that the Upper Mississippi River is an extremely dynamic ecosystem, influenced by many natural variables which affect the entire ecosystem, including the fishery. These variables can operate independently or in consort with one another. Similar environmental conditions seldom, if ever, occur during consecutive years. To assign one particular factor (e.g., operation of a power plant) as being the principle cause for an observed or measured change in the fishery is virtually impossible. In estimating the number of fish lost to the river system by impingement on the Station's intake screens, the direct impact is confounded by the observation that the majority of these fish are either dead or moribund prior to their arrival on the screens. Consequently, these studies have not identified any measurable impact of Station operation on the fishery of Pool 14 that is clearly verifiable. They have, however, led to the conclusion that the river system can be highly variable and subject to relatively rapid change.

With respect to the overall fishery, there have been wide fluctuations in abundance during these studies; but community composition has remained relatively stable. The fish community is heavily dominated by gizzard shad and freshwater drum, with emerald shiner, river shiner, bullhead minnow, carp and bluegill also being abundant. Other common species include mooneye, silver chub, golden shiner, spottail shiner, spotfin shiner, river carpsucker, smallmouth buffalo, shorthead and golden redhorse, channel catfish, flathead catfish, white bass, largemouth bass, black crappie, sauger and walleye. Walleye abundance has increased measurably in recent years as a result of stocking fingerling fish reared in the inactive cooling canal. Paddlefish have become increasingly uncommon while modest numbers of lake sturgeon have been collected in recent years.

Ten cove rotenone surveys conducted over the years yielded mean standing crop estimates of 380 lb/A. This mean value is slightly higher than a "pooled river" average of 320 lb/A previously reported by Pitlo (1987), but agrees reasonably well with Jenkin's regression analysis of 356 lb/A (Nalco Environmental Sciences 1977). Grouping of species into categories or guilds (Pitlo 1987) found only minor differences between Pool 14 and the "pooled river". These values should be viewed cautiously because they tend to fluctuate temporally. As backwater areas become shallow and deteriorate due to siltation, their carrying capacity diminishes. Consequently, deeper suitable backwaters may continue to support high standing crops of fish; but the areal extent of high quality backwater habitat within a pool may decline to such an extent that pool-wide populations of lacustrine species (largemouth bass, bluegill and crappie) may suffer substantial losses (UMRCC 1993).

The various sampling techniques employed in the long-term monitoring effort have not detected any measurable changes in the Pool 14 fishery that are attributable to Station operation; but several program elements have been sufficiently sensitive to document changes for several species following major hydrologic events. Electrofishing catches, mark/recapture population studies, and impingement monitoring have helped to detect increased recruitment and abundance of largemouth bass, bluegill, gizzard shad and freshwater drum during the severe drought conditions of 1987-1989. Effects of prolonged drought on the freshwater drum population were also manifested through a dramatic decline in body condition and increased mortality, presumably brought about by an expanding population that was confronted with declining habitat availability and food supply. Similarly, these same program elements also detected very poor recruitment of numerous species during the prolonged record flood of 1993. With few exceptions, e.g. northern pike and channel catfish, the reproductive success of many fish species was poor in Pool 14 during that major flood period. Impingement collections were also greatly affected by a record fall flood during October, 1986. During that event, large numbers of young-of-year carp and largemouth bass were impinged. Neither species has ever comprised more than a small fraction of impingement collections throughout the entire 24-year monitoring program, except during this period.

Certain collection methods employed in this monitoring program have been much more informative than others. Impingement monitoring has certainly been one of the most informative and sensitive of all data gathering techniques. Because Quad Cities Station operates as a "base load" facility, there is only minor variation in cooling water usage between years. Consequently, wide annual fluctuations in the numbers of fish impinged are indicative of actual changes in fish abundance in the pool, as well as a measure of climatic and hydrologic effects on fish survival. The majority of the rare, unusual and errant species collected during these studies have been documented through impingement monitoring.

Electrofishing has been a very effective field collection technique, providing valuable data on a wide array of species taken from a variety of riverine habitats. Electrofishing results have been essential in describing recent increases in bluegill and largemouth bass abundances and in observing declines in white crappie and sauger numbers. These observations do not necessarily reflect "pool-wide" changes, but instead reflect habitat alteration within the "fixed point" sampling locations.

Hoop net sampling efforts utilized in the spring tagging program have provided most of the data that are used to assess the life history parameters and population dynamics of freshwater drum. These data are also used to estimate the numerical populations of channel and flathead catfish within the pool. Pool 14 supports a large population of freshwater drum characterized by extremely variable population estimates, high standing crop estimates, high annual survival, and moderate growth. This species is lightly exploited in the pool by sport and commercial fishermen. Catfish population and standing crops have increased during the past five years, presumably in response to more restrictive commercial harvest length regulations implemented in 1985.

Haul seine collections have provided useful information on the fall standing crop of individuals that are vulnerable to this gear, particularly gizzard shad, freshwater drum and smallmouth buffalo, which typically dominate the catch in terms of biomass. These data have been extremely useful as a predictor of relative abundance entering the winter, high-impingement period for Quad Cities Station.

Data developed through bottom trawl sampling have been of limited usefulness in addressing program objectives. Although bottom trawling is one of only a few methods available to sample fish populations in the main channel, this technique is too species and size selective to provide a qualitative characterization of that habitat.

Data derived from those hoop nets that are randomly selected daily to provide information on all species are also of limited use because hoop nets tend to select for riverine species. In addition, the study design was not sufficient to adequately address the influences of temperature, river discharge, depth, and time on catch rates, because the nets were moved in response to changing river conditions. The effects of moving the nets cannot be separated from those of physical parameters.

In summary, the fish population of Pool 14 of the Upper Mississippi River is extremely dynamic and resilient. Individual species and the overall fishery have exhibited both long-term and short-term fluctuations in response to a wide range of environmental influences. This long-term data base affords the opportunity to observe multiple occurrences of short-term cycles overcoming the disadvantage of short-term investigations, i.e., the investigator cannot fully perceive at which point the cycle was entered. Merriman and Thorpe (1976) cautioned "Because of the complexity of the interrelationships between the various elements in a natural aquatic ecosystem, it is next to impossible to provide a masterwork of the whole. These are problems of such complexity that their detailed solution is next to impossible with reference to the siting and operation of power plants".

From a historical perspective, this effort represents little more than a still photograph of the complexities of the fish population in Pool 14. Yet, in comparison to most conventional investigations of three years or less, this monitoring record is both extensive and comprehensive. Resource managers and regulators who must base decisions and actions on brief glimpses into aquatic ecosystems are urged to exercise a reasonable degree of caution when long-term information is lacking. The long-term fisheries monitoring program in Pool 14 of the Upper Mississippi River has provided valuable information over its 24-year history; its continuation should be encouraged to maintain the integrity of this valuable and unique data base.

References Cited

Chapman, D.G. 1952. Inverse, multiple, and sequential sample censuses. Biometrics 8:286-306.

Christenson, L.M. and L.L. Smith. 1965. Characteristics of fish populations in Upper Mississippi River backwater areas. Circular 212, U.S. Department of the Interior, Washington, D.C., 53 pp..

Environmental Research & Technology (ERT). 1982. Quad Cities aquatic program, 1981 annual report. Volumes I and II. Prepared for Commonwealth Edison Company. Chicago, IL.

Hazelton Environmental Sciences, Inc. 1978. Environmental monitoring in the Mississippi River near Quad Cities Station, January 1971 through November 1978. Prepared for Commonwealth Edison Company. Chicago, IL.

Illinois Endangered Species Protection Board. 1990. Checklist of endangered and threatened animals and plants of Illinois. Illinois Department of Conservation, Springfield, IL. 26 p.

Interagency Floodplain Management Review Committee. 1994. Sharing the challenge: Floodplain management into the 21st century. Report to the Administration Floodplain Management Task Force. Washington, D.C.

Iowa Department of Natural Resources (IDNR). 1985. Article 290-19.1 (109A). Division of Fish and Game; Endangered or threatened plants and animals. Chapter 19. pp. 1-2.

Jenkins, R.M. 1976. Prediction of fish production in Oklahoma reservoirs on the basis of environmental variables. Oklahoma Academy of Science, No. 5, pp. 11-20.

LaJeone, L.J., T.W. Bowzer and D.L. Bergerhouse. 1992. Supplemental stocking of fingerling walleyes in the Upper Mississippi River. North American Journal of Fisheries Management 12:307-312.

Lawler, Matusky & Skelly Engineers (LMS). 1985. Quad Cities aquatic program, 1984 annual report. Prepared for Commonwealth Edison Company, Chicago, IL.

Lawler, Matusky & Skelly Engineers (LMS). 1992. Quad Cities aquatic program, 1991 annual report. Prepared for Commonwealth Edison Company, Chicago, IL.

Lawler, Matusky & Skelly Engineers (LMS). 1994. Quad Cities aquatic program, 1993 annual report. Prepared for Commonwealth Edison Company, Chicago, IL.

Lawler, Matusky & Skelly Engineers (LMS). 1995. Quad Cities aquatic program, 1994 annual report. Prepared for Commonwealth Edison Company, Chicago, IL.

References Cited
(Continued)

Lewis, W.M. and L. Bodensteiner. 1985. State of health of freshwater drum (*Aplodinotus grunniens* Rafinesque) through the winter in Pool 14 of the Mississippi River. Interim report to Commonwealth Edison Company, Chicago, IL; by the Cooperative Fisheries Laboratory, Southern Illinois University, Carbondale IL.

McHenry, J.R. 1981. Recent sedimentation rates in two backwater channel lakes, Pool 14, Mississippi River. Report to Southern Illinois University;, Carbondale and Commonwealth Edison Co., Chicago by the U.S. Dept. of Agriculture, Durant, Oklahoma. 32 pp-memo.

Merriman, D. and L.M. Thorpe. eds. 1976. The Connecticut River Ecological Study - The impact of a nuclear power plant. Monograph No. 1. American Fisheries Society, Washington, D.C. 252 pp.

Nalco Environmental Sciences. 1977. Operational environmental monitoring in the Mississippi River near Quad Cities Station, February 1976 through January 1977. Annual report to Commonwealth Edison Company, Chicago, IL.

Ohio Environmental Protection Agency. 1989. Addendum to biological criteria for the protection of aquatic life: Vol. II. Users manual for biological field assessment of Ohio surface waters. Division of Water Quality Monitoring and Assessment., Surface Water Section. Columbus, Ohio.

Pitlo, J. 1987. Standing stock of fishes in the Upper Mississippi River. Fish Technical Section of the Upper Mississippi River Conservation Committee. Rock Island, IL., 51 pp.

Pitlo, J., A. VanVooren and J. Rasmussen. 1995. Distribution and relative abundance of Upper Mississippi River fishes. UMRCC Fish Tech. Sec. Rep., 20 pp.

Rasmussen, J.L. (ed.). 1979. A compendium of fishery information on the Upper Mississippi River. Upper Mississippi River Conservation Committee, Rock Island, IL. 259 p. plus appendices.

Schnabel, Z.E. 1938. The estimation of the total fish population of a lake. Am. Math. Mon. 45:348-352.

Upper Mississippi River Conservation Committee (UMRCC). 1947. Proceedings of the 3rd annual meeting. St. Paul, MN, pp 24-27.

Upper Mississippi River Conservation Committee (UMRCC). 1993. Facing the threat: An ecosystem management strategy for the Upper Mississippi River. Rock Island, Illinois 17 pp.