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Fish Sampling Data from Navigation Pool 8 of the Upper Mississippi River, 1991–1997

April 2000

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Fish Sampling Data from Navigation Pool 8 of the Upper Mississippi River, 1991–1997

by

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Preface

This report is a product of the Long Term Resource Monitoring Program (LTRMP) for the Upper Mississippi River System (UMRS). The LTRMP was authorized under the Water Resources Development Act of 1986 (Public Law 99-662) as an element of the U.S. Army Corps of Engineers' Environmental Management Program. The LTRMP is being implemented by the Upper Midwest Environmental Sciences Center, a U.S. Geological Survey science center, in cooperation with the five UMRS States of Illinois, Iowa, Minnesota, Missouri, and Wisconsin. The U.S. Army Corps of Engineers provides guidance and has overall Program responsibility. The mode of operation and respective roles of the agencies are outlined in a 1988 Memorandum of Agreement.

The UMRS encompasses the commercially navigable reaches of the Upper Mississippi River, as well as the Illinois River and navigable portions of the Kaskaskia, Black, St. Croix, and Minnesota Rivers. Congress has declared the UMRS to be both a nationally significant ecosystem and a nationally significant commercial navigation system. The mission of the LTRMP is to provide decision makers with information for maintaining the UMRS as a sustainable large river ecosystem given its multiple-use character. The long-term goals of the Program are to understand the system, determine resource trends and effects, develop management alternatives, manage information, and develop useful products.

Data (factual record) and information (usable interpretation of data) are the primary products of the LTRMP. Data on water quality, vegetation, aquatic macroinvertebrates, and fish are collected using a network of six field stations on the Upper Mississippi and Illinois Rivers. Analysis, interpretation, and the reporting of information are conducted at the six field stations and at the Upper Midwest Environmental Sciences Center, the operational center of the LTRMP. Informational products of the LTRMP include professional presentations, reports, and publications in the open and peer-reviewed scientific literature.

This document is intended to serve as a synthesis of fisheries data supplemental to that contractually reported annually by the Onalaska Field Station of the Wisconsin Department of Natural Resources to the U.S. Geological Survey and the Long Term Resource Monitoring Program. The report relates to Tasks 2.2.8.4, *Summarize and Evaluate Results of Annual Monitoring*; 2.2.8.5, *Evaluate and Refine Experimental Design*; and 2.2.8.6, *Summarize and Evaluate 5-Year Trends* of the Operating Plan for the Long Term Resource Monitoring Program (U.S. Fish and Wildlife Service 1993). It does not in itself fulfill any of these tasks, but is valuable in contributing toward all three.

Fish Sampling Data from Navigation Pool 8 of the Upper Mississippi River, 1991–1997

by

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Abstract. Personnel of the Long Term Resource Monitoring Program for the Upper Mississippi River System have collected fish information in Navigation Pool 8 since 1989. In this report, I summarize data collected during the period 1991–97, in which gear deployment methods and sampling periods remained stable but fixed-site sampling changed to predominantly stratified random sampling in 1993. Sampling collections totaled 3,596 and yielded 324,948 fish of 91 species. Sampling effort increased over time, mainly when the change to random sampling occurred. Annual catches and species totals increased when random sampling was implemented; catches increased even with stable sampling effort in recent years. Of 12 gear types used, day and night electrofishing, seining, and mini-fyke netting were used the most often, produced the greatest catch totals, and also yielded the highest species totals each year. Bluegill (*Lepomis macrochirus*), spotfin shiner (*Cyprinella spiloptera*), and emerald shiner (*Notropis atherinoides*) were the most abundant species and also occurred in the greatest percentage of collections, indicating widespread abundance. Sixteen species yielded more than 5,000 individuals each. Family Cyprinidae was represented by 21 species and 141,497 fish, Centrarchidae by 9 species and 71,375 fish, and Catostomidae by 14 species and 26,776 fish. Twenty-one of 91 total species were rarely caught. Skipjack herring (*Alosa chrysochloris*), previously described as extirpated, was documented in the 1993 flood year. American brook lamprey (*Lampetra appendix*) and rainbow smelt (*Osmerus mordax*) were recorded for the first time in the Upper Mississippi River in 1993. Fantail darter (*Etheostoma flabellare*) and banded darter (*Etheostoma zonale*) were documented for the first time in Pool 8 in 1997. Population trends for 15 species of perceived interest to river managers and the public indicated mainly stable populations.

Key words: Fish community, fish monitoring, fishes, Long Term Resource Monitoring Program, Pool 8, Upper Mississippi River

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Introduction

I summarize here 7 years of fish data collected in Navigation Pool 8 (Pool 8) of the Upper Mississippi River (UMR) for the Long Term Resource Monitoring Program (LTRMP). The LTRMP is part of the federally funded UMR Environmental Management Program, established by Congress in 1986. The fisheries component of LTRMP was initiated in 1989, and the Wisconsin Department of Natural Resources has been monitoring fishes in Pool 8 according to LTRMP protocols since that time.

The goal of the LTRMP fisheries component is to provide information on UMR fishes to river managers and other decision makers that will aid them in understanding and managing this diverse and important resource. Two main focal areas are fish community trends and population trends for species of interest. Fish community information includes relative abundance of fishes, species richness, rare and endangered species, exotic species, and fish distribution among aquatic area types. Population data include catch-per-unit-effort (C/f), length distribution, and spatial data. Additional studies are undertaken to examine age and growth, feeding habits, range expansion, disturbance responses, and address a variety of other questions. The present report contains only data from routine monitoring activities.

The primary products of the LTRMP fish component are data and hard-copy reports. Raw data files and annual summary reports have been produced for each year from 1991 to 1997 (Gutreuter et al. 1997a–e; Burkhardt et al. 1997, 1998). The LTRMP has also produced several other fisheries reports (Gutreuter 1992, 1997), which summarize data from multiple years or from all reaches but were limited in analytical detail because of their broad scope. This report encompasses the years 1991–97 and focuses on Pool 8, which allows for greater analytical detail than systemic reports. I emphasize visual interpretation of the data, with the intent of identifying topics for further investigation. This is a first step toward long-term trend analysis of Pool 8 fisheries data and eventual integration of these data with other resource components of the LTRMP.

Methods

Study Area

Pool 8 is located near La Crosse, Wisconsin (Figure 1). It is impounded by Lock and Dam 8 at Genoa, Wisconsin, and is bounded on the upstream end by Lock and Dam 7, near Dresbach, Minnesota. The pool extends 37.8 km (24 miles) and contains 8,094 ha (20,300 acres) of surface water. The upper half of the pool retains much of its preimpoundment character, having many large side channels, sloughs, and backwater lakes. The lower half of Pool 8 has been flooded by water held behind Lock and Dam 8, and surface features are less evident. Some historical channels remain, but depth diversity is low, and essentially all areas contain flowing current. Two large habitat rehabilitation and enhancement projects in the upper impounded area have recently restored some of the islands lost to wind and flow erosion over the past 50 years. The Root River (Minnesota) and the La Crosse River and Coon Creek (Wisconsin) are major tributaries in this reach. The Black River (Wisconsin) now enters the Mississippi River in Pool 7, after construction of the lock and dam system, but still greatly influences water quality in Pool 8, especially during runoff. The cities of La Crescent, Minnesota, and La Crosse and Stoddard, Wisconsin, are situated in and near the floodplain, and are potential sources of human effects on the river's water quality and habitat. Much of the nonurbanized floodplain remains undeveloped and is contained in the Upper Mississippi River National Wildlife and Fish Refuge.

Fish Sampling

From Program inception, the LTRMP fisheries component has emphasized standardized sampling protocols, which include the use of standardized gear types and deployments. Lack of standardization was identified as a deficiency in previous projects that precluded systemic or temporal analysis of changes to UMR fish populations. Despite necessary improvements in sampling design, the LTRMP has striven for standardization over time.

The LTRMP fish sampling design has undergone two major changes since the component was initiated in 1989. During the first 2 years, separate sampling efforts for fish community and population analyses were conducted at two different times—in summer to evaluate the overall fish community and in fall to evaluate populations of selected fish species. Beginning in 1991, population sampling methods were incorporated into an expanded community design. Additionally, side channel, wing dam, and tailwater aquatic areas were added to the community sampling design. This change resulted in larger sample sizes and new areas being sampled for fish community data, with no loss of population data for species of interest. However, the change from two to three community sampling periods complicated comparisons from before and after the change.

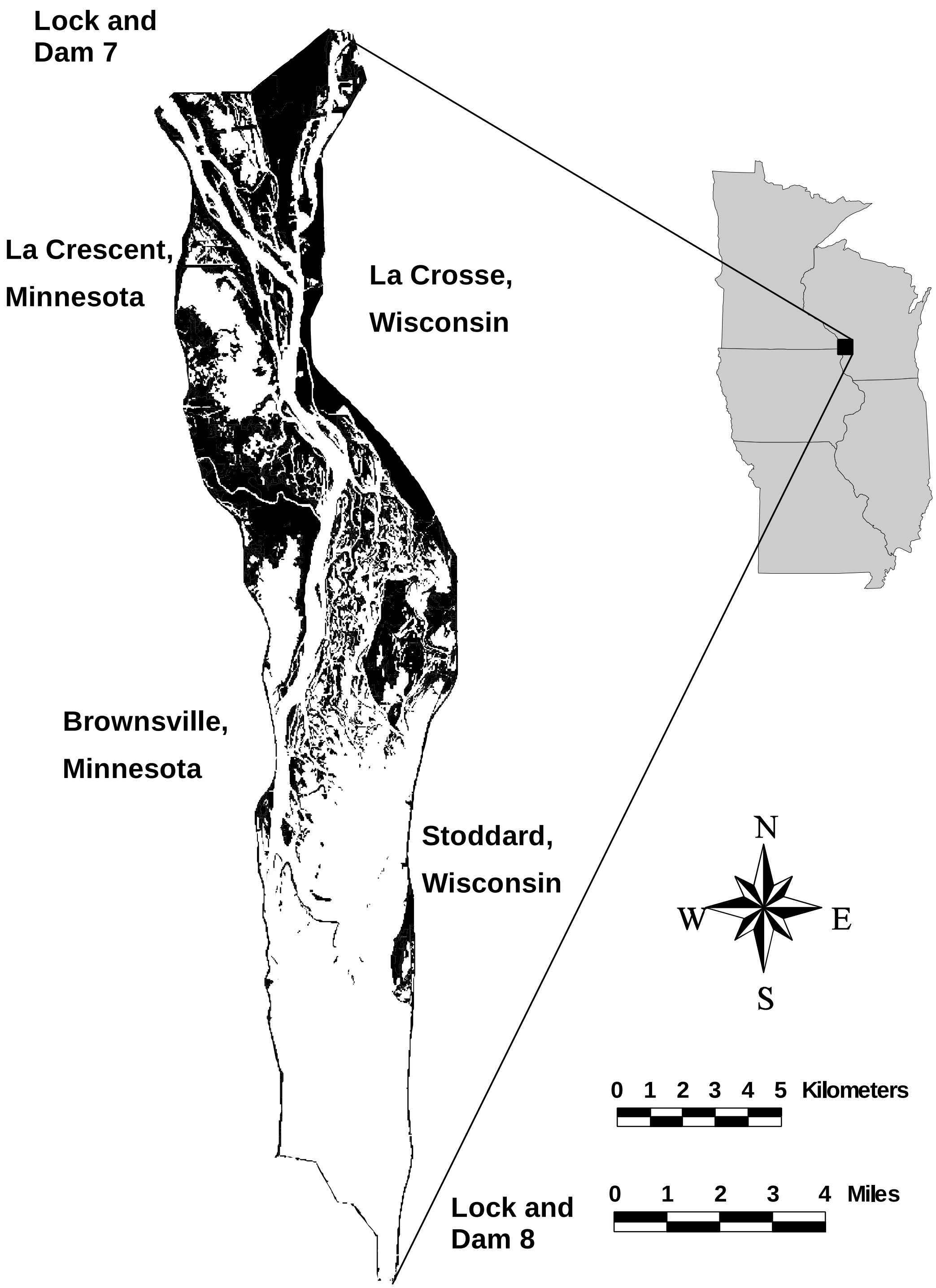

Figure 1. Navigation Pool 8, Upper Mississippi River, near La Crosse, Wisconsin.

From 1989 through 1992, all sampling was conducted at fixed sites (Figure 2). Since 1993, as a result of an internal statistical review of the sampling design (Gutreuter 1993), most routine monitoring has been conducted at randomly selected sites within a stratified framework. The stratification scheme is based on aquatic area types defined by Wilcox (1993), which are delineated by enduring geomorphologic features of the floodplain. The stratified random sampling (SRS) design allows data from a limited number of sites to be applied to the entire pool for analyses. These sampling design changes have improved the scientific validity of the data but have confounded interpretation of the data from before the change. Data collected prior to 1993 are representative of fixed sampling sites only and do not represent entire strata or the entire pool. Inferences drawn from pre-SRS data relate only to actual sites sampled.

For the present report, data from 1991 to 1997 were included, encompassing the change to SRS, but maintaining the same sampling periods each year. The LTRMP fish sampling periods were June 15–July 31, August 1–September 15, and September 16–October 31. A complete deployment of all sampling gear and sampling stratum combinations was performed during each period. The sampling periods were intended to (1) ensure that sampling with a particular gear or in a particular location was not concentrated during a short time, and (2) account for effects of water-level fluctuations on catch because of changes in gear efficiency.

The target level of analytical resolution for the LTRMP fisheries component is annual and poolwide, and the sampling design was intended to yield enough collections to make valid estimates at this level. Analyses may be performed at the aquatic area stratum or sampling period level, but sample sizes at these levels of resolution may have low statistical validity. Focused research projects on a small scale are another method for examining fisheries questions at a finer level of resolution and may be undertaken when routine monitoring does not provide adequate numbers of collections to address a particular question. This report contains both poolwide and stratum-level analyses at the annual level of temporal resolution, because the intent herein is to provide an initial summary that will identify hypotheses for further study.

Fixed sampling sites from 1991 to 1992 consisted of (1) an upper pool and a lower pool site in each of the following sampling strata: main channel border unstructured (MCBU), side channel border (SCB), backwater contiguous shoreline (BWCS), and backwater contiguous offshore (BWCO); (2) six main channel border wing dam (MCBW) sites; (3) one impounded shoreline (IMPS) and one impounded offshore (IMPO) site; and (4) two fixed tailwater zone (TWZ) sites. A complement of three to five gear types was fished in duplicate at each site and in each sampling period. Annual collection totals by gear type and sampling stratum are presented in Table 1.

Since 1993, a complement of three to five gear types has again been fished within each stratum, but at independently selected sites for each gear type. At least three gear types are required in each stratum, with a minimum of four collections for each of those gears, but additional optional gears or collections are allowed at the discretion of the field station specialists. Although no attempt is made to replicate collections at a given site, a minimum of two and usually four or more collections per gear type are made in each stratum each sampling period. Two fixed BWCS sites were retained for potential comparisons with pre-SRS data from those same sites, and the TWZ stratum has been sampled at fixed sites because its small size precluded effective randomization of sites.

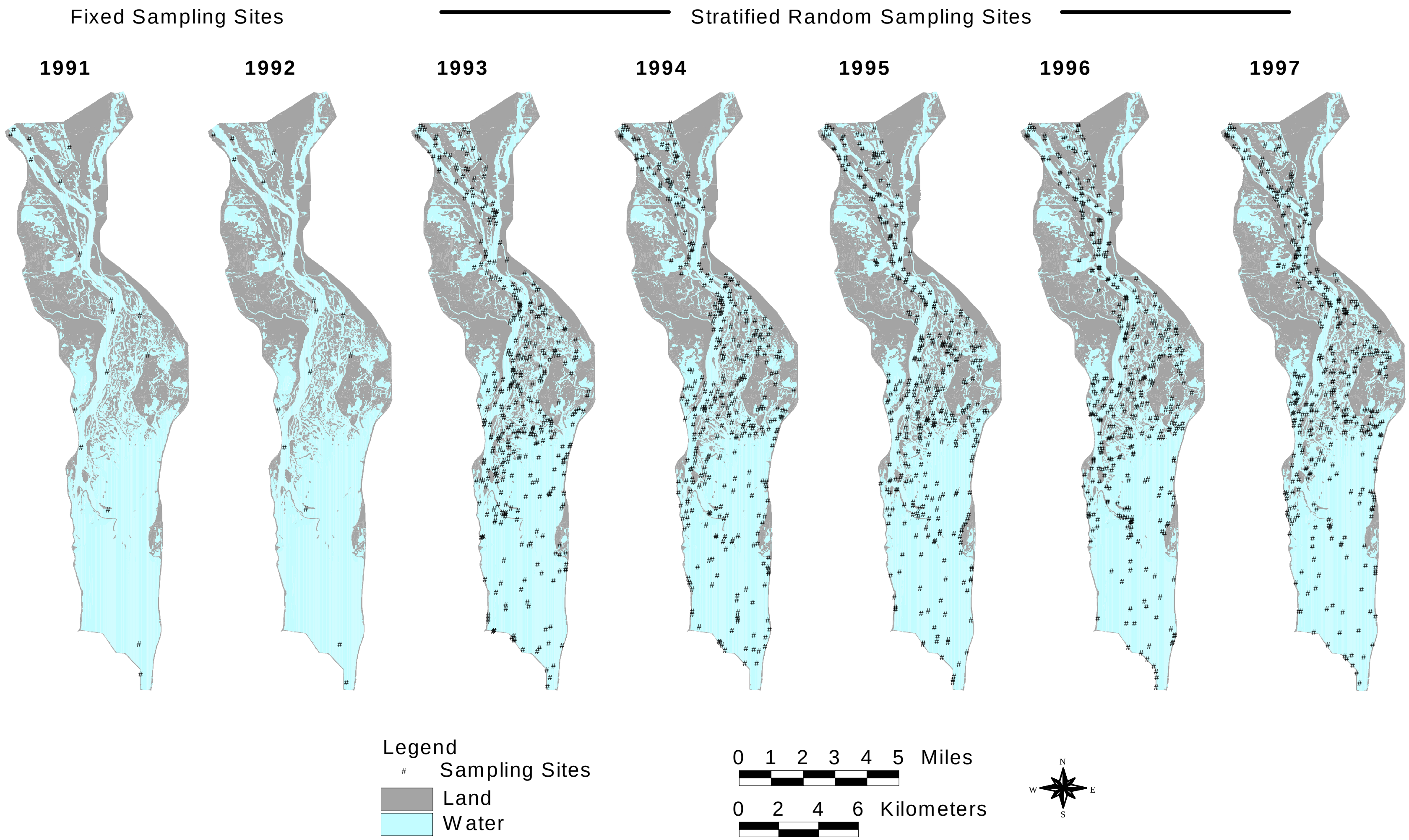

Figure 2. Fish sampling site locations in Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

Table 1. Number of fish collections made annually, by gear type and sampling stratum, in Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

Fish sampling	1991	1992	1993	1994	1995	1996	1997	Overall
Gear								
Day electrofishing	68	66	86	93	96	96	102	607
Night electrofishing	60	60	54	54	54	54	54	390
Fyke netting	54	36	52	60	60	60	60	382
Tandem fyke netting	6	6	12	12	12	18	18	84
Mini-fyke netting	42	42	84	79	84	84	84	499
Tandem mini-fyke netting	6	6	12	12	12	18	18	84
Tandem hoop netting	46	48	0	0	0	0	0	94
Small hoop netting	0	0	66	66	66	66	66	330
Large hoop netting	0	0	66	66	66	66	66	330
Seining	36	60	116	118	72	72	72	546
Trawling	72	72	12	12	12	12	12	204
Gill netting	0	0	20	14	7	0	0	41
Total collections	390	396	580	586	541	546	552	3,591
Stratum								
Backwater, contiguous offshore	0	0	36	36	36	48	48	204
Backwater, contiguous shoreline	84	84	142	147	139	138	138	872
Impounded, offshore	18	18	48	50	43	36	36	249
Impounded, shoreline	18	18	36	36	36	36	36	216
Main channel border, unstructured	72	84	102	107	84	84	90	623
Main channel border, wing dam	88	72	60	60	60	60	60	460
Main channel trough	36	36	0	0	0	0	0	72
Side channel border	36	48	102	100	89	90	90	555
Tailwater zone	38	36	54	50	54	54	54	340
Total collections	390	396	580	586	541	546	552	3,591

The LTRMP standardized fishing gear array includes electrofishing (both day and night), fyke nets (large and mini, single shoreline or tandem offshore), hoop nets (small and large, paired, set separately), bag seines, and otter trawls. Gill and trammel netting were conducted experimentally over three seasons but were discontinued in Pool 8 after analysis revealed low catch rates, high mortality of captured fish, and little or no additional information beyond the standard gears. A description of each gear, how it is deployed, and specifications are given in the *LTRMP Procedures Manual* (Gutreuter et al. 1995). All gears are routinely inspected for standardized construction, and at least one member of each field crew is certified in LTRMP deployment methods. The only change in gear deployment during the reporting period was that paired hoop nets were tied together in a linear set before 1993 and recorded as a single collection, and since then they have been fished side by side, not tied together. The data from the small and large hoop nets are now recorded as separate collections.

Data Analyses

Water Levels

Annual hydrographs for Pool 8 were constructed from data provided by the U.S. Army Corps of Engineers. The data are from the Lock and Dam 7 tailwater station and include daily values for both the postimpoundment means and individual years 1991–97. The LTRMP fish sampling periods were superimposed on the hydrographs to illustrate possible effects of water levels on catch rates and sampling effectiveness.

Fish Community Analyses

Total catch of fish by sampling stratum and gear type and total catch of fish annually by species were simple tabulations. Common and scientific names follow Robins et al. (1991). Mean species per collection, with standard errors, were calculated for the number of species encountered in individual collections, by gear type. The means were unweighted for sampling effort and must be interpreted cautiously. Annual changes in sampling intensity for individual gears, within strata or overall, may suggest the false appearance of a change in mean number of species per collection. Species were ranked for abundance and frequency of occurrence (percentage of collections they occurred in, regardless of number), for all years combined. Individual yearly ranks were also included in the summary tables. Total species by gear type and stratum were also simple tabulations. Finally, the total and individual yearly catches of fishes on Wisconsin's threatened and endangered species list were calculated.

Species of Interest Analyses

Fish population information was assembled for 15 species of interest to river managers and the public. These include gizzard shad (*Dorosoma cepedianum*), common carp (*Cyprinus carpio*), smallmouth buffalo (*Ictiobus bubalus*), channel catfish (*Ictalurus punctatus*), flathead catfish (*Pylodictis olivaris*), northern pike (*Esox lucius*), white bass (*Morone chrysops*), bluegill (*Lepomis macrochirus*), smallmouth bass (*Micropterus dolomieu*), largemouth bass (*M. salmoides*), black crappie (*Pomoxis nigromaculatus*), yellow perch (*Perca flavescens*), sauger (*Stizostedion canadense*), walleye (*Stizostedion vitreum*), and freshwater drum (*Aplodinotus grunniens*). The analyses for these species consisted of total catches by gear and stratum, C/f (poolwide mean and standard error) for three gear types, length distribution graphs (subgrouped by sampling gear and stratum), and maps depicting the total catch of each species by sampling location within the pool. The C/f values were calculated by using the same formulae used in the LTRMP annual summary reports (e.g., Burkhardt et al. 1997), weighted by the amount of each sampling stratum available. The C/f data exclude the two fixed backwater sites retained since 1993 and the fixed sites in the tailwater zone stratum.

Results

Water Levels

Annual hydrographs for the tailwater station at Lock and Dam 7, constructed from daily water elevation measurements, are presented in Figure 3. The historical (postimpoundment) daily mean hydrograph indicates that the spring flood pulse for Pool 8 usually occurs in mid-April. Typically, this spring pulse is followed by a gradual decrease in water elevation through May and June. A slight rise in early July is then followed by a decrease to essentially flat-pool conditions from August until the following spring pulse.

The most notable departures from historical water levels during the reported time occurred in 1993 and 1997. The 1993 hydrograph was unique because (1) the highest water that year occurred in July, during the peak of the growing season, and (2) water levels remained above the historical mean for about 6 months. Although the 1997 spring peak ranked among the five highest ever recorded for the area, this peak coincided with the typical timing of the spring snowmelt flood, and, by the start of the sampling season, water levels had returned to near normal.

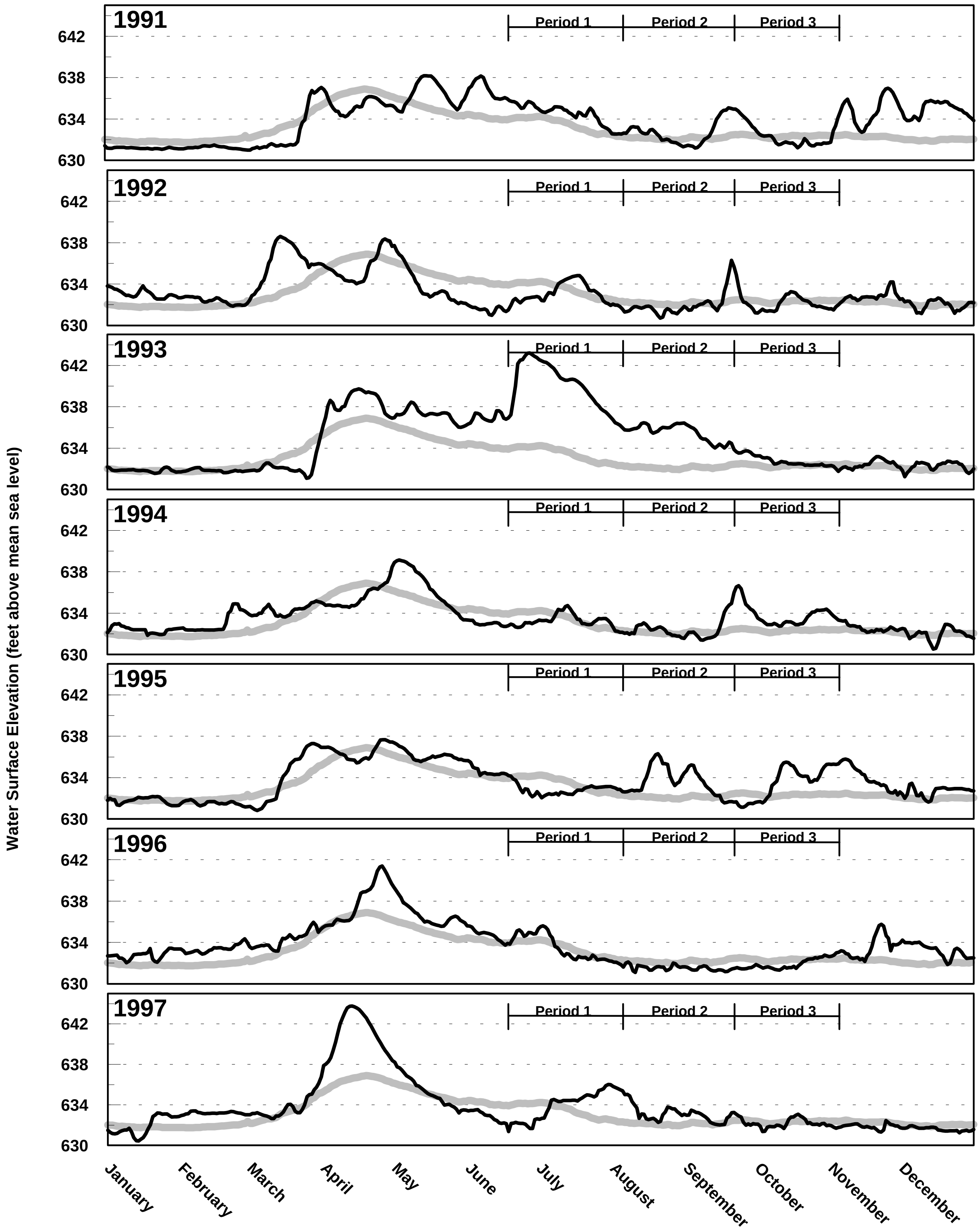

Figure 3. Daily water surface elevations (*black lines*) at Lock and Dam 7 for Pool 8, Upper Mississippi River, 1991–1997, and mean daily elevation (*gray lines*) since 1940. *Data source: U.S. Army Corps of Engineers*.

The earliest spring peak occurred in March 1992; the latest spring peaks occurred in May 1991 and 1994. Fall rises occurred in 1991, 1992, 1994, and 1995, though the long-term hydrograph did not indicate fall rises occurred frequently. Although no extreme low water periods occurred during the report period, the drought of 1988 and 1989 resulted in some of the lowest water elevations recorded in Pool 8 since its impoundment. These extended periods of low water levels presumably could have had major effects on the fish community for several years.

During the routine LTRMP fish sampling period from June 15 through October 31, extreme high-water conditions occurred only in 1993. Although departures of as high as 1.3 m (4 feet) from normal water levels were not uncommon during other years and may have affected catches somewhat over the short term, these event-related changes probably did not result in overall annual reductions to catch or sampling efficiency.

Sampling Effort

Overall sampling effort (numbers of collections) increased substantially when SRS was implemented, but has remained quite stable during the time of SRS data collection (Table 1). The total number of collections each year has varied from 541 to 586 during the time of SRS data collection. The apparent reduction in effort after the first 2 years of SRS is actually due to a change in the way seine and trawl data were recorded. Until 1994, each seine or trawl haul was recorded as a separate collection but, after that time, multiple hauls made at a single collection site were recorded under a single collection. This change was made simply to increase efficiency of field data recording and did not affect the actual level of sampling effort. Individual hauls were identified by a user-defined field on the data sheets and were separated out for C/f analyses. Thus, C/f values are comparable among years.

The number of collections made with individual gear types (Table 1) changed substantially when SRS was implemented and slightly since then. Day electrofishing, mini-fyke netting, and seining accounted for the greatest increase in sampling effort through time. These increases were intended to reduce variance in catch rates and to increase the ability to detect uncommon species. Trawling effort was dramatically reduced to include only the TWZ stratum (four fixed stations) because of the lack of effectiveness of this gear for LTRMP samples in the main channel trough (CTR). Tandem hoop nets were replaced in 1993 by paired, separate, small and large hoop nets after a comparison study suggested side-by-side nets caught more fish than a linear pair of nets. Night electrofishing, fyke netting, and hoop netting had the most consistent effort over time. Day electrofishing (607 collections), seining (546), and mini-fyke netting (499) had the greatest number of collections.

Several changes occurred in the number of collections made per sampling stratum (Table 1) from 1991 through 1997, but the changes were fewer than the gear type changes. The most obvious changes were the addition of the BWCO stratum and the deletion of the CTR stratum, both in 1993. Since little useful data were being generated, CTR otter trawl sampling was dropped to improve Program efficiency. The BWCO stratum was added because the fish component collectively recognized that individual, large backwaters were underrepresented in the overall design when only shoreline areas were sampled. Large, open backwaters have much less shoreline per area than smaller backwaters and thus received proportionately lower sampling effort. However, the offshore areas within a large backwater may be as productive as the near-shore zone. Creating a separate backwater offshore stratum ensured that these large, expansive backwater areas would be sampled. Additional tandem fyke and tandem mini-fyke net sets increased the number of samples in the BWCO stratum in 1996 for Pool 8. This change was again intended to better represent the large, open backwaters. Increased sampling with fyke nets, mini-fyke nets, and day electrofishing accounted for the large increase in the number of BWCS samples in 1991–97,with the latter two accounting for the increase in SCB collections. After the change in the way hauls were recorded has been accounted for, the number of seine collections per stratum has remained stable since the inception of SRS. When considering all gear types, the BWCS (872 collections), MCBU (623), and SCB (555) strata received the greatest amount of sampling effort.

Fish Community

Total Catch

The total catch of fish from 1991 through 1997 was 324,948 (Table 2). In general, catches increased throughout this period; the lowest catch (23,832 fish) occurred in 1991 and the highest catch (67,481 fish) in 1997. The 1993 flood year was an exception to this trend (28,407 fish were caught); reductions in catch probably resulted from a combination of reduced gear efficiency during high flows, and scattered fish concentrations resulted from the availability of large amounts of flooded terrestrial habitat. The number of fish collected annually, divided by the number of collections annually, indicates that the catch of fish per collection doubled through the period (61.1 in 1991 compared to 122.2 in 1997). This is a crude calculation, heavily influenced by the number of collections made per gear type and sampling stratum, but it suggests that there may have been more fish in Pool 8 in 1997 than there were in 1991.

Table 2. Total catch of fish collected annually, by gear type and stratum, in Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

Fish sampling	1991	1992	1993	1994	1995	1996	1997	Overall
Gear								
Day electrofishing	4,867	5,094	6,199	9,570	8,496	14,762	13,525	62,513
Night electrofishing	8,139	12,558	4,308	12,707	10,088	13,849	14,980	76,629
Fyke netting	3,178	6,314	3,147	4,621	4,150	4,567	4,686	30,663
Tandem fyke netting	67	136	654	973	1,190	2,611	1,909	7,540
Mini-fyke netting	2,861	4,816	3,964	5,495	13,673	10,488	13,495	54,792
Tandem mini-fyke netting	71	199	70	927	1,164	966	2,501	5,898
Tandem hoop netting	1,537	909	0	0	0	0	0	2,446
Small hoop netting	0	0	263	845	660	603	387	2,758
Large hoop netting	0	0	351	656	679	856	1,158	3,700
Seining	2,874	14,895	9,360	10,701	8,084	14,775	14,783	75,472
Trawling	238	1,672	58	163	108	91	57	2,387
Gill netting	0	0	33	59	58	0	0	150
Annual total catch[a]	23,832	46,593	28,407	46,717	48,350	63,568	67,481	324,948
Stratum								
Backwater, contiguous offshore	0	0	767	1,603	2,375	3,400	4,314	12,459
Backwater, contiguous shoreline	11,037	17,402	10,747	14,842	18,030	23,955	22,728	118,741
Impounded, offshore	249	380	234	768	607	466	528	3,232
Impounded, shoreline	431	402	1,588	4,231	3,142	1,962	2,184	13,940
Main channel border, unstructured	2,821	3,755	4,713	7,116	6,628	9,553	12,592	47,178
Main channel border, wing dam	3,082	4,319	875	2,061	1,921	2,150	3,794	18,202
Main channel trough	41	890	0	0	0	0	0	931
Side channel border	3,741	13,480	6,632	8,244	9,419	14,235	12,715	68,466
Tailwater zone	2,430	5,965	2,851	7,852	6,228	7,847	8,626	41,799
Annual total catch[a]	23,832	46,593	28,407	46,717	48,350	63,568	67,481	324,948

[a]These totals do not include larval fish identified only to genus or family.

The greatest number of fish (Table 2) were collected by night electrofishing (76,629), seining (75,472), and day electrofishing (62,513). These three gears, plus mini-fyke netting (54,792) and fyke netting (30,663), accounted for more than 92% of the total catch of fish during the period. Most gears showed a steady increase in total catch through time, although 1992 yielded large numbers of fish for night electrofishing, fyke netting, and seining. The 1993 flood had the greatest catch reduction for night electrofishing, although several other gears also showed reductions.

The BWCS stratum yielded the most fish (118,741) from 1991 through 1997, which was nearly double that of the SCB stratum (68,466 fish), the next most productive stratum (Table 2). Although BWCS sites also provided the greatest number of fish per collection (136), again, by dividing the total catch by number of collections per stratum, the SCB and TWZ strata collections were also high at 123 and 122, respectively. As with catches by gear type, most strata showed a general increase in total catch through time. Catch increased substantially in the BWCO stratum with the addition of more sites in 1996.

Total Catch by Species

The three most abundant fishes (Table 3) in the total catch from 1991 through 1997 were bluegill (42,281), spotfin shiner (*Cyprinella spiloptera*, 40,259), and emerald shiner (*Notropis atherinoides*, 36,683). Sixteen species provided more than 5,000 individuals each, nine of those yielding more than 10,000 fish. Family Cyprinidae, represented by 21 species, provided the largest number of fish (141,497), followed by Centrarchidae (9 species and 71,375 fish), and Catostomidae (14 species and 26,776 fish). Catches of several fishes have generally increased from 1991 through 1997, including those of shortnose gar (*Lepisosteus platostomus*), spotfin shiner, channel shiner (*Notropis wickliffi*), pugnose minnow (*Opsopoeodus emiliae*), bullhead minnow (*Pimephales vigilax*), orangespotted sunfish (*Lepomis humilis*), bluegill, and smallmouth bass. Conversely, catches of several other fishes have decreased: shovelnose sturgeon (*Scaphirhynchus platorynchus*), mooneye (*Hiodon tergisus*), Mississippi silvery minnow (*Hybognathus nuchalis*), pallid shiner (*Notropis amnis*), and silver chub (*Macrhybopsis storeriana*). An apparent decline in mimic shiners (*Notropis volucellus*) is an artifact of taxonomical problems within this species group. Those fish referred to as mimic or channel shiners in this report are probably all the same species, but taxonomy has yet to be resolved. An additional group of fishes exhibits no clear trend in abundance, but instead seems to fluctuate widely in number based on year-class strength. This group includes gizzard shad, quillback carpsucker (*Carpiodes carpio*), white bass, and freshwater drum.

Species Ranks

Table 4 depicts the 10 most abundant species over the 7-year period. Bluegill, most abundant overall, ranked first in 1991 and sixth in 1994. Spotfin shiner, second overall, ranked most abundant in 3 of the 7 years. White bass is the lowest ranked species (fifth most abundant overall) to rank first in a given year, indicating the variability in abundance of this species. Of the 10 most abundant species, four were cyprinids, two centrarchids, and each of the following families had one representative: Clupeidae—gizzard shad, Catostomidae—shorthead redhorse (*Moxostoma macrolepidotum*), Percichthyidae—white bass, and Sciaenidae—freshwater drum.

Table 3. Total catch of all fish species in Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

Fish species	1991	1992	1993	1994	1995	1996	1997	Overall
Chestnut lamprey	9	6	15	8	9	4	15	66
Silver lamprey	8	5	5	12	20	17	13	80
American brook lamprey	0	0	1	1	1	2	0	5
Lake sturgeon	0	0	0	0	1	0	0	1
Shovelnose sturgeon	14	29	16	18	5	1	4	87
Longnose gar	67	61	212	120	110	96	128	794
Shortnose gar	60	59	213	219	222	400	330	1,503
Bowfin	99	99	88	124	160	160	76	806
Goldeye	0	0	0	14	1	0	0	15
Mooneye	83	197	52	157	81	56	49	675
American eel	2	2	0	1	0	1	0	6
Skipjack herring	0	0	1	0	0	0	0	1
Gizzard shad	1,443	4,428	177	5,101	3,460	2,306	2,035	18,950
Central stoneroller	0	1	0	0	0	0	0	1
Common carp	585	765	1,065	2,007	1,053	1,162	1,696	8,333
Brassy minnow	0	0	2	0	0	0	0	2
Mississippi silvery minnow	327	56	450	2	11	0	1	847
Speckled chub	1	3	0	0	0	1	0	5
Silver chub	45	47	8	63	25	10	23	221
Golden shiner	48	39	64	31	81	584	58	905
Pallid shiner	8	1	5	0	0	0	0	14
Emerald shiner	2,056	8,239	3,040	2,284	5,914	6,571	8,579	36,683
River shiner	447	1,275	792	3,131	2,937	2,513	2,887	13,982
Pugnose minnow	168	467	816	444	933	1,738	3,048	7,614
Spottail shiner	248	450	225	328	461	168	497	2,377
Spotfin shiner	1,590	2,299	6,463	4,342	4,327	10,140	11,098	40,259
Sand shiner	0	15	9	11	6	47	7	95
Weed shiner	2	2	147	2	2	7	22	184
Mimic shiner	191	629	59	267	2	0	1	1,149
Channel shiner	0	0	147	855	969	2,446	4,166	8,583
Bluntnose minnow	0	7	2	0	1	4	1	15
Fathead minnow	1	0	106	2	50	19	10	188
Bullhead minnow	1,468	1,405	890	1,175	4,991	6,291	3,817	20,037
Creek chub	2	0	0	0	0	0	1	3
River carpsucker	14	21	16	22	30	27	26	156
Quillback	188	1,634	234	879	942	406	247	4,530
Highfin carpsucker	4	10	2	1	2	7	7	33
White sucker	3	1	6	2	3	23	6	44
Blue sucker	0	33	0	7	4	6	12	62
Northern hog sucker	0	0	1	0	1	1	17	20
Smallmouth buffalo	278	869	134	567	217	329	449	2,843
Bigmouth buffalo	12	11	8	23	15	38	7	114
Black buffalo	0	0	1	0	0	0	0	1
Spotted sucker	178	218	180	158	231	287	227	1,479
Silver redhorse	1,005	906	418	728	619	768	716	5,160
River redhorse	110	176	69	117	88	87	88	735

Table 3. Continued.

Fish species	1991	1992	1993	1994	1995	1996	1997	Overall
Golden redhorse	151	152	191	283	224	392	275	1,668
Shorthead redhorse	990	1,274	902	1,627	1,723	1,903	1,512	9,931
Black bullhead	1	22	1	1	5	2	2	34
Yellow bullhead	22	11	7	12	0	33	8	93
Brown bullhead	1	2	2	2	2	5	3	17
Channel catfish	677	473	328	868	550	791	696	4,383
Stonecat	0	0	0	1	0	2	3	6
Tadpole madtom	5	3	75	23	10	19	21	156
Flathead catfish	46	34	80	71	88	87	97	503
Northern pike	73	79	117	99	129	155	125	777
Central mudminnow	1	0	8	5	1	5	1	21
Rainbow smelt	0	0	1	0	0	0	0	1
Brown trout	0	0	1	1	0	1	1	4
Trout perch	10	8	15	6	2	0	2	43
Pirate perch	0	0	0	1	0	2	0	3
Burbot	0	0	10	36	23	13	5	87
Brook silverside	302	112	137	25	198	403	345	1,522
Brook stickleback	0	2	0	0	0	4	0	6
White bass	1,200	5,764	296	5,873	1,824	3,463	1,535	19,955
Yellow bass	11	2	1	4	2	0	0	20
Rock bass	46	54	230	272	405	419	483	1,909
Green sunfish	33	22	216	24	65	194	141	695
Pumpkinseed	43	22	48	55	57	67	216	508
Warmouth	17	6	10	16	11	14	11	85
Orangespotted sunfish	38	62	45	58	379	747	861	2,190
Bluegill	4,734	5,285	4,245	2,769	5,704	9,645	9,899	42,281
Smallmouth bass	205	356	437	704	873	1,061	925	4,561
Largemouth bass	1,086	487	343	706	2,024	1,351	646	6,643
White crappie	120	160	90	46	56	55	59	586
Black crappie	1,098	1,950	1,940	2,148	1,641	2,767	2,282	13,826
Crystal darter	0	2	2	0	0	1	0	5
Western sand darter	27	114	101	81	79	60	264	726
Mud darter	31	94	66	92	46	34	33	396
Iowa darter	0	0	1	3	0	0	1	5
Fantail darter	0	0	0	0	0	1	1	2
Johnny darter	73	482	309	561	255	287	667	2,634
Banded darter	0	0	0	0	0	0	1	1
Yellow perch	59	359	191	476	267	331	795	2,478
Logperch	232	376	98	600	259	290	894	2,749
Blackside darter	0	0	0	0	0	0	1	1
Slenderhead darter	10	6	18	28	58	28	34	182
River darter	4	84	14	88	10	10	64	274
Sauger	425	1,535	877	1,138	1,004	1,031	1,942	7,952
Walleye	278	750	185	677	509	470	803	3,672
Freshwater drum	1,019	1,984	630	4,014	1,882	702	1,463	11,694
Total catch[a]	23,832	46,593	28,407	46,717	48,350	63,568	67,481	324,948

[a] These totals do not include larval fish identified to only genus or family.

Table 4. Fish species abundance ranks, overall and annually, in Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

Fish species	Total catch	Annual numeric rank 1991	1992	1993	1994	1995	1996	1997
Bluegill	42,281	1	3	2	6	2	2	2
Spotfin shiner	40,259	3	5	1	3	4	1	1
Emerald shiner	36,683	2	1	3	7	1	3	3
Bullhead minnow	20,037	4	10	7	11	3	4	5
White bass	19,955	6	2	18	1	9	5	12
Gizzard shad	18,950	5	4	29	2	5	9	9
River shiner	13,982	14	11	10	5	6	7	7
Black crappie	13,826	7	7	4	8	11	6	8
Freshwater drum	11,694	9	6	11	4	8	19	14
Shorthead redhorse	9,931	11	12	6	10	10	10	13

The same 10 species listed in the overall abundance ranks appeared in the same order for frequency of occurrence (Table 5). Thus, those species that were most abundant in Pool 8 were also widespread and vulnerable to a variety of gear types. Bluegill ranked first, occurring in nearly 41% of all samples. This high ranking was bolstered by high rates of occurrence in 1996 and 1997. Each of the next three species that occurred in a large proportion of collections were minnows, probably occurring in most seine, mini-fyke net, and electrofishing samples.

Table 5. Fish species frequency of occurrence ranks, overall and annually, in Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997. Occurrence frequency was calculated as the percentage of collections where each species was detected.

Fish species	Overall frequency (%)	Annual frequency rank 1991	1992	1993	1994	1995	1996	1997
Bluegill	40.85	4	6	5	10	3	1	1
Spotfin shiner	39.74	5	3	3	6	1	2	7
Emerald shiner	37.9	1	2	8	1	2	10	9
Bullhead minnow	37.09	7	5	4	3	4	6	5
White bass	35.11	2	4	7	9	9	5	8
Gizzard shad	34.25	13	7	2	5	5	3	2
River shiner	33.75	6	12	1	8	8	7	4
Black crappie	32.67	3	1	18	2	6	9	14
Freshwater drum	31.77	9	9	6	7	10	8	6
Shorthead redhorse	28.67	10	10	9	13	11	4	3

Total Species

Through 1997, the species total for LTRMP monitoring in Pool 8 was 91 (Table 3). This total included 87 of the 98 species documented historically in Pool 8 (Pitlo et al. 1995), plus four species that had not previously been identified: American brook lamprey (*Lampetra appendix*), channel shiner, fantail darter (*Etheostoma flabellare*), and banded darter (*E. zonale*). The taxonomy of the channel and mimic shiner group is presently unresolved, and most likely all specimens labeled as either of these species in Pool 8 were the same species. This would reduce the species total to 90 and would also reduce the list of historically documented species to 97.

Paddlefish (*Polyodon spathula*) are known to exist in the Black River (contiguous with the Mississippi River in Pool 8), but have not appeared in LTRMP collections. Ghost shiner (*Notropis buchanani*), common shiner (*Luxilus cornutus*), bigmouth shiner (*Notropis dorsalis*), suckermouth minnow (*Phenacobius mirabilis*), greater redhorse (*Moxostoma valenciennesi*), muskellunge (*Esox masquinongy*), and bluntnose darter (*Etheostoma chlorosomum*) have all been recorded historically in Pool 8, but not in recent years. A bluntnose darter was recently documented from Pine Creek, a tributary to Pool 8 on the Minnesota side of the river (Konrad Schmidt, St. Paul, Minnesota, personal communication). Rainbow trout, brook trout, and hybrid striped bass have also been reported as strays in Pool 8, but have not been recorded during 1991–97 by LTRMP sampling.

The greatest number of species overall (Table 6) was recorded for day electrofishing (76), night electrofishing (75), and seining and mini-fyke netting (68 species each). However, in each year, night electrofishing revealed the most species. Through time, the number of species detected by most gears remained fairly stable, as did the totals for all gears combined. Since 1993, when SRS was initiated, the annual species count was between 72 and 78. Seining and mini-fyke netting, despite their high total species

Table 6. Number of fish species collected annually, by gear type and stratum, in Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

Fish sampling	1991	1992	1993	1994	1995	1996	1997	Overall
Gear								
Day electrofishing	52	55	58	59	57	59	57	76
Night electrofishing	54	56	63	62	61	59	63	75
Fyke netting	41	37	35	35	35	34	36	46
Tandem fyke netting	12	9	30	30	29	34	34	41
Mini-fyke netting	47	43	50	49	47	51	51	68
Tandem mini-fyke netting	7	9	23	28	28	31	40	53
Tandem hoop netting	21	21	0	0	0	0	0	24
Small hoop netting	0	0	17	21	24	18	21	31
Large hoop netting	0	0	23	25	23	19	20	32
Seining	32	45	55	47	41	45	47	68
Trawling	14	24	6	10	8	8	11	27
Gill netting	0	0	12	18	15	0	0	22
Annual species total	68	71	78	75	72	75	76	91
Stratum								
Backwater, contiguous offshore	0	0	43	39	40	45	52	59
Backwater, contiguous shoreline	56	59	60	62	57	59	60	72
Impounded, offshore	20	19	24	29	30	27	25	47
Impounded, shoreline	31	30	48	40	43	44	44	63
Main channel border,	39	46	60	55	57	50	54	75
Main channel border, wing dam	48	41	45	40	41	44	44	66
Main channel trough	7	13	0	0	0	0	0	14
Side channel border	49	51	63	55	56	56	58	72
Tailwater zone	52	51	57	52	53	54	59	76
Annual species total	68	71	78	75	72	75	76	91

count, usually averaged less than 50 species each per year. Conversely, both electrofishing methods averaged about 60 species per year. The number of species per gear type increased annually for both electrofishing methods and both tandem fyke netting methods after SRS was implemented. The increase in 1993 was due to the initiation of tandem fyke and tandem mini-fyke netting in the BWCO stratum, which has high species richness in relation to the IMPO stratum, where these nets were fished exclusively before SRS was implemented.

Although BWCS and SCB strata (72 species each) exhibited high numbers of species (Table 6), the TWZ (76) and MCBU (75) strata produced the greatest overall species richness. However, either BWCS or SCB stratum consistently had the most species each year. This indicates that the TWZ and MCBU strata had higher variability, with a wide variety of species occurring there through time, but fewer in any given sampling episode than the off-channel strata. As with gear types, most sampling strata had stable total species counts from year to year. The number of species per stratum generally increased by about 5–10 when SRS was implemented.

The mean number of species encountered per collection (Figure 4) provides an additional assessment of changes in species richness over time. These data are greatly affected by the number of collections within each stratum and gear type, however, and must be interpreted cautiously. In general, night electrofishing provided the greatest species richness, averaging 13–21 species per collection. Day electrofishing was also effective, averaging 10–15 species per collection. In most instances, with the exception of 1993, the mean number of species per collection increased with the inception of SRS. Ironically, even though low numbers of species were obtained per collection, 1993 produced the highest species total (78) for any given year. The increase in species per collection for day electrofishing may be an artifact of increasing sampling effort. However, increases were also evident for night electrofishing and large hoop netting, for which sampling effort remained stable through time. Apparent increases for both tandem fyke and tandem mini-fyke netting are most likely the result of increased sampling effort in the BWCO stratum. Trawling and small hoop netting exhibited no trend except a low species richness for the entire period.

Rare, Threatened, and Endangered Species

Eight fishes on Wisconsin's list of threatened and endangered species have been found in LTRMP catches from Pool 8 in 1991–97 (Table 7). Most abundant of these species was the river redhorse (*Moxostoma carinatum*), with a total catch of 735 fish. Annual totals for river redhorse ranged from a low of 69 in 1993 to a high of 176 in 1992. Skipjack herring (*Alosa chrysochloris*) and black buffalo (*Ictiobus niger*) occurred only in 1993, whereas all other species on the list occurred in multiple years. With the exception of river redhorse and perhaps blue sucker (*Cycleptus elongatus*), both threatened in Wisconsin, the protected status of all these fishes seems warranted. Though most fishes on the list have been collected in more than 1 year, total catches were extremely low. Pallid shiner has not been identified since 1993 and may have been extirpated from Pool 8 in conjunction with the 1993 flood.

Other fishes have occurred in extremely low numbers throughout the entire period (Table 3). From 1991 through 1997, we collected only five American brook lamprey (*Lampetra appendix*), one lake sturgeon (*Acipenser fulvescens*), six American eel (*Anguilla rostrata*), one central stoneroller (*Campostoma anomalum*), two brassy minnow (*Hybognathus hankinsoni*), three creek chub (*Semotilus atromaculatus*), six stonecat (*Noturus flavus*), one rainbow smelt (*Osmerus mordax*), four brown trout (*Salmo trutta*), three pirate perch (*Aphredoderus sayanus*), six brook stickleback (*Culaea inconstans*), five Iowa darter (*Etheostoma exile*), two fantail darter, one banded darter, and one blackside darter (*Percina maculata*). Many of these species were probably strays from tributary streams, and they probably came from healthy populations

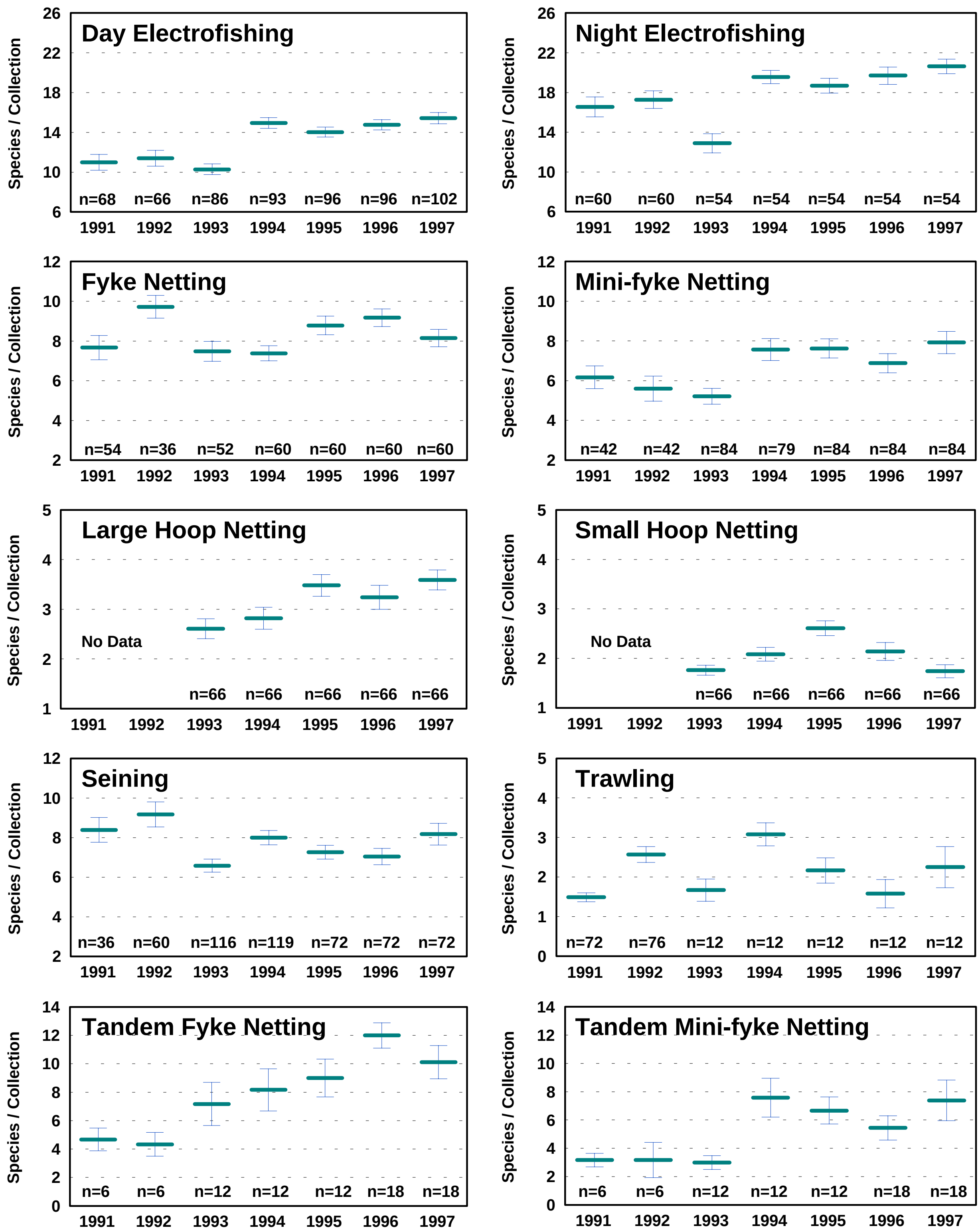

Figure 4. Mean (and standard error) number of fish species per collection for various gear types, in Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997 (note differences in scale).

in their preferred environments. Lake sturgeon, historically regarded as a large river species, is a notable exception. Historical records suggest that a long-term reduction in lake sturgeon numbers has occurred throughout the UMRS (Rasmussen 1979). The American brook lamprey was not previously recorded anywhere in the UMRS before LTRMP, and rainbow smelt had previously been recorded only in the unpooled portion of the Mississippi River below St. Louis (Pitlo et al. 1995). The occurrence of fantail darter and banded darter were the first recordings for those species in Pool 8.

Table 7. Fish species on Wisconsin's threatened or endangered species list collected in Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program,1991–1997.

Fish species	1991	1992	1993	1994	1995	1996	1997	Total catch
Goldeye	0	0	0	14	1	0	0	15
Skipjack herring	0	0	1	0	0	0	0	1
Speckled chub	1	3	0	0	0	1	0	5
Pallid shiner	8	1	5	0	0	0	0	14
Blue sucker	0	33	0	7	4	6	12	62
Black buffalo	0	0	1	0	0	0	0	1
River redhorse	110	176	69	117	88	87	88	735
Crystal darter	0	2	2	0	0	1	0	5

Species of Interest

Gizzard Shad

The LTRMP total catch of gizzard shad in Pool 8 during 1991–97 was 18,950 (Table 8). The annual catch of this species ranged from 177 in 1993 to 5,101 in 1994. Although the 1993 flood seemingly had a negative effect on gizzard shad populations during the flood year, populations were able to recover well in succeeding years, as 1993 was the only year in which less than 1,000 gizzard shad were captured. Total catches remained fairly consistent between 2,000 and 3,000 after 1994. Day (7,242 fish) and night (6,592 fish) electrofishing accounted for 73% of all gizzard shad collected, and seining provided another 2,961 individuals (16% of the total catch).

The BWCS stratum (7,012 fish) produced the most gizzard shad among strata, with much of the remaining catch divided among MCBU, MCBW, SCB, and TWZ sites. Although total catch differed among strata, the differences were somewhat parallel to differences in sampling intensity (Table 1) among strata.

The C/f data for gizzard shad (Figure 5) showed no clear trends in abundance through time. Day electrofishing catch rates have been higher since SRS was initiated, but showed a general decline since 1994. Night electrofishing catch rates declined throughout the period, mostly the result of low catches during 1996 and 1997. Fyke netting generally exhibited a low catch rate for gizzard shad, except for 1995, when one or several large catches contributed to a high mean C/f but also to a large standard error.

From 1991 through 1997, gizzard shad in Pool 8 (Figure 6) commonly ranged from 20 to 140 mm TL (Total Length). Most of these gizzard shad were probably age-0 fish; length modes within the range probably represent large individual catches from different times in the growing season. In 1995, a significant number of gizzard shad longer than 200 mm TL were caught, presumably carryover from the large 1994 year class. The longest gizzard shad recorded was 523 mm TL. Combined electrofishing methods accounted for much of the catch over a broad range of sizes in all years. Fyke nets tended to catch medium-to-large gizzard shad; mini-fyke nets caught nearly 500 small gizzard shad in 1994.

Table 8. Total catch of gizzard shad (*Dorosoma cepedianum*) collected annually, by gear type and stratum, in Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

Fish sampling	1991	1992	1993	1994	1995	1996	1997	Overall
Gear								
Day electrofishing	633	871	75	1,831	1,418	1,737	677	7,242
Night electrofishing	598	2,627	4	1,493	811	295	764	6,592
Fyke netting	116	14	6	103	354	29	45	667
Tandem fyke netting	2	7	0	263	30	203	18	523
Mini-fyke netting	17	172	10	486	95	14	17	811
Tandem mini-fyke netting	1	0	0	72	9	0	28	110
Tandem hoop netting	0	0	0	0	0	0	0	0
Small hoop netting	0	0	0	1	1	1	0	3
Large hoop netting	0	0	1	0	3	0	0	4
Seining	74	731	81	847	739	24	485	2,981
Trawling	2	6	0	0	0	3	1	12
Gill netting	0	0	0	5	0	0	0	5
Annual total catch	1,443	4,428	177	5,101	3,460	2,306	2,035	18,950
Stratum								
Backwater, contiguous offshore	0	0	1	171	34	183	45	434
Backwater, contiguous shoreline	568	1,352	94	2,045	1,329	762	862	7,012
Impounded, offshore	18	19	0	170	9	21	1	238
Impounded, shoreline	31	65	29	271	396	25	74	891
Main channel border, unstructured	168	156	7	447	655	984	151	2,568
Main channel border, wing dam	209	1,458	0	155	73	46	150	2,091
Main channel trough	0	0	0	0	0	0	0	0
Side channel border	226	97	11	734	488	207	133	1,896
Tailwater zone	223	1,281	35	1,108	476	78	619	3,820
Annual total catch	1,443	4,428	177	5,101	3,460	2,306	2,035	18,950

Contiguous backwaters (BWCS and BWCO) consistently provided the broadest range of sizes for gizzard shad (Figure 7), although the MCBU stratum often produced a wide size range among larger gizzard shad. A significant proportion of the catch came from the TWZ in 1992, 1994, and 1997. The MCBW yielded the largest single size group—20 mm in 1992, whereas MCBU sites produced large catches of 40-mm fish in 1995 and 100-mm fish in 1996.

The poolwide distribution map (Figure 8) shows that gizzard shad exhibited no definite lateral or longitudinal patterns of abundance. Although the two sites with the greatest total catch during the period were both in the upper sections of the pool, one was in the TWZ stratum and the other was a fixed backwater shoreline site. Farther downstream, larger catches have occurred along the main channel and in off-channel areas.

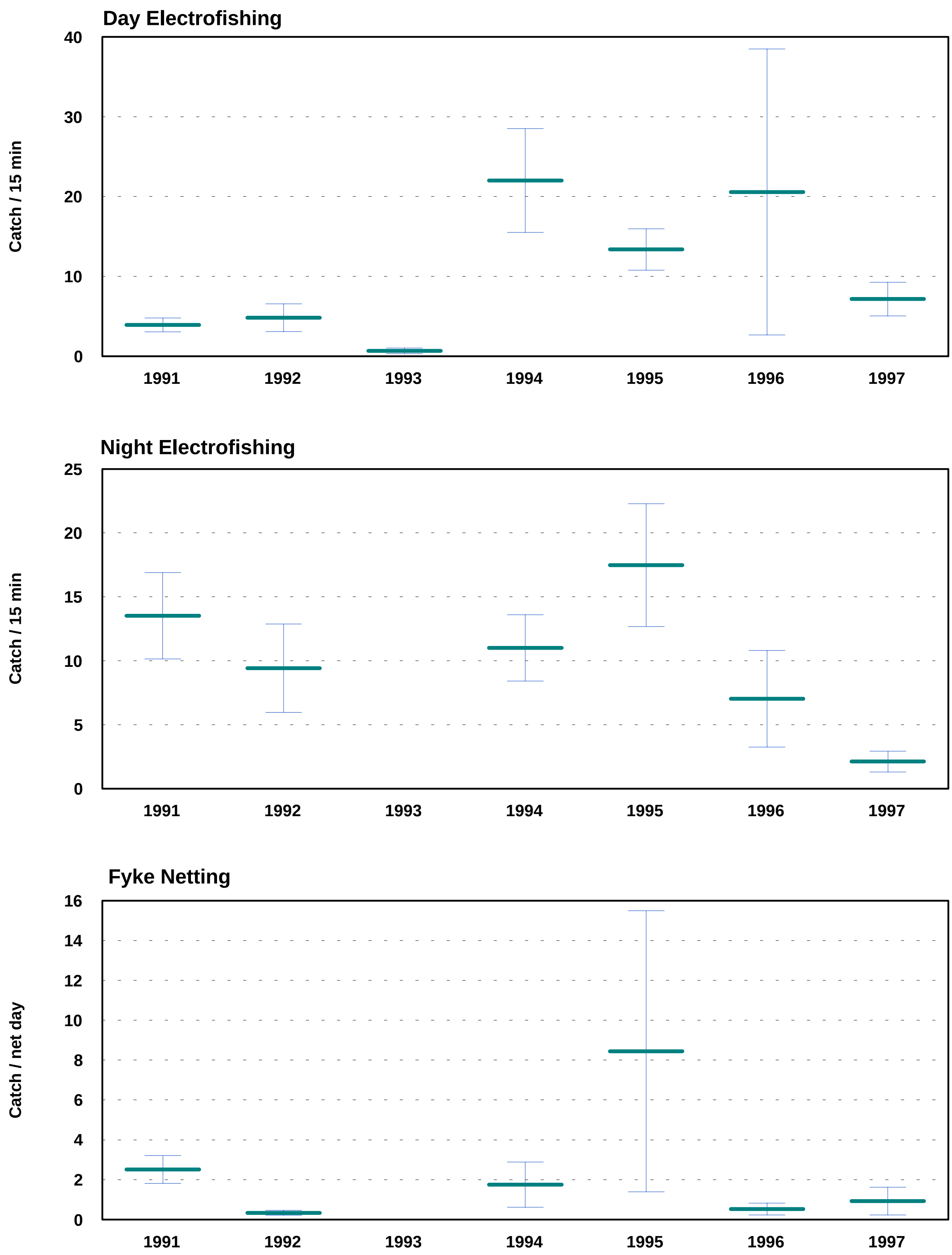

Figure 5. Gizzard shad (*Dorosoma cepedianum*) catch-per-unit-effort values (reachwide mean and standard error) for selected gear types from Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

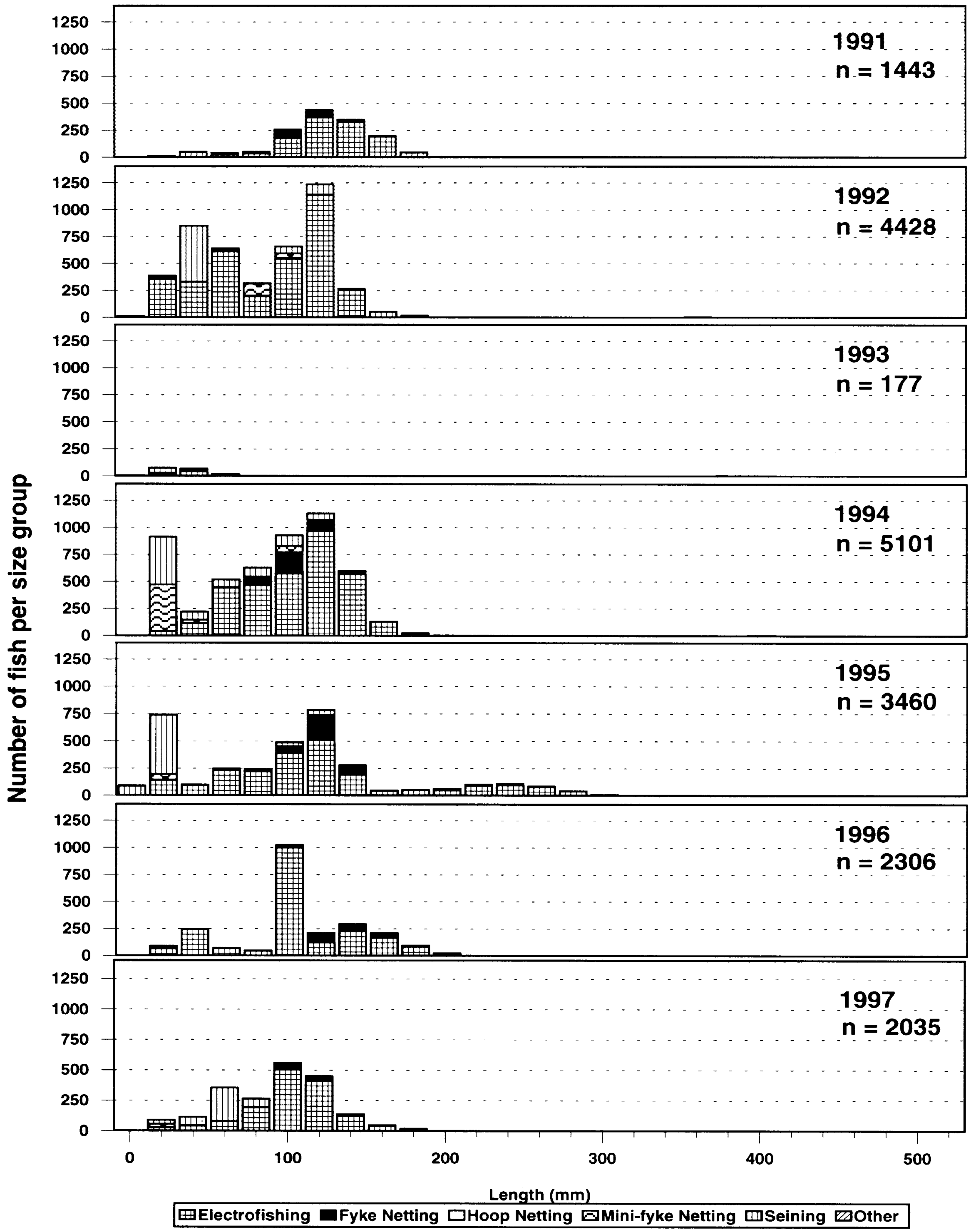

Figure 6. Length distribution, by gear type, for gizzard shad (*Dorosoma cepedianum*) collected in Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

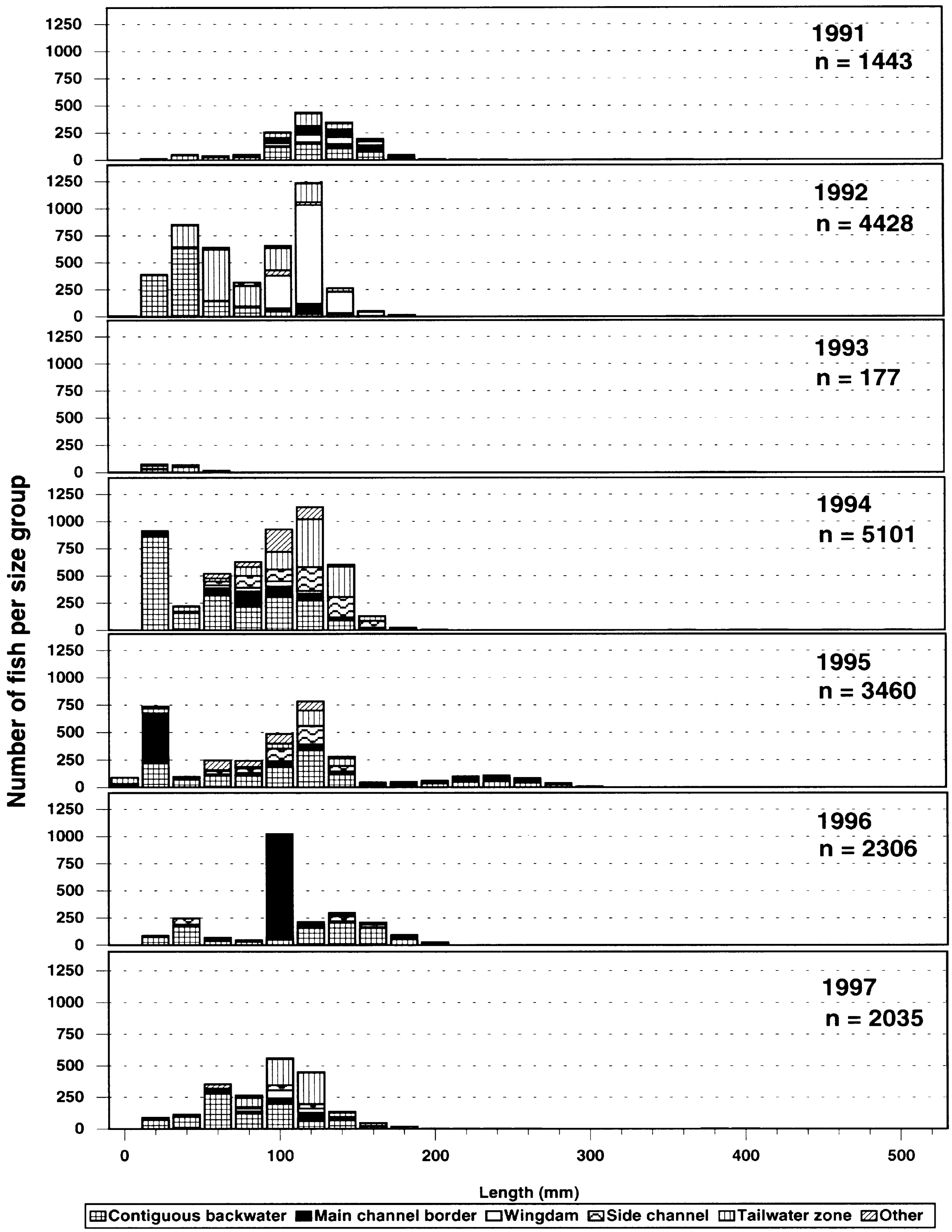

Figure 7. Length distribution, by sampling stratum, for gizzard shad (*Dorosoma cepedianum*) collected in Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

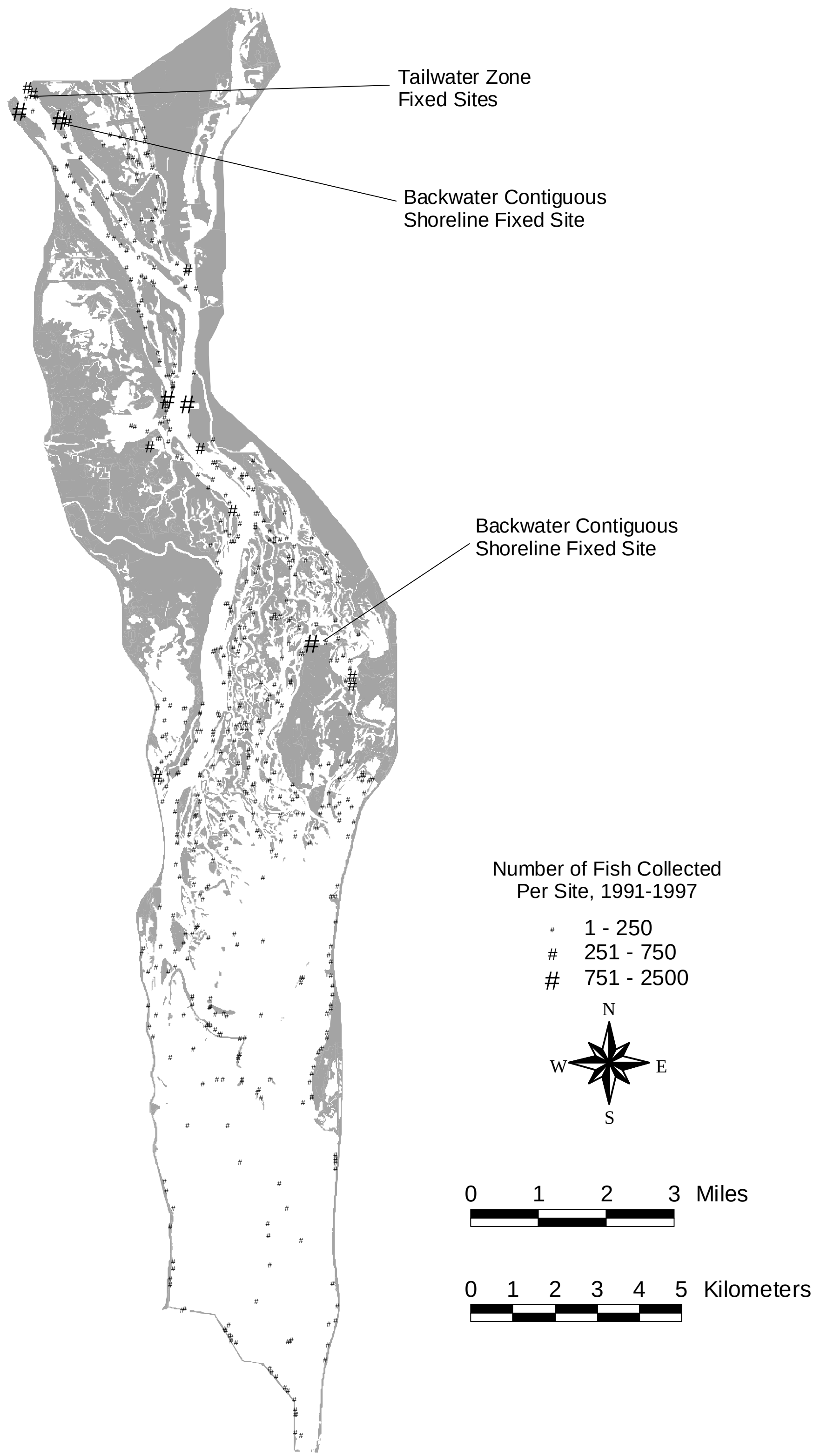

Figure 8. Total number of gizzard shad (*Dorosoma cepedianum*) caught per sampling site in Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

Common Carp

The LTRMP total catch of common carp in Pool 8 during 1991–97 was 8,333 (Table 9). Despite a large increase in catch when SRS began, catches were otherwise stable through time. The greatest total catch (2,007 fish) occurred in 1994. Day (3,401 fish) and night (1,804 fish) electrofishing produced the most common carp. Mini-fyke net (983 fish) catches were variable, with large catches occurring in 1994 and 1997. Large numbers of common carp were also found in seine hauls during 1994.

Table 9. Total catch of common carp (*Cyprinus carpio*) collected annually, by gear type and stratum, in Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

Fish sampling	1991	1992	1993	1994	1995	1996	1997	Overall
Gear								
Day electrofishing	180	189	620	843	480	576	513	3,401
Night electrofishing	207	381	251	281	221	304	159	1,804
Fyke netting	66	61	113	53	83	60	103	539
Tandem fyke netting	1	3	16	13	17	35	49	134
Mini-fyke netting	2	10	1	405	48	45	472	983
Tandem mini-fyke netting	0	2	1	15	6	8	353	385
Tandem hoop netting	124	75	0	0	0	0	0	199
Small hoop netting	0	0	18	36	36	21	10	121
Large hoop netting	0	0	37	101	136	111	31	416
Seining	0	38	1	251	15	2	6	313
Trawling	5	6	0	2	2	0	0	15
Gill netting	0	0	7	7	9	0	0	23
Annual total catch	585	765	1,065	2,007	1,053	1,162	1,696	8,333
Stratum								
Backwater, contiguous offshore	0	0	33	38	43	61	396	571
Backwater, contiguous shoreline	225	273	295	712	274	268	268	2,315
Impounded, offshore	1	15	30	48	62	64	16	236
Impounded, shoreline	14	22	78	347	82	111	576	1,230
Main channel border, unstructured	93	62	82	290	134	89	119	869
Main channel border, wing dam	117	44	24	40	49	57	44	375
Main channel trough	1	1	0	0	0	0	0	2
Side channel border	64	277	440	434	298	396	225	2,134
Tailwater zone	70	71	83	98	111	116	52	601
Annual total catch	585	765	1,065	2,007	1,053	1,162	1,696	8,333

The BWCS (2,315 fish), SCB (2,134 fish), and IMPS (1,230 fish) strata ranked highest for total catch of common carp (Table 9). In relation to the amount of sampling effort (Table 1), catches were particularly great in the IMPS and SCB strata. The IMPS catch was heavily influenced by large numbers of common carp in 1994 and 1997, and the BWCS stratum yielded very high numbers in 1994. Catches in the SCB stratum were consistently high in all years except 1991.

Although total catches of common carp have been stable over time, catch rates for day and night electrofishing and fyke netting showed slight-to-moderate decreases during 1991–97 (Figure 9). Both electrofishing methods, with the exception of 1993, show nearly identical trends, with C/f decreasing

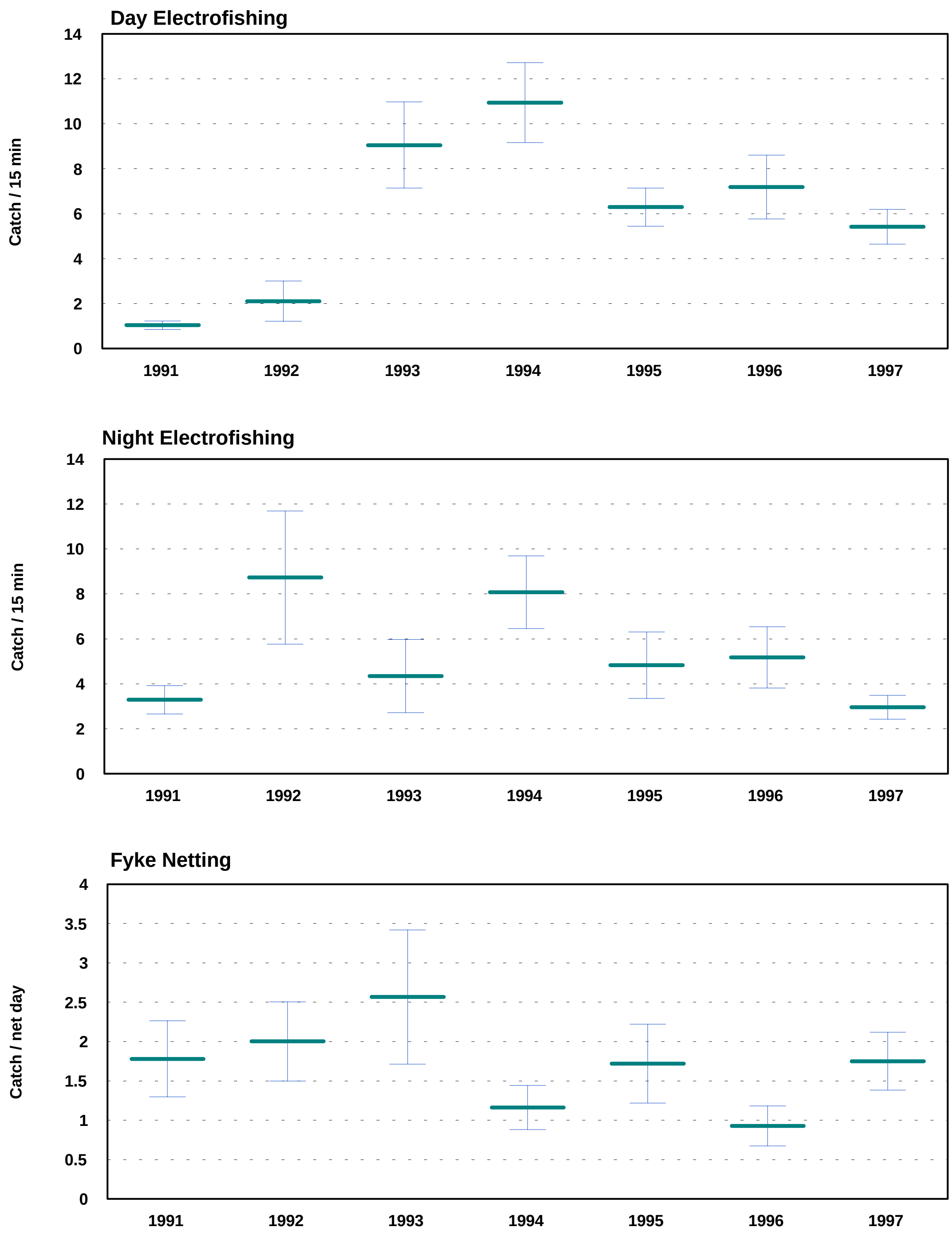

Figure 9. Common carp (*Cyprinus carpio*) catch-per-unit-effort values (reachwide mean and standard error) for selected gear types from Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

about 50%. Fyke net mean catch rates dropped after 1993, but remained within one standard error of previous means. Error bars (standard errors) indicated fairly low variability in catch rates for most years. Thus, the apparent declines were not simply the result of inconsistent catch rates.

Length distributions by gear type for common carp (Figure 10) clearly depict the large catches reported for mini-fyke netting in 1994 and 1997, and seining in 1994. These fish were most likely age-0 common carp, representing good spawning and hatching success in those years. In other years, common carp less than 300 mm long were scarce, suggesting that common carp may rely on occasional strong year classes for their abundance in Pool 8. Other than common carp less than 100 mm TL, which were presumed to be age-0, nearly all common carp in Pool 8 were longer than 400 mm. It is unknown why common carp from 100 to 400 mm TL were largely absent from the catch. The length mode of adult common carp has gradually shifted from about 400 mm TL in 1991 to 520 mm TL in 1997. It is also unclear if the shift toward larger adult common carp through time represents a single year class maturing, or if some other factor has influenced average length. Adult common carp were collected most commonly by electrofishing, then fyke netting, with hoop netting contributing moderately in 1991 and in 1994–96. The largest common carp recorded was 915 mm TL.

The small common carp (less than 100 mm TL), caught by mini-fyke netting and seining in 1994 and 1997, occurred primarily in contiguous backwater and impounded sites (Figure 11). Small common carp were also caught in the MCBU stratum during 1994. Larger common carp seem to be equally represented by contiguous backwater and SCB strata; MCBU sites provided a lesser number of adults. From 1994 through 1997, a modest proportion of adult common carp came from the impounded strata. Few common carp were caught in the TWZ.

The distribution map of total catch by sampling location for common carp (Figure 12) indicates that common carp were found nearly everywhere in Pool 8 in equal density. Numerous sampling sites provided as many as 50 common carp and at least 10 sites yielded more than 100 common carp. No longitudinal or lateral gradients in distribution were evident. The offshore impounded stratum produced no sites with large catches, although sampling effort was low in that stratum.

Smallmouth Buffalo

The LTRMP total catch of smallmouth buffalo in Pool 8 during 1991–97 was 2,843 (Table 10). Annually, catches ranged from 134 in 1993 to 869 in 1992, the year before SRS began. The onset of SRS did not seem to have an effect on smallmouth buffalo catches. Large hoop netting was the most productive sampling gear, providing 31% of the total catch. Electrofishing and seining were also effective in catching this species, although hoop netting catches have increased through time, and electrofishing and seining catches have declined.

The SCB (779 fish), BWCS (768 fish), and TWZ (521 fish) strata yielded the most smallmouth buffalo overall. Catches have declined precipitously in the BWCS stratum, but have remained stable or increased in all other strata.

The C/f data (Figure 13) demonstrate the same trend for smallmouth buffalo as total catch data: increasing catch rate through time for large hoop netting and a general decrease for electrofishing. High catch rates for electrofishing in 1992 and 1994 were also coupled with proportionately large standard errors, indicating isolated collections with a large number of individuals. Aside from these productive collections, electrofishing does not seem to be an effective means for collecting smallmouth buffalo.

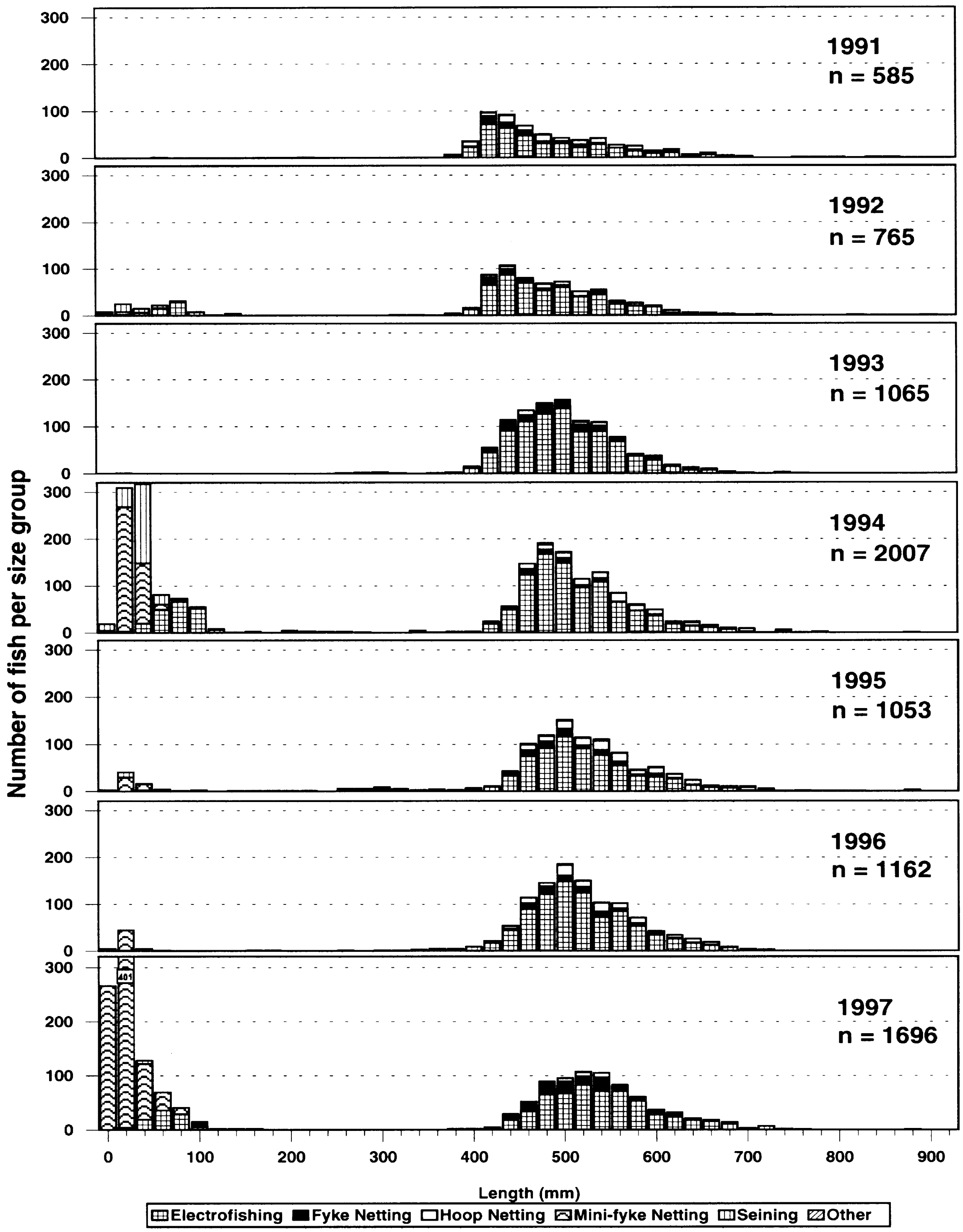

Figure 10. Length distribution, by gear type, for common carp (*Cyprinus carpio*) collected in Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

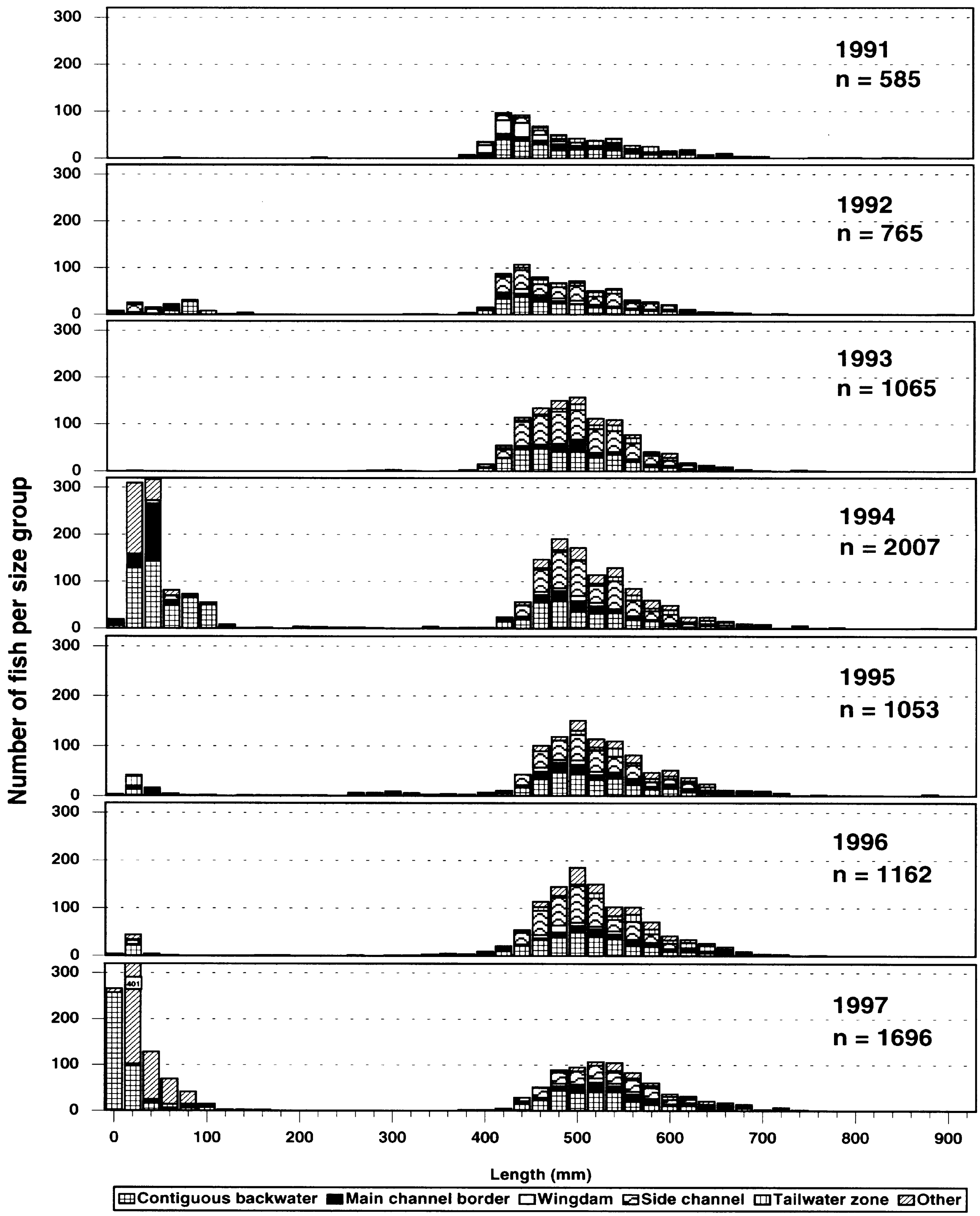

Figure 11. Length distribution, by sampling stratum, for common carp (*Cyprinus carpio*) collected in Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

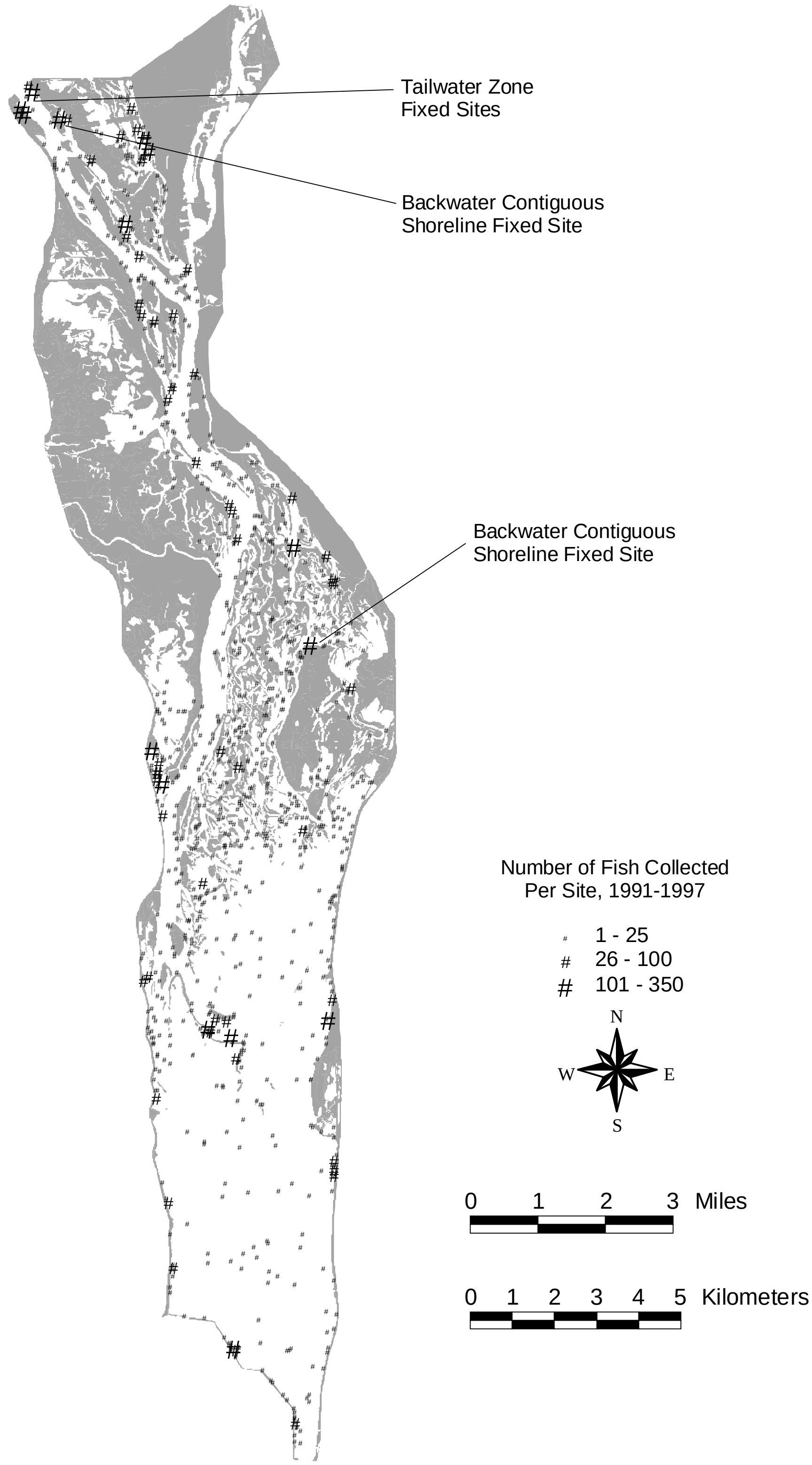

Figure 12. Total number of common carp (*Cyprinus carpio*) caught per sampling site in Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

Table 10. Total catch of smallmouth buffalo (*Ictiobus bubalus*) collected annually, by gear type and stratum, in Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

Fish sampling	1991	1992	1993	1994	1995	1996	1997	Overall
Gear								
Day electrofishing	14	69	8	169	44	18	13	335
Night electrofishing	25	311	36	137	42	19	12	582
Fyke netting	9	31	10	30	12	5	2	99
Tandem fyke netting	0	0	6	1	9	5	2	23
Mini-fyke netting	0	4	1	35	0	0	2	42
Tandem mini-fyke netting	0	0	0	6	0	1	0	7
Tandem hoop netting	230	155	0	0	0	0	0	385
Small hoop netting	0	0	2	3	5	15	12	37
Large hoop netting	0	0	70	38	104	266	406	884
Seining	0	299	1	147	1	0	0	448
Trawling	0	0	0	0	0	0	0	0
Gill netting	0	0	0	1	0	0	0	1
Annual total catch	278	869	134	567	217	329	449	2,843
Stratum								
Backwater, contiguous offshore	0	0	9	7	15	12	15	58
Backwater, contiguous shoreline	28	326	25	329	45	9	6	768
Impounded, offshore	0	0	29	7	16	8	48	108
Impounded, shoreline	4	3	6	63	4	0	6	86
Main channel border, unstructured	39	79	25	57	34	68	82	384
Main channel border, wing dam	11	19	6	17	26	33	27	139
Main channel trough	0	0	0	0	0	0	0	0
Side channel border	132	350	9	52	40	90	106	779
Tailwater zone	64	92	25	35	37	109	159	521
Annual total catch	278	869	134	567	217	329	449	2,843

The length distribution by gear type for smallmouth buffalo (Figure 14) explains the changes in catch rates noted previously. The large electrofishing and seining catches in 1992 and 1994 were small fish (<200 mm TL). As with common carp, it is apparent that smallmouth buffalo produce large numbers of hatchlings infrequently and may rely on sporadic large year classes to maintain populations. Carryover from the 1994 year class seems evident in succeeding years, but was less evident for the 1992 class. Large smallmouth buffalo were caught almost exclusively by hoop netting. Catch rates for hoop netting increased as fish from preceding year classes were recruited to the gear. The largest smallmouth buffalo recorded was 820 mm TL.

In the 2 years (1992 and 1994) where age-0 smallmouth buffalo were evident, the majority of them were collected from the backwater strata (Figure 15). The SCB sites produced the largest single group (243 fish, 20–39 mm TL) in 1992. However, age-0 smallmouth buffalo were found in most strata those years. A shift to SCB, TWZ, and MCBU strata was evident for larger smallmouth buffalo.

The distribution of smallmouth buffalo in LTRMP samples from Pool 8 (Figure 16) has been patchy. Although Table 10 indicated that smallmouth buffalo were caught in a variety of sampling strata, only a few sites have produced the majority of the fish. Highest concentrations were in the upper part of the pool, and largest catches were related to the main navigation channel or large side channels.

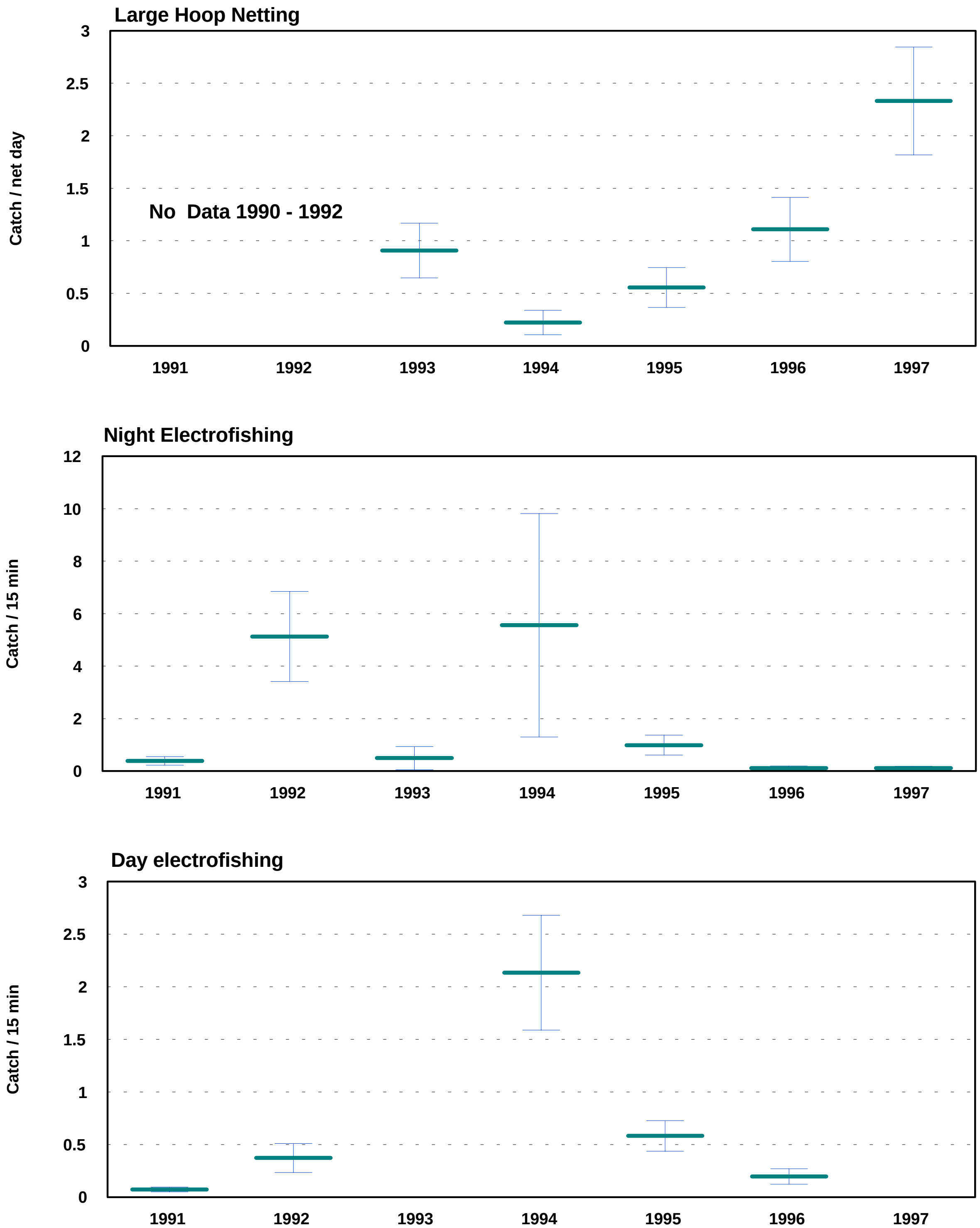

Figure 13. Smallmouth buffalo (*Ictiobus bubalus*) catch-per-unit-effort values (reachwide mean and standard error) for selected gear types from Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

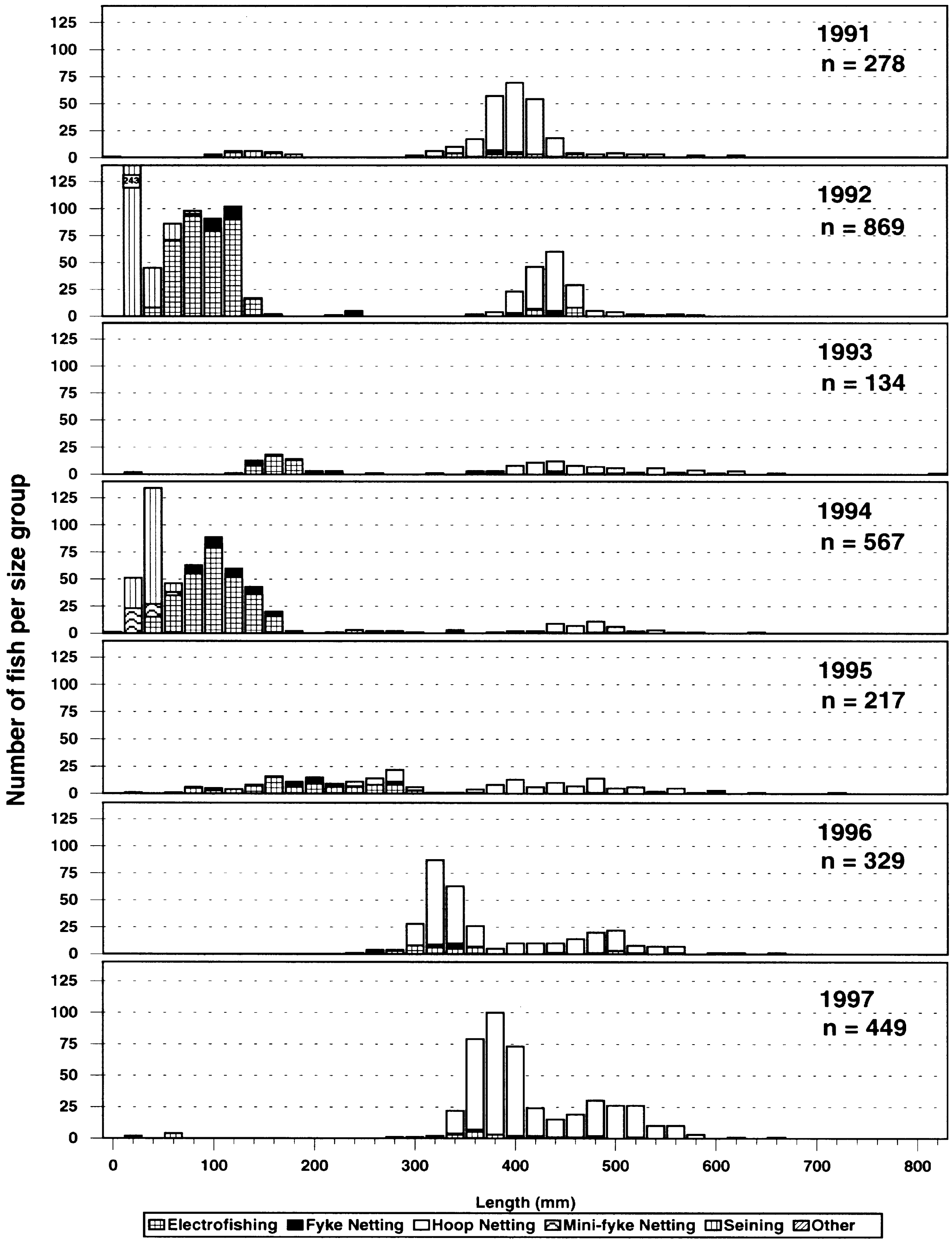

Figure 14. Length distribution, by gear type, for smallmouth buffalo (*Ictiobus bubalus*) collected in Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

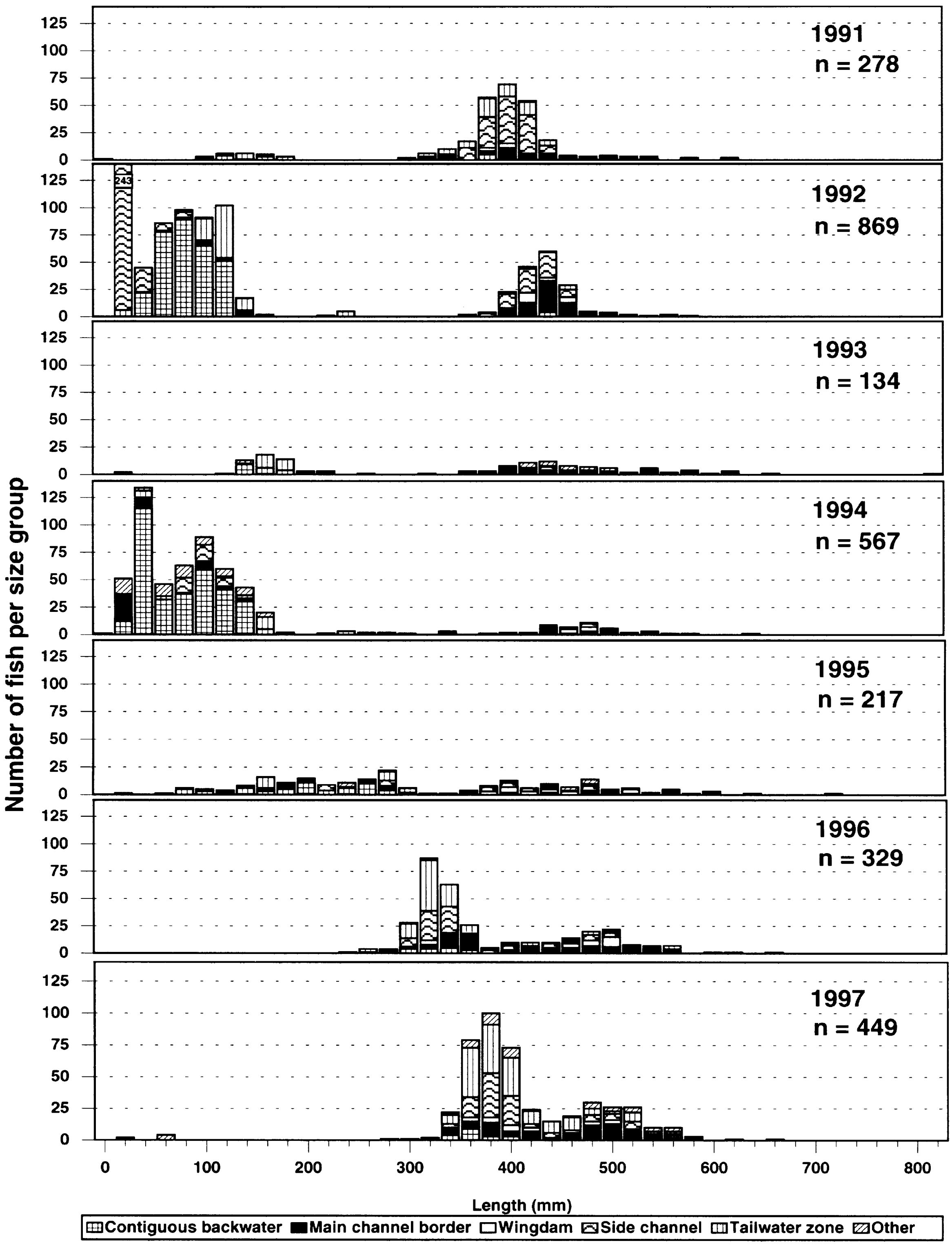

Figure 15. Length distribution, by sampling stratum, for smallmouth buffalo (*Ictiobus bubalus*) collected in Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

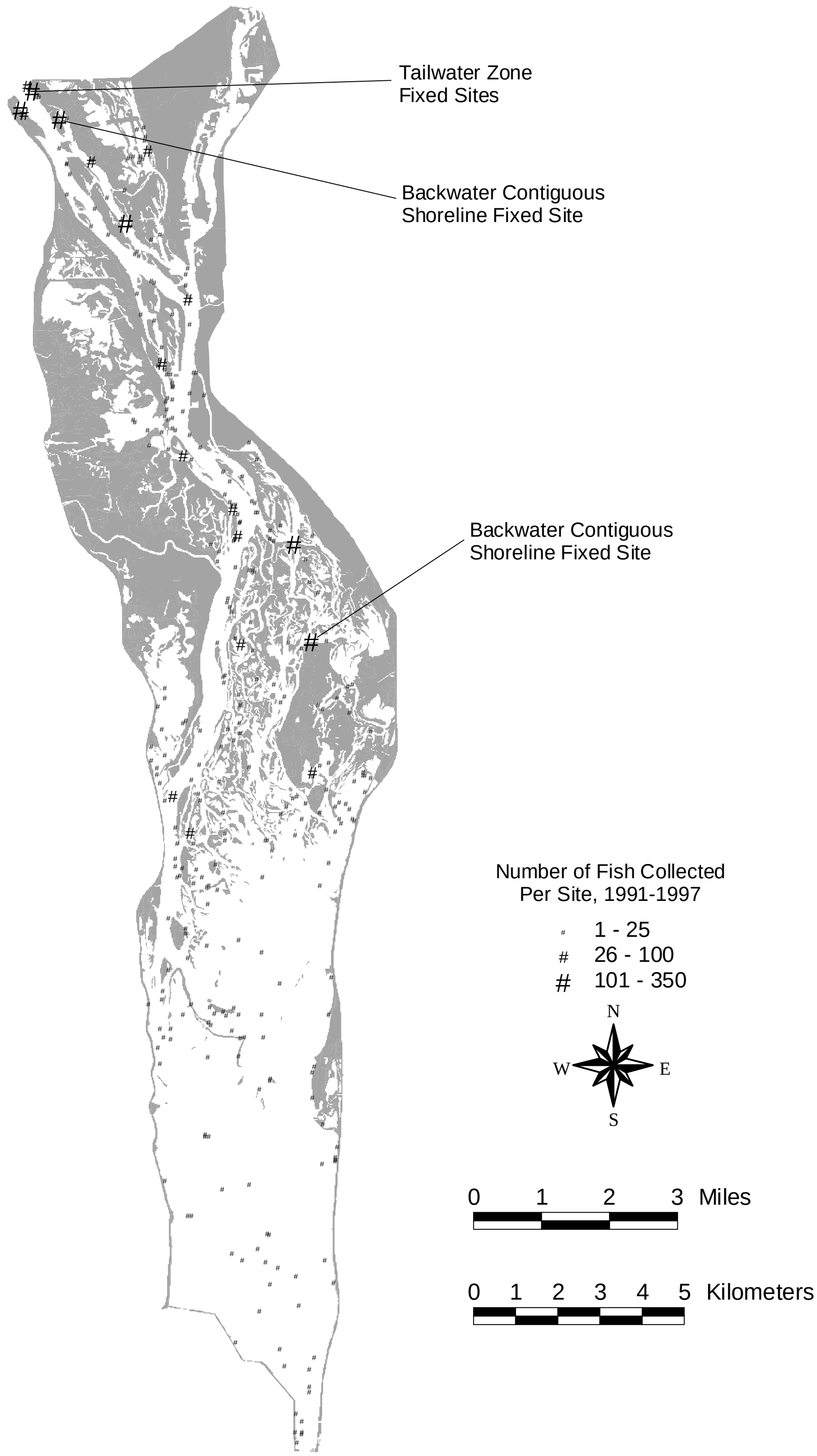

Figure 16. Total number of smallmouth buffalo (*Ictiobus bubalus*) caught per sampling site in Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

Channel Catfish

The LTRMP total catch of channel catfish in Pool 8 during 1991–97 was 4,383 (Table 11). The lowest catch was in 1993 (328 fish) and the highest catch was in 1994 (868 fish). No trend in total catch was evident overall. Small (1,751 fish), large (900 fish), and tandem (671 fish) hoop nets were by far the most effective gears for channel catfish, followed by night electrofishing (419 fish) and trawling (326 fish). When trawling effort was eliminated from the MCBU stratum in 1993, trawling catches plummeted dramatically. Catches with other gears have remained stable through time.

Table 11. Total catch of channel catfish (*Ictalurus punctatus*) collected annually, by gear type and stratum, in Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

Fish sampling	1991	1992	1993	1994	1995	1996	1997	Overall
Gear								
Day electrofishing	11	10	17	40	21	23	27	149
Night electrofishing	103	63	62	52	31	85	23	419
Fyke netting	13	7	17	19	11	14	6	87
Tandem fyke netting	0	2	2	0	6	7	10	27
Mini-fyke netting	6	0	0	0	5	2	0	13
Tandem mini-fyke netting	14	0	0	0	6	3	1	24
Tandem hoop netting	460	211	0	0	0	0	0	671
Small hoop netting	0	0	131	600	338	414	268	1,751
Large hoop netting	0	0	64	126	119	241	350	900
Seining	7	0	1	0	0	0	0	8
Trawling	63	180	32	29	9	2	11	326
Gill netting	0	0	2	2	4	0	0	8
Annual total catch	677	473	328	868	550	791	696	4,383
Stratum								
Backwater, contiguous offshore	0	0	33	43	95	35	32	238
Backwater, contiguous shoreline	5	7	14	25	19	20	10	100
Impounded, offshore	14	2	58	29	116	54	77	350
Impounded, shoreline	4	5	12	12	7	9	3	52
Main channel border, unstructured	262	46	53	175	89	160	67	852
Main channel border, wing dam	45	29	52	49	90	138	69	472
Main channel trough	10	12	0	0	0	0	0	22
Side channel border	248	46	43	261	75	205	152	1,030
Tailwater zone	89	326	63	274	59	170	286	1,267
Annual total catch	677	473	328	868	550	791	696	4,383

The TWZ (1,267 fish) produced the most channel catfish, followed by the SCB (1,030 fish) and MCBU (852 fish) strata (Table 11). Catch has increased through time for the BWCO, IMPO, and MCBW strata, but has varied through time for the other strata.

The C/f data for channel catfish (Figure 17) show conflicting trends. Small hoop net catch rates, except for 1993, have declined over time, while large hoop net mean catch rates have steadily increased. Aside from an unusually high catch rate in 1991, night electrofishing catch rates for channel catfish have not changed.

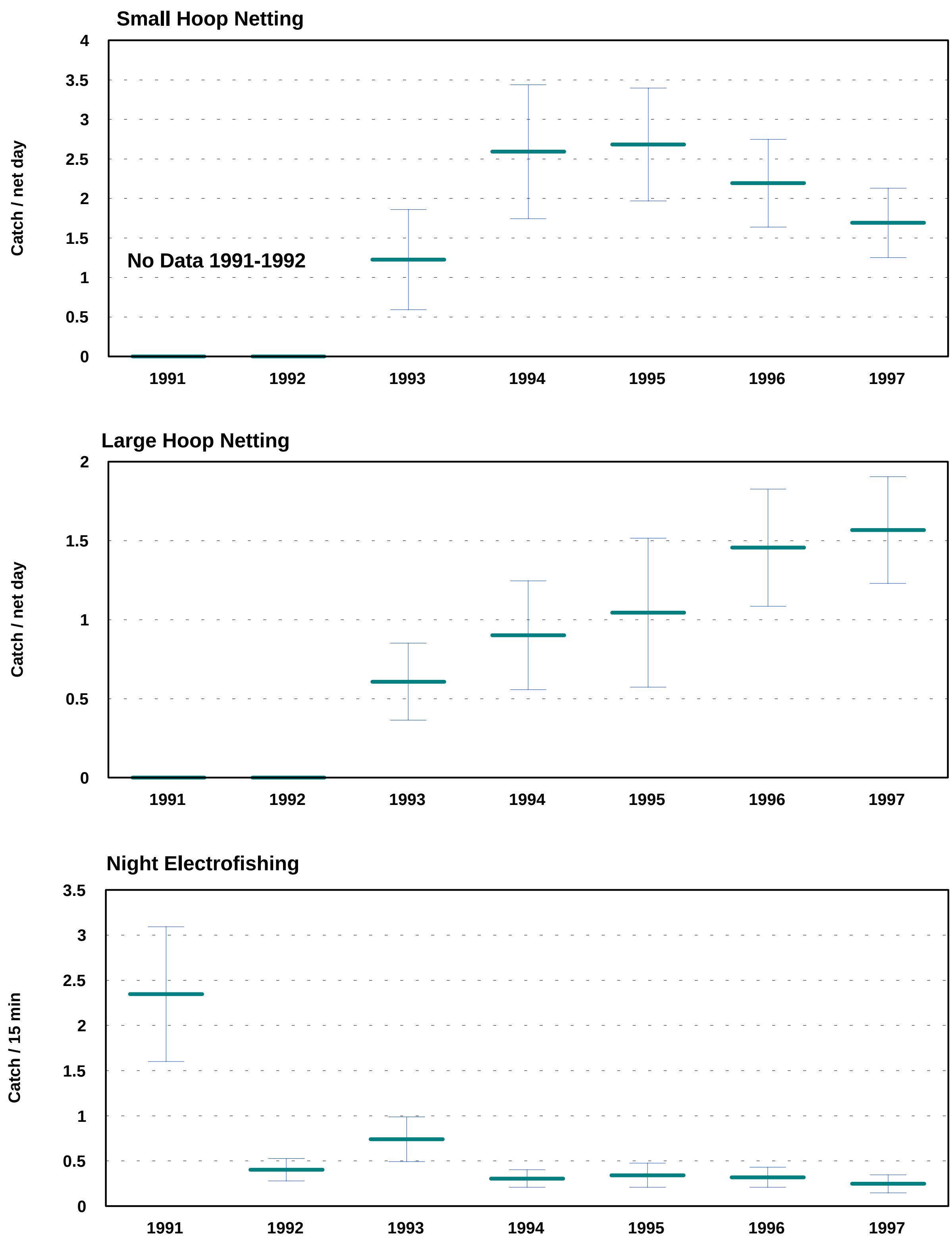

Figure 17. Channel catfish (*Ictalurus punctatus*) catch-per-unit-effort values (reachwide mean and standard error) for selected gear types from Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

For hoop nets, standard errors often encompassed mean values from other years, precluding the detection of any potential trends.

Length distributions by gear type for channel catfish (Figure 18) show only 1 year, 1991, in which channel catfish shorter than 100 mm TL made up a substantial part of the catch. These catfish were presumed to be age-0 and can be followed through the population each successive year as a strong year class. Extremely small channel catfish were caught primarily by trawling (36%) and electrofishing (40%), but nearly all large fish were caught in hoop nets. Though trawling effort was greatly reduced after 1992, age-0 channel catfish, if present in substantial numbers, should have been detected by other gears, as they were in 1991. Because the population throughout the period seems to be predominantly 1 year class, the opposing trends for small and large hoop net catch rates were probably due to size selectivity of the gears as the population matured.

Channel catfish in most years came from a variety of sampling strata (Figure 19). No clear size-based preferences were evident, although channel catfish of 200–300 mm TL tended to be found in the TWZ in several years. Channel catfish of 300–500 mm TL were caught in all strata, whereas those longer than 500 mm TL were usually found in the MCBU stratum. The longest channel catfish recorded was 785 mm TL.

The distribution map of channel catfish in Pool 8 (Figure 20) shows that they were present throughout the entire pool. However, large catches tended to be along the main navigation channel and were always associated with flowing channels. Although most of the sites with large catches came from the upper two-thirds of the pool, a cluster of sites with as many as 175 catfish each was found near main channel border islands in the upper impounded area.

Flathead Catfish

The LTRMP total catch of flathead catfish in Pool 8 during 1991–97 was 503 (Table 12). Annual totals ranged from 34 to 97, with a general increase over time; catches doubled when SRS began in 1993. The most effective gear type for flathead catfish was night electrofishing (190 fish). Similar catches were recorded for day electrofishing (73 fish), fyke netting (76 fish), and large hoop netting (77 fish).

The TWZ (132 fish) produced the most flathead catfish (Table 12). The BWCS (89 fish) and MCBU (83 fish) strata also had high catch totals. Catches in most strata remained stable or increased slightly through time.

Flathead catfish C/f remained stable during the 1991–97 period (Figure 21) for the three most effective gear types, although fyke netting C/f increased greatly in 1997. Standard errors were large, indicating high variability.

Length distributions by gear type for flathead catfish (Figure 22) showed little change over time. A broad size range of fish were caught in all years, although flathead catfish less than 150 mm TL were few. Gear selectivity was somewhat evident, as electrofishing tended to yield flatheads shorter than 400 mm TL, fyke nets tended to produce 400–600 mm TL fish, and hoop nets caught most of the flatheads over 600 mm TL. The largest flathead catfish was caught by night electrofishing and was 1,228 mm TL.

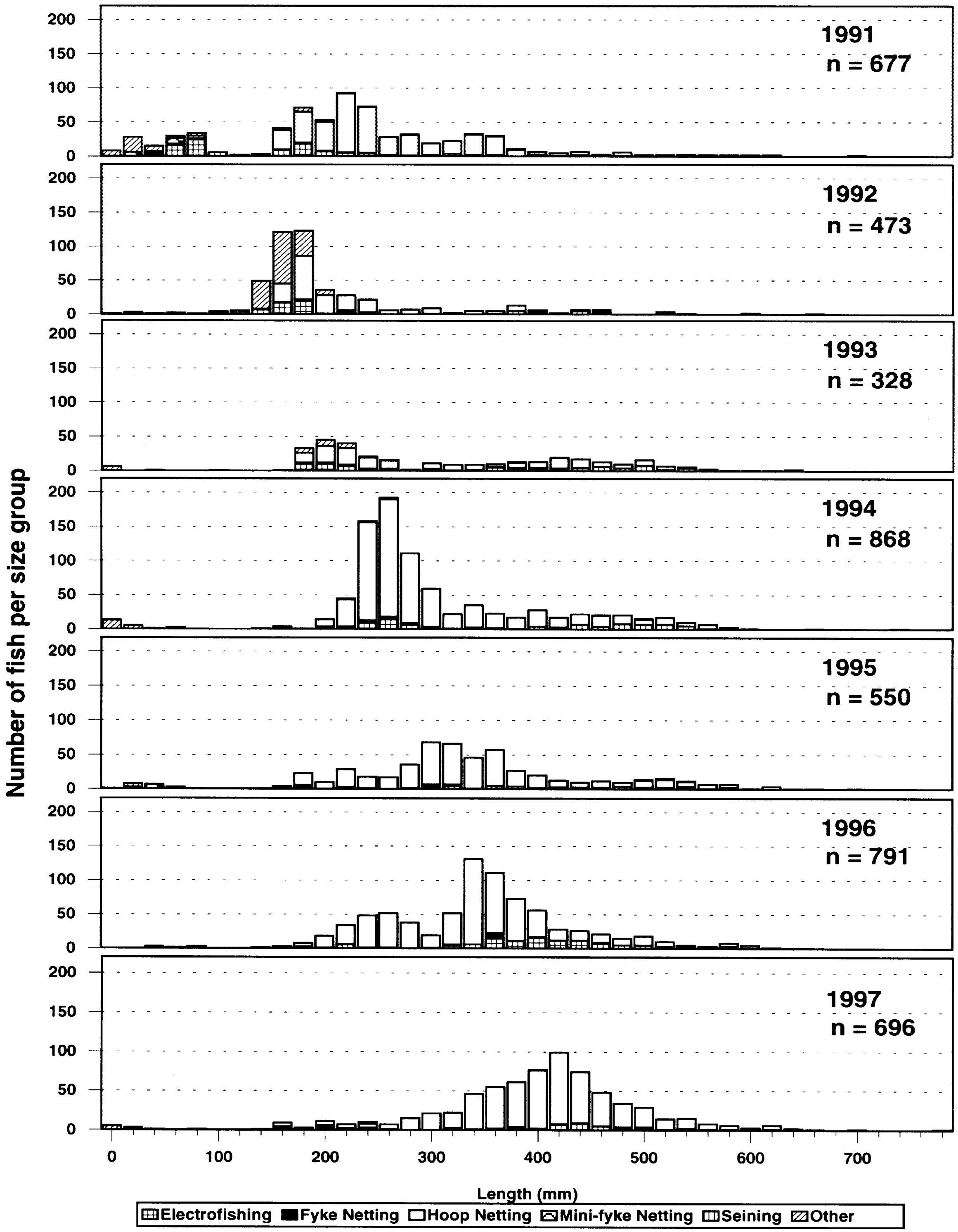

Figure 18. Length distribution, by gear type, for channel catfish (*Ictalurus punctatus*) collected in Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

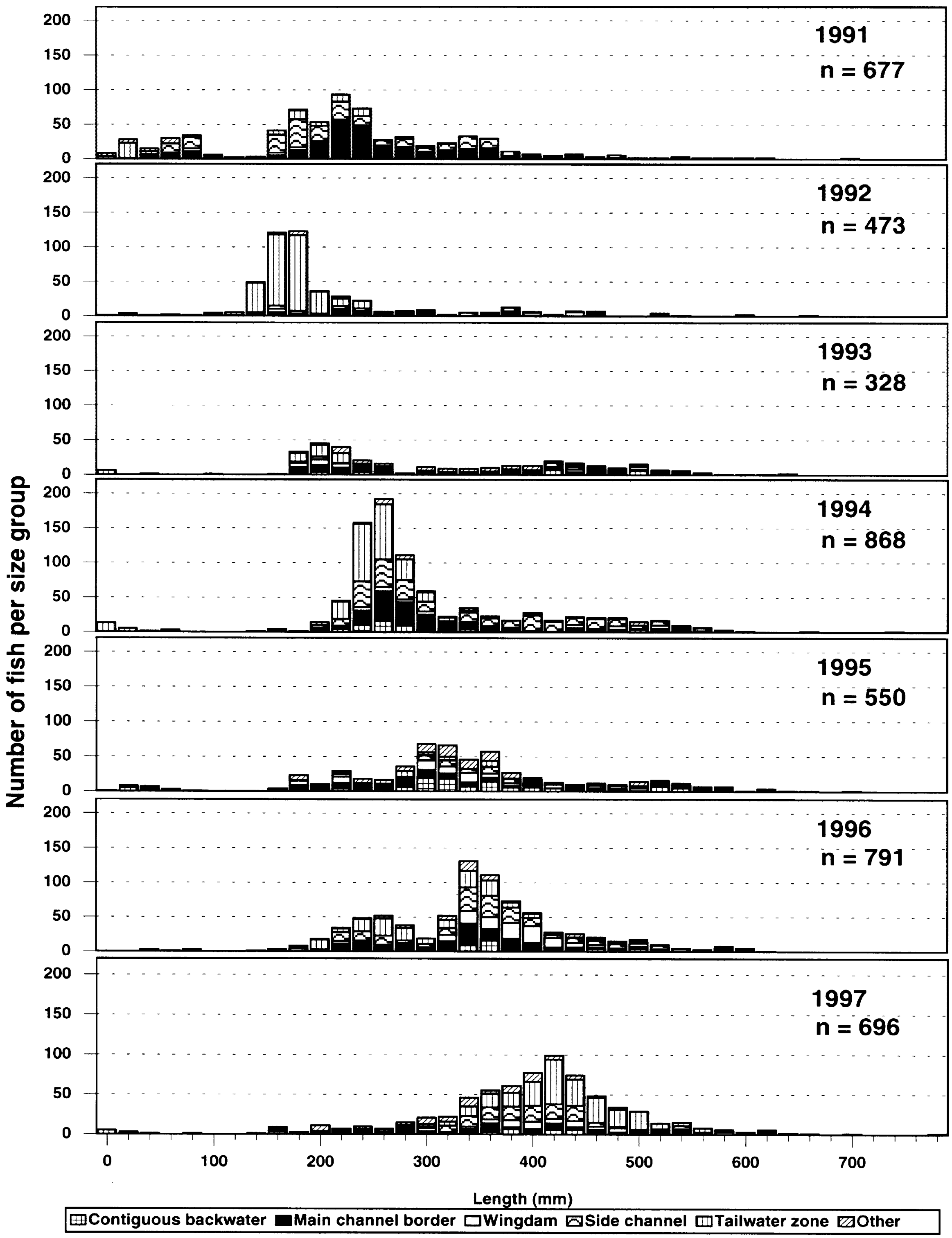

Figure 19. Length distribution, by sampling stratum, for channel catfish (*Ictalurus punctatus*) collected in Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

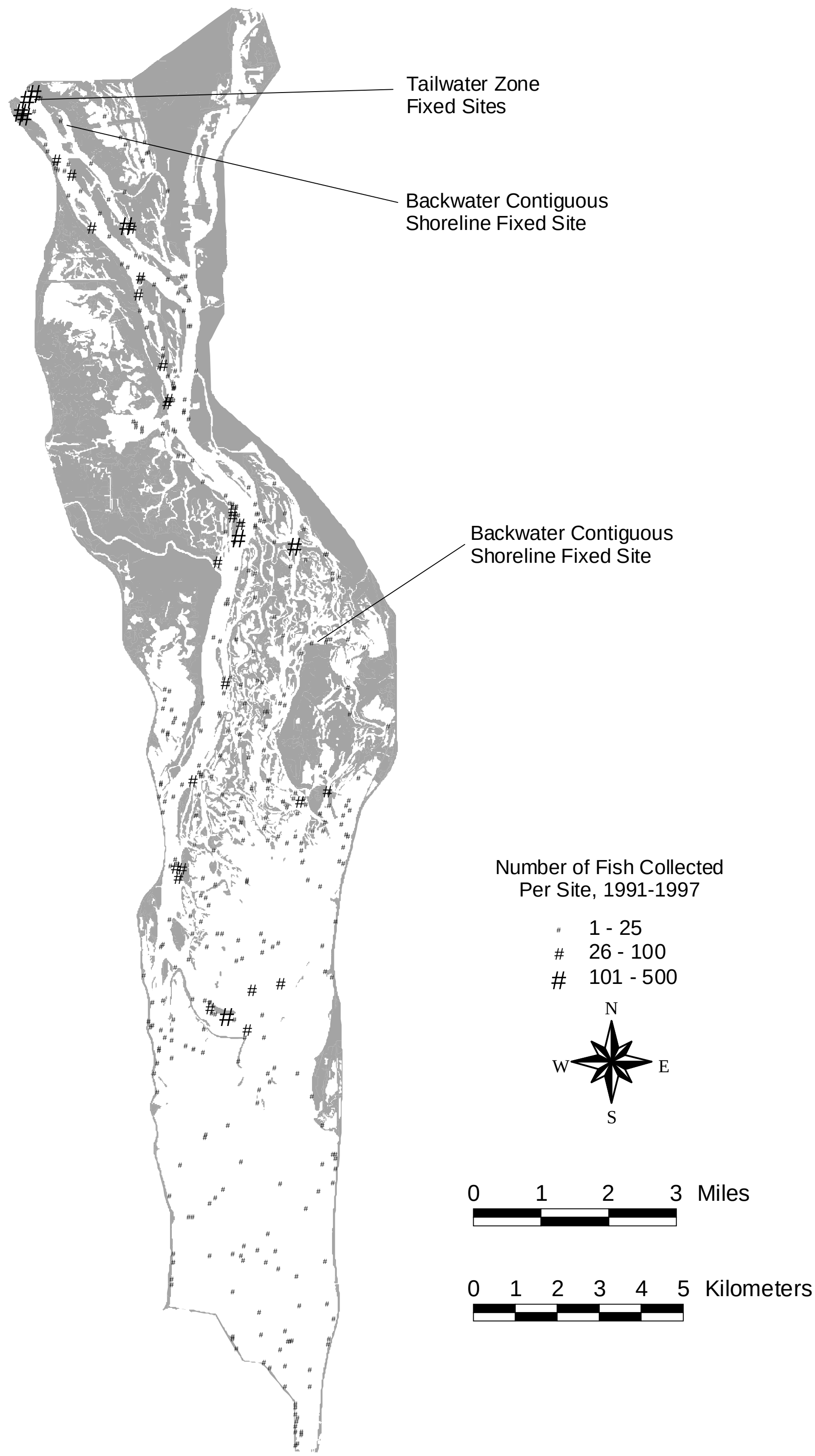

Figure 20. Total number of channel catfish (*Ictalurus punctatus*) caught per sampling site in Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

Table 12. Total catch of flathead catfish (*Pylodictis olivaris*) collected annually, by gear type and stratum, in Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

Fish sampling	1991	1992	1993	1994	1995	1996	1997	Overall
Gear								
Day electrofishing	2	2	17	16	10	16	10	73
Night electrofishing	18	10	28	29	31	36	38	190
Fyke netting	6	7	4	10	13	15	21	76
Tandem fyke netting	1	0	2	1	4	4	7	19
Mini-fyke netting	2	0	2	6	0	3	3	16
Tandem mini-fyke netting	0	0	1	0	0	0	0	1
Tandem hoop netting	14	14	0	0	0	0	0	28
Small hoop netting	0	0	6	1	4	2	2	15
Large hoop netting	0	0	19	6	25	11	16	77
Seining	0	0	1	0	0	0	0	1
Trawling	3	1	0	2	0	0	0	6
Gill netting	0	0	0	0	1	0	0	1
Annual total catch	46	34	80	71	88	87	97	503
Stratum								
Backwater, contiguous offshore	0	0	3	1	4	3	6	17
Backwater, contiguous shoreline	11	10	6	9	11	18	24	89
Impounded, offshore	2	1	2	0	4	2	4	15
Impounded, shoreline	1	1	7	9	5	8	3	34
Main channel border, unstructured	14	5	15	6	10	18	15	83
Main channel border, wing dam	7	5	6	11	16	6	12	63
Main channel trough	0	0	0	0	0	0	0	0
Side channel border	6	4	15	14	7	13	11	70
Tailwater zone	5	8	26	21	31	19	22	132
Annual total catch	46	34	80	71	88	87	97	503

Length distributions by stratum for flathead catfish (Figure 23) indicated no preference for a particular stratum among any size range of fish. In all years, flathead catfish of all sizes were found in multiple strata and in nearly equal numbers.

The distribution map showing total catch of flathead catfish by location (Figure 24) indicates that the most productive sites were located in the upper pool. Although flathead catfish were caught in many off-channel areas, these sites usually produced only one or two fish per site. The sites producing the most flathead catfish were usually associated with flowing waters along the main navigation channel.

Northern Pike

The LTRMP total catch of northern pike in Pool 8 during 1991–97 was 777 (Table 13). Annual catches increased 30–50% when SRS began and have increased slightly since then. Annual totals ranged from a low of 73 fish in 1991 to a high of 155 northern pike in 1996. Fyke netting (234 fish) yielded the most fish, followed by day electrofishing (187 fish) and night electrofishing (159 fish). Tandem fyke netting also proved effective for catching northern pike in 1996 and 1997.

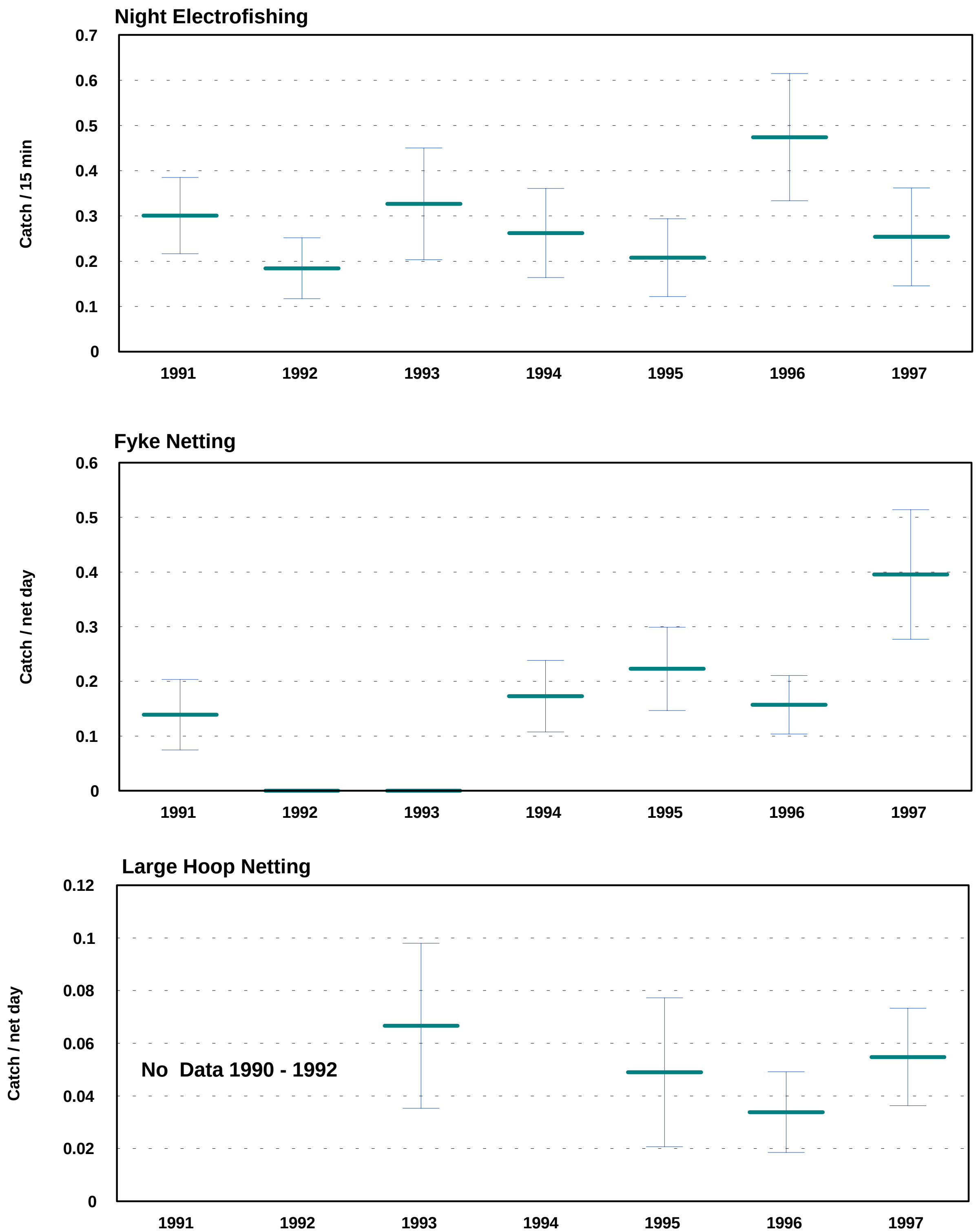

Figure 21. Flathead catfish (*Pylodictis olivaris*) catch-per-unit-effort values (reachwide mean and standard error) for selected gear types from Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

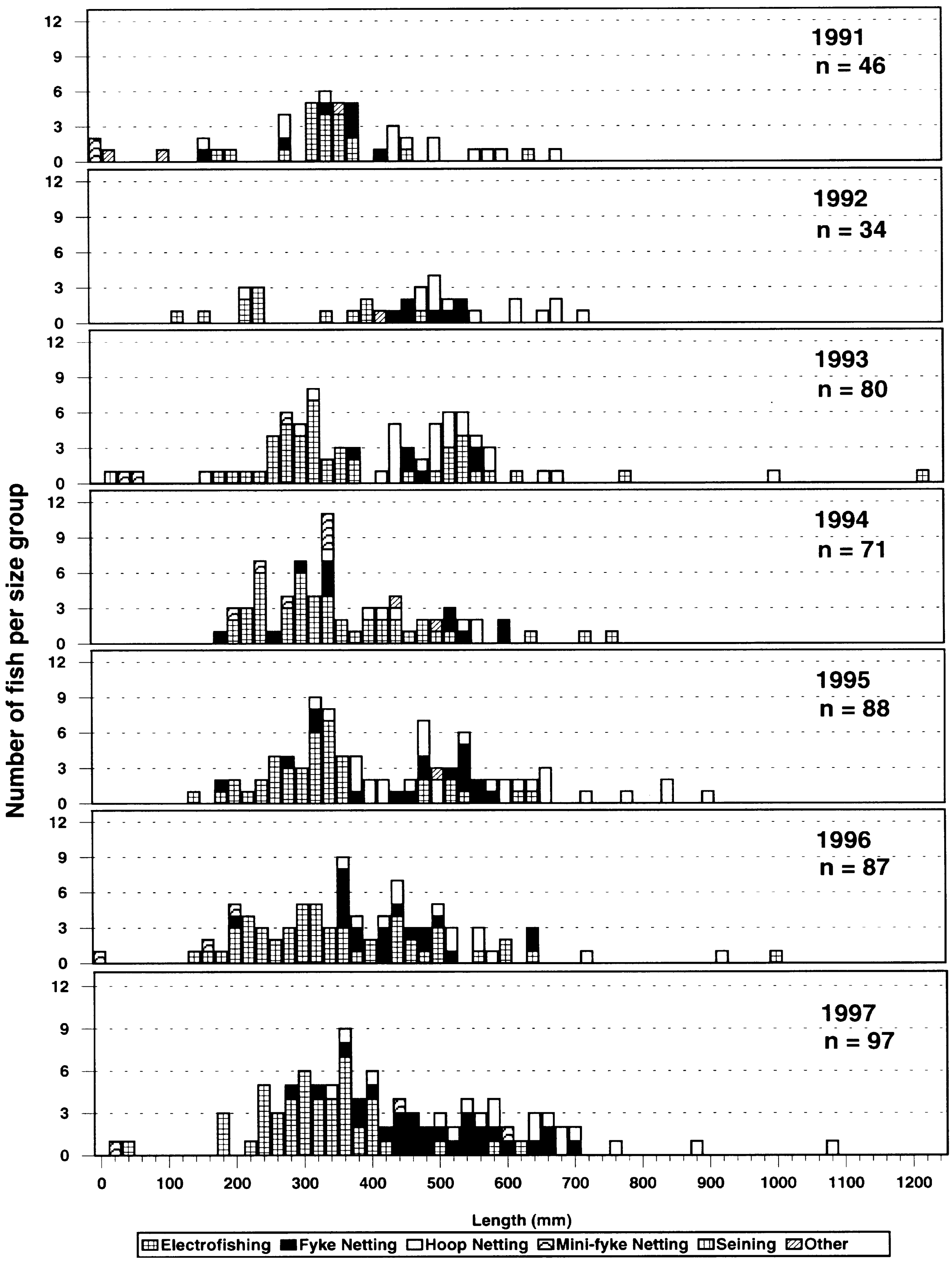

Figure 22. Length distribution, by gear type, for flathead catfish (*Pylodictis olivaris*) collected in Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

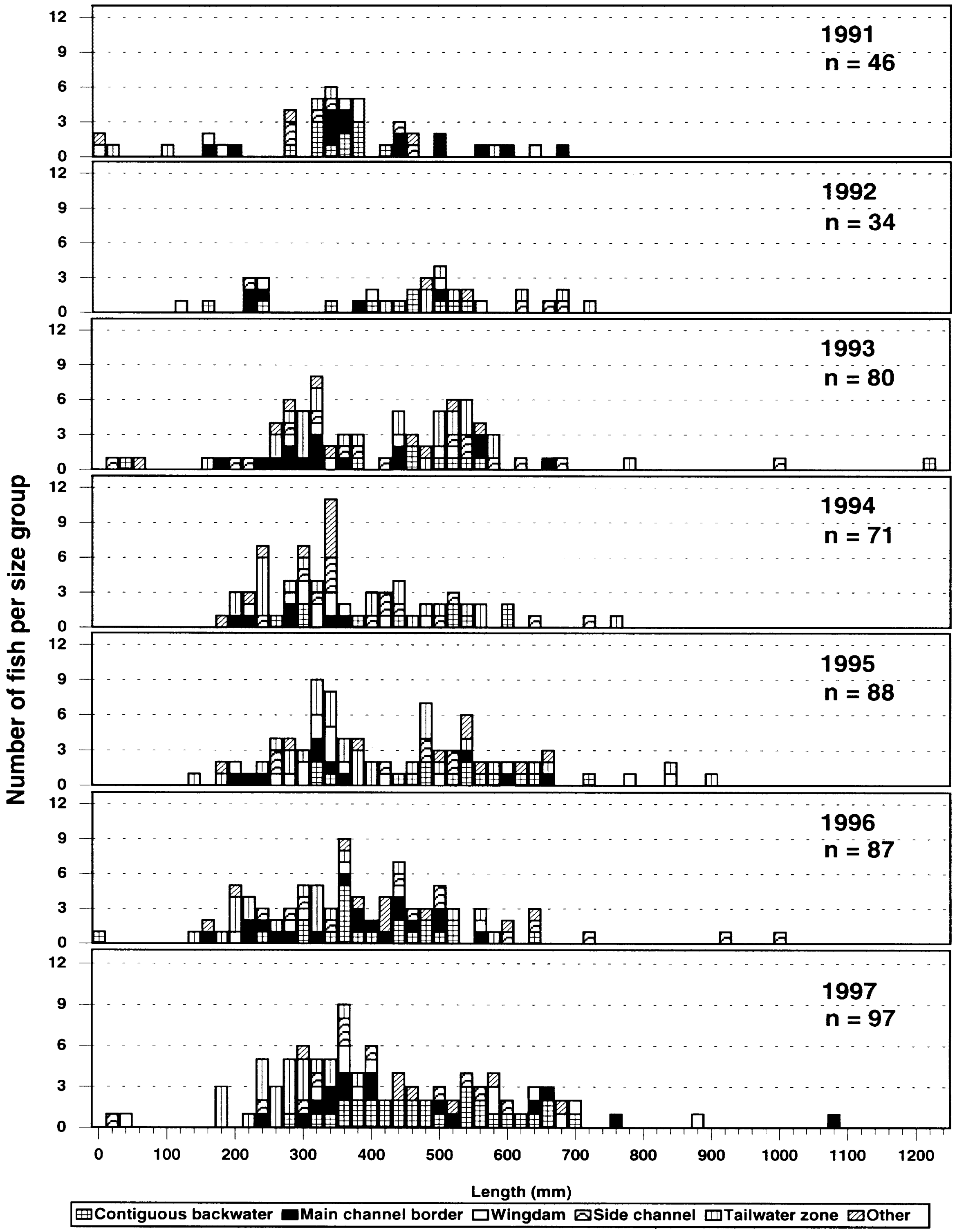

Figure 23. Length distribution, by sampling stratum, for flathead catfish (*Pylodictis olivaris*) collected in Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

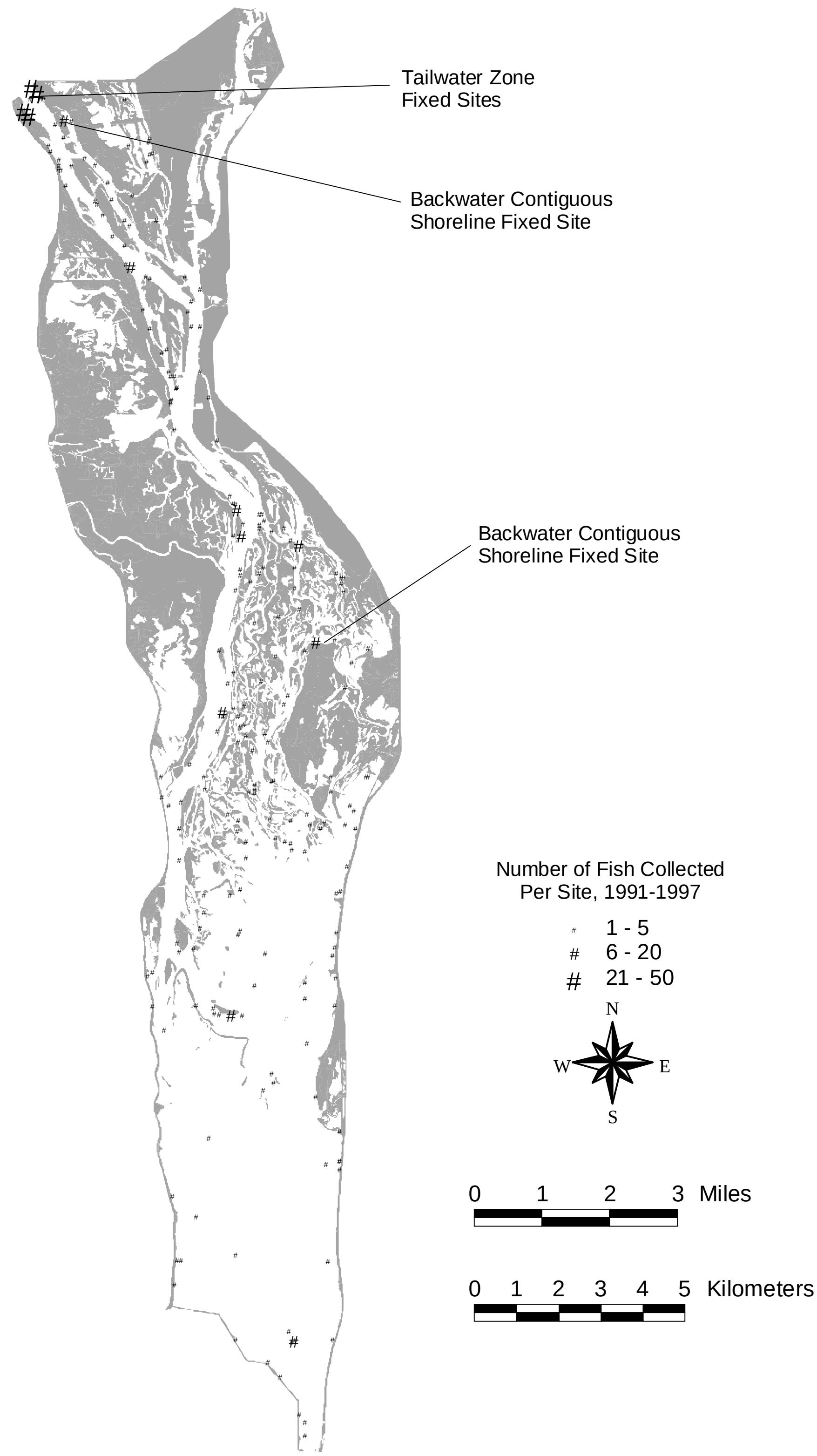

Figure 24. Total number of flathead catfish (*Pylodictis olivaris*) caught per sampling site in Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

Table 13. Total catch of northern pike (*Esox lucius*) collected annually, by gear type and stratum, in Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

Fish sampling	1991	1992	1993	1994	1995	1996	1997	Overall
Gear								
Day electrofishing	17	9	34	23	37	30	37	187
Night electrofishing	15	21	23	20	27	38	15	159
Fyke netting	40	47	14	26	43	31	33	234
Tandem fyke netting	0	0	6	17	9	46	22	100
Mini-fyke netting	0	1	23	3	2	6	8	43
Tandem mini-fyke netting	0	0	0	1	0	0	1	2
Tandem hoop netting	1	1	0	0	0	0	0	2
Small hoop netting	0	0	0	0	0	0	0	0
Large hoop netting	0	0	3	3	7	2	5	20
Seining	0	0	11	5	2	2	4	24
Trawling	0	0	0	0	0	0	0	0
Gill netting	0	0	3	1	2	0	0	6
Annual total catch	73	79	117	99	129	155	125	777
Stratum								
Backwater, contiguous offshore	0	0	7	20	12	45	26	110
Backwater, contiguous shoreline	54	54	53	51	76	65	68	421
Impounded, offshore	0	0	1	1	2	2	0	6
Impounded, shoreline	0	0	5	3	2	2	2	14
Main channel border, unstructured	0	1	5	1	4	4	3	18
Main channel border, wing dam	2	4	3	1	2	3	1	16
Main channel trough	0	0	0	0	0	0	0	0
Side channel border	2	3	20	5	14	3	17	64
Tailwater zone	15	17	23	17	17	31	8	128
Annual total catch	73	79	117	99	129	155	125	777

The BWCS stratum (421 fish) produced by far the most northern pike (Table 13). The TWZ (128) and BWCO (110) strata also contributed substantial numbers of fish. Catch has remained stable in the TWZ, increased slightly in the BWCS stratum, and increased substantially in the BWCO stratum through time. The increase in the BWCO stratum was most likely a result of increased sampling effort with tandem fyke nets.

Day and night electrofishing graphs of northern pike C/f (Figure 25) demonstrate a general increase in catch rates through time. Fyke net catch rates declined substantially when SRS began, suggesting that the fixed-site sampling design did not represent poolwide northern pike populations well. Since 1993 fyke net catch rates have rebounded somewhat. Standard errors for electrofishing were quite large, indicating highly variable catch rates.

Length distributions by gear type for northern pike (Figure 26) show a wide range of sizes present in most years. The greatest number of northern pike less than 200 mm TL, presumed to be age-0 fish, was seen in 1993. Most of these small fish were caught by mini-fyke netting and electrofishing. Electrofishing consistently produced the largest range of sizes, but the majority of adult northern pike were caught in fyke nets. The longest northern pike recorded was 1,010 mm TL.

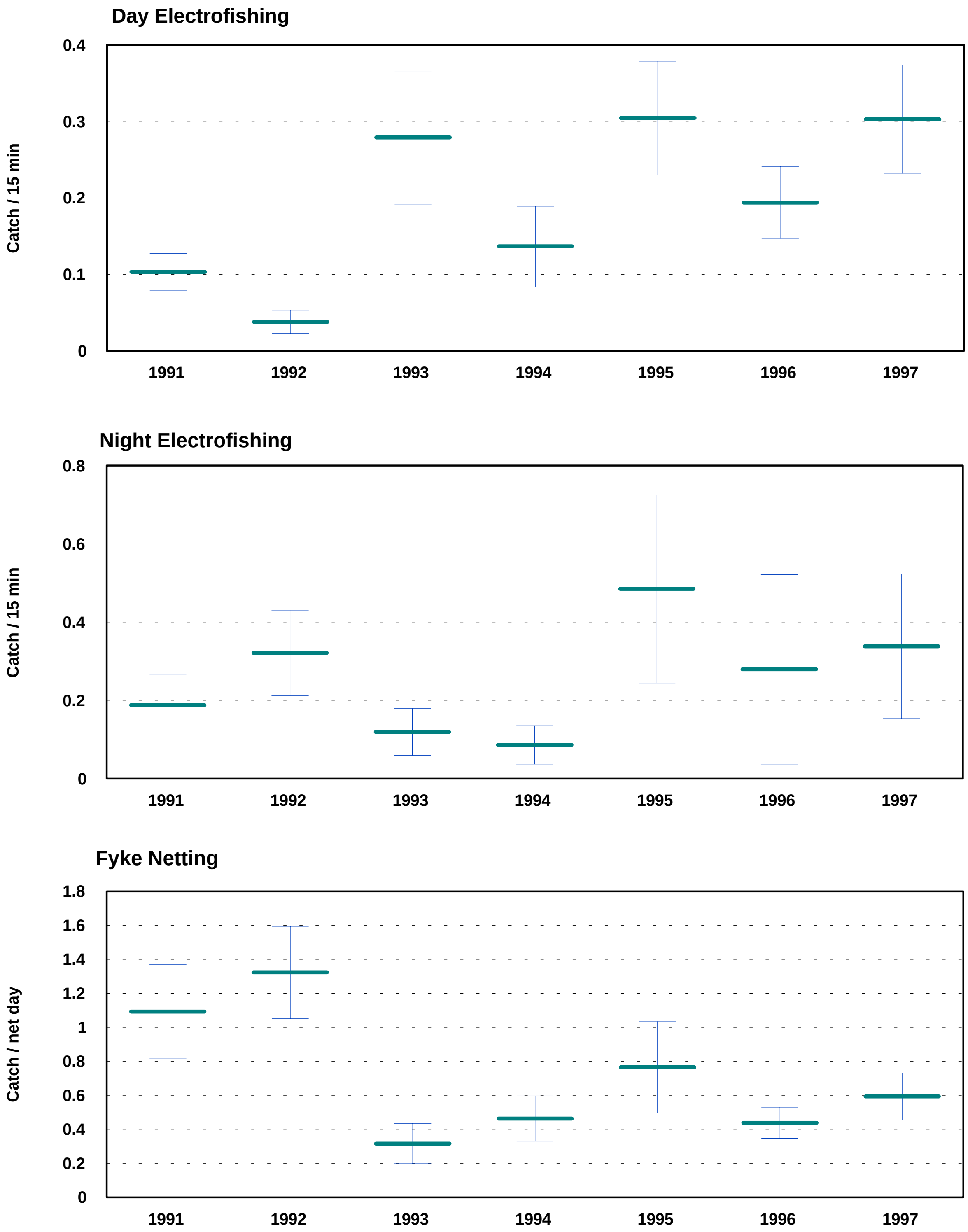

Figure 25. Northern pike (*Esox lucius*) catch-per-unit-effort values (reachwide mean and standard error) for selected gear types from Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

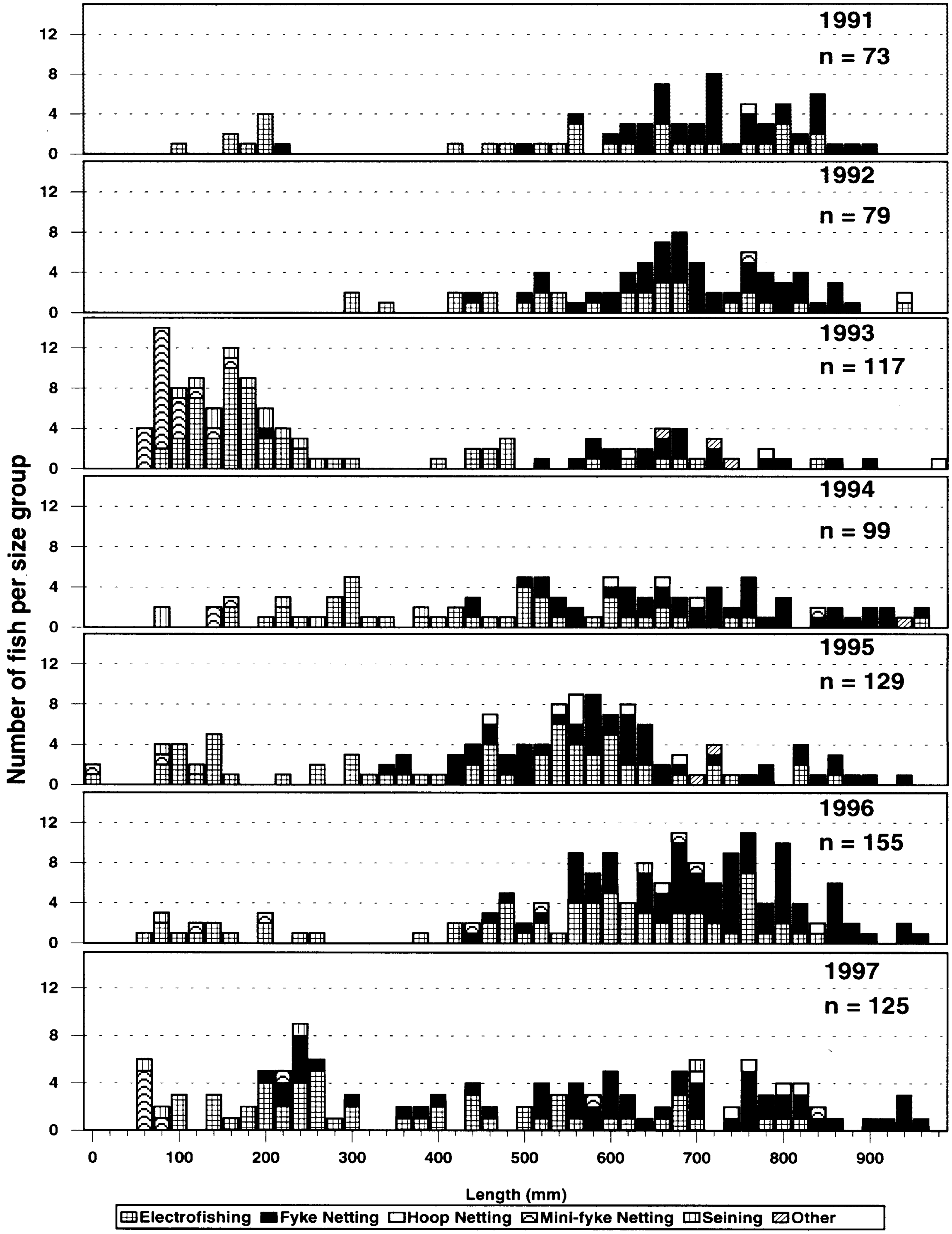

Figure 26. Length distribution, by gear type, for northern pike (*Esox lucius*) collected in Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

Length distributions by sampling stratum (Figure 27) showed that northern pike prefer the backwater strata. However, a major proportion of northern pike less than 200 mm TL was caught from the SCB stratum in most years. Except for 1993, the TWZ yielded mostly adult fish. The greatest number of large northern pike (>500 mm TL) was caught in 1996. These fish may have been part of the 1993 year class, although carryover from 1993 was not evident in the 1994 length distribution.

The distribution map for northern pike (Figure 28), showing total catch by sampling site, shows most fish coming from a small group of sites. These sites include the TWZ and several small backwaters in the upper pool and two other backwater areas in the midsection of the pool. Though small catches of northern pike occurred in many areas, nearly all of these sites were shoreline sites, and most were in off-channel areas.

White Bass

The LTRMP total catch of white bass in Pool 8 during 1991–97 was 19,955 (Table 14). More than 58% of the white bass total catch was produced in 1992 and 1994, whereas in 1993, the total catch of white bass was < 1,000. The most productive gear types, overall, were night electrofishing (9,567 fish), fyke netting (5,575 fish), and seining (1,519 fish). Night electrofishing and fyke netting combined for more than 75% of the total. No trends in total catch were evident over the period.

Table 14. Total catch of white bass (*Morone chrysops*) collected annually, by gear type and stratum, in Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

Fish sampling	1991	1992	1993	1994	1995	1996	1997	Overall
Gear								
Day electrofishing	77	271	24	464	193	144	161	1,334
Night electrofishing	765	2,059	160	2,149	1,134	2,268	1,032	9,567
Fyke netting	167	2,596	47	1,842	224	647	52	5,575
Tandem fyke netting	16	90	11	197	62	223	36	635
Mini-fyke netting	67	165	43	262	114	77	98	826
Tandem mini-fyke netting	32	47	1	136	22	36	6	280
Tandem hoop netting	11	42	0	0	0	0	0	53
Small hoop netting	0	0	0	5	3	3	0	11
Large hoop netting	0	0	5	7	11	23	9	55
Seining	51	414	4	807	60	42	141	1,519
Trawling	14	80	0	2	0	0	0	96
Gill netting	0	0	1	2	1	0	0	4
Annual total catch	1,200	5,764	296	5,873	1,824	3,463	1,535	19,955
Stratum								
Backwater, contiguous offshore	0	0	8	114	21	100	15	258
Backwater, contiguous shoreline	326	2,930	36	668	187	695	109	4,951
Impounded, offshore	48	142	9	224	72	163	29	687
Impounded, shoreline	91	149	55	1,954	258	113	132	2,752
Main channel border, unstructured	226	752	19	890	199	122	253	2,461
Main channel border, wing dam	72	61	2	25	23	73	13	269
Main channel trough	0	6	0	0	0	0	0	6
Side channel border	206	454	30	589	101	119	258	1,757
Tailwater zone	231	1,270	137	1,409	963	2,078	726	6,814
Annual total catch	1,200	5,764	296	5,873	1,824	3,463	1,535	19,955

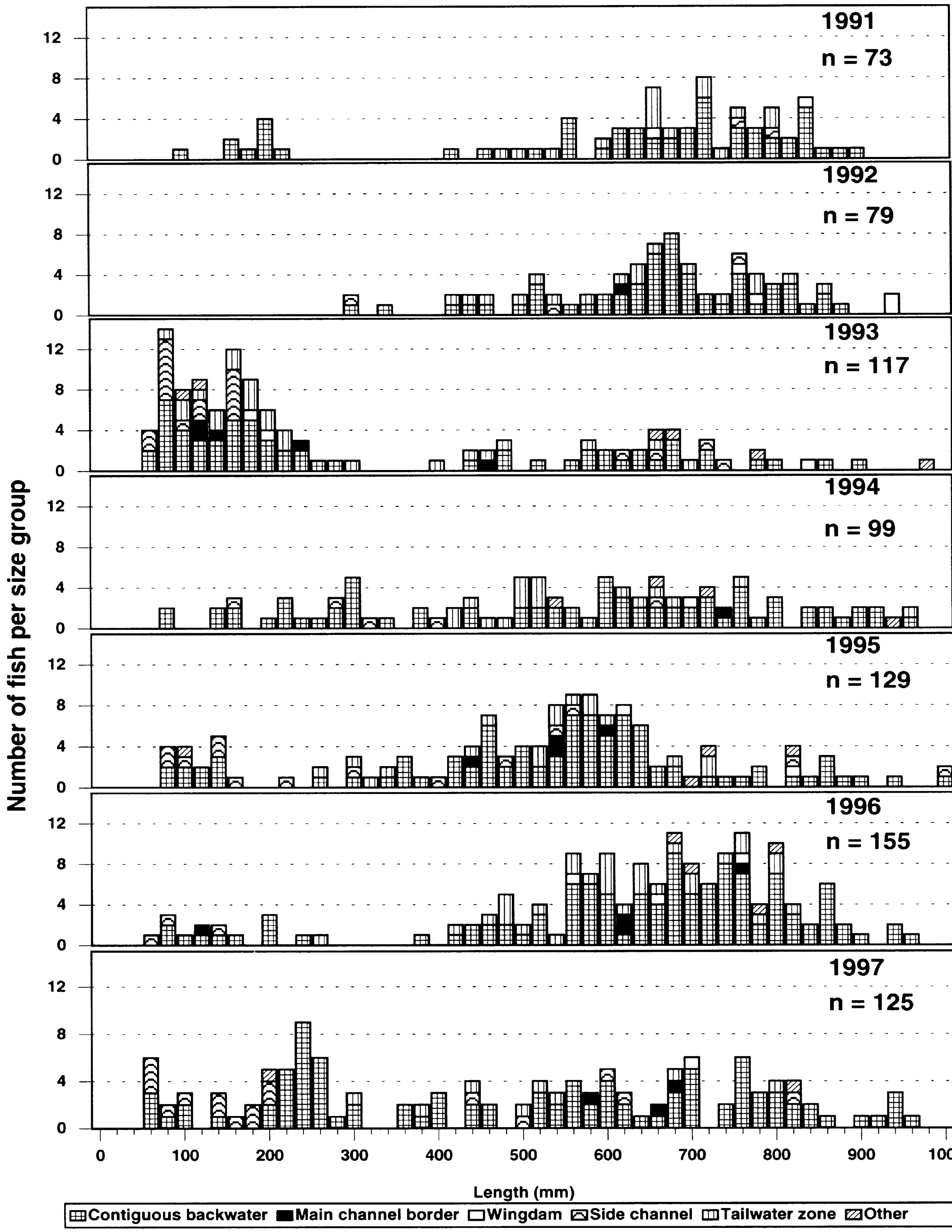

Figure 27. Length distribution, by sampling stratum, for northern pike (*Esox lucius*) collected in Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

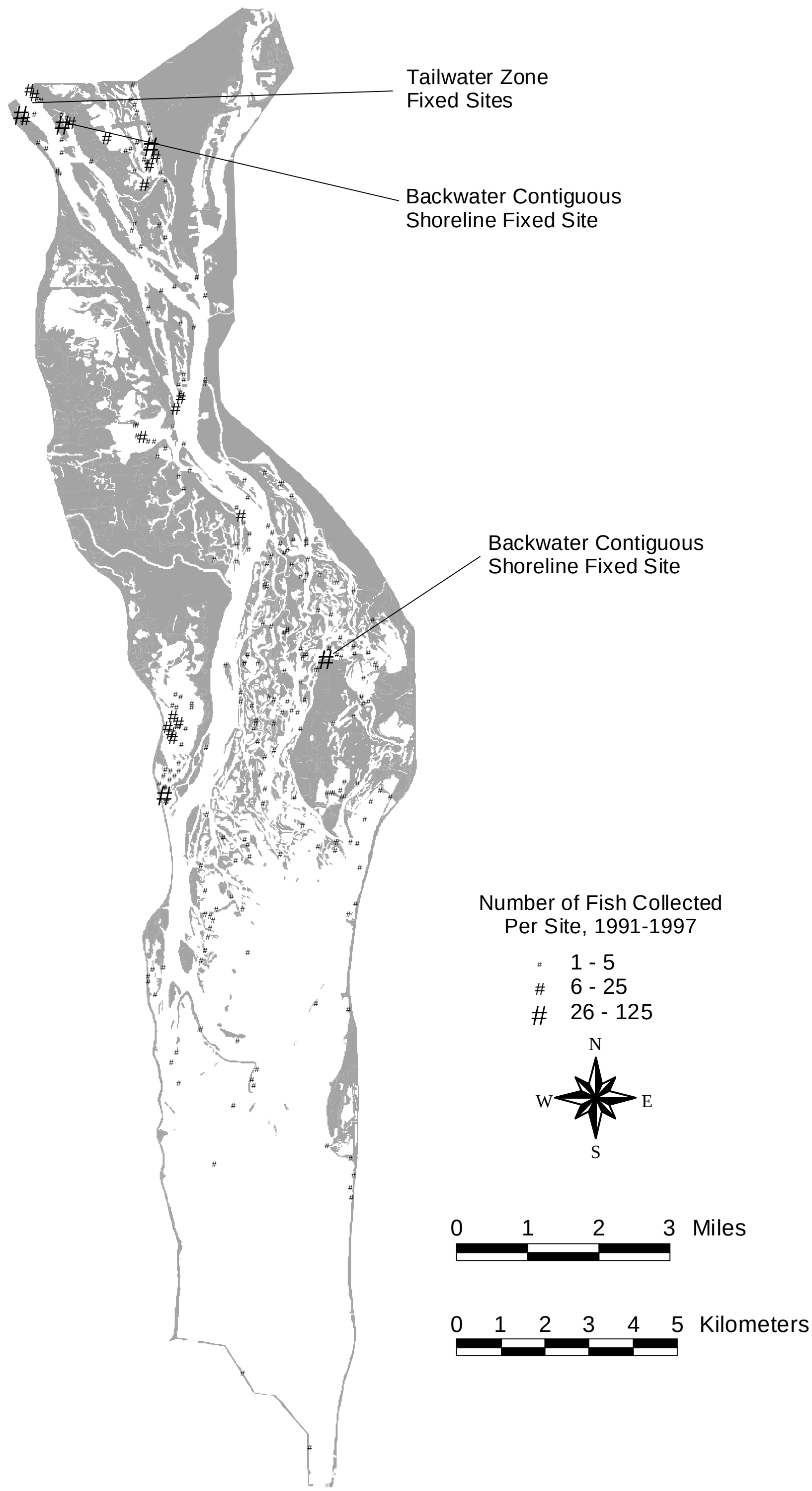

Figure 28. Total number of northern pike (*Esox lucius*) caught per sampling site in Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

The TWZ (6,814 fish) yielded the most white bass (Table 14). However, catches were also high in the BWCS (4,951 fish), IMPS (2,752 fish), and MCBU (2,461 fish) strata. In 1992, the bulk of the total catch came from the BWCS stratum, but in 1994 the highest catches were from the IMPS stratum. The TWZ consistently yielded large numbers of white bass.

White bass C/f (Figure 29) shows high catch rates for day electrofishing in 1994, fyke netting in 1992, and for night electrofishing in both years. For all three of these gear types, C/f declined substantially in 1995 and has remained low since. The fyke net C/f in 1992 was highly variable, as indicated by the large standard error.

Length distributions of white bass (Figure 30) by gear type show few fish longer than 140 mm TL in any year. These small white bass were presumed to be age-0, suggesting a population with very few adult fish. However, large white bass are known to be pelagic and may be poorly represented in the sampling design. Some carryover from the 1994 year class to 1995 and 1996 in the form of larger fish was present, but these numbers paled in comparison to those of small white bass. Gear selectivity was evident, as seining generally yielded white bass less than, and fyke netting greater than, 100 mm TL. A broad range of sizes was collected by electrofishing.

Length distributions for white bass showed no clear trend in preferences by a particular size range for a particular sampling stratum over time (Figure 31). In 1992, the dominant size classes (100–120 mm TL) were found primarily in the TWZ and the two backwater strata. In 1994, the impounded and MCBU strata were as productive as the TWZ, and backwater catches were proportionately lower. In 1996, the majority of white bass came from the TWZ.

The distribution map for white bass (Figure 32) showed a large portion of the total catch coming from a small number of sites. These sites included upper and lower pool sites, as well as channel-oriented and off-channel sites. Smaller numbers of white bass were collected nearly everywhere in Pool 8 in equal distribution.

Bluegill

The LTRMP total catch of bluegill in Pool 8 during 1991–97 was 42,281 (Table 15). Catches were consistently high in all years, with an increasing trend since 1994. The years 1996 and 1997 yielded the two highest catches overall. A variety of gears were effective for bluegill, with mini-fyke netting (11,336 fish), fyke netting (9,554 fish), and day electrofishing (9,510 fish) providing the greatest totals. The inception of SRS did not seem to affect catches among gear types, except seining catch, which increased substantially after 1992.

The BWCS stratum yielded 30,631 bluegill (Table 15), which was more than 72% of the total catch. The SCB (4,588 fish) and BWCO (3,594 fish) also yielded high catches by comparison. Catch has increased dramatically in the BWCO stratum in recent years, with the addition of several tandem fyke and mini-fyke net sets each period. However, catch also increased through time for most other strata, although not to the same degree.

An increase in bluegill C/f through time was evident for day electrofishing (Figure 33), but not for night electrofishing and fyke netting. The lowest C/f for day electrofishing occurred in 1992 and 1993; for fyke netting the lowest C/f was in 1994. Ironically, 1994 produced the highest catch for night electrofishing, but standard error was nearly as large as the mean C/f, making interpretation difficult. Pre-SRS C/f was much

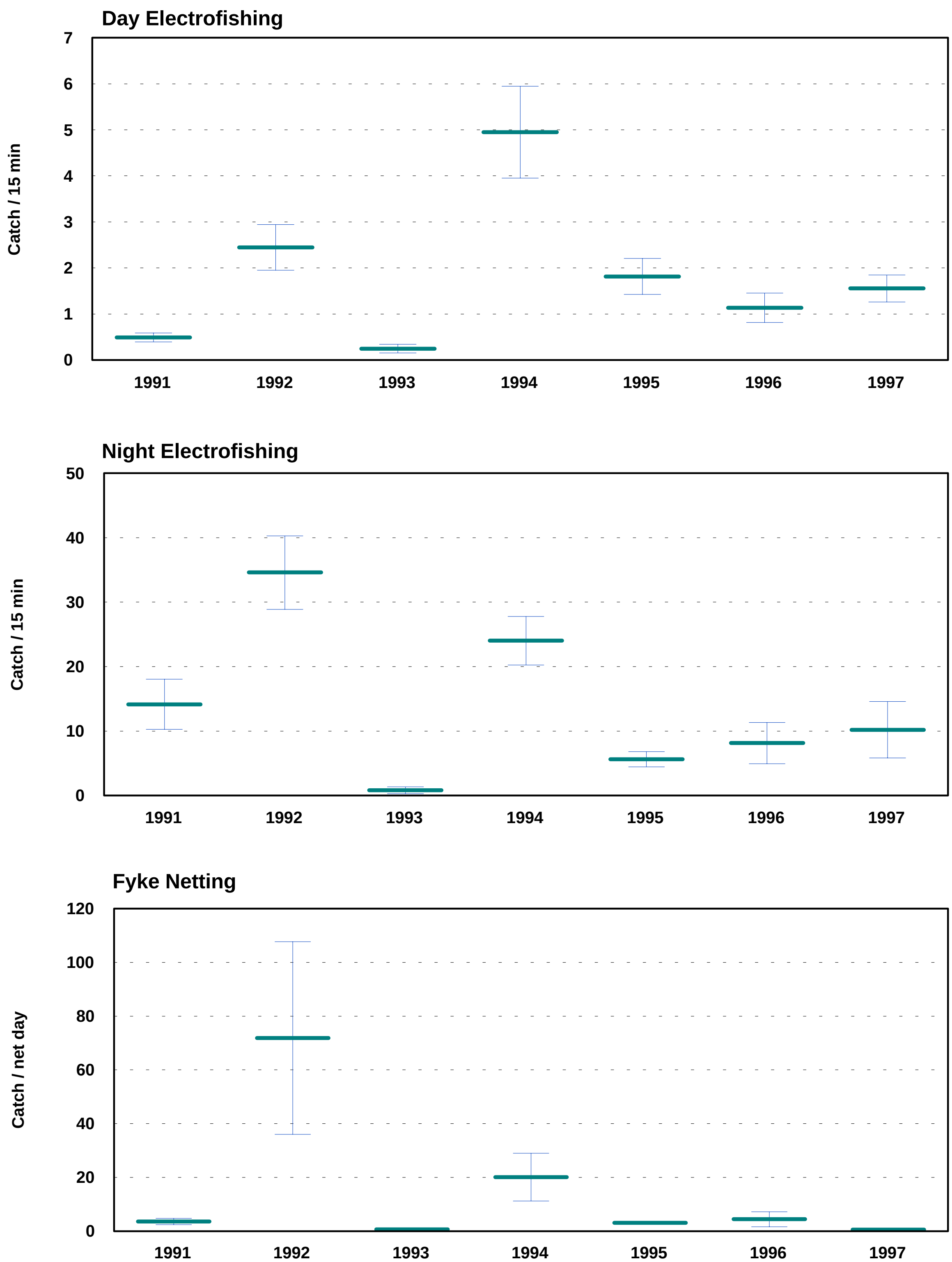

Figure 29. White bass (*Morone chrysops*) catch-per-unit-effort values (reachwide mean and standard error) for selected gear types from Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

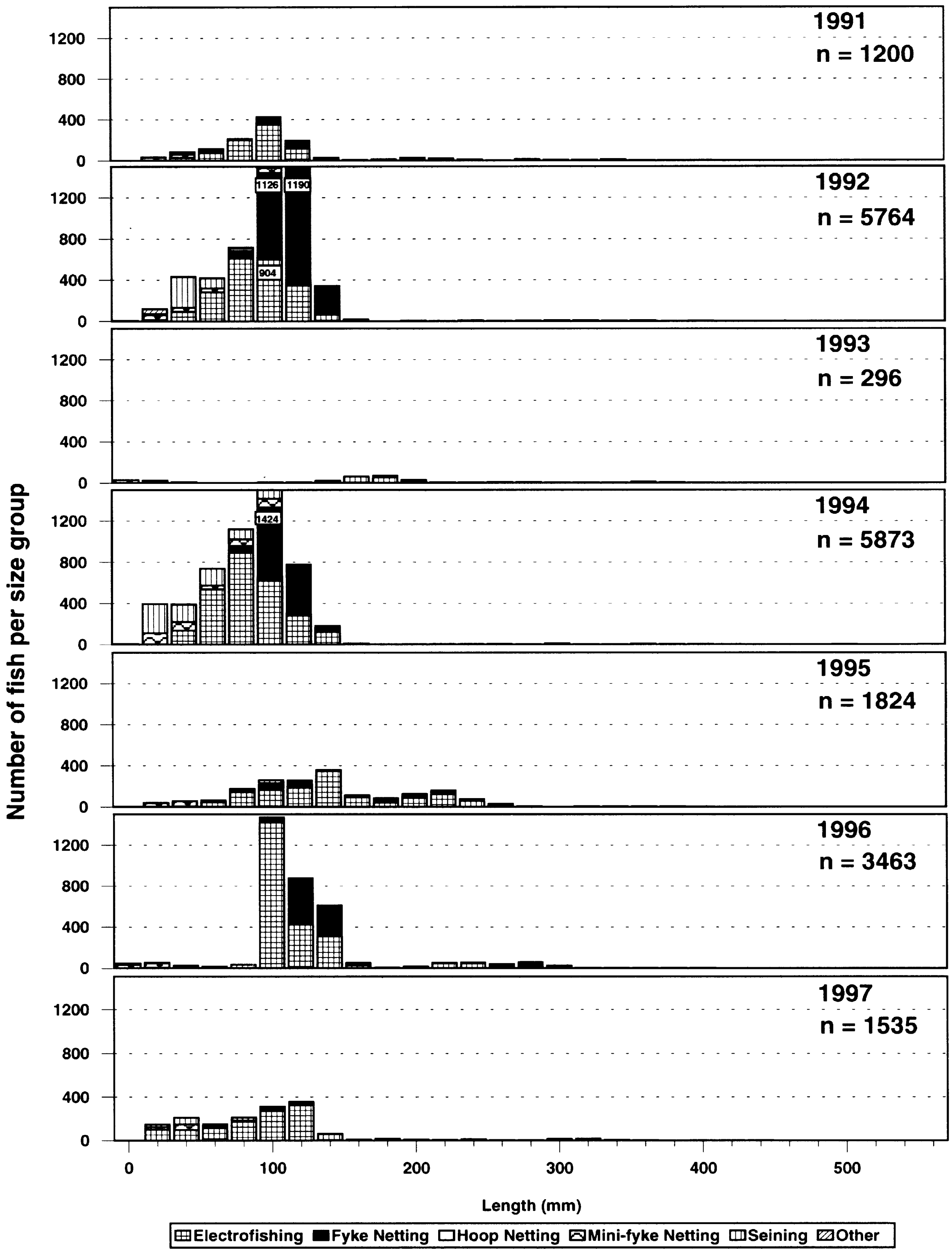

Figure 30. Length distribution, by gear type, for white bass (*Morone chrysops*) collected in Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

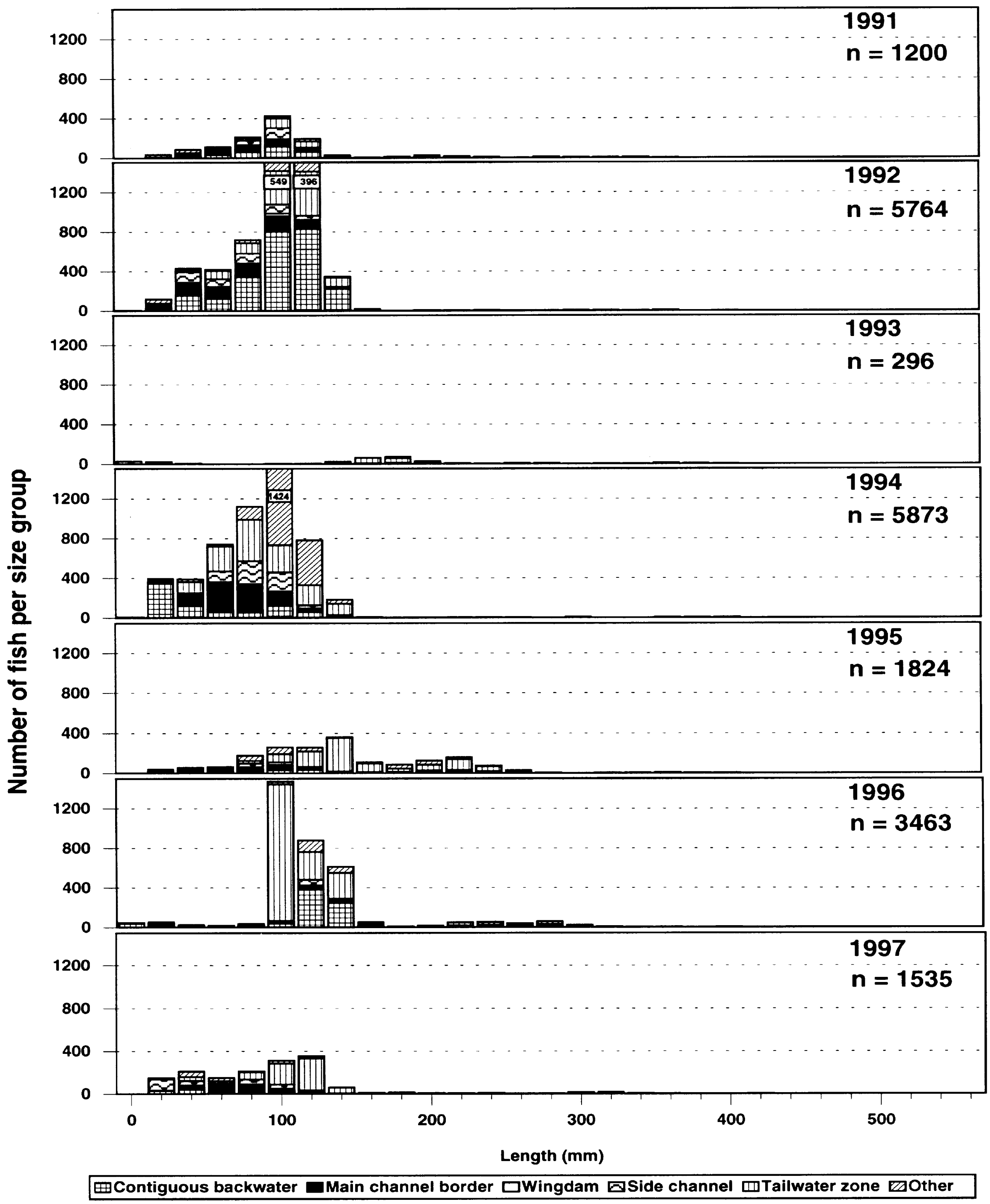

Figure 31. Length distribution, by sampling stratum, for white bass (*Morone chrysops*) collected in Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

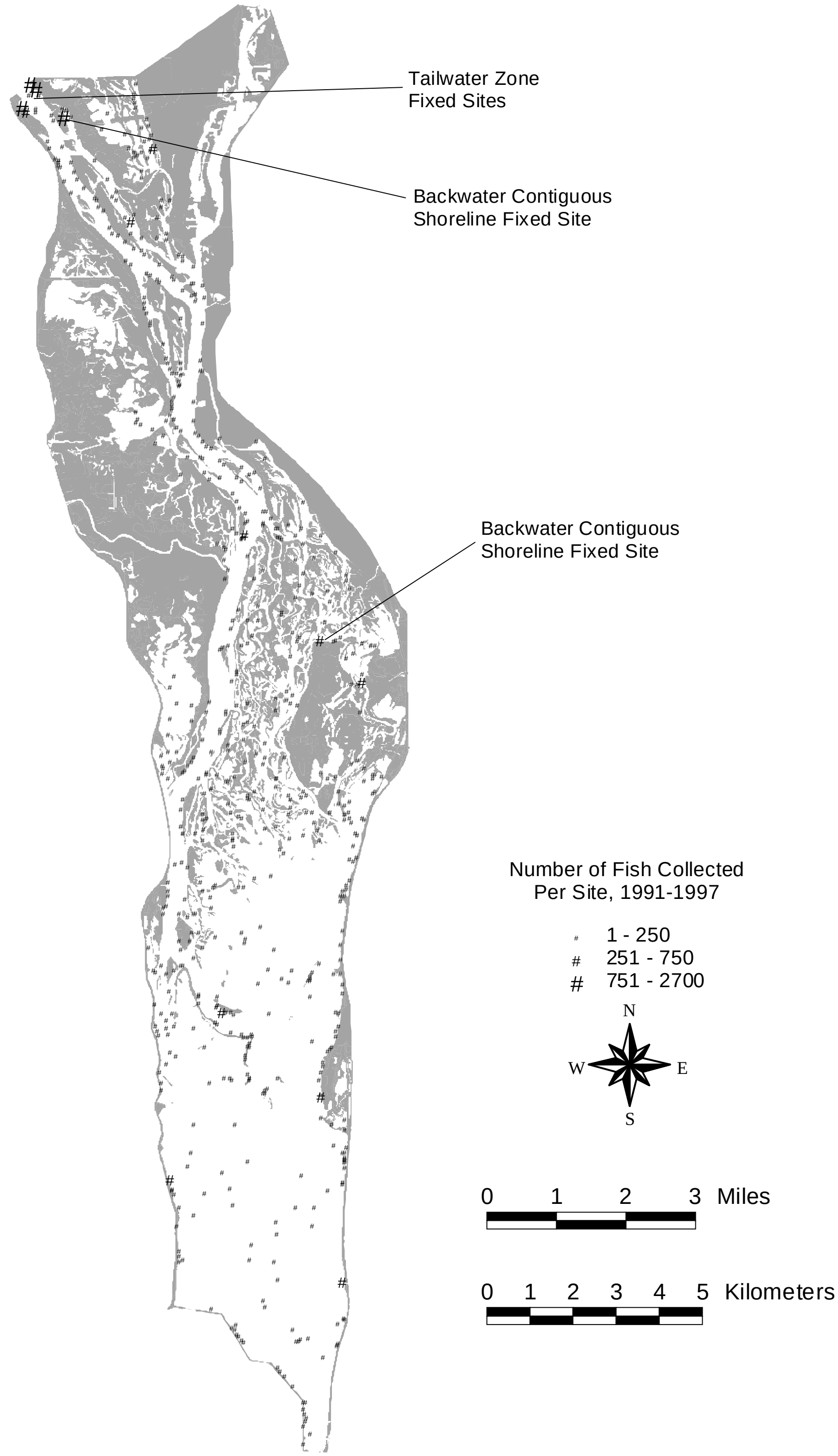

Figure 32. Total number of white bass (*Morone chrysops*) caught per sampling site in Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

Table 15. Total catch of bluegill (*Lepomis macrochirus*) collected annually, by gear type and stratum, in Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

Fish sampling	1991	1992	1993	1994	1995	1996	1997	Overall
Gear								
Day electrofishing	1,221	737	584	545	1,334	2,695	2,394	9,510
Night electrofishing	1,131	657	67	554	530	911	610	4,460
Fyke netting	1,415	1,279	837	487	1,539	1,696	2,301	9,554
Tandem fyke netting	0	0	21	55	522	522	748	1,868
Mini-fyke netting	836	2,558	1,846	632	809	2,691	1,964	11,336
Tandem mini-fyke netting	0	1	6	25	826	102	653	1,613
Tandem hoop netting	44	4	0	0	0	0	0	48
Small hoop netting	0	0	2	3	24	17	16	62
Large hoop netting	0	0	15	18	3	32	68	136
Seining	87	49	867	450	117	979	1,145	3,694
Trawling	0	0	0	0	0	0	0	0
Gill netting	0	0	0	0	0	0	0	0
Annual total catch	4,734	5,285	4,245	2,769	5,704	9,645	9,899	42,281
Stratum								
Backwater, contiguous offshore	0	0	40	95	1,364	640	1,455	3,594
Backwater, contiguous shoreline	4,257	5,073	3,328	2,165	3,056	6,345	6,407	30,631
Impounded, offshore	0	1	2	0	5	4	0	12
Impounded, shoreline	3	14	56	31	72	210	112	498
Main channel border, unstructured	26	28	83	82	109	453	213	994
Main channel border, wing dam	160	12	5	8	24	103	62	374
Main channel trough	0	0	0	0	0	0	0	0
Side channel border	76	51	545	369	854	1,670	1,023	4,588
Tailwater zone	212	106	186	19	220	220	627	1,590
Annual total catch	4,734	5,285	4,245	2,769	5,704	9,645	9,899	42,281

higher for fyke netting than in 1993 and later years, although the mean C/f value in 1997 fell within 1 standard error of the 1991–92 data, and catch rates seemed to be increasing.

The length distribution by gear type for bluegill (Figure 34) in Pool 8 showed striking gear selectivity. Nearly all bluegill less than 80 mm TL were caught by electrofishing and mini-fyke netting. The great majority of bluegill greater than 80 mm TL were caught in fyke nets. Bluegill less than 100 mm TL were present each year in sizable numbers, implying successful reproduction, but obscuring year classes in overlapping size ranges. The longest bluegill recorded was 266 mm TL.

Length distribution of bluegill by sampling stratum (Figure 35) illustrated, as did total catch, that bluegill preferred the backwater strata. This preference was evident across size ranges and years. The only exceptions to this preference were the smaller size ranges (0–40 mm TL), where some fish were present in the SCB stratum, and a few bluegill longer than 100 mm TL, which were found in the MCBU stratum in 1991 and in 1995–97.

The distribution map for bluegill in Pool 8 (Figure 36) showed many sites with total catches exceeding 150 and a handful of sites exceeding 500. The map showed bluegill concentrated primarily in four backwater areas, two each in the upper pool and midpool. However, bluegill were present in at least small numbers in most areas. They were noticeably absent from the offshore impounded section of the pool, perhaps limited by current flow.

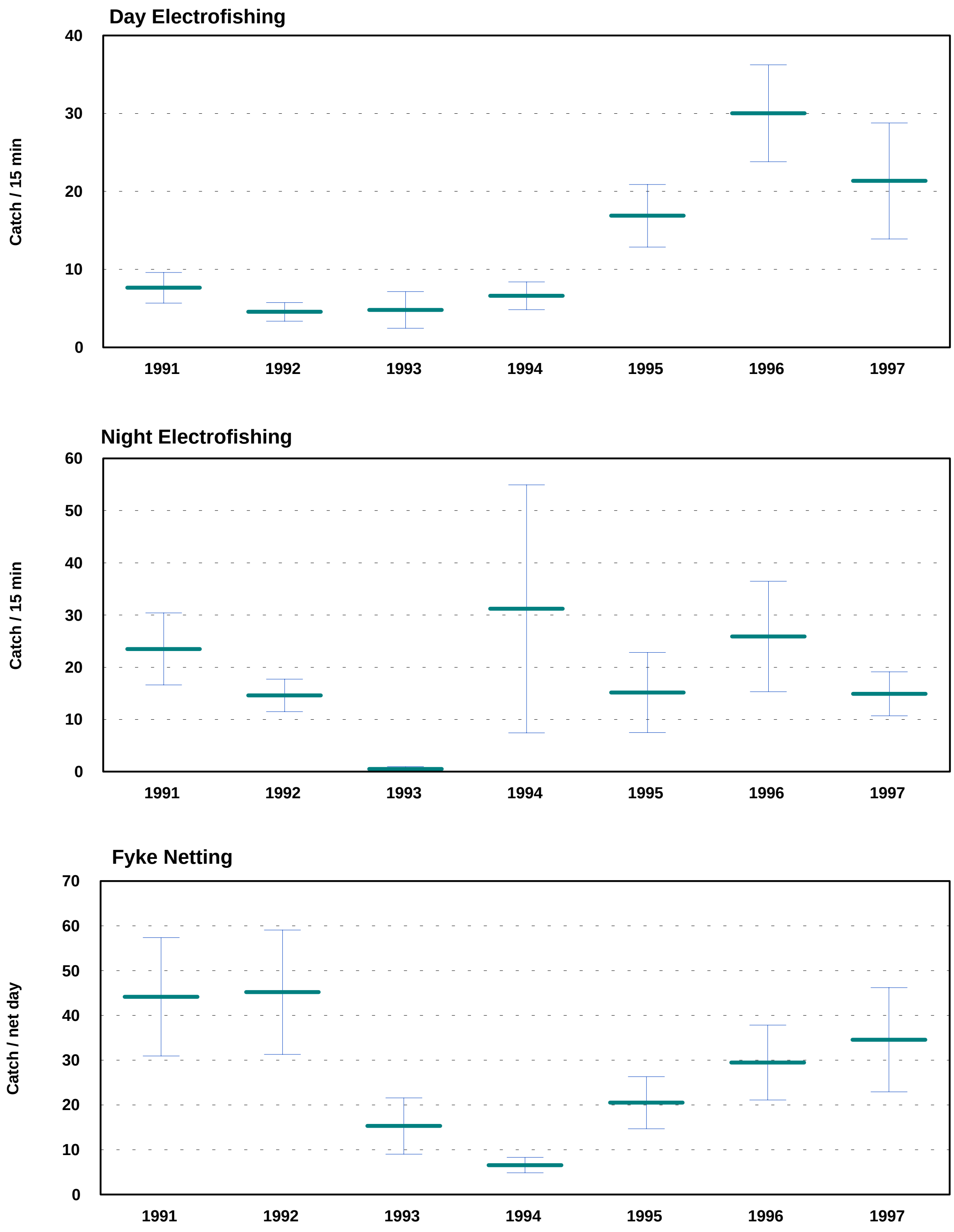

Figure 33. Bluegill (*Lepomis macrochirus*) catch-per-unit-effort values (reachwide mean and standard error) for selected gear types from Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

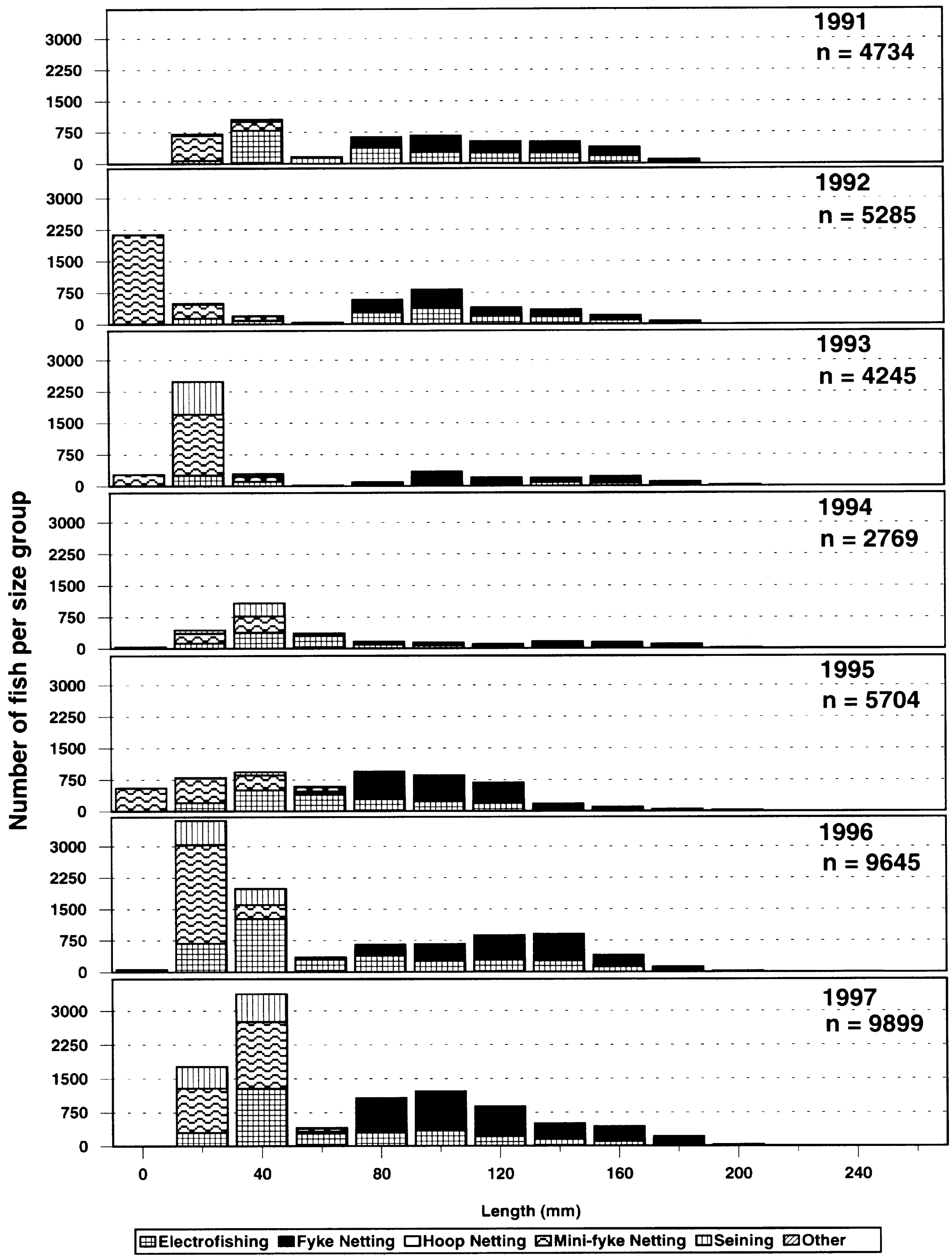

Figure 34. Length distribution, by gear type, for bluegill (*Lepomis macrochirus*) collected in Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

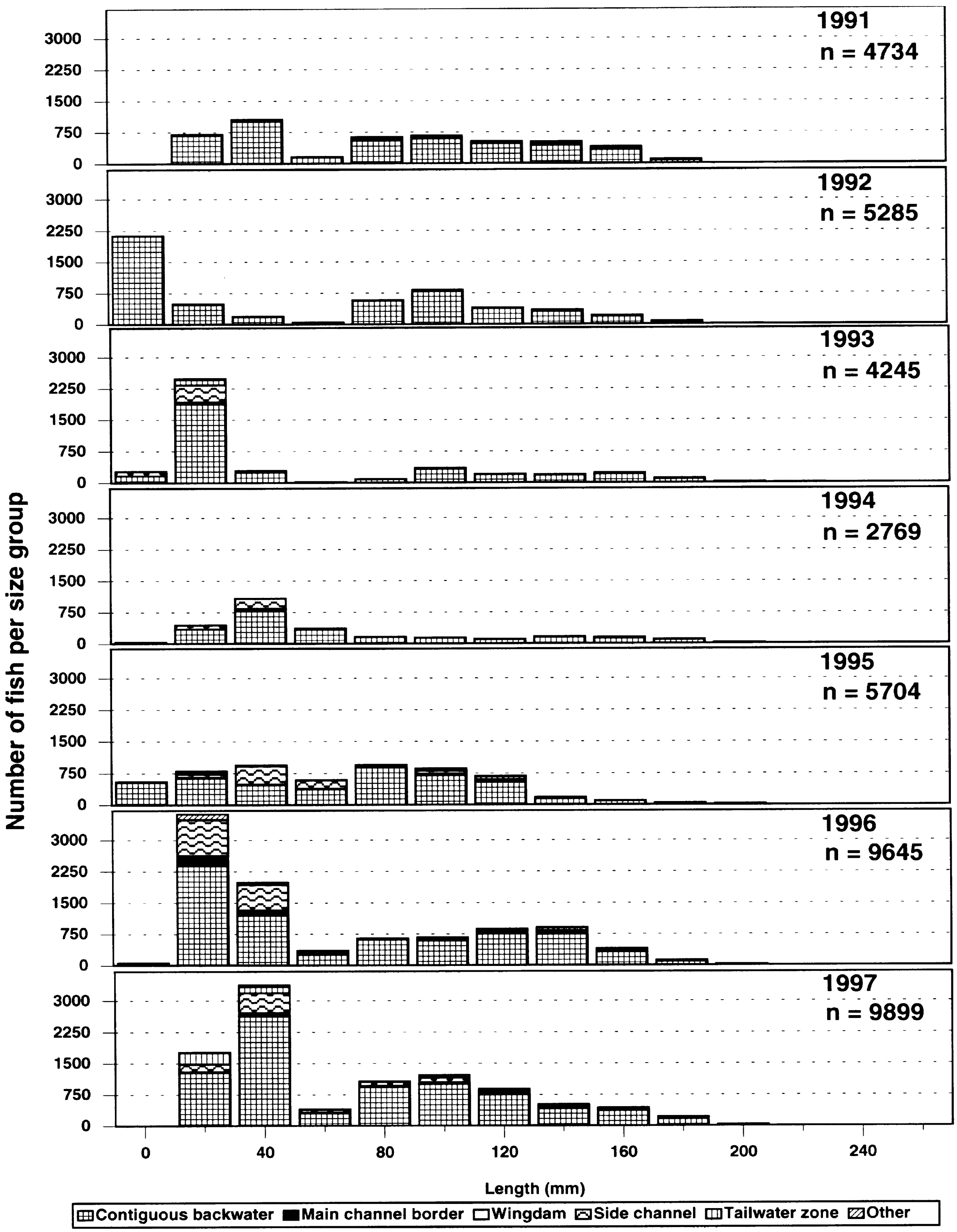

Figure 35. Length distribution, by sampling stratum, for bluegill (*Lepomis macrochirus*) collected in Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

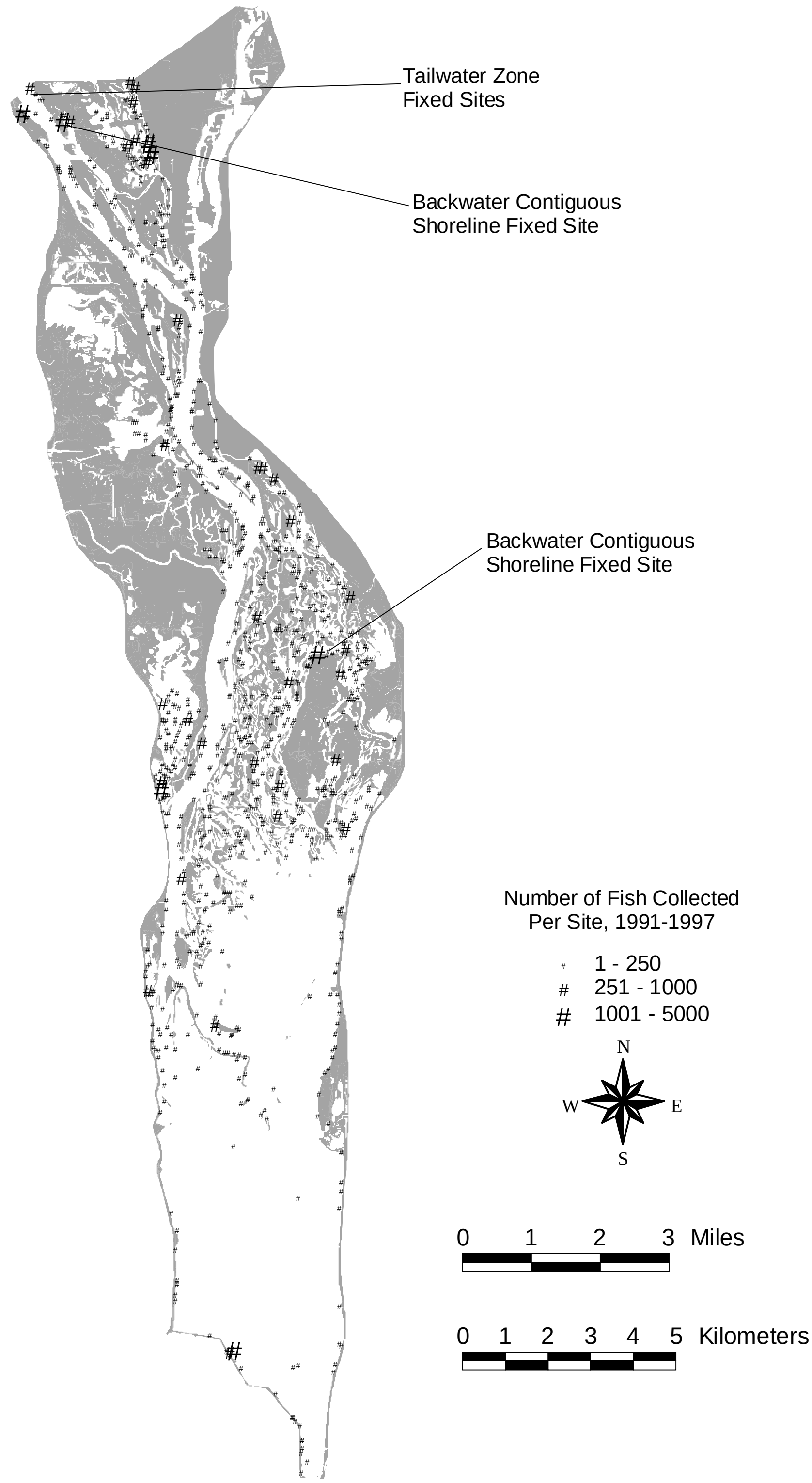

Figure 36. Total number of bluegill (*Lepomis macrochirus*) caught per sampling site in Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

Smallmouth Bass

The LTRMP total catch of smallmouth bass in Pool 8 during 1991–97 was 4,561 (Table 16). The total catch increased each year, except in 1997, from a low of 205 in 1991 to a high of 1,061 in 1996. Night electrofishing (2,716 fish) was by far the most effective gear, accounting for nearly 60% of the total catch. Day electrofishing (1,608 fish) provided another 35% of the total. The only other gear to produce more than 100 smallmouth bass during the period was seining (145 fish).

Table 16. Total catch of smallmouth bass (*Micropterus dolomieu*) collected annually, by gear type and stratum, in Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

Fish sampling	1991	1992	1993	1994	1995	1996	1997	Overall
Gear								
Day electrofishing	62	78	108	330	293	373	364	1,608
Night electrofishing	131	220	313	327	542	653	530	2,716
Fyke netting	0	0	2	0	0	3	0	5
Tandem fyke netting	0	0	1	1	2	1	0	5
Mini-fyke netting	0	3	0	6	14	15	10	48
Tandem mini-fyke netting	0	0	1	0	0	2	3	6
Tandem hoop netting	5	2	0	0	0	0	0	7
Small hoop netting	0	0	1	1	1	1	1	5
Large hoop netting	0	0	1	2	3	2	5	13
Seining	7	53	9	36	17	11	12	145
Trawling	0	0	0	0	0	0	0	0
Gill netting	0	0	1	1	1	0	0	3
Annual total catch	205	356	437	704	873	1,061	925	4,561
Stratum								
Backwater, contiguous offshore	0	0	2	0	0	2	3	7
Backwater, contiguous shoreline	22	71	34	77	49	54	63	370
Impounded, offshore	0	0	3	3	4	2	2	14
Impounded, shoreline	1	2	17	30	52	81	49	232
Main channel border, unstructured	22	23	92	125	187	215	215	879
Main channel border, wing dam	127	142	48	129	162	188	191	987
Main channel trough	0	0	0	0	0	0	0	0
Side channel border	12	60	57	197	169	226	211	932
Tailwater zone	21	58	184	143	250	293	191	1,140
Annual total catch	205	356	437	704	873	1,061	925	4,561

The TWZ (1,140 fish) had the highest stratum total catch (Table 16). The MCBW (987 fish), SCB (932 fish), and MCBU (879 fish) strata produced nearly equal numbers of smallmouth bass. Catch increased substantially over time in the IMPS, MCBU, SCB, and TWZ strata, but remained fairly stable in the MCBW stratum.

Both day and night electrofishing showed an increase in C/f through time for smallmouth bass (Figure 37), although C/f for day electrofishing was stable from 1994 to 1997. Both electrofishing gears had similar C/f values in 1996 and 1997, possibly indicating a slowing of population growth. Seining C/f was generally low and stable, except for 1992. The large standard error for 1992 indicated highly variable catches.

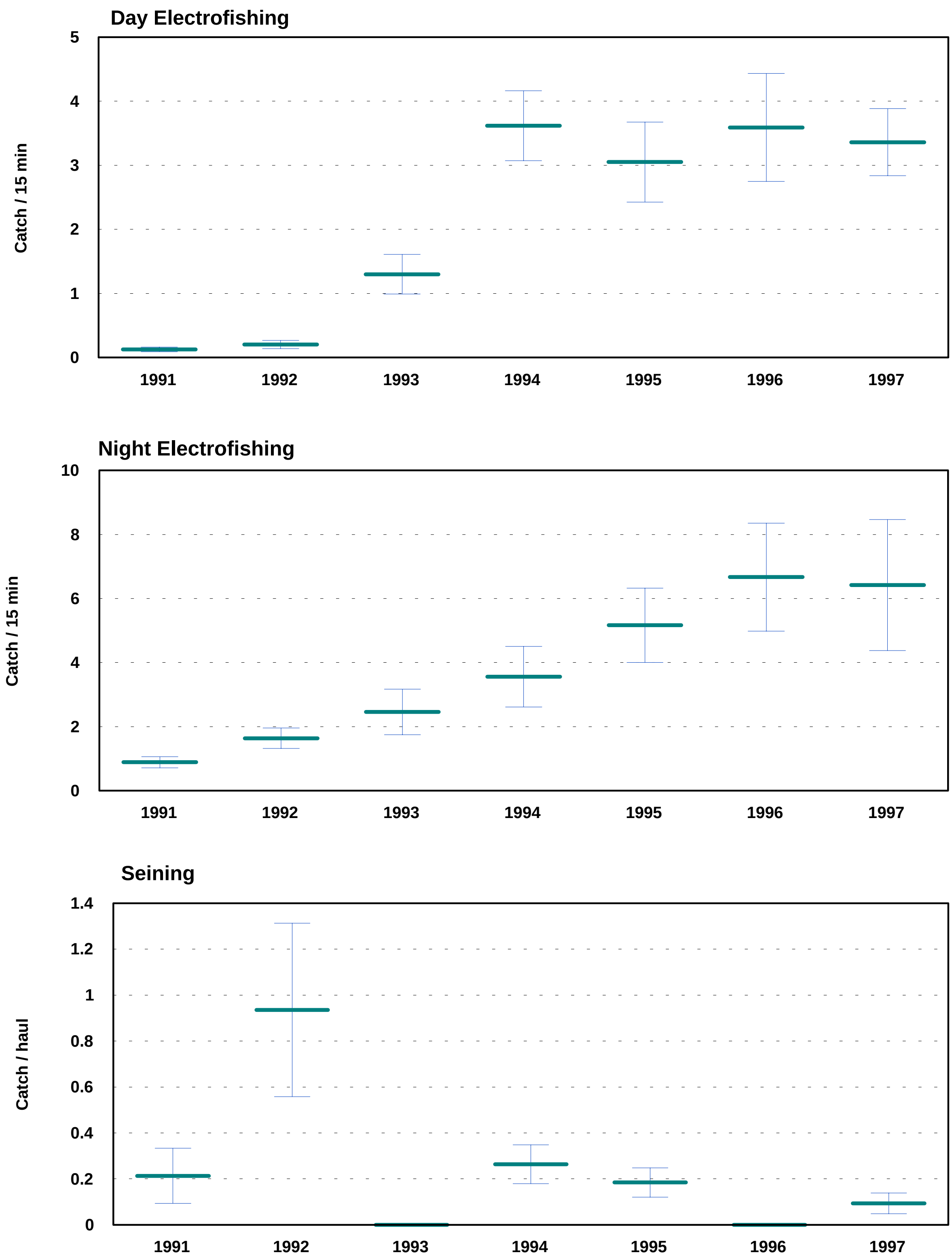

Figure 37. Smallmouth bass (*Micropterus dolomieu*) catch-per-unit-effort values (reachwide mean and standard error) for selected gear types from Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

The most obvious feature of the smallmouth bass length distribution, by gear type (Figure 38), was the importance of electrofishing in the catch. Electrofishing provided the bulk of nearly all size ranges in all years, although seining in 1991 and 1994, and mini-fyke netting in 1995–97, produced some small fish. Smallmouth bass about 100 mm TL, presumed to be age–0 fish, were present in larger numbers after 1994 than in 1993 and earlier. However, there may have been a good year class produced in 1992, as was indicated by a group of smallmouth bass that averaged 140 mm TL in 1993, 260 mm TL in 1994, and 360 mm TL in 1995. A strong 1994 year class also seems apparent from the number of fish proceeding through to the 160–300-mm range in succeeding years.

In general, smallmouth bass of all sizes came from a variety of strata (Figure 39). Small fish tended to be found in the MCBU and SCB strata. The MCBW and TWZ strata tended to produce large smallmouth bass, although MCBU and SCB sites produced large fish as well. The largest smallmouth bass recorded was 556 mm TL.

Smallmouth bass were found more often in the upper two-thirds of Pool 8 than in the lower pool (Figure 40), although impounded shoreline sites produced some fish. Sites that produced the most fish were clustered along the main channel and in some off-channel sloughs in the midpool. The highest catches occurred below Lock and Dam 7 at the upper end of the pool. Smallmouth bass were seldom caught in offshore areas, impounded or backwater.

Largemouth Bass

The LTRMP total catch of largemouth bass in Pool 8 during 1991–97 was 6,643 (Table 17). The greatest total catch occurred in 1995 (2,024 fish), and the smallest total came during 1993 (343 fish). Total catches for largemouth bass appeared cyclical, as high numbers also occurred in 1991 (1,086 fish). The most effective gear type was day electrofishing (3,607 fish), followed by mini-fyke netting (1,243 fish) and night electrofishing (1,138 fish). Electrofishing catches were the most consistent over time.

Nearly 66% (4,377 fish) of all largemouth bass were collected in the BWCS stratum (Table 17). The SCB sites (1,550 fish) provided another 23%, with remaining strata contributing little toward the total catch. Although BWCS sites consistently produced many largemouth bass, the SCB stratum yielded most of its fish in 1995 and fewer numbers in other years.

Catch rates for largemouth bass (Figure 41) show a cyclical trend similar to that of the total catch. Day electrofishing C/f reached a peak in 1996, after a low in 1992–93. Night electrofishing C/f was high in 1991, then dropped through 1993, rebounded in 1994, and dropped again after that time. Seining C/f was generally low, but exhibited peaks in 1991 and 1995.

The length distribution by gear type for largemouth bass (Figure 42) indicated the importance of electrofishing across most size ranges. Seining, in 1995, and mini-fyke netting, in 1995 and 1996, were the only other gears to produce large numbers of largemouth bass. Largemouth bass 100 mm TL, presumed to be age-0 fish, were numerous in 1991 and in 1994–97. However, carryover of year classes seems to be sporadic, and largemouth bass longer than 200 mm TL were few after 1991, with the exception of 1996.

The length distribution of largemouth bass by sampling stratum (Figure 43) indicates that the backwater strata provided suitable conditions for the widest range of sizes, but that SCB sites were utilized by small fish in 1995–97, and large largemouth bass were found in a variety of strata. The longest largemouth bass recorded was 507 mm TL.

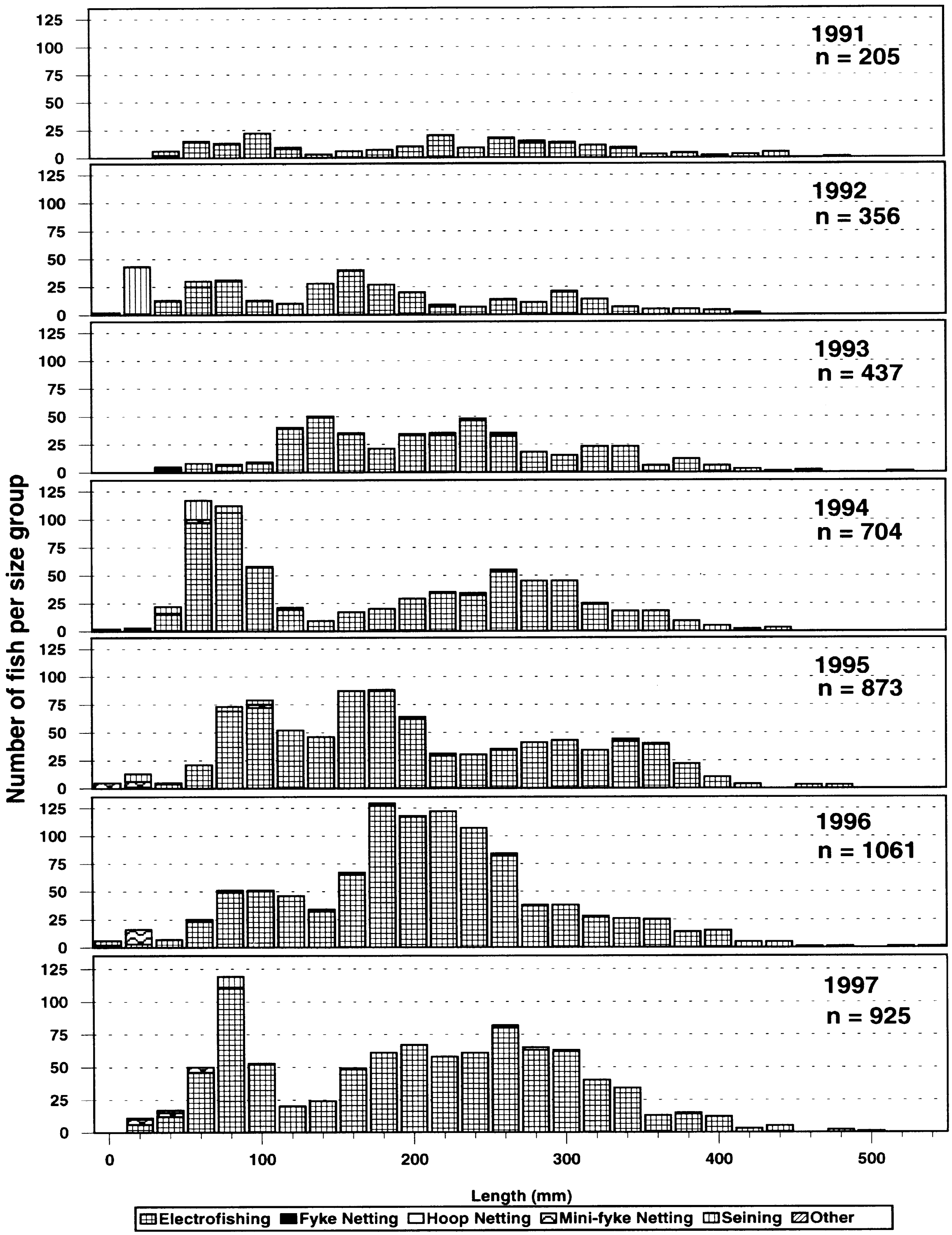

Figure 38. Length distribution, by gear type, for smallmouth bass (*Micropterus dolomieu*) collected in Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

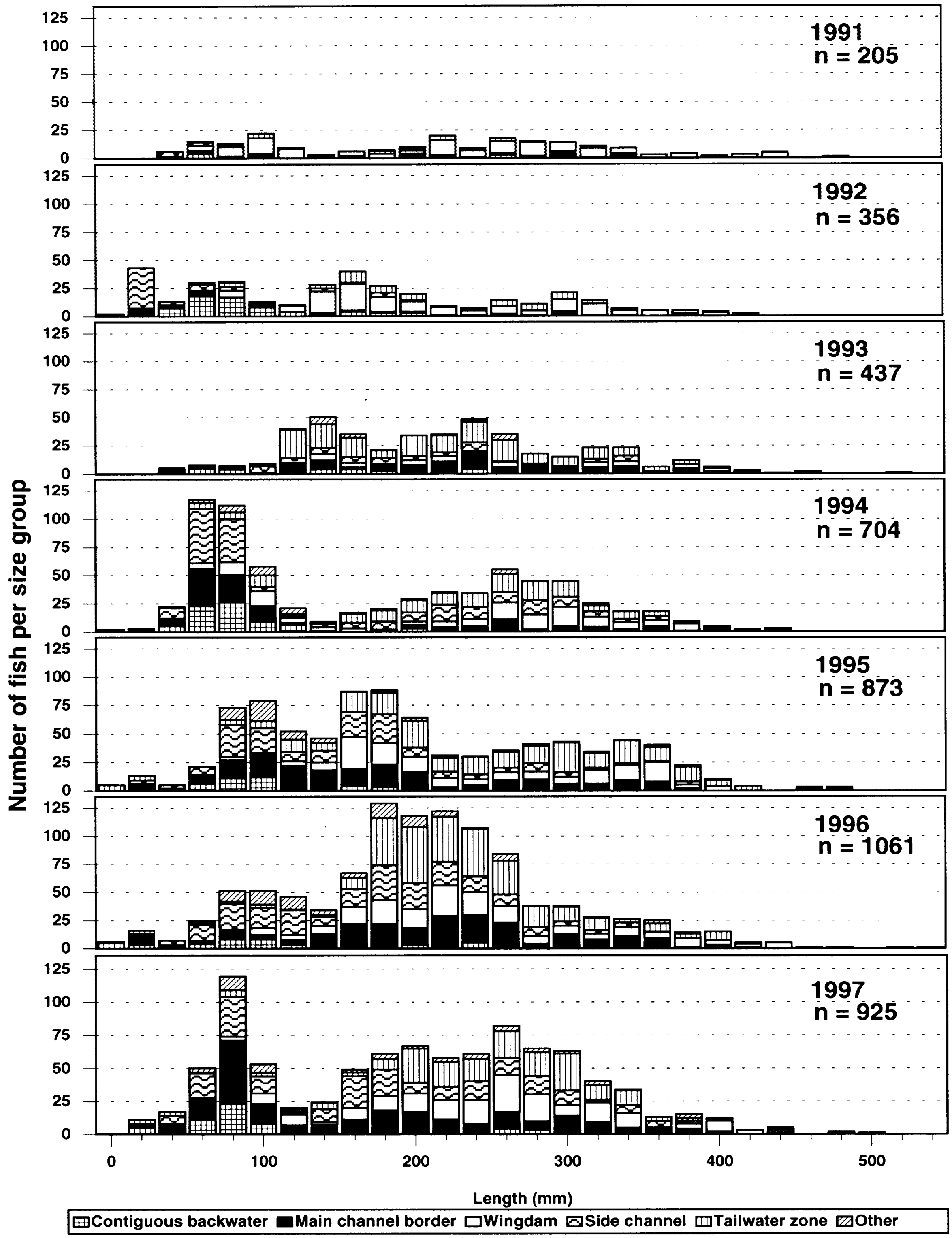

Figure 39. Length distribution, by sampling stratum, for smallmouth bass (*Micropterus dolomieu*) collected in Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

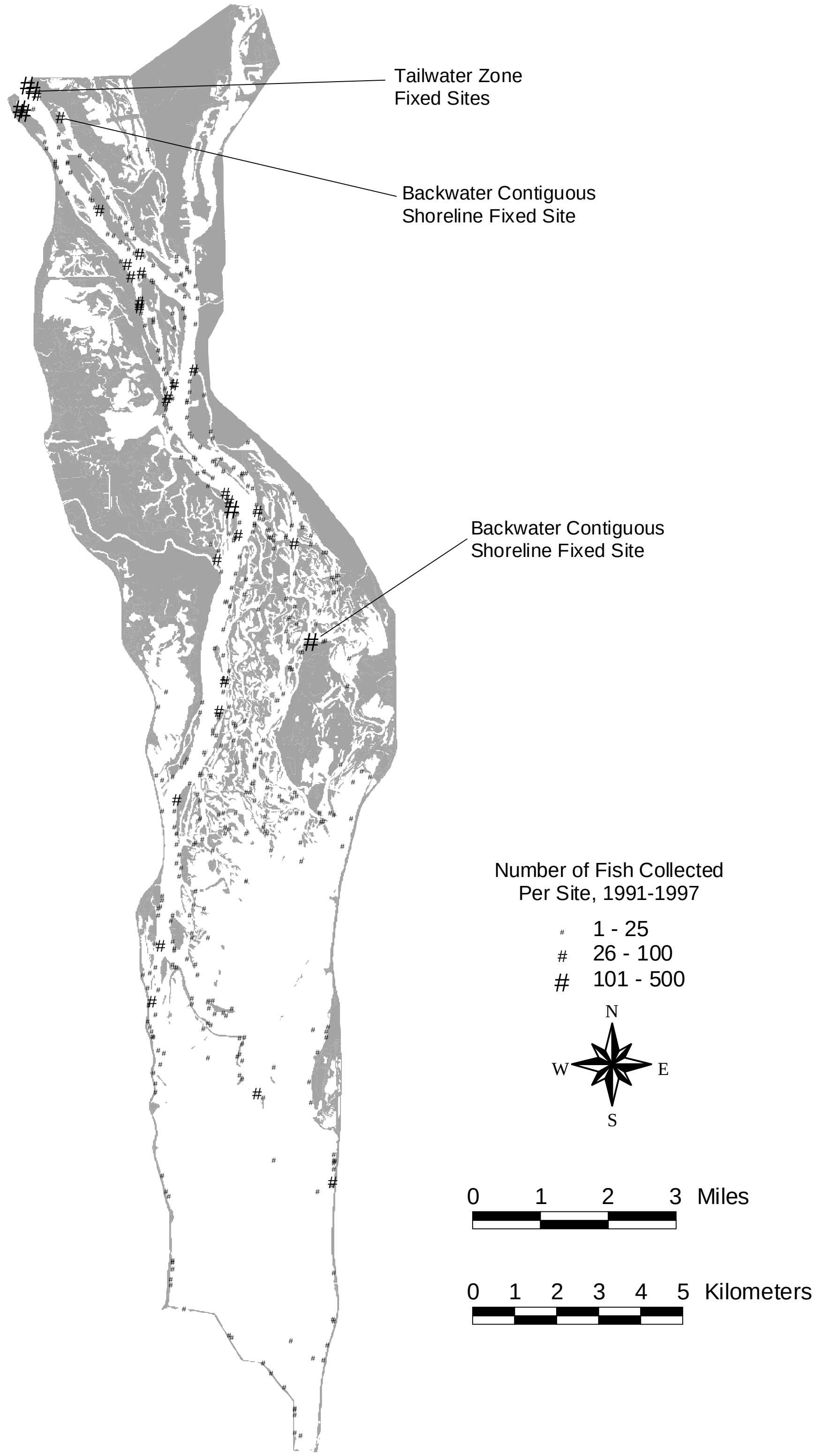

Figure 40. Total number of smallmouth bass (*Micropterus dolomieu*) caught per sampling site in Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

Table 17. Total catch of largemouth bass (*Micropterus dolomieu*) collected annually, by gear type and stratum, in Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

Fish sampling	1991	1992	1993	1994	1995	1996	1997	Overall
Gear								
Day electrofishing	581	302	278	479	519	995	453	3,607
Night electrofishing	400	144	27	106	203	182	76	1,138
Fyke netting	15	11	6	18	25	16	7	98
Tandem fyke netting	0	0	1	4	1	2	0	8
Mini-fyke netting	34	2	8	40	1,027	78	54	1,243
Tandem mini-fyke netting	0	0	0	2	1	6	8	17
Tandem hoop netting	0	0	0	0	0	0	0	0
Small hoop netting	0	0	0	0	0	0	0	0
Large hoop netting	0	0	0	0	0	0	0	0
Seining	56	28	23	57	248	72	48	532
Trawling	0	0	0	0	0	0	0	0
Gill netting	0	0	0	0	0	0	0	0
Annual total catch	1,086	487	343	706	2,024	1,351	646	6,643
Stratum								
Backwater, contiguous offshore	0	0	1	5	2	8	8	24
Backwater, contiguous shoreline	978	439	278	598	723	958	403	4,377
Impounded, offshore	0	0	0	1	0	0	0	1
Impounded, shoreline	2	0	13	13	5	19	53	105
Main channel border, unstructured	10	17	7	17	15	14	37	117
Main channel border, wing dam	16	2	0	1	1	14	11	45
Main channel trough	0	0	0	0	0	0	0	0
Side channel border	31	10	12	50	1,139	204	104	1,550
Tailwater zone	49	19	32	21	139	134	30	424
Annual total catch	1,086	487	343	706	2,024	1,351	646	6,643

The distribution map for largemouth bass in Pool 8 (Figure 44) shows three backwater sites that produced large catches of fish and many sites that had lower numbers of largemouth bass. Nearly all of the sites for largemouth bass were located in the upper two-thirds of the pool, and most were off-channel areas.

Black Crappie

The LTRMP total catch of black crappie in Pool 8 during 1991–97 was 13,826 (Table 18). Annually, total catches were fairly consistent, ranging from a low of 1,098 in 1991 to a high of 2,767 in 1996. Fyke netting (8,515 fish) was the top producer for black crappie, followed by tandem fyke netting (2,189 fish) and day electrofishing (772 fish). Catches with most gear types increased substantially when SRS was implemented, but these increases were masked by the dominance of fyke netting total catch, which did not increase a great deal after SRS began.

The BWCS stratum (9,599 fish) yielded nearly 70% of all black crappie collected. The BWCO sites (2,698 fish), first sampled in 1993, provided another 20% of the total catch. Most other strata contributed similarly to the total. Catches remained consistent across strata before and after SRS was implemented.

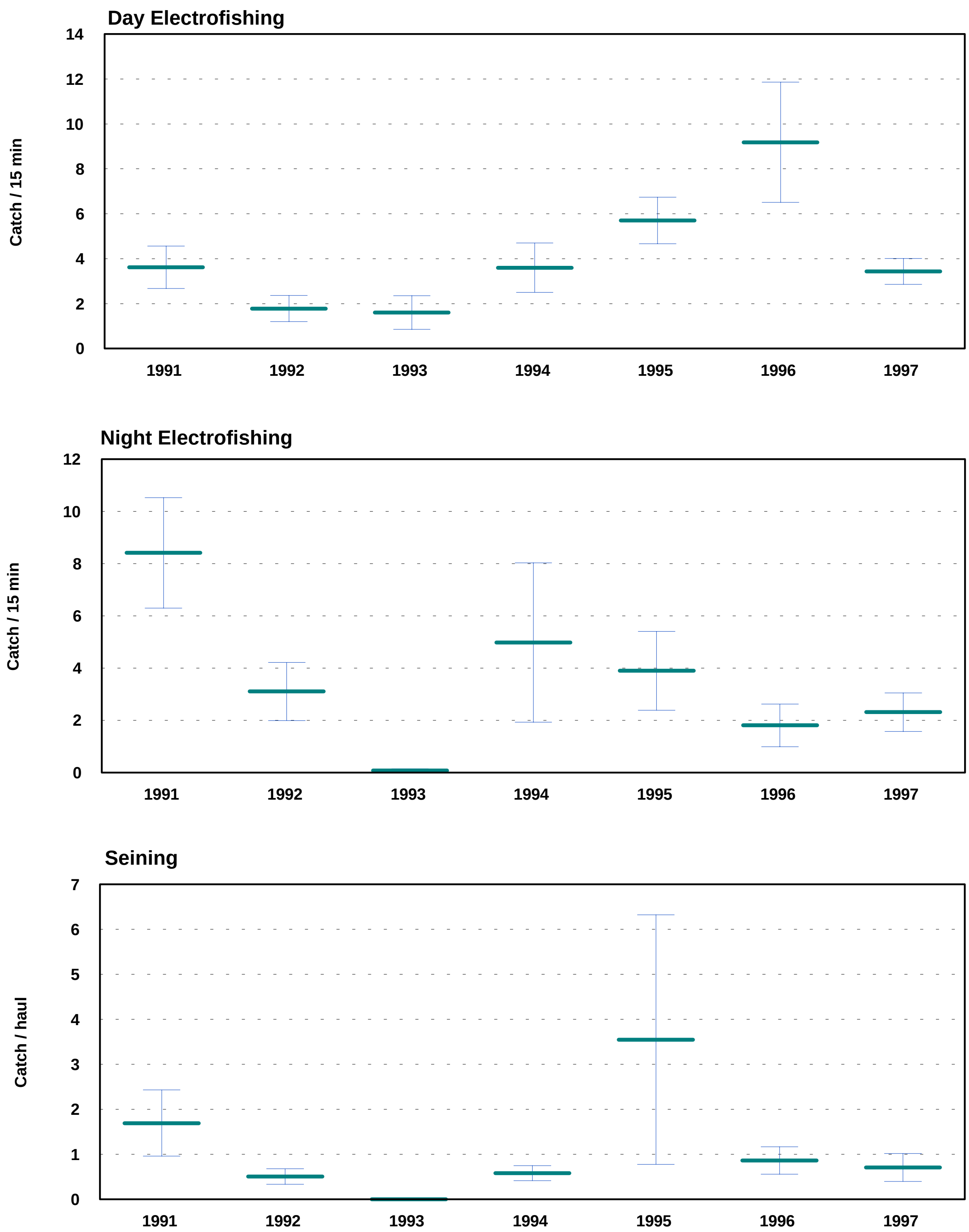

Figure 41. Largemouth bass (*Micropterus salmoides*) catch-per-unit-effort values (reachwide mean and standard error) for selected gear types from Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

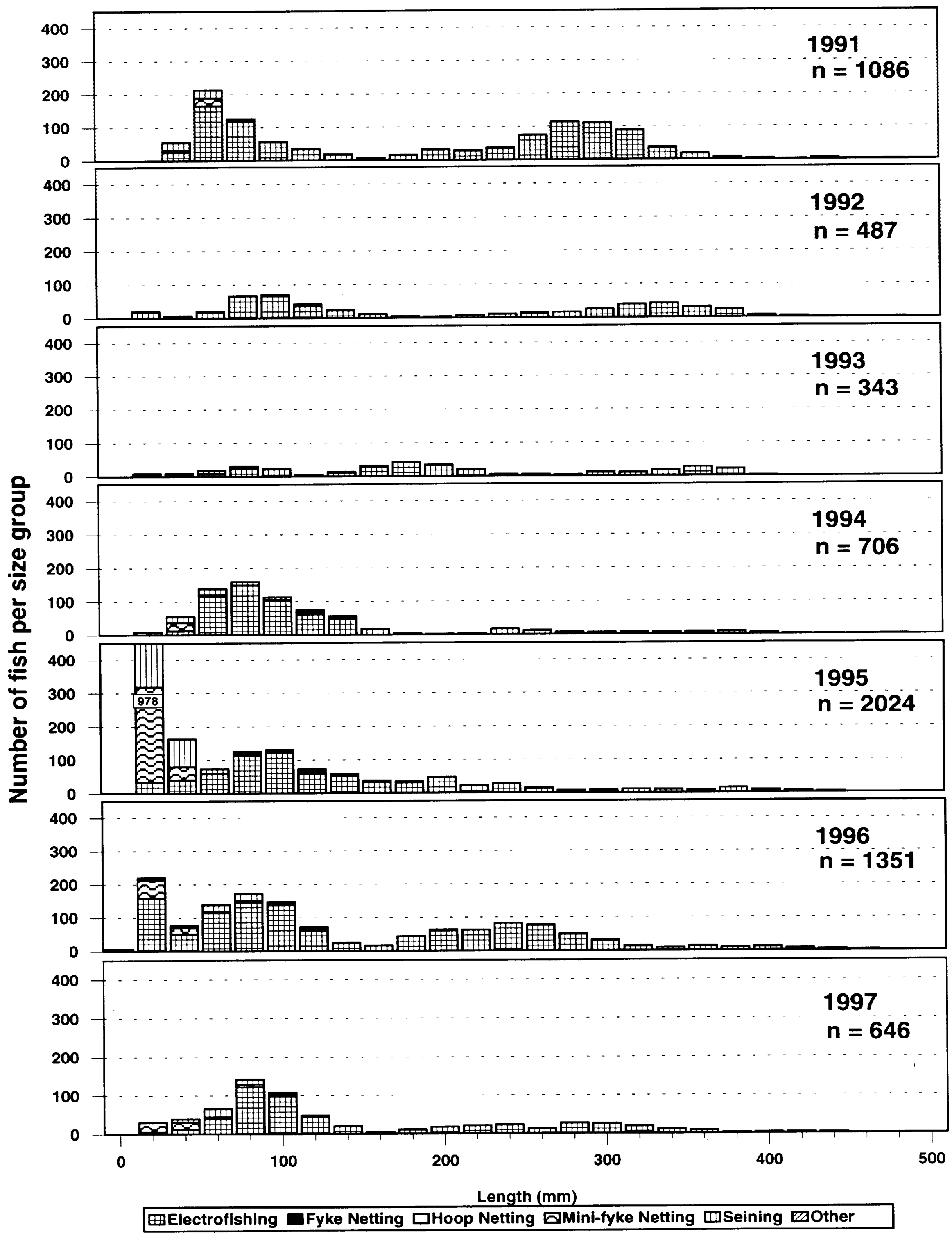

Figure 42. Length distribution, by gear type, for largemouth bass (*Micropterus salmoides*) collected in Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

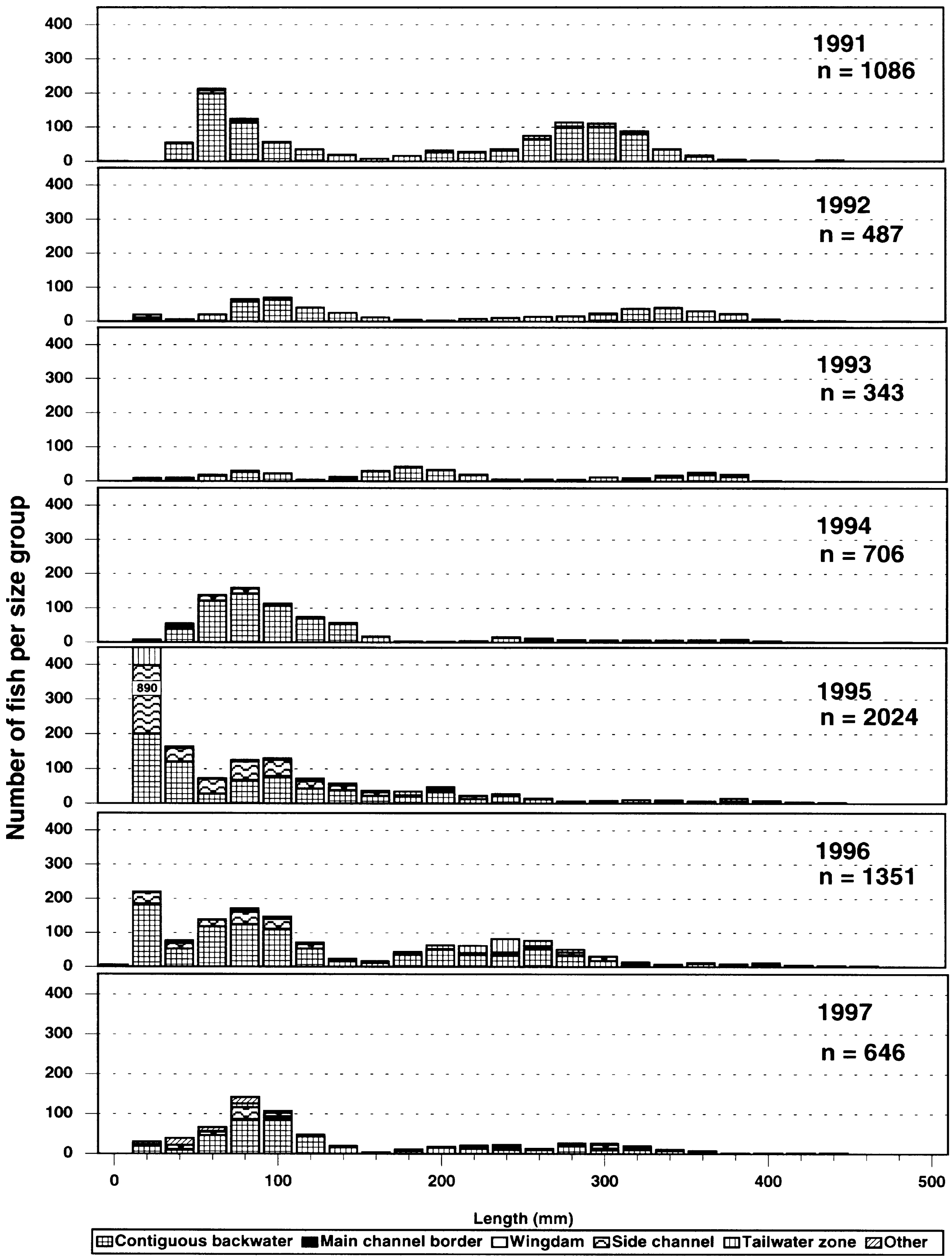

Figure 43. Length distribution, by sampling stratum, for largemouth bass (*Micropterus salmoides*) collected in Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

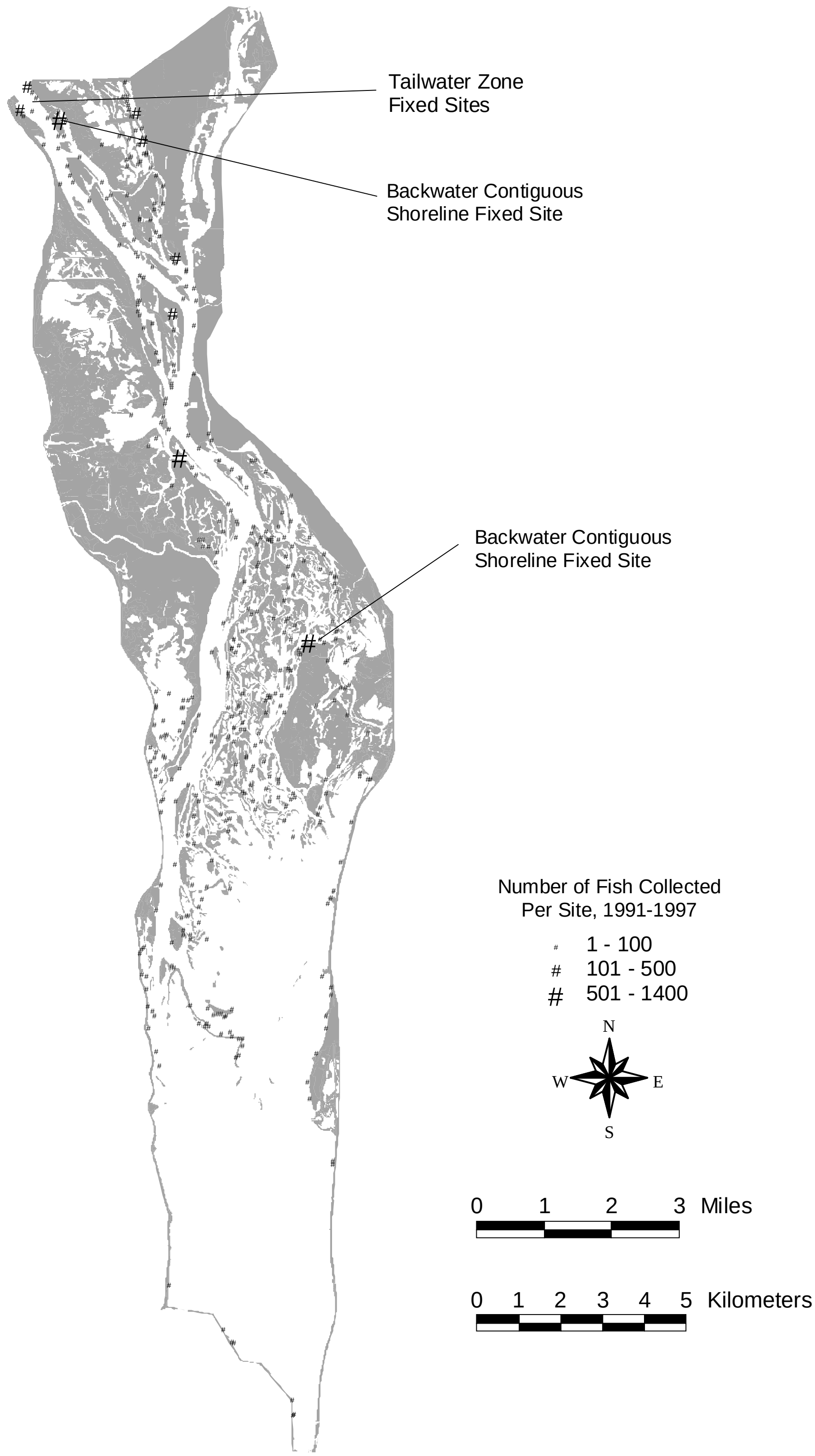

Figure 44. Total number of largemouth bass (*Micropterus salmoides*) caught per sampling site in Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

Table 18. Total catch of black crappie (*Pomoxis nigromaculatus*) collected annually, by gear type and stratum, in Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

Fish sampling	1991	1992	1993	1994	1995	1996	1997	Overall
Gear								
Day electrofishing	95	97	48	147	112	167	106	772
Night electrofishing	98	89	46	133	110	122	85	683
Fyke netting	654	1,672	1,387	1,216	1,011	1,258	1,317	8,515
Tandem fyke netting	1	0	356	190	241	980	421	2,189
Mini-fyke netting	188	50	36	140	83	131	60	688
Tandem mini-fyke netting	0	0	1	71	22	36	108	238
Tandem hoop netting	47	32	0	0	0	0	0	79
Small hoop netting	0	0	7	33	27	6	14	87
Large hoop netting	0	0	25	158	32	51	141	407
Seining	15	6	34	60	3	16	30	164
Trawling	0	4	0	0	0	0	0	4
Gill netting	0	0	0	0	0	0	0	0
Annual total catch	1,098	1,950	1,940	2,148	1,641	2,767	2,282	13,826
Stratum								
Backwater, contiguous offshore	0	0	368	386	309	1,025	610	2,698
Backwater, contiguous shoreline	951	1,823	1,283	1,536	1,094	1,533	1,379	9,599
Impounded, offshore	1	0	2	12	4	12	4	35
Impounded, shoreline	13	23	203	58	72	17	72	458
Main channel border, unstructured	13	6	19	22	25	37	29	151
Main channel border, wing dam	42	9	2	43	16	24	44	180
Main channel trough	0	2	0	0	0	0	0	2
Side channel border	8	20	16	57	93	57	91	342
Tailwater zone	70	67	47	34	28	62	53	361
Annual total catch	1,098	1,950	1,940	2,148	1,641	2,767	2,282	13,826

Black crappie C/f (Figure 45), depicted for day and night electrofishing and fyke netting, did not indicate a trend in black crappie relative abundance. Day electrofishing catch rates rose in 1994 and remained at an elevated level over previous years through 1997. Night electrofishing catch rates were consistently around two black crappie per 15 minutes of sampling, except for 1994. Fyke netting exhibited a peak in 1992 C/f and remained stable in other years.

Length distribution by gear type for black crappie (Figure 46) illustrated the importance of fyke netting in total catch. However, black crappie less than 80 mm TL were caught by mini-fyke netting and electrofishing, demonstrating the size selectivity of fyke nets. Abundance of black crappie less than 100 mm TL, presumed to be age-0, was generally low, except in 1991 and 1994. In each case, a progression of size groups from 100 to 240 mm TL was evident in the 3 succeeding years, indicating strong year classes produced for those 2 years. However, black crappie longer than 240 mm TL were uncommon. The longest black crappie recorded was 443 mm TL.

The length distribution for black crappie by sampling stratum (Figure 47) indicated almost total reliance on the two backwater strata. Other strata sporadically produced small numbers of fish but without any pattern of preference by a particular size.

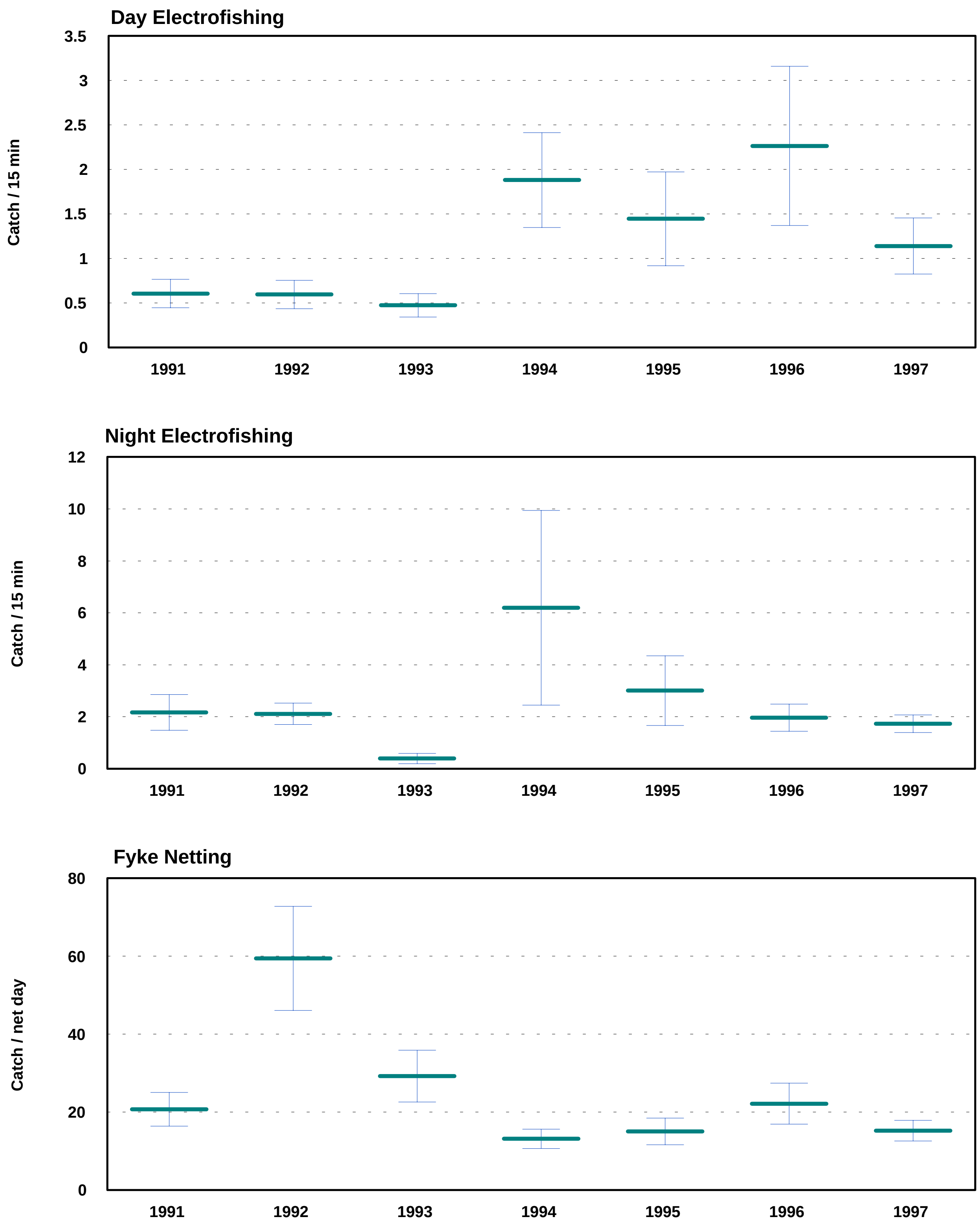

Figure 45. Black crappie (*Pomoxis nigromaculatus*) catch-per-unit-effort values (reachwide mean and standard error) for selected gear types from Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

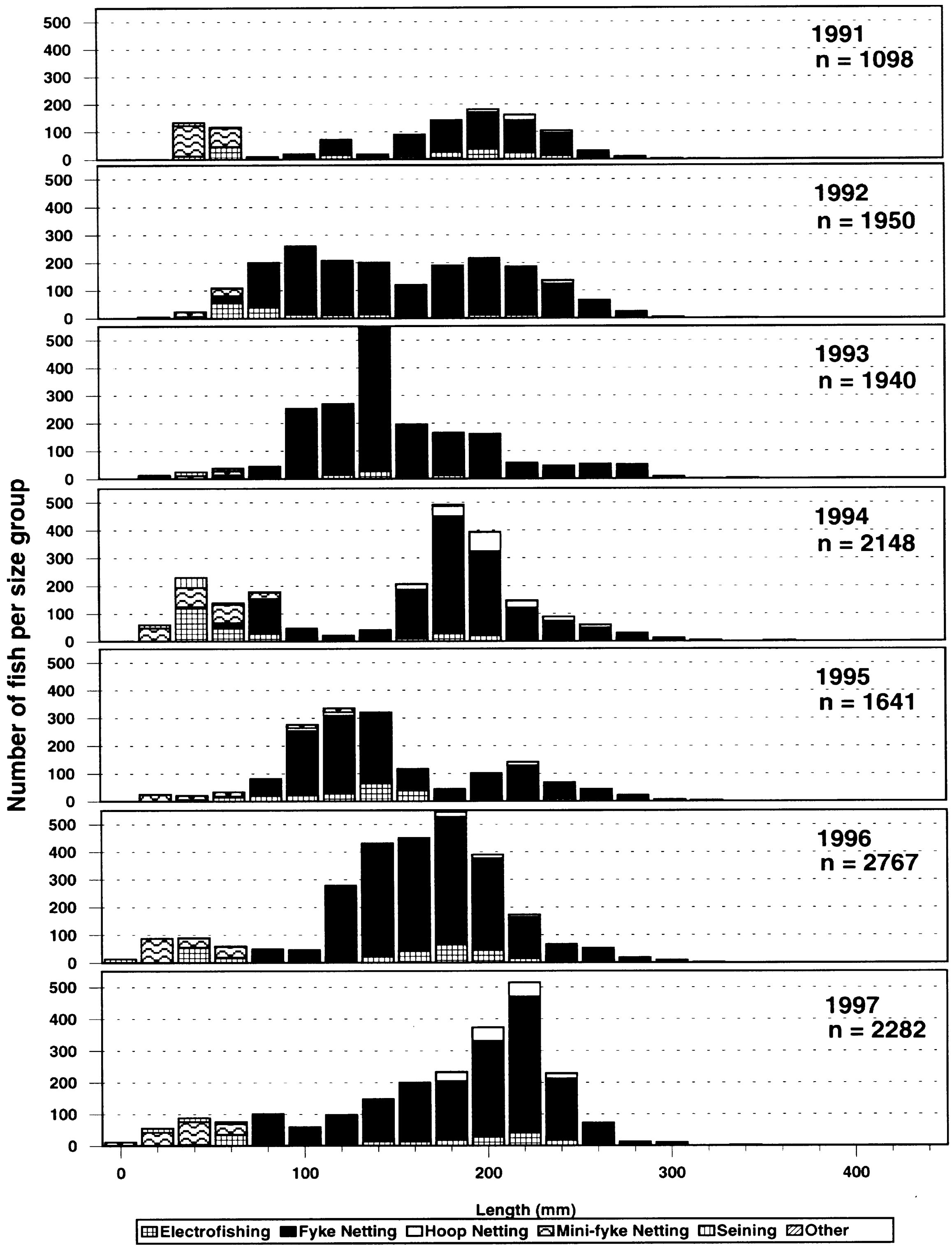

Figure 46. Length distribution, by gear type, for black crappie *(Pomoxis nigromaculatus)* collected in Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

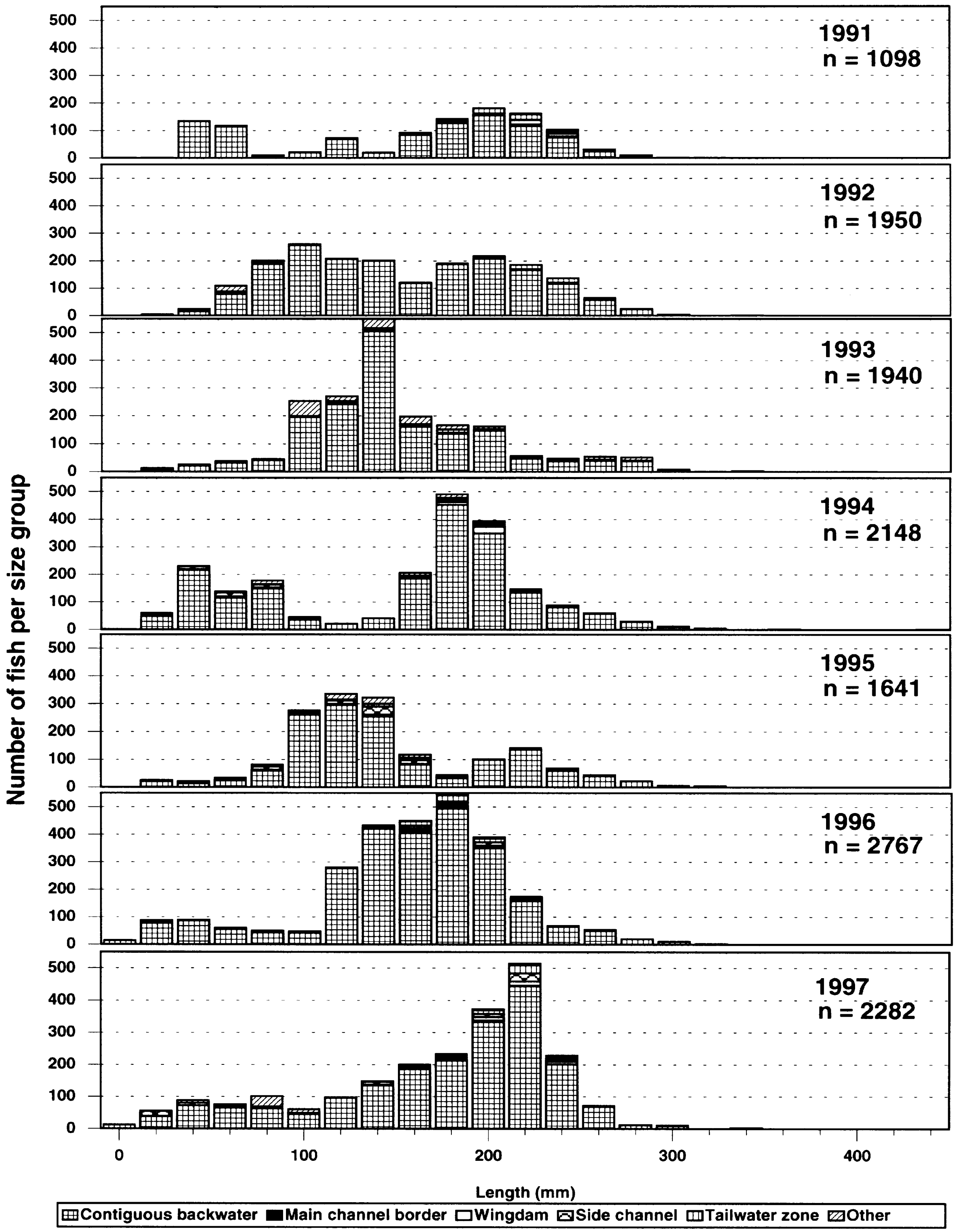

Figure 47. Length distribution, by sampling stratum, for black crappie *(Pomoxis nigromaculatus*) collected in Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

The distribution map for black crappie (Figure 48) indicates their widespread presence in Pool 8. However, large catches came from four backwater areas, two each in the upper- and midpool. Several other backwater areas in the midpool have produced moderate catches of as many as 200 fish. Fewer black crappie were caught along the main channel and in the impounded (lower) third of the pool.

Yellow Perch

The LTRMP total catch of yellow perch in Pool 8 during 1991–97 was 2,478 and ranged from a low of 59 fish in 1991 to 795 fish in 1997 (Table 19). Day electrofishing (994 fish) yielded the highest total, followed by night electrofishing (417 fish), fyke netting (352 fish), and seining (308 fish). Catches for most gears increased during the period.

Table 19. Total catch of yellow perch (*Perca flavescens*) collected annually, by gear type and stratum, in Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

Fish sampling	1991	1992	1993	1994	1995	1996	1997	Overall
Gear								
Day electrofishing	26	163	39	286	70	68	342	994
Night electrofishing	16	87	68	48	86	22	90	417
Fyke netting	8	47	61	28	67	80	61	352
Tandem fyke netting	0	0	8	19	17	88	120	252
Mini-fyke netting	5	3	3	27	4	5	38	85
Tandem mini-fyke netting	0	0	0	2	2	6	31	41
Tandem hoop netting	0	0	0	0	0	0	0	0
Small hoop netting	0	0	1	0	3	0	24	28
Large hoop netting	0	0	0	1	0	0	0	1
Seining	4	59	11	65	18	62	89	308
Trawling	0	0	0	0	0	0	0	0
Gill netting	0	0	0	0	0	0	0	0
Annual total catch	59	359	191	476	267	331	795	2,478
Stratum								
Backwater, contiguous offshore	0	0	9	22	22	94	174	321
Backwater, contiguous shoreline	54	291	125	327	142	199	391	1,529
Impounded, offshore	0	0	0	0	0	0	1	1
Impounded, shoreline	0	2	1	3	3	5	20	34
Main channel border, unstructured	2	5	1	31	8	0	29	76
Main channel border, wing dam	1	0	0	0	0	0	2	3
Main channel trough	0	0	0	0	0	0	0	0
Side channel border	0	32	4	88	38	13	110	285
Tailwater zone	2	29	51	5	54	20	68	229
Annual total catch	59	359	191	476	267	331	795	2,478

The BWCS sites (1,529 fish) produced by far the most yellow perch (Table 19). However, catches in the BWCO (321 fish), SCB (285 fish), and TWZ (229 fish) strata were also high. Catches increased slightly in the most productive strata through the period, although they fluctuated annually.

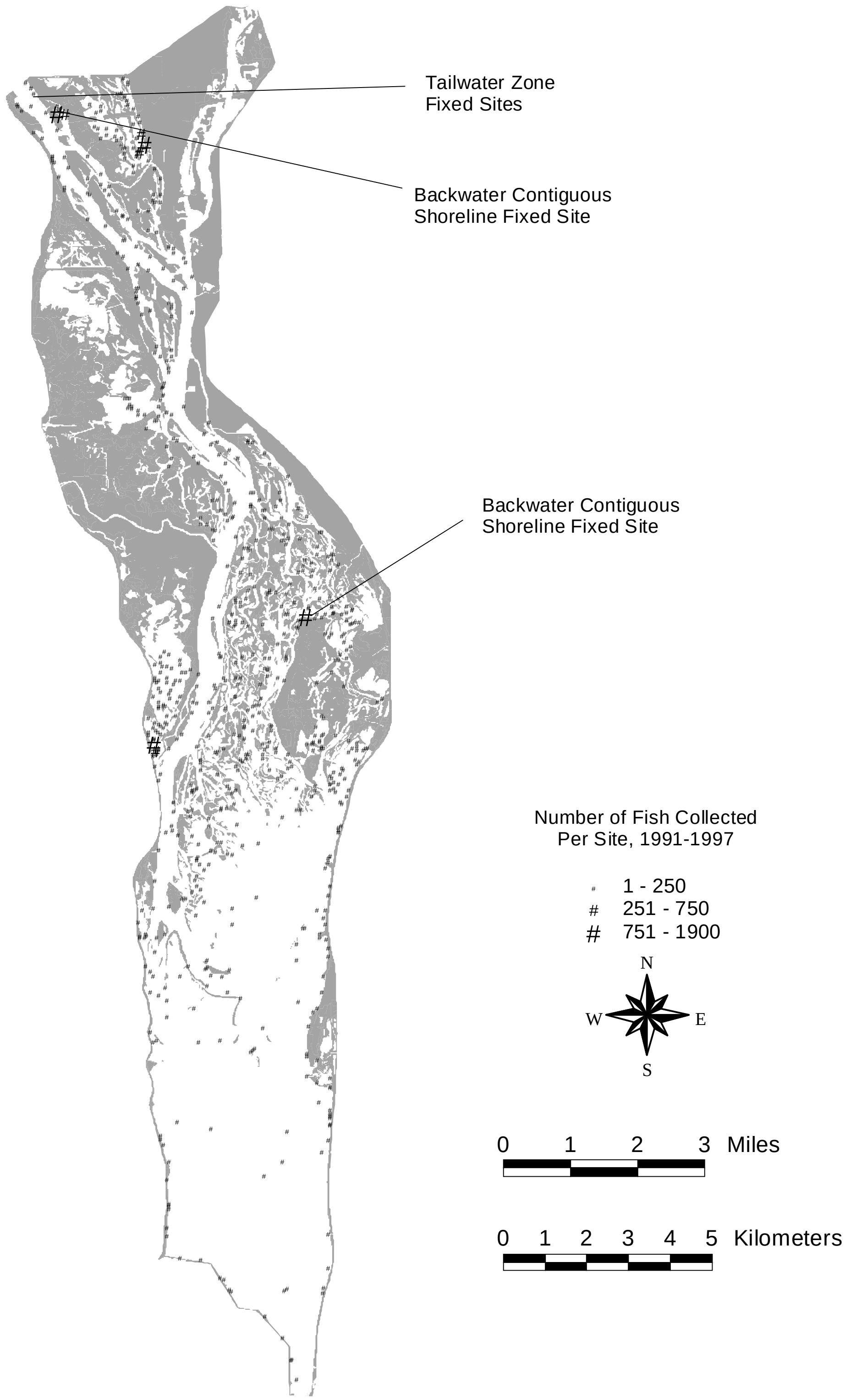

Figure 48. Total number of black crappie *(Pomoxis nigromaculatus*) caught per sampling site in Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

Yellow perch C/f graphs (Figure 49) showed inconsistent patterns from 1991 through 1997, although electrofishing C/f increased slightly. Standard errors were large whenever mean C/f values were large, indicating high variability within given years.

Length distributions by gear type (Figure 50) showed size selectivity among gears. Electrofishing, seining, and mini-fyke netting provided most of the small yellow perch, whereas fyke netting yielded nearly all large fish. Yellow perch less than 100 mm TL, presumed to be age-0, were numerous in 1992, 1994, and 1997. Some carryover to the following years was evident, especially for the 1994 year class, where successive years yielded length modes at 120 (1995), 160 (1996), and 180 (1997) mm TL.

The full size range of yellow perch was found in the backwater strata (Figure 51). Small- and medium-sized yellow perch also came from the SCB stratum in 1992, 1994, 1995, and 1997. A variety of strata yielded small yellow perch in 1997. The longest yellow perch recorded was 325 mm TL, although yellow perch longer than 200 mm TL were uncommon.

Yellow perch were most concentrated in off-channel areas (Figure 52). The largest catches came from upper- and midpool backwater sites, although TWZ sites also produced moderate catches. Many sites in the upper two-thirds of the pool produced at least a few yellow perch, but very few yellow perch were found in the lower, impounded third of the pool.

Sauger

The LTRMP total catch of sauger in Pool 8 during 1991–97 was 7,952 (Table 20). Though 1991 provided only 425 sauger, all other years produced at least 1,000, with the highest total in 1997 (1,942 fish). Nearly 90% (7,113) of these fish were caught by night electrofishing. Day electrofishing produced another 549 sauger, and fyke netting (141) was the only other gear to yield more than 100 fish.

The TWZ (5,550 fish) produced nearly 70% of all sauger (Table 20). The BWCS (755 fish), MCBU (627 fish), and SCB (651 fish) strata yielded similar numbers. However, catches in all three of the lesser strata have decreased over time, while TWZ catches seem to be increasing.

All three sauger C/f graphs (Figure 53) illustrated somewhat different trends in sauger catch rates. Day electrofishing C/f increased substantially from 1991 through 1997, although the greatest increase was seemingly due to the inception of SRS in 1993. Night electrofishing C/f, contrarily, steadily decreased from 1992 through 1996, with a slight rebound in 1997. Fyke netting C/f increased slightly through the period, with an exceptionally high catch rate and a large standard error in 1995.

The length distribution by gear type for sauger (Figure 54) showed a large peak in most years at about 140–160 mm TL and a smaller peak somewhere between 200 and 300 mm TL. These fish were presumed to be age-0 and age-1 sauger. The smallest sauger in 1993 were typically about 20 mm longer than in other years, but the 1993 length distribution was shaped similarly, suggesting faster growth that year. Electrofishing produced nearly all fish, whereas fyke netting yielded a few small and large sauger.

The length distribution by sampling stratum for sauger (Figure 55) showed little segregation of sizes by stratum. The backwater and SCB strata showed a slight tendency to produce smaller sauger. However, nearly all large sauger were found in the TWZ or in the MCBU stratum. The longest sauger recorded was 508 mm TL.

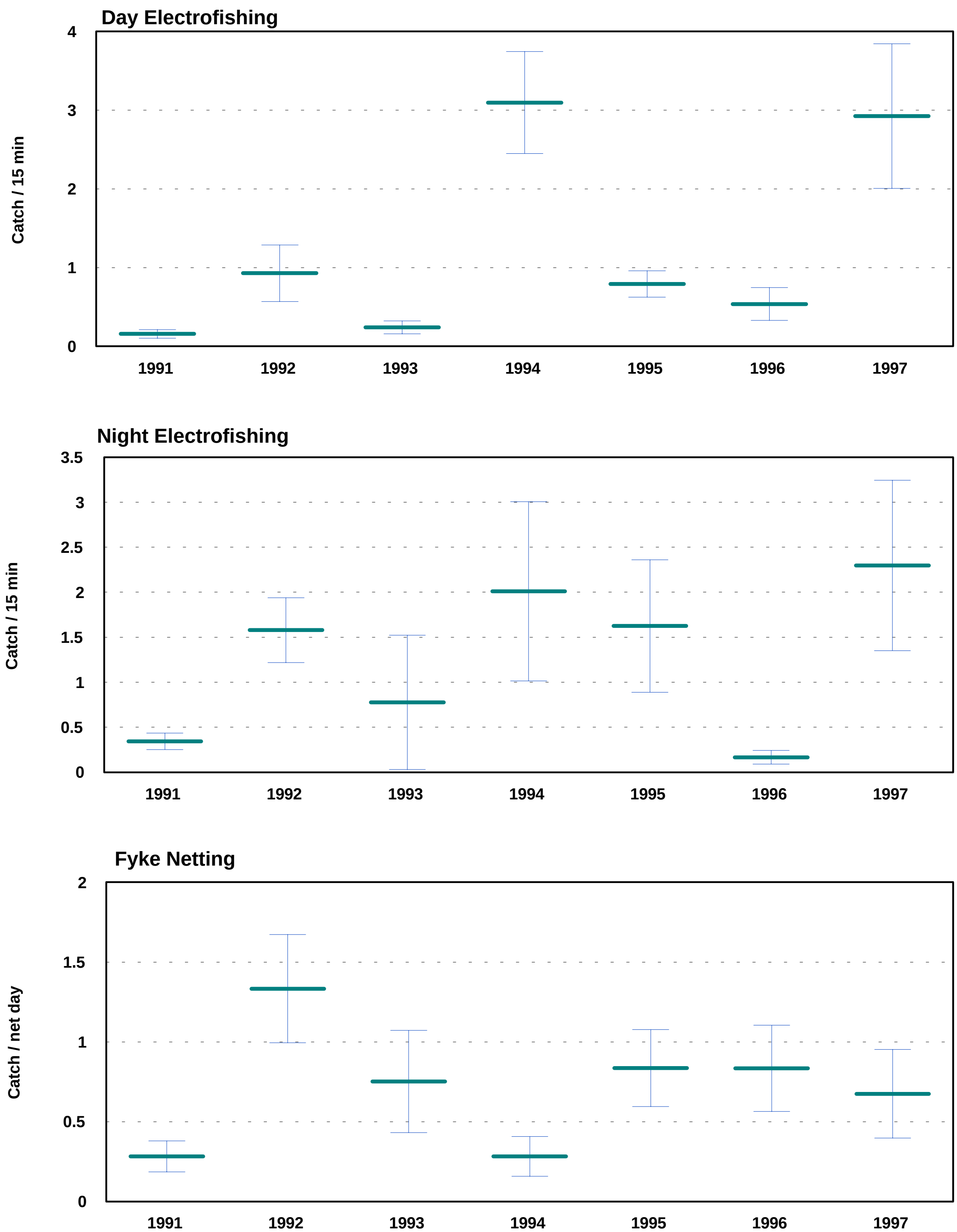

Figure 49. Yellow perch (*Perca flavescens*) catch-per-unit-effort values (reachwide mean and standard error) for selected gear types from Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

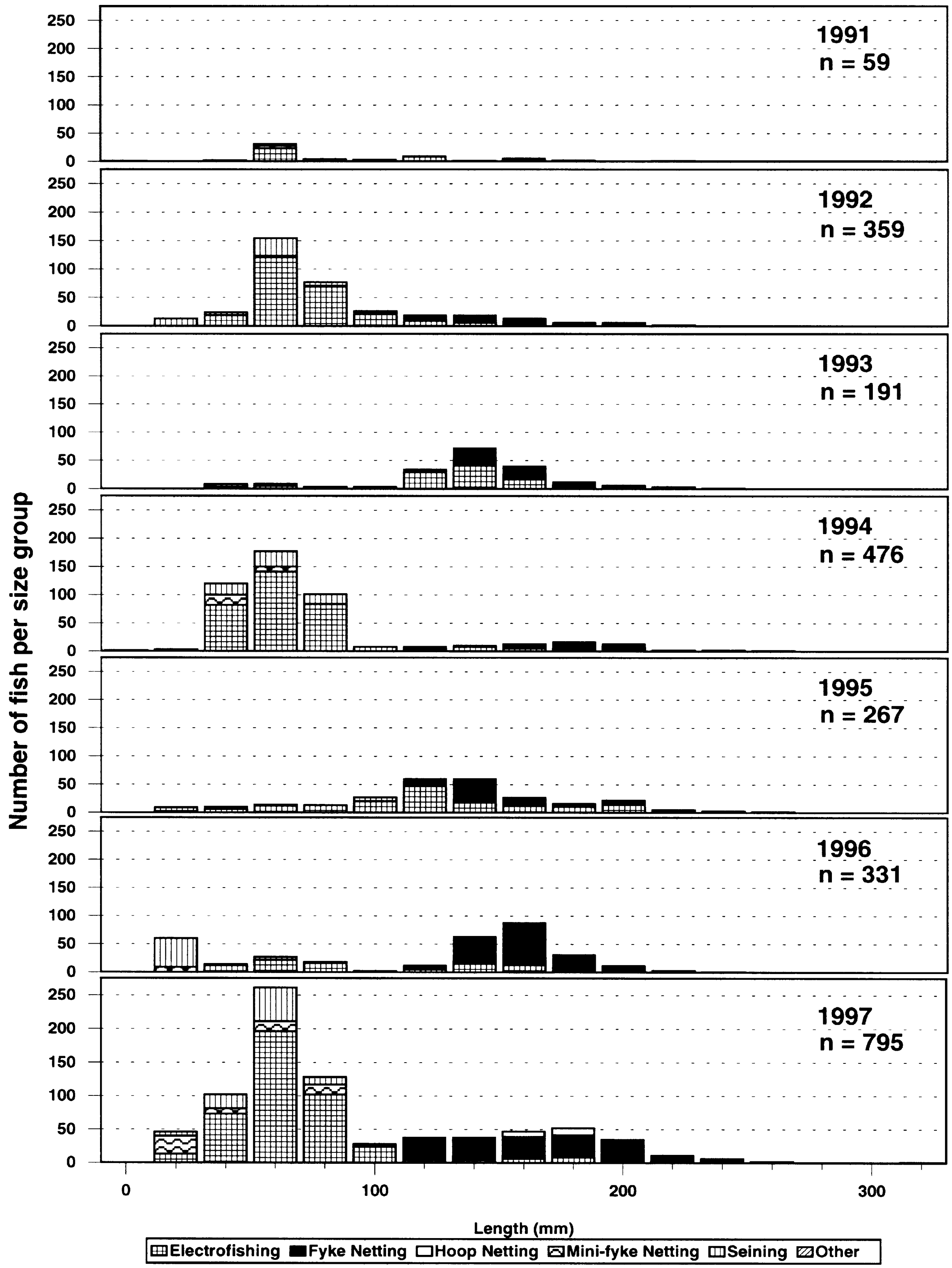

Figure 50. Length distribution, by gear type, for yellow perch (*Perca flavescens*) collected in Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

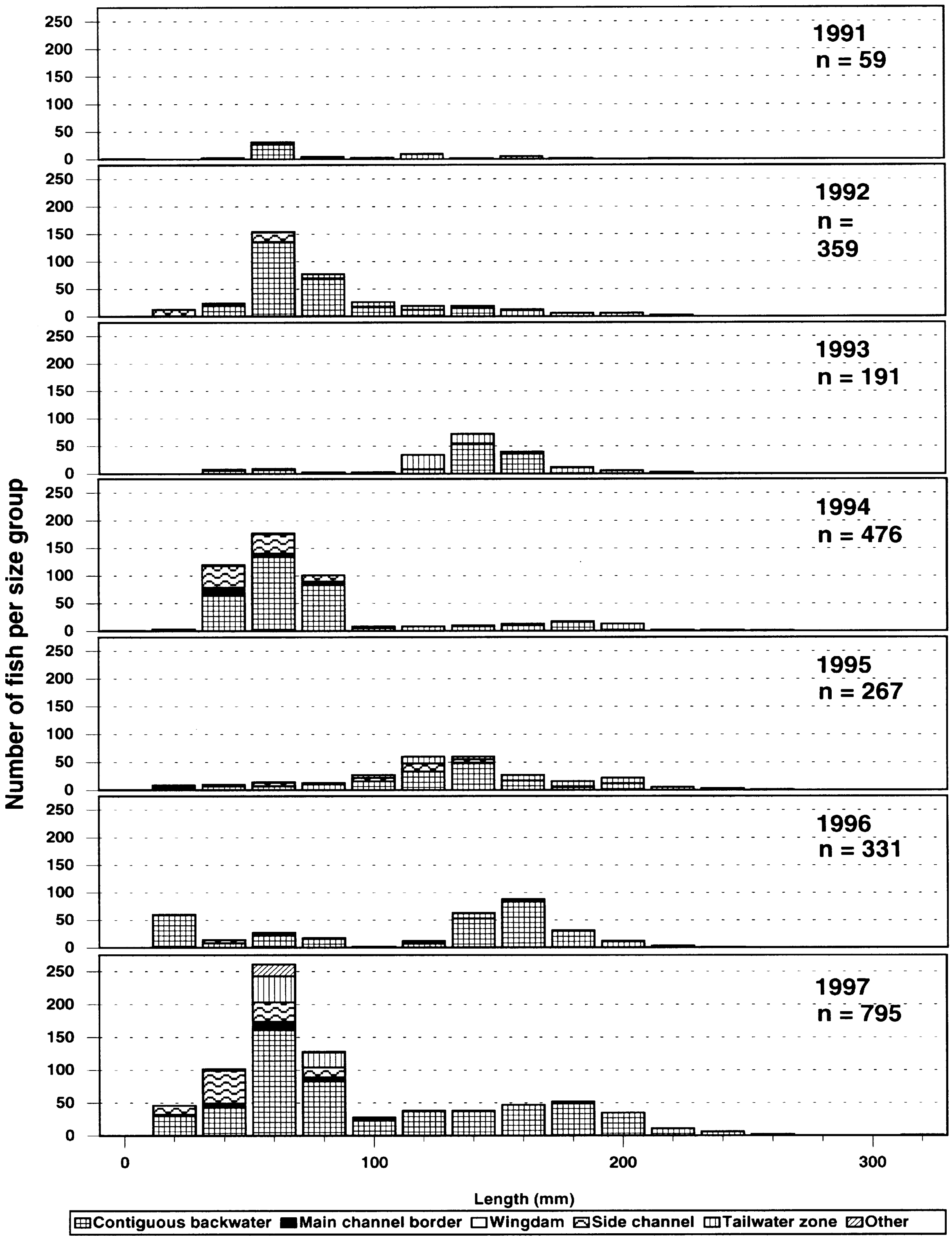

Figure 51. Length distribution, by sampling stratum, for yellow perch (*Perca flavescens*) collected in Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

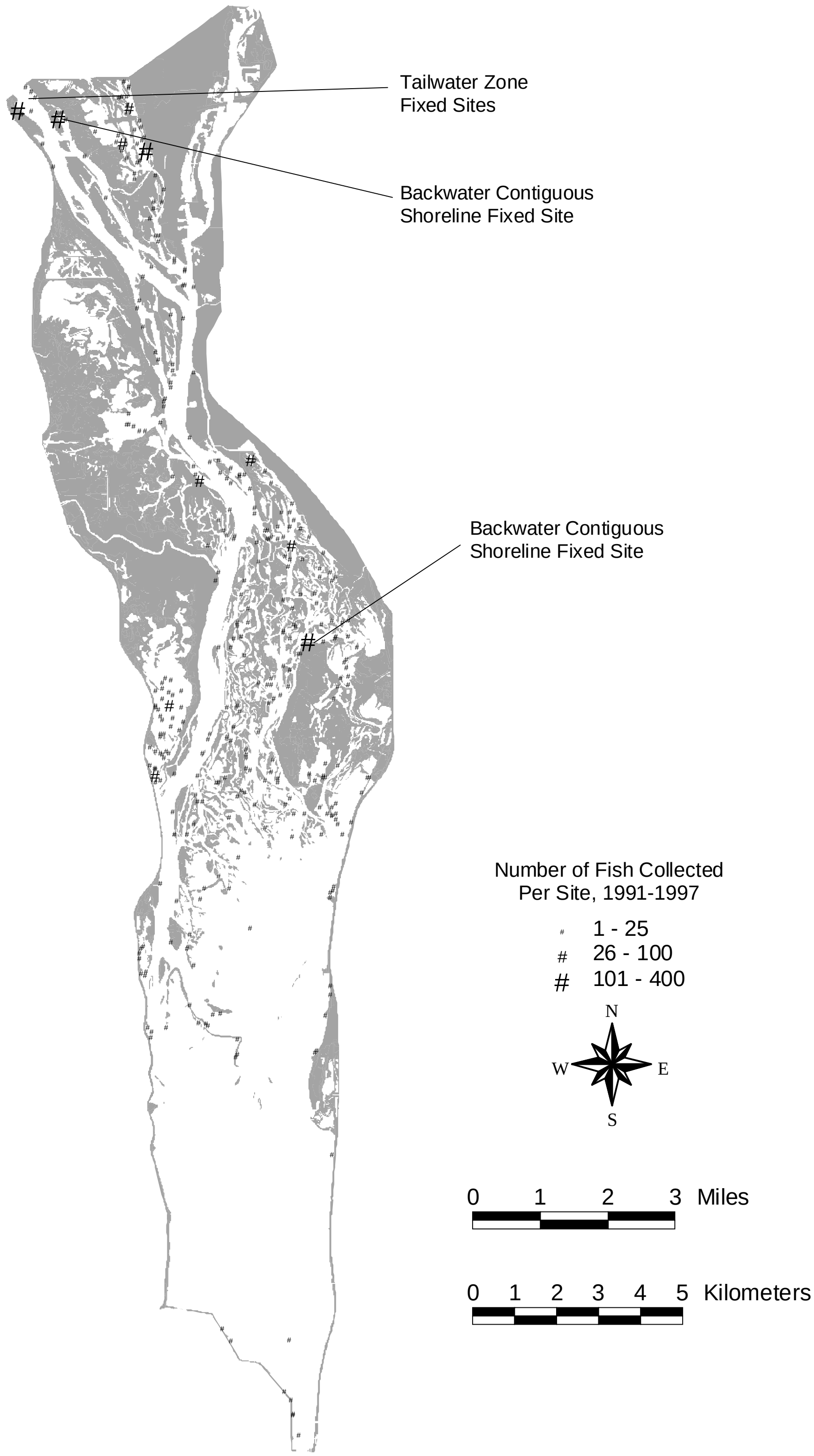

Figure 52. Total number of yellow perch (*Perca flavescens*) caught per sampling site in Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

Table 20. Total catch of sauger (*Stizostedion canadense*) collected annually, by gear type and stratum, in Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

Fish sampling	1991	1992	1993	1994	1995	1996	1997	Overall
Gear								
Day electrofishing	11	53	114	95	63	100	113	549
Night electrofishing	403	1,447	721	1,005	870	871	1,796	7,113
Fyke netting	6	10	14	17	50	34	10	141
Tandem fyke netting	2	1	4	6	7	12	9	41
Mini-fyke netting	1	5	11	3	2	8	4	34
Tandem mini-fyke netting	0	0	0	0	0	2	1	3
Tandem hoop netting	1	3	0	0	0	0	0	4
Small hoop netting	0	0	1	3	0	1	0	5
Large hoop netting	0	0	0	0	0	0	0	0
Seining	0	4	11	9	4	2	5	35
Trawling	1	12	1	0	7	1	4	26
Gill netting	0	0	0	0	1	0	0	1
Annual total catch	425	1,535	877	1,138	1,004	1,031	1,942	7,952
Stratum								
Backwater, contiguous offshore	0	0	4	2	1	7	6	20
Backwater, contiguous shoreline	75	228	101	93	93	85	80	755
Impounded, offshore	2	1	1	5	7	7	4	27
Impounded, shoreline	3	6	23	22	18	41	36	149
Main channel border, unstructured	29	116	163	110	94	48	67	627
Main channel border, wing dam	17	27	18	35	23	24	26	170
Main channel trough	0	3	0	0	0	0	0	3
Side channel border	66	121	105	127	118	56	58	651
Tailwater zone	233	1,033	462	744	650	763	1,665	5,550
Annual total catch	425	1,535	877	1,138	1,004	1,031	1,942	7,952

Sauger distribution (Figure 56) was widespread throughout the upper pool but sparse in the impounded section. The TWZ yielded all of the large catches. Other than in the TWZ sites, there was no indication that sauger preferred sites associated with channels more than those in off-channel areas.

Walleye

The LTRMP total catch of walleye in Pool 8 during 1991–97 was 3,672 (Table 21). Annual totals ranged from 185 (1993) to 803 (1997), but did not indicate a trend over time. Night electrofishing (3,010 fish) produced 82% of the total catch. Day electrofishing (448 fish) yielded another 12%, leaving the remaining 6% scattered equally among the remaining gears.

The TWZ (1,936 fish) dominated the other strata in total catch of walleye (Table 21). However, BWCS (527 fish), MCBW (441 fish), MCBU (346 fish), and SCB (330 fish) sites also produced substantial numbers of walleye. No stratum showed a trend in total catch over time.

Fyke netting C/f for walleye (Figure 57) showed a decreasing trend from 1991 through 1997, although variability in catch rates was large. Neither day nor night electrofishing C/f showed a clear trend, although catch rates at the end of the period were somewhat higher than at the beginning.

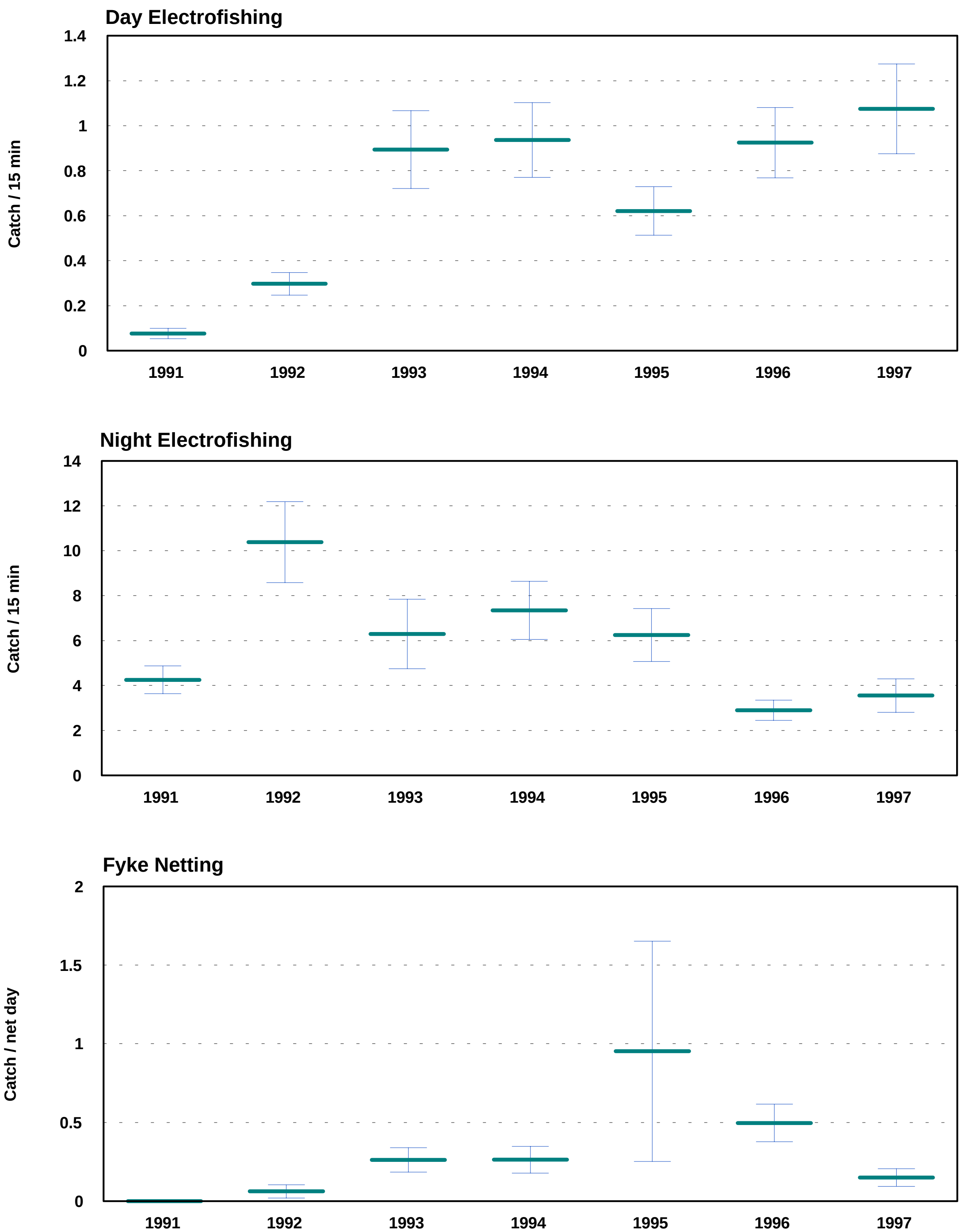

Figure 53. Sauger (*Stizostedion canadense*) catch-per-unit-effort values (reachwide mean and standard error) for selected gear types from Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

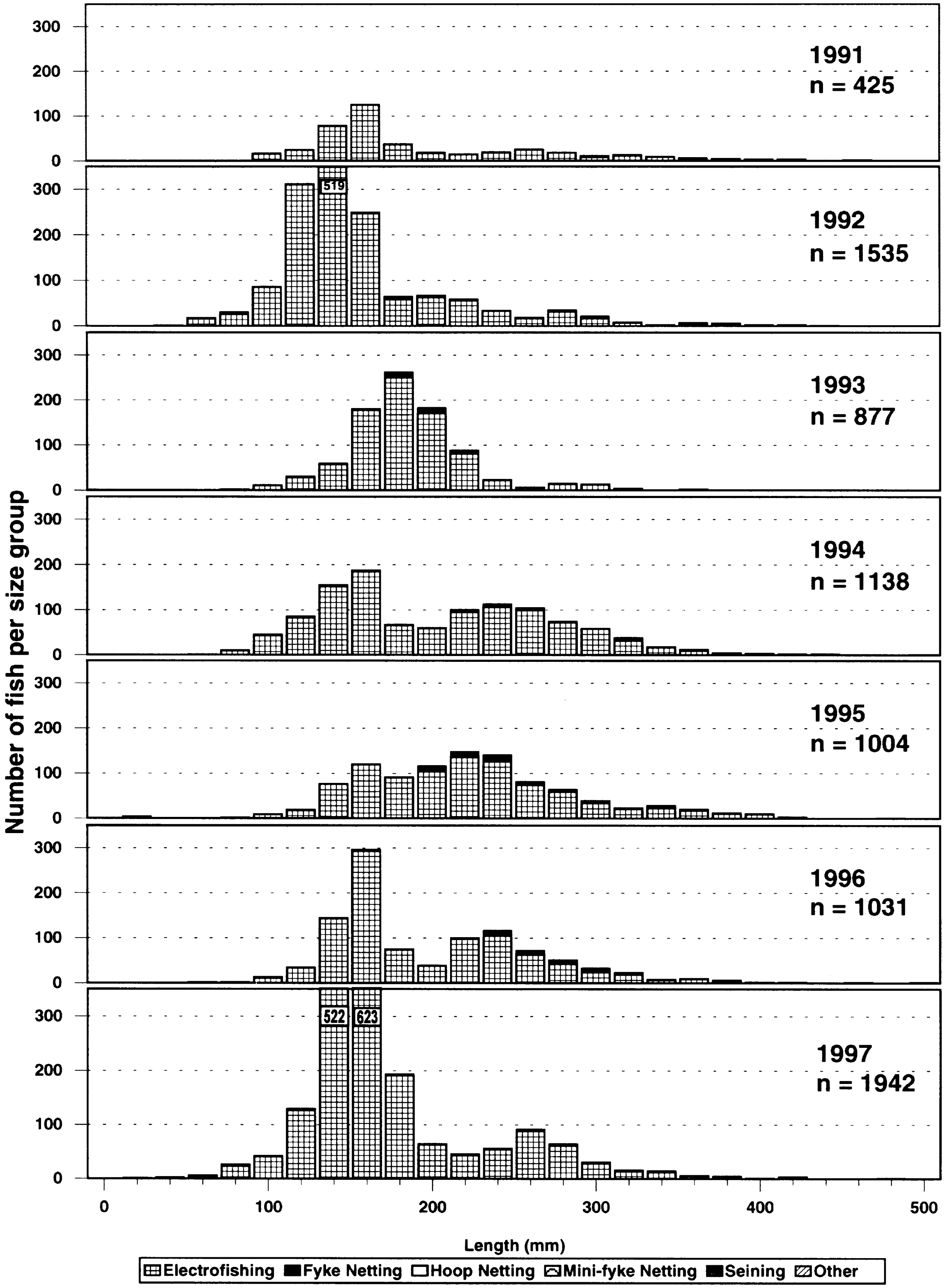

Figure 54. Length distribution, by gear type, for sauger (*Stizostedion canadense*) collected in Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

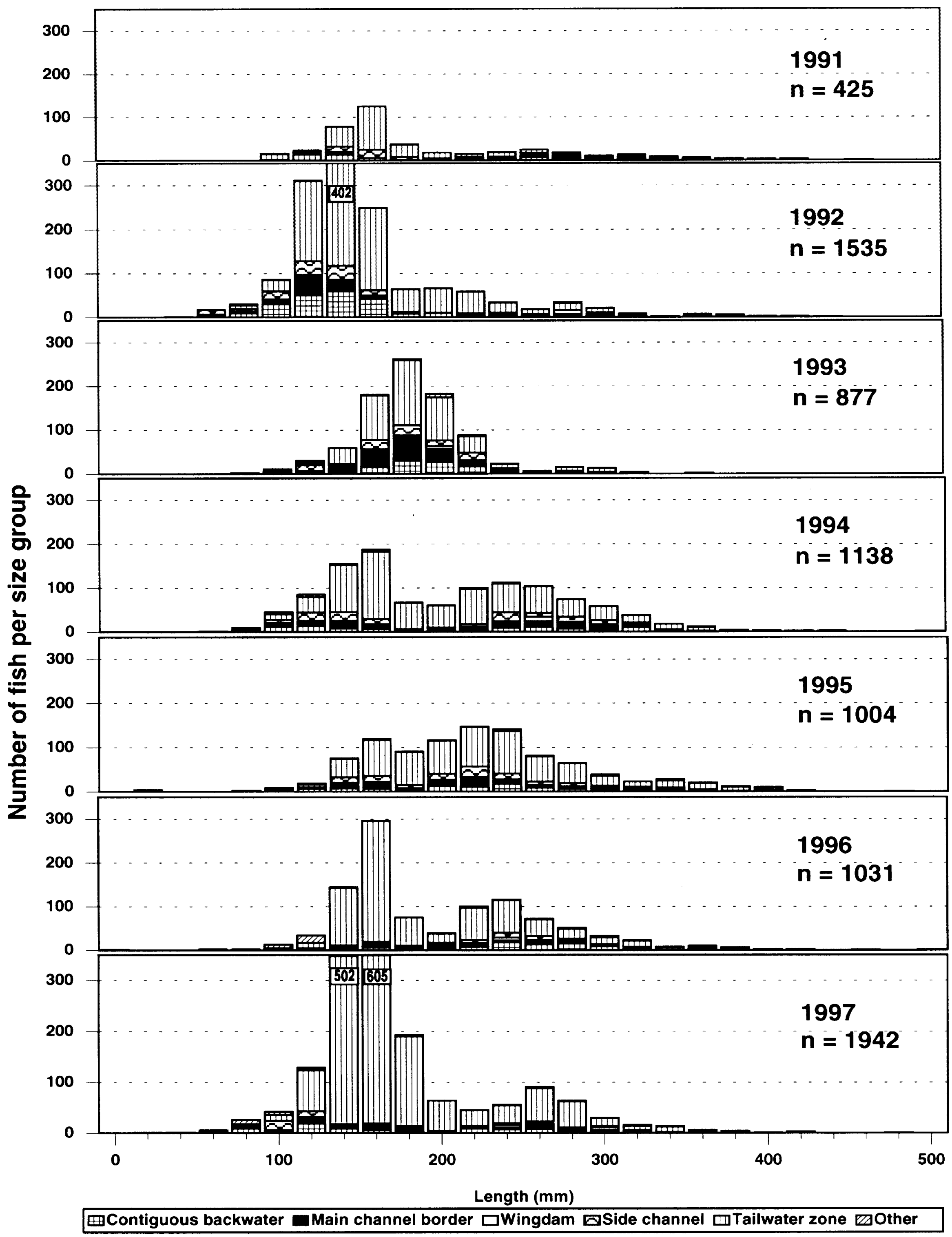

Figure 55. Length distribution, by sampling stratum, for sauger (*Stizostedion canadense*) collected in Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

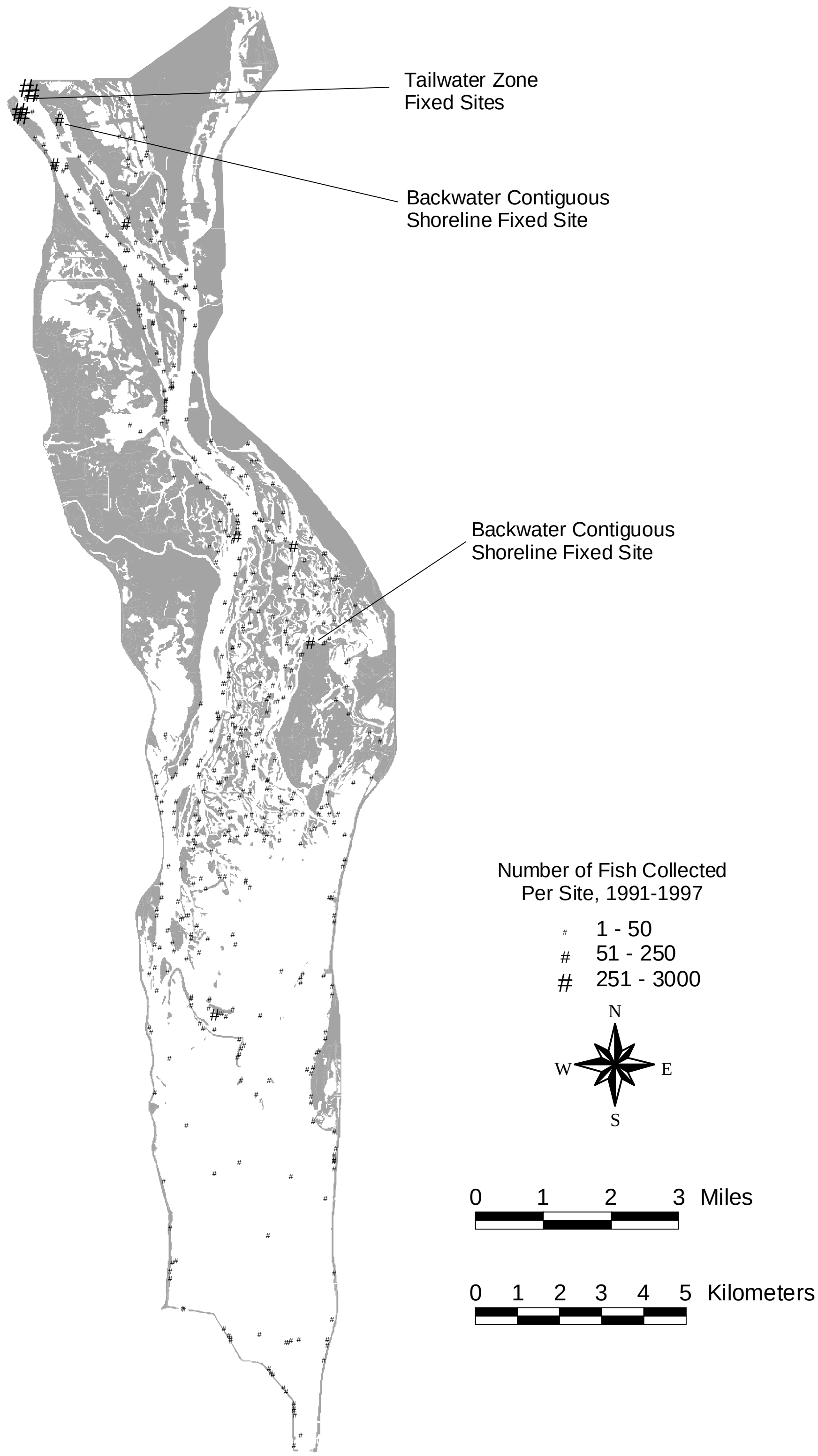

Figure 56. Total number of sauger (*Stizostedion canadense*) caught per sampling site in Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

Table 21. Total catch of walleye (*Stizostedion vitreum*) collected annually, by gear type and stratum, in Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

Fish sampling	1991	1992	1993	1994	1995	1996	1997	Overall
Gear								
Day electrofishing	53	79	24	84	35	53	120	448
Night electrofishing	212	638	136	574	440	381	629	3,010
Fyke netting	6	13	10	4	13	14	8	68
Tandem fyke netting	0	0	4	1	2	6	8	21
Mini-fyke netting	3	1	5	0	2	6	8	25
Tandem mini-fyke netting	0	0	0	1	2	1	1	5
Tandem hoop netting	3	4	0	0	0	0	0	7
Small hoop netting	0	0	1	0	1	0	0	2
Large hoop netting	0	0	4	3	1	1	1	10
Seining	0	9	1	9	12	7	27	65
Trawling	1	6	0	0	0	1	1	9
Gill netting	0	0	0	1	1	0	0	2
Annual total catch	278	750	185	677	509	470	803	3,672
Stratum								
Backwater, contiguous offshore	0	0	1	2	3	7	6	19
Backwater, contiguous shoreline	68	181	31	69	50	34	94	527
Impounded, offshore	1	0	5	1	3	1	4	15
Impounded, shoreline	3	3	6	13	1	17	15	58
Main channel border, unstructured	10	52	29	64	47	39	105	346
Main channel border, wing dam	69	106	31	59	37	86	53	441
Main channel trough	0	0	0	0	0	0	0	0
Side channel border	24	52	20	61	46	42	85	330
Tailwater zone	103	356	62	408	322	244	441	1,936
Annual total catch	278	750	185	677	509	470	803	3,672

Walleye length distribution by gear type (Figure 58) illustrated the dominance of electrofishing over all size ranges. Small walleyes were sometimes caught by seining. Age-0 walleyes were presumed to be in the 160–180 mm TL range, as judged by large numbers present in these size classes during 1992, 1994, and 1997. Carryover from the 1992 and 1994 year classes was subsequently evident for as long as 2 additional years, when most of these fish were about 400 mm TL. The 1997 year class had the highest number of hatchlings during the period.

Length distribution by sampling stratum (Figure 59) for walleye showed some size-based preferences for strata. The backwater and SCB strata yielded walleyes mostly less than 200 mm TL. The MCBU sites produced walleye of all sizes, but usually tended toward the smaller end of the range. Walleyes of all sizes were found in the TWZ, but only larger walleyes were found in the MCBW stratum. Walleyes longer than 400 mm TL were generally few. The largest walleye collected was 712 mm TL.

The walleye distribution map (Figure 60) showed, similarly to sauger, that most walleye were caught in the upper pool. The TWZ sites yielded the highest catches, with additional moderate catches occurring at several MCBW and SCB sites. Distribution was widespread throughout the upper pool, but sparse in the impounded section. Off-channel and channel sites exhibited similar propensities to produce walleyes.

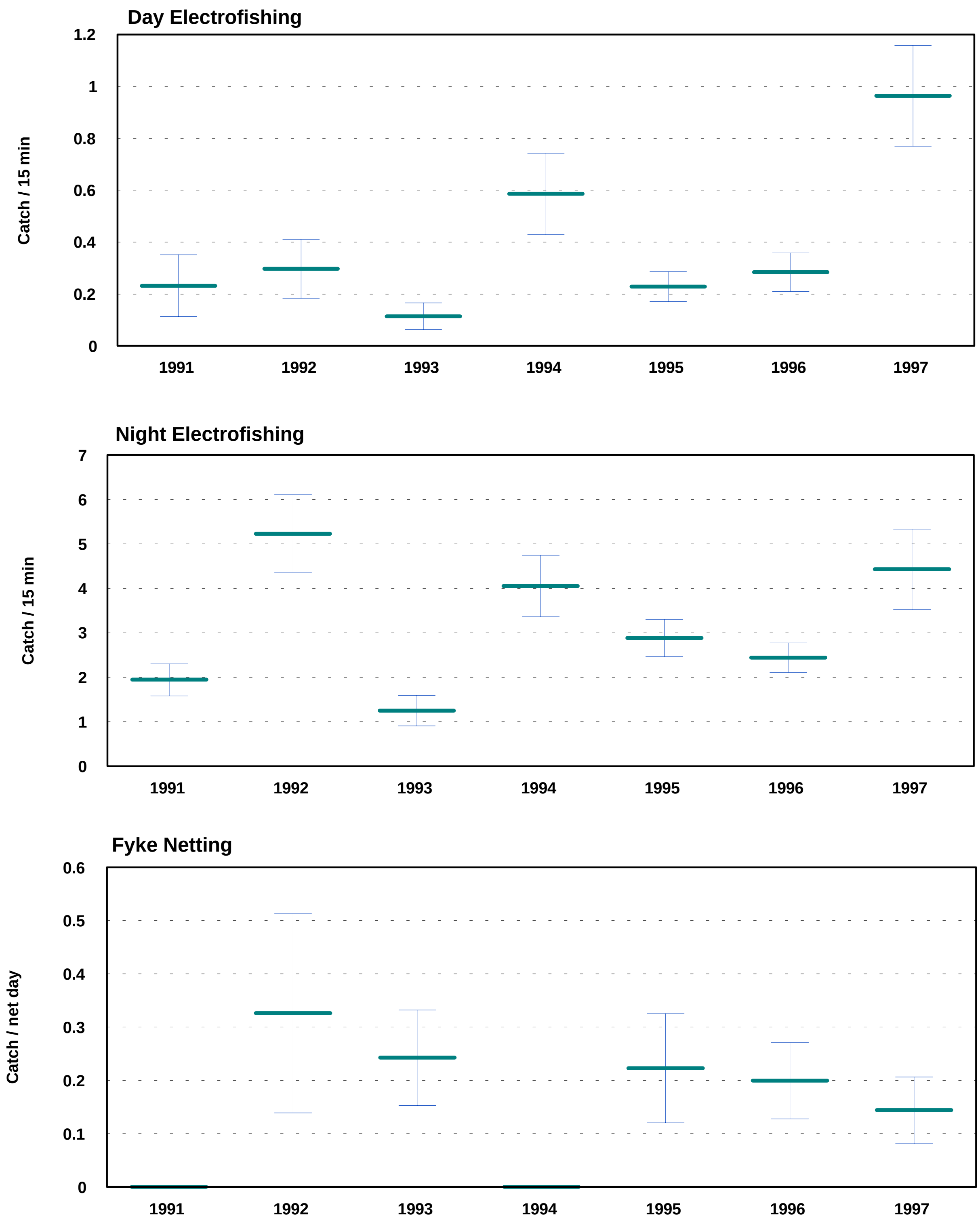

Figure 57. Walleye (*Stizostedion vitreum*) catch-per-unit-effort values (reachwide mean and standard error) for selected gear types from Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

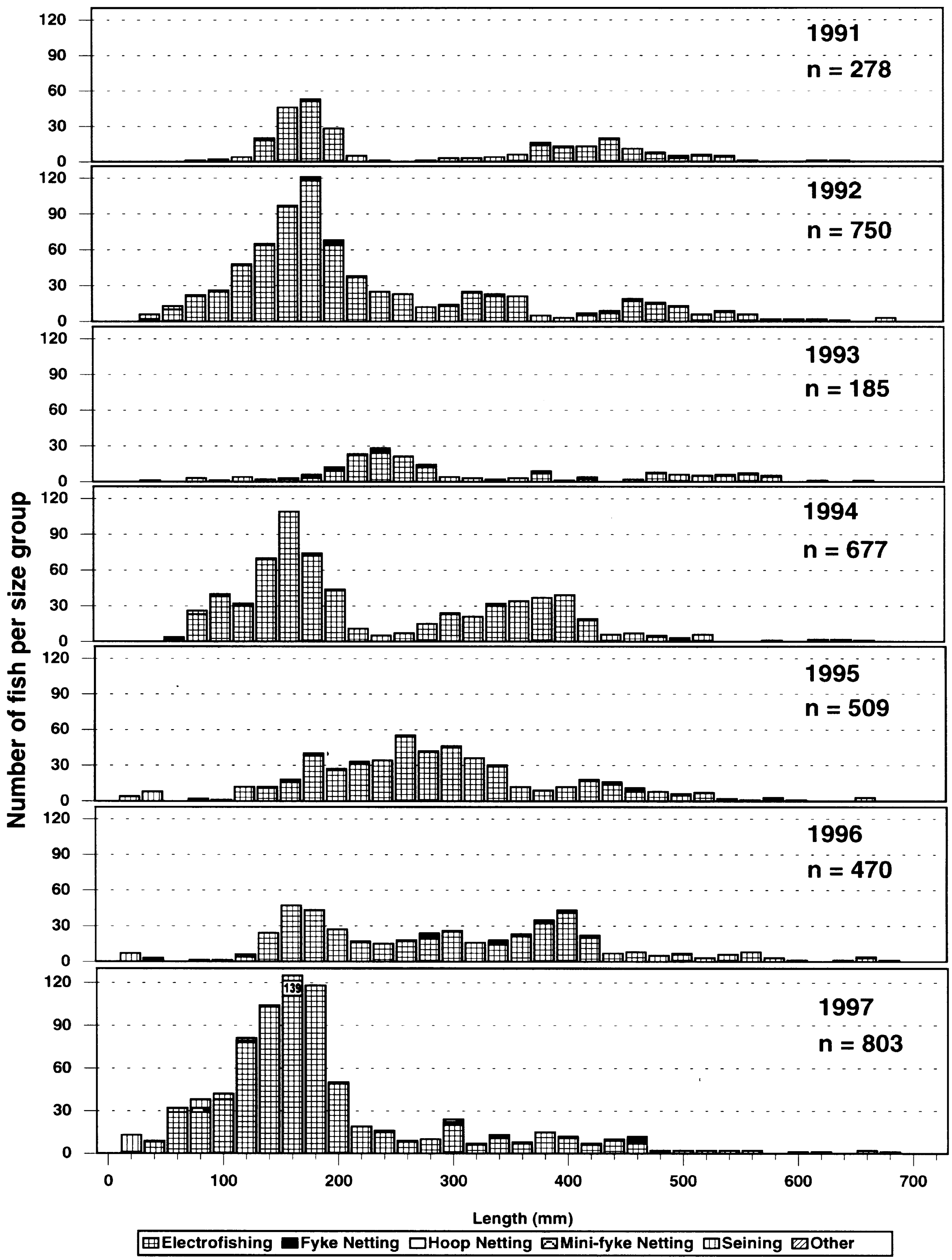

Figure 58. Length distribution, by gear type, for walleye (*Stizostedion vitreum*) collected in Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

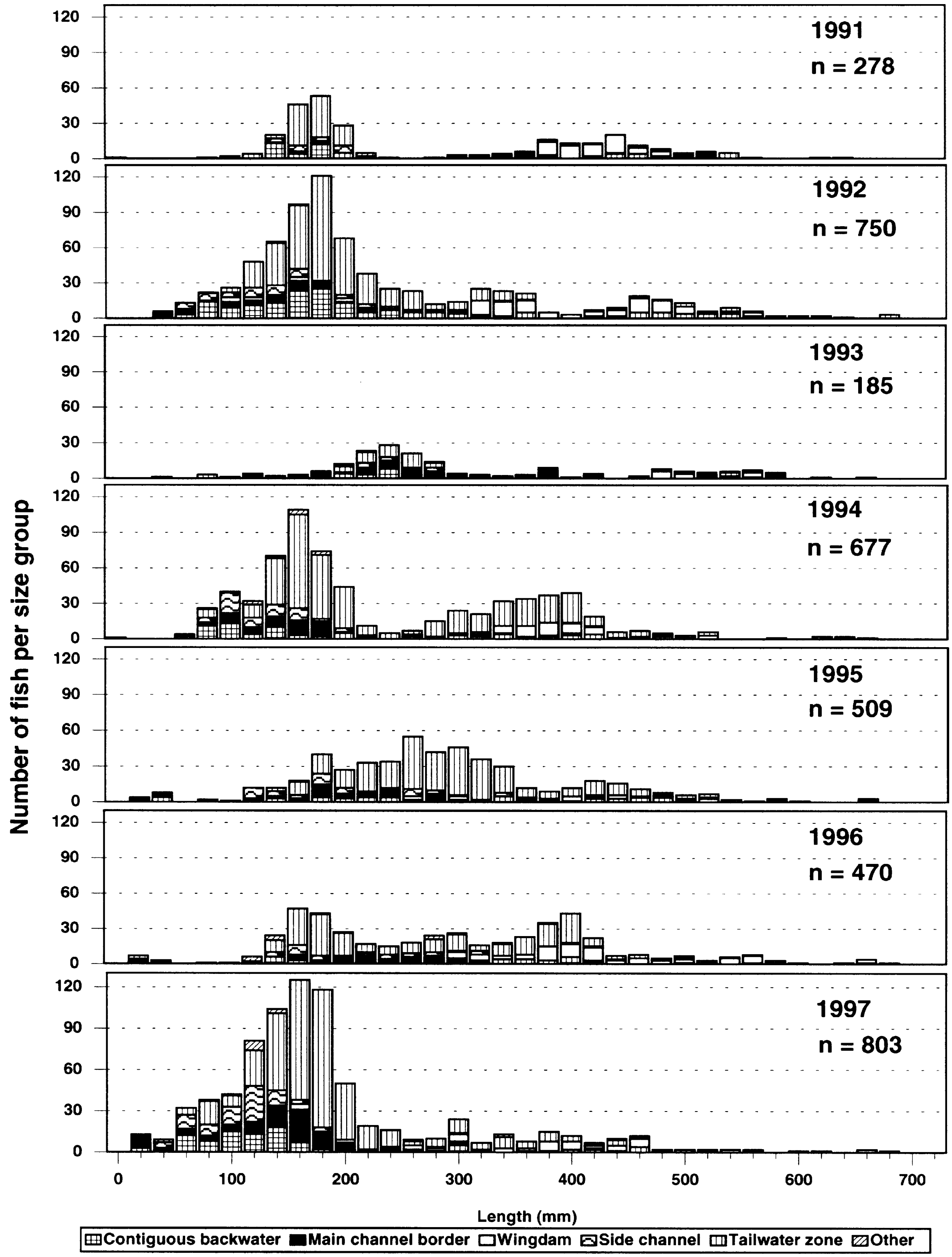

Figure 59. Length distribution, by sampling stratum, for walleye (*Stizostedion vitreum*) collected in Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

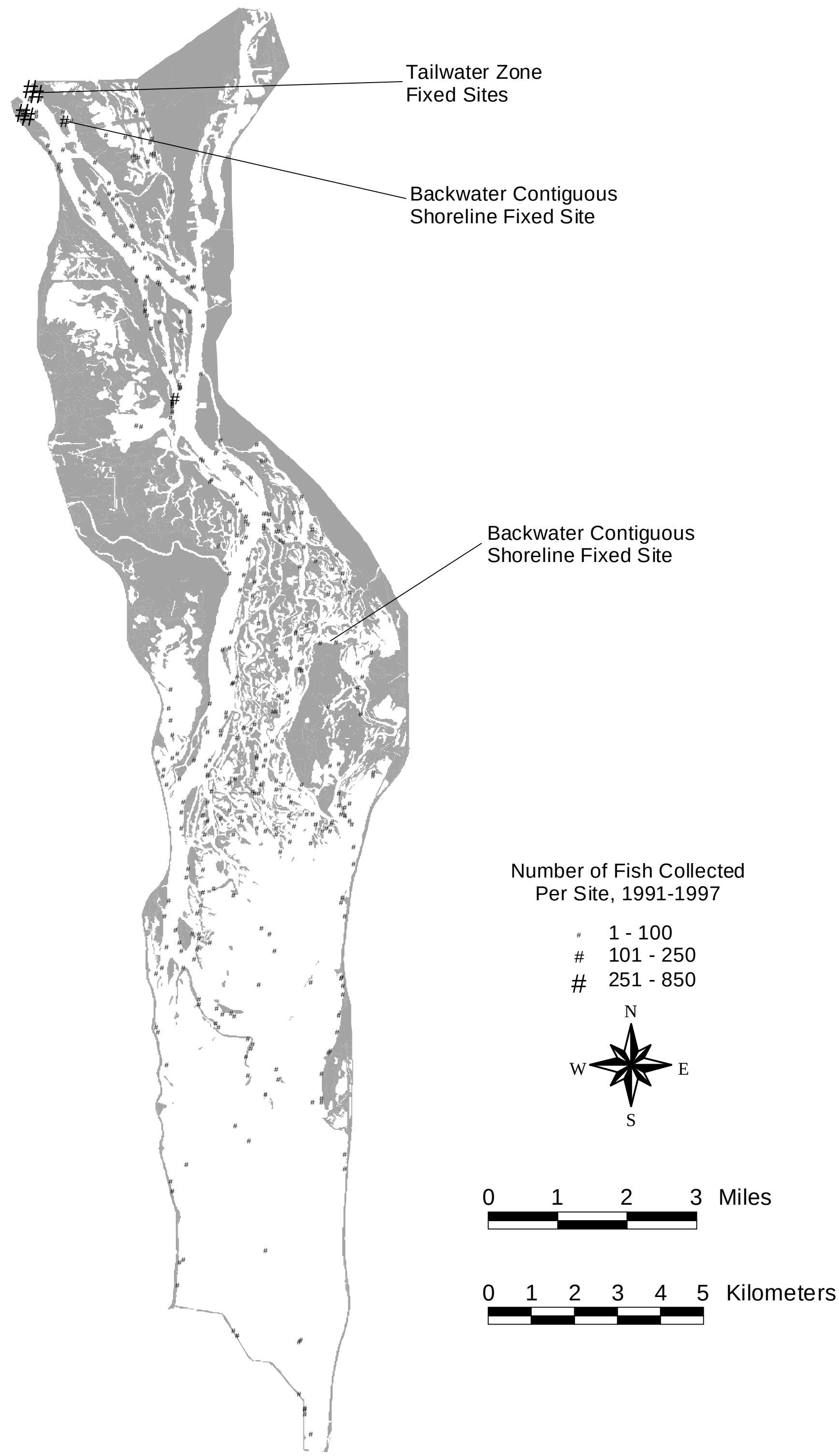

Figure 60. Total number of walleye (*Stizostedion vitreum*) caught per sampling site in Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

Freshwater Drum

The LTRMP total catch of freshwater drum in Pool 8 during 1991–97 was 11,694 (Table 22). Although annual totals ranged from 630 in 1993 to 4,014 in 1994, they were usually between 1,000 and 2,000. There was no evidence of any trend in catch overall. Night electrofishing (4,470 fish), trawling (1,669 fish), and day electrofishing (1,191 fish) yielded the highest total catches. However, three-fourths of the freshwater drum caught by trawling came in 1992. The remaining catch was divided evenly among the other gears. Catches were not greatly affected by the change to SRS in 1993.

Table 22. Total catch of freshwater drum (*Aplodinotus grunniens*) collected annually, by gear type and stratum, in Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

Fish sampling	1991	1992	1993	1994	1995	1996	1997	Overall
Gear								
Day electrofishing	72	76	45	576	226	75	121	1,191
Night electrofishing	451	288	378	1,156	1,029	324	844	4,470
Fyke netting	90	27	50	268	165	48	58	706
Tandem fyke netting	19	11	73	78	120	55	153	509
Mini-fyke netting	7	11	15	496	57	7	74	667
Tandem mini-fyke netting	21	139	4	488	26	10	73	761
Tandem hoop netting	203	162	0	0	0	0	0	365
Small hoop netting	0	0	14	85	88	53	20	260
Large hoop netting	0	0	36	78	85	46	64	309
Seining	35	9	5	670	2	4	32	757
Trawling	121	1,261	4	103	76	80	24	1,669
Gill netting	0	0	6	16	8	0	0	30
Annual total catch	1,019	1,984	630	4,014	1,882	702	1,463	11,694
Stratum								
Backwater, contiguous offshore	0	0	57	458	54	22	43	634
Backwater, contiguous shoreline	146	77	73	641	286	117	107	1,447
Impounded, offshore	41	151	37	198	150	53	233	863
Impounded, shoreline	27	14	39	801	154	27	113	1,175
Main channel border, unstructured	184	198	107	852	230	49	76	1,696
Main channel border, wing dam	155	70	13	140	179	71	62	690
Main channel trough	25	832	0	0	0	0	0	857
Side channel border	292	143	46	462	280	54	55	1,332
Tailwater zone	149	499	258	462	549	309	774	3,000
Annual total catch	1,019	1,984	630	4,014	1,882	702	1,463	11,694

The TWZ (3,000 fish) produced the most freshwater drum (Table 22). The MCBU (1,696 fish), BWCS (1,447 fish), SCB (1,332 fish), and IMPS (1,175 fish) sites also contributed substantially to the total catch. Freshwater drum were consistently found in most strata each year, with no apparent trends or preferences.

The C/f graph for freshwater drum (Figure 61) was similar among the three gear types presented. Both electrofishing methods and fyke netting showed stable catch rates until 1994, when C/f increased dramatically. All three gear types showed a steady decline in successive years, back to previous C/f levels.

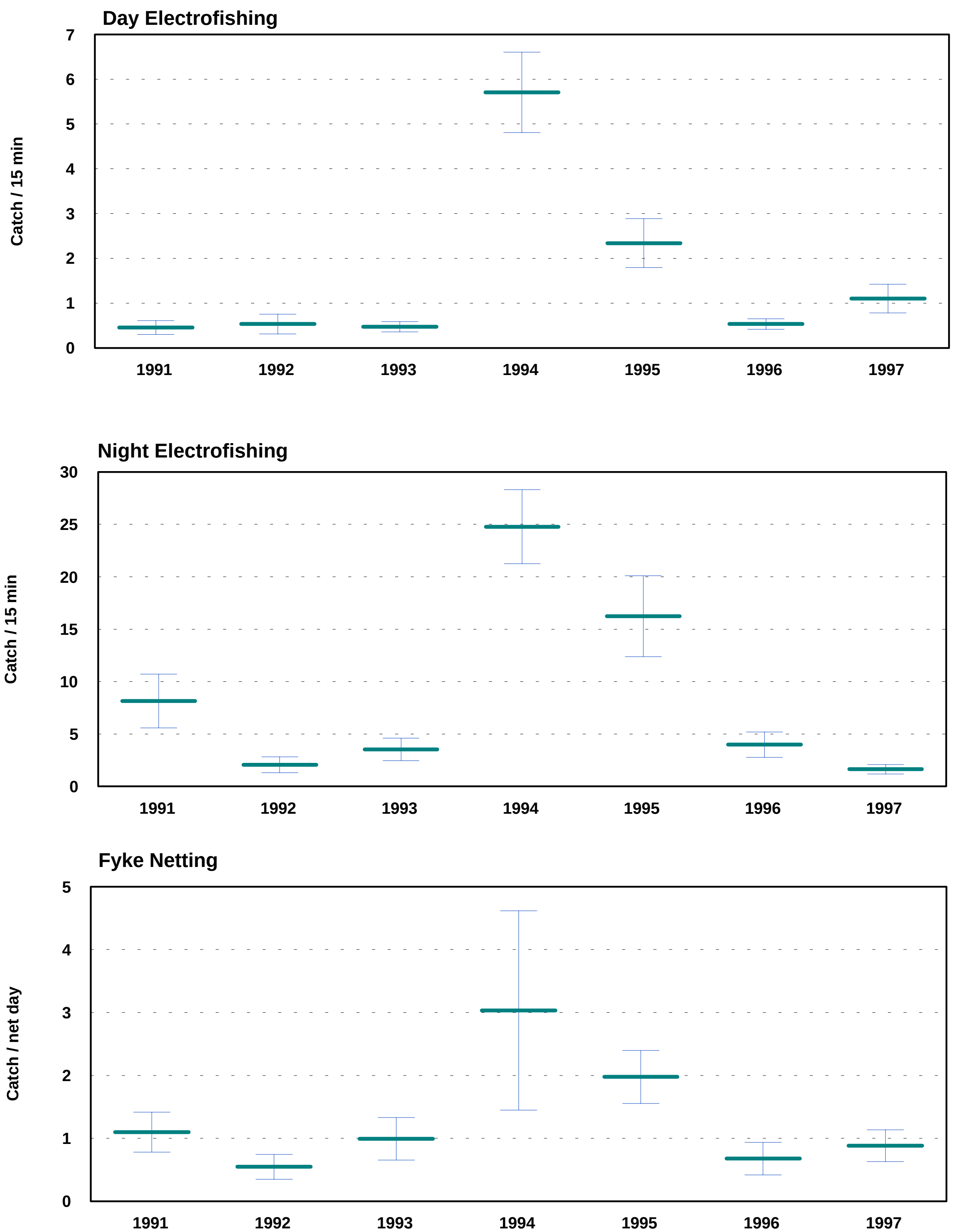

Figure 61. Freshwater drum (*Aplodinotus grunniens*) catch-per-unit-effort values (reachwide mean and standard error) for selected gear types from Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

The length distribution of freshwater drum, by gear type, indicated a predominance of small fish each year (Figure 62). Freshwater drum less than 140 mm TL, presumed to be age-0, made up the bulk of the catch and were especially numerous in 1992, 1994, and 1997. It was difficult to determine from the length distribution graphs which of these year classes carried over into successive years because few larger freshwater drum were collected. Individual gears contributed greatly toward the catch of certain sizes of freshwater drum differently each year. Trawling was effective in 1992, particularly for small freshwater drum. Mini-fyke netting and seining yielded very small freshwater drum in 1994. Electrofishing provided the broadest range of sizes. Fyke netting and hoop netting tended to catch most of the larger freshwater drum.

Length distribution by sampling stratum for freshwater drum (Figure 63) indicated the ability of freshwater drum to utilize a variety of habitats. In 1992, many small freshwater drum were caught in the CTR stratum, but this stratum was discontinued the next year. In 1994, small freshwater drum came from all strata nearly equally. In 1997, small freshwater drum were caught primarily in the TWZ. However, most larger freshwater drum tended to be caught in the MCBU stratum.

The distribution map for freshwater drum in Pool 8 (Figure 64) showed widespread catches of freshwater drum in all areas of the pool. Unlike most of the other species examined, they seemed to show no preference for shoreline or offshore sites, nor for channel-oriented or off-channel areas. Individual large catches came from the TWZ, the CTR in the lower pool, and scattered other sites at various places in Pool 8. Freshwater drum occurrence seemed to be nearly random.

Discussion

Water Levels

The question of how and to what extent hydrology influences fish communities and populations is complex, and most likely many other factors are involved. High-water periods occurred in both 1993 and 1997. The 1993 total catch was among the lowest of the report period, but species detection was the highest that year. In 1997, total catch and species detection were high. Also, total catches have steadily increased since 1993, regardless of water levels. In 1992, still during the fixed-site design, the total catch was more than 50,000 fish—nearly double that of any other year in the fixed-site design. Yet, the 1992 hydrograph did not indicate any obvious patterns that would suggest ideal conditions for spawning or recruitment. Additionally, a pattern of strong year classes for several species in 1992, 1994, and 1997 seems apparent. However, no obvious features of the hydrograph separate these years from others. A short-term study of fish growth (Bartels 1995) indicated that, although growth responses were consistent with predictions of the flood-pulse concept during high-water years, low-water years during droughts may also have great effects on fishes, the ramifications of which could be manifested in populations for several years thereafter. The advent of analytical models that define and incorporate a host of hydrological variables may assist scientists and managers in understanding water-level effects on river fishes.

Water-level and flow effects on fish sampling activities are tangible and also need to be considered in data interpretation. Certainly the unusually low catches that occurred in 1993 were in some way linked to the 1993 flood. These low catch rates were most likely the result of a combination of reduced gear efficiency and altered fish distributions. The large number of species detected that year may also have been linked to high water levels. It is possible that fish were flushed into and through Pool 8 from both upstream pools and tributaries, making species available that do not usually exist in Pool 8. On a shorter time scale, individual precipitation events, short-term dry periods, and lock and dam operations can alter river levels, and thus fish

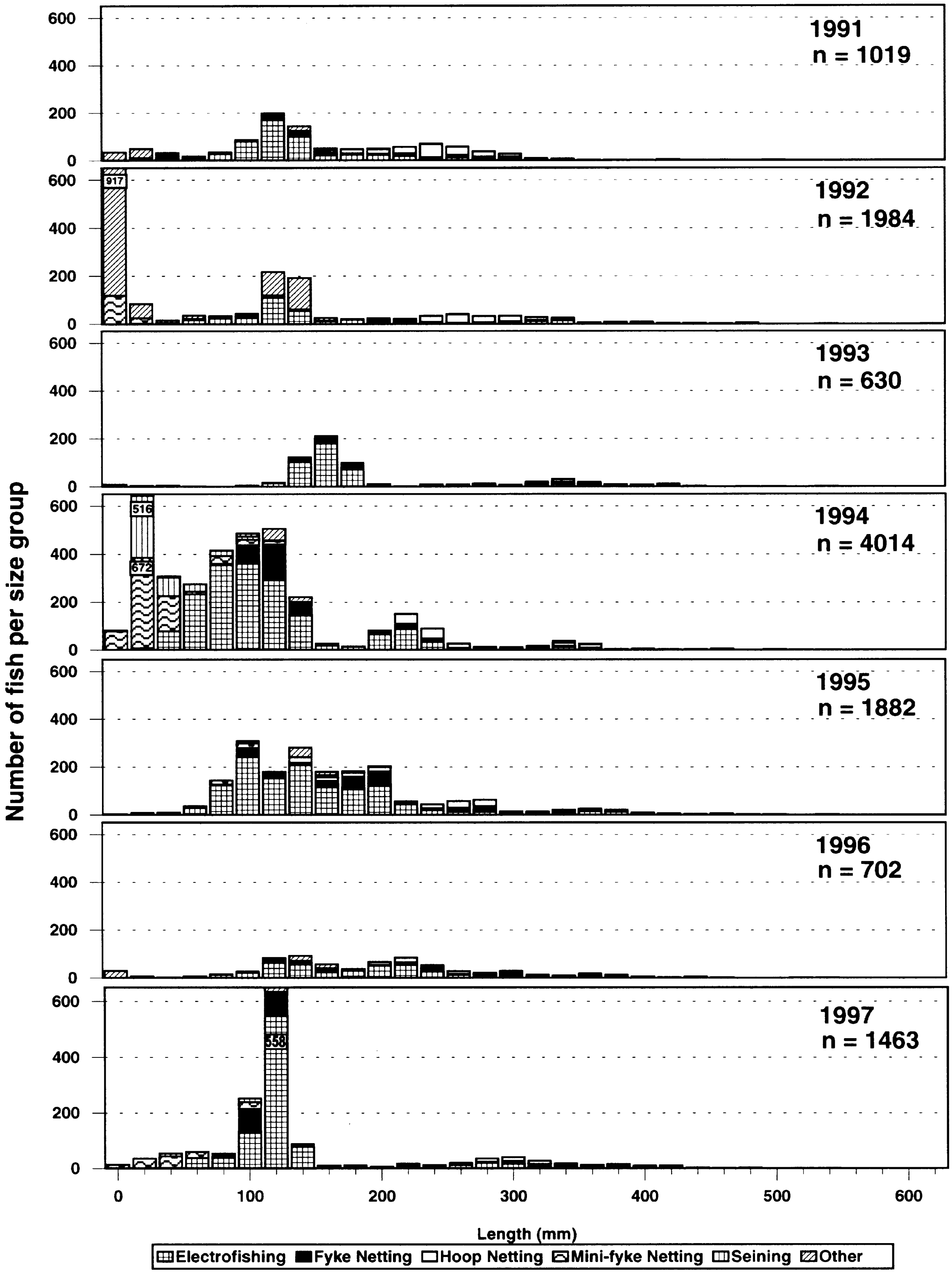

Figure 62. Length distribution, by gear type, for freshwater drum (*Aplodinotus grunniens*) collected in Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

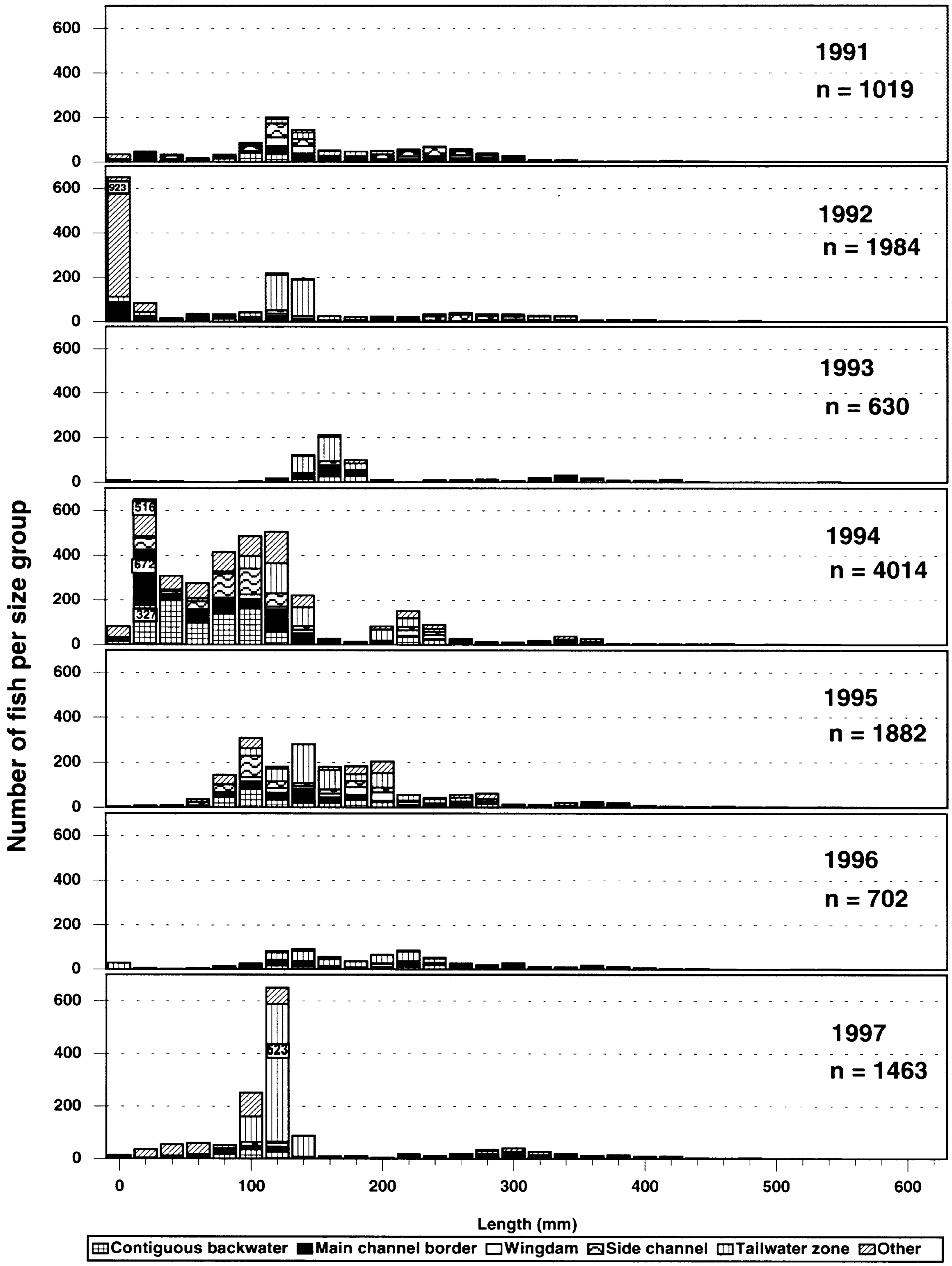

Figure 63. Length distribution, by sampling stratum, for freshwater drum (*Aplodinotus grunniens*) collected in Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

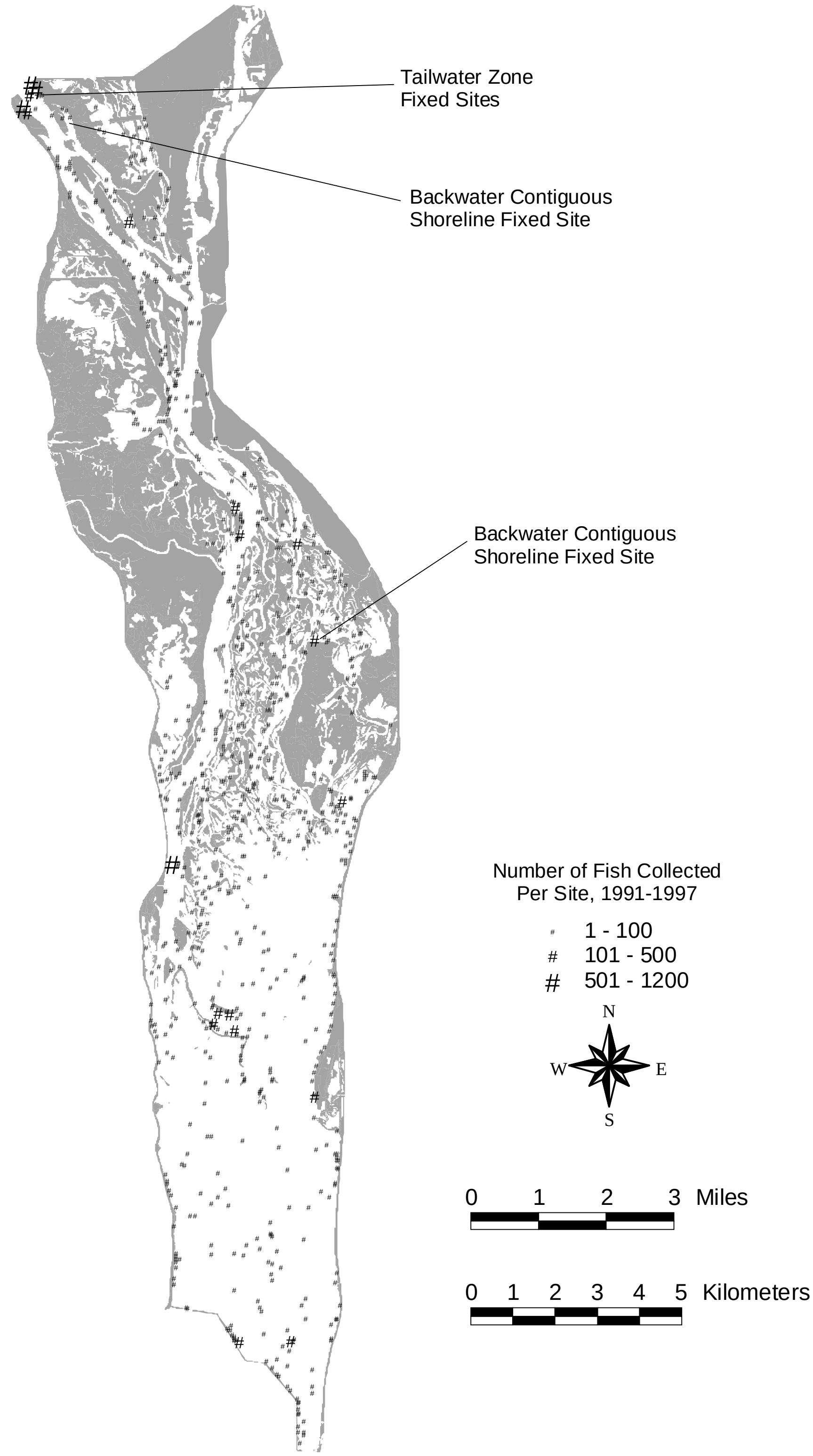

Figure 64. Total number of freshwater drum (*Aplodinotus grunniens*) caught per sampling site in Pool 8 of the Upper Mississippi River, for the Long Term Resource Monitoring Program, 1991–1997.

distributions, for periods of days and weeks. The effects of these short-term fluctuations on individual samples are probably manifested in the same way as larger hydrological events, but at a different magnitude.

In view of the complexities of trying to sample mobile organisms (such as fishes) in a constantly changing medium (such as the Upper Mississippi River), uncertainties are bound to exist. The LTRMP fish sampling is designed to account for these uncertainties by annually deploying multiple gears in a randomized fashion over an extended time, when water levels have historically been the most stable.

The intent is that small-scale disturbances can be accounted for, and large-scale disturbances can be documented as an effect. Total catch has gradually increased and species richness has remained stable through time in Pool 8, suggesting that the sampling design is indeed robust enough to absorb small disturbances within given years. In 1993, however, when a large-scale disturbance occurred, this event was reflected in the monitoring data by the detection of unusual species and lower catch rates.

Sampling Design

Although the comparison of fixed and random sampling was not a focus of the present report, some general observations can be drawn from the data presented. Sampling effort increased substantially when SRS was implemented. Total catch also increased from 1991 through 1997, but the increase was gradual and did not seem to be a direct result of increased effort. Annual species detection levels increased somewhat when SRS began; however, the number of species per collection for most gear types has exhibited the same gradual increase over time as total catch. In a few instances, C/f values for species of interest (i.e., northern pike in fyke nets) differed dramatically from before and after SRS was implemented.

Since SRS began in 1993, the overall sampling design has remained quite stable. Because this type of sampling design had not been attempted before on a large river system, refinements through time were expected. Of particular importance was the need to ensure adequate sampling in offshore areas of the backwater and impounded strata. An apparent weakness of the sampling design that still remains is the inability to sample effectively in pelagic areas, especially after CTR trawling was discontinued. Otherwise, most habitats and riverine fish guilds seem to be well-represented in the sampling design.

Fish Community

In most aspects, the fish community of Pool 8 seems to be stable or improving. Catches of many species have increased or remained stable over the short term, indicating at least a stable pattern of abundance. A prolonged period of drought during 1988 and 1989, followed several years later by the 1993 flood, were major ecological events for the pool in a relatively short period. Nevertheless, although catches were low during the 1993 flood year, an immediate increase in total catch was seen in 1994 and each succeeding year as well. Thus, the fish community of Pool 8 as a whole seemingly has retained the ability to endure hydrological disturbances without long-term effect.

The most dominant species numerically were also the most frequently encountered, indicating that they have widespread abundance throughout the pool and are found in a variety of habitats. Bluegill are usually thought of as a backwater-oriented species and, because they were the most abundant and most frequently detected species, there is an indication that off-channel habitats in Pool 8 are still viable at this time. However, of the other species in the 10 most abundant list, only black crappie is believed to be primarily a lentic species.

As determined from historical records (Rasmussen 1979; Van Vooren 1983; Pitlo et al. 1995), most fish species that inhabited Pool 8 are still present. In each year since SRS began, the annual species total was at least 79% of the LTRMP overall species total for Pool 8 and was at least 73% of the historical species total. Species richness of individual strata remains high as well, averaging 40 to 60 species per year in most strata. Additionally, the catch has been distributed widely among many species, suggesting high species evenness. Even the most abundant species constitute only about 12% of the total catch, and a gradual gradient in catch occurs from the most to least abundant species.

However, some species seemingly are at risk in Pool 8. Six of eight fishes sampled in Pool 8 that are on Wisconsin's threatened or endangered species list were found infrequently. An additional group of 15 species, not considered threatened or endangered in Wisconsin, was also present in extremely low numbers (<20 individuals sampled). Thus, 21 of 91 documented species in Pool 8 (23%) presently have low abundance and may be susceptible to extirpation if unfavorable conditions develop or persist. A long-term data set will be valuable in assessing the status of these species in Pool 8 and the UMRS.

Species of Interest

Abundance

Most species of interest seemed to have stable populations throughout the 1991–97 period. Some, such as gizzard shad, white bass, and freshwater drum, exhibited dramatic changes in abundance as determined by sporadic, successful hatches of young fish. Others, such as channel catfish, flathead catfish, and northern pike, yielded similar numbers in most years. Species showing a general increasing trend in abundance were bluegill and smallmouth bass. White bass, largemouth bass, and black crappie showed moderate decreases in abundance.

Length Distributions

Length distributions for the 15 selected species showed some unique patterns. Populations of gizzard shad, white bass, bluegill, largemouth bass, black crappie, yellow perch, sauger, and freshwater drum tended to consist primarily of small fish, seldom producing any substantial populations of large adults. Gizzard shad are near the northern extreme of their range in Pool 8, and many gizzard shad die in winter each year, so a lack of large adults is not surprising. Bluegill, largemouth bass, black crappie, and yellow perch prefer backwater habitats and may be becoming limited by lack of overwintering habitat. White bass, sauger, and freshwater drum often inhabit deep water or pelagic areas, and larger individuals of these species may be escaping detection in LTRMP gears. Additional study is warranted for these species because they are valued by resource managers and the public.

Age-0 common carp (<100 mm TL) were present in several years; however, few common carp were captured in the juvenile size ranges. Adults over 400 mm TL were abundant in all years. The most plausible explanations for this gap in size ranges of common carp are either that the standard LTRMP gear-stratum complement is not effective at catching larger juveniles, or that juvenile mortality is extremely high and adult mortality is low enough to sustain a large population of adults. Because common carp are a commercially harvested species, it would seem that steady recruitment would be necessary to maintain population levels. One gap in the LTRMP sampling design is the lack of ability to sample effectively at middepths in deep offshore areas. Perhaps juvenile common carp inhabit these types of locations and are able to escape detection. Further study of common carp is warranted to address these questions.

Year Classes

Although age and growth data were not routinely collected for most species, the length distributions suggested some patterns of year class strength. Several species, including common carp, smallmouth buffalo, white bass, smallmouth bass, black crappie, yellow perch, sauger, walleye, and freshwater drum, tended to produce large hatches in 1992, 1994, 1997, or a combination of these years. This pattern suggests widespread favorable conditions for spawning and recruitment among many species in those years. However, survival, as evidenced by carryover to larger sizes the next year, was not evident in many of these instances.

The channel catfish population seemed to consist primarily of fish from the 1991 year class. Fewer age-0 catfish were seen in other years, which may have resulted from poor year class strength or because main channel trawling was discontinued after 1991. However, the most numerous group of channel catfish shifted to a larger size each year that seems consistent with expected annual growth and few small channel catfish followed behind this group. As the dominant year class reaches the end of its lifespan, close attention should be paid to this species to determine if additional successful year classes have been produced to maintain the population at high levels.

A third unique feature of year classes apparent from the length distributions was that most species experienced poor recruitment of young fish into the population during the 1993 flood year. The only species of interest that seemed to produce more young fish that year was northern pike. Because northern pike are among the earliest spawners in the river, it is plausible that juvenile pike grew fast enough to survive the dangers of the flood, whereas most juveniles of other species had not grown enough to endure the harsher conditions. An additional factor favoring good recruitment for northern pike in 1993 was that river levels never fell low enough to drain spawning marshes in late spring, allowing juveniles plenty of time to hatch, grow, and exit the marshes. Because this particular flood occurred in midsummer when water levels are normally dropping, it is not surprising to see negative effects on year classes of species that spawn at that time. High current velocities and physical disruption by floating debris would be particularly harmful to the spawning success of nest-building fishes, such as centrarchids. Further examination of the data may indicate if spawning success, recruitment success, or both were decreased for species of interest in 1993.

Spatial Distribution

In general, the 15 selected species can be classified into three groups for spatial distribution and stratum preferences. Gizzard shad, common carp, smallmouth buffalo, smallmouth bass, and freshwater drum composed a group that was distributed widely throughout the pool and occurred in a variety of strata. Northern pike, bluegill, largemouth bass, black crappie, and yellow perch formed another group that preferred a small group of backwater sites in the middle and upper pool. A third group that preferred the tailwater zone and channel areas were channel catfish, flathead catfish, white bass, sauger, and walleye. These groupings are generally consistent with the known habitat preferences for these species in a lotic environment.

Conclusions

Pool 8 Fish Resource

Navigation Pool 8 of the Upper Mississippi River has a diverse and valuable fish community, consisting of the majority of species historically present and large populations of many species considered important to managers and the public. However, 21 species were present only in extremely low numbers, and some species of interest (e.g., common carp, channel catfish, white bass, largemouth bass, and sauger) exhibited gaps in size ranges that suggest the need for further study. Continued long-term monitoring and research to define population trends, determine limiting factors, and examine responses to disturbances is warranted. Although many agencies have shifted management focus toward ecosystem-based approaches, life history and population dynamics data for individual species are still important for evaluating the success of those approaches in achieving healthy ecosystems.

Sampling Design

The SRS design, on a cursory level, seems to be adequate for achieving most of its goals. To date, efforts in Pool 8 have resulted in a large and useful database. Species detection rates were high annually and over the long term, and many rare species were detected. For most species of interest, the data set provided enough information to allow comparisons of catch rates and size structure among years. However, a critical review of the sampling design should be a high priority in the future. The level (percentage) of change required in individual fish populations before a change could statistically be detected is unknown—at the pool level or within sampling strata. Also needed is an evaluation of the gear deployment array within strata, to yield information about sampling redundancies or shortcomings among strata and gear types. Next, focused research should be undertaken to determine if the missing size ranges of certain species are a result of inadequate sampling or simply absence in the population. A final consideration concerning the sampling design is that, although random sampling in the present framework provides unbiased samples of fish populations within pools, systemic extrapolation of those data would not be valid because data are lacking for areas between the key pools. A plan to randomly select logistically manageable areas within larger study reaches for annual sampling may be more adequate for assessing systemwide trends. Data sets and sampling must be kept uniform to facilitate trend analyses and allow persons other than the data collectors the opportunity to analyze and interpret data. The LTRMP is the first attempt to assemble a long-term record of data on the UMRS. It must retain continuity and standardization to effectively accomplish that mission.

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13. ABSTRACT (Maximum 200 words)

Personnel of the Long Term Resource Monitoring Program for the Upper Mississippi River System have collected fish information in Navigation Pool 8 since 1989. In this report, I summarize data collected during the period 1991–97, in which gear deployment methods and sampling periods remained stable but fixed-site sampling changed to predominantly stratified random sampling in 1993. Sampling collections totaled 3,596 and yielded 324,948 fish of 91 species. Sampling effort increased over time, mainly when the change to random sampling occurred. Annual catches and species totals increased when random sampling was implemented; catches increased even with stable sampling effort in recent years. Of 12 gear types used, day and night electrofishing, seining, and mini-fyke netting were used the most often, produced the greatest catch totals, and also yielded the highest species totals each year. Bluegill (*Lepomis macrochirus*), spotfin shiner (*Cyprinella spiloptera*), and emerald shiner (*Notropis atherinoides*) were the most abundant species and also occurred in the greatest percentage of collections, indicating widespread abundance. Sixteen species yielded more than 5,000 individuals each. Family Cyprinidae was represented by 21 species and 141,497 fish, Centrarchidae by 9 species and 71,375 fish, and Catostomidae by 14 species and 26,776 fish. Twenty-one of 91 total species were rarely caught. Skipjack herring (*Alosa chrysochloris*), previously described as extirpated, was documented in the 1993 flood year. American brook lamprey (*Lampetra appendix*) and rainbow smelt (*Osmerus mordax*) were recorded for the first time in the Upper Mississippi River in 1993. Fantail darter (*Etheostoma flabellare*) and banded darter (*Etheostoma zonale*) were documented for the first time in Pool 8 in 1997. Population trends for 15 species of perceived interest to river managers and the public indicated mainly stable populations.

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The Long Term Resource Monitoring Program (LTRMP) for the Upper Mississippi River System was authorized under the Water Resources Development Act of 1986 as an element of the Environmental Management Program. The mission of the LTRMP is to provide river managers with information for maintaining the Upper Mississippi River System as a sustainable large river ecosystem given its multiple-use character. The LTRMP is a cooperative effort by the U.S. Geological Survey, the U.S. Army Corps of Engineers, and the States of Illinois, Iowa, Minnesota, Missouri, and Wisconsin.