FINAL STUDY REPORT
CHARACTERIZATION OF DOWNSTREAM AQUATIC COMMUNITIES
RSP 3.18

CONOWINGO HYDROELECTRIC PROJECT

FERC PROJECT NUMBER 405

Prepared for:

Exelon

Prepared by:

Normandeau Associates, Inc.

Gomez and Sullivan Engineers, P.C

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EXECUTIVE SUMMARY

Exelon Generation Company, LLC (Exelon) has initiated with the Federal Energy Regulatory Commission (FERC) the process of relicensing the 573-megawatt Conowingo Hydroelectric Project (Conowingo Project). The current license for the Conowingo Project was issued on August 14, 1980 and expires on September 1, 2014. FERC issued the final study plan determination for the Conowingo Project on February 4, 2010, approving the revised study plan with certain modifications.

The final study plan determination required Exelon to conduct a literature-based study to provide a characterization of the current aquatic community below Conowingo Dam, which is the subject of this report. The objectives of this study are to utilize existing data to: 1) characterize resident fish abundance, size structure, condition, and reproductive success below Conowingo Dam-the existing data includes fish lift catches as well as results from other common fisheries gear types such as electrofishing, gill nets, and ichthyoplankton nets; 2) describe the benthic macroinvertebrate communities below Conowingo Dam collected by various common collection gears; and 3) provide updated information on these communities available through studies focused on other objectives.

An initial study report (ISR) was filed on February 22, 2011, containing Exelon's 2010 study findings. An initial study report meeting was held on March 9, 10 and 11, 2011 with resource agencies and interested members of the public. Formal comments on the ISR including requested study plan modifications were filed with FERC on April 27, 2011 by Commission Staff, several resource agencies and interested members of the public. Exelon filed responses to the ISR comments with FERC on May 27, 2011. On June 24, 2011, FERC issued a study plan modification determination order. The order specified what, if any, modifications to the ISRs should be made. For this study, FERC's June 24, 2011 order required no modifications to the original study plan. An updated study report (USR) was filed on January 23, 2012 addressing comments from stakeholders received at the March ISR meeting, those comments addressed by Exelon in the May 27, 2011 responses to ISR comments, as well as editorial and minor text changes. This final study report is being filed with the Final License Application for the Project.

From 1980 through 1991 a series of quantitative benthic studies were conducted in the non-tidal area of the Lower Susquehanna River below the Conowingo Dam to determine a release schedule sufficient to maintain healthy fish and macroinvertebrate communities. A cumulative total of 71 macroinvertebrate taxa were collected and were identified to the genus level. This result was used as a basis to characterize the invertebrate community as moderately rich. The community was generally comprised of facultative or

tolerant warm-water genera. Most abundant were: Chironomidae in the genera *Cricotopus*, *Dicrotendipes*, and *Polypedilum*; caddisflies in the genera *Cheumatopsyche* and *Hydroptila*; Asiatic clams in the genus *Corbicula*; flatworms in the genus *Dugesia*; a crustacean in the genus *Gammarus*; a snail in the genus *Goniobasis*; and aquatic worms in the genera *Manayunkia*, and *Nais*. The most important food items in the stomach contents of eight fish species examined were Chironomidae, *Cheumatopsyche*, and *Gammarus*.

Thirty-eight years of annual collections at the West Fish Lift (WFL) and 19 years at the East Fish Lift (EFL) facilitate description of year-to-year and long term fluctuations in catch and proportional abundance in key resident and migratory species of the Lower Susquehanna River fish assemblage from relicensing studies were conducted by Exelon from 1982 to 1987. These included electrofishing, gill net and ichthyoplankton sampling efforts from Conowingo Dam downstream to the tidal waters at Havre de Grace, Maryland. These data augment the fish lift collections by providing a more detailed spatially and temporally diverse characterization of the downstream fish populations in regards to species assemblage, condition, food habits and habitat use. Data collected in the 2010 fish stranding summer surveys in the spillway reach below Conowingo Dam also supplement the fish lift catches for a season not typically sampled by the lifts.

The dominant species documented by the macroinvertebrate and fish community studies downstream of Conowingo Dam to the tidal zone, are summarized in Table ES-1 and discussed below.

TABLE ES-1: SUMMARY OF FISH COMMUNITY AND DOMINANT SPECIES DOCUMENTED TO OCCUR DOWNSTREAM OF CONOWINGO DAM BASED ON HISTORICAL STUDIES, 1972-2010

		DATA SOURCE					
		WFL	EFL	Ichthyo-plankton sampling	Electrofishing	Gill Nets	Stranding Surveys
Years		1972 to 2009	1997-2009	1982-1984	1982-1987	1981-1984	2010
Total fish		31,533,545	16,411,728	275,710 (eggs)	235,458	4,054	
Taxa		72	59	27	66	28	14
Average CPUE		1,148/lift	1,289/lift	n/a	953/hr	34/net	n/a
Dominant species	Gizzard Shad	75%	87%	3%	49%	22%	57%
	American Eel				11%		
	American shad	<1%	8%				
	White perch	12%	<1%	72%	12%	23%	
	Blueback herring	4%	4%	24% (incl. alewife)			
	Channel catfish	3%			4%	42%	
	Banded killfish						23%
	Sunfish				7%		11%
	Largemouth bass						4%
	Yellow Perch				6%		
	Other species	5% (67 taxa)	<1% (5 taxa)	1% (24 taxa)	11% (60 taxa)	13% (24 taxa)	5% (10 taxa)

The WFL has been operated during anadromous spawning migrations since 1972 as part of a cooperative private, state, and Federal effort to restore American shad to the upper Susquehanna River. From 1972 to 2009 the WFL collected 31,533,545 fish of 72 different taxa from 27,481 lifts. The overall catch per unit effort (CPUE) of the WFL during the 38 years of operation was 1,148 fish per lift. From 1972 to 2009 gizzard shad accounted for 75% of the overall CPUE at the WFL. Gizzard shad became the dominant species in 1977 and retained its dominance over the next three decades. Overall, American shad comprised 1% of the overall collection at the West Fish Lift from 1972 to 2009. American shad CPUE at the West Fish Lift remained low throughout the 1970's but began to increase in the late 1980's and continued to increase through the 1990's; after 1996, American shad was routinely one of the top five most frequently collected species. The highest CPUE for American shad occurred in 2003 at 27 fish per lift. White perch (12%), blueback herring (4%) and channel catfish (3%) were other species proportionally abundant in CPUE. Sixty-seven other taxa combined for a total of 5% of the overall CPUE 1972 to 2009.

Pursuant to a settlement agreement on water quality and fish passage approved by FERC on January 24, 1989, Exelon was required to construct facilities for the protection of fish. The EFL began operation in 1991 as the cornerstone of the agreement. Beginning in 1997 all fish were lifted to the exit channel for continued volitional upstream movement following the construction and operations of fish lifts at the upstream Holtwood and Safe Harbor dams. From 1991 to 2009 the EFL collected 16,411,728 fish of 59 different taxa from 12,733 lifts. The overall CPUE from the 19 years of lift operation was 1,289 fish per lift. Gizzard shad have dominated the catch at the EFL, accounting for 86% of all fish collected since 1991. Other species proportionally abundant in CPUE at the EFL included American shad (8%) blueback herring (4%) and white perch (1%). Fifty-five other taxa combined for a total approximately 1% of the overall CPUE 1991 to 2009.

From 1982 to 1984 ichthyoplankton sampling was generally performed from late March to late June to characterize the use of the lower Susquehanna River downstream of Conowingo Dam by resident and anadromous fishes as a spawning and nursery area. A total of 275,710 eggs, larvae or young from 27 taxa was collected from 1,322 icthyoplankton samples. During each year eggs were the most abundant life stage collected. White perch was the most frequently collected species, constituting 72% of all icthyoplankton observed. *Alosa* spp. (alewife and blueback herring) comprised 24% and gizzard shad comprised 3% of the ichthyoplankton collected. Other less commonly collected species included American shad and carp; these along with 24 other species accounted for less than 1% of the specimens collected.

Over the course of the 1982 to 1987 electrofishing series, 247 hours of effort were spent sampling the Conowingo tailrace, the riverine areas consisting of Lee's Ferry and the Pool, and the tidal zone. A representative collection was completed in every month of the year except February. A total of 235,458 fish of 66 taxa was collected in the lower Susquehanna River electrofishing program from May 1982 to October 1987. Overall, the CPUE from 1982 to 1987 was 953 fish/hr. Gizzard shad was the most proportionally abundant species comprising 49% of all fish collected, followed by white perch (12%) and American eel (11%). Species assemblage and proportional abundance varied seasonally in the Conowingo tailrace. Gizzard shad dominated the catch from September through December and were relatively high in proportion in April through June. Comely shiners were relatively abundant in both December and March collections. Carp were most prevalent in spring. A relatively high rate of collection for American eel was maintained throughout all months of sampling. White perch were also relatively abundant May through

October. Lee's Ferry and the Pool had very little month to month variability and white perch was the most frequently collected fish in all years. Other species frequently collected at Lee's Ferry and the Pool included: American eel, channel catfish, carp, gizzard shad, shorthead redhorse and yellow perch. At the tidal zone, the most frequently collected species varied more from year to year than the other survey areas. Gizzard shad were the most frequently collected species in 1983 and 1985. Redbreast sunfish were the most frequently collected species in 1986 and 1987. Yellow perch was the most frequently collected species in 1982 and 1984. Other species common in the tidal zone included: American eel, carp, pumpkinseed, bluegill, channel catfish, smallmouth bass, white sucker, spottail shiner and comely shiner.

Gill netting was conducted monthly from July through November in 1981 to 1984 in the same general areas as sampled by electrofishing below Conowingo Dam. A total of 4,054 fish of 28 taxa was collected from 118 gill net sets. Channel catfish was the most proportionally abundant species in CPUE (42%) followed by white perch (23%) and gizzard shad (22%) in all areas across all years. Twenty-four taxa comprised the remaining 13% of fish collected. White perch exhibited several seasonal trends; at the Conowingo tailrace white perch catches were higher in July and August than in other months, and at Lee's Ferry white perch CPUE's were significantly higher in September. For gizzard shad the highest CPUEs consistently occurred in September and October.

Various food habits studies conducted 1982 to 1985 depict fishes below Conowingo Dam opportunistically utilizing food resources available from lotic habitats below the dam as well as forage produced in Conowingo Pond upstream. Detailed stomach analyses of individual white perch, channel catfish and yellow perch taken by electrofishing in the tailrace below Conowingo Dam July through December reported small zooplankters were abundant in white perch stomachs, but caddisfly larva (*Cheumatopsyche*) and chironomid larva were more important on a frequency basis, with caddis larvae most important based on percent of the biomass eaten (Weisberg and Janicki 1985). Chironomids were most important to channel catfish numerically and on a frequency basis. However, similar to white perch, caddis larva formed most of the diet biomass. The amphipod *Gammarus* was the most important food of yellow perch. Food resources recruited from Conowingo Pond and available to downstream fishes include zooplankton, important to both resident fishes and young of larger predators, and also young gizzard shad which sustain many of the larger resident and migratory predators below the dam.

Smallmouth bass have historically been and remain a highly sought after recreational species below Conowingo Dam. Smallmouth bass age and growth below Conowingo Dam were evaluated over a 4-year period from 1980 to 1983 (RMC 1985a). Mean fork length data depict a typical growth pattern. Based on mean FL attained by Age 4 (366 mm), most smallmouth bass were recruited to the harvestable population below Conowingo Dam (~305 mm TL) during their 4th year of life. Growth of smallmouth bass below Conowingo Dam was similar to or greater than that reported for several waters in PA and MD (RMC 1985a).

Length frequency data were collected and summarized for several species from electrofishing, gill nets and fish lifts 1982 to 1984 (RMC 1985a,b,c). Differences between years in length frequencies of collected fishes were likely due to varied growth or recruitment of particular year classes. In electrofishing samples, a majority of white perch in each sampling area were 141 to 170 mm, and electrofishing samples taken late in the spawning run in the spring reflected the size distribution of transient white perch adult spawners. Nearly 50% of channel catfish collected from the riverine reach and tidal zone were 151 to 200 mm. In the tailrace, the catch of channel catfish was almost exclusively juvenile (<250 mm). The size distribution of gizzard shad collected by electrofishing in the tailrace and riverine reach was dominated by individuals exceeding 200 mm, whereas the tidal zone was dominated by smaller (101-150 mm) gizzard shad. During electrofishing collections a majority of yellow perch collected throughout the study reach were 141 to 180 mm Electrofishing and fish lift collections for smallmouth bass exhibited seasonal variability in length as a majority of spring and summer collections consisted of larger fish (>151 mm) while increasing numbers of small fish (<150 mm) were collected in the fall. Striped bass collected during electrofishing in 1982 were distinctly adult or juvenile in age class as indicated by the sizes collected. The 1982 year class was dominant in subsequent collections in 1983 and 1984. The electrofishing and fish lift collections of walleye were comprised of larger, adult fish.

The length weight relationship as expressed by slope of the regression equation based on data collected in 2010 indicates that lengths and weights of selected species collected at the WFL were similar to those collected 1982 to 1987 (Table 9.1-2).Walleye and channel catfish slopes from 2010 were near the median ranges discovered in the 1980's. Smallmouth bass and largemouth bass slopes from 2010 were slightly lower (2%) than the lower portion of range discovered in the 1980's. Though the comparison is limited to one year from the 1980's, yellow perch from 2010 are lower (17%) than the slope estimated in 1983. Both the 1980's fish and those collected in 2010 were within the ranges presented in Carlander (1969, 1977, 1997).

The relative robustness of a fish can often be described via fish condition ($K=\text{weight}/(\text{length})^3$). Fish condition may express the relative nutritional state as 'K' greater or less than a usual weight at a particular length. Condition factor may also vary with stage of development, maturation and sex in some species. Length weight data were collected for several species at the WFL of the Conowingo Dam in 2010 including channel catfish, redbreast sunfish, bluegill, smallmouth bass, largemouth bass, yellow perch and walleye. Fish conditions for species collected at the WFL in 2010 were within the normal range of means presented from various populations of the same species in Carlander 1969 and 1977.

Data collected in the 2010 fish stranding summer surveys in the spillway reach below Conowingo Dam supplemented the fish lift catches for a season not typically sampled by the lifts. The most commonly observed fish species were similar on both the east and west sides of the spillway reach. Gizzard shad, banded killifish and sunfish were the three most observed species comprising 57%, 23% and 11% of the total observations, respectively. Largemouth bass comprised an additional 4% of the observations. The remaining 5% of the observations consisted of American eel, carp, minnows, quillback, catfishes, white perch, smallmouth bass, sunfish (*Lepomis* spp.), walleye, and darters. Blue crab were also observed.

Over the sampling duration 1972 to 2009, the fish lift catch data captured year to year variability and long term trends in fish assemblage of species vulnverable to the lift. Fish lift catches at both the EFL and WFL were robust and provide a baseline indicator of the dominant species in the lower Susquehanna River. Generally, species that were routinely dominant in the fish lift collections (gizzard shad, channel catfish, carp and white perch) were also dominant in 1980's electrofishing, gill net and ichthyoplankton collections. Electrofishing and gill net collections augment the data provided by the fish lift, adding detail to temporal and spatial description of the downstream fish populations. Fish recruitment to these other gear types investigated the various habitats from the Cononwingo tailrace to the tidal zone below Spencer Island throughout all seasons. Icthyoplankton samples provided detail on the reproduction and utilization of the lower Susquehanna habitats by earlier life stages of fish. Data collected in the 2010 fish stranding summer surveys along with recent fish lift catches depict the most current assemblage of species in the tailrace and the lower Susquehanna. Supplemental analyses on condition and length weight relationships describe fish health, benthic macro invertebrate studies and food habits studies explore relationships in predator prey interaction and community ecology. The fish lift, electrofishing, gill net, icthyoplankton studies and supplemental analyses collectively provide a thorough characterization of the fish community and habitat use.

Although several species have increased or declined in abundance, the fish species assemblage has remained diverse below Conowingo Dam with the same core group of species as was observed in the 1980's. A core assemblage consisting of gizzard shad, white perch, common carp, quillback, comely shiner, channel catfish, walleye, smallmouth and largemouth bass along with seasonal migrants like American shad, blueback herring, alewife, sea lamprey and striped bass form the primary group of inhabitants. Condition factor and length weight relationships of representative common fish species downstream of Conowingo Dam are comparable to those from other normal, natural populations and are indicative of relatively favorable conditions and habitats in the lower Susquehanna River.

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LIST OF ABBREVIATIONS

Agencies

EFL	East Fish Lift
FERC	Federal Energy Regulatory Commission
ISR	Initial Study Report
MDE	Maryland Department of Environment
MDNR	Maryland Department of Natural Resources
MGS	Maryland Geological Survey
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
PADEP	Pennsylvania Department of Environmental Protection
PADCNR	Pennsylvania Department of Conservation and Natural Resources
PEPCo	PECO Energy Power Company
PFBC	Pennsylvania Fish and Boat Commission
PGC	Pennsylvania Game Commission
PGS	Pennsylvania Geological Survey
SPCo	Susquehanna Power Company
SRBC	Susquehanna River Basin Commission
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
USFWS	United States Fish and Wildlife Service
USR	Updated Study Report
WFL	West Fish Lift

Units of Measure

C	Celsius, Centigrade
cfs	cubic feet per second
cm	centimeter
El.	elevation
F	Fahrenheit
ft	feet
fps	feet per second
h	hour
L	liter
m	meter
mm	millimeter
MW	megawatt

Miscellaneous

DC	Direct Current
EA	Environmental Assessment
EIS	Environmental Impact Statement
FL	Fork Length
FPA	Federal Power Act

1.0 INTRODUCTION

Exelon Generation Company, LLC (Exelon) has initiated with the Federal Energy Regulatory Commission (FERC) the process of relicensing the 573-megawatt (MW) Conowingo Hydroelectric Project (Project). Exelon is applying for a new license using the FERC's Integrated Licensing Process (ILP). The current license for the Conowingo Project was issued on August 14, 1980 and expires on September 1, 2014.

Exelon filed its Pre-Application Document (PAD) and Notice of Intent (NOI) with FERC on March 12, 2009. On June 11 and 12, 2009, a site visit and two scoping meetings were held at the Project for resource agencies and interested members of the public. Following these meetings, formal study requests were filed with FERC by several resource agencies. Many of these study requests were included in Exelon's Proposed Study Plan (PSP), which was filed on August 24, 2009. On September 22 and 23, 2009, Exelon held a meeting with resource agencies and interested members of the public to discuss the PSP.

Formal comments on the PSP were filed with FERC on November 22, 2009 by Commission staff and several resource agencies. Exelon filed a Revised Study Plan (RSP) for the Project on December 22, 2009. FERC issued the final study plan determination for the Project on February 4, 2010, approving the RSP with certain modifications.

The final study plan determination required Exelon to conduct a literature-based study to provide a characterization of the current aquatic community below Conowingo Dam. The report should include data beyond that provided by annual fish lift catches, including information on fish size, age, condition factor, and abundance indexed by CPUE. The objective of this report is to utilize existing data to: 1) characterize resident fish abundance, size structure, condition, and reproductive success below Conowingo Dam --the existing data includes fish lift catches as well as results from other common fisheries gear types such as electrofishing, gill nets, and ichthyoplankton nets; 2) describe the benthic macroinvertebrate communities below Conowingo Dam collected by various common collection gears; and 3) provide updated information on these communities available through 2010 studies focused on other objectives. The freshwater mussel community, part of the overall invertebrate community, was examined separately and results are reported in Conowingo Project Study 3.19-Freshwater Mussel Characterization Study below Conowingo Dam.

An initial study report (ISR) was filed on February 22, 2011, containing Exelon's 2010 study findings. An initial study report meeting was held on March 9, 10 and 11, 2011 with resource agencies and interested members of the public. Formal comments on the ISR including requested study plan modifications were filed with FERC on April 27, 2011 by Commission Staff, several resource agencies and interested members of the public. Exelon filed responses to the ISR comments with FERC on May 27, 2011. On June 24, 2011, FERC issued a study plan modification determination order. The order specified what, if any, modifications to the ISRs should be made. For this study, FERC's June 24, 2011 order required no modifications to the original study plan. An updated study report (USR) was filed on January 23, 2012 addressing comments from stakeholders received at the March ISR meeting, those comments addressed by Exelon in the May 27, 2011 responses to ISR comments, as well as editorial and minor text changes. This final study report is being filed with the Final License Application for the Project.

2.0 BACKGROUND

The Susquehanna River below Conowingo Dam flows approximately 10 miles before entering Chesapeake Bay. The non-tidal portion of the Susquehanna River encompasses approximately 3.5 miles of river length from Conowingo Dam downstream to the mouth of Deer Creek (a tributary), which is the approximate natural upstream limit of tidal influence. The Chesapeake Bay stretches about 200 miles from the Susquehanna River in the north to the Atlantic Ocean in the south. A broad, shallow area called the Susquehanna Flats, south of Havre de Grace, Maryland, represents the point where the Susquehanna River flows into upper Chesapeake Bay.

The Conowingo Project uses limited active storage within Conowingo Pond for generation purposes. Maximum hydraulic capacity of the Conowingo powerhouse is 86,000 cfs. The current minimum flow regime below Conowingo Dam was formally established with the signing of a settlement agreement in 1989 between the Project owners and several federal and state resource agencies (46 FERC ¶61,063) (FERC 1989). The established minimum flow regime below Conowingo Dam is the following:

March 1 – March 31	3,500 cfs or natural river flow
April 1 – April 30	10,000 cfs or natural river flow, whichever is less
May 1 – May 31	7,500 cfs or natural river flow, whichever is less
June 1 – September 14	5,000 cfs or natural river flow, whichever is less
September 15 – November 30	3,500 cfs or natural river flow, whichever is less
December 1 – February 28	3,500 cfs intermittent (maximum six hours off followed by equal amount on)

The downstream discharge must equal these values or the discharge measured at the Susquehanna River at the Marietta, Pennsylvania United States Geological Survey (USGS) gage (No. 01576000), whichever is less. The Marietta USGS gage is located approximately 35 miles upstream of Conowingo Dam above the Safe Harbor Dam.

The Lower Susquehanna River below the Conowingo Dam contains a variety of freshwater habitats that support communities of resident and migratory fishes. The river in this reach consists of lotic, riverine habitat conditions extending 9 miles to the upper Chesapeake Bay. The upper 3.5 miles are non-tidal and the lower 6.5 miles to Havre de Grace, Maryland exhibit daily tidal cycles.

Thirty-eight years of annual collections at the West Fish Lift (WFL) and 19 years at the East Fish Lift (EFL) facilitate description of year to year and long term fluctuations in catch and proportional abundance in key resident and migratory species of the Lower Susquehanna River fish assemblage. In addition to the fish lift data, fish distribution and abundance surveys from previous relicensing studies were conducted by Exelon from 1982 to 1987. These data augment the fish lift collections in providing a more detailed spatially and temporally diverse characterization of the downstream fish populations in regards to species assemblage, condition, and habitat use. These studies included electrofishing, gillnet and ichthyoplankton sampling efforts from Conowingo Dam to the tidal zone just below Spencer Island.

Benthic macroinvertebrate communities were also examined as part of the these studies. In parallel and extending through the 1980's into the 1990's, benthic community studies were performed by Maryland Power Plant Siting (now Power Plant Research Program, PPRP) towards eventual settlement in 1989 of the minimum flow issue. Resolution of the minimum flow issue yielded the seasonal flow release schedule described above.

3.0 STUDY AREA

The lower river is the 10 mile stretch of the Susquehanna River from Conowingo Dam to the Chesapeake Bay. Within this 10 miles the character of the river varies considerably. The tailrace extends from Conowingo Dam to below Rowland Island. The maximum depth at zero generation is 23 ft. The main flow of water occupies the deep channel between the west bank and Rowland Island. In the riverine reach below the tailrace, the water flow spreads out toward the east shore. This is a typical shallow bedrock river with numerous boulders and bedrock outcroppings. At the head of this reach is Lee's Ferry. This is a shallow, rocky pool with depths of 6.5 ft at zero generation. From Lee's Ferry water flows through shallow riffles, runs, and pools to a larger area called The Pool, which has a depth of 10 ft at zero generation. The non-tidal portion of the lower river is composed of the tailrace and the riverine reach. The lower limit to the riverine reach is the *de facto* tidal limit at Deer Creek. The tidal portion of the lower river extends from just upstream of Deer Creek to the mouth of the river at the head of the Susquehanna Flats. The upper end of the tidal area is rocky and shallow similar to the riverine reach. Below Spencer Island the river deepens and broadens. Maximum depth is approximately 39 ft. The tidal amplitude in this reach is normally 2 ft.

4.0 BENTHIC MACRO INVERTEBRATES

Several studies provide the data that will be used here to characterize the benthic macroinvertebrate community below Conowingo Dam. These include:

- Janicki and Ross (1982) (study year 1980)
- Janicki and Weisberg (1983) (study year 1982)
- Weisberg and Janicki (1985) (study years 1982-1984)
- RMC (1985 a;b;c) (study years 1982-1984)
- Scott. (1991) (study years 1988-1991)

Several hundred samples and tens of thousands of specimens were quantitatively collected with multiple gear types during the referenced studies. Samples were taken from habitats within the non-tidal reach below Conowingo Dam, extending downstream about 3.5 miles (Figure 4.1). The individual studies above were performed during the initial decade of the current license period. A number of comprehensive benthic macroinvertebrate studies were completed between 1980 and 1991 to address the minimum flow issue, which contributed information towards a Settlement Agreement between the Maryland Department of Natural Resources (MDNR) and the Philadelphia Electric Company (now Exelon). The Settlement Agreement resulted in the flow release schedule identified above (see Section 2.0, Background).

Descriptions of the resident benthic communities are made through an evaluation of the most abundant taxa collected. This report provides an ecological characterization of the invertebrate communities as they existed during the study years: 1980, 1982, 1983, 1984, 1988, 1989, and 1991. To assemble it a literature search was conducted and augmented by communications with MDNR and the Susquehanna River Basin Commission (SRBC).

4.1 Study Year 1980

Samples were collected in 1980 by Janicki and Ross (1982) with rock basket samplers. Each sampler consisted of a wire basket 16 cm in diameter, 25 cm long, and filled with stones 5 to 20 cm on the longest axis. Ten baskets were placed in series along each of four transects (Figure 4.1) and secured with cable. Following a colonization period of three weeks they were removed and replaced with new ones. Five of the ten baskets from each transect were randomly selected for processing. The collection effort spanned a time period of June through October and included three habitat types: channel, isolated pool, and exposed substrate.

Specimen identifications in the original study were made to genus. A Tolerance Index, ranging from 0 to 10 (where low numbers indicate pollution sensitivity) was applied to each taxon for the present characterization. The Indices were taken from lists published by MDNR (2005) and PADEP (2009). Tolerance Indices from 0 to 3 are considered to represent sensitive forms, whereas values between 4 and 6 are considered facultative and values from 7 to 10 represent tolerant taxa. Taxa listed in the tables in bold represent 10% or more of the cumulative total.

Mean number of specimems per basket ranged between 311 and 911 for channel and isolated pool habitats. The numbers of specimens taken from exposed habitat were lower by one or two orders of magnitude, so most of the data summarized in Table 4.1-1 are from wetted portions of the river bottom. Omitting rare and uncommon taxa, the invertebrates in Table 4.1-1 combined represent 90.1% of all specimens collected. The most abundant taxa were *Gammarus* (32.2%), *Dugesia* (25.1%), Chironomidae (16.1%), and *Nais* (5.6%). All of these are tolerant forms found in warm-water habitats.

Gammarus is a relatively mobile crustacean found in both lotic (flowing) and lentic (still) habitats. They tend to prefer shallow areas (less than one meter) of slow to moderate current and do best in well oxygenated water. The most common species in the Susquehanna River is *G. fasciatus*, a generalist found in a variety of rivers, streams, lakes, and ponds at densities that can exceed 10,000 per square meter. They are more or less confined to the upper surface of the substrate (are epi-benthic) but have the capacity to swim in a haphazard fashion that is the basis for the common names given to them: scuds or side-swimmers. Their mobility allows them to adapt to fluctuating water levels characteristic of the tailwaters below Conowingo Dam. Omnivorous, they are noted in Pennak (1989) as voracious feeders that tend to be most active at night. They readily consume a wide variety of plant and animal matter and are also known to scavenge. *Gammarus* are a fairly large invertebrate that attains an adult size approaching 10 mm making them an energy laden food source for resident fish. Stomach content analysis of eight fish species conducted by Weisberg and Janicki (1985) during 1982 and 1983 showed *Gammarus* to be a major component (expressed as number and/or biomass) in the diets of channel catfish, white catfish, brown bullhead, yellow perch, white perch, bluegill, and pumpkinseed. They were also common but somewhat less numerous in the stomachs of green sunfish.

The primitive flatworm *Dugesia* ranked second in abundance. By far the most common species in warm rivers is *D. tigrina*, a small worm usually less than five mm long and capable of only limited locomotion on the surface of submerged substrates. This, in combination with a preference for still shallow water, would make them susceptible to water level fluctuation. Respiration is accomplished by gas exchange through the epidermis so they are able to persist in low oxygen environments. They have the capacity to reproduce either asexually or sexually but usually do so via fission, an adaptation that allows them to avoid loss of progeny due to egg destruction. To facilitate locomotion *Dugesia* secrete a distasteful slime through their body wall, so they are seldom a major component in the diet of fishes. They were not found in the stomach contents of any of the eight fish species noted above.

Chironomidae (midges) are a complex and species-rich family of two-winged (true) flies that are found in all types of fresh water. Because of the numerous ecological roles they play as both consumers and prey and the degree of resource partitioning they represent, chironomids enhance the stability of aquatic systems. Collections typically included 10 to 20 genera. Most midges are either facultative or pollution tolerant. The family is so versatile that it is difficult to provide a description applicable to the majority of genera commonly identified from large data sets. Some are epi-benthic, living in cases, while many others are adept burrowers. Burrowing forms would be favored in the non-tidal reach because they would be able to avoid desiccation (or freezing in the winter) on periodically exposed substrates by migrating downward into the still-moist subsurface. The genera listed in Table 4.1-1 fall within the subfamilies Chironominae and Orthocladiinae that include many burrowers. Midges are small, thin-bodied insects and usually less than 5 mm in length. On an individual basis they do not provide much energy when fed upon by large predators. However, they are normally so numerous that when taken together they form an important component of the diet of almost all of the omnivorous and carnivorous fish found in the non-tidal reach. Midges undergo what is termed a complete metamorphosis, meaning a pupal stage is included. During metamorphosis, pupae migrate en mass from the stratum through the water column to the surface where they molt and emerge as terrestrial adults. It is at this (exposed) stage in their life history that they become particularly susceptible to predation. Numerically, chironomids were the most frequently encountered forage item in the stomach contents of all eight fish species investigated.

The most commonly identified chironomid was *Dicrotendipes*, one of the most tolerant genera within the family. They are included in a group referred to as the blood-red midges. Their color is produced by a hemoglobin-like compound called erythrocruorin (Pennak 1978) that acts as respiratory pigment, allowing them a selective advantage in low-oxygen environments. They have also been observed to be disproportionately thermal-tolerant in heated discharges.

Also common was a very small segmented worm in the genus *Nais*, a widely distributed genus often found associated with filamentous algae. *Nais* feed upon single celled algae and bacteria that form a film on the surface of the filaments. Some species prefer soft sediments. Because only limited amounts of either habitat type are found in the tailrace, the presence of *Nais* may be due in part to passage downstream from Conowingo Pond. They reproduce asexually via budding. Respiration is through the body membrane. Segmented worms (identified to the Class Oligochaeta) were present in the stomach contents of all eight fish species investigated by Weisberg and Janicki (1985) but were not numerous.

4.2 Study Year 1982

During 1982 data were collected by RMC (RMC 1985a) and Weisberg and Janicki (1985) using three quantitative gear types: a drift sampler, a Surber sampler, and a T-Sampler.

Drift is a dispersal mechanism through which invertebrates, both actively or passively, enter the water column and are transported by the current downstream. When this occurs they become available as prey for resident fishes. RMC collected samples at up to seven locations from July through September using a 0.5-m diameter drift net with 1-mm mesh (Figure 4-1). The net was deployed from a boat and suspended in or towed through the current for a period of ten minutes. Following retrieval, specimens were washed into a cod-end of the net and preserved. The volume of water passing through the net was measured with a flow meter mounted to the inside. A cumulative total of 258 m^3 of water was passed through the net during the course of study.

RMC also collected benthic samples at seven locations with a Surber sampler. The Surber consists of a metal frame that encloses a 0.092 m^2 area of substrate. Samples were collected by placing the Surber on cobble/gravel substrate in an area of current. The enclosed substrate within the frame was then disturbed by hand, allowing the river flow to transport specimens into a capture net attached to the downstream end of the device. The Surber is designed to collect samples from areas where water depth is one foot or less. Either one or two samples were collected at each station over a four-month period in the summer and autumn and the specimens identified to genus, except for the midges (left at Chironomidae) and segmented worms (left at Oligochaeta).

Weisberg and Janicki used a T-Sampler to collect specimens from gravel and bedrock substrates arrayed along a transect (Transect D) established downstream of the Octoraro Creek confluence (Figure 4-1). The T-Sampler is a suction device deployed by divers to collect benthic samples at greater depth than what is possible with the Surber. It is constructed of plastic drain pipes assembled in the shape of a “T” with a 15-cm diameter neoprene flange attached to one end to allow a good seal with the substrate. The sampler, when deployed, encloses a 0.025 m^2 area of substrate. Samples are collected by inserting a hand onto an opening leading to the flange and disturbing the substrate inside the enclosure in a similar fashion to the

Surber. A submersible pump was attached to one end of the device to force dislodged specimens into a sampling receptacle. Five replicates were collected at each location at approximately two-week intervals from July through December, yielding a total of 120 samples. Collections included both intermittently exposed and permanently wetted portions of the river channel.

Drift net densities varied from month to month between 91 individuals per m^3 in July to 10 per m^3 in September. The collection effort produced a total of 20 taxa (all stations/dates combined). However, only four taxa were numerous enough to represent at least 5% of the total during at least one of the months sampled (Table 4.2-1) including: *Leptodora* (70.6%), Chironimidae (15.8%), *Hydroptila* (2.8%), and *Cheumatopsyphe* (1.6%).

Leptodora kindti is a limnetic (found in the water column) crustacean in the order Cladocera that was particularly abundant (76/m^3: 82.6% of the total) in the July collections. A zooplankter adapted to lakes and ponds, they represent an out-migrant from Conowingo Pond, which serves as a transported food item. They are large for a planktonic organism, attaining a length of nearly 1-mm when fully mature, predatory, and attract to aquatic vegetation. Stomach content analysis showed that they were preyed upon in large numbers by white perch.

The phantom midge (*Chaoborus punctipennis*) was another drift organism not as abundant and was found in the diet of white perch and bluegill. *Chaoborus* are a limnetic form present in large numbers in Conowingo Pond. Predatory, they are mobile swimmers that migrate vertically into the water column after dark, becoming subject to passage downstream during generation. Their presence along with *L. kindti* illustrates the contribution that organisms in flow releases from Conowingo Pond make to the forage base available to the fish found below the dam.

The Surber sampler study produced a total of 25 taxa in 1982 at a mean density of 2,065 per m^2 (Table 4.2-2), indicating a fairly sparse community. Productive ecosystems typically produce invertebrate densities exceeding 10,000 per m^2 (Hynes, 1970). Most abundant were Chironomidae (46.8%), *Cheumatopsyche* (19.7%), *Gammarus* (10.7%), *Corbicula* (7.0%), *Hydroptila* (4.4%), Oligochaeta (2.7%), and *Goniobasis* (2.5%). *Cheumatopsyche* belong to a group referred to as the net-spinning caddisflies and attain a length of up to 15 mm as mature larvae. Often very numerous, *Cheumatopsyche* are an epi-benthic insect that construct protective retreats (casings) attached to the top and sides of medium to large stones. They also build silken capture-nets from which they passively filter food items from the water column. *Cheumatopsyche* are omnivores. They are relatively immobile, adapted (obligated) to lotic habitats and, as such, are susceptible to water level fluctuation, especially on bedrock substrates. Respiration is both through the body surface and through external gills so they do best in well-oxygenated environments. *Cheumatopsyche* mature through complete metamorphosis and frequently emerge synchronously when they become most available to predatory fishes. Both the larvae and pupae were a major component in the diet of the fish species examined, except for brown bullhead.

Hydroptila is the most common genus within a family referred to as the micro-caddisflies. They are very small, usually with a body length of 2 or 3 mm, preferring to live in backwaters and areas of relatively slow current. Given their limited size and adaptation to slow moving currents, they are likely susceptible to sudden rises in water level. Unless very numerous, they do not provide a large amount of energy to foraging fishes. As is true of most caddisflies, *Hydroptila* are case-makers, although the cases are not fixed as in *Cheumatopsyche* and they do not build them until their fifth (final) larval instar (stage). Thus, they are free-living throughout roughly half of their larval development. *Hydroptila* feed on filamentous algae and diatoms and prosper in well oxygenated habitats. They were present in low numbers in the stomach contents of six of the eight fish species examined, brown bullhead and channel catfish excepted.

Corbicula fluminea is a medium-sized clam native to Asia that, since its introduction in the Midwest, has become one of the most abundant mollusks found in warm-water environments. They attain a maximum shell diameter of 35 mm. They feed through a pair of siphons extended into the water column to “pump” unicellular algae and bacteria into their gills from where it is filtered and transported to their digestive systems. Habitual burrowers, *Corbicula* can easily retain moisture on de-watered substrates by closing their shells until flow is restored. They prefer gravel/cobble substrates to which they can attach themselves. *Corbicula* are most available as forage to bottom-feeding species but were not found in the stomachs of any of the catfishes inspected.

Goniobasis virginica is a relatively large, gilled snail common in rivers. Shell length in mature specimens reaches 20 mm and width at the aperture (opening) is about 5 mm. As is typical of most snails, *Goniobasis* move about by secreting a thin ribbon of mucus referred to as a “slime track” that acts a lubricant allowing locomotion. Slow movers, they can nonetheless cover a considerable distance given sufficient time. Gilled snails generally require more oxygen than their pulmonate (air breathing) counterparts but *Goniobasis* are relatively tolerant, able to survive low-oxygen environments for periods of time. They prefer slow-moving, shallow areas but are adept at attachment and can avoid displacement due to water level fluctuations. Gilled snails all possess a chitinous operculum dorsally on the body, that when retracted into the shell forms a seal protecting the individual from drying. *Goniobasis* are mostly preyed upon by bottom feeders. They were found in small numbers in the stomach contents of channel catfish and brown bullhead.

Oligochaete worms represented 8.4% of the sample totals from the November collection. Two sub-families were represented: Naidinae and Tubificinae. *Naid* genera identified from collections included *Dero*, *Nai*s, *Pristina* and *Stylaria*. Tubificid genera were *Aulodrilus*, *Bothrioneureum*, and *Branchiura*. The three additional *Naid* genera essentially occupy the same niche as *Nais*. The tubificines are burrowers that perform a similar ecological role as that of the more familiar terrestrial earthworms; aerating, mixing, and breaking down the sediment. Most (*Branchiura* excepted) are very small, less than 10 mm in length, thin-bodied, and all are very tolerant organisms. Their preference for soft (unstable) sediments makes them susceptible to water level fluctuation. Oligochaetes were found in small numbers in the stomachs of all species investigated except for green sunfish.

A total of 31 genera was collected with the T-Sampler at a noticeably higher density (12,270 per m^2) than the Surber Sampler (Table 4.2-3). This higher density suggests that community density increased in deeper (more permanently wetted) areas. With one exception, the dominance hierarchy was very similar to that observed with either the Surber or rock basket samplers including: Chironomidae (30.0%), *Manayunkia* (22.3%), *Dugesia* (12.2%), *Cheumatopsyche* (8.7%), Oligochaeta (6.3%), *Gammarus* (5.8%), and *Corbicula* (5.7%).

Manayunkia is part of the class Polychaeta, known as marine or bristle worms. Although Polychaera are found almost exclusively in saline bay and ocean environments, a limited number of genera have been able to colonize oligohaline and tidal freshwater areas. *M. speciosa* is a polychaete that is fully adapted to fresh non-tidal rivers. *Manayunkia* is a very small (less than 5 mm), sedentary, tube-building organism that feeds with a pair of tentacular fan-like gills (lophophores). They live in soft (unstable) sediments and feed by extending their gills from the tubes to filter particulate matter from the water column. *Manayunkia* is seldom found at dissolved oxygen concentrations lower than 5 mg/L, so the Tolerance Index of 10 given them may be erroneous, and more a function of the species ability to colonize fresh-water environments. Small but very numerous, they have the potential to form a fairly substantial food source for resident fishes. However, *Manayunkia* were only found in small numbers in the stomachs of one species, white perch.

4.3 Study Years 1983 and 1984

Data sets were condensed from studies completed by RMC (1985b) and Weisberg and Janicki (1985). Gear types were the Surber sampler and the T-Sampler, each used to collect specimens from the same locations/transects as during 1982 (Figure 4-1). A total of 53 samples was obtained from quarterly collections during 1983 with the Surber, augmented with 160 samples collected over two-week intervals with the T-Sampler between July 1983 and February 1984.

Forty-one genera were collected by RMC by Surber sampler at a mean density of 2,303 per m^2 (Table 4.3-1), Dominant taxon included Chironomidae (38.5%), Oligochaeta (23.5%), *Cheumatopsyche* (11.8%), *Gammarus* (7.0%), *Corbicula* (4.3%), *Hydroptila* (3.4%), and *Goniobasis* (2.6%)

Except for Oligochaeta, the abundant taxa identified from the 1983 collections were taken in numbers similar to those observed during 1982. Densities exceeding 1,000 per m^2 from at least one of the sample periods were recorded for Oligochaeta, *Cheumatopsyche*, and Chironomidae.

Analysis of the 1983-84 samples collected with the T-Sampler, illustrated in Table 4.3-2, produced 48 genera. Mean density was 13,635 individuals per m^2, similar to the 1982 data. Most frequently collected taxon were Chironomidae (29.4%), *Gammarus* (17.3%), *Manayunkia* (14.4%), *Dugesia* (5.6%), *Cheumatopsyche* (5.2%), Sphaeriidae (4.9%), and *Ferrissia* (4.9%).

Three additional taxa were abundant (relative to 1982): sphaeriid clams (genera *Pisidium*, or *Musculium*) and *Ferrissia rivularis,* a small snail.

The clams essentially occupy the same niche as do the *Corbicula* noted earlier although they are considerably smaller as adults, seldom exceeding a diameter of 10 mm. Sphaeriids were found in small numbers within the stomachs of white catfish, white perch, yellow perch, and pumpkinseed.

Ferrissia rivularis is a small, pulmonate (non-gilled) snail, referred to as a limpet, which feeds by scraping algae from rocky substrates in the shallows of running waters. They are one of a fairly small number of snail species found more commonly in areas of discernable current rather than in quiescent pool and backwater areas. *F. rivularis* are almost always less than 5 mm in length. The pulmonary cavity is vestigial so they breathe through the body surface. Due to the lack of a functioning pulmonary cavity, oxygen requirements for *F. rivularis* are greater than that of other pulmonates. *Ferrissia rivularis* were found in small numbers in the stomachs of channel catfish, yellow perch, pumpkinseed, and bluegill.

4.4 Study Year 1984

Data reported from 42 samples collected during the summer and fall of 1984 with a Surber sampler (RMC 1985c) are provided in Table 4.4-1. This effort produced 40 genera and a density of 2,017 per m^2. Dominant taxon included: Chironomidae (31.3%), *Cheumatopsyche* (27.2%), Oligochaeta (12.9%), *Corbicula* (7.3%), *Gammarus* (6.2%), *Goniobasis* (2.6%), and *Hydra* (2.4%).

Hydra is a very small, sessile form attached to hard substrates in either flowing or quiet waters at depths of 1.5 ft or less. They feed by immobilizing prey (e.g., zooplankton) that comes into contact with toxic nematocysts incorporated within their tentacles. Reproduction is through budding. Hydras were not widely fed upon.

4.5 Study Year 1988 – 1989

These data (Table 4.5-1) are condensed from Scott (1991), who collected with a T-Sampler from Transect D below Octoraro Creek using the same methodology employed during the 1982 – 1984 studies by Weisberg and Janicki (1985). During September 1988 through March 1989, 144 samples were obtained from gravel and bedrock substrates at two-week intervals. Community Density averaged 11,925 per m^2, similar to earlier years. Dominant taxa were *Corbicula (28%), Polypedilum (16%), Cheumatopsyche* (9%) *Manayunkia (8%),* Oligochaeta (8%) *Dugesia* (5%) and *Cricotopus (5%).*

These results indicated that taxonomic composition among those genera that represented the majority of the specimens collected had changed little during the time interval since the earlier collections in 1980 – 1984. The invertebrate community continued to be dominated by facultative or tolerant warm-water taxa. Two midge genera were identified, that were not to be especially numerous from the earlier datasets were *Polypedilum* (within the subfamily Chironominae) and *Cricotopus* (Orthocladiinae). Both genera likely provide ample forage to resident fish species.

Polypedilum occur in both still and flowing waters and on a variety of substrates. Many species are able to avoid exposure by burrowing, while others are case-makers found on hard substrates. During the T-sampler collections they were found in considerably greater numbers on bedrock substrates. Thus, *Polypedilum* appear well adapted to the swift currents produced during generation periods but may not be able to withstandstand desiccation when bedrock is exposed.

Tolerance indices for the common *Cricotopus* species range between 6 and 10. Most are 7 or higher, making *Cricotopus* one of the more tolerant genera within the family. *Cricotopus* tend to be more riverine in their habitat preference than are many other large chironomid genera, meaning they are more often found in swifter currents and coarser substrates. They are adept burrowers.

4.6 Study Year 1989 – 1990

Data reported by Scott (1991) were gathered from a total of 118 T-sampler collections from September 1989 to March 1990 (Table 4.6-1). Community Density increased relative to the earlier study years. An average of 20,225 per m^2 was calculated. Commonly collected taxa were *Manayunkia* (30%), *Polypedilum* (19%), *Cheumatopsyche* (12%), *Corbicula* (8%), Oligochaeta (6%) and *Dugesia* (5%).

Taxomomic composition observed from the 1989 to 1990 data were similar to those collected during previous years, except for a higher percent abundance of *Manayunkia speciosa*.

4.7 Study Year 1990 – 1991

The data summarized below from Table 4.7-1 were assembled from 107 T-sampler collections between September 1990 and March 1991 (Scott, 1991). Community Density was again relatively high, 18,500 per m^2. Dominant taxa included *Corbicula* (23%), Chironomidae (19%), *Manayunkia* (18%), *Cheumatopsyche* (10%), Oligochaeta (6%), and *Dugesia* (5%).

The dominance hierarchy from 1990 – 1991 was similar to those observed in earlier years. Thus, we conclude that the character of the benthic macroinvertebrate community in the Susquehanna River below Conowingo Dam changed little during the ten-year time frame encompassed by this review.

4.8 Trend Analysis

Figures 4.2-1 and 4.2-2 are provided to show temporal trends in community density for two gear types, the Surber and the T-sampler, respectively. To compile them, standing crop data were taken from RMC (1985) for the Surber samples collected during 1982 to 1984. T-Sampler densities were taken from Weisberg and Janicki (1985) for the years 1982 to 1984. Others were derived (estimated to within 25 specimens per m^2) from figures given in Scott (1991) for 1988 to 1991. Also shown are population densities for seven common taxa (those abundant during most years), including *Cheumatopsyche*, Chironomidae, and *Gammarus* (those commonly identified from the stomach content analyses).

There are some inherent problems with this calculation because sampling from year to year occurred: during different seasons; from different habitats (cobble or bedrock); from exposed versus wetted substrates; from different locations; and during a number of flow regimes. However, with this in-mind some attention can be given to the results, including those from the latter years of study (after 1988) once the current flow regime was essentially in-place. Note that the density values on the figures are a cumulative mean of all of the samples collected each year.

As noted, the Surber data from 1982 to 1984 produced community density estimates that varied within a narrow range of 2,017 and 2,303 specimens per m^2.

In comparison, the T-Sampler data from this same (earlier) time-frame produced community densities that were also consistent from year to year, ranging between 12,270 and 13,635 per m^2. Higher densities from the T-Samples may have been due to placement of the device in deeper water (more permantly wetted locations). However, the results from both gear types were consistant in that they show little change in the respective densities during this earlier three-year period. Community density from the 1988-89 year was 11,925 per m^2.

Higher densities were observed from the T-Sampler data during 1989 to 1991. The result from the 1989-90 study year was 20,225 per m^2, followed by 18,500 per m^2 in 1990-91. This represents a near fifty percent increase in community density from the years 1982, 1983-84, and 1988-89. This increase may be cautiously interpreted as a positive response to the new flow regime. Individual taxa that displayed new maxima during one or both latter years were: *Cheumatopsyche*, Chironomidae, *Corbicula*, and *Manayunkia*. The greatest increase was observed for *Manayunkia* that attained a population density of 6,125 per m^2 in 1989-90.

4.9 Summary Discussion and Conclusions

During 1980 through 1991 a series of quantitative benthic studies was conducted in the Susquehanna River in the tailrace and non-tidal waters below Conowingo Dam to determine a release schedule sufficient to maintain healthy fish and macroinvertebrate communities. These data provide a descriptive characterization of the invertebrate community during the study years 1980, 1982, 1983, 1984, 1988, 1989, and 1991. The study area encompassed a 3.5-mile non-tidal section of river channel bounded by two tributaries: Octoraro Creek (upstream near the tailrace) and Deer Creek (downstream near where the Susquehanna River becomes tidal). Gear types used were rock basket, drift net, Surber, and T-Samplers. Gravel and bedrock substrates were sampled, including both submerged and exposed areas.

A cumulative (all years combined) total of 71 taxa was collected and identified to the genus endpoint. The 1988 through 1991 study years produced a total of 115 invertebrate taxa identified to the genus/species level (Scott, 1991). Note that the identifications shown on Tables 4.5-1, 4.6-1 and 4.7-1 are to genus.

Community density estimates from the Surber collections were near 2,000 individuals per m^2. Density estimates from the T-Samples (taken in deeper water) were higher, near 13,000 individuals per m^2. These results were used as a basis to characterize the community as moderately dense. During the final two years of study density increased to near 18,000 and 20,000 per m^2.

The community was generally comprised of facultative or tolerant warm-water genera. Most abundant were: Chironomidae (*Cricotopus*, *Dicrotendipes*, and *Polypedilum*), *Cheumatopsyche*, *Corbicula*, *Dugesia*, *Gammarus*, *Goniobasis*, *Hydroptila*, *Manayunkia*, and Oligochaeta (*Nais*). The most important food items in the stomach contents of eight fish species examined were Chironomidae, *Cheumatopsyche*, and *Gammarus*.

Most of the genera identified from the studies possess some adaptation to water level fluctuation and low dissolved oxygen concentrations. Review of the tolerance indices listed on the report tables shows only 8 of 71 genera with values of 3 or less, the range used herein to denote sensitive (intolerant) taxa. Although tolerance indices are assigned to invertebrate taxa more according to their ability to adapt to chemical degradation than for habitat instability caused by changes in water levels. In general invertebrate taxa resistant to reductions in water quality also tend to be resistant to habitat alteration. Twenty-eight genera were facultative (Tol. = 4 – 6) and the remainder (35 genera) were tolerant (Tol. = 7 – 10).

The fishery below the dam described within subsequent sections of this report appears robust, suggesting that the invertebrate populations provide an adequate food base. The fish also appear be in good condition (see Section 9.0). The invertebrate data collected during the later years of the tailrace studies showed observable increases in community density, after much of the current release schedule had become operational. However, it seems unlikely that the community composition has changed appreciably, given the water quality and habitat constraints imposed upon it by impoundment.

TABLE 4.1-1: COMMON BENTHIC MACROINVERTEBRATE TAXA COLLECTED BY ROCK BASKET IN 1980 (JANICKI AND ROSS) FROM THE SUSQUEHANNA RIVER BELOW CONOWINGO DAM.

Order	Family	Genus	Common Name	Tolerance Index	Percent Abundance (5)	Dominant and Subdominant Taxon Feeding Group/Habitat
Hydroida	Hydridae	*Hydra*	hydra	4	2%	
Turbellaria	Planariidae	***Dugesia***	flat worm	9	**25%**	predator/sprawler
Oligochaeta	Naididae	*Nais*	naiad worm	8	6%	collector /burrower
Gastropoda	Ancylidae	*Ferrissia*	limpet snail	7	3%	
	Planorbidae	*Gyraulis*	orb snail	8	4%	
Amphipoda	Gammaridae	***Gammarus***	side swimmer	7	**32%**	shredder/sprawler
Trichoptera	Hydropsychidae	*Cheumatopsyche*	caddisfly	6	4%	
Diptera	**Chironomidae** (4)	(pupae)	midge	7	1%	collector /burrower
		Cricotopus	midge	8	3%	
		Dicrotendipes	midge	9	6%	collector /burrower
		Glyptotendipes	midge	7	1%	
		Polypedilum	midge	6	2%	
		Tanytarsus	midge	5	3%	
			Total		**90%** (3)	

(1) Source: Janicki and Ross, 1982.
(2) Dominant taxa listed in bold print.
(3) The total does not include rare/uncommon taxa.
(4) Genera within the family Chironomidae represented 16.1 percent of the cumulative total.
(5) The mean number of specimens per Rock Basket, taken from channel and isolated pool habitats.
(6) Study Period: June through October 1980.
(7) Sample Type: Rock Basket.
(8) Pooled Data for transects A through D

TABLE 4.2-1: BENTHIC MACROINVERTEBRATES COLLECTED BY DRIFT NET IN 1982 (RMC) FROM THE SUSQUEHANNA RIVER BELOW CONOWINGO DAM.

Study Year 1982												
Sample Type: Drift Net (diameter = 0.5 - meter: total volume sampled = 258.2 cubic meters.)												
Order	**Family or Genus**	**Common Name**	**Tolerance Index**	**July**		**August**		**September**		**Annual Means[3]**		**Dominant and Subdominant Taxon Feeding Group/Habitat**
				Density (no./m^3)	**Pct.**	**Density (no./m^3)**	**Pct.**	**Density (no./m^3)**	**Pct.**	**Density (no./m^3)**	**Pct.**	
Hydroida	*Hydra*	hydra	4	3	4%	P	0.1%	P	0.1%	1	3%	
Nematoda		Round worm	9	P[3]	0.1%	P	P	P	1%	P	0.2%	
Turbellaria	*Dugesia*	flat worm	9					P	0.3%	P	P	
Oligochaeta		segmented worms	10					P	0.2%	P	P	
Polychaeta	*Manayunkia*	fan worm	10		1%	P	0.1%	P	3%	P	1%	
Bivalvia	*Corbicula*	Asiatic clam	6	P	P	P	0.3%	P	0.8%	P	P	
Gastropoda	*Physella*	pouch snail	7	P	P					P	P	
	Planorbidae	orb snail	8	P	P			P	0.2%	P	1%	
	Ferrissia	limpet snail	7	P	P			P	0.2%	P	P	
Amphipoda	*Gammarus*	side swimmer	7	1	1	P	1%	P	4%	P	1%	
Cladocera	***Leptodora***	water flea	-	76	**83%**	P	1%	1	4%	**34**	**71%**	plankter
Copepoda	*Argulus*	fish louse	-	P	P			P	0.3%	P	P	
Ephemeroptera	*Baetis*	mayfly	4	P	P			P	0.1%	P	P	
	Heptagenia	mayfly	3	P	P	P	0.1%	P	0.2%	P	P	
Trichoptera	**prob. *Hydroptila***	caddisfly	6		0.1%	P	2%	5	**35%**	1	3%	scraper/clinger
	Cheumatopsyche	caddisfly	6	2	2%	1	5%	2	**19%**	3	2%	filterer/clinger
	Leptoceridae	caddisfly	4			P	0.1%			P	P	
Diptera	*Chaoborus*	phantom midge	8			P	0.1%	P	1	P	P	
	Chironomidae	midge	7	9	9%	11	**90%**	2	**16%**	**8**	**16%**	Collector /burrower
	Tipula	cranefly	7					P	0.1%	P	P	
		Totals		91	99%	12	99%	10	84%	**47**	**100% [4]**	

(1) Source: RMC, 1985a.
(2) Dominant taxa (> 10.0 % of the total in one or more collections) are entered in bold print
(3) Different volumes of water were collected at the various stations/dates throughout the summer so the annual means are not calculated by averaging the preceding columns.
(4) The totals for percent abundance do not include terrestrial invertebrates or fish larvae.
(5) The letter P indicates taxa present at a density of less than 1 per cubic meter or that are less than 0.1 percent of the total.
(6) Study year 1982.
(7) Sample type: Drift Net (diameter = 0.5 – meter, total volume sampled = 258.2 cubic meters).
(8) Pooled Data: Stations 1 through 7.

TABLE 4.2-2: BENTHIC MACROINVERTEBRATES COLLECTED BY SURBER IN 1982 (RMC) FROM THE SUSQUEHANNA RIVER BELOW CONOWINGO DAM.

Study Year:		**1982**												**Dominant and Subdominant Taxon Feeding Group/Habitat**
Sample Type:		**Surber Sampler (area = 0.092 square meter)**												
				Pooled Data: Stations 1 through 7										
				July		**August**		**September**		**November**		**Annual Means[1]**		
		Common	**Tol.**	**Density**		**Density**		**Density**		**Density**		**Density**		
Taxon:		**Name**	**Index**	**(no./m^2)**	**Pct.**	**(no./m^2)**	**Pct.**	**(no./m^2)**	**Pct.**	**(no./m^2)**	**Pct.**	**(no./m^2)**	**Pct.**	
Hydroida														
	Hydra	hydra	4	3	0.3%			27	1%			8	0.4%	
Nematoda		round worm	9					P [3]	0.1%	P	0.2%	P	0.1%	
Turbellaria														
	Dugesia	flat worm	8	48	4%	11	0.4%	85	2%	P	0.2%	38	2%	
	Hirudinia	leech	6					P	P	P	0.1%	P	P	
Oligochaeta		segmented worms	10	8	1%	11	0.4%	102	3%	97	8%	57	3%	collector / burrower
Bivalvia														
	Corbicula	Asiatic clam	6	13	1%	22	1%	139	4%	386	**34%**	147	7%	filterer / burrower
Gastropoda														
	Physella	pouch snail	7	3	0.3%			P	P	3	0.3%	P	0.1%	
	Planorbidae	orb snail	8					12	0.3%	33	3%	12	1%	
	prob. *Goniobasis*	horn snail	7	34	3%	34	1%	74	2%	66	6%	53	3%	scraper / climber
	Ferrissia	limpet snail	7			4	0.2%	37	1%	35	3%	20	1%	
Amphipoda														
	Gammarus	side swimmer	7	252	21%	46	2	199	6%	359	**31%**	224	**11%**	shredder / sprawler
Cladocera														
	Leptodora	water flea	-					P	0.1%	P	0.2%	P	P	
Isopoda														
	Caecidotea	sow bug	6			1	0.1%	P	0.1%			P	P	
Mysidacea														
	Mysis	opossum shrimp	-					P	0.1%			P	P	
Hydracarina		water mite	7					P	P			P	P	

Table 4.2-2 Cont.

Study Year:		**1982**												**Dominant and Subdominant Taxon Feeding Group/Habitat**
Sample Type:		**Surber Sampler (area = 0.092 square meter)**												
				Pooled Data: Stations 1 through 7										
				July		**August**		**September**		**November**		**Annual Means[1]**		
Taxon:		**Common Name**	**Tol. Index**	**Density ($no./m^2$)**	**Pct.**	**Density ($no./m^2$)**	**Pct.**	**Density ($no./m^2$)**	**Pct.**	**Density ($no./m^2$)**	**Pct.**	**Density ($no./m^2$)**	**Pct.**	
Ephemeroptera														
	Baetis	mayfly	4			1	0.1%					P	P	
	Heptagenia	mayfly	3	24	2%	26	1%	12	0.3%	10	1%	22	1%	
	Tricorythodes	mayfly	4	1				7	0.2%			P	0.1%	
Odonata														
	Calopteryx	damselfly	8			1	0.1%					P	P	
Megaloptera														
	Chauloides	alderfly	1							P	0.1%	P	P	
Trichoptera														
	prob. Hydroptila	caddisfly	6	7	1%	261	**10%**	112	3%	25	2%	92	4%	scraper / clinger
	Cheumatopsyche	caddisfly	6	395	**33%**	509	**20%**	755	**21%**	16	1%	415	**20%**	clinger
	Neotrichia	caddisfly	2					P	P			P	P	
	Polycentropus	caddisfly	6					P	P			P	P	
Lepidoptera														
	Petrophila	moth	5							P	0.1%	P	P	
Diptera														
	Chironomidae	midge	7	384	**33%**	1,634	**62%**	1,987	**56%**	46	4%	978	**47%**	collector / burrower
	Simulium	black fly	6			1	0.1%					P	P	
		Totals		1,171	99%	2,561	99%	3,548	100%	1,075	94%	**2,065**	**99%** [2]	

(1) Source: RMC, 1985a
(2) Dominant taxa listed in bold print
(3) Different numbers of samples were collected at the various stations/dates throughout the year so the annual means are not calculated by averaging the preceding columns.
(4) The totals for Density and Percent Abundance do not include rare/uncommon taxa.
(5) The letter P indicates taxa present at a density of less than 1 per square foot or that are less than 0.1 percent of the total (a cum. of 25 genera were collected)
(4) Dominant taxa (> 10.0 % of the total in one or more collections) are entered in bold print.
(6) Study year 1982.

TABLE 4.2-3 : COMMON BENTHIC MACROINVERTEBRATE TAXA COLLECTED BY T- SAMPLER IN 1982 (WESIBERG AND JANICKI) FROM THE SUSQUEHANNA RIVER BELOW CONOWINGO DAM.

Order	Family	Genus	Common Name	Tolerance Index	Frequency of occurrence	Density (no./m^2)	Percent Abundance	Dominant and Subdominant Taxon Feeding Group/Habitat
Nematoda			round worm	9			P (3)	
Hoplonemertea	Tetrastemmatidae	*Prostoma*	proboscis worm	7			P	
Turbellaria	Tricladida	***Dugesia***	flat worm	9	99	1,552	**12%**	predator/sprawler
Oligochaeta	Naididae	*Dero*	naiad worm	8	96	776	6%	collector/burrower
		Nais	naiad worm	8			P	
		Pristina	naiad worm	8			P	
		Stylaria	naiad worm	8			P	
	Tubificinae	*Aulodrilus*	tube worm	10			P	
		Bothrioneureum	tube worm	8			P	
		Branchiura	tube worm	8			P	
		imm. Tubificid w/hair chaetae	tube worm	8			P	
Hiridinea	Glossophoniidae	*Batracobdella*	leech	6			P	
		Helobdella	leech	6			P	
Polychaeta	Sabellidae	***Manyunkia***	fan worm	10	113	2,776	**22%**	filterer/burrower
Bivalvia	Corbiculidae	*Corbicula*	Asiatic clam	6	59	720	6%	filterer/burrower
	Sphaeriidae				70	164	1%	
		Musculium	fingernail clam	6			P	
		Pisidium	pill clam	6			P	
Gastropoda	Ancylidae	*Ferrissia*	limpet snail	7	74	323	3%	
	Lymnaeidae	prob. *Fossaria*	pond snail	7				
	Physidae	*Physella*	pouch snail	7				
	Planorbidae	*Gyraulus*	orb snail	8				
Amphipoda	Gammaridae	*Gammarus*	side swimmer	7	101	713	6%	shredder/ sprawler
Isopoda	Asellidae	*Caecidotea*	sowbug	6			P	
Hydrachnidia			water mite	7			P	

Table 4.2-3: Cont.

Order	Family	Genus	Common Name	Tolerance Index	Frequency [2] of occurrence	Density (no./m^2)	Percent Abundance	Dominant and Subdominant Taxon Feeding Group/Habitat
Ephemeroptera	Heptaganiidae	*Heptagenia*	mayfly	3			P	
		Maccaffertium	mayfly	5			P	
	Isonychiidae	*Isonychia*	mayfly	2			P	
Odonata	Libellulidae		dragonfly	9			P	
Trichoptera	Hydropsychidae	*Cheumatopsyche*	caddisfly	6	80	1,086	**9%**	filterer/clinger
	Hydroptilidae	*Hydroptila*	caddisfly	6			P	
	Polycentropodidae	*Cyrnellus*	caddisfly	8				
Diptera	**Chironomidae**		midge	7	120	3,747	**30%**	collector/burrower
	Simuliidae	*Simulium*	black fly	6			P	
	Tabanidae		deer fly	6			P	
			Totals			**12,270**	**98%**	

(1) Source: Wesiberg and Janicki, 1983.
(2) Dominant taxa listed in bold print.
(3) Study year 1982.
(4) Sample type: T-sampler (area = 0.025 square meter)
(5) Pooled data transect D.
(6) The letter P indicates taxa present at a density of less than 1 per cubic meter or that are less than 0.1 percent of the total.

TABLE 4.3-1: BENTHIC MACROINVERTEBRATES COLLECTED BY SURBER SAMPLER 1983 (RMC) FROM THE SUSQUEHANNA RIVER BELOW CONOWINGO DAM.

Order	Family or Genus	Common Name	Tolerance Index	Winter		Summer		September [5]		Fall		Annual Means[2]		Dominant and Subdominant Taxon Feeding Group/Habitat
				Density (no./m^2)	Pct.	Density (no./m^2)	Pct.	Density (no./m^2)	Pct.	Density (no./m^2)	Pct.	Density (no./m^2)	Pct.	
Hydroida	*Hydra*	hydra	4	-	-	-	-	-	-	-	-	-	P [4]	
Nematoda		round worm	9	-	-	-	-	-	-	-	-	-	P	
Turbellaria	*Dugesia*	flat worm	8	-	-	-	-	-	-	-	-	-	P	
	Hirudinia	leech	6	-	-	-	-	-	-	-	-	-	P	
Oligochaeta		segmented worms	10	1,341	**82%**	185	5%	793	**30%**	102	10%	567	**24%**	collector/ burrower
	Branchiobdellidae	commensal worm	6	-	-	-	-	-	-	-	-	-	P	
Polychaeta	*Manyunkia*	fan worm	10	-	-	-	-	-	-	-	-	-	P	
Bivalvia	*Pyganodon*	freshwater mussel	4	-	-		-	-	-	-	-	-	P	
	Corbicula	Asiatic clam	6	17	1%	99	3%	95	40%	173	**16%**	105	4%	filterer/burrower
Gastropoda	*Bithynia*	mud snail	7	-	-	-	-	-	-	-	-	-	P	
	Physella	pouch snail	7	-	-	-	-	-	-	-	-	-	P	
	Planorbidae	orb snail	8	-	-	-	-	-	-	-	-	-	P	
	prob. *Goniobasis*	horn snail	7	-	-	48	1%	32	1%	177	**17%**	63	**3%**	scraper/climber
	Ferrissia	limpet snail	7	2	0.1%	5	0.2%	41	2%	48	4%	32	1%	
Amphipoda	***Gammarus***	side swimmer	7	23	1%	288	8%	72	3%	336	**31%**	170	**7%**	shredder/sprawler
Decapoda	Cambaridae	crayfish	6	-	-	-	-	-	-	-	-	-	P	
Hydracarina		water mite	7	-	-	-	-	-	-	-	-	-	P	
Isopoda	*Caecidotea*	sow bug	6	-	-	-	-	-	-	-	-	-	P	
Ephemeroptera	*Baetis*	mayfly	4	-	-	-	-	-	-	-	-	-		
	Caenis	mayfly	7	2	0.1%	-	-	90	3%	-	-	43	2%	
	Heptagenia	mayfly	3	2	0.1%	-	0.1%	41	2%	5	1%	23	1%	
	Isonychia	mayfly	2	-	-	-	-	-	-	-	-	-	P	
	Maccaffertium	mayfly	5	-	-	-	-	-	-	-	-	-	P	
	Tricorythodes	mayfly	4	-	-	-	-	-	-	-	-	-	P	

Table 4.3-1: Cont.

Order	Family or Genus	Common Name	Tolerance Index	Winter		Summer		September (5)		Fall		Annual Means(2)		Dominant and Subdominant Taxon Feeding Group/Habitat
				Density (no./m^2)	Pct.	Density (no./m^2)	Pct.	Density (no./m^2)	Pct.	Density (no./m^2)	Pct.	Density (no./m^2)	Pct.	
Odonata	*Erythemis*	dragonfly	7	-	-	-	-	-	-	-	-	-	P	
Megaloptera	*Chauloides*	alderfly	1	-	-	-	-	-	-	-	-	-	P	
Trichoptera	*prob. Hydroptila*	caddisfly	6	12	1%	120	3%	114	4%	7	1%	83	3	scraper/ clinger
	Cheumatopsyche	caddisfly	6	14	1%	1,060	**30%**	115	4%	17	2%	286	**12%**	filterer/ clinger
	Leptoceridae	caddisfly	4	-	-	-	-	-	-	-	-	-	P	
	Polycentropus	caddisfly	6	-	-	-	-	-	-	-	-	-	P	
Lepidoptera	*Petrophila*	moth	5	-	-	-	-	-	-	-	-	-	P	
Coleoptera	*Stenelmis*	riffle beetle	5	-	-	-	-	-	-	-	-	-	P	
	Psephenus	riffle beetle	4	-	-	-	-	-	-	-	-	-	P	
Diptera	*Chaoborus*	phantom midge	8	-	-	-	-	-	-	-	-	-	P	
	Chironomidae	midge	7	151	9%	1,624	**46%**	1,138	**43%**	103	10%	932	**39%**	collector/ burrower
	Culicidae	mosquito	8	-	-	-	-	-	-	-	-	-	P	
	Culicoides	biting midge	10	-	-	-	-	-	-	-	-	-	P	
	Hemerodromia	dance fly	8	-	-	-	-	-	-	-	-	-	P	
	Simulium	black fly	6	-	-	-	-	-	-	-	-	-	P	
	Tabanidae	deer fly	6	-	-	-	-	-	-	-	-	-	P	
	Tipulidae	crane fly	5	-	-	-	-	-	-	-	-	-	P	
		Totals		1,565	95%	3,428	97%	2,530	95%	968	90%	**2,303**	**95%**(3)	

(1) Source: RMC, 1985b
(2) Different numbers of samples were collected at the various stations/dates throughout the year so the annual means are not calculated by averaging the preceding columns.
(3) The totals for Density and Percent Abundance do not include rare/uncommon taxa.
(4) The letter P indicates taxa less than 1.0 percent of the annual total (a cum. of 41 genera were collected).
(5) Combination of two sample dates: 15 and 21 September (prior to and imm. after minimum flow release).
(6) Dominant taxa (> 10.0 % of the total in one or more collections) are entered in bold print.
(7) Combination of two sample dates: 15 and 21 September (prior to and imm. after minimum flow release).
(8) Study year 1983.
(9) Gear type = Surber sampler (area = 0.092 square meter).
(10) Pooled Data: Stations 1 through 7.

TABLE 4.3-2: COMMON BENTHIC MACROINVERTEBRATE TAXA COLLECTED BY T– SAMPLER IN 1983-1984 (WEISBERG AND JANICKI) FROM THE SUSQUEHANNA RIVER BELOW CONOWINGO DAM.

Order	Family	Genus	Common Name	Tolerance Index	Frequency [(3)] of occurrence	Density (no./m^2)	Percent Abundance	Dominant and Subdominant Taxon Feeding Group/Habitat
Turbellaria	Planariidae	*Dugesia*	flat worm	9	109	778	6%	predator/sprawler
Hoplonemertea	Tetrastemmatidae	*Prostoma*	proboscis worm	7	71	71	1%	
Oligochaeta			segmented worms	10	130	969	7%	
Polychaeta	Sabellidae	***Manyunkia***	fan worm	10	118	2,020	**14%**	filterer/burrower
			clams	-	24	133	1%	
Bivalvia	Corbiculidae	*Corbicula*	Asiatic clam	6	76	304	2%	
	Sphaeriidae	prob. *Pisidium*	pill clam	6	107	685	5%	filterer/burrower
		or Musculium						
Gastropoda	Ancylidae	*Ferrissia*	limpet snail	7	91	689	5%	scraper/climber
	Pleuroceridae	prob. *Goniobasis*	horn snail	7	75	222	2%	
Amphipoda	Gammaridae	***Gammarus***	side swimmer	7	131	2,427	**17%**	shredder/sprawler
			caddisfly	6	43	210	2%	
Trichoptera	Hydropsychidae	*Cheumatopsyche*	caddisfly	6	92	732	5%	filterer/clinger
	Polycentropodidae	*Cyrnellus*	caddisfly	8	38	69	1%	
	Hydroptilidae	prob. *Hydroptila*	caddisfly	6	67	182	1%	
Diptera	**Chironomidae**		midge	7	160	4,144	**29%**	collector/burrower
			Totals			**13,635**	**97%**	

(1) Source: Weisberg, S.B. and A. J. Janicki, 1985.
(2) Dominant taxa listed in bold print
(3) Number of samples out of a total of 160 in which this taxon was found
(4) The remaining 2.9 percent of the total benthic abundance included 33 taxa (genus/species identifications).
(5) The total number of taxa collected during 1982 - 1983 for the Project was 48
(6) Study period July 1983 through February 1984
(7) Sampler type: T - Sampler (area = 0.025 square meter).
(8) Pooled Data: Transects B and D

TABLE 4.4-1: BENTHIC MACROINVERTEBRATES COLLECTED BY SURBER SAMPLER IN 1984 (RMC) FROM THE SUSQUEHANNA RIVER BELOW CONOWINGO DAM.

Order	Family or Genus	Common Name	Tolerance Index	Summer		September [6]		Fall		Annual Means[2]		Dominant and Subdominant Taxon Feeding Group/Habitat
				Density (no./m²)	Pct.	Density (no./m²)	Pct.	Density (no./m²)	Pct.	Density (no./m²)	Pct.	
Hydroida	*Hydra*	hydra	4	8	0.3%	24	2%	175	8%	53	2%	predator/clinger
Nematoda		round worm	9	-	-	-	-	-	-	-	P [4]	
Turbellaria	*Dugesia*	flat worm	8	-	-	-	-	-	-	-	P	
	Hirudinia	leech	6	-	-	-	-	-	-	-	P	
Oligochaeta		segmented worms	10	47	2%	123	5%	829	**39%**	279	**13%**	collector/burrower
Polychaeta	*Manyunkia*	fan worm	10	-	-	-	-	-	-	-	P	
Bivalvia	***Corbicula***	Asiatic clam	6	100	4%	204	**11%**	220	**10%**	158	7%	filterer/burrower
Gastropoda	*Bithynia*	mud snail	7	-	-	-	-	-	-	-	P	
	Physella	pouch snail	7	-	-	-	-	-	-	-	P	
	Planorbidae	orb snail	8	-	-	-	-	-	-	-	P	
	prob. *Goniobasis*	horn snail	7	71	3%	46	2%	38	2%	55	3%	scraper/climber
	Ferrissia	limpet snail	7	47	2%	30	2%	30	2%	38	2%	
Amphipoda	***Gammarus***	side swimmer	7	73	3%	96	4%	302	**14%**	135	6%	shredder/sprawler
Cladocera	*Leptodora*	water flea	-	-	-	-	-	-	-	-	P	
Hydracarina		water mite	7	-	-	-	-	-	-	-	P	
Isopoda	*Caecidotea*	sow bug	6	-	-	-	-	-	-	-	P	
Ephemeroptera	*Anthopotamus*	mayfly	3	-	-	-	-	-	-	-	P	
	Baetis	mayfly	4	-	-	-	-	-	-	-	P	
	Caenis	mayfly	7	3	0.2%	25	2%	-	-	-	P	
	Heptagenia	mayfly	3	23	1%	35	2%	22	1%	26	1%	
	Maccaffertium	mayfly	5	-	-	-	-	-	-	-	P	
	Siplonuridae	mayfly	7	-	-	-	-	-	-	-	P	
	Stenacron	mayfly	2	-	-	-	-	-	-	-	P	
	Tricorythodes	mayfly	4	-	-	-	-	-	-	-	P	

Table 4.4.-1 Cont.

Order	Family or Genus	Common Name	Tolerance Index	Summer Density (no./m^2)	Summer Pct.	September [(6)] Density (no./m^2)	September Pct.	Fall Density (no./m^2)	Fall Pct.	Annual Means[(2)] Density (no./m^2)	Annual Means Pct.	Dominant and Subdominant Taxon Feeding Group/Habitat
Odonata	*Didymops*	dragonfly	4	-	-	-	-	-	-	-	P	
	Libellulidae	dragonfly	9	-	-	-	-	-	-	-	P	
	Macromia	dragonfly	3	-	-	-	-	-	-	-	P	
Hemiptera	*Corixidae*	water boatman	6	-	-	-	-	-	-	-	P	
	Veliidae	water strider	8	-	-	-	-	-	-	-	P	
Megaloptera	*Chauloides*	alderfly	1	-	-	-	-	-	-	-	P	
Trichoptera	prob. *Hydroptila*	caddisfly	6	14	1%	11	1%	1	0.1 %	-	P	
	Cheumatopsyche	caddisfly	6	803	**35%**	528	**25%**	184	9%	591	**27%**	filterer/clinger
	Leptoceridae	caddisfly	4	-	-	-	-	-	-	-	P	
	Polycentropus	caddisfly	6	-	-	-	-	-	-	-	P	
Lepidoptera	*Petrophila*	moth	5	-	-	-	-	-	-	-	P	
Coleoptera	*Stenelmis*	riffle beetle	5	-	-	-	-	-	-	-	P	
	Psephenus	riffle beetle	4	-	-	-	-	-	-	-	P	
Diptera	*Chaoborus*	phantom midge	8	-	-	-	-	-	-	-	P	
	Chironomidae	midge	7	984	**42%**	584	**29%**	179	9%	679	**31%**	collector/burrower
	Hemerodromia	dance fly	8	-	-	-	-	-	-	-	P	
	Simulium	black fly	6	48	2	-	-	-	-	2	1%	
		Totals		2,247	96%	1,706	84%	1,980	94%	**2,017**	**94%**	

(1) Source: RMC, 1985c
(2) Different numbers of samples were collected at the various stations/dates throughout the year so the annual means are not calculated by averaging the preceding columns.
(3) The totals for Density and Percent Abundance do not include rare/uncommon taxa.
(4) The letter P indicates taxa less than 1.0 percent of the annual total (a cum. of 40 genera were collected).
(5) Dominant taxa (> 10.0 % of the total in one or more collections) are entered in bold print.
(6) Combination of two sample dates: 19 and 26 - 27 September (prior to and imm. after minimum flow release).
(7) Study year 1984.
(8) Sampler type surber sampler (area = 0.092 square meter)
(9) Pooled Data: Stations 1 through 7

TABLE 4.5-1: COMMON BENTHIC MACROINVERTEBRATE TAXA COLLECTED BY T- SAMPLER 1988-1989 (SCOTT) FROM THE SUSQUEHANNA RIVER BELOW CONOWINGO DAM.

Order	Family	Genus	Common Name	Tolerance Index	Percent Abundance(2)			Dominant and Subdominant Taxon Feeding Group/Habitat
					Gravel Substrate	Bedrock Substrate	Average	
Turbellaria	Planariidae	*Dugesia*	flat worm	9	9%	1%	5%	predator/sprawler
Oligochaeta			segmented worms	10	9%	7%	8%	collector/burrower
Polychaeta	Sabellidae	*Manyunkia*	fan worm	10	**12%**	4%	8%	filterer/burrower
Bivalvia	Corbiculidae	***Corbicula***	Asiatic clam	6	**36%**	**20%**	**28%**	filterer/burrower
Gastropoda	Ancylidae	*Ferrissia*	limpet snail	7	5%	1%	3%	
	Planorbidae	*Micromenetus*	orb snail	8	2%	1%	2%	
Amphipoda	Gammaridae	*Gammarus*	side swimmer	7	4%	1%	3%	
Trichoptera	Hydropsychidae	***Cheumatopsyche***	caddisfly	6	7%	**11%**	9%	filterer/clinger
			midge	7	2%	8%	5%	
Diptera	**Chironomidae**	*Cricotopus*	midge	8	1%	9%	5%	shredder/burrower
		Polypedilum	midge	6	3%	**29%**	**16%**	shredder/clinger
			Totals		**90%**	**92%**	**91%**	

(1) Source: Scott, 1991
(2) Dominant taxa (10 pct. or more of the totals) are listed in bold print
(3) Study period 1988 through March 1989
(4) Sampler type T- sampler (area = 0.025 square meters)
(5) Pooled Data: Transect D [(4)]

TABLE 4.6-1: COMMON BENTHIC MACROINVERTEBRATE TAXA COLLECTED 1989-1990 (SCOTT) FROM THE SUSQUEHANNA RIVER BELOW CONOWINGO DAM.

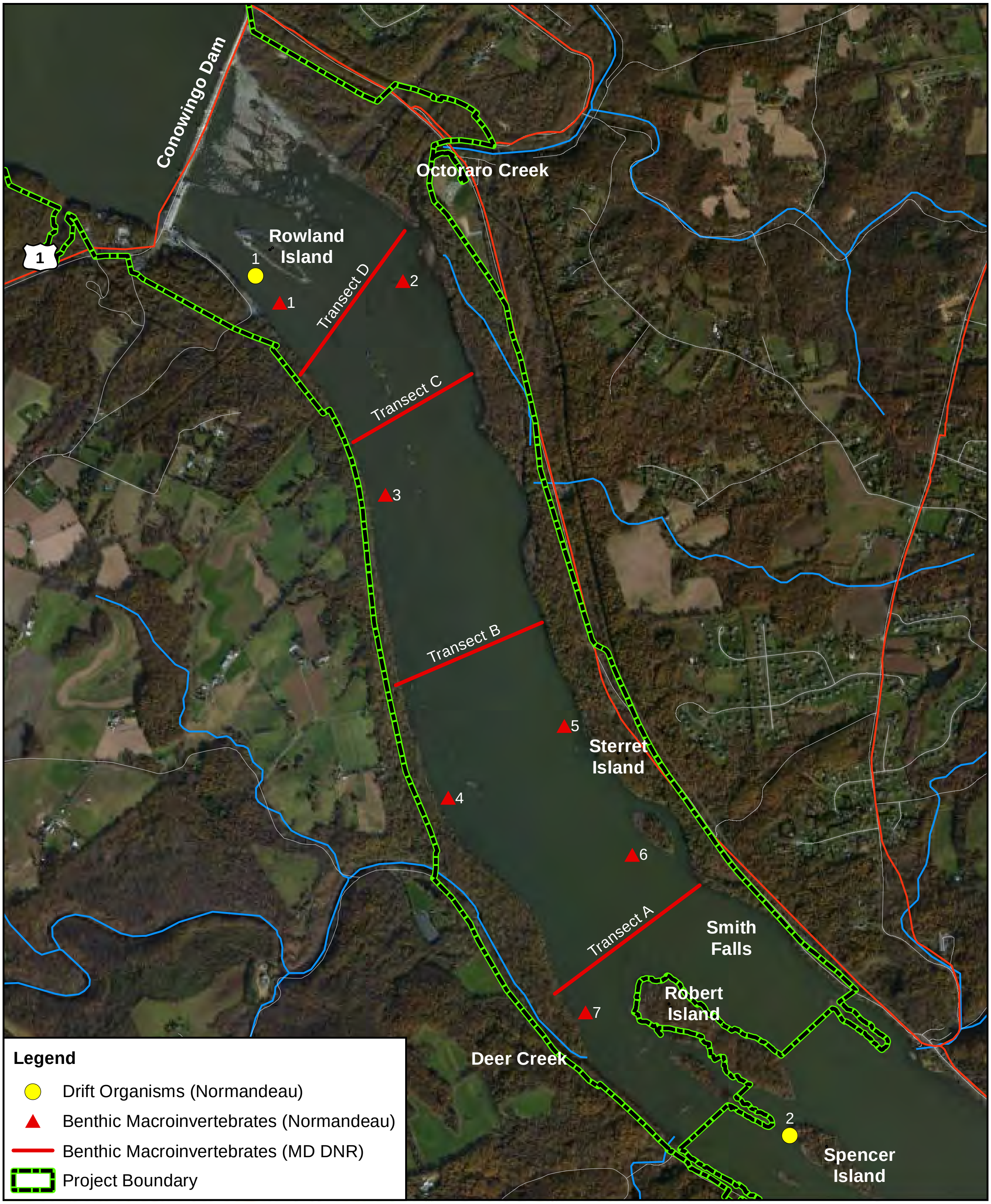
Order	Family	Genus	Common Name	Tolerance Index	Percent Abundance(2)			Dominant and Subdominant Taxon Feeding Group/Habitat
					Gravel Substrate	Bedrock Substrate	Average	
Turbellaria	Planariidae	*Dugesia*	flat worm	9	8%	1%	5%	predator/sprawler
Oligochaeta			segmented worms	10	4%	7%	6%	collector/burrower
Polychaeta	Sabellidae	***Manyunkia***	fan worm	10	**36%**	**23%**	**30%**	filterer/burrower
Bivalvia	Corbiculidae	***Corbicula***	Asiatic clam	6	**10%**	5%	8%	filterer/burrower
Gastropoda	Ancylidae	*Ferrissia*	limpet snail	7	4%	< 1%	2%	
	Planorbidae	*Micromenetus*	orb snail		6%	< 1%	3%	
Amphipoda	Gammaridae	*Gammarus*	side swimmer	7	5%	1%	3%	
Trichoptera	Hydropsychidae	***Cheumatopsyche***	caddisfly	6	**11%**	**13%**	**12%**	filterer/clinger
Diptera	**Chironomidae** (3)		midge	7	2%	6%	4%	
		Cricotopus	midge	8	1%	6%	4%	
		Polypedilum	midge	6	4%	**34%**	**19%**	shredder/clinger
			Totals (3)		**91%**	**96%**	**94%**	

(1) Source: Scott, 1991
(2) Dominant taxa (10 pct. or more of the totals) are listed in bold print
(3) The totals do not include rare/uncommon taxa.
(4) A cumulative total of 115 macroinvertebrate taxa (genus/species) were collected over three winter sampling periods (1988, 1990, and 1991
(5) The Percent Abundance of all chironomid genera combined was 7 pct. from bedrock substrate and 46 pct. from bedrock substrate.
(6) The total number of samples collected was 118.
(7) Study period 1989 through March 1990 (Year 2).
(8) Sampler type T-sampler (area=0.25 square meters).
(9) Pooled data, transect D.

TABLE 4.7-1: COMMON BENTHIC MACROINVERTEBRATE TAXA COLLECTED BY T-SAMPLER IN 1990-1991 (SCOTT) FROM THE SUSQUEHANNA RIVER BELOW CONOWINGO DAM.

Order	Family	Genus	Common Name	Tolerance Index	Percent Abundance(2) (Gravel Substrate)	Percent Abundance(2) (Bedrock Substrate)	Percent Abundance(2) Average	Dominant and Subdominant Taxon Feeding Group/Habitat
Turbellaria	Planariidae	*Dugesia*	flat worm	9	5%	1%	3%	
Oligochaeta			segmented worms	10	7%	4%	6%	collector/burrower
Polychaeta	Sabellidae	***Manyunkia***	fan worm	10	9%	**26%**	**18%**	filterer/burrower
Bivalvia	Corbiculidae	***Corbicula***	Asiatic clam	6	**30%**	**15%**	**23%**	filterer/ burrower
Gastropoda	Ancylidae	*Ferrissia*	limpet snail	7	2%	> 0.1%	1%	
	Planorbidae	*Micromenetus*	orb snail	8	1%	> 0.1%	1%	
Amphipoda	Gammaridae	***Gammarus***	side swimmer	7	**17%**	4%	**11%**	shredder/ sprawler
Trichoptera	Hydropsychidae	***Cheumatopsyche***	caddisfly	6	7%	**13%**	**10%**	filterer/clinger
Diptera	**Chironomidae**		midge	7	8%	**29%**	**19%**	collector/ burrower
			Totals (2)		**86%**	**92%**	**89%**	

(1) Source: Scott, 1991
(2) Dominant taxa (10 pct. or more of the totals) are listed in bold print.
(3) The totals do not include rare/uncommon taxa.
(4) A cumulative total of 115 macroinvertebrate taxa (genus/species) were collected over three winter sampling periods (1988, 1990, and 1991).
(5) The total number of samples collected was 107.
(6) Study period 1990 through March 1991 (Year 3)
(7) Sampler type T-sampler (area=0.25 square meters).
(8) Pooled data, transect D



EXELON GENERATION COMPANY, LLC

CONOWINGO HYDROELECTRIC PROJECT
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Figure 4.1:
Sampling Locations for Drift Organisms and Bethnic Macroinvertebrates below Conowingo Dam 1980-1991

Path: X:\GISMaps\project_maps\study_plan\conowingo\Study_3.18\Drift_Organisms.mxd

FIGURE 4.2-1: COMMUNITY DENSITY AND DENSITY OF COMMON INVERTEBRATE TAXA COLLECTED WITH A SURBER SAMPLER FROM THE CONOWINGO DAM TAILRACE DURING 198 -1984.

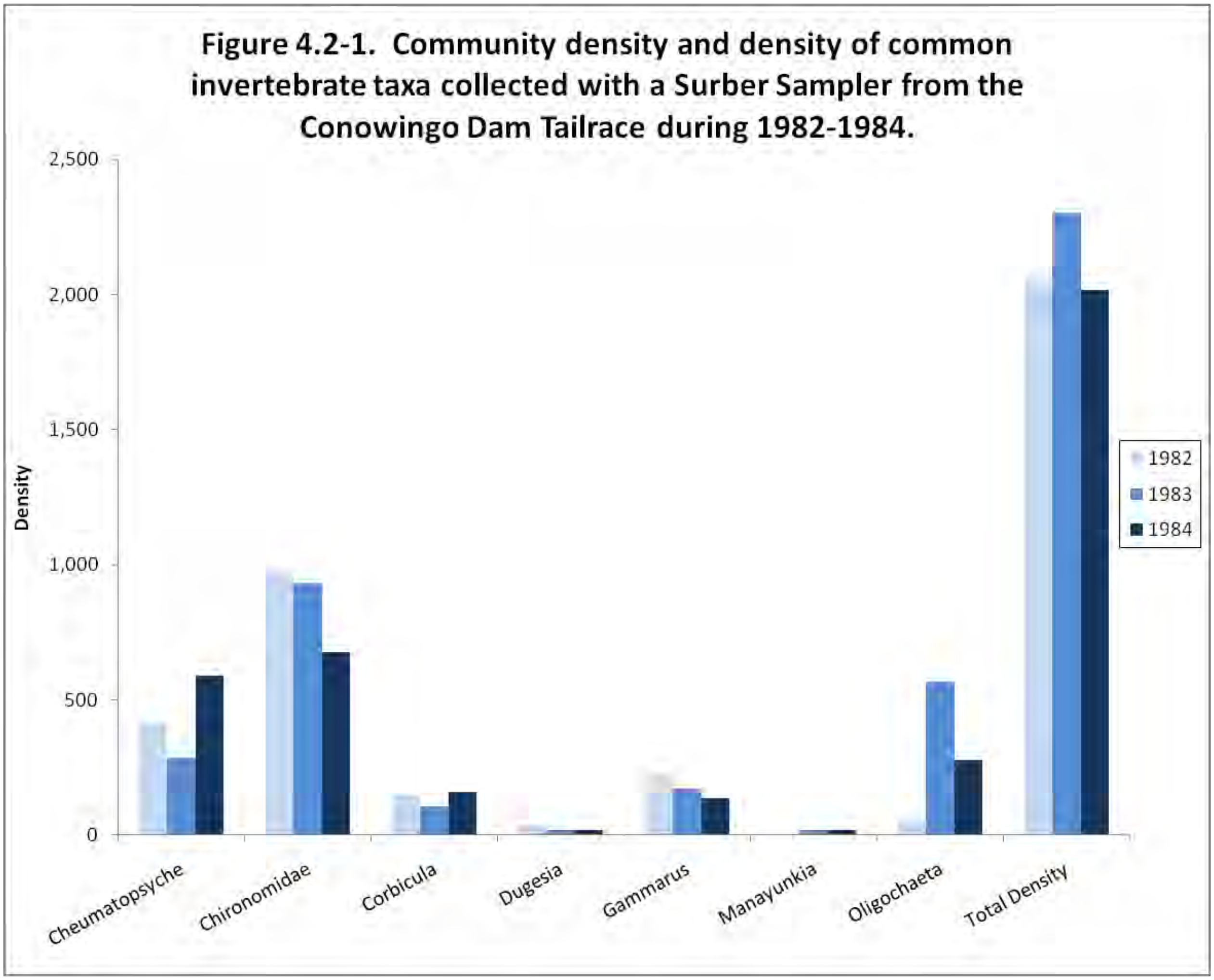
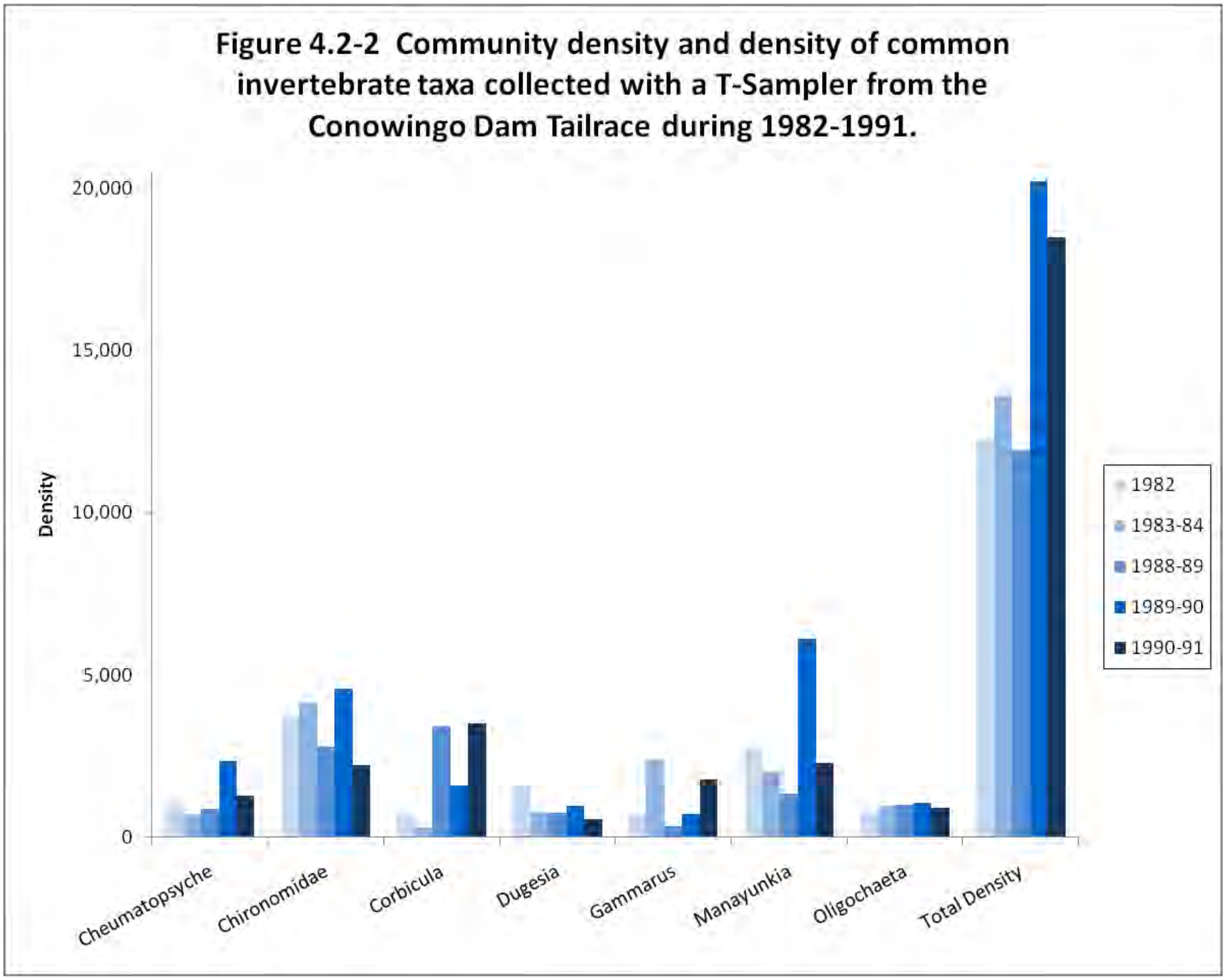


FIGURE 4.2-2: COMMUNITY DENSITY AND DENSITY OF COMMON INVERTEBRATE TAXA COLLECTED WITH A T-SAMPLER FROM THE CONOWINGO DAM TAILRACE DURING 1982 – 1991.



5.0 FISH LIFTS

Data from both the West and East Fish lifts have been compiled in Susquehanna River Anadromous Fish Restoration Cooperative (SRAFRC)Annual Progress Reports (SRAFRC, 2006) up to 2006.

5.1 West Fish Lift (WFL) Operations

The Conowingo Dam Fish Passage Facility has been operated during anadromous spawning migrations since 1972 as part of a cooperative private, state, and Federal effort to restore American shad to the upper Susquehanna River. Annual operation of the WFL at Conowingo Dam has yielded a 38-year timeline of catch and proportional abundance of migratory and resident fish. Routine spring operations typically targeted the April to mid-June time period. WFL operations were expanded in some years to include some summer operation to monitor relative abundance of fishes other than alosids at low dissolved oxygen (DO) and high water temperatures conditions. Also, as part of the biologically-based study plan following the last relicensing, the WFL operations were further expanded in 1981 to include fall months as well. The WFL was used to acquire specimens of several species for various life history studies (e.g., food habits, age and growth, and movement). In 1982 and 1984 the fish lift was also operated intermittently on a monthly basis July through November to investigate seasonal variablitity in species composition and relative abundance.

The WFL is an elevator device that lifts the fish to a sorting tank or transport truck located on the west bank of the tailrace (Figure 5.1-1). There are two telescoping weir entrances to the facility, one facing approximately east, the other approximately south. There is a short holding channel (approximately 25 feet long), at the upper end of which rests the hopper. The hopper rests in a depression in the floor of the holding channel, and lifts the fish out of the facility to the tank above. Also located in the holding channel is a crowder which acts to partially trap the fish by the V-position of its gates. Attraction water is provided by the generation of Station Service Units 1 and 2. Part of this water is directed through a diffusion grating to the weir gates. The remainder passes beneath the holding channel, emerging upstream of the hopper to continue flowing through the holding channel and out the weir gates. Fish that are attracted to this flow, enter the facility through the weir gates, and swim to the upstream end of the holding channel near the hopper. When a lift is to be made, the crowder gates are closed; the crowder is moved upstream, sweeping all fish into the hopper area; then the hopper is lifted collecting all the trapped fish.

Since before 1985, most shad collected at the WFL have been sorted from the daily catch, placed into circular transport tanks, and stocked into suitable spawning waters upstream of Holtwood and Safe

Harbor dams, or utilized for a variety of other scientific purposes such as tank spawning trials. Resident fishes were returned to the river after their numbers were estimated (SRAFRC, 2006).

The current objectives of Conowingo WFL operations generally include: the collecting and enumerating of American shad, river herring and other migratory and resident fishes and obtaining American shad for an on-site tank spawning and shad egg collection program conducted at Conowingo Dam. WFL operational procedures adopted by the Susquehanna River Technical Committee (SRTC) in 1997 included limiting the period of operation to the peak six weeks of the run (late April through the first week in June) and limiting daily lift operations to 8 hours (1100-1900). Within these parameters the WFL maintained appropriate entrance velocities of 4 to 7 fps and curbed use of adjacent turbine units 1 and 2 whenever river flow dropped below 60,000 cfs.

5.2 East Fish Lift (EFL) Operations

Pursuant to a settlement agreement on water quality and fish passage approved by the FERC on January 24, 1989, Exelon was required to construct facilities for the protection of fish. The EFL began operation in 1991 as the cornerstone of the agreement.(46 FERC ¶61,063) (FERC, 1989).

From 1991 through 1996, American shad and river herring were transported across Conowingo Dam and trucked to upstream release sites because the upstream dams were not equipped with upstream fishways. During the spring runs of 1991 through 1996, EFL catches were sorted as at the WFL. Beginning in 1997 all fish were lifted to the exit channel for continued volitional upstream movement following the construction and operations of fish lifts at Holtwood and Safe Harbor dams. Sorting and trucking operations from the EFL were stopped. The number of fish passed upstream at the EFL were estimated by a trained observer counting fish at the window in the viewing room. Annual operation of the EFL at Conowingo Dam has yielded a 19-year timeline of catch and proportional abundance of migratory and resident fish species. Routine spring operations typically targeted the April to mid June time period.

The EFL is located to the east of the Project's turbine units and adjacent to the deflection wall, which separates the tailrace from the spillway (Figure 5.1-2). The EFL consists of two functioning entrance channels with independent weir gates at the downstream end of each channel to regulate flow. The entrance channels are 14 ft high by 10 ft wide and can transport 300 cfs of supplemental attraction flow, creating velocities ranging from three to six fps inside the entrance gate. The specific entrance(s) used to attract fishes was dictated by the station discharge and which turbine units were operating. (SRAFRC 2006).

The EFL merges into a single crowder channel upstream of the entrance channels. Entering the crowder channel, the fish pass through the crowder gate. Once a number of fish have passed through the crowder gate, the gate is closed and the fish are trapped. The crowder screen upstream of the crowder gate is raised allowing the fish to move into the hopper area at the upstream end of the crowder channel. With the hopper sitting on the bottom of the channel, the crowder gate is moved forward, concentrating the fish into the area immediately over the hopper. The crowder screen is then lowered into position further corralling the fish, which are now ready to be lifted to the exit trough. As the 3,500 gallon hopper is raised to the exit trough, the crowder is returned downstream into its fishing position. When the hopper reaches the exit trough, a door to the hopper is opened and the fish and water within are released into the exit trough. The exit trough is 14 ft wide x 12 ft high x 190 ft long. On their own volition, the fish swim by a viewing window situated in a constricted area of the Exit Trough before heading upstream into Conowingo Pond.

The mechanical aspects of EFL operation are similar to those described in RMC (1992) and Normandeau Associates, Inc. (1999). Fishing time and/or lift frequency was determined by fish abundance, but the hopper was cycled at least hourly during daily operations. The method of lift operation was also influenced by fish abundance. In order to not overload the hopper or place undue stress on fish when many fish were in the fishing channel, the crowder was not operated; instead the crowder screen was raised and then lowered trapping fish over the hopper. This mode of operation, called "fast fish", involved leaving the crowder in the normal fishing position and raising the hopper frequently to remove fish that accumulated in the holding channel.

The fish lift data provides baseline account of the dominant species below Conowingo Dam prone to utilizing the fish lift. Numerous physical and biological factors influence the species and sizes of fish collected. These factors include: fish behavior and swimming ability, crowding, predator – prey interaction, water velocities, hydraulic patterns, turbulence, noise, smell and light intensity. Due to operational constraints, velocities and restrictions on the lower limits of screen mesh size, small fish and small-sized species are generally collected less effectively relative to larger fish (Larinier et al. 2002).

The fish lift facilities at the Conowingo Dam are designed to pass migratory fishes, particularly membersof the herring family (Clupeidae), including the American shad (*Alosa sapidissima*), alewife (*Alosa pseudoharengus*), blueback herring (*Alosa aestivalis*), and hickory shad (*Alosa mediocris*) and are primarily operated during the spring and early to summer migration period (April to early June).

5.3 Fish Lift Catch Per Unit Effort

From 1972 – 2009 variability in the annual totals of fish collected at the lifts was considerable. Operational methodologies were influenced by natural river flows, water temperatures, generation schedules and fish population numbers. Inter-annual variability in fish lift collections is likely due to a variety of natural and anthropogenic factors such as hydrological regimes, commercial and recreational fishing pressures, varying accessibility to habitats, yearly operational changes, and varying efforts of collection. Variability related to efforts of collection such as, scheduling, mechanical modes, hours of operation, fishing time (time crowder gates are open), number of lifts and number of days of fish lift operation impacted the overall year to year totals of fish collected. When consistently documented, collection efforts can be standardized to represent a unit of collection per effort. Based on the fish lift data presented in "Fish Lift Operation Reports"(RMC 1991 to 1996, NAI 1997 to 2010) and annual SRAFRC progress reports (SRAFRC 1982 to 2006), standardization of catch is best represented as fish per lift. Due to variability in notation and documentation of "fishing time" and "operational time", as well the EFL documenting only "estimated operational time" from 1997 through 2009 and the WFL documenting only "fishing time" in 2000 through 2009, "fish per lift" is the most practical choice for standardization of effort. As numerous operational changes have occurred over the years, fish per lift is the most consistent and finite normalization of effort that exists for the fish lift data for the purposes of characterizing the fish community.

5.3.1 West Fish Lift

From 1972 to 2009 the WFL collected 31,533,545 fish of 72 different taxa from 27,481 lifts (Table 5.3.1-1). The overall lift CPUE during the 38 years of operation was 1,148 fish per lift (Table 5.3.1-1). The highest overall catch was in 1987 (2,593,445 fish, Table 5.3.1-1) and the highest CPUE was in 1981 (2,762 fish per lift, Table 5.3.1-1). The lowest amount of fish per lift was collected in 2004 (249 fish per lift) along with the lowest total catch (37,589 fish, Table 5.3.1-1). Richness ranged from a high of 49 taxa collected in 1988 to a low of 30 taxa in both 2003 and 2004 (Table 5.3.1-1); the average number of taxa collected per year from 1972 to 2009 was 40.

The 1970's fish lift collections present a relatively balanced fish assemblage (Table 5.3.1-2). Overall, the most commonly collected species 1972 to 1979 were white perch (534 fish per lift), gizzard shad (277 fish per lift), blueback herring (153 fish per lift), channel catfish (85 fish per lift), American eel (42 fish per lift), alewife (30 fish per lift), common carp (21 fish per lift) and quillback (14 fish per lift, Table 5.3.1-2). White perch was prevalent throughout the decade, ranging from 19% of the overall CPUE in 1977 to 56% in 1975 (Table 5.3.1-2). In 1974 white perch comprised the largest overall CPUE of the decade for any species, 1,095 fish per lift (Table 5.3.1-2). Gizzard shad became increasingly common in the latter part of the decade. In 1973 gizzard shad represented only 4% (30 fish per lift) of the overall CPUE and increased to 64% (1,050 fish per lift) of the overall CPUE in 1977 (Table 5.3.1-2). Blueback herring was one of the most commonly collected species in the early 1970's representing 25% of the overall CPUE in 1973, but declined rapidly to 8% by 1975 (Table 5.3.1-2). The CPUE of blueback herring decreased from 415 fish per lift in 1974 to 8 fish per lift in 1979 (Table 5.3.1-2). Catches of channel catfish fluctuated throughout the 1970's. Channel catfish was 25% of the overall CPUE in 1972 (75 fish per lift), declining to 4% of the overall CPUE in 1976 (61 fish per lift) and increasing again to 19% of the overall CPUE in 1979 (127 fish per lift, Table 5.3.1-2).

Amongst decades, the 1980's had the highest overall CPUE at 1,685 fish per lift (1980 to 1989, Table 5.3.1-1). The catch was dominated by gizzard shad every year, ranging from 61% of the overall CPUE in 1982 (1,692 fish per lift) to 96% of the overall CPUE in 1987 (1,760 fish per lift, Table 5.3.1-2). The highest CPUE for a species during the decade occurred in 1981 when gizzard shad were collected at a rate of 2,361 fish per lift Table 5.3.1-2. Overall, gizzard shad were collected at a CPUE of 1,540 fish per lift 1980 to 1989. Other species prevalent in the fish lift collections 1980 to 1989 included white perch (53 fish per lift), channel catfish (32 fish per lift), comely shiner (11 fish per lift), common carp (11 fish per lift), blueback herring (7 fish per lift) and shorthead redhorse (5 fish per lift, Table 5.3.1-2).

Relative abundance of fishes varied seasonally in 1982 and 1984 as did species diversity and was similar to the electrofishing catch (Section 6.5). In both years species diversity was highest in the spring and lowest in the fall, likely due to the addition of migrant clupeids in the spring and a limited sample size in the fall. Gizzard shad dominated the catch in all months (Appendix A-24). The relative abundance of gizzard shad was high during October and November due to recruitment of large numbers of young-of-the-year. Generally, channel catfish were most abundant in the spring (June) and fall (October, November). Smallmouth bass and white perch were most abundant during spring with the highest catches occurring in May and June. Walleyes were present in all months with the highest catches occurring in summer months. Juvenile striped bass were abundant during the summer months of July and August.

The 1990's had the lowest overall CPUE amongst decades at 765 fish per lift (Table 5.3.1-1). (As of 1997, the WFL operations were modified to an 8 hour day (from a 12 hour day) and a 6 week time frame.). Species relatively common throughout 1990 to 1999 included gizzard shad (663 fish per lift), blueback herring (31 fish per lift), white perch (29 fish per lift), American shad (11 fish per lift), channel catfish (7 fish per lift), comely shiner (6 fish per lift), and common carp (6 fish per lift, Table 5.3.1-2).

In all years except 1997, gizzard shad were the dominant species collected at the WFL. The catch of gizzard shad represented 87% of the overall CPUE 1990 to 1999 (Table 5.3.1-2). In 1997, blueback herring comprised 39% of the overall CPUE (218 fish per lift) while gizzard shad comprised 37% (207 fish per lift, Table 5.3.1-2). White perch constituted 17% of the overall CPUE (96 fish per lift, Table 5.3.1-2) in 1997.

Gizzard shad also dominated the collections at the WFL 2000 to 2009, ranging from 61% of the catch in 2004 (152 fish per lift) to 99% of the catch in 2008 (1,507 fish per lift, Table 5.3.1-2). White perch were more common in the early part of the decade. In 2002 white perch accounted for 16% of the overall CPUE (156 fish per lift); in 2006 the proportion of white perch declined to <1% of the overall CPUE (3 fish per lift, Table 5.3.1-2). White perch had an overall CPUE of 50 fish per lift from 2000 to 2009. Although they comprised only 1% of the collection 2000 to 2009, channel catfish were the second most proportionally abundant fish in 2004, comprising 13% of the overall CPUE (32 fish per lift). Other species common 2000 to 2009 included, American shad (19 fish per lift), blueback herring (9 fish per lift), channel catfish (7 fish per lift) and alewife (5 fish per lift, Table 5.3.1-2).

From 1972 to 2009 gizzard shad accounted for 75% of the overall CPUE at the WFL. Gizzard shad became the dominant species for the first time in 1977 and retained its dominance over the next three decades (Figure 5.3.1-1). White perch (13%), blueback herring (4%), channel catfish (3%) were other species relatively abundant in CPUE. Sixty-eight other taxa combined for a total of 5% of the overall CPUE 1972 – 2009 (Appendix A-25).

Clupeids, apart from hickory shad (gizzard shad, blueback herring, American shad, and alewife) were in the overall top ten species collected 1972 – 2009 and together comprised 80% of the number of fish collected at the WFL (Table 5.3.1-2). The Moronidae family (white perch and striped bass) were frequently in the yearly top 10 of species collected and combined, comprised 13% of the overall collection 1972 – 2009 (Table 5.3.1-2). Members of the Ictaluridae family including channel catfish, white catfish, brown bullhead, yellow bullhead, flathead catfish were well represented. Channel catfish were the fourth most frequently caught species and comprised 3% of the overall collection 1972 to 2009. Members of the Catostomidae family including quillback, shorthead redhorse, northern hog sucker, creek chubsucker combined composed less than 1% of the overall collections; shorthead redhorse and quillback were often in the top ten annual species collected and were the tenth and eleventh most commonly collected species overall 1972 to 2009 (Appendix A-25). Centrarchids including redbreast sunfish, bluegill, white crappie, smallmouth bass, largemouth bass, pumpkinseed, and rock bass were frequently collected but combined, represented less than 1% of the total catch (Appendix A-25). Percidae including walleye, yellow perch, tessellated darter and logperch were also frequently collected (Appendix A-25). Many different species of Cyprinids were collected (common carp, comely shiner, spotfin shiner, spottail shiner, golden shiner, bluntnose shiner, goldfish, rosyface shiner, swallowtail shiner). Common carp was the fifth most frequently collected species 1972 to 2009, but overall comprised less than 1% of the overall total collected (Appendix A-25).

Several catadromous and estuarine species were collected at the WFL. American eel were the sixth most frequently collected species overall 1972 to 2009 (Table 5.3.1-2). Atlantic menhaden were collected in the 1970's (2,214 fish, Appendix A-25), were rare in the 1980's, and were not collected in the 1990's or 2000's. Sea lamprey were collected regularly (1,013 fish, Appendix A-25).

5.3.2 East Fish Lift

From 1991 to 2009 the EFL collected 16,411,728 fish of 63 different taxa from 12,733 lifts (Table 5.3.2-1). The overall catch per lift from the 19 years of operation was 1,289 fish per lift (Table 5.3.2-1). The highest overall catch (2,394,583 fish) and the highest overall CPUE (3,998 fish per lift) occurred in 1992 (Table 5.3.2-1). The lowest total catch occurred in 2005 (377,762 fish) and the lowest CPUE occurred in 1991 (557 fish per lift, Table 5.3.2-1). Richness was highest in 1992 (45 taxa), lowest in 2003 (25 taxa) and averaged 33 taxa 1991 to 2009 (Table 5.3.2-1).

Similar to catches at the WFL since 1977, gizzard shad have dominated the catch at the EFL since it began operation in 1991 (Figure 5.3.2-1), ranging from 98% of the overall catch in 1992 to 47% of the overall catch in 2001 (Table 5.3.2-2). In all years combined (1991 to 2009), gizzard shad account for 86% of all fish collected (Table 5.3.2-2). In 1992, 2,351,351 gizzard shad were collected, the most of any species in any year (Table 5.3.2-2). In 1992, the highest CPUE for gizzard shad also occurred (3,925 fish per lift, Table 5.3.2-2).

Routinely, American shad were the second most frequently collected species at the EFL. From 1991 to 2009 American shad comprised 7% of the overall catch per lift (Table 5.3.2-2). The proportional abundance of American shad CPUE at the fish lift ranged from 31% in 2000 to less than 1% in 1992 (Table 5.3.2-2). In 2001 the highest CPUE of American shad occurred (346 fish per lift, Table 5.3.2-2) and the lowest CPUE of American shad occurred in 1993 (10 fish per lift, Table 5.3.2-2).

From 1991 to 2009, blueback herring comprised 4% of the overall CPUE at the EFL (Table 5.3.2-2). In 1997, 1999 and 2001 significant catches of blueback herring were made. In 2001, 510 herring per lift were collected (Table 5.3.2-2), the highest amount in any year and the second most proportionally abundant species that year after gizzard shad. Very few blueback herring have been collected since 2001 with none taken in 2006. Populations of blueback herring have been declining in the northeast due to a number of potential causes including habitat loss, targeted or by catch at sea via commercial fishing and increased numbers of striped bass and other types of predators (ASMFC, 2009).

Other species frequently collected and proportionally abundant at the EFL included: white perch (9 fish per lift, <1% of overall CPUE), common carp (5 fish per lift, <1% of overall CPUE), quillback (2 fish per lift, <1% of overall CPUE), comely shiner (1 fish per lift, <1% of overall CPUE), channel catfish (1 fish per lift, <1% of overall CPUE), and walleye (1 fish per lift, <1% of overall CPUE, Table 5.3.2-2).

Over the operating history at the EFL (1991 to 2009), members of the clupeid family including gizzard shad, American shad and blueback herring were the overall top three species collected and comprised 97% of all fish collected (Table 5.3.2-2). Alewife was the eleventh most frequently collected species and in 2001 had an overall CPUE of 13 fish per lift (Table 5.3.2-2), the highest of any year. Another clupeid, hickory shad, was collected occasionally (Appendix B-23). The Moronidae family, represented by white perch and striped bass, were frequently in the yearly top 10 of species collected though combined, were less than 1% of the total fish. Striped bass was the tenth most frequently collected species and had an overall CPUE of less than1 fish per lift (Table 5.3.2-2). The highest CPUE for striped bass occurred in 1998 (2 fish per lift, Table 5.3.2-2).

Many different species of Cyprinids were collected (common carp, comely shiner, spotfin shiner, spottail shiner, golden shiner, blacknose dace, creek chub, longnose dace, bluntnose minnow, Appendix B-23). Common carp was the fifth most frequently collected species overall, and populations have trended downward since the early 1990's. In 1991 a high CPUE of 20 fish per lift were collected, in 2006 a low of less than 1 fish per lift was collected (Table 5.3.2-2). Comely shiner was the seventh most frequently collected species with a CPUE of 1 fish per lift 1991 to 2009 (Table 5.3.2-2). The Catostomidae family (quillback, shorthead redhorse, northern hog sucker, creek chubsucker) combined composed less than 1% of the overall collections, but shorthead redhorse and quillback were often in the top ten annual species collected (Appendix B-23). Quillback was the sixth most frequently collected species, with an overall CPUE of 1 fish per lift 1991 to 2009 (Table 5.3.2-2).

Species from the Ictaluridae family collected at the EFL included channel catfish, brown bullhead, yellow bullhead and white catfish (Appendix B-23). Channel catfish were routinely in the top ten species collected and ranged in CPUE from a high of fish per lift in 2009 to a low of less than 1 fish per lift in 2001 (Appendix B-23). Species of the Percidae family including walleye, yellow perch, tessellated darter, logperch and shield darter were also regularly collected (Appendix B-23). Walleye were the ninth most frequently collected species and catches fluctuated from 4 fish per lift in 2008 to a low of less than 0.1 fish per lift in 1993 (Table 5.3.2-2). Centrarchids, including smallmouth bass, redbreast sunfish, largemouth bass, rock bass, pumpkinseed, green sunfish, white crappie and black crappie were also regularly collected throughout 1991 to 2009 (Appendix B-23).

Several catadromous and estuarine species were collected at the EFL. A total of 566 American eel was collected 1991 to 2009 (Appendix B-23). The highest collection rate occurred in 1992 at only less than 1 fish per lift; no American eels were collected in 2000, 2002 to 2004 or 2007 to 2009 (Appendix B-23). Sea lamprey were common at the EFL (1,245 fish, Appendix B-23).

5.4 Discussion

As documented by WFL data, a fish assemblage consisting of white perch, blueback herring, channel catfish, gizzard shad and other species in the 1970's has become increasingly dominated by gizzard shad (Figure 5.3.1-1). Throughout many aquatic systems within their range, gizzard shad populations increased dramatically in the mid 20th century as broad based ecological changes on the landscape provided a potential increase in suitable habitats (Miller 1960). These same changes, while beneficial to gizzard shad, may have provided unfavorable habitat conditions for other fish species.

Gizzard shad thrive in warm, shallow bodies of water that have a soft mud bottom, high turbidity, and relatively few predators. Gizzard shad are known to be near-exclusively herbivorous throughout much of their life, feeding heavily on microscopic plant life, phytoplankton, and algae. However, in very early life stages consume zooplankton, often to the detriment of other young fishes, including species popularly targeted by anglers (NAI, 1994). They have a high reproductive capacity and grow rapidly, potentially aiding in the avoidance of predation (Miller 1960).

Gizzard shad were inadvertently introduced into Conowingo Pond in 1972 and the population has increased exponentially. In 1997 the introduction of volitional passage at the EFL into Conowingo Pond exacerbated the population growth.

As gizzard shad have trended upward in population, many other species have declined. White crappie catches at the WFL have declined substantially since the mid 1970's (Figure 5.3.1-1). It has been noted that one of the primary mechanisms of low recruitment of white crappie is the competition for zooplankton with juvenile gizzard shad (NAI, 1994).

TABLE 5.3.1-1: TOTAL ANNUAL CATCH OF FISHES PER YEAR AT THE CONOWINGO DAM WEST FISH LIFT 1972-2009.

Year	1972	1973	1974	1975	1976	1977	1978	1979	Totals 1972-1979
No. Days	54	62	58	55	63	61	35	29	417
Lifts	817	1,527	819	514	684	707	358	301	5,727
Est. Oper. Time (HR)	608	996	500	500	307	375	413	187	3,886
Fishing Time (HR)	313	623	222	222	189	252	136	123	2,080
#Taxa	40	43	42	41	38	40	44	37	55
Total	241,419	1,300,345	1,617,887	917,043	1,175,616	1,169,061	276,045	197,769	6,895,185
Fish per Lift	296	852	1,975	1,784	1,719	1,654	771	657	1,204

Year	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	Totals 1980-1989
No. Days	30	37	44	29	34	55	59	60	63	51	462
Lifts	403	490	725	648	519	1,118	831	1,414	1,330	1,117	8,595
Est. Oper. Time (HR)	221	275	502	299	251	542	546	639	637	539	4,451
Fishing Time (HR)	117	178	336	224	192	421	449	532	513	457	3,419
#Taxa	42	48	46	40	35	41	43	46	49	45	72
Total	372,379	1,353,310	1,403,176	1,028,092	957,821	2,317,797	1,830,569	2,593,445	1,592,938	1,035,121	14,484,648
Fish per Lift	924	2,762	1,935	1,587	1,846	2,073	2,203	1,834	1,198	927	1,685

Table 5.3.1-1: Cont.

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	Totals 1990-1999
No. Days	64	63	64	45	47	68	28	44	41	43	507
Lifts	1,363	1,257	1,559	1,032	964	1,245	464	611	476	709	9,680
Est.Oper. Time (HR)	664	681	698	505	535	744	285	349	239	315	5,014
Fishing Time (HR)	571	547	589	417	441	652	259	295	226	313	4,310
#Taxa	43	45	46	37	46	44	38	39	38	34	53
Total	1,162,841	533,052	1,559,814	713,155	563,773	995,447	232,615	345,983	575,220	722,945	7,404,845
Fish per Lift	853	424	1,000	691	585	800	501	566	1,208	1,020	765

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Totals 2000-2009	Totals 1972-2009
No. Days	34	41	31	31	14	30	37	29	34	28	309	1,695
Lifts	424	425	417	367	151	295	349	288	481	282	3,479	27,481
Est. Oper. Time (HR)	--	--	--	--	--	--	--	--	--	--	--	--
Fishing Time (HR)	206	195	147	171	74	166	215	135	174	144	1,627	11,436
#Taxa	37	38	35	30	30	36	38	35	37	39	53	72
Total	458,349	309,804	419,103	147,388	37,589	94,767	163,131	159,389	733,553	225,794	2,748,867	31,533,545
Fish per lift	1,081	729	1,005	402	249	321	467	553	1,525	801	790	1,148

TABLE 5.3.1-2: TOP TEN TOTALS OF ANNUAL CATCH OF FISHES BY YEAR, CPUE (FISH PER LIFT) AND PROPORTIONAL ABUNDANCE AT THE CONOWINGO DAM EAST AND WEST FISH LIFTS:YEARS 1972-2009.

1972				1973				1974			
Species	No.	CPUE	%	Species	No.	CPUE	%	Species	No.	CPUE	%
Channel Catfish	61,042	75	25%	White Perch	647,493	424	50%	White Perch	897,113	1,095	55%
Blueback Herring	58,198	71	24%	Blueback Herring	330,341	216	25%	Blueback Herring	340,084	415	21%
White Perch	50,991	62	21%	Alewife	144,727	95	11%	Gizzard Shad	119,672	146	7%
Gizzard Shad	24,849	30	10%	Channel Catfish	55,084	36	4%	American Eel	91,937	112	6%
Alewife	10,345	13	4%	Gizzard Shad	45,668	30	4%	Channel Catfish	75,663	92	5%
Quillback	7,119	9	3%	Quillback	27,780	18	2%	Common Carp	34,383	42	2%
Yellow Perch	5,955	7	2%	Common Carp	16,362	11	1%	Alewife	16,675	20	1%
White Crappie	4,457	5	2%	White Catfish	6,394	4	0.5%	Quillback	14,565	18	1%
Common Carp	4,370	5	2%	Brown Bullhead	5,328	3	0.4%	White Crappie	4,371	5	0.3%
Striped Bass	3,142	4	1%	Shorthead Redhorse	4,420	3	0.3%	Comely Shiner	3,870	5	0.2%

1975				1976				1977			
Species	No.	CPUE	%	Species	No.	CPUE	%	Species	No.	CPUE	%
White Perch	511,699	996	56%	White Perch	568,018	830	48%	Gizzard Shad	742,056	1,050	63%
Gizzard Shad	139,222	271	15%	Gizzard Shad	382,275	559	33%	White Perch	224,843	318	19%
Channel Catfish	74,042	144	8%	American Eel	60,409	88	5%	Channel Catfish	90,442	128	8%
Blueback Herring	69,916	136	8%	Spotfin Shiner	45,879	67	4%	Blueback Herring	24,395	35	2%
American Eel	64,375	125	7%	Channel Catfish	41,508	61	4%	Common Carp	16,256	23	1%
Common Carp	15,114	29	2%	Blueback Herring	35,519	52	3%	American Eel	14,601	21	1%
White Crappie	9,290	18	1%	Quillback	9,882	14	1%	Redbreast Sunfish	8,277	12	1%
Quillback	8,388	16	1%	Common Carp	6,755	10	1%	Spottail Shiner	8,107	11	1%
White Catfish	6,178	12	1%	Redbreast Sunfish	3,772	6	0.3%	Spotfin Shiner	7,960	11	1%
Alewife	4,311	8	1%	White Crappie	2,987	4	0.3%	Quillback	6,734	10	1%

Table 5.3.1-2: Cont

1978				1979				1972-1979 Total			
Species	**No.**	**CPUE**	**%**	**Species**	**No.**	**CPUE**	**%**	**Species**	**No.**	**CPUE**	**%**
White Perch	113,164	316	41%	Gizzard Shad	75,553	251	38%	White Perch	3,056,424	534	44%
Gizzard Shad	55,104	154	20%	White Perch	43,103	143	22%	Gizzard Shad	1,584,399	277	23%
Channel Catfish	48,575	136	18%	Channel Catfish	38,251	127	19%	Blueback Herring	873,833	153	13%
Blueback Herring	13,098	37	5%	Common Carp	14,946	50	8%	Channel Catfish	484,607	85	7%
Common Carp	11,842	33	4%	Quillback	5,134	17	3%	American Eel	241,657	42	4%
Spottail Shiner	8,506	24	3%	Redbreast Sunfish	3,466	12	2%	Alewife	176,495	31	3%
American Eel	5,878	16	2%	Walleye	2,491	8	1%	Common Carp	120,028	21	2%
Redbreast Sunfish	4,187	12	2%	Blueback Herring	2,282	8	1%	Quillback	81,963	14	1%
Spotfin Shiner	3,751	10	1%	Shorthead Redhorse	2,163	7	1%	Spotfin Shiner	62,016	11	1%
Quillback	2,361	7	1%	Comely Shiner	1,707	6	1%	Redbreast Sunfish	26,903	5	0.4%

1980				1981				1982			
Species	**No.**	**CPUE**	**%**	**Species**	**No.**	**CPUE**	**%**	**Species**	**No.**	**CPUE**	**%**
Gizzard Shad	275,736	684	74%	Gizzard Shad	1,156,662	2,361	85%	Gizzard Shad	1,226,374	1,692	61%
Channel Catfish	38,929	97	10%	White Perch	83,363	170	6%	White Perch	53,527	74	3%
White Perch	26,971	67	7%	Channel Catfish	55,528	113	4%	Channel Catfish	40,941	56	2%
Common Carp	8,879	22	2%	Common Carp	18,313	37	1%	Blueback Herring	25,249	35	1%
Walleye	4,153	10	1%	American Eel	11,329	23	1%	Common Carp	15,362	21	1%
Quillback	2,929	7	1%	Shorthead Redhorse	6,533	13	1%	Comely Shiner	14,214	20	1%
Striped Bass x White Bass	2,674	7	1%	Quillback	3,622	7	0.3%	Shorthead Redhorse	6,974	10	0.3%
Redbreast Sunfish	1,524	4	0.4%	Striped Bass	3,277	7	0.2%	American Eel	3,961	5	0.2%
Shorthead Redhorse	1,394	4	0.4%	Walleye	2,645	5	0.2%	Alewife	3,433	5	0.2%
White Sucker	1,145	3	0.3%	White Catfish	2,199	4	0.2%	American Shad	2,039	3	0.1%

Table 5.3.1-2: Cont

1983				1984				1985			
Species	**No.**	**CPUE**	**%**	**Species**	**No.**	**CPUE**	**%**	**Species**	**No.**	**CPUE**	**%**
Gizzard Shad	950,252	1,466	92.4%	Gizzard Shad	912,666	1,759	95%	Gizzard Shad	2,182,888	1,952	94%
White Perch	23,151	36	2.3%	Channel Catfish	20,479	39	2%	White Perch	68,344	61	3%
Common Carp	16,273	25	1.6%	Common Carp	8,012	15	1%	Channel Catfish	15,200	14	1%
Channel Catfish	12,559	19	1.2%	White Perch	6,402	12	1%	Blueback Herring	6,763	6	0.3%
Shorthead Redhorse	7,558	12	0.7%	Shorthead Redhorse	3,467	7	0.4%	Common Carp	6,729	6	0.3%
Quillback	4,679	7	0.5%	Quillback	1,942	4	0.2%	Bluegill	6,048	5	0.3%
Comely Shiner	3,176	5	0.3%	Comely Shiner	871	2	0.1%	Comely Shiner	5,141	5	0.2%
Spottail Shiner	2,132	3	0.2%	Smallmouth Bass	608	1	0.1%	Spottail Shiner	3,525	3	0.2%
American Eel	1,080	2	0.1%	Yellow Perch	487	1	0.1%	Redbreast Sunfish	3,366	3	0.1%
Smallmouth Bass	1,003	2	0.1%	Redbreast Sunfish	465	1	0.0%	Shorthead Redhorse	3,362	3	0.1%

1986				1987				1988			
Species	**No.**	**CPUE**	**%**	**Species**	**No.**	**CPUE**	**%**	**Species**	**No.**	**CPUE**	**%**
Gizzard Shad	1,714,441	2,063	94%	Gizzard Shad	2,488,618	1,760	96%	Gizzard Shad	1,402,565	1,055	88%
White Perch	56,977	69	3%	White Perch	29,995	21	1%	White Perch	90,651	68	6%
Channel Catfish	18,898	23	1%	Comely Shiner	21,199	15	1%	Channel Catfish	36,212	27	2%
Blueback Herring	6,327	8	0.3%	Channel Catfish	11,699	8	0.5%	Blueback Herring	14,570	11	1%
Spottail Shiner	6,247	8	0.3%	American Shad	7,667	5	0.3%	Comely Shiner	11,734	9	1%
American Shad	5,195	6	0.3%	Striped Bass x White Bass	5,895	4	0.2%	Common Carp	8,535	6	1%
Common Carp	2,930	4	0.2%	Blueback Herring	5,861	4	0.2%	Striped Bass x White Bass	6,203	5	0.4%
Alewife	2,822	3	0.2%	Common Carp	4,607	3	0.2%	American Shad	5,146	4	0.3%
Quillback	2,327	3	0.1%	Shorthead Redhorse	3,583	3	0.1%	Shorthead Redhorse	4,782	4	0.3%
Yellow Perch	2,267	3	0.1%	Bluegill	2,436	2	0.1%	White Catfish	3,849	3	0.2%

Table 5.3.1-2: Cont

1989				1980 - 1989 Total			
Species	No.	CPUE	%	Species	No.	CPUE	%
Gizzard Shad	926,213	829	89%	Gizzard Shad	13,236,415	1,540	91%
Comely Shiner	35,239	32	3%	White Perch	455,094	53	3%
Channel Catfish	21,692	19	2%	Channel Catfish	272,137	32	2%
White Perch	15,713	14	2%	Comely Shiner	93,198	11	1%
American Shad	8,218	7	1%	Common Carp	90,515	11	1%
Spotfin Shiner	5,381	5	1%	Blueback Herring	64,316	7	0.4%
Striped Bass x White Bass	5,243	5	1%	Shorthead Redhorse	42,445	5	0.3%
Blueback Herring	3,598	3	0.3%	American Shad	30,858	4	0.2%
Shorthead Redhorse	2,735	2	0.3%	Striped Bass x White Bass	23,941	3	0.2%
Alewife	1,902	2	0.2%	Quillback	21,702	3	0.1%

1990				1991				1992			
Species	No.	CPUE	%	Species	No.	CPUE	%	Species	No.	CPUE	%
Gizzard Shad	1,084,073	795	93%	Gizzard Shad	433,108	345	81%	Gizzard Shad	1,450,299	930	93%
White Perch	24,581	18	2%	Comely Shiner	18,356	15	3%	White Perch	37,521	24	2%
American Shad	15,719	12	1%	Blueback Herring	15,616	12	3%	Blueback Herring	27,533	18	2%
Blueback Herring	9,658	7	1%	White Perch	14,996	12	3%	American Shad	10,335	7	1%
Channel Catfish	8,689	6	1%	American Shad	13,330	11	3%	Comely Shiner	8,974	6	1%
Comely Shiner	5,798	4	1%	Channel Catfish	10,252	8	2%	Channel Catfish	7,070	5	1%
Shorthead Redhorse	4,228	3	0.4%	Common Carp	8,257	7	2%	Common Carp	4,105	3	0.3%
Common Carp	2,761	2	0.2%	Quillback	2,990	2	1%	Alewife	3,344	2	0.2%
Quillback	1,270	1	0.1%	Shorthead Redhorse	2,871	2	1%	American Eel	2,622	2	0.2%
Striped Bass x White Bass	1,172	1	0.1%	Alewife	2,649	2	1%	Striped Bass	2,094	1	0.1%

Table 5.3.1-2: Cont

1993				1994				1995			
Species	No.	CPUE	%	Species	No.	CPUE	%	Species	No.	CPUE	%
Gizzard Shad	666,010	645	93%	Gizzard Shad	511,139	530	91%	Gizzard Shad	799,694	642	80%
Channel Catfish	10,841	11	2%	Comely Shiner	13,973	15	2%	Blueback Herring	93,859	75	9%
Common Carp	8,488	8	1%	White Perch	9,537	10	2%	White Perch	55,719	45	6%
Comely Shiner	7,358	7	1%	Common Carp	7,403	8	1%	American Shad	15,588	13	2%
American Shad	5,343	5	1%	American Shad	5,615	6	1%	Common Carp	6,209	5	1%
Blueback Herring	4,052	4	1%	Striped Bass	4,261	4	1%	Striped Bass	5,467	4	1%
White Perch	3,892	4	1%	Channel Catfish	3,551	4	1%	Alewife	5,405	4	1%
Striped Bass	1,595	2	0%	Blueback Herring	2,603	3	0.5%	Channel Catfish	2,432	2	0.2%
American Eel	1,487	1	0%	Shorthead Redhorse	1,994	2	0.4%	Shorthead Redhorse	2,098	2	0.2%
Shorthead Redhorse	858	1	0%	Quillback	1,576	2	0.3%	Comely Shiner	1,746	1	0.2%

1996				1997				1998			
Species	No.	CPUE	%	Species	No.	CPUE	%	Species	No.	CPUE	%
Gizzard Shad	196,019	422	84%	Blueback Herring	133,257	218	39%	Gizzard Shad	497,375	1,045	86%
American Shad	11,473	25	5%	Gizzard Shad	126,570	207	37%	White Perch	32,891	69	6%
Common Carp	5,726	12	2%	White Perch	58,685	96	17%	Channel Catfish	17,250	36	3%
Channel Catfish	5,487	12	2%	American Shad	12,974	21	4%	Common Carp	8,206	17	1%
White Perch	4,583	10	2%	Shorthead Redhorse	3,134	5	1%	American Shad	6,577	14	1%
Comely Shiner	2,180	5	1%	Striped Bass	2,665	4	1%	Blueback Herring	5,511	12	1%
Striped Bass	1,845	4	1%	Common Carp	2,281	4	1%	Striped Bass	2,570	5	0.4%
Walleye	964	2	0.4%	Walleye	1,063	2	0.3%	Walleye	827	2	0.1%
Blueback Herring	871	2	0.4%	Spottail Shiner	1,041	2	0.3%	Smallmouth Bass	812	2	0.1%
Shorthead Redhorse	754	2	0.3%	Channel Catfish	977	2	0.3%	Comely Shiner	570	1	0.1%

Table 5.3.1-2: Cont

1999				1990-1999 Total			
Species	**No.**	**CPUE**	**%**	**Species**	**No.**	**CPUE**	**%**
Gizzard Shad	652,770	921	90%	Gizzard Shad	6,417,057	663	87%
White Perch	35,357	50	5%	Blueback Herring	301,506	31	4%
American Shad	9,658	14	1%	White Perch	277,762	29	4%
Blueback Herring	8,546	12	1%	American Shad	106,612	11	1%
Common Carp	5,124	7	1%	Channel Catfish	69,113	7	1%
Channel Catfish	2,564	4	0.4%	Comely Shiner	60,046	6	1%
Alewife	1,795	3	0.2%	Common Carp	58,560	6	1%
Shorthead Redhorse	1,485	2	0.2%	Striped Bass	24,248	3	0.3%
Smallmouth Bass	1,306	2	0.2%	Shorthead Redhorse	19,592	2	0.3%
Striped Bass	1,001	1	0.1%	Alewife	14,303	1	0.2%

2000				2001				2002			
Species	**No.**	**CPUE**	**%**	**Species**	**No.**	**CPUE**	**%**	**Species**	**No.**	**CPUE**	**%**
Gizzard Shad	366,099	863	80%	Gizzard Shad	218,124	513	70%	Gizzard Shad	339,292	814	81%
White Perch	40,318	95	9%	White Perch	44,364	104	14%	White Perch	65,031	156	16%
Blueback Herring	14,326	34	3%	Blueback Herring	16,320	38	5%	American Shad	9,347	22	2%
American Shad	9,785	23	2%	American Shad	10,940	26	4%	Striped Bass	2,086	5	1%
Alewife	9,189	22	2%	Alewife	7,824	18	3%	Channel Catfish	844	2	0.2%
Channel Catfish	8,394	20	2%	Spottail Shiner	5,833	14	2%	Blueback Herring	428	1	0.1%
Common Carp	3,236	8	1%	Comely Shiner	1,228	3	0.4%	Smallmouth Bass	390	1	0.1%
Striped Bass	2,453	6	1%	Common Carp	994	2	0.3%	Shorthead Redhorse	317	1	0.1%
Shorthead Redhorse	1,317	3	0.3%	Redbreast Sunfish	783	2	0.3%	Common Carp	225	1	0.1%
Smallmouth Bass	764	2	0.2%	Striped Bass	710	2	0.2%	Redbreast Sunfish	179	0.4	0.04%

Table 5.3.1-2: Cont.

2003				2004				2005			
Species	**No.**	**CPUE**	**%**	**Species**	**No.**	**CPUE**	**%**	**Species**	**No.**	**CPUE**	**%**
Gizzard Shad	118,852	324	81%	Gizzard Shad	22,899	152	61%	Gizzard Shad	82,412	279	87%
White Perch	14,476	39	10%	Channel Catfish	4,839	32	13%	American Shad	3,896	13	4%
American Shad	9,802	27	7%	American Shad	3,426	23	9%	Channel Catfish	1,692	6	2%
Common Carp	1,110	3	1%	Common Carp	2,702	18	7%	Common Carp	1,179	4	1%
Shorthead Redhorse	749	2	1%	Brown Bullhead	1,599	11	4%	White Perch	1,102	4	1%
Striped Bass	703	2	0.5%	White Perch	976	6	3%	Shorthead Redhorse	863	3	1%
Channel Catfish	626	2	0.4%	Striped Bass	458	3	1%	Quillback	848	3	1%
Smallmouth Bass	232	1	0.2%	White Catfish	271	2	1%	Brown Bullhead	713	2	1%
Blueback Herring	183	0.5	0.1%	Redbreast Sunfish	70	0.5	0.2%	Smallmouth Bass	560	2	1%
Brown Bullhead	104	0.3	0.1%	Comely Shiner	67	0.4	0.2%	Striped Bass	489	2	1%

2006				2007				2008			
Species	**No.**	**CPUE**	**%**	**Species**	**No.**	**CPUE**	**%**	**Species**	**No.**	**CPUE**	**%**
Gizzard Shad	149,250	428	91%	Gizzard Shad	146,821	510	92%	Gizzard Shad	724,737	1,507	99%
American Shad	3,970	11	2%	American Shad	4,272	15	3%	American Shad	2,627	6	0.4%
Channel Catfish	2,880	8	2%	White Perch	2,276	8	1%	White Perch	2,036	4	0.3%
Walleye	1,962	6	1%	Walleye	1,776	6	1%	Walleye	1,971	4	0.3%
Brown Bullhead	1,060	3	1%	Channel Catfish	1,480	5	1%	Channel Catfish	781	2	0.1%
White Perch	1,001	3	1%	Spottail Shiner	986	3	1%	Common Carp	400	1	0.1%
Common Carp	716	2	0.4%	Common Carp	372	1	0.2%	Shorthead Redhorse	325	1	0.04%
Comely Shiner	548	2	0.3%	Striped Bass	263	1	0.2%	Smallmouth Bass	95	0.2	0.01%
Striped Bass	383	1	0.2%	Brown Bullhead	237	1	0.1%	Spotfin Shiner	83	0.2	0.01%
Smallmouth Bass	306	1	0.2%	Blueback Herring	153	1	0.1%	Spottail Shiner	76	0.2	0.01%

Table 5.3.1-2: Cont.

2009				2000-2009 Total				1972-2009 Total			
Species	No.	CPUE	%	Species	No.	CPUE	%	Species	No.	CPUE	%
Gizzard Shad	210,633	747	93%	Gizzard Shad	2,379,119	684	87%	Gizzard Shad	23,616,990	859	75%
American Shad	6,534	23	3%	White Perch	174,675	50	6%	White Perch	3,963,955	144	13%
White Perch	3,095	11	1%	American Shad	64,599	19	2%	Blueback Herring	1,271,244	46	4%
Channel Catfish	2,393	8	1%	Blueback Herring	31,589	9	1%	Channel Catfish	850,014	31	3%
Walleye	977	3	0.4%	Channel Catfish	24,157	7	1%	Common Carp	280,436	10	1%
Common Carp	399	1	0.2%	Alewife	17,201	5	1%	American Eel	268,870	10	1%
Bluegill	313	1	0.1%	Common Carp	11,333	3	0.4%	Alewife	217,753	8	1%
Brown Bullhead	198	1	0.1%	Striped Bass	7,766	2	0.3%	American Shad	202,875	7	1%
Flathead Catfish	196	1	0.1%	Walleye	7,558	2	0.3%	Comely Shiner	165,985	6	1%
Striped Bass	179	1	0.1%	Spottail Shiner	6,920	2	0.3%	Quillback	115,476	4	0.4%

TABLE 5.3.2-1: TOTALS OF ANNUAL CATCH OF FISHES AT THE CONOWINGO DAM, EAST FISH LIFT 1991-2009.

Year	1991	1992	1993	1994	1995	1996	1997
No. Days	60	49	42	55	68	49	64
Lifts	1,168	599	848	955	986	599	652
Est. Oper. Time(HR)	647.2	454.1	463.5	574.8	706.2	454.1	640
#Taxa	42	45	29	36	36	35	36
Total	650,940	2,394,583	529,594	1,062,634	1,796,460	492,384	719,297
Fish per Lift	557	3,998	624	1,113	1,822	822	1,103

Year	1998	1999	2000	2001	2002	2003	2004
No. Days	50	53	45	43	51	44	44
Lifts	652	610	570	559	560	645	590
Est. Oper. Time(HR)	640	467	367.8	359.8	440.7	416.6	390.3
#Taxa	33	31	31	30	31	25	31
Total	712,993	1,184,101	493,953	921,916	656,894	589,177	715,664
Fish per Lift	1,094	1,941	86	1,649	1,173	914	1,213

Year	2005	2006	2007	2008	2009	Total 1991-2009
No. Days	52	61	39	51	57	977
Lifts	541	619	479	483	618	12,733
Est. Oper. Time(HR)	434.3	429.8	335.2	409	495.6	9126
#Taxa	28	32	31	28	30	63
Total	377,762	714,918	539,203	943,838	915,417	16,411,728
Fish per Lift	698	1,155	1,126	1,954	1,481	1,289

TABLE 5.3.2-2: TOP TEN TOTALS OF ANNUAL CATCH OF FISHES BY YEAR, CPUE (FISH PER LIFT) AND PROPORTIONAL ABUNDANCE AT THE CONOWINGO DAM EAST FISH LIFT:YEARS 1991-2009.

1991				1992				1993			
Gizzard Shad	575,505	493	88%	Gizzard Shad	2,351,351	3,925	98%	Gizzard Shad	504,116	594	95%
Common Carp	23,833	20	4%	American Shad	15,386	26	1%	American Shad	8,203	10	2%
American Shad	13,897	12	2%	White Perch	8,725	15	0.4%	Common Carp	6,649	8	1%
Blueback Herring	13,149	11	2%	Blueback Herring	7,347	12	0.3%	Blueback Herring	4,574	5	1%
Comely Shiner	11,847	10	2%	Common Carp	6,072	10	0.3%	Comely Shiner	3,563	4	1%
Quillback	3,220	3	0.5%	Channel Catfish	1,124	2	0.05%	Quillback	540	1	0.1%
Spotfin Shiner	2,647	2	0.4%	Comely Shiner	650	1	0.03%	Channel Catfish	534	1	0.1%
White Perch	2,610	2	0.4%	Carps and Minnows	554	1	0.02%	Striped Bass	327	0.4	0.1%
Striped Bass x White Bass	827	1	0.1%	Smallmouth Bass	494	1	0.02%	White Perch	215	0.3	0.04%
Smallmouth Bass	671	1	0.1%	Quillback	483	1	0.02%	Smallmouth Bass	185	0.2	0.03%

1994				1995				1996			
Gizzard Shad	1,025,418	1,,074	96%	Gizzard Shad	1,737,685	1,762	97%	Gizzard Shad	455,317	760	92%
American Shad	26,715	28	3%	American Shad	46,062	47	3%	American Shad	26,040	43	5%
Common Carp	5,042	5	0.5%	Blueback Herring	4,004	4	0.2%	Common Carp	4,139	7	1%
Quillback	2,507	3	0.2%	Common Carp	3,262	3	0.2%	Quillback	3,773	6	1%
Channel Catfish	544	1	0.1%	Quillback	2,910	3	0.2%	Channel Catfish	1,037	2	0.2%
Striped Bass	506	1	0.05%	White Perch	528	1	0.03%	Smallmouth Bass	531	1	0.1%
Comely Shiner	433	0.5	0.04%	Striped Bass	505	1	0.03%	Walleye	351	1	0.1%
Walleye	255	0.3	0.02%	Walleye	271	0.3	0.02%	Striped Bass	276	1	0.1%
Blueback Herring	248	0.3	0.02%	Redbreast Sunfish	185	0.2	0.01%	Blueback Herring	261	0.4	0.1%
Shorthead Redhorse	242	0.3	0.02%	Alewife	170	0.2	0.01%	Shorthead Redhorse	228	0.4	0.05%

Table 5.3.2-2: Cont.

1997				1998				1999			
Gizzard Shad	344,332	528	48%	Gizzard Shad	654,575	1,004	92%	Gizzard Shad	950,500	1,558	80%
Blueback Herring	242,815	372	34%	American Shad	39,904	61	6%	Blueback Herring	130,625	214	11%
American Shad	90,971	140	13%	Common Carp	6,205	10	1%	American Shad	697,12	114	6%
White Perch	27,312	42	4%	Channel Catfish	4,135	6	1%	White Perch	27,133	44	2%
Common Carp	3,256	5	0.5%	White Perch	2,731	4	0.4%	Common Carp	2,430	4	0.2%
Quillback	2,488	4	0.3%	Striped Bass	1,467	2	0.2%	Striped Bass	1,231	2	0.1%
Walleye	2,334	4	0.3%	Shorthead Redhorse	885	1	0.1%	Smallmouth Bass	797	1	0.1%
Shorthead Redhorse	1,475	2	0.2%	Blueback Herring	700	1	0.1%	Walleye	421	1	0.04%
Channel Catfish	1,178	2	0.2%	Walleye	685	1	0.1%	Channel Catfish	266	0.4	0.02%
Striped Bass	1,015	2	0.1%	Smallmouth Bass	508	1	0.1%	Shorthead Redhorse	245	0.4	0.02%

2000				2001				2002			
Gizzard Shad	317,753	557	64%	Gizzard Shad	429,461	768	47%	Gizzard Shad	513,794	917	78%
American Shad	153,546	269	31%	Blueback Herring	284,921	510	31%	American Shad	108,001	193	16%
Blueback Herring	14,963	26	3%	American Shad	193,574	346	21%	White Perch	29,404	53	4%
White Perch	4,387	8	1%	Alewife	7,458	13	1%	Blueback Herring	2,037	4	0.3%
Striped Bass	802	1	0.2%	White Perch	2,659	5	0.3%	Striped Bass	913	2	0.1%
Channel Catfish	677	1	0.1%	Common Carp	1,267	2	0.1%	Smallmouth Bass	597	1	0.1%
Smallmouth Bass	427	1	0.1%	Striped Bass	543	1	0.1%	Quillback	400	1	0.1%
Quillback	408	1	0.1%	Smallmouth Bass	404	1	0.04%	Sea Lamprey	316	1	0.05%
Common Carp	388	1	0.1%	Shorthead Redhorse	382	1	0.04%	Shorthead Redhorse	292	1	0.04%
Walleye	177	0.3	0.04%	Spottail Shiner	318	1	0.03%	Yellow Perch	258	0.5	0.04%

Table 5.3.2-2: Cont.

2003				2004				2005			
Gizzard Shad	459,634	713	78%	Gizzard Shad	602,677	1,021	84%	Gizzard Shad	305,378	564	80.8%
American Shad	125,135	194	21%	American Shad	109,360	185	15%	American Shad	68,926	127	18.2%
White Perch	1,572	2	0.3%	Channel Catfish	928	2	0.1%	Quillback	2,145	4	0.6%
Common Carp	561	1	0.1%	White Perch	512	1	0.1%	Common Carp	540	1	0.1%
Quillback	548	1	0.1%	Striped Bass	391	1	0.1%	Smallmouth Bass	256	0.5	0.1%
Blueback Herring	530	1	0.1%	Quillback	308	1	0.04%	Shorthead Redhorse	131	0.2	0.03%
Shorthead Redhorse	304	0.5	0.1%	Comely Shiner	291	0.5	0.04%	Striped Bass	89	0.2	0.02%
Striped Bass	272	0.4	0.05%	Common Carp	257	0.4	0.04%	Channel Catfish	83	0.2	0.02%
Smallmouth Bass	247	0.4	0.04%	Smallmouth Bass	172	0.3	0.02%	Walleye	47	0.1	0.01%
Sea Lamprey	68	0.1	0.01%	Brown Bullhead	161	0.3	0.02%	Sea Lamprey	35	0.1	0.01%

2006				2007				2008			
Gizzard Shad	655,990	1,060	91%	Gizzard Shad	508,627	1,062	94%	Gizzard Shad	919,975	1,905	97%
American Shad	56,899	92	8%	American Shad	25,464	53	5%	American Shad	19,914	41	2%
Walleye	641	1	0.1%	White Perch	1,434	3	0.3%	Walleye	2,088	4	0.2%
Quillback	407	1	0.1%	Quillback	1,236	3	0.2%	Channel Catfish	496	1	0.1%
White Perch	277	0.4	0.04%	Walleye	695	1	0.1%	Quillback	400	1	0.04%
Smallmouth Bass	165	0.3	0.02%	Blueback Herring	460	1	0.1%	White Perch	388	1	0.04%
Sea Lamprey	128	0.2	0.02%	Alewife	429	1	0.1%	Common Carp	199	0.4	0.02%
Common Carp	108	0.2	0.02%	Shorthead Redhorse	173	0.4	0.03%	Smallmouth Bass	96	0.2	0.01%
Channel Catfish	75	0.1	0.01%	Striped Bass	127	0.3	0.02%	Shorthead Redhorse	66	0.1	0.01%
Striped Bass	73	0.1	0.01%	Smallmouth Bass	123	0.3	0.02%	Bluegill	65	0.1	0.01%

Table 5.3.2-2: Cont.

2009				1991-2009			
Gizzard Shad	876,412	1,418	96%	Gizzard Shad	14,188,500	1,114	86%
American Shad	29,272	47	3%	American Shad	1,226,981	96	7%
Channel Catfish	4,201	7	0.5%	Blueback Herring	706,811	56	4%
Walleye	1,832	3	0.2%	White Perch	110,923	9	1%
Quillback	899	1	0.1%	Common Carp	65,373	5	0.4%
Common Carp	886	1	0.1%	Quillback	23,275	2	0.1%
White Perch	839	1	0.1%	Comely Shiner	17,372	1	0.1%
Sea Lamprey	190	0.3	0.02%	Channel Catfish	16,082	1	0.1%
Alewife	160	0.3	0.02%	Walleye	10,747	1	0.1%
Brown Bullhead	153	0.2	0.02%	Striped Bass	9,420	1	0.1%

FIGURE 5.1-1: WEST FISH LIFT SCHEMATIC DRAWING

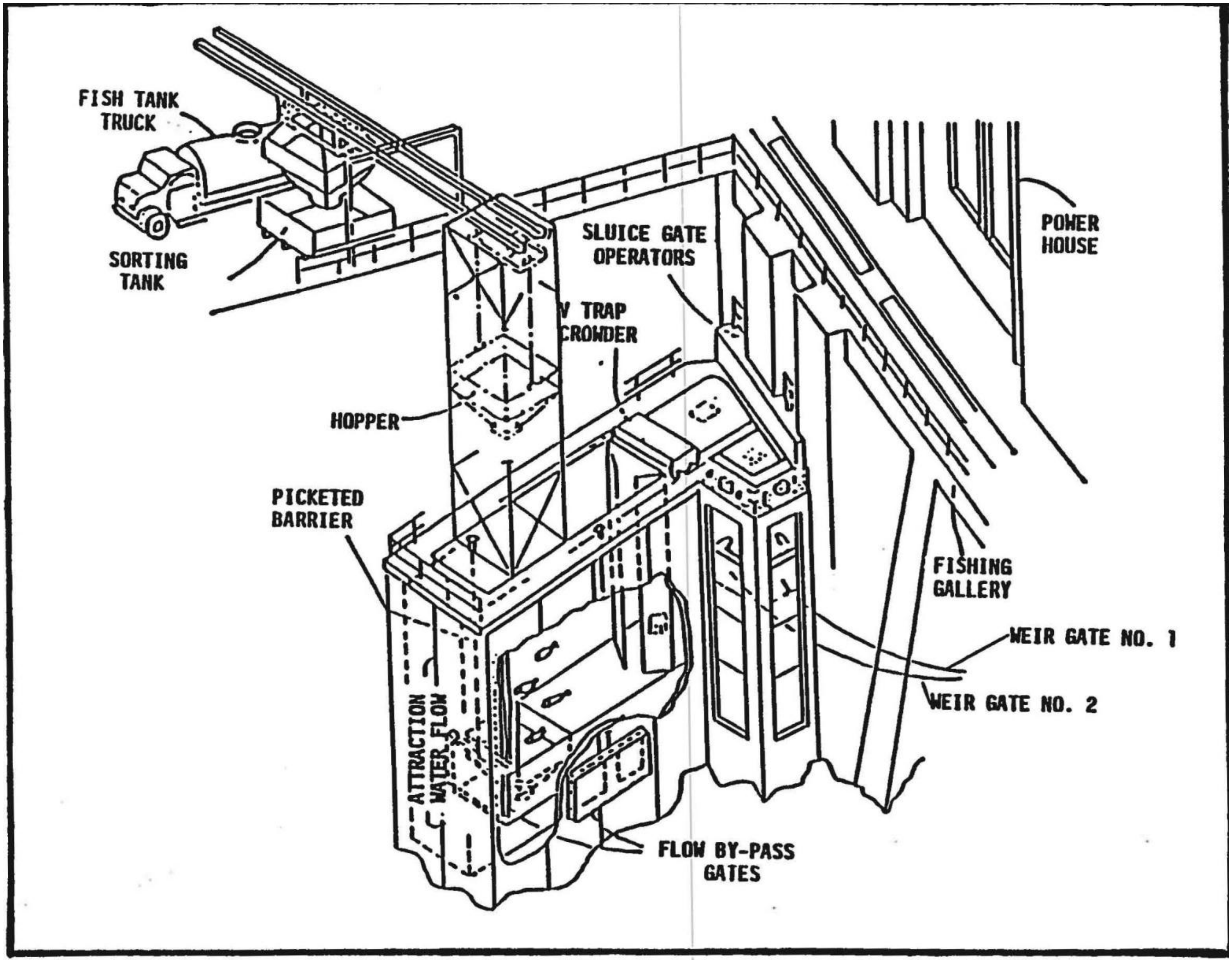


FIGURE 5.1-2: EAST FISH LIFT SCHEMATIC DRAWING

NEW LIFT DESIGN AND CONSTRUCTION

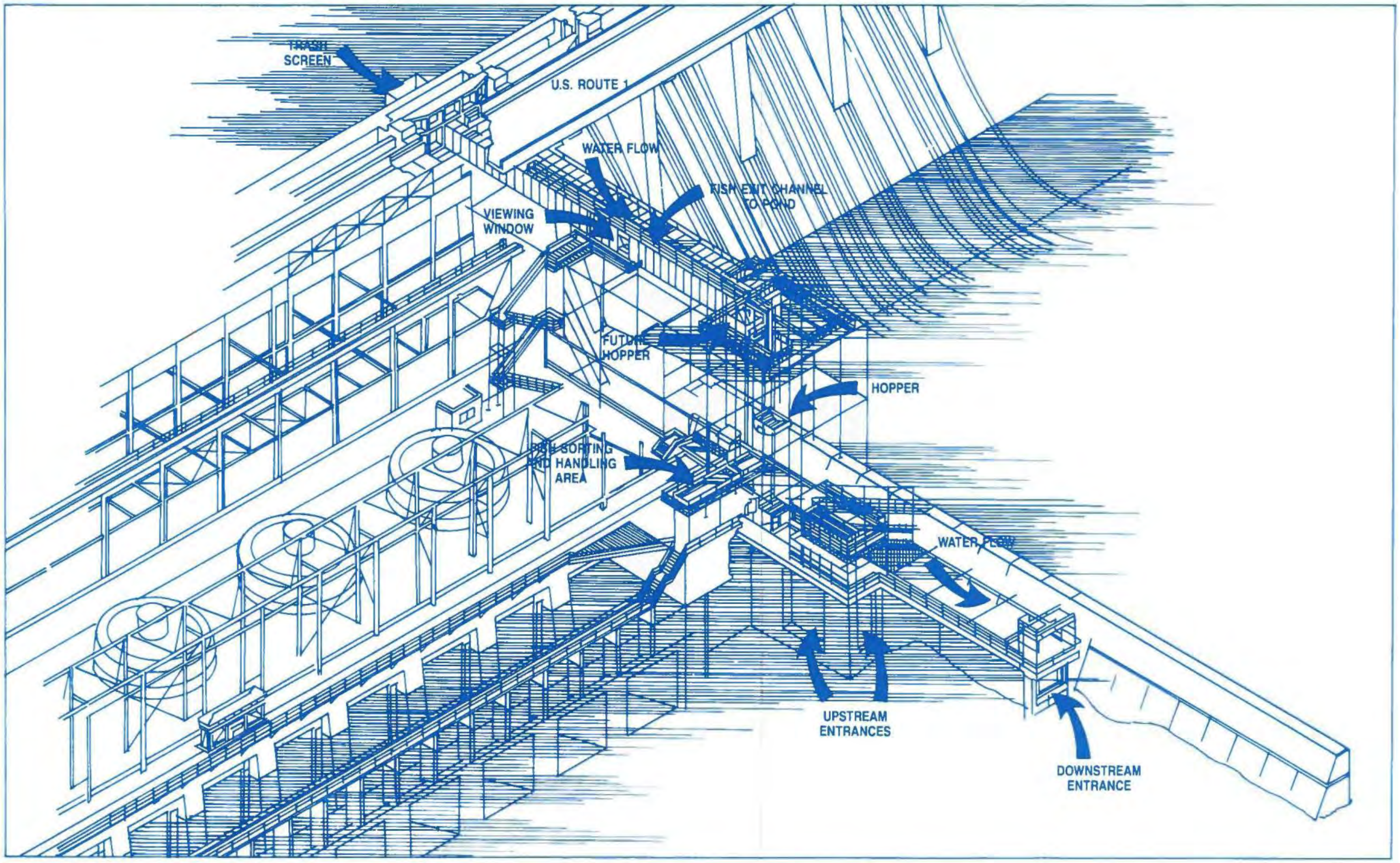


FIGURE 5.3.1-1: WEST FISH LIFT PROPORTIONAL ABUNDANCE, BASED ON TOP TEN CPUES (FISH PER LIFT) 1972-2009.

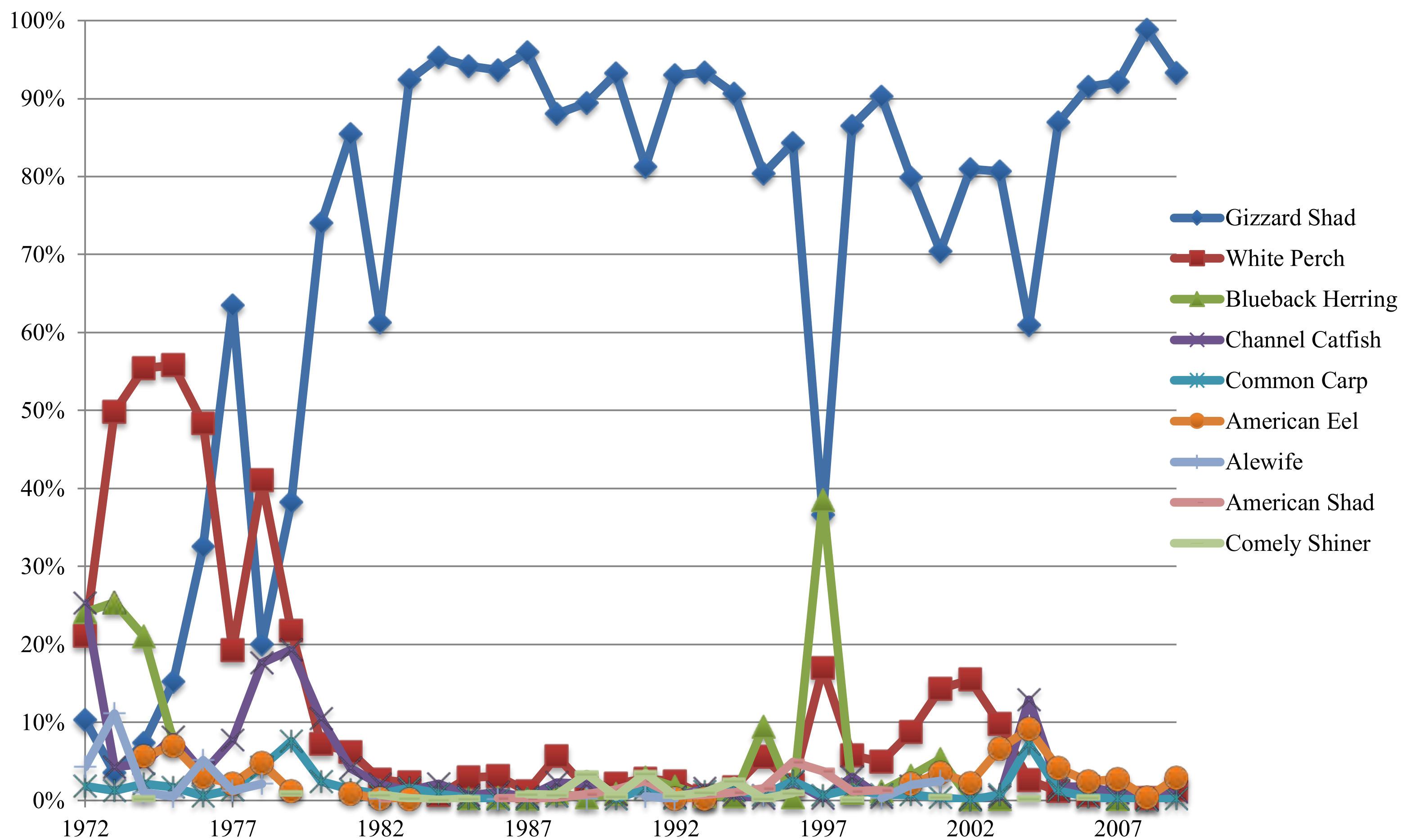
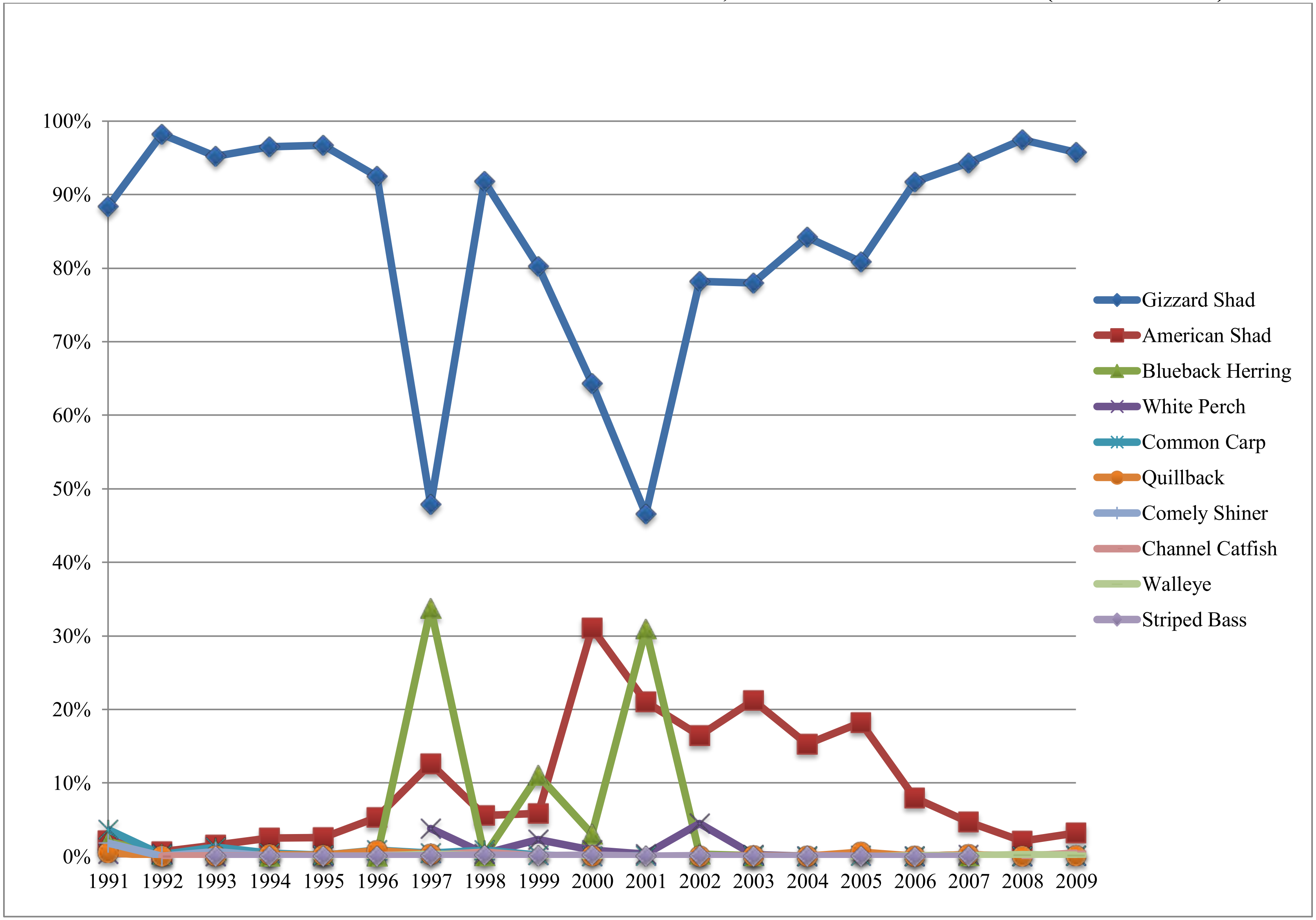


FIGURE 5.3.2-1: EAST FISH LIFT PROPORTIONAL ABUNDANCE, BASED ON TOP TEN CPUES (FISH PER LIFT) 1991-2009.



6.0 ICHTHYOPLANKTON, GILL NETS, AND ELECTROFISHING

Pursuant to a new FERC license issued to Philadelphia Electric Company (PECO) and Susquehanna Electric Company in 1980 for continued operation of the Conowingo Project (FERC No. 405), biological-based studies (by FERC-approved Study Plan) were planned for two successive 5-year periods (1982 to 1986; 1987 to 1991) to address minimum flow issues. The various elements of study continued through 1987. In 1988, PECO (now Exelon) reached a settlement agreement with the resource agencies and the studies were halted. Because the studies were terminated following the settlement agreement, most collected data were only tabulated, processed electronically and stored on PECO's mainframe system; these data were not analyzed or formally presented in any reports. The biological data stored on electronic media were subsequently lost. As a result, data presented here are drawn from three progress reports and other available hard-copy data stored by Normandeau.

As part of the biological based studies and in addition to the fisheries information obtained during annual operations (mostly in spring) at the Conowingo WFL, the seasonal occurrence, distribution, and relative abundance of young-of-the-year (YOY), juvenile and adult fishes below Conowingo Dam were characterized from extensive electrofishing and gill net collections at three primary locations: the Conowingo tailrace, the non-tidal riverine area (Lee's Ferry and The Pool) and the tidal zone (Figure 6.1-1). These collections also provided specimens for concurrent studies to determine fish food habits and age/growth analysis. Reproduction of fishes below Conowingo Dam was investigated by spring ichthyoplankton collections.

The combination of various gears analyzed in conjunction with the fish lift catches were complimentary for characterizing species composition and abundance, size and trophic structures and reproductive success in the fish assemblage in thoroughly examining the habiats below Conowingo. Each collection method and associated gear type has a finite efficacy in sampling targeted stratas of habitat and corresponding assembladges of fish. The success of the gear is affected by the working physical conditions found in the habitats targeted during sampling. Physical conditions are variable due to dynamic factors (e.g., temperature, flow, turbidity, dissolved oxygen, conductivity and are influenced by seasonality, climate conditions, hydro operations and other anthrogenic and natural factors.

6.1 Icthyoplankton Sample Methods

From 1982 to 1984 ichthyoplankton sampling was generally performed from late March to late June to characterize the use of the lower Susquehanna River by resident and anadromous fishes as a spawning and nursery area. In 1982 eight regular sampling transects or locations were established for the study;

three in the tidal area below Spencer Island and five in the riverine area above Robert Island (Figure 6.1-2). In addition to samples at these river stations, surface tows were made in Deer and Octoraro Creeks near their confluences with the Susquehanna.

The sampling was conducted weekly at all transect stations, but during the suspected peak of spawning, samples were generally collected twice per week at each station. Samples were collected with 0.5 m plankton net (0.5 mm mesh). Nets were towed for five minutes heading upstream at speeds sufficient to maintain the net no more than one foot below the surface. Bottom samples were collected at the mid-channel stations on the three lowermost transects in 1982 and 1983 and at the two lowermost transects in 1984. The surface and bottom tows collected a sample of pelagic eggs and larvae suspended in the water column; demersal and adhesive eggs were collected by the sampling gear type less effectively.

In 1983, 33 additional samples were collected near Spencer Island targeting American shad, supplemented by 21 additional collections taken at other areas in tidal water where telemetered American shad frequented or were observed spawning.

Water volume filtered was measured with a General Oceanics (model 2030) digital flowmeter mounted in the center of each net mouth. The volume (m^3) of water filtered in each tow was calculated by the formula:

$$V = n\,(f/100)\,A$$

Where "V" was the volume of water filtered, "n" was the number of flowmeter revolutions, "f" was the factor for converting counts/sec to velocity (cm/sec); divided by 100 to convert cm/sec to m/sec, and "A" was the cross sectional area of the net mouth (0.196349 m^2).

Field samples were immediately preserved in 20 to 25% formalin, rinsed in the laboratory, stained with rose bengal (to facilitate sorting), sorted, and stored in vials in 5% buffered formalin until identification. Specimens were examined under a stereoscopic dissecting microscope, identified to the lowest taxon, and enumerated.

Specimens were classified as eggs, larvae (prolarvae or postlarvae), or young. Damaged specimens too distorted to identify were tabulated as unidentifiable. Larvae of the genus Alosa, particularly Alosa aestivalis (blueback herring) and Alosa pseudoharengus (alewife) were indistinguishable to species and were termed (for the purposes of reporting) Alosa spp. The larval stage was defined as the early development after hatching during which the yolk sac and larval finfold were absorbed, and the fin rays were formed. The larval stage was subdivided into prolarvae and postlarvae. Prolarvae were those specimens that had not completely absorbed their yolk sac. Postlarvae had absorbed the yolk sac but not completely differentiated to their adult form. Young were fully transformed larvae, characterized by complete absorption of the larval finfold and attainment of the adult compliment of rays and spines in all fins.

6.2 Electrofishing Sample Methods

Electrofishing surveys were conducted at least monthly (meteorological and hydrological conditions permitting) from 1981 to 1987 at multiple stations in three general areas below Conowingo Dam: the Conowingo tailrace, the riverine area (Lee's Ferry and The Pool) and the tidal zone (Figure 6.1-1). Flow conditions sampled included periods of interim minimum flow (*i.e.*, summer) and zero generation (other months) at Conowingo Dam. These sampling areas all shared the characteristic of retaining deep water (at least 6.5 ft in some locations) even after 8 hours or more of reduced generation. Stations in these areas were selected so that sampling at night at reduced generation (<5,000 cfs) was feasible. In 1987 electrofishing was conducted below Conowingo Dam only in the tailrace and tidal zone. Fish were sampled at night with a boat-mounted electrofisher, oriented upstream, with pulsed DC current at 5-6 amps. Water temperature and dissolved oxygen (DO) were recorded at each location sampled.

Some of the factors commonly associated with parameterizing the limitations of electrofishing catch include: range of efficacy (distance at which fish are affected), water depth (difficulty capturing immobilized fish at depths beyond 0.9 - 1.2 m) due to visibility and length of dipnet handle, size of investigator, water quality (best response depends on the species and water temperature, conductivity, etc.), and selectivity for species and size related swimming ability (Klemm et al. 1993).

Substrate and cover varied somewhat among the sampling locations. Tailrace stations had a rubble substrate punctuated with various size boulders, whereas tidal zone stations had primarily rubble substrate with frequent boulders and occasional stretches of sand or silt. Patches of dense submerged aquatic vegetation (primarily *Myriophyllum*) were present along most tidal zone stations. In the tailrace and tidal zone, all stations were bordered by an island or main channel shoreline. Stations in Lee's Ferry and The Pool were characterized by rubble and boulder substrate, a lack of vegetation, and interspersed areas of shallow runs, riffles, and pockets behind boulders. These stations were located along the "boundaries" of each pooled location.

Each station was sampled for approximately 30 minutes in a continuous run. Generally, the same four or five stations in each area were sampled each night. During a run, most stunned fishes were retrieved and placed in a flow-through live well. The numbers of carp and eels were visually estimated. At the completion of a run, all captured fishes were identified, counted, measured, and released. A representative length frequency (10 mm FL groups) was obtained for those species most abundant in an area. Selected specimens were utilized for various life history studies, which included age and growth, food habits and movement (conventional anchor tags and radio telemetry). The raw data were adjusted for fishing effort to facilitate comparison or relative abundance among areas and months. CPUE data are expressed as number of specimens captured (or observed, in the case of carp and eels) per hour shocked.

6.3 Gill Net Sample Methods

Gill netting was conducted monthly from July through November in 1981 to 1984 and in the same general areas sampled by electrofishing. The experimental monofilament gill nets used were 125 ft long, 6 ft deep, and consisted of five 25 ft panels increasing in mesh size from 0.5 inch to 2.5 inch at 0.5 inch intervals. Generally, the size of the mesh determines the species and size of the fish to be caught in the gill net. Varying mesh sizes are used to increase the potential of obtaining samples of several year classes of a single species while also providing a greater potential to increase the number of species caught (Klemm et al. 1993). Conditions permitting, two to three nets were fished perpendicular to shore, usually from sunset to sunrise (average fishing time was 12 to 13 hours per set). Water temperature and DO were recorded at each location at the time nets were set and retrieved.

Gill nets were set in three general areas below Conowingo Dam: the Conowingo tailrace, the riverine area (Lee's Ferry and The Pool) and the tidal zone (Figure 6.1-1), to determine spatial and temporal differences in relative abundance of fishes. Substrate at all sampling sites consisted of gravel, rocks, and boulders. Water depth at net sites never exceeded eight ft (2.44 m) during a fishing period. Captured fishes were identified, enumerated and measured, and selected fishes were processed for age/growth and food habitats analysis.

Relative abundance of fishes was determined by the number of each species, the percent composition and the catch per unit effort (no. fish/net-night, CPUE = no. fish captured/no. nets set). Abundance indices were considered by month and location. Mean lengths of the five most abundant species were analyzed for each location by combined monthly collections. Length ranges for each location were determined for combined monthly collections only.

6.4 Icthyoplankton Results

From 1982 to 1984 275,710 eggs, prolarvae or postlarvae from 27 taxa were collected from 1,322 icthyoplankton samples (Table 6.4-1). The most frequently collected species was white perch, constituting 72% of all icthyoplankton collected. River herring (alewife and blueback herring) comprised an additional 24% of the icthyoplankton collected (Table 6.4-1). Gizzard shad comprised 3% of the ichthyoplankton collected (Table 6.4-1). Other less commonly collected species included American shad and carp; these along with all other species accounted for less than 1% of the specimens collected (Table 6.4-1).

During each year eggs were the most abundant life stage collected, comprising 81%, 84% and 90% of the total, respectively (Tables 6.4-2, 6.4-3, and 6.4-4). Prolarvae and postlarvae were the second and third most frequently collected life stages while older icthyoplankters were relatively scarce. In 1982 prolarvae and postlarvae were collected in near equal amounts while in 1983 and 1984 more prolarvae was collected than postlarvae.

The numerical peak of ichthyoplankton collections generally occurred in mid May through early June (Figure 6.4-1). The overall number of icthyoplankton were strongly related to the large numbers of white perch eggs and river herring eggs collected during this period. For example, in 1984 eggs represented 91% of the 61,589 white perch specimens collected (Table 6.4-5) and 95% of the 26,677 river herring specimens collected (Table 6.4-6).

6.4.1 Alosa spp.

From 1982 to 1984, highest egg densities of river herrings occurred from late April to early June when river temperatures ranged from 45 to 80°F (RMC 1985b), indicating earlier spawning compared to other species. Egg densities were highest at sites near Conowingo Dam (Table 6.4-6). The increased abundance of prolarvae at stations further downstream suggested that recently hatched *Alosa* spp. were quickly transported downstream and/or *Alosa* spp. eggs hatch in the tidal area. The near absence of postlarvae and young suggests either most development takes place downstream of the study area in the Susquehanna Flats or upper Chesapeake Bay, or the rate of larval mortality is extremely high.

In 1983 *Alosa* spp. were collected throughout the study area from 22 April through 26 June (Appendix C-1) at water temperatures of 45 to 80°F (RMC 1985b). The peak density occurred on 25 May at 66°F (Appendix C-1, RMC 1985b). Mean density by station was highest in the tailrace near Conowingo Dam with a secondary peak at the old bridge piers near the head of tide (Table 6.4-6).

In 1984 *Alosa* spp. were collected from 17 April through 28 June. Eggs were first collected on 17 April (Appendix C-1) at 47°F (RMC 1985c). Peak abundance occurred on 15 May (Appendix C-2). *Alosa* spp. were most abundant in the upper riverine, non-tidal reach, particularly in the tailrace (Table 6.4-6). As in 1982 and 1983, stations within the tidal area in 1984 had higher numbers of prolarvae and postlarvae than those stations located further upstream (Table 6.4-6).

6.4.2 American shad

In 1982 only 7 American shad eggs were collected (Table 6.4-2) and the highest density occurred at the end of May (RMC 1985a). In 1983 a total of 138 American shad eggs were collected at regular sampling stations (Table 6.4-3); nearly all were collected below the tide line. A single prolarvae was collected at the mouth of Deer Creek on 5 May at 60°F.

Thirty three additional samples were collected near Spencer Island in 1983 yielding 145 additional eggs from 15 May through 20 June (Appendix C-3). RMC 1985b reported that densities ranged from 0 to 0.3 eggs/m^3 and were taken from 25 to 27 May and 19 to 20 June. Generally, egg densities were lower in May and increased in early June, remaining above 0.1 eggs/m^3 through 12 to 13 June. The highest densities (0.3 eggs/m^3·) occurred on 5 to 6 June. Water temperature ranged from 59 to 73°F when eggs were collected and was near 66 °F at the time of peak egg density. Samples were taken at station depths ranging from 2 to 6 ft depending upon tidal stage and/or river flow. Although American shad were observed spawning in the immediate vicinity of Spencer Island, no telemetered shad were located at the time samples were collected.

Also in spring 1983, a total of 21 collections was taken at other areas where telemetered American shad frequented or were observed spawning (Appendix C-4). RMC 1985b reported that eggs were taken from 20 May through 5 June. A total of 533 eggs was collected and densities ranged from 0 to 2.8 eggs/m^3. Higher egg densities (>0.5 eggs/m^3) were estimated on 20 to 21 May, 1 to 2 June and 5 to 6 June. Water temperature ranged from 61 to 66°F. Eggs were taken at station water depths of 3 to 13 ft; the highest egg densities (>0.5 eggs/m^3) were observed where water depths ranged from 3 to 4 ft. Surface water velocities in areas of intense spawning activity ranged from 0.7 to 2.4 ft/s. Bottom substrate was primarily gravel and cobble. High egg densities and observed spawning activity indicated that a primary shad spawning area was along the east and west shores of Spencer Island.

In 1984, 48 night collections on 15, 17, and 22 May and 5 June yielded 179 eggs (Table 6.4-4). RMC 1985c reported that a majority of eggs were collected on 5 June (170 eggs, Appendix C-2) and water temperature averaged 52°F on this date (RMC 1985c). Samples were taken at station depths of 6 to 12 ft depending upon tidal stage and/or river flow. Most eggs (91 eggs) were collected at Station 7009 (along the west shore of the Susquehanna River near Lapidum boat launch) (RMC 1985c).

6.4.3 Gizzard shad

From 1982 to 1984, the greater abundance of gizzard shad postlarvae relative to prolarvae and comparatively few eggs (Tables 6.4-2, 6.4-3, 6.4-4) suggested most successful spawning occurred upstream of the study area.

In 1982 there were two periods of higher gizzard shad egg density. The first occurred in late May when the river temperature was 70°F. A second peak occurred late in June at river temperatures of 70 to 77° F (RMC 1985a). The total density of gizzard shad in 1982 was 0.19 eggs, prolarvae and postlarvae/m^3 (Table 6.4-2). The greater density of postlarvae compared to prolarvae (0.15 postlarvae/m^3 to 0.01 prolarvae/m^3, Table 6.4-2) suggested that most spawning occurred upstream of the dam.

In 1983 gizzard shad eggs were absent (Table 6.4-3), indicating little spawning occurred below Conowingo Dam. Gizzard shad prolarvae and postlarvae were first taken on 17 May when water temperature averaged 64.2°F (RMC 1985b). Highest density of prolarvae occurred on 30 May at 66°F (RMC 1985b). All prolarval gizzard shad collected in 1983 had already attained the one to three day old stage of development (Jones et al. 1978), indicating their source was outside the study area. Peak density of postlarvae occurred on 10 June at 71.6°F (RMC 1985b). As in 1982, the overall abundance of postlarvae relative to prolarvae (0.13 postlarvae/m^3 to 0.04 prolarvae/m^3, Table 6.4-3) and the decline in larval density with distance downstream from Conowingo Dam suggested most successful spawning occurred upstream of the study area.

In 1984, gizzard shad eggs were again nearly absent (Table 6.4-4). Gizzard shad prolarvae were first taken on 17 April; the water temperature averaged 50.9°F. The highest combined egg, prolarvae and postlarvae density occurred on 20 June at 74.4°F (RMC 1985c). All prolarval gizzard shad taken in 1984 had attained the one to three day old stage of development (Jones et al. 1978), indicating their source was outside the study area. Peak density of postlarvae occurred on 10 June at 71.6°F (RMC 1985c).

6.4.4 White Perch

White perch was the most frequently caught species in each sample year. In 1982 spawning activity for white perch was extensive, as indicated by relatively high egg density (1.0 eggs/m^3,Table 6.4-2). High egg and prolarval densities were recorded from late April through the end of May when the river temperatures ranged from 54 to 79°F (RMC 1985a).

In 1983, white perch was the most abundant ichthyoplankton taxa and accounted for 80% of the eggs and 75% of the prolarvae collected (Table 6.4-3). Eggs were first collected on 5 April at 47°F (RMC 1985b).

Peak spawning activity and egg density occurred on 21 May (168.7 eggs and prolarvae/m^3) at 63°F (RMC 1985b). Highest daily abundance of prolarvae occurred on 24 May (3.9 prolarvae/m^3). White perch eggs are highly demersal and adhesive and, therefore, were much more abundant in bottom collections. Egg density at the three tidal Stations combined was 0.4 eggs/m^3 on the surface compared to 2.2 eggs/m^3 on the bottom (RMC 1985b). Greatest spawning activity occurred near the tide line. Egg densities were greatest near Wood Island, followed by stations immediately downstream near Lapidum. Some spawning occurred throughout the non-tidal riverine area, but densities of eggs and prolarvae at the three Stations in and just below the Conowingo tailrace were lower (RMC 1985b).

In 1984, white perch accounted for 68% of the eggs and 90% of the prolarvae collected (Table 6.4-4). Eggs were first collected on 12 April at 47°F (RMC 1985c). Peak spawning activity and egg density occurred on 22 May at 62.9°F (RMC 1985c). The greatest spawning activity occurred in the upper tidal area as indicated by the large amount of eggs collected (Table 6.4-5). Egg densities were greatest near Wood Island followed by stations just above Deer Creek off of Lapidum. Similar to 1983, less spawning occurred further upstream throughout the non-tidal, riverine area as evidenced by the lower numbers of eggs and prolarvae.

6.4.5 Other Fishes

Eggs, prolarvae and postlarvae of other fishes generally accounted for 1% or less of the total catch. Collections of the early lifestages of carp, yellow perch, walleye, bluegill, pumpkinseed, white crappie, smallmouth bass and largemouth bass were relatively low (Appendix C-1 & C-2). All of these species have demersal, adhesive or both adhesive and demersal egg types that are not as effectively collected by the gear. No redbreast sunfish were collected, a species which commonly occurs as a resident. No striped bass were collected despite a nomadic presence in the sample area. It’s unlikely that any striped bass spawning occurs downstream of Conowingo Dam to the tidal zone. Striped bass eggs are buoyant, pelagic and remain suspended in the water column increasing the likelihood of being recruited to the gear if present. Very few hickory shad (*Alosa mediocris*) were collected in 1984, mostly in early May.

6.5 Electrofishing Results

Over the course of the 1982 to 1987 electrofishing series, 247 hours (Table 6.5-1) of effort were spent sampling the Conowingo tailrace, Lee’s Ferry, The Pool and tidal zone areas. A collection was completed in every month of the year except February. More effort was allocated to the tidal zone (93 hr) and Conowingo tailrace (92 hr) than The Pool (31 hr) and Lee’s Ferry (30.5 hr, Table 6.5-1). Overall, the most effort was expended during the months of July (43 hr), August (49 hr) and September (40 hr, Table 6.5-2).

A total of 235,458 fish of 66 taxa (Table 6.5-3) were collected in the lower Susquehanna River electrofishing program from May 1982 to October 1987. Overall, the rate of collection (CPUE) from 1982 to 1987 was 953 fish/hr (Table 6.5-3). Yearly CPUE ranged from 487 fish/hr in 1986 to 2,295 fish/hr in 1985 (Table 6.5-4). Correspondingly, the most fish were collected in 1985 (89,633 fish) and the least in 1986 (24,653 fish, Table 6.5-5).

The Conowingo tailrace had the highest overall CPUEs of the four locations from 1982 to 1984 and in 1987; the tidal zone had the highest CPUEs in 1985 and 1986 (Table 6.5-4). From 1982 to 1987 the tidal zone had the highest combined overall CPUE at 1,170 fish/hr, followed by the Conowingo tailrace (1,042 fish/hr), Lee's Ferry (533 fish/hr) and The Pool (454 fish/hr, Table 6.5-5).

The highest monthly rate of collection occurred in November 1985 in the tidal zone, at a CPUE of 32,868 fish/hr (Table 6.5-6); this is the equivalent of collecting nine fish per second. Masses of juvenile gizzard shad were responsible for the high CPUE. Overall, May and November had the highest average CPUEs across all locations and years at 1,432 fish/hr and 4,418 fish/hr, respectively (Table 6.5-6).

In the Conowingo tailrace electrofishing samples occurred from May through December 1982, January and May through November in 1983, January, March and June through December in 1984, June through December in 1985, March through December in 1986, and July through October in 1987 (Appendix D-1). In the Conowingo tailrace, the September 1987 rate of collection for gizzard shad was the highest of any species (9,425 fish/hr, Appendix D-2) 1982 to 1987. Gizzard shad was the most frequently caught species in the Conowingo tailrace every year except 1982 when carp was the most frequently collected species (222 fish/hr, Table 6.5-7). The other frequently collected species in the Conowingo tailrace 1982 to 1987 included American eel, white perch, bluegill, channel catfish, yellow perch, pumpkinseed, smallmouth bass, striped bass, redbreast sunfish and green sunfish (Table 6.5-7).

Species assemblage and proportional abundance based on rates of collection in the Conowingo tailrace varied seasonally. Thirteen different species accounted for 68% to 92% of the overall CPUE in each month from 1982 to 1987 (Table 6.5-8). Gizzard shad dominated the catch from September through December and were relatively high in proportion in April through June. Comely shiners were relatively abundant in both December and March collections. Carp were most prevalent in spring, and accounted for more than 50% of the May CPUE across all years (Table 6.5-8); a significant collection of carp in May 1982 yielded 3,291 fish/hr (Appendix D-2). A relatively high rate of collection for American eel was maintained throughout all months of sampling. American eel had the highest rates of collection in January, March, July and August across all years. White perch were also relatively abundant May through October.

At Lee's Ferry electrofishing samples occurred from July to September 1982 to 1985 and from June to September in 1986 (Appendix D-1). White perch was the most frequently collected fish in all years ranging from an overall catch rate of 43 fish/hr in 1983 to 358 fish/hr in 1984 (Table 6.5-9). The highest monthly catch rate for white perch among all years (430 fish/hr) occurred in July 1984 (Appendix D-2). Other species frequently collected 1982 to 1987 included American eel, channel catfish, carp, gizzard shad, shorthead redhorse and yellow perch (Table 6.5-9).

Proportional abundance based on rates of collection for electrofishing samples in Lee's Ferry during the summer months had very little month to month variability. In every month June through September across all years, white perch was the dominant species, comprising nearly 50% of the catch for each month (Table 6.5-10). American eel was the second most frequently collected fish June through September ranging from 28% in June to 23% of the overall CPUE in August (Table 6.5-10). Channel catfish were third in proportional abundance, followed by carp throughout the summer months (Table 6.5-10).

At The Pool, electrofishing samples occurred from July to September 1982 to 1985 and June to September in 1986 (Appendix D-1). White perch was the most frequently collected fish in all years ranging from 176 fish/hr in 1982 to 256 fish/hr in 1983 (Table 6.5-11). The highest monthly catch rate in The Pool of any species across all years occurred in July 1983 (white perch; 345 fish/hr, Appendix D-2); 1983 also had the highest catch rate for all species amongst all years at The Pool (535 fish/hr, Table 6.5-4). Other species frequently collected at The Pool included American eel, channel catfish, carp and shorthead redhorse (Table 6.5-11).

Proportional abundance based on rates of collection for electrofishing samples remained consistent throughout the summer months in The Pool. White perch was the dominant species each month over all years, ranging from 42% of the monthly overall CPUE in September to 51% of the monthly overall CPUE in June (Table 6.5-12). American eel was the second most proportionally abundant species, ranging from 25% of collections in June to 37% in September (Table 6.5-12). Channel catfish was third in proportional abundance for each month followed by carp and shorthead redhorse (Table 6.5-12).

At the tidal zone, electrofishing samples occurred May through December in 1982 and 1986, January and May through November in 1983, January and March and June through December in 1984, June through

December in 1985 and July, August and October 1987 (Appendix D-1). The most frequently collected species varied more from year to year than the other survey areas. White perch was the most frequently collected species in 1982 (82 fish/hr, Table 6.5-13). Gizzard shad were the most frequently collected species in 1983 (84 fish/hr) and 1985 (4,706 fish/hr, Table 6.5-13). In November 1985, an unusually large number of gizzard shad were observed (32,500 fish/hr), the highest amount of fish at any station in any month across all years (Appendix D-2). Yellow perch was the most frequently collected species in 1984 (71 fish/hr). Redbreast sunfish were the most frequently collected species in 1986 (84 fish/hr) and 1987 (90 fish/hr, Table 6.5-13). Other species common in the tidal zone included American eel, carp, pumpkinseed, bluegill, channel catfish, smallmouth bass, white sucker, spottail shiner and comely shiner (Table 6.5-13).

Proportional abundance based on rates of collection varied seasonally in the tidal zone. Catches in January 1983 and 1984 and March 1984 were dominated by American eel, gizzard shad, comely shiner, green sunfish, yellow perch and pumpkinseed (Table 6.5-14). These species accounted for 88% of the combined CPUE during both these winter months. Comely shiner was collected more frequently in the winter months and represented 69% of the total CPUE in March of 1984 (Table 6.5-14). December was dominated by many of the same species as in January, though with fewer American eel and more spottail shiner (Table 6.5-14). The late spring through early fall months (May through October) were dominated by catches of white perch, yellow perch, redbreast sunfish, and American eel. These species combined constituted at least 55% of the CPUE in these months (Table 6.5-14). The late fall catch was dominated by gizzard shad, which constituted 95% of the collections in November (Table 6.5-14).

6.6 Gill Net Results

A total of 4,054 fish of 28 taxa was collected from 118 gill net sets in the Conowingo tailrace, Lee's Ferry, The Pool and the tidal zone from 1982 to 1984 (Table 6.6-1). Effort in 1982 was 48 net-nights and yielded 1,298 fish of 21 different taxa (Table 6.6-1). A total effort of 45 net-nights occurred in 1983; 1,563 fish of at least eight different taxa were collected (Table 6.6-1). A total of 25 net-nights in 1984 yielded 1,193 fish of 25 different taxa (Table 6.6-1). Because of high river flows in 1984 only one collection was made in The Pool, thus 1984 data from this location was excluded from the analysis.

Channel catfish was the most frequently collected species in gill nets during 1982 to 1984. A total of 1,691 channel catfish were collected overall at a rate of 14 fish/net-night (Table 6.6-1). White perch (8 fish/net-night) and gizzard shad (8 fish/net-night) were more commonly collected than other species in all areas across all years (Table 6.6-1).

The overall total catch from 1982 to 1984 in the Conowingo tailrace was 2,592 fish, collected at a rate of 96 fish/net-night (Table 6.6-2). Both the tailrace total catch and collection rate were the highest of the four locations. The largest catch occurred in 1983 (934 fish) whereas 1982 yielded the highest catch rate (105 fish/net-night, Table 6.6-2). Channel catfish were the most frequently caught species in the tailrace during 1982 to 1984. The overall CPUE was 43 fish/net-night and channel catfish comprised 44% of the fish collected (Table 6.6-2). Species composition in the tailrace was very similar from 1982 to 1984; besides channel catfish, gizzard shad (23 fish/net-night), white perch (20 fish/net-night), striped bass (3 fish/net-night), hybrid striped bass (3 fish/net-night) and carp (2 fish/net-night) were caught most frequently (Table 6.6-2).

The overall catch from 1982 to 1984 at Lee's Ferry totaled 617 fish, collected at a rate of 22 fish/net-night (Table 6.6-3). The most fish were caught in 1983 (253 fish) whereas 1984 yielded the highest rate of collection (25 fish/net-night, Table 6.6-3). Overall, from 1982 to 1984 channel catfish was the most commonly collected species at Lee's Ferry. Channel catfish were collected at a rate of 9 fish/net-night and comprised 39% of the fish assemblage collected across all years (Table 6.6-3). White perch was the most frequently collected species in 1983 and 1984. CPUE was 8 fish/net-night and 10 fish/net-night comprising 38% and 40% of the fish collected in those years, respectively (Table 6.6-3). Shorthead redhorse (2 fish/net-night), gizzard shad (2 fish/net-night), and carp (1 fish/net-night) were also frequently collected species at Lee's Ferry (Table 6.6-3).

Sampling at The Pool was limited to only 1982 and 1983 due to higher than average natural river flows in 1984. Overall, 258 fish were collected at Lee's Ferry during the two years at a CPUE of 10 fish/net-night (Table 6.6-4). The highest number of fish was collected in 1982 (186 fish) at an overall rate of 14 fish/net-night (Table 6.6-4). Channel catfish was the most frequently collected species in both 1982 and 1983. They comprised 48% of the fish assemblage and were collected at a rate of 5 fish/net-night across both years (Table 6.6-4). White perch (3 fish/net-night), shorthead redhorse (1 fish/net-night) and gizzard shad (1 fish/net-night) were also frequently collected species in The Pool. (Table 6.6-4)

The overall total catch from 1982 to 1984 at tidal zone stations was 587 fish, collected at a CPUE of 15 fish/net-night (Table 6.6-5). The largest collection occurred in 1983 (304 fish) at a rate of 25 fish/net-night (Table 6.6-5). Overall, gizzard shad were the most frequently collected species (5 fish/net-night) from 1982 to 1984 at the tidal zone and comprised 33% of the fish assemblage (Table 6.6-5). In 1984, channel catfish was the most frequently collected species (11 fish/net-night) and comprised 45% of the fish assemblage for that year (Table 6.6-5). Only 32 fish were collected in the tidal zone in 1982; white perch (<1 fish/net-night) and spottail shiner (<1 fish/net-night) were the most frequently collected species (Table 6.6-5).

Seasonal variability existed among several of the common species caught by gill nets. White perch exhibited several seasonal trends based on CPUEs from 1982 to 1984. At the Conowingo tailrace white perch catches were higher in July and August than in other months, averaging 45 fish/net-night and 27 fish/net-night respectively (Table 6.6-6). At Lee's Ferry white perch CPUE's were significantly higher in September, averaging 13 fish/net-night (Table 6.6-6). There was no discernable monthly trend in white perch CPUE in the tidal zone amongst the years sampled (Table 6.6-6).

The monthly CPUE for gizzard shad was variable, but the highest CPUEs consistently occurred in September and October. CPUEs from the tailrace in 1982 and 1984 averaged 42 fish/net-night in October (Table 6.6-7). At Lee's Ferry the average catch was higher in September (5 fish/net-night) than in other months (Table 6.6-7), but overall was lower than in the other locations. The highest CPUE for gizzard shad in the tidal zone occurred in October (22 fish/net-night,Table 6.6-7). Catches of gizzard shad consistently increased in the late summer and early fall at each location downstream of the Conowingo Dam.

In contrast, the monthly CPUE of channel catfish was variable at the different locations, with no discernable trend in catch from month to month at the tailrace, Lee's Ferry, or the tidal zone (Table 6.6-8). Similarly, the monthly CPUE of striped bass was low and variable at each of the sampling areas. There was no discernable monthly trend in catch at the tailrace, Lee's Ferry or the tidal zone (Table 6.6-9)

TABLE 6.4-1: TOTAL NUMBER ICHTHYOPLANKTON COLLECTED BY 0.5M PLANKTON NETS LOWER SUSQUEHANNA RIVER 1982 TO 1984

Species	1982	1983	1984		
No. Taxa	18	20	22		
No. Samples	405	446	471	Total 1322	% of Total
American shad	7	138	179	324	<1%
River herrings	11,772	26,827	26,677	65,276	24%
White perch	23,270	112,249	61,589	197,108	72%
Carp	371	307	118	796	<1%
Gizzard shad	3,911	3,464	1,886	9,261	3%
Other	1,040	1,099	806	2,945	1%
TOTAL	40,371	144,084	91,255	275,710	

TABLE 6.4-2: SUMMARY OF ICHTHYOPLANKTON DENSITIES (N/M3) COLLECTED BY 0.5M PLANKTON NETS LOWER SUSQUHANNA RIVER, APRIL THROUGH JUNE 1982.

Species	Eggs	Pro larvae	Post larvae	Older	Total Density	Total Number
American shad	0.00	0.00	0.00	0.00	0.00	7
Blueback herring	0.01	0.00	0.00	0.00	0.01	197
River herrings	0.52	0.04	0.02	0.00	0.58	11,772
White perch	1.03	0.11	0.00	0.00	1.14	23,270
Carp	0.01	0.00	0.00	0.00	0.02	371
Gizzard shad	0.03	0.01	0.15	0.00	0.19	3,911
Other	0.01	0.02	0.01	0.00	0.04	843
TOTAL	1.60	0.19	0.18	0.00	1.97	40,371
% Composition	81.%	10%	9%	<1%		

TABLE 6.4-3:SUMMARY OF ICHTHYOPLANKTON DENSITIES (N/M3) COLLECTED BY 0.5M PLANKTON NETS LOWER SUSQUEHANNA RIVER, 30 MARCH THROUGH 28 JUNE 1983.

Species	Eggs	Pro larvae	Post larvae	Older	Total Density	Total Number
American shad	0.01	0.00	0.00	0.00	0.01	138
River herrings	1.13	0.17	0.00	0.00	1.30	26,827
Gizzard shad	0.00	0.04	0.13	0.00	0.17	3,464
Carp	0.01	0.00	0.00	0.00	0.01	307
White perch	4.65	0.69	0.00	0.00	5.34	112,249
Other	0.02	0.02	0.01	0.00	0.05	1,099
TOTAL	5.82	0.92	0.14	0.00	6.88	144,084
% Composition	84%	13%	2%	0%		

TABLE 6.4-4: SUMMARY OF ICHTHYOPLANKTON DENSITIES (N/M3) COLLECTED BY 0.5M PLANKTON NETS LOWER SUSQUEHANNA RIVER, 3 APRIL THROUGH 28 JUNE 1984.

Species	Eggs	Pro larvae	Post larvae	Older	Total Density	Total Number
American shad	0.01	0.00	0.00	0.00	0.01	179
River herrings	0.85	0.04	0.01	0.00	0.90	26,677
White perch	1.89	0.18	0.00	0.00	2.07	61,589
Carp	0.00	0.00	0.00	0.00	0.00	118
Gizzard shad	0.00	0.01	0.06	0.00	0.06	1,886
Other	0.01	0.01	0.00	0.00	0.03	806
TOTAL	2.76	0.24	0.07	0.00	3.074	91,255
% Composition	90%	8%	2%	0%		

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TABLE 6.4-5: MONTHLY SUMMARY OF WHITE PERCH (EGGS, PROLARVAE AND POSTLARVAE) BY AREA APRIL THROUGH JUNE 1984.

	April			May			June			Total		
	Egg	Pro larvae	Post larvae	Egg	Pro larvae	Post larvae	Egg	Pro larvae	Post larvae	Egg	Pro larvae	Post larvae
Upper river	64			346	2		892	4		1,302	6	
Lower river	286			4,240	54		3,024	29	1	7,550	83	1
Upper tidal	5,657	448		24,650	2,486		14,260	1,029	4	44,567	3,963	4
Lower tidal	59	284		467	537		49	426	1	775	1,247	1
Creeks	157			1,732	14		166	21		2,055	5	
TOTAL	6,223	731		31,435	3,093		18,591	1,509	6	56,249	5,334	6

TABLE 6.4-6: MONTHLY SUMMARY OF ALOSA SPP. (EGGS, PROLARVAE AND POSTLARVAE) BY AREA APRIL THROUGH JUNE 1984.

	April			May			June			Total		
	Egg	Pro larvae	Post larvae	Egg	Pro larvae	Post larvae	Egg	Pro larvae	Post larvae	Egg	Pro larvae	Post larvae
Upper river	383			9,443	46		1,743	9		11,569	55	
Lower river	584	1		5,913	37	4	296	5		6,793	43	4
Upper tidal	344	4		5,884	443		388	290	4	6,616	737	4
Lower tidal		1		22	281		3	39	229	25	321	229
Creeks	16	16		158	44		40	7		214	67	
TOTAL	1,327	22		21,420	851	4	2,470	350	233	25,217	1,223	237

TABLE 6.4.3-1: MONTHLY SUMMARY OF GIZZARD SHAD (EGGS, PROLARVAE AND POSTLARVAE) BY AREA APRIL THROUGH JUNE 1984.

	April			May			June			Total		
	Egg	Pro larvae	Post larvae	Egg	Pro larvae	Post larvae	Egg	Pro larvae	Post larvae	Egg	Pro larvae	Post larvae
Upper river		1			20	2		15	476		36	478
Lower river		2			33	1		8	319		43	320
Upper tidal		2			33	1		18	440		53	441
Lower tidal		1			10			5	498		16	498
Creeks									1			1
TOTAL		6			96	4		46	1,734		148	1,738

TABLE 6.5-1:TOTAL NUMBER HOURS OF ELECTROFISHING LOWER SUSQUEHANNA RIVER: ALL LOCATIONS COMBINED 1982 – 1987

Conowingo Tailrace	Lees Ferry	The Pool	Tidal Zone	Total Hours Shocked
92.0	30.5	31.3	93.2	247.0

TABLE 6.5-2: MONTHLY TOTAL HOURS OF ELECTROFISHING LOWER SUSQUEHANNA RIVER: ALL LOCATIONS 1982 – 1987

	1982	1983	1984	1985	1986	1987	Total
January		3.6	3.0				6.5
March			3.2		1.7		4.9
April					1.9		1.9
May	2.1	2.8			3.9		8.8
June	3.5	4.0	3.9	8.0	8.3		27.7
July	7.8	8.3	8.0	7.9	8.0	4.0	43.9
August	12.3	8.5	8.3	7.9	8.3	4.0	49.2
September	9.6	8.5	8.4	3.5	8.3	2.2	40.4
October	8.7	4.5	4.5	4.0	4.0	3.8	29.5
November	3.9	4.0	4.4	4.0	3.1		19.4
December	3.9		3.9	3.8	3.3		14.9
Total	51.8	44.1	47.5	39.1	50.6	13.9	247.0

TABLE 6.5-3: ELECTROFISHING LOWER SUSQUEHANNA RIVER ANNUAL L HOURS OF EFFORT, TOTAL FISH AND CPUE (FISH/HR) 1982 - 1987

	1982	1983	1984	1985	1986	1987	Total
Total Hours Shocked	51.8	44.1	47.5	39.1	50.6	13.94	247.0
Total Fish	31,599	33,204	29,091	89,633	24,653	27,278	235,458
Total CPUE	611	753	612	2,295	487	1,957	953
# Taxa	52	42	51	42	54	35	66

TABLE 6.5-4: ELECTROFISHING LOWER SUSQUEHANNA RIVER OVERALL ANNUAL CPUE (FISH/HR) BY LOCATION 1982 - 1987

		Cono Tailrace	Lees Ferry	The Pool	Tidal Zone	All Areas
1982	Total	822	488	425	496	610
1983	Total	1,175	96	535	528	753
1984	Total	874	638	449	417	612
1985	Total	907	578	433	5,102	2,295
1986	Total	559	396	434	701	487
1987	Total	3,053			432	1,957

TABLE 6.5-5: ELECTROFISHING LOWER SUSQUEHANNA RIVER ANNUAL TOTAL FISH AND COMBINED OVERALL CPUE (FISH/HR) BY LOCATION 1982 - 1987

		Cono Tailrace	Lees Ferry	The Pool	Tidal Zone
1982	Total	16,147	2,563	2,547	10,342
1983	Total	17,018	3,578	3,212	9,396
1984	Total	14,841	3,805	2,694	7,751
1985	Total	12,549	3,167	2,487	71,430
1986	Total	10,597	3,164	3,273	7,619
1987	Total	24,761			2,517
	Total Catch	95,913	16,277	14,213	109,055
	Total Hours	92.0	30.5	31.3	93.2
	Combined CPUE	1,042	533	454	1,170

TABLE 6.5-6: ELECTROFISHING LOWER SUSQUEHANNA RIVER MONTHLY CPUE BY AREA 1982-1987

	1982	1983	1984	1985	1986	1987	1982	1983
	Cono Tailrace	Cono Tailrace	Cono Tailrace	Cono Tailrace	Cono Tailrace	Cono Tailrace	Lees Ferry	Lees Ferry
January		199	187					
March			184		102			
April					803			
May	4,003	1,366			1,190			
June	650	1,054	1,490	1,075	524			
July	592	902	777	808	948	465	457	770
August	538	499	606	578	536	633	445	528
September	569	797	726	821	572	10,076	561	561
October	498	740	1,298	1,456	659	460		
November	571	3,806	2,187	1,313	399			
December	1,335		179	230	243			
Total	822	1,174	874	907	559	12,443	488	96

	1984	1985	1986	1987	1982	1983	1984	1985
	Lees Ferry	Lees Ferry	Lees Ferry	Lees Ferry	The Pool	The Pool	The Pool	The Pool
January								
March								
April								
May								
June		536	315					516
July	716	569	338		371	717	421	328
August	545	647	450		460	418	352	448
September	653		480		443	472	575	
October								
November								
December								
Total	638	578	396		425	535	449	433

Table 6.5-6: Cont.

	1986	1987	1982	1983	1984	1985	1986	1987	
	The Pool	The Pool	Tidal Zone	Tidal Zone	Tidal Zone	Tidal Zone	Tidal Zone	Tidal Zone	Average CPUEs All Areas
January				74	163				156
March					137				141
April									803
May			662	803			570		1,432
June	422		438	502	784	565	467		667
July	285		323	524	490	354	449	495	550
August	459		454	411	474	476	429	416	491
September	578		438	423	448	469	502		1,061
October			386	454	513	544	368	381	646
November			618	1,072	455	32,868	895		4,418
December			955		87	439	141		451
Total	434		496	528	417	5,102	701	432	1,315

TABLE 6.5-7: ELECTROFISHING CONOWINGO TAILRACE LOWER SUSQUEHANNA ANNUAL TOP TEN SPECIES, CPUES (FISH/HR)

1982			1983			1984		
	Species	CPUE		Species	CPUE		Species	CPUE
1	Carp	222	1	Gizzard Shad	473	1	Gizzard Shad	400
2	Gizzard Shad	148	2	American Eel	200	2	American Eel	143
3	American Eel	119	3	White Perch	89	3	White Perch	70
4	White Perch	59	4	Yellow Perch	78	4	Bluegill	41
5	Channel Catfish	41	5	Pumpkinseed	57	5	Yellow Perch	39
6	Pumpkinseed	40	6	Bluegill	57	6	Pumpkinseed	33
7	Bluegill	33	7	Channel Catfish	44	7	Carp	33
8	Smallmouth Bass	15	8	Striped Bass	31	8	Channel Catfish	32
9	Green Sunfish	14	9	Green Sunfish	27	9	Green Sunfish	14
10	Striped Bass	11	10	Carp	26	10	Smallmouth Bass	12
1985			**1986**			**1987**		
	Species	CPUE		Species	CPUE		Species	CPUE
1	Gizzard Shad	323	1	Gizzard Shad	106	1	Gizzard Shad	10,382
2	White Perch	142	2	American Eel	100	2	American Eel	734
3	American Eel	118	3	Yellow Perch	72	3	White Perch	345
4	Yellow Perch	98	4	White Perch	61	4	Yellow Perch	185
5	Channel Catfish	45	5	Channel Catfish	27	5	Bluegill	172
6	Bluegill	41	6	Carp	27	6	Striped Bass	131
7	Pumpkinseed	37	7	Redbreast Sunfish	26	7	Smallmouth Bass	88
8	Carp	27	8	Bluegill	26	8	Carp	84
9	Redbreast Sunfish	16	9	Smallmouth Bass	17	9	Channel Catfish	84
10	Striped Bass	12	10	Pumpkinseed	17	10	Redbreast Sunfish	66

TABLE 6.5-8: ELECTROFISHING LOWER SUSQUEHANNA MONTHLY PROPORTIONAL ABUNDANCE BASED ON CPUE (FISH/HR) 1982-1987 AT THE CONOWINGO TAILRACE

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Alewife				6%								
American Eel	30%		26%	15%	11%	13%	26%	22%	9%	15%	10%	11%
Bluegill							9%	10%	3%			
Carp	9%			12%	52%							
Channel Catfish			21%							6%	2%	9%
Comely Shiner			14%									4%
Gizzard Shad	22%			28%	9%	25%		10%	72%	38%	72%	51%
Pumpkinseed	6%		9%			7%	7%				2%	
Shad sp				7%								
Spottail Shiner	9%											
White Perch					8%	17%	21%	20%	5%	5%		
White Sucker			5%									
Yellow Perch					6%	9%	1%	8%	2%	10%	6%	7%

TABLE 6.5-9: ELECTROFISHING LEES FERRY LOWER SUSQUEHANNA ANNUAL TOP FIVE SPECIES, CPUES (FISH/HR)

1982			1983			1984		
	Species	CPUE		Species	CPUE		Species	CPUE
1	White Perch	241	1	White Perch	43	1	White Perch	358
2	American Eel	139	2	American Eel	26	2	American Eel	133
3	Channel Catfish	80	3	Channel Catfish	24	3	Channel Catfish	92
4	Yellow Perch	11	4	Gizzard Shad	1	4	Gizzard Shad	17
5	Carp	9	5	Carp	0.3	5	Carp	13

1985			1986		
	Species	CPUE		Species	CPUE
1	White Perch	309	1	White Perch	177
2	American Eel	166	2	American Eel	95
3	Channel Catfish	68	3	Channel Catfish	81
4	Shorthead Redhorse	9	4	Carp	14
5	Carp	8	5	Shorthead Redhorse	8

TABLE 6.5-10: ELECTROFISHING LOWER SUSQUEHANNA RIVER MONTHLY RELATIVE ABUNDANCE BASED ON CPUE (FISH/HR) 1982-1987 AT LEES FERRY

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
American Eel						28%	24%	23%	28%			
Carp						3%	2%	2%	2%			
Channel Catfish						11%	16%	18%	17%			
Gizzard Shad								2%	2%			
Shorthead Redhorse						2%	2%					
White Perch						52%	53%	52%	48%			

TABLE 6.5-11 ELECTROFISHING THE POOL LOWER SUSQUEHANNA ANNUAL TOP FIVE SPECIES, CPUES

1982			1983			1984		
	Species	CPUE		Species	CPUE		Species	CPUE
1	White Perch	176	1	White Perch	256	1	White Perch	177
2	American Eel	135	2	American Eel	158	2	American Eel	138
3	Channel Catfish	90	3	Channel Catfish	87	3	Channel Catfish	77
4	Carp	11	4	Shorthead Redhorse	9	4	Carp	25
5	Shorthead Redhorse	5	5	Carp	9	5	Shorthead Redhorse	8

1985			1986		
	Species	CPUE		Species	CPUE
1	White Perch	201	1	White Perch	192
2	American Eel	159	2	American Eel	128
3	Channel Catfish	43	3	Channel Catfish	68
4	Shorthead Redhorse	8	4	Carp	16
5	Carp	5	5	Shorthead Redhorse	9

TABLE 6.5-12: ELECTROFISHING LOWER SUSQUEHANNA RIVER MONTHLY RELATIVE ABUNDANCE BASED ON CPUE (FISH/HR) 1982-1987 AT THE POOL

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
American Eel						26%	28%	31%	38%			
Carp						2%	3%	3%	4%			
Channel Catfish						15%	19%	14%	12%			
Gizzard Shad								2%				
Shorthead Redhorse						2%	2%	1%	2%			
White Perch						51%	45%	46%	42%			

TABLE 6.5-13 ELECTROFISHING TIDAL ZONE LOWER SUSQUEHANNA ANNUAL TOP TEN SPECIES, CPUES

1982			1983			1984		
	Species	CPUE		Species	CPUE		Species	CPUE
1	White Perch	82	1	Gizzard Shad	84	1	Yellow Perch	71
2	Yellow Perch	85	2	Yellow Perch	80	2	Redbreast Sunfish	68
3	Redbreast Sunfish	67	3	American Eel	77	3	American Eel	58
4	American Eel	66	4	White Perch	66	4	White Perch	55
5	Gizzard Shad	62	5	Redbreast Sunfish	65	5	Pumpkinseed	26
6	Carp	38	6	Pumpkinseed	35	6	Gizzard Shad	25
7	Pumpkinseed	21	7	Carp	24	7	Carp	20
8	Channel Catfish	18	8	Bluegill	22	8	Channel Catfish	19
9	White Sucker	15	9	Channel Catfish	17	9	Bluegill	18
10	Smallmouth Bass	8	10	Smallmouth Bass	14	10	Smallmouth Bass	17
1985			**1986**			**1987**		
	Species	CPUE		Species	CPUE		Species	CPUE
1	Gizzard Shad	4,706	1	Redbreast Sunfish	84	1	Redbreast Sunfish	90
2	Yellow Perch	93	2	Yellow Perch	71	2	White Perch	85
3	White Perch	91	3	Gizzard Shad	66	3	Yellow Perch	68
4	Redbreast Sunfish	56	4	White Perch	66	4	American Eel	64
5	American Eel	45	5	American Eel	51	5	Pumpkinseed	31
6	Carp	24	6	Pumpkinseed	34	6	Brown Trout	19
7	Channel Catfish	17	7	Channel Catfish	19	7	Bluegill	17
8	Pumpkinseed	13	8	Bluegill	14	8	Channel Catfish	14
9	Spottail Shiner	12	9	Smallmouth Bass	12	9	Gizzard Shad	8
10	Bluegill	12	10	Carp	11	10	Smallmouth Bass	8

TABLE 6.5-14: ELECTROFISHING LOWER SUSQUEHANNA RIVER MONTHLY PROPORTIONAL ABUNDANCE BASED ON CPUE (FISH/HR) 1982-1987 AT THE TIDAL ZONE

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
American Eel		17%				8%	13%	18%	16%	18%	13%	0.4%	
Carp											8%		
Comely Shiner		15%		69%									6%
Gizzard Shad		37%										95%	52%
Green Sunfish				4%				6%					
Pumpkinseed		11%		3%				7%	7%	7%			6%
Redbreast Sunfish						14%	23%	20%	15%	15%	16%	1%	
Smallmouth Bass						4%	6%						
Spottail Shiner				5%									5%
White Perch						28%	15%	15%	25%	23%	10%	0.3%	
Yellow Perch		9%		7%		23%	16%	18%	11%	12%	16%	2%	17%

TABLE 6.6-1: GILL NETS LOWER SUSQUEHANNA RIVER ANNUAL TOTAL FISH, CPUE (FISH/NET-NIGHT) AND PROPORTIONAL ABUNDANCE 1982- 1984

	1982 Total			1983 Total			1984 Total[3]			1982-1984		
No. of Species	21			8 (minimum)[1]			25			28		
No. Nets Set	48			45			25			118		
	No.	CPUE[2]	%	No.	CPUE	%	#	CPUE	%	#	CPUE	%
Channel Catfish	714	15	55%	540	12	35%	437	17	37%	1,691	14	42%
White Perch	316	7	24%	361	8	23%	246	10	21%	923	8	23%
Gizzard shad	151	3	12%	452	10	29%	292	12	25%	895	8	22%
Shorthead Redhorse	42	1	3%	46	1	3%	20	1	5%	108	1	3%
Striped Bass	8	0.2	1%	71	2	5%	28	1	2%	107	1	3%
Carp	24	1	2%	25	1	2%	52	2	4%	101	1	2%
Hybrid Striped Bass	8	0.2	1%	12	0.3	1%	67	3	6%	87	1	2%
Atlantic Menhaden	6	0.1	0.5%	31	1	2%	9	0.4	4%	46	0.4	1%
Other Fishes				25	1	2%				25	0.2	1%
Spot	2	0.04	0.2%				9	0.4	4%	11	0.1	0.3%
White Crappie	3	0.1	0.2%				8	0.3	1%	11	0.1	0.3%
Spottail shiner	8	0.2	0.6%							8	0.1	0.2%
White catfish	5	0.1	0.4%				3	0.1	1%	8	0.1	0.2%

1 Other species collected were combined under the category 'Other Fishes' in 1983; the species denoted represent the known minimum species richness

2 The CPUE presented here has been altered from data originally reported in "Annual Report (Article 34; Objective 5): 1982 Fisheries Studies for Determination of Flow Needs for Protection and Enhancement of Fish Populations Below Conowingo" to standardize with 1983 and 1984 data where CPUE is determined as No. of Fish Collected / effort (No. nets set) and includes zero catches as part of the effort. In 1982 if a net yielded zero fish the effort was not included in determining the species specific CPUE;

3 Because of high river flows in 1984 only one collection was made in the Pool, thus data from this location has been excluded from the analysis.

Table 6.6-1:Cont.

	1982 Total			1983 Total			1984 Total[3]			1982-1984		
No. of Species	**21**			**8 (minimum)[1]**			**25**			**28**		
No. Nets Set	**48**			**45**			**25**			**118**		
	No.	**CPUE[2]**	**%**	**No.**	**CPUE**	**%**	**#**	**CPUE**	**%**	**#**	**CPUE**	**%**
Walleye	1	0.02	0.1%				4	0.2	0.4	5	0.04	0.1%
Yellow perch	2	0.04	0.2%				2	0.1	0.2	4	0.03	0.1%
American shad	1	0.02	0.1%				2	0.1	0.2	3	0.03	0.1%
Blueback herring	3	0.06	0.2%							3	0.03	0.1%
Quillback							3	0.1	0.3	3	0.03	0.1%
White sucker	2	0.04	0.2%				1	0.04	0.1	3	0.03	0.1%
Largemouth Bass	1	0.02	0.1%				1	0.04	0.1	2	0.02	0.0%
Shad							2	0.1	0.2	2	0.02	0.0%
Yellow bullhead	1	0.02	0.1%				1	0.04	0.1	2	0.02	0.0%
Alewife							1	0.04	0.4	1	0.01	0.0%
Black Crappie							1	0.04	0.1	1	0.01	0.0%
Hickory shad							1	0.04	0.4	1	0.01	0.0%
Redbreast Sunfish							1	0.04	0.4	1	0.01	0.0%
Smallmouth Bass							1	0.04	0.1	1	0.01	0.0%
Tiger Musky							1	0.04	0.1	1	0.01	0.0%
Totals	**1,298**	**27**		**1,563**	**35**		**1,193**	**48**		**4,054**	**34**	

1 Other species collected were combined under the category 'Other Fishes' in 1983; the species denoted represent the known minimum species richness

2 The CPUE presented here has been altered from data originally reported in "Annual Report (Article 34; Objective 5): 1982 Fisheries Studies for Determination of Flow Needs for Protection and Enhancement of Fish Populations Below Conowingo" to standardize with 1983 and 1984 data where CPUE is determined as No. of Fish Collected / effort (No. nets set) and includes zero catches as part of the effort. In 1982 if a net yielded zero fish the effort was not included in determining the species specific CPUE;

3 Because of high river flows in 1984 only one collection was made in the Pool, thus data from this location has been excluded from the analysis.

TABLE 6.6-2: GILL NETS TAILRACE TOTAL FISH, CPUE (FISH/NET-NIGHT) AND PROPORTIONAL ABUNDANCE 1982 -1984

Year	1982			1983			1984			Total		
Area	Tailrace			Tailrace			Tailrace			Tailrace		
No. Nets Set	8			9			10			27		
	No.	CPUE [1]	%	No.	CPUE	%	No.	CPUE	%	#	CPUE	%
Channel catfish	491	61	58%	381	42	41%	279	28	34%	1,151	43	44%
Gizzard shad	125	16	15%	281	31	30%	220	22	27%	626	23	24%
White perch	191	24	23%	168	19	18%	174	17	21%	533	20	21%
Striped bass	3	0.4	1%	65	7	7%	19	2	2%	87	3	3%
Hybrid Striped	7	1	1%	11	1	1%	64	6	8%	82	3	3%
Carp	11	1	2%	10	1	1%	39	4	5%	60	2	2%
Other Fishes				14	2	2%				14	1	1%
White crappie	3	0.4	1%				8	1	1%	11	0.4	0.4%
Atlantic menhaden	5	1	1%	4	0.4	0.4%				9	0.3	0.3%
Walleye	1	0.1	0%				3	0.3	0.4%	4	0.1	0.2%

In certain instances the CPUE presented here has been altered from data originally reported in "Annual Report (Article 34; Objective 5): 1982 Fisheries Studies for Determination of Flow Needs for Protection and Enhancement of Fish Populations Below Conowingo" to standardize with 1983 and 1984 data where CPUE is determined as No. of Fish Collected / effort (No. nets set) and includes 'zero catches' as part of the effort. In 1982 if a gill net yielded zero fish of a particular species the effort was not included in determining the species specific CPUE. All data presented here as CPUE is number of fish / number of nets set. The 1983 and 1984 data were derived from "Annual Report (Article 34; Objective 5): 1983 Fisheries Studies for Determination of Flow Needs for Protection and Enhancement of Fish Populations Below Conowingo" and "Annual Report (Article 34; Objective 5): 1984 Fisheries Studies for Determination of Flow Needs for Protection and Enhancement of Fish Populations Below Conowingo" respectively.

Table 6.6-2: Cont.

Year	1982			1983			1984			Total		
Area	**Tailrace**			**Tailrace**			**Tailrace**			**Tailrace**		
No. Nets Set	**8**			**9**			**10**			**27**		
	No.	**CPUE [1]**	**%**	**No.**	**CPUE**	**%**	**No.**	**CPUE**	**%**	**#**	**CPUE**	**%**
Yellow perch	2	0.3	1				1	0.1	0.1	3	0.11	0.1%
Quillback							2	0.2	0.2	2	0.07	0.1%
Yellow bullhead	1	0.1	0.4				1	0.1	0.1	2	0.07	0.1%
American shad							1	0.1	0.1	1	0.04	0.04%
Black Crappie							1	0.1	0.1	1	0.04	0.04%
Blueback herring	1	0.1	0.3							1	0.04	0.04%
Largemouth bass							1	0.1	0.1	1	0.04	0.04%
Smallmouth Bass							1	0.1	0.1	1	0.04	0.04%
Tiger Musky							1	0.1	0.1	1	0.04	0.04%
White catfish	1	0.1	0.4							1	0.04	0.04%
White sucker							1	0.1	0.1	1	0.04	0.04%
Totals	**842**	**105**		**934**	**104**		**816**	**82**		**2,592**	**96**	

In certain instances the CPUE presented here has been altered from data originally reported in "Annual Report (Article 34; Objective 5): 1982 Fisheries Studies for Determination of Flow Needs for Protection and Enhancement of Fish Populations Below Conowingo" to standardize with 1983 and 1984 data where CPUE is determined as No. of Fish Collected / effort (No. nets set) and includes 'zero catches' as part of the effort. In 1982 if a gill net yielded zero fish of a particular species the effort was not included in determining the species specific CPUE. All data presented here as CPUE is number of fish / number of nets set. The 1983 and 1984 data were derived from "Annual Report (Article 34; Objective 5): 1983 Fisheries Studies for Determination of Flow Needs for Protection and Enhancement of Fish Populations Below Conowingo" and "Annual Report (Article 34; Objective 5): 1984 Fisheries Studies for Determination of Flow Needs for Protection and Enhancement of Fish Populations Below Conowingo" respectively.

TABLE 6.6-3: GILL NETS LEES FERRY TOTAL FISH, CPUE (FISH/NET-NIGHT) AND PROPORTIONAL ABUNDANCE 1982 - 1984

Year	1982			1983			1984			Total		
Area	Lee's Ferry			Lee's Ferry			Lee's Ferry			Lee's Ferry		
No. Nets Set	11			12			5			28		
	No.	CPUE [1]	%	No.	CPUE	%	#	CPUE	%	#	CPUE	%
Channel catfish	139	13	58%	60	5	24%	44	9	35%	243	9	39%
White perch	60	5	25%	95	8	38%	50	10	40%	205	7	33%
Shorthead redhorse	17	2	7%	32	3	13%	14	3	11%	63	2	10%
Gizzard shad	5	0	2%	49	4	19%	6	1	5%	60	2	10%
Carp	8	1	3%	10	1	4%	8	2	6%	26	1	4%
Striped bass	4	0.4	2%	2	0.2	1%	1	0.2	1%	7	0.3	1%
Other Fishes				5	0.4	2%				5	0.2	1%
White catfish	4	0.4	2%							4	0.1	1%
Hybrid Striped							2	0.4	2%	2	0.1	0.3%
Atlantic menhaden	1	0.1	0.4%							1	0.04	0.2%
Yellow perch							1	0.2	1%	1	0.04	0.2%
Totals	**238**	**22**		**253**	**21**		**126**	**25**		**617**	**22**	

In certain instances the CPUE presented here has been altered from data originally reported in "Annual Report (Article 34; Objective 5): 1982 Fisheries Studies for Determination of Flow Needs for Protection and Enhancement of Fish Populations Below Conowingo" to standardize with 1983 and 1984 data where CPUE is determined as No. of Fish Collected / effort (No. nets set) and includes 'zero catches' as part of the effort. In 1982 if a gill net yielded zero fish of a particular species the effort was not included in determining the species specific CPUE. All data presented here as CPUE is number of fish / number of nets set. The 1983 and 1984 data were derived from "Annual Report (Article 34; Objective 5): 1983 Fisheries Studies for Determination of Flow Needs for Protection and Enhancement of Fish Populations Below Conowingo" and "Annual Report (Article 34; Objective 5): 1984 Fisheries Studies for Determination of Flow Needs for Protection and Enhancement of Fish Populations Below Conowingo" respectively.

TABLE 6.6-4: GILL NETS THE POOL TOTAL FISH, CPUE (FISH/NET-NIGHT) AND PROPORTIONAL ABUNDANCE 1982 - 1984

Year	**1982**			**1983**			**Total[3]**		
Area	**The Pool**			**The Pool**			**The Pool**		
No. Nets Set	**13**			**12**			**25**		
	No.	**CPUE[2]**	**%**	**No.**	**CPUE**	**%**	**No.**	**CPUE**	**%**
Channel catfish	81	6	44%	43	4	60%	124	5	48%
White perch	57	4	32%	18	2	25%	75	3	29%
Shorthead redhorse	22	2	15%	4	0.3	6%	26	1	10%
Gizzard shad	15	1	10%	2	0.2	3%	17	1	7%
Carp	5	0.4	3%				5	0.2	2%
Striped bass	1	0.1	1%	2	0.2	3%	3	0.1	1%
Blueback herring	2	0.2	4%				2	0.1	1%
Hybrid Striped	1	0.1	1%	1	0.1	1%	2	0.1	1%
Other Fishes[1]				2	0.2	3%	2	0.1	1%
American shad	1	0.1	2%				1	0.0	0.4%
White sucker	1	0.1	1%				1	0.0	0.4%
Totals	**186**	**14**		**72**	**6**		**258**	**10**	

(1) Other species collected were combined under the category 'Other Fishes' in 1983; the species denoted represent the known minimum species richness
(2) The CPUE presented here has been altered from data originally reported in "Annual Report (Article 34; Objective 5): 1982 Fisheries Studies for Determination of Flow Needs for Protection and Enhancement of Fish Populations Below Conowingo" to standardize with 1983 and 1984 data where CPUE is determined as No. of Fish Collected / effort (No. nets set) and includes zero catches as part of the effort. In 1982 if a net yielded zero fish the effort was not included in determining the species specific CPUE;
(3) Because of high river flows in 1984 only one collection was made in the Pool, thus data from this location has been excluded from the analysis.

TABLE 6.6-5: GILL NETS TIDAL ZONE TOTAL FISH, CPUE (FISH/NET-NIGHT) AND PROPORTIONAL ABUNDANCE 1982 – 1984

Year	**1982**			**1983**			**1984**			**Total**		
Area	**Tidal Zone**			**Tidal Zone**			**Tidal Zone**			**Tidal Zone**		
No. Nets Set	**16**			**12**			**10**			**38**		
	No.	**CPUE** [1]	**%**	**No.**	**CPUE**	**%**	**#**	**CPUE**	**%**	**#**	**CPUE**	**%**
Gizzard shad	6	0.4	19%	120	10	39%	66	7	26	192	5	33%
Channel catfish	3	0.2	9%	56	5	18%	114	11	45	173	5	29%
White perch	8	0.5	25%	80	7	26%	22	2	9	110	3	19%
Atlantic menhaden				27	2	9%	9	1	4	36	1	6%
Shorthead redhorse	3	0.2	9%	10	1	3%	6	1	2	19	1	3%
Spot	2	0.1	6%				9	1	4	11	0.3	2%
Carp				5	0.4	2%	5	1	2	10	0.3	2%
Striped bass				2	0.2	1%	8	1	3	10	0.3	2%
Spottail shiner	8	1	25%							8	0.2	1%
Other Fishes				4	0.3	1%				4	0.1	1%
White catfish							3	0.3	1	3	0.1	1%
Shad							2	0.2	1	2	0.1	0.3%
Alewife							1	0.1	0.4	1	0.03	0.2%
American shad							1	0.1	0.4	1	0.03	0.2%
Hickory shad							1	0.1	0.4	1	0.03	0.2%
Hybrid Striped							1	0.1	0.4	1	0.03	0.2%
Largemouth bass	1	0.1	3%							1	0.03	0.2%
Quillback							1	0.1	0.4	1	0.03	0.2%
Redbreast Sunfish							1	0.1	0.4	1	0.03	0.2%
Walleye							1	0.1	0.4	1	0.03	0.2%
White sucker	1	0.1	3%							1	0.03	0.2%
Totals	**32**	**2**		**304**	**25**		**251**	**25**		**587**	**15**	

TABLE 6.6-6: COMPARISON OF THE MONTHLY CPUE (FISH/NET-NIGHT) OF WHITE PERCH COLLECTED BY EXPERIMENTAL GILL NET AT THREE LOCATIONS IN THE SUSQUEHANNA RIVER BELOW CONOWINGO DAM.

Zone	Year	Jul	Aug	Sep	Oct	Nov	Annual CPUE
Conowingo Tailrace	1982	-	43	17	7	-	24
	1983	41	19	12	-	3	19
	1984	50	14	7	11	-	17
*	1982 - 1984	45	27	11	9	3	20
Lee's Ferry	1982	6	4	6	-	-	6
	1983	1	1	15	-	-	8
	1984	2	-	15	-	-	10
*	1982 - 1984	4	2	13	-	-	7
Tidal Zone	1982	-	-	-	4	-	4
	1983	8	14	1	4	-	7
	1984	4	0	3	3	-	2
*	1982 - 1984	6	7	2	4	-	5

*Weighted mean, all years

- No sample taken

TABLE 6.6-7: COMPARISON OF MONTHLY CPUE (FISH/NET-NIGHT) OF GIZZARD SHAD COLLECTED BY EXPERIMENTAL GILL NET AT THREE LOCATIONS IN THE SUSQUEHANNA RIVER BELOW CONOWINGO DAM 1982 - 1984

Zone	Year	Jul	Aug	Sep	Oct	Nov	Annual CPUE
Conowingo Tailrace	1982	-	8	7	41	-	16
	1983	11	11	20	-	160	31
	1984	29	7	16	43	-	22
*	1982 - 1984	20	8	15	42	160	23
Lee's Ferry	1982	0	1	1	-	-	1
	1983	0	0	8	-	-	4
	1984	1	-	1	-	-	1
*	1982 - 1984	0	1	5	-	-	2
Tidal Zone	1982	-	-	-	28	-	28
	1983	6	6	5	22	-	10
	1984	2	3	7	17	-	7
*	1982 - 1984	4	5	6	22	-	10

*Weighted mean, all years

- No sample taken

TABLE 6.6-8: COMPARISON COMBINED MONTHLY CPUE (FISH/NET-NIGHT) OF CHANNEL CATFISH COLLECTED BY EXPERIMENTAL GILL NET AT THREE LOCATIONS IN THE SUSQUEHANNA RIVER BELOW CONOWINGO DAM.

Zone	Year	Jul	Aug	Sep	Oct	Nov	Annual CPUE
Conowingo Tailrace	1982	-	34	67	94	-	61
	1983	49	65	37	-	7	42
	1984	38	24	31	17	-	28
*	1982 - 1984	43	40	43	55	-	43
Lee's Ferry	1982	7	5	29	-	-	13
	1983	4	5	6	-	-	5
	1984	12	-	7	-	-	9
*	1982 - 1984	7	5	12	-	-	9
Tidal Zone	1982	-	-	-	2	-	2
	1983	8	3	5	3	-	5
	1984	10	12	16	5	-	11
*	1982 - 1984	9	8	10	3	-	7

*Weighted mean, all years

- No sample taken

TABLE 6.6-9: COMPARISON OF THE MONTHLY CPUE(FISH/NET-NIGHT) OF STRIPED BASS COLLECTED BY EXPERIMENTAL GILL NET AT THREE LOCATIONS IN THE SUSQUEHANNA RIVER BELOW CONOWINGO DAM.

Zone	Year	Jul	Aug	Sep	Oct	Nov	Annual CPUE
Conowingo Tailrace	1982	-	0.3	-	1	-	0.4
	1983	5	20	4	-	-	7
	1984	5	4	1	0	-	2
*	1982 - 1984	5	7	2	0.5	-	3
Lee's Ferry	1982	0.4	-	1	-	-	0.4
	1983	7	-	-	-	-	0.2
	1984	5	-	-	-	-	0.2
*	1982 - 1984	1	-	0.2	-	-	0.3
Tidal Zone	1982	-	-	-	-	-	0
	1983	-	-	0	1	-	0.2
	1984	1	1	1	2	-	1
*	1982 - 1984	0.2	0.3	0.3	1	-	0.4

*Weighted mean, all years

- No sample taken

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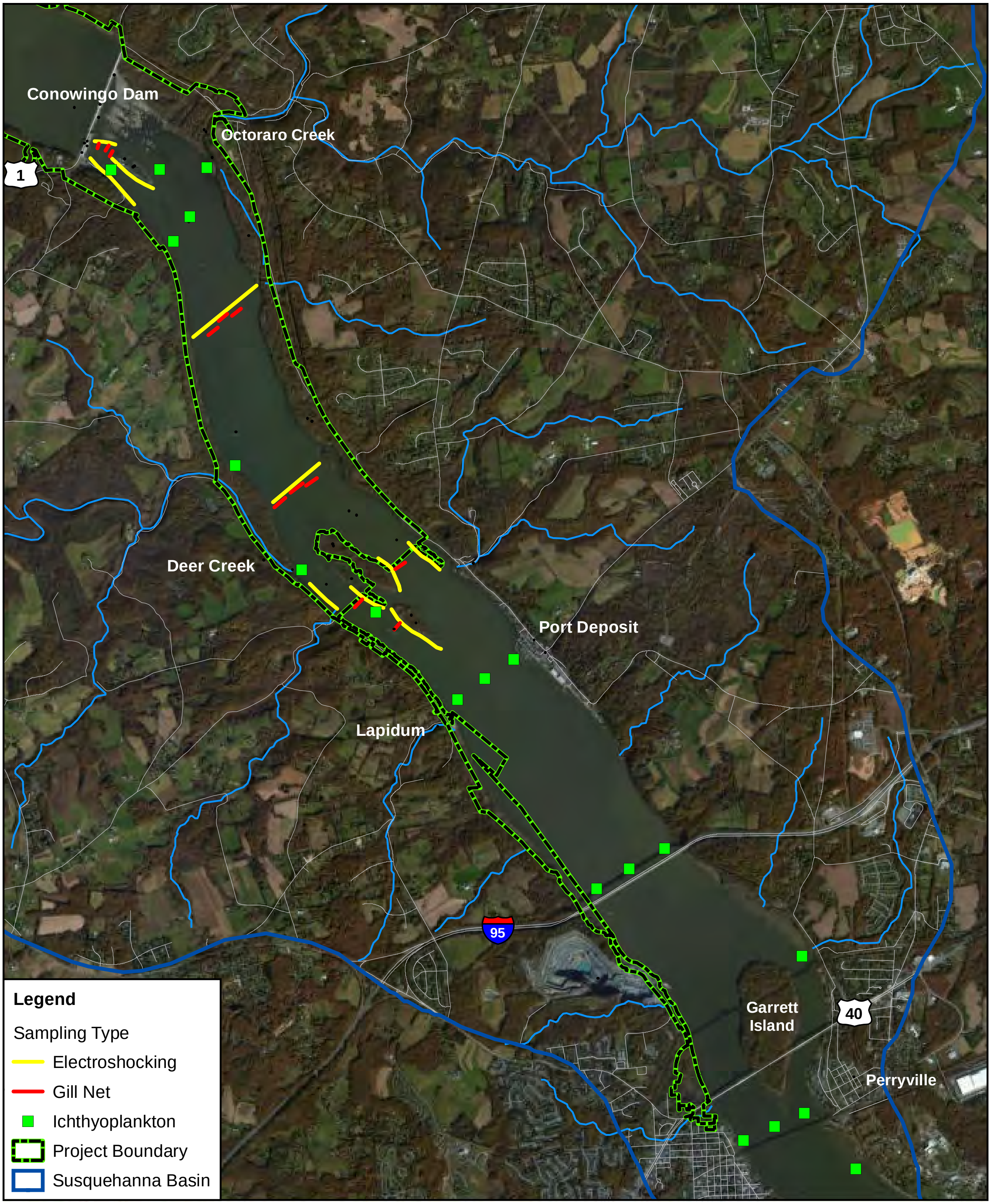
Figure 6.1-1:
General Locations for Electrofishing and Gill Net Sampling Below Conowingo Dam, 1980-1991

Path: X:\GISMaps\project_maps\study_plan\conowingo\Study_3.18\Figure_6_1-1_general_locations.mxd



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PROJECT NO. 405

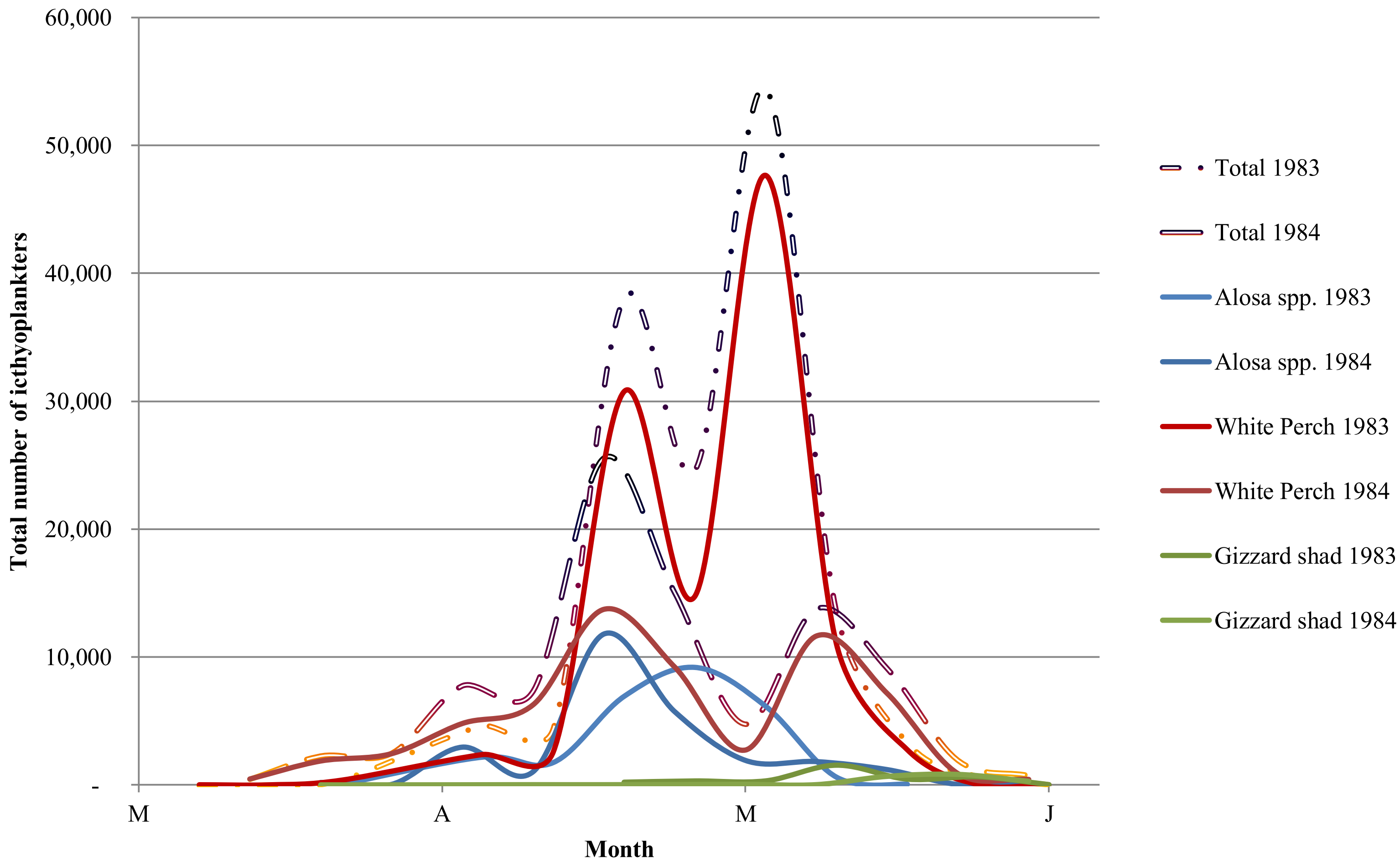
1 inch = 1 miles

0 0.5 1 2 Miles

Figure 6.1-2:
Locations for Electrofishing, Gill Net, and Ichthyoplankton Sampling Below Conowingo Dam, 1980-1991

Path: X:\GISMaps\project_maps\study_plan\conowingo\Study_3.18\Figure_6_1-2_sampling_locations.mxd

FIGURE 6.4-1: MONTHLY TOTAL ICHTHYOPLANKTON COLLECTED 1983 AND 1984 FOR ALOSA SPP., WHITE PERCH AND GIZZARD SHAD.



7.0 SUPPLEMENTAL STUDIES OF THE FISH COMMUNITY

7.1 Fish Food Habits Below Conowingo Dam

The benthic invertebrate studies summarized in Section 4 noted which autochthonous food items (organisms originating from the sample locations) appeared most often in stomachs of some of the resident fishes below Conowingo Dam. Detailed stomach analyses of individual white perch, channel catfish and yellow perch taken by electrofishing in the tailrace below Conowingo Dam July through December 1982 and 1983 were reported by Weisberg and Janicki (1985). Small zooplankters were abundant in white perch stomachs, but caddisfly larva (Cheumatopsyche) and chironomid larva were more important on a frequency basis, with caddis larvae most important based on percent of the biomass eaten. Chironomids were most important to channel catfish numerically and on a frequency basis. However, similar to white perch, caddis larva formed most of the diet biomass. The amphipod Gammarus was the most important food of yellow perch.

The three common resident fishes examined appeared to utilize both autochthonous (primarily benthic taxa) and allochthonous (organisms originating and transported from areas other than the sampling location, likely from above Conowingo Dam and available in the drift) food resources. Major drift taxa from Conowingo Pond, as reported by Weisberg and Janicki (1985), were the large zooplankters Leptodora and Chaoborus, similar to those found by RMC in 1982 (RMC 1985a). However, the food habit studies concluded that benthic taxa originating from below Conowingo Dam (chironomids and Cheumatopsyche) were more important to these three species.

Additional food habits investigations were performed by RMC during the same temporal period that targeted smallmouth bass and striped bass below Conowingo Dam. Smallmouth bass are year-long residents that move seasonally throughout the entire river reach below Conowingo Dam, whereas striped bass can also be residents much of the year or on nomadic incursions from Chesapeake Bay. Common dietary indices employed included frequency of occurrence, percent weight of total, and percent number of total. The Index of Relative Importance (IRI, (N+V)/F where N is percentage of a certain food organism, V is percentage of food volume and P is percentage of frequency of occurrence) was used to integrate these three indices (numerical percentage, volumetric percentage, and frequency of occurrence percentage)and reduce bias of an individual index (Pinkase et al. 1971).

Most smallmouth bass examined for food habits were > 150 mm. These yearling and older fish were highly predacious and ate mainly gizzard shad (Table 7.1-1) and other fishes. Amphipods (Gammarus) and mayflies (Ephemeroptera), along with gizzard shad and unidentified fishes, were important food of smallmouth bass less than 150 mm.

Young-of-the-year striped bass (approximately 60 to 150 mm based on RMC 1985b) fed mostly on *Chaoborus*, a drift organism likely from Conowingo Pond, and chironomids based on frequency of occurrence in 181 stomachs examined (Table 7.1-2). The IRI depicted dominant food items differently, with copepods and fish more important than *Chaoborus* (RMC 1985b). Copepods reflected daytime feeding whereas *Chaorborus* were consumed at night (RMC 1985b). Gizzard shad were the most important prey of 70 sub-adult and adult striped bass (243-735 mm FL) examined (RMC 1985c). Sizes of the gizzard shad consumed reflected those abundant seasonally, typically young-of-the-year. Striped bass clearly ate numerous gizzard shad and exhibited gorging behavior; as many as 47 young gizzard shad were counted in one stomach. Gizzard shad dominated the diets of both striped bass and smallmouth bass in late summer and fall, especially in the tailrace and upper tidal reaches.

Young-of-the-year striped bass and smallmouth bass diets in 1982 were examined with an overlap index (McKeown et al. 1984). Low to moderate overlap occurred among smaller individuals due to feeding on chironomids. Overlap increased among larger young as feeding on small gizzard shad increased. The authors noted utilization of all available food resources, and that gizzard shad served to attract striped bass to the Susquehanna River below Conowingo Dam.

When taken together, the various food habits studies depict fishes below Conowingo Dam opportunistically utilizing food resources available from lotic habitats below the dam as well as forage produced in Conowingo Pond upstream. For example, the fishes eaten by smallmouth bass appeared to reflect seasonal prey availability. Minnows (*Notropis* spp.), catfishes, yellow perch, darters, and white perch were eaten in spring and early summer but gizzard shad dominated later in the year. Food resources recruited from Conowingo Pond and available to downstream fishes include zooplankton, important to both resident fishes and young of larger predators, and most notably young gizzard shad which sustain many of the larger resident and migratory predators below the dam (McKeown et al. 1984).

7.2 Age and Growth of Smallmouth Bass

Smallmouth bass have been and remain a highly sought recreational species below Conowingo Dam (see Conowingo RSP Study 3.25: Creel Survey of Conowingo Pond and the Susquehanna River below Conowingo Dam). Smallmouth bass age and growth below Conowingo Dam were evaluated over a 4-year period from 1980 to 1983 (RMC 1985a). Four gear types contributed specimens for age determination: WFL, electrofishing, experimental gill nets, and rod/reel. A total of 2,106 scale samples were aged. The WFL provided 77% of the smallmouth bass aged, with electrofishing an additional 20%.

The aged samples showed three dominant year classes in the population below Conowingo Dam during the four sample years. Apparent abundance of the 1974 year class was waning by 1980 (Age 6 and Age 7 fish in 1980 and 1981, respectively, Table 7.1-3). Bass from the 1978 and 1980 year classes dominated the population by 1983 as 3 and 5-year old fish. The electrofishing catch in 1982 foretold the abundance of the 1980 year class as Age 2 individuals before this cohort was effectively sampled by the WFL. Reproduction of smallmouth bass is highly variable in rivers, and development of periodic dominant year classes is characteristic of smallmouth bass (and many other fishes) throughout the Susquehanna River (PFBC 2006**)**.

Growth of smallmouth bass below Conowingo Dam during 1980 to 1983 is summarized for 1,577 fish in Table 7.1-4. Mean fork length data depict a typical growth pattern. Based on mean FL attained by Age 4 (366 mm), most smallmouth bass were recruited to the harvestable population below Conowingo Dam (~305 mm TL) during their 4th year of life. Growth of smallmouth bass below Conowingo Dam was similar to or greater than that reported for several waters in PA and MD (Table 7.1-5 in RMC 1985b).

TABLE 7.1-1: INDEX OF RELATIVE IMPORTANCE (IRI) BY SIZE GROUPS FOR STOMACH CONTENTS OF SMALLMOUTH BASS FROM THE SUSQUEHANNA RIVER BELOW CONOWINGO DAM, 1982.

Food Item	N	Smallmouth bass size group (mm)				
		< 80	80-100	101-125	126-150	> 150
		7	3	10	16	189
Copepoda		-	-	-	-	1
Amphipoda		2,530	-	2,386	1,006	177
Crayfish		-	-	-	504	51
Trichoptera		580	150	115	237	448
Ephemeroptera		4,945	4,370	263	2,188	404
Diptera		409	-	915	378	308
Gizzard shad		-	-	3,939	-	2,992
Catfishes		-	-	-	-	33
Yellow perch		-	-	-	-	23
Darters		-	-	-	298	2
Unidentified fish		-	4,294	232	1,592	968

TABLE 7.1-2: SUMMARY OF FOOD ITEMS CONSUMED BY 181 YOUNG-OF-THE-YEAR STRIPED BASS FROM THE SUSQUEHANNA RIVER BELOW CONOWINGO DAM, 1982.

Food Item	Frequeny of Occurrence (%)	Index of Relative Importance
Amphipoda	19%	29
Chaoborids	62%	1,409
Chironomids	56%	383
Cladocerans	18%	105
Copepods	31%	2,943
Fish	27%	1,453
Isopoda	21%	22
Trichopterans	20%	146

TABLE 7.1-3: AGE GROUPS REPRESENTED IN SCALE SAMPLES FROM SMALLMOUTH BASS COLLECTIONS BELOW CONOWINGO DAM, 1980-1983.

		Number	**Age Group**											
Year	**Gear type**	**Aged**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**12**
1980	Fish Lift	103		1	6	19	30	9	34	3	1			
	Rod/reel	3			1	2								
	Year Total	106		1	7	21	30	9	34	3	1			
1981	Fish Lift	423			3	295	77	26	5	13	4			
	Rod/reel	8				4	1			3				
	Year Total	431			3	299	78	26	5	16	4			
1982	Electrofisher	219	33	44	100	9	19	12			2			
	Fish Lift	442			3	11	369	39	11	4	4	1		
	Rod/reel	34			11	2	12	8			1			
	Year Total	695	33	44	114	22	400	59	11	4	7	1		
1983	Electrofisher	198	61	33	36	48	3	11	2	1	1		1	1
	Fish Lift	655			6	336	28	249	27	6		2	1	
	Gill net	2	1				1							
	Rod/reel	19			1	12	2	3	1					
	Year Total	874	62	33	114	396	34	263	30	7	1	2	2	1
	4-year total	**2,106**	**95**	**78**	**167**	**738**	**542**	**357**	**80**	**30**	**13**	**3**	**2**	**1**

TABLE 7.1-4: LENGTH DATA (FL-MM) FOR AGE GROUPS OF SMALLMOUTH BASS COLLECTED BELOW CONOWINGO DAM, 1980-1983. TOTAL FISH = 1,577.

	Age Group										
Length data	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**12**
No. Fish	7	39	557	514	339	80	25	12	2	1	1
Min FL	49	147	223	249	315	358	407	438	464	492	470
Max FL	130	310	392	427	456	478	480	485	470	492	470
Mean FL	90	206	297	366	405	432	446	459	467	492	470

TABLE 7.1-5: COMPARISON OF MEAN TOTAL LENGTH (MM) BY AGE ATTAINED BY SMALLMOUTH BASS AT THE END OF THE GROWING SEASON COLLECTED FROM MARYLAND WATERS AND THE SUSQUEHANNA RIVER DRAINAGE IN PENNSYLVANIA.

Location	Year Collected	Number	Age Group								Reference
Maryland			I	II	III	IV	V	VI	VII	VIII	
Bennet Creek			58	137	206	216	239				Sanderson (1958)
Catoctin Creek			76	173	226	282	340				Sanderson (958)
Israel Creek			74	168	234	287					Sanderson (1958)
Potomac (Allegheny County)			99	193	244	284	335	373			Sanderson (1958)
Potomac River (Frederick County)			107	188	249	295	333	386			Sanderson (1958)
Potomac River			99	196	262	328	404	457			MDRE (1955)
Deep Creek Lake			99	175	267	338	378	427			MDRE (1955)
Loch Raven			99	201	305	386	445	475			HDRE (1955)
Pennsylvania											
Susquehanna River											
North Branch (Falls)	1976	114	95	150	199	247	281	301			Buynak (1978)8
North Branch (SSES)	1976	112	96	143	181	217	263	277			Buynak (1978)a
Lake Clarke	1954	125	81	198	259	307	335				Campbell (1954)
Conowingo Pond b	1962-1973	224	106	182	237	248	352	443			Heisey (1980)a
Conowingo Pond	1974-1977	399	106	187	241	321	361	395			Heisey (1980) a
Muddy Run Pump Storage Pond	1967-1973	106	121	184	224	243	274	310			Heisey (1980)a
Muddy Run Pump Storage Pond b	1974-1977	190	129	242	317	370	389	409			Heisey (1980)a
Below Conowingo Dam	1980-1983	1588	96	219	315	388	429	458	473	487	Present Study a

a Fork length (FL) measurements were converted to total length: (TL) 0.26 + 1.06 FL.
b After the introduction of gizzard shad as a forage fish.

8.0 LENGTH FREQUENCY

Length frequency data were collected and summarized for several species from electrofishing, gill nets and fish lifts 1982 to 1984 (RMC 1985a,b,c). The original referenced plots are in Appendix F. The length frequencies for fishes collected at Lee's Ferry and the Pool were combined (riverine reach) either due to similarity or small sample size. Length frequency plots for channel catfish, red breast sunfish, bluegill, smallmouth bass, largemouth bass, yellow perch and walleye collected at the West Fish Lift in 2010 are also included at the end of Appendix F.

8.1 White Perch

During 1982 to 1984 electrofishing samples , the size distribution of white perch throughout the study reach from the Conowingo tailrace to the tidal zone was similar year to year (RMC 1985a: Figure 6.1.2; RMC 1985b: Figure 5.1-2). In 1982 and 1983, over 35% of white perch in each sampling area were 141 to 160 mm. In 1984, 51% of the white perch collected were 151 to 170 mm. From 1982 to 1984, white perch 151 to 170 were most abundant in the riverine reach, but were also found in the tailrace and tidal area. Juvenile white perch (length <120 mm) were collected from both the tailrace (in 1982) and the tidal zone (in 1983). Electrofishing samples taken late in the spawning run in the spring reflect the size distribution of transient adult spawners. For example in 1983, up to 30% of white perch in April and early May exceeded 170 mm with many fish >200 mm. By mid-summer white perch >170 mm typically comprised about only 10% or less of the catch, with few fish >200 mm. Summer and fall samples reflect the size of white perch that remain in the river after the spring spawning run has dispersed.

The size distribution of white perch collected by gill nets was similar to that of electrofishing, and variation in length was limited. Greater than 92% of white perch collected in 1982 and 89% in 1983 were between 141 to 200 mm in length (RMC 1985a; RMC 1985b). Greater than 75% of those captured in 1984 measured between 151-190 mm and greater than 50% of the white perch collected measured 151 to 171 mm (RMC 1985c: Figure 5.2-4). These lengths corresponded to age groups III and IV (St. Pierre and Davis 1972). The smaller, less effective mesh of the gill nets may have caused lower estimates of the younger fish of this and other species.

8.2 Channel Catfish

The size distribution of channel catfish from electrofishing collections in 1982 and 1983 was similar for fish from the riverine reach and tidal zone. Nearly 50% of channel catfish collected in these areas were 151 to 200 mm (RMC 1985a: Figure 6.1.5; RMC 1985b). A majority of channel catfish this size were collected in the summer and fall. The size distribution of channel catfish in the tailrace was varied and more small sized fish were accounted. The modal size group (101 to 150 mm, 34%) of channel catfish in the tailrace was smaller than at the other reaches and more small channel catfish (51 to 100 mm) were collected in the tailrace than the riverine reach or tidal zone. Typically, young-of-the-year channel catfish have been almost exclusively in the tailrace (RMC 1985a).

Little variation in size distribution of channel catfish was observed in gill nets 1982 to 1984. In 1982 and 1983, 59% and 44% respectively, of the channel catfish collected were 181 to 260 mm in length. Greater than 50% of the channel catfish captured while gill netting in 1984 measured from 161 to 240 mm. Significant amounts of catfish greater than 381 mm were also collected. Intermediate length groups were not well represented. Catfish length groupings were clustered around 220 mm. Previous age and growth studies (Keany 1984, Fewlass 1980) indicated an over-population of catfish below Conowingo Dam exhibiting stunted growth. This may be responsible for a lack of large catfish and prevalence of small catfish. Recruitment from the overcrowded populations in Conowingo Pond may contribute to the slow growth shown by catfish.

In 1984, the length frequency distribution of channel catfish collected at the WFL exhibited a decreasing seasonal trend (RMC 1985c: Figure 4.1-7). The catch of channel catfish in the spring was dominated by larger fishes with over 65% of those measured exceeding 271 mm. This was also in the case in the 2010 WFL collections, with 94% exceeding 271 mm (Appendix F). The summer and fall catch in 1984 was dominated by channel catfish ranging from 171 to 270 mm and 71 to 170 mm, respectively. Over 85% of the channel catfish collected during the summer and fall were less than 271 mm.

8.3 Gizzard shad

The prevalence of small gizzard shad throughout the study reach provides an excellent forage base in all seasons. During electrofishing collections in 1982 to 1984 most gizzard shad were collected in the fall.

In 1982, collections in the tidal zone yielded a majority of smaller (51 to100 mm) gizzard shad (86%, RMC 1985a: Figure 6.1.4); the remaining 14% were evenly distributed amongst the size classes. The riverine reach was dominated by larger gizzard shad; 80% were 201 to 300 mm. The tailrace had representative catches from all size classes; 40% of fish collected were 51 to 100 mm and 28% were 251 to 300 mm.

Similar to 1982, during the 1983 electrofishing collections the largest percentage of gizzard shad (41%) in the tidal zone was composed of smaller (51 to 100 mm) fish. The riverine reach had a more heterogeneous distribution throughout the varying size classes; 70% of the gizzard shad collected were

101 to 200 mm. In the tailrace, the overall size distribution of gizzard shad was dominated by gizzard shad 101 to 150 mm (RMC 1985b: Figure 5.1-4)

The size distribution of gizzard shad collected by electrofishing in the tailrace and riverine reach in 1984 was dominated by individuals exceeding 200 mm (RMC 1985c), whereas the tidal zone was more typical of 1982 and 1983, when size distributions were dominated by smaller (101-150 mm) gizzard shad. In the tidal zone, most of the small gizzard shad were collected in January and were likely 1983 progeny. The lack of small gizzard shad is evidence of poor recruitment in 1984. An unusual episode of high natural river flow occurred in early July, with an associated heavy silt load, may have resulted in low survival of young gizzard shad.

In 1982, a majority of the gizzard shad collected by gill nets (74%) were 281 to 340 mm; 13% were less than 281 mm. In 1983, a higher proportion of small gizzard shad were collected as fish less than 281 mm comprised 64% of the total. In 1984 gizzard shad collected by gill nets showed a relatively even distribution among length groups, though, a higher proportion were in the 281-300 mm grouping (21%) than the 321 mm and greater groupings (16%), RMC 1985c: Figure 5.2-3).

In 1984 the majority of gizzard shad (90%) at the WFL were adults greater than 200 mm. From 1 to 15 June, 16 June to 15 September and 16 September to 30 November 89%, 86%, and 99% of the gizzard shad collected were over 200 mm respectively (RMC 1985c: Figure 4.1-6). Limited numbers of young-of-year and juvenile gizzard shad were present in fish lift catches in any season in 1984. This was probably a result of high spring flows in June which resulted in a very weak 1984 year class of gizzard shad.

8.4 Yellow Perch

During electrofishing collections in 1983 a majority of yellow perch collected throughout the study reach were 141 to 180 mm (RMC 1985b: Figure 5.1-5). More juvenile yellow perch (<120 mm) were collected in the tidal zone than in the other locations. Yellow perch from the riverine reach were nearly all >140 mm and 12% were over 221 mm.

During the 1984 electrofishing collections the modal length group of yellow perch was 161-180 mm in the tailrace and 141-160 mm in the tidal zone. A higher percentage of large perch (> 200 mm) occurred in the tailrace, while substantially more young perch (<120 mm) occurred in the tidal zone (RMC 1985c).

8.5 Smallmouth Bass

Electrofishing collections in 1983 exhibited seasonal variability in length for smallmouth bass as a majority of spring and summer collections consisted of larger fish (>151 mm) while increasing numbers of small fish (<150 mm) were collected in the fall (RMC 1983b: Figure 5.1-6). In the tidal zone, fish 151 to 300 mm comprised 69% of the catch; most were collected in the spring and summer; 26% of those collected were <150 mm and most were collected in the fall. In the tailrace, the spring and summer catch was dominated by fish 151 to 300 mm (56%). Some 17% of the early June catch in the tailrace consisted of large smallmouth bass >351 mm, while in subsequent months only one fish >351 mm was collected. Smallmouth bass <150 mm comprised 39% of the collection in the tailrace, and almost all small fish were collected in the fall. The catch in the tailrace from September through November was comprised primarily of young-of-the-year (72%). In the riverine reach, a majority of fish were collected in the summer and more than half of the smallmouth bass collected were larger than 250 mm (58%).

In 1984 the catch of bass was dominated by fish 100-200 mm in length. This size range was mostly comprised of yearling bass, and demonstrated the relative strength of the 1983 year class. Similar to 1983, more large bass (>300 mm) were taken in the tailrace. By late summer and through fall, few bass >300 mm were taken. In contrast to that observed in the tailrace and tidal zone, few bass <151 mm were collected in the riverine reach. The highest proportion of large bass (350 mm) occurred in the riverine reach (RMC 1985c).

The size distribution of smallmouth bass (RMC 1985c) varied seasonally during fish lift catches in 1984. The spring catch of smallmouth bass was dominated by fishes that ranged from 321 to 410 mm with over 75% of the smallmouth bass collected greater than 320 mm. In the spring of 2010, 98% of the 60 smallmouth bass collected, weighed and measured were greater than 320mm (Appendix F). The catch of smallmouth bass in the summer and fall was limited compared to that in the spring and was generally comprised of smaller fish.

8.6 Striped bass

Striped bass collected during electrofishing in 1982 were distinctly adult or juvenile in age class as indicated by the sizes collected. Of the 210 striped bass caught in summer and fall collections at the tailrace, 98% were <150 mm. In the tidal zone (9 fish), 22 % of the fish collected were 51 to 100 mm and 67% of the fish collected were >351 mm. In the riverine reach (5 fish), all striped bass were > 301 mm (RMC 1985a).

The catch of striped bass in the tailrace during electrofishing in 1983 was dominated by the yearling fish of the 1982 year class (RMC 1985b, Figure 5.1-7). Of the 280 fish collected in the tailrace, 75% were 101 to 150 mm and 21% were 150 to 200 mm. The mean length of yearling striped bass captured (limited to those <200 mm; only 6% of 300 collected exceeded 200 mm) increased from 129 mm in June to 168 mm in September. In the tidal and riverine reaches no yearling striped bass were captured, indicating that the tailrace was the primary habitat utilized in the study reach for yearling striped bass.

In both the tailrace and tidal zone the electrofishing catch of striped bass in 1984 was largely made up of individuals 250 to 350 mm in length (fish of the 1982 year class). In the riverine reach nearly half of the striped bass taken were > 350 mm (15 fish) and six ranged from 501-710 mm. The largest striped bass collected to date was taken in September from the tidal zone immediately below Deer Creek. It measured 912 mm and weighed 8.75kg (RMC 1985c).

Although the sample size for striped bass was small in gill net collections 1982 to 1984, variation in size and abundance was observed. All striped bass collected by gill net in 1982 (8 fish) were greater than 301 mm, whereas in 1983 striped bass greater than 301 mm made up only 24% of those collected (15 fish). In 1983, a majority of striped bass were between 181 to 300 mm in length.

The size distribution of striped bass collected at the fish lift in the spring and summer of 1984 was similar to the size distributions from the electrofishing and gill net efforts, with over 90% of fishes measured ranging in size from 211 to 350 mm. The length frequency distribution of striped bass collected at the fish lift does not reflect the size distribution of these fishes present in the tailrace on a seasonal basis. This is evident through examination of the angler harvest. The range of harvested striped bass was 229 to 766 mm and the mean length was 400 mm (RMC 1985c). The size distribution of striped bass collected at the fish lift indicates predominantly adult striped bass.

The length frequency distribution of striped bass x white bass hybrid at the fish lift (RMC 1985c: Figure 4.1-11) was similar for all seasons. Generally, a minimum of 70% of the hybrids collected were less than 380 mm in all seasons. The observed increase in the catch of hybrids in the summer and fall was a direct result of the collection of young-of-year (YOY, fish born within the past year) hybrids recruited from Conowingo Pond. Generally, the YOY hybrids ranged from 101 to 200 mm.

8.7 Walleye 1984

The 1982 and 1983 electrofishing collections of walleye were comprised of larger, adult fish. In 1982 92% of the walleye collected in the tidal zone (12 fish) were > 351 mm and 86% of the walleye collected in the tailrace (42 fish) were > 251 mm. In 1983, all walleye (6 fish) collected in the tidal zone were >251 and in the tailrace 94% were >251 mm. In 1984 electrofishing collections most walleye taken were large; 25% of walleye in the tailrace were >461 mm (RMC 1985a: Figure 6.1.10, RMC 1985b: Figure 5.1-8).

Walleye collected at the fish lift in 1984 ranged in size from 241 to 590 mm. In 2010, 76% of the Walleye processed for length and weight athe the WFL were 381 to 520mm (Appendix F). Generally, the catch and size distribution of walleyes exhibited a similar trend in all seasons with the majority of fish collected exceeding 311 mm (RMC 1985c).

9.0 LENGTH WEIGHT RELATIONSHIPS AND FISH CONDITION

9.1 Length Weight Relationships

Length weight relationships are utilized to estimate or convert weight from length or vice versa. Variation from an expected weight from length of individuals or groups of individuals may be used to determine relative 'fatness', well being, gonad development etc (Anderson and Neuman 1996).

Relationships between length and weight can be expressed by the equation: $W=cL^n$

W= weight
L = length
c and n = constants

The parameters "c" and "n" can be estimated by linear regression of logarithmically transformed length weight data ($\log W = \log c + n \log L$). The curvilinear length weight relationship becomes linear after logarithmic transformation, allowing for estimation of c and n. An "n" of 3 indicates isometric growth, as the shape of the fish does not change as it grows (Carlander 1969). In general fish with an "n" less than 3 become less rotund as length increases; fish with an "n" greater than 3 become more rotund as length increases.

Several texts have compiled data on length weight relationships for fish body types, families or species or individual populations. Carlander (1969, 1977, 1997) is used here to reference accepted length weight relationship ranges for families or species of fish.

Log transformed lengths and weights for five species (smallmouth bass, largemouth bass, yellow perch, walleye, channel catfish) caught at the WFL in the spring of 2010 were plotted to derive a linear regression equation and are included at the end of Appendix F. The linear regression equation provides an estimation of the length weight relationship in 2010 which can be compared to length weight relationship equations for the same fish species weighed and measured throughout the sampling season during 1982 to 1987 at the WFL and from electrofishing and gill net samples (Table 9.1-1).

The length weight relationship as expressed by the slope of the regression equation based on data collected in 2010 indicates that lengths and weights of selected species collected at the WFL are similar to those collected 1982 to 1987 (Table 9.1-2). Walleye and channel catfish slopes from 2010 are near the median ranges estimated in the 1980's. Smallmouth bass and largemouth bass slopes from 2010 are slightly lower (2%) than the lowest value from the 1980's. Though the comparison is limited to one year from the 1980's, yellow perch from 2010 are lower (17%) than the slope in 1983. The values for both the 1980's fish and those collected in 2010 are within the reference ranges presented. Walleye, channel catfish, largemouth bass and smallmouth bass were near the median of the ranges presented in Carlander (1969, 1977, 1997). Yellow perch was within the range of means derived in the reference populations, though the 2010 slope was near the lower end of the range (Carlander 1997).

9.2 Fish Condition

The relative robustness of a fish can often be described via fish condition ($K = weight/(length)^3$). Fish condition may express the relative nutritional state as "K" greater or less than a usual weight at a particular length. Condition factor may also vary with stage of development, maturation and sex in some species.

Fish condition from various, distinct populations of the same species have been compiled, analyzed and reported for use as a reference for range of condition factors (Carlander 1969, 1977, 1997). Length weight data were collected for several species at the WFL of the Conowingo Dam in 2010 including channel catfish, redbreast sunfish, bluegill, smallmouth bass, largemouth bass, yellow perch and walleye. For each individual fish a condition factor was derived; the range and mean condition factor for each species is presented in Table 9.2-1. Reference condition factors for each species are also presented.

Fish conditions for species collected at the WFL in 2010 were within the normal range of means presented from various populations of the same species in Carlander 1969, 1977 and 1997.

TABLE 9.1-1: RANGE OF SLOPE OF LENGTH WEIGHT REGRESSION IN 1980'S AND 2010 AND REFERENCE RANGE

Family	Species	1980's	2010	Carlander range
Centrarchidae	smallmouth bass	3.1 - 3.3	3.0	2.5 - 3.5
Centrarchidae	largemouth bass	3.3 - 3.5	3.2	2.5 - 4.0
Percidae	yellow perch	3.0 (1)	2.5	2.4 - 3.5
Percidae	walleye	3.0 - 3.2	3.2	2.3 - 3.9
Ictaluridae	channel catfish	3.1 - 3.3	3.2	2.9 - 3.8

(1) Only 80's yellow perch sample year from 1983

TABLE 9.1-2: LENGTH WEIGHT RELATIONSHIPS BY SPECIES AND YEAR

Year	Species	Length weight formula	R^2	N
1982	smallmouth bass	LogW = 3.1636LogL - 5.1825	0.98	881
1983	smallmouth bass	LogW = 3.1710LogL - 5.2010	0.98	1,005
1984	smallmouth bass	LogW = 3.2507LogL - 5.4077	0.99	1,008
1985	smallmouth bass	LogW = 3.1084LogL - 5.0570	0.99	553
1986	smallmouth bass	LogW = 3.1573LogL - 5.1832	0.99	602
1987	smallmouth bass	LogW = 3.1887LogL - 5.2581	0.99	451
2010	**smallmouth bass**	**LogW = 3.0329LogL - 4.9376**	**0.92**	**60**
1982	largemouth bass	LogW = 3.3585LogL - 5.7101	0.98	18
1983	largemouth bass	LogW = 3.2658LogL - 5.4286	0.99	52
1984	largemouth bass	LogW = 3.4565LogL - 5.9201	0.99	65
2010	**largemouth bass**	**LogW = 3.1897LogL - 5.3201**	**0.77**	**23**
1983	yellow perch	LogW = 3.0337LogL - 4.9211	0.96	212
2010	**yellow perch**	**LogW = 2.5252LogL - 3.8688**	**0.85**	**17**
1982	walleye	LogW = 3.0246LogL - 5.0238	0.93	406
1983	walleye	LogW = 3.1047LogL - 5.2281	0.96	695
1984	walleye	LogW = 3.1618LogL - 5.3972	0.95	532
1985	walleye	LogW = 3.1953LogL - 5.4762	0.98	413
1986	walleye	LogW = 3.2436LogL - 5.6159	0.95	277
1987	walleye	LogW = 2.9944LogL - 4.9457	0.89	194
2010	**walleye**	**LogW = 3.185LogL - 5.5276**	**0.92**	**190**
1982	channel catfish	LogW = 3.1098LogL - 5.1768	0.99	1,300
1983	channel catfish	LogW = 3.1026LogL - 5.1500	0.96	1,196
1984	channel catfish	LogW = 3.2317LogL - 5.4878	0.98	1,017
1985	channel catfish	LogW = 3.1641LogL - 5.3075	0.99	641
1986	channel catfish	LogW = 3.2245LogL - 5.4749	0.96	477
1987	channel catfish	LogW = 3.2936LogL - 5.6404	0.97	372
2010	**channel catfish**	**LogW = 3.1956LogL - 5.5305**	**0.94**	**351**

TABLE 9.2-1: 2010 CONDITION FACTOR

Species	N	Range Total Length	2010 Range of K	2010 Mean K	Range of Mean K in Carlander 1969
Channel catfish	315	134 - 635	0.3 - 3.6	0.96	0.1 - 1.1
Redbreast sunfish	77	147 - 220	1.2 - 3.2	2.14	1.9 - 4.2
Bluegill	84	124 - 214	0.5 - 3.9	1.95	1.1 - 3.3
Smallmouth bass	60	286 - 480	1.0 - 1.7	1.41	1.3 - 1.9
Largemouth bass	23	290 - 420	1.1 - 3.3	1.50	1.1 - 1.8
Yellow perch	17	123 - 282	0.7 - 1.6	1.14	1.0 - 1.4
Walleye	190	222 - 545	0.4 - 1.7	0.92	0.6 - 1.1

Condition factor (K= weight/(length)3 *100,000) based on fishes collected at the WFL 2010.

10.0 FISH STRANDING

10.1 Methods

Summer 2010 fish observations in rearing habitats below Conowingo Dam were made during on-ground field searches for stranded fishes conducted for Conowingo RSP Study 3.8, Downstream Flow Ramping and Stranding Study. Fish stranding surveys consisted primarily of on-ground surveys of the spillway reach below Conowingo Dam by two 2-person teams. The spillway reach areas searched include approximately 106 acres of largely rocks and boulder substrates interspersed with pool habitats of varying size and depth. A smaller area of interconnected small, shallow pools associated with the mouth of Octoraro Creek downstream of the spillway reach was also searched (see Figure 6.1-1)

Four summer stranding surveys were scheduled. The spatial coverage achieved by the on-ground teams for the summer studies (June 11 through September 1) was generally consistent among studies. The on-ground teams traversed the spillway reach and observed fish in and along attainable pools of various dimensions that remained at the prevailing summer minimum flow of 5,000 cfs. Survey days began after dawn, following crew transport to the study area and with allowance for sufficient light to permit safe walking and to facilitate counting and identification of fishes in spillway pools, lasted 5-6 h, and typically followed a period of generation the previous day, although this was not always the case (i.e., peaking flow levels were not arranged but rather those dispatched by PJM, Interconnection, the regional transmission organization).

Fish observations were recorded along with position of the siting by hand-held GPS and water temperatures in many of the pools. Stranded fish in de-watered areas were identified to species. Live fish in pooled areas were identified to species, if possible, by simple observation made feasible by normally high water clarity, clear weather, and little or no wind. Numerous small fishes seen but not identifiable to species were grouped as darters, minnows, and young sunfish (*Lepomis*). Efforts were also made to collect specimens with small-mesh nets for identification of species classified as darters, minnows, and sunfishes as well as young of larger fishes.

10.2 Results

Data collected in the 2010 surveys in the spillway reach below Conowingo Dam supplement the fish lift catches for a season not typically sampled by the lifts. These data also identify rearing habitats for small fish and young of larger fishes that in summer are largely unaffected by daily flow changes.

Four surveys were conducted on June 11, July 7, August 11, and September 1, 2010 on both the east and west sides of the spillway reach. The east side had more observed fish (6,896 fish) than the west side

(3,422 fish, Table 10.1-1). Fewer fish were caught in the June (134 fish) and July (168 fish) sample events and the most fish were observed during the August survey (5,608 fish, Table 10.1-1). The most commonly observed fish species were similar on both the east and west sides of the spillway reach. Gizzard shad (4,153 fish east, 1,727 fish west), banded killifish (1,306 fish east, 1,045 fish west) and sunfish (*Lepomis* spp., 918 fish east, 225 fish west) were the three most observed species comprising 57%, 23% and 11% of the total observations respectively (Table 10.1-1). Largemouth bass (420 fish) comprised an additional 4% of the observations (Table 10.1-1). The remaining 5% of the observations consisted of American eel, carp, minnows, quillback, catfishes, white perch, smallmouth bass, walleye, and darters (Table 10.1-1). Blue crab (15 crab) were also observed (Table 10.1-1).

10.3 Discussion

Species observed in the fish stranding study were those which inhabit the area below Conowingo Dam in the summer in a variety of hydrological conditions. Generally these areas would be inaccessible and not sample-able or available to other types of gear.

The observations indicate a diverse array of species immediately below Conowingo Dam. Species which are commonly collected at the EFL and WFL were observed. Seven out of the top ten species observed at the EFL in 2009 (gizzard shad, channel catfish, walleye, quillback, common carp, white perch, and brown bullhead) were accounted for in the summer stranding collections. The other three EFL species not accounted for in the stranding surveys were American shad, sea lamprey and alewife, all seasonal migrants. The stranding study also identified species which are not routinely collected at the fish lifts. For example, large amounts of banded killifish were observed in the area below Conowingo spillway but historically, no banded killifish have been lifted during the 38 years of operations at the WFL and 19 years of operation at the EFL. The presence of many juvenile centrarchids (*Lepomis, Micropterus*) indicate good rearing habitat for those species as well as an array of smaller minnows and darters that provide a good forage base for larger piscivorous fish.

TABLE 10.1-1: SUMMARY OF SUMMER STRANDING STUDIES, JUNE-SEPTEMBER 2010

	11-Jun		7-Jul		11-Aug		1-Sep		Summer Total		Season	
Species	**East**	**West**	**East**	**West**	**East**	**West**	**East**	**West**	**East**	**West**	**Total**	**Percent**
American eel						2				2	2	0.02%
Gizzard shad		43		22	2,570	579	1,583	1,083	4,153	1,727	5,880	57%
Carp	*	8	13		5				18	8	26	0.3%
Minnows	8		34	*	28			8	70	8	78	1%
Quillback		9	*	1	80	49	25	3	105	62	167	2%
Catfishes		10	1	3	1		1	2	3	15	18	0.2%
Banded killifish				2	590	702	716	341	1,306	1,045	2,351	23%
White perch		51		1						52	52	1%
Smallmouth bass				28	2	5		7	2	40	42	0.4%
Largemouth bass		2	1	7	119	86	123	82	243	177	420	4%
Micropterus spp.						20			0	20	20	0.2%
Sunfish (*Lepomis*)	*	2	8	*	639	75	271	148	918	225	1,143	11%
Walleye		1								1	1	0.01%
Darters			47	*	21	25			68	25	93	1%
Blue crabs							10	5	10	5	15	0.1%
Unidentified						10				10	10	0.1%
Totals	**8**	**126**	**104**	**64**	**4,055**	**1,553**	**2,729**	**1,679**	**6,896**	**3,422**	**10,318**	

* Observed, no estimate made.

11.0 CONCLUSION

The literature-based study, including data collected from 1972 to 2010, provided a broad based characterization of the fisheries and macroinvertebrate communities in the aquatic ecosystem below Conowingo Dam to the area just below Spencer Island.

Over the period 1972 to 2009, Conowingo fish lift catches depicted inter-annual variability and long term trends in fish species assemblage (of species vulnerable to collection in the fish lifts). The species assemblage of both the EFL and WFL catches, dominated by gizzard shad, channel catfish, common carp, and white perch, were similar to those observed in electrofishing, gill net, and ichthyoplankton sampling conducted below Conowingo Dam during the 1980's. The year to year similarities in catches amongst the various additional sampling gears and the fish lifts suggest fish lift collections provide a baseline indicator of the dominant species in the lower Susquehanna River.

The 1980's electrofishing and gill netting collections provided spatio-temporal habitat use detail, and together with fish lift counts and supplementary analyses, such as condition factor, macro-invertebrate sampling, and fish diet analysis provided a comprehensive description of the fish community below Conowingo Dam. Icthyoplankton samples provided further insight into reproduction and utilization of the lower Susquehanna River habitats by earlier life stages of fish. A series of quantitative benthic studies conducted in the non-tidal area of the Lower Susquehanna River below Conowingo Dam from 1980 through 1991 characterized the invertebrate community as moderately rich and moderately dense. The community was generally comprised of facultative or tolerant warm-water genera. Most abundant were: Chironomidae (*Cricotopus*, *Dicrotendipes*, and *Polypedilum*), *Cheumatopsyche*, *Corbicula*, *Dugesia*, *Gammarus*, *Goniobasis*, *Hydroptila*, *Manayunkia*, and Oligochaeta (*Nais*). Fish food habit investitgations indicate that diverse trophic interactions are supported in the habitats below Conowingo.

Changes to the fish species assemblage were evident over the period studied; most notably with regards to clupeids. Gizzard shad became the increasingly dominant species over time, American shad generally increased proportionally, and blueback herring decreased proportionally. Gizzard shad were inadvertently introduced into Conowingo Pond in 1972 and the population has increased exponentially. In 1997, implementation of volitional upstream passage via the EFL into Conowingo Pond appears to have accelerated the gizzard shad population growth. As gizzard shad have trended upward in abundance, some other species have declined. White crappie catches at the WFL have declined substantially since the mid 1970's, and it has been noted that one of the primary mechanisms of low recruitment of white crappie is the competition for zooplankton with juvenile gizzard shad (NAI, 1994). From 1991 to 2009, blueback herring comprised 4% of the overall CPUE at the EFL. In 1997, 1999 and 2001 significant catches of blueback herring were made. As recently as 2001, 510 herring per lift were collected, the highest amount in any year and the second most proportionally abundant species that year after gizzard shad. Since 2002; however, very few blueback herring have been passed. This decline might reflect recent population declines coast-wide due to a number of potential causes including habitat loss, targeted or bycatch in commercial fisheries, and increased numbers of striped bass and other of predators (ASMFC, 2009). In the 1970's and 1980's the proportion of American shad in the fish lift catch was very low, but as the result of restoration measures, American shad have increased through the 1990's. Since mid 1990's American shad has been one of the top 5 most abundant fish in annual fish lift counts, and is usually second most abundant in the EFL.

Although several species have increased or declined in abundance, the fish species assemblage has remained diverse below Conowingo Dam with the same core group of species as was observed in the 1980's. The fish lift catches have ranged from 30 to 49 taxa annually at the WFL and 25 to 45 taxa annually at the EFL. The taxonomically rich environment is likely a result of Conowingo's lower longitudinal position in the watershed, proximity to the convergence of the freshwater and estuarine environments and the subsequent available regional diversity (Matthews, 1998). Data collected in the 2010 fish stranding summer surveys along with recent years fish lift catches demonstrate the current species assemblage in the Susquehanna River below Conowingo Dam. Seven of the ten most abundant species found at the EFL 1991 to 2009 were represented in the fish stranding survey and the other three, alewife, American shad, and sea lamprey are seasonal migrants that would not have been present during the summer period of the stranding survey. A core assemblage consisting of gizzard shad, white perch, common carp, quillback, comely shiner, channel catfish, walleye, smallmouth and largemouth bass along with seasonal migrants like American shad, blueback herring, alewife, sea lamprey and striped bass form the primary group of inhabitants.

Condition factor of seven species collected at the WFL in 2010 were within the normal range of means presented from various reference populations of the same species in Carlander 1969, 1977 and 1997. The length weight relationship expressed by the slope of the regression equation based on data collected in 2010 indicates that lengths and weights of selected species collected at the WFL were similar to those collected 1982 to 1987 (Table 9.1-2). Both the 1980's fish and those collected in 2010 were within the reference length weight relationship ranges presented. Condition factor and length weight relationships of representative common fish species downstream of Conowingo Dam are comparable to those from other normal, natural populations and are indicative of relatively favorable conditions and habitats in the lower Susquehanna.

12.0 REFERENCES

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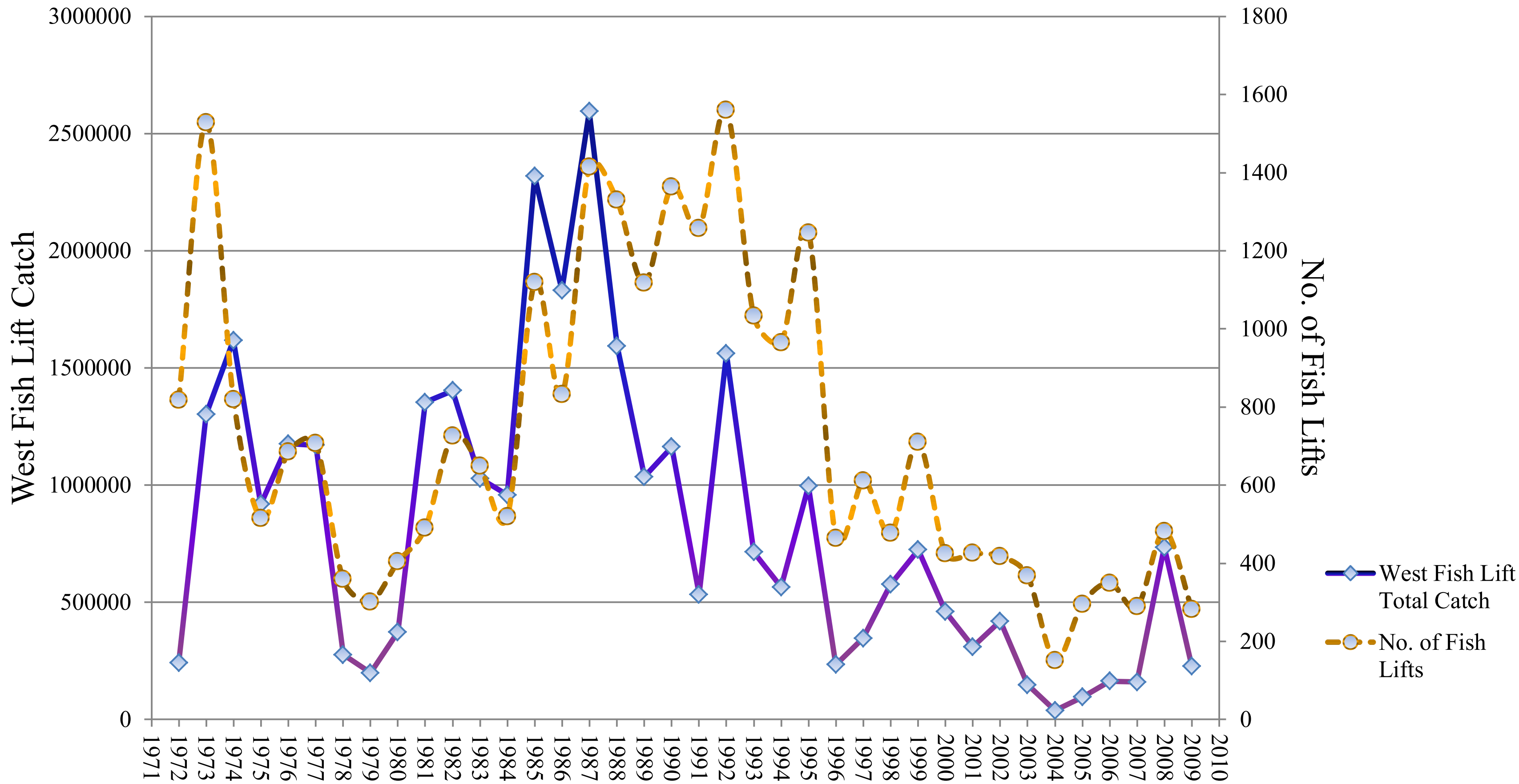
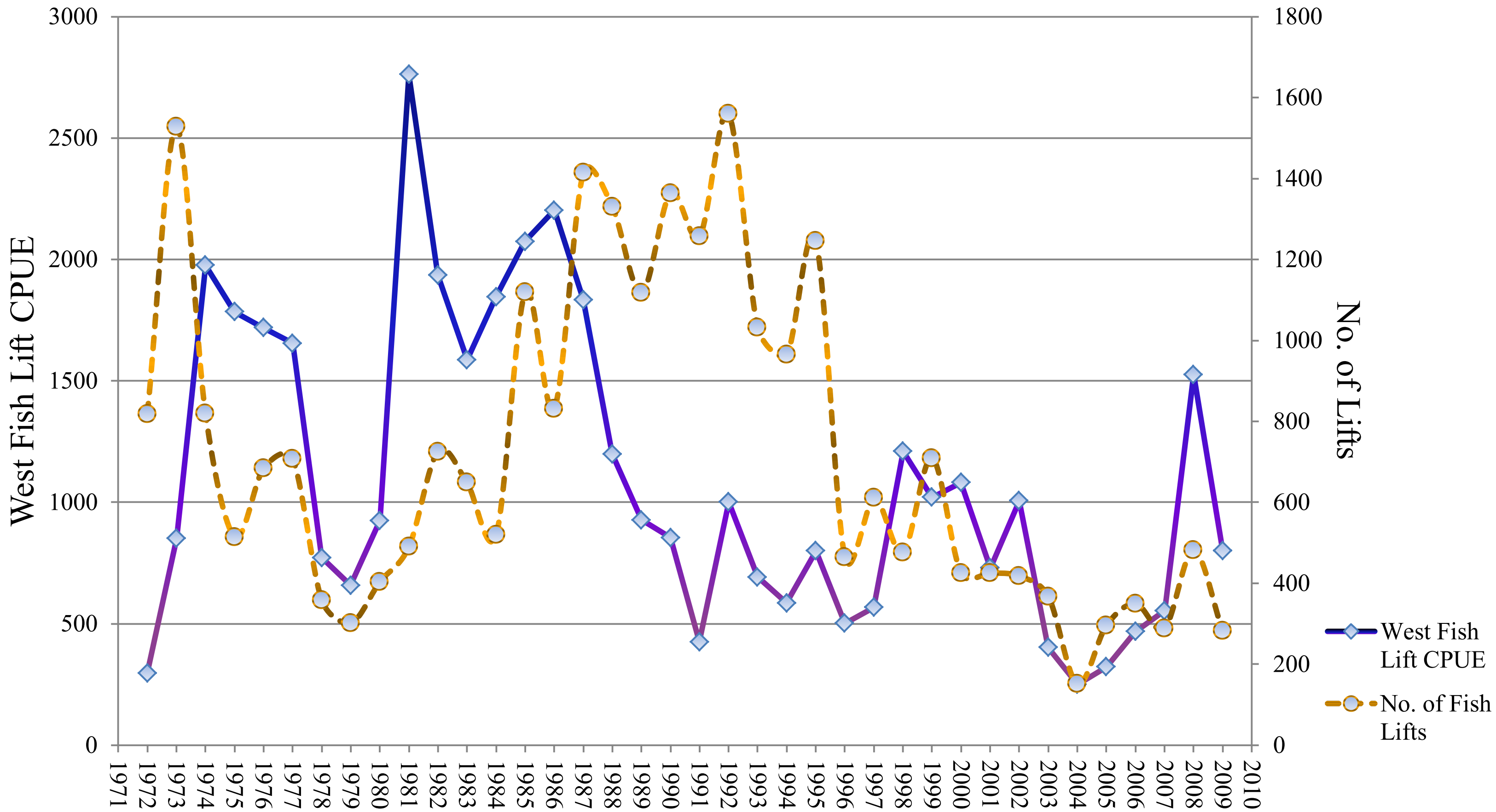
APPENDIX A – WEST FISH LIFT DATA

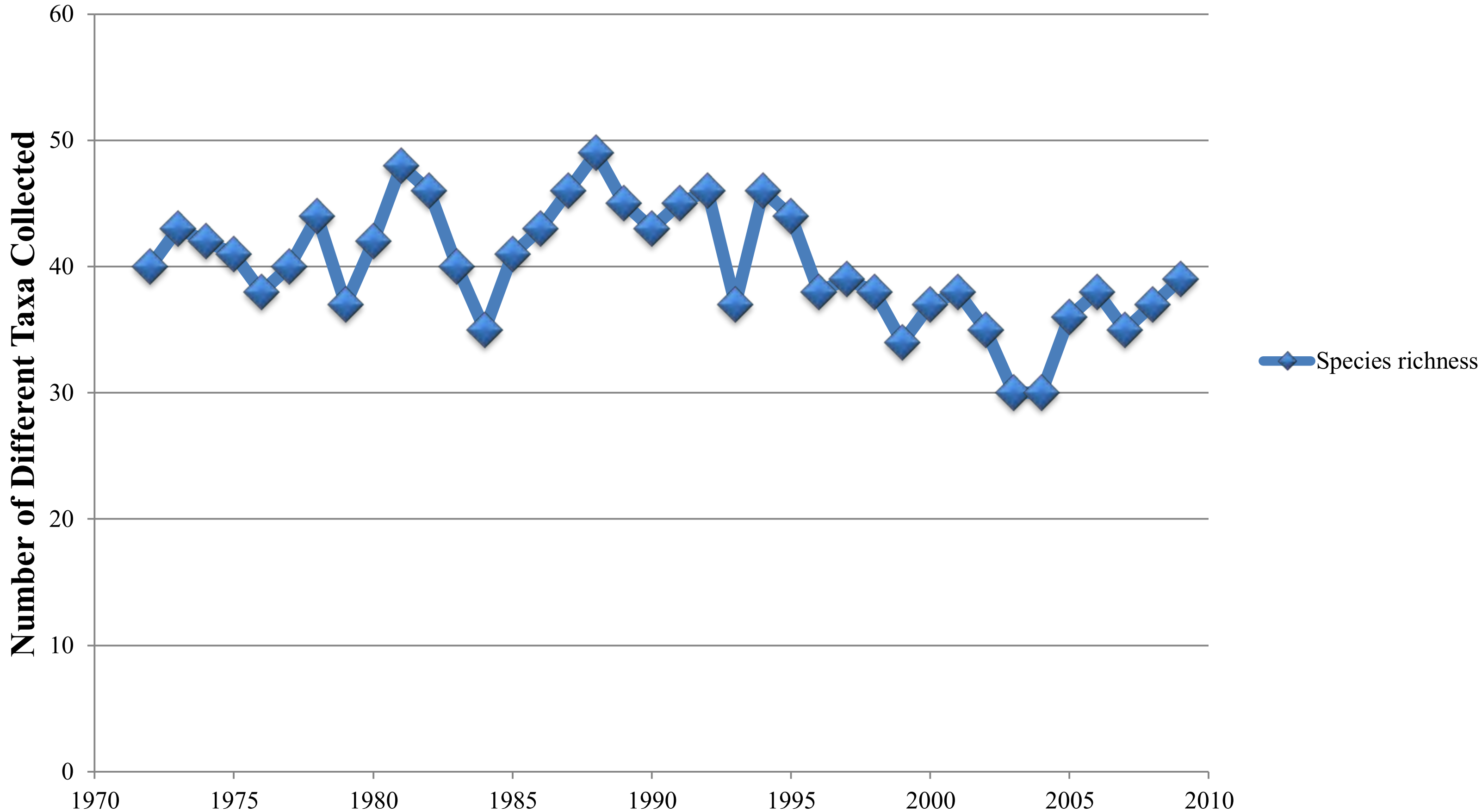
A-1. CONOWINGO DAM WEST FISH LIFT TOTAL CATCH AND NUMBER OF FISH LIFTS 1972 – 2009



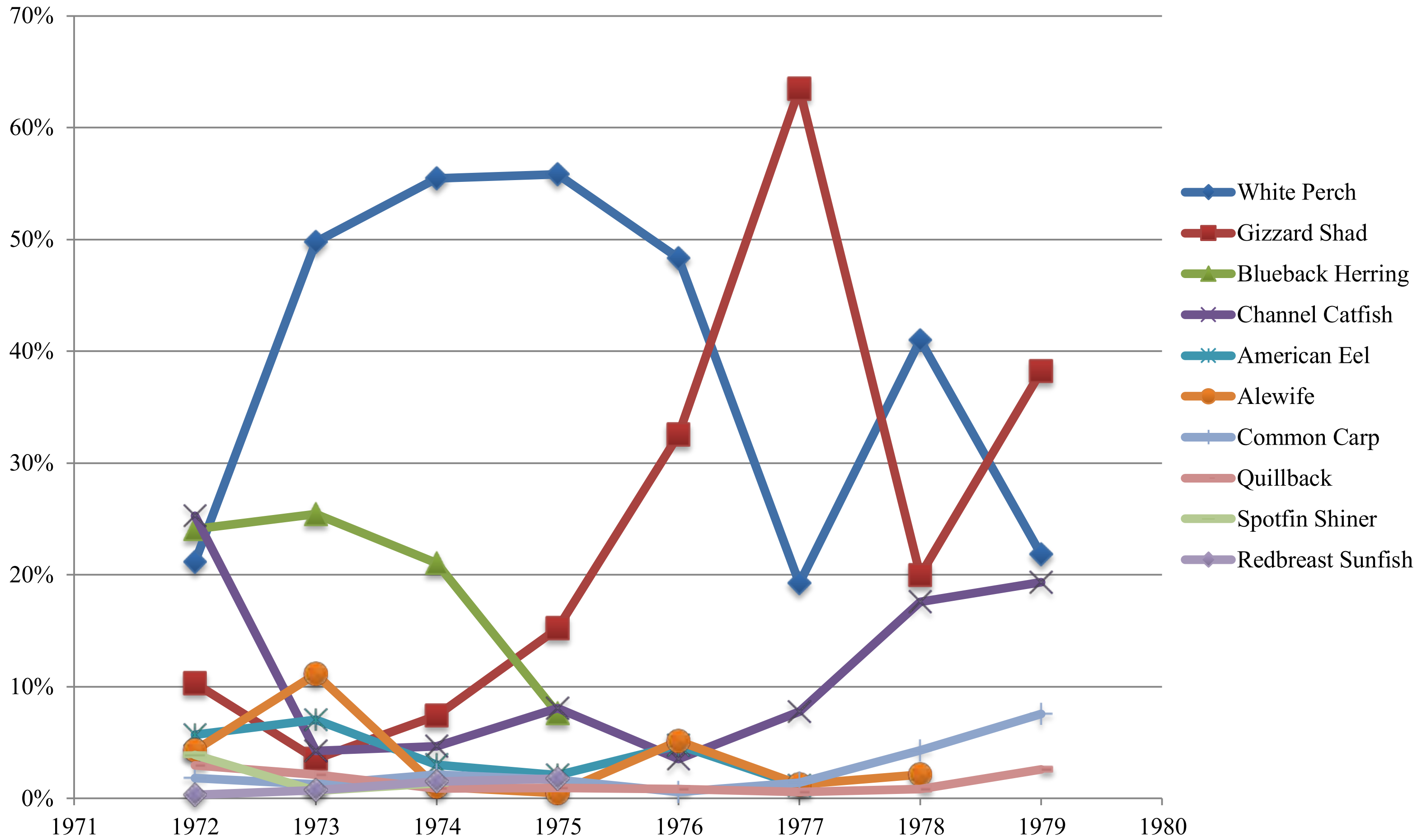
A-2. CONOWINGO DAM WEST FISH LIFT CPUE AND NUMBER OF FISH LIFTS 1972 – 2009



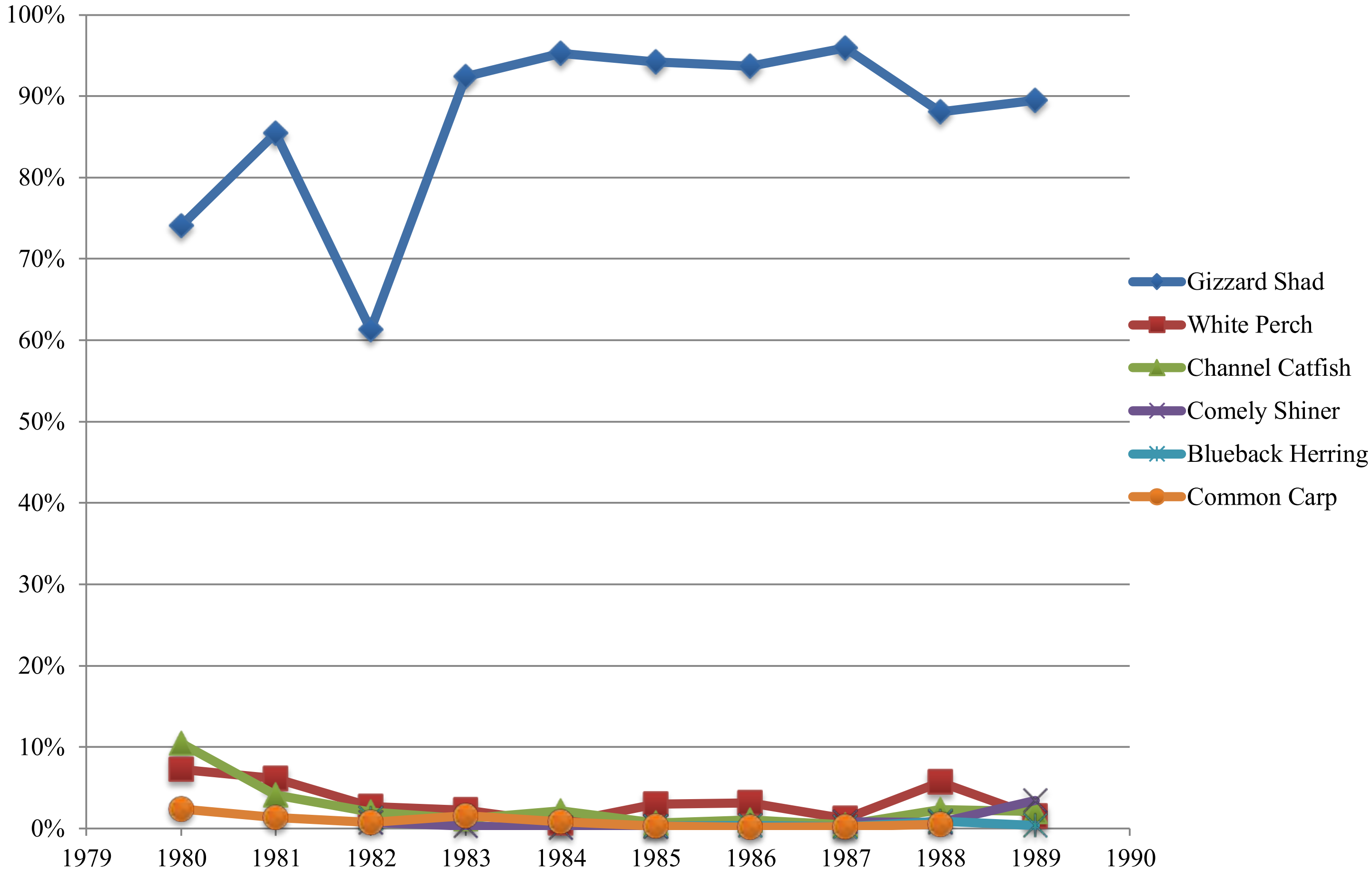
A-3. SPECIES RICHNESS, WEST FISH LIFT: AMOUNT OF DIFFERENT TAXA EACH YEAR 1972 – 2009



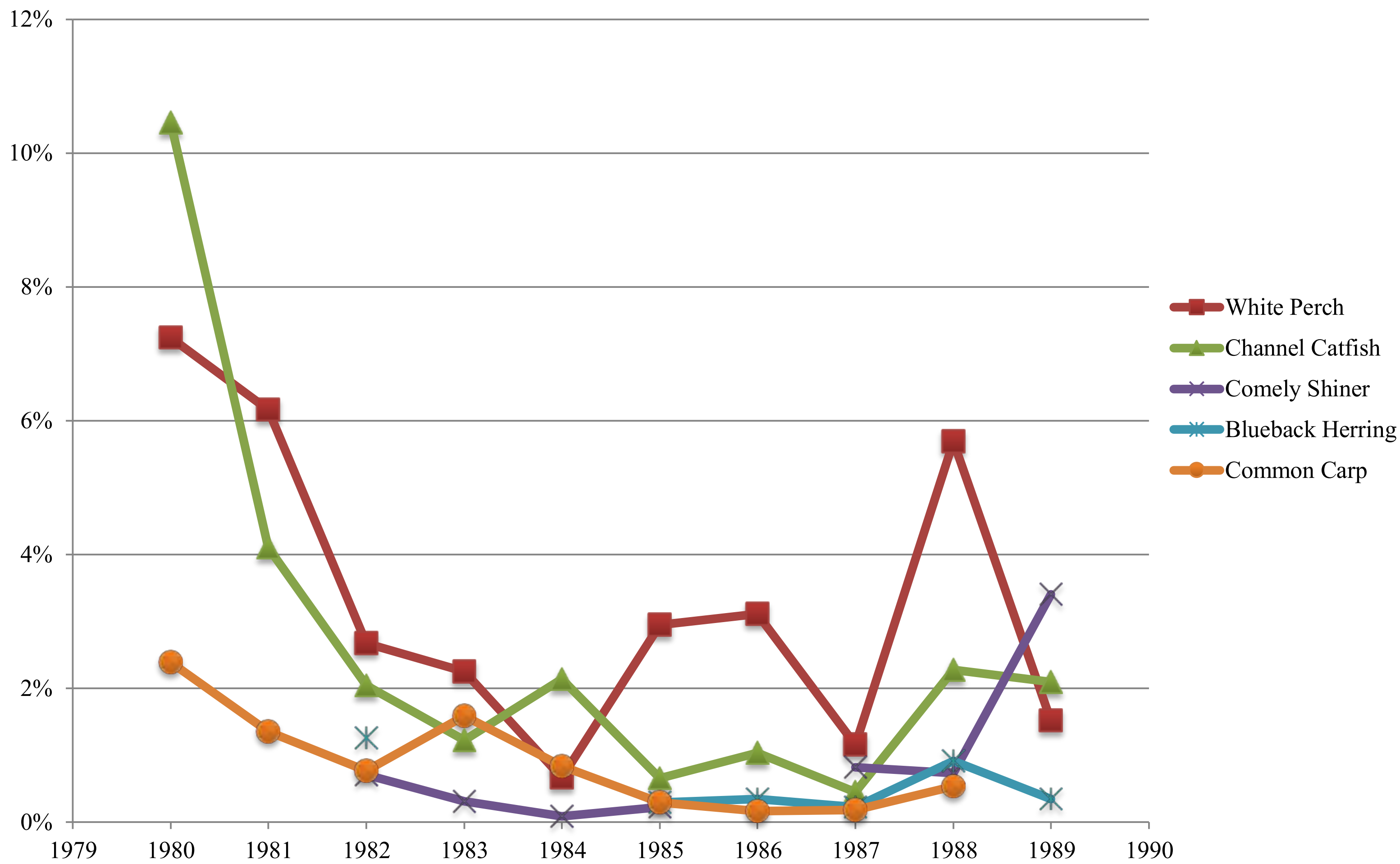
A-4. WEST FISH LIFT PROPORTIONAL ABUNDANCE, BASED ON TOP TEN CPUES 1972 - 1979



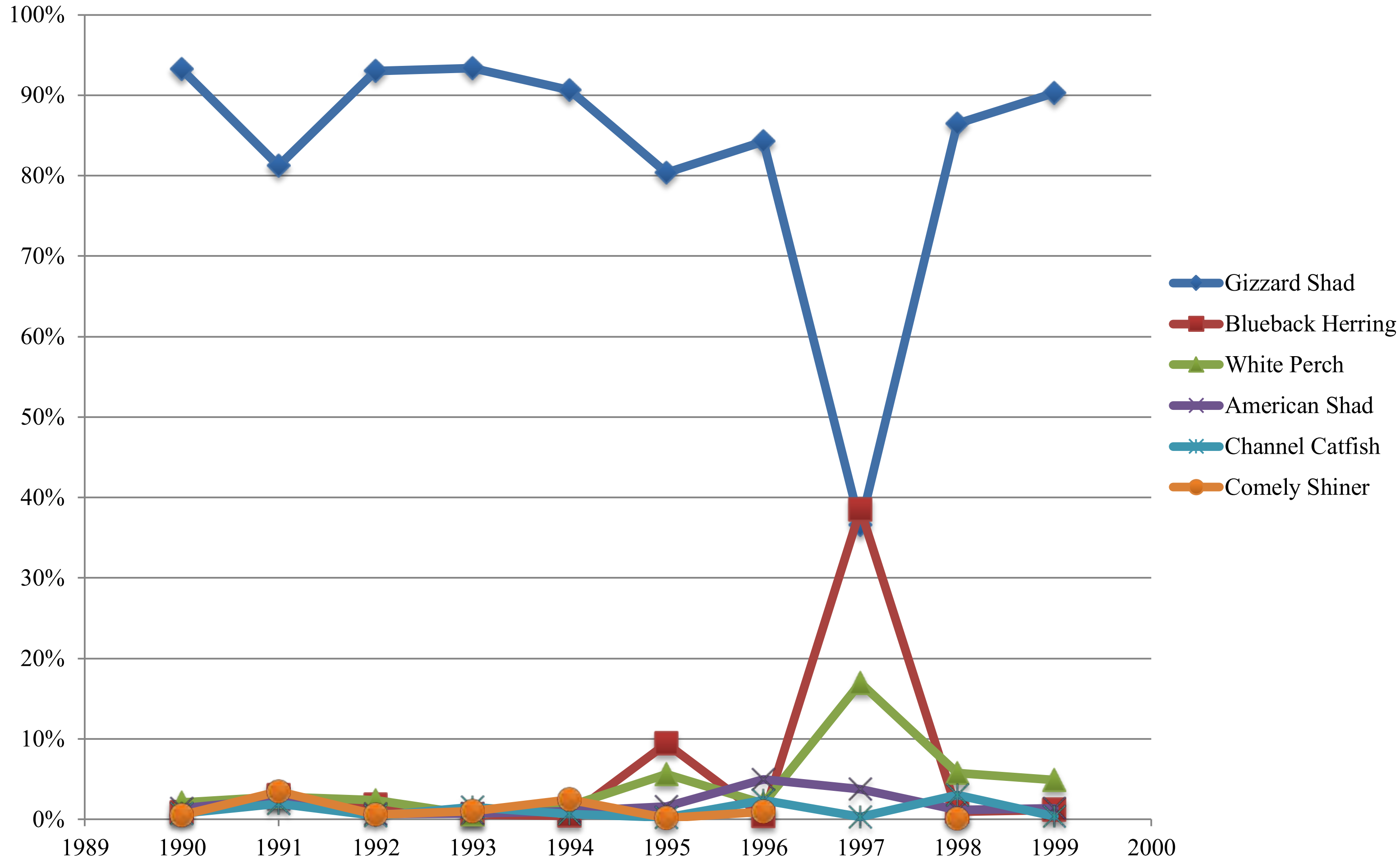
A-5. WEST FISH LIFT PROPORTIONAL ABUNDANCE, BASED ON TOP TEN CPUES 1980 – 1989



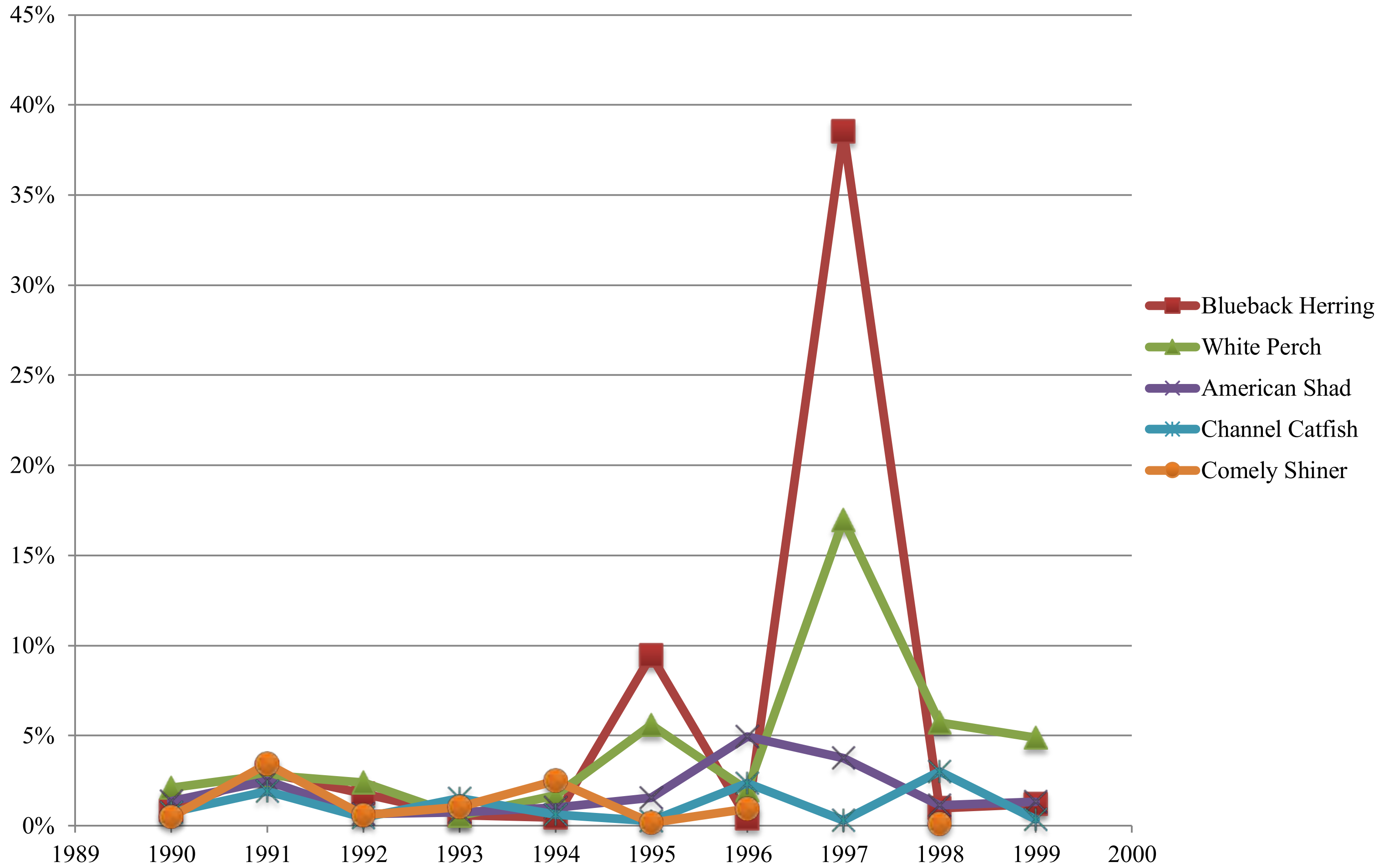
A-6. WEST FISH LIFT PROPORTIONAL ABUNDANCE, BASED ON TOP TEN CPUES 1980 – 1989 GIZZARD SHAD REMOVED



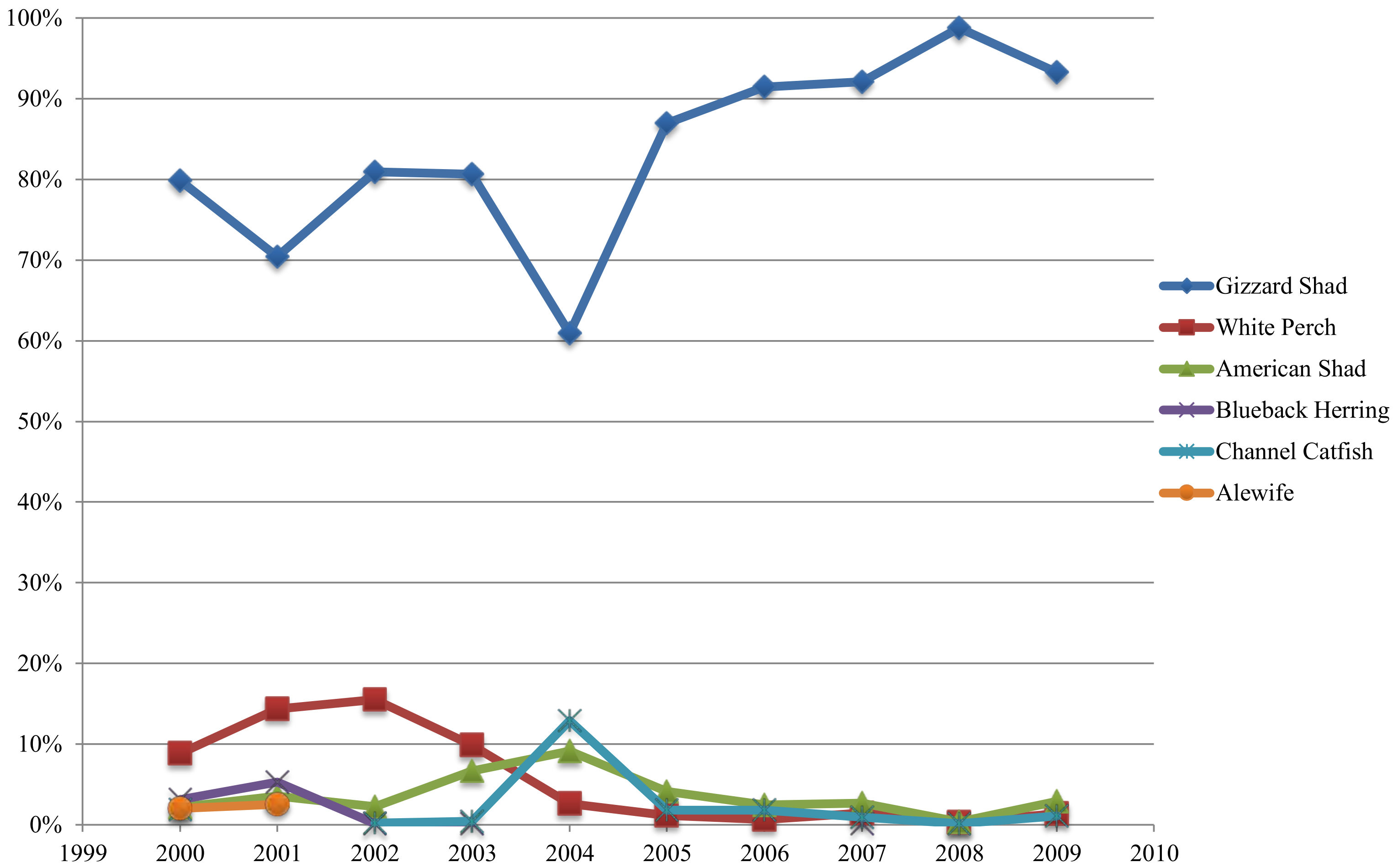
A-7. WEST FISH LIFT PROPORTIONAL ABUNDANCE, BASED ON TOP TEN CPUES 1990 – 1999



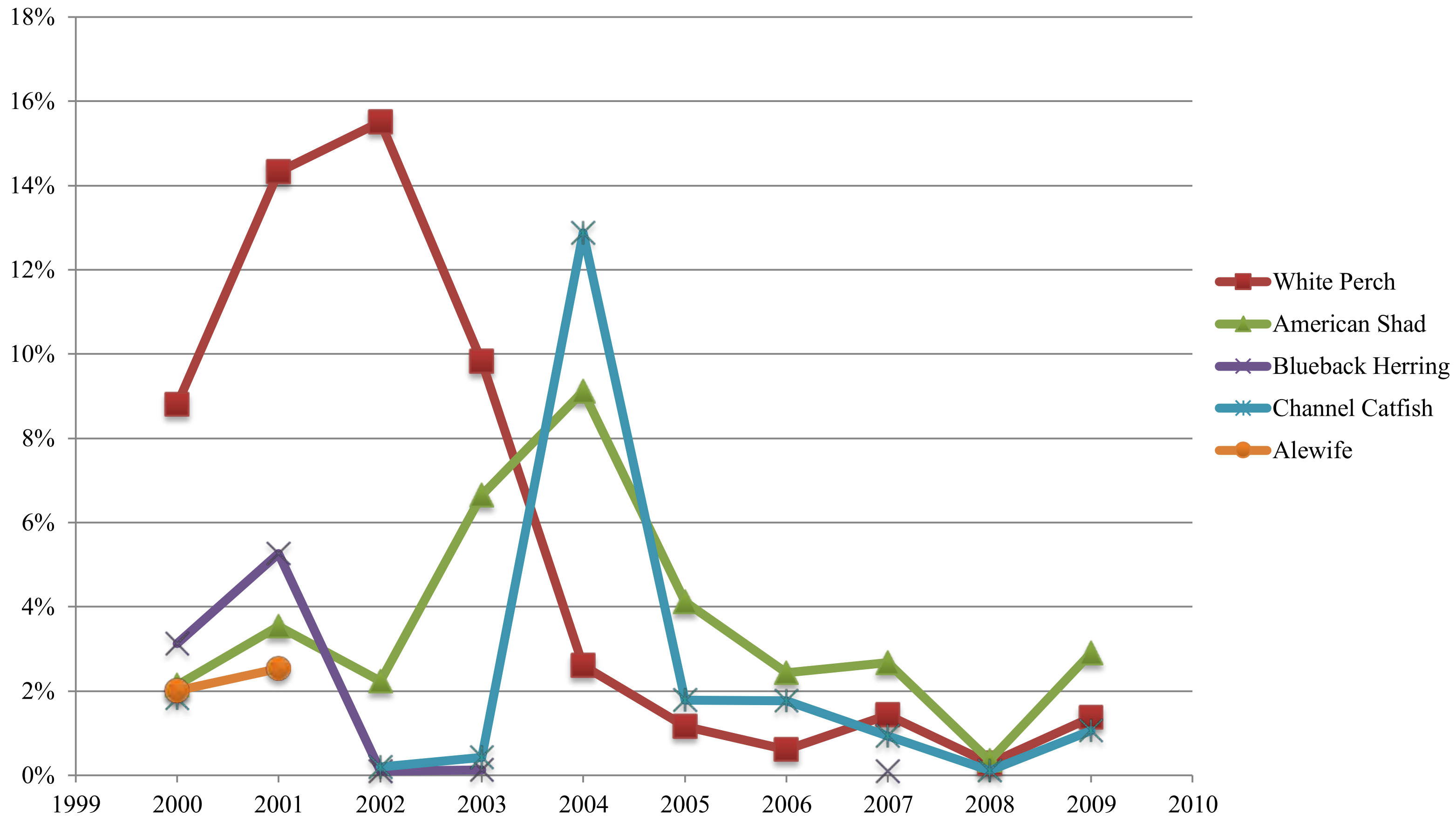
A-8. WEST FISH LIFT PROPORTIONAL ABUNDANCE, BASED ON TOP TEN CPUES 1990 – 1999 GIZZARD SHAD REMOVED



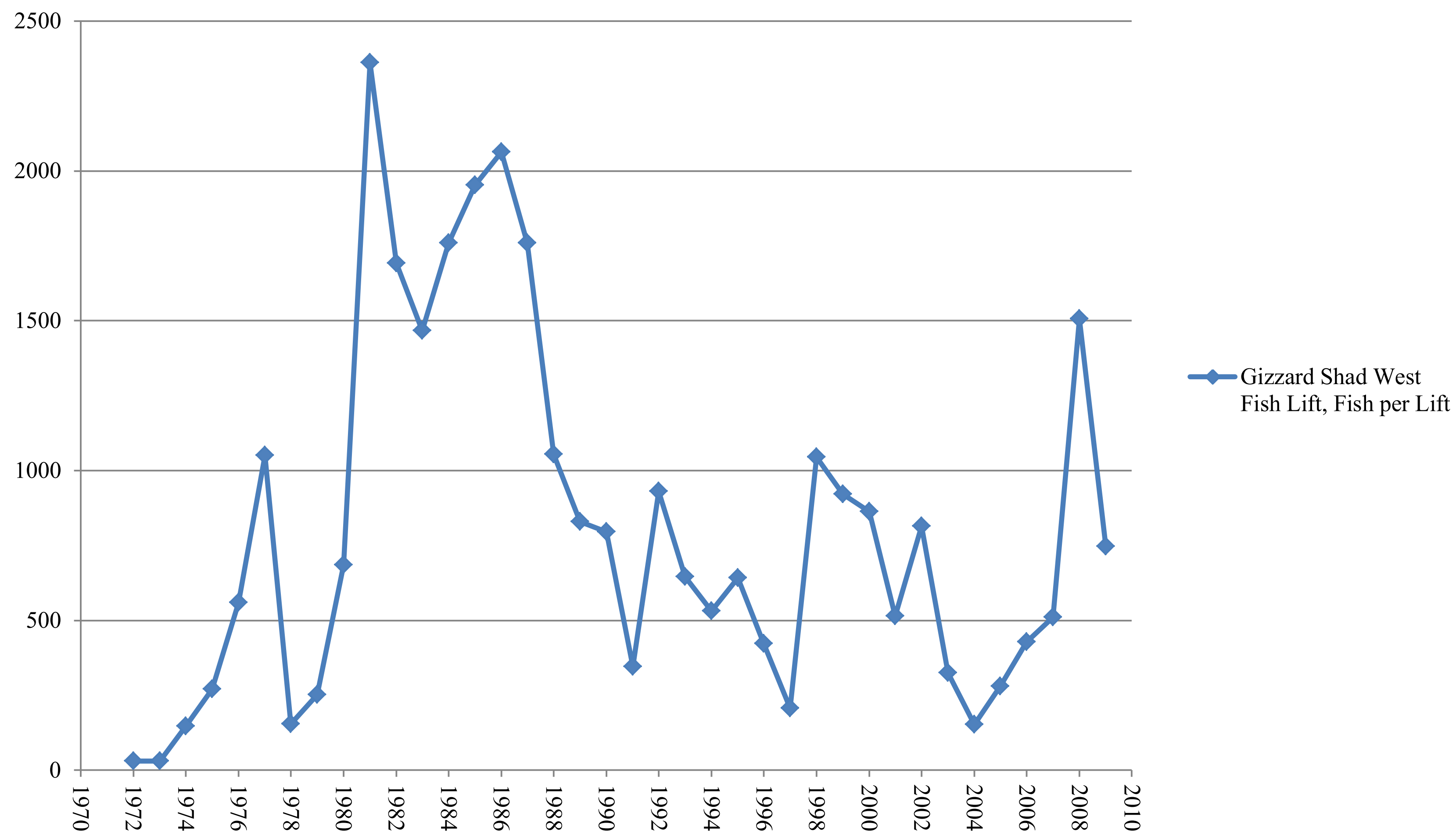
A-9. WEST FISH LIFT PROPORTIONAL ABUNDANCE, BASED ON TOP TEN CPUES 2000 – 2009



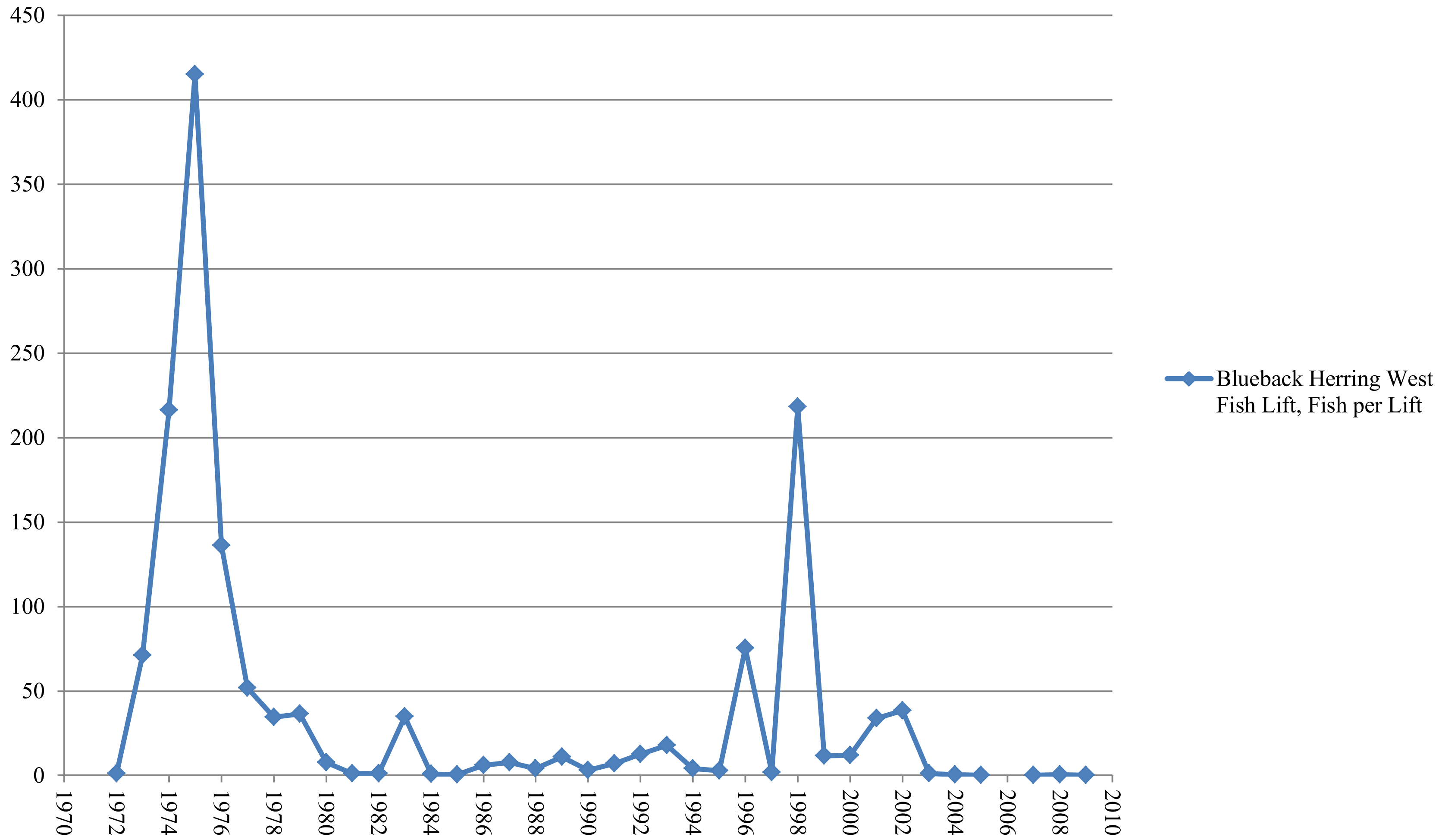
A-10. WEST FISH LIFT PROPORTIONAL ABUNDANCE, BASED ON TOP TEN CPUES 2000 – 2009 GIZZARD SHAD REMOVED



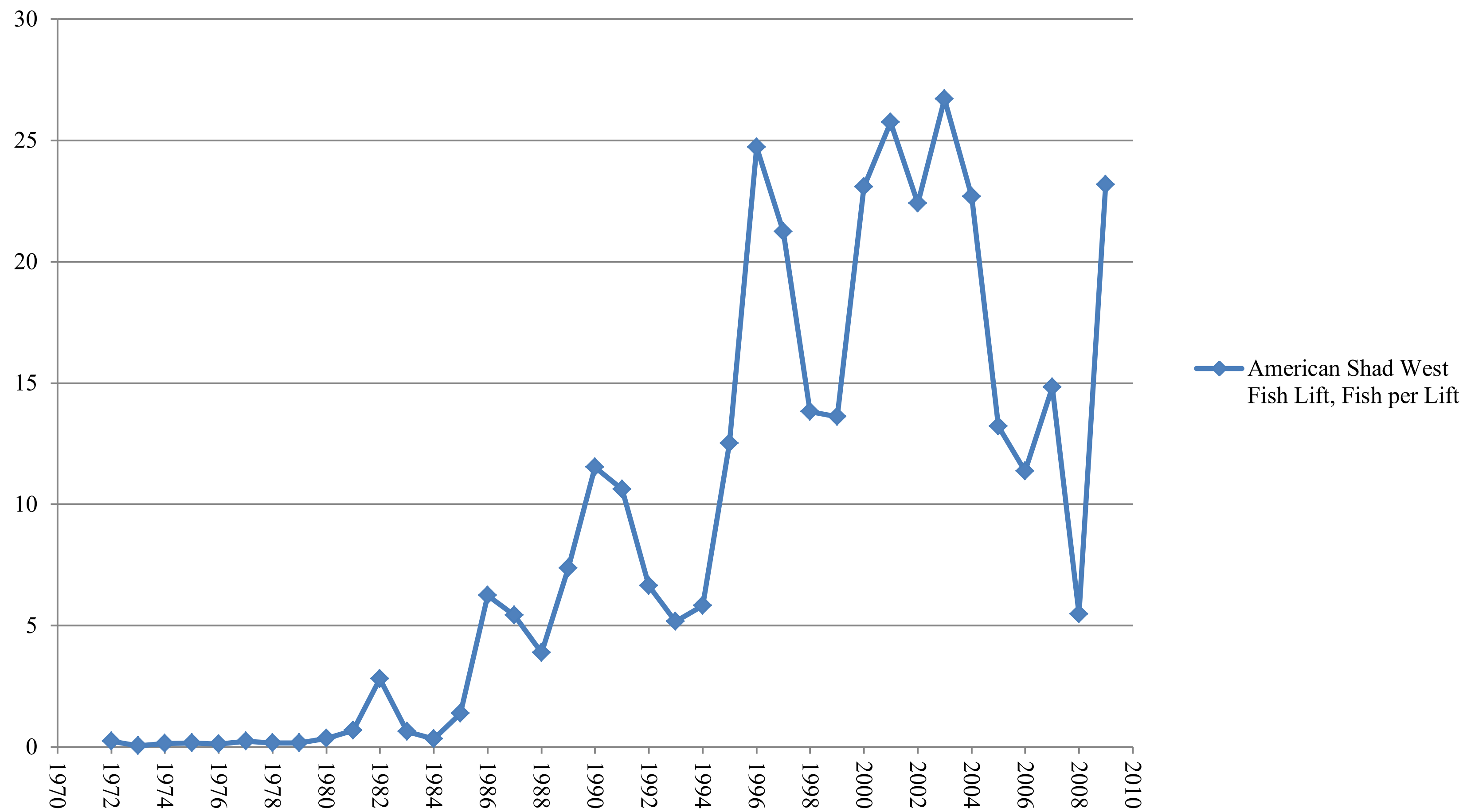
A-11. GIZZARD SHAD (DOROSOMA CEPEDIANUM) WEST FISH LIFT, FISH PER LIFT



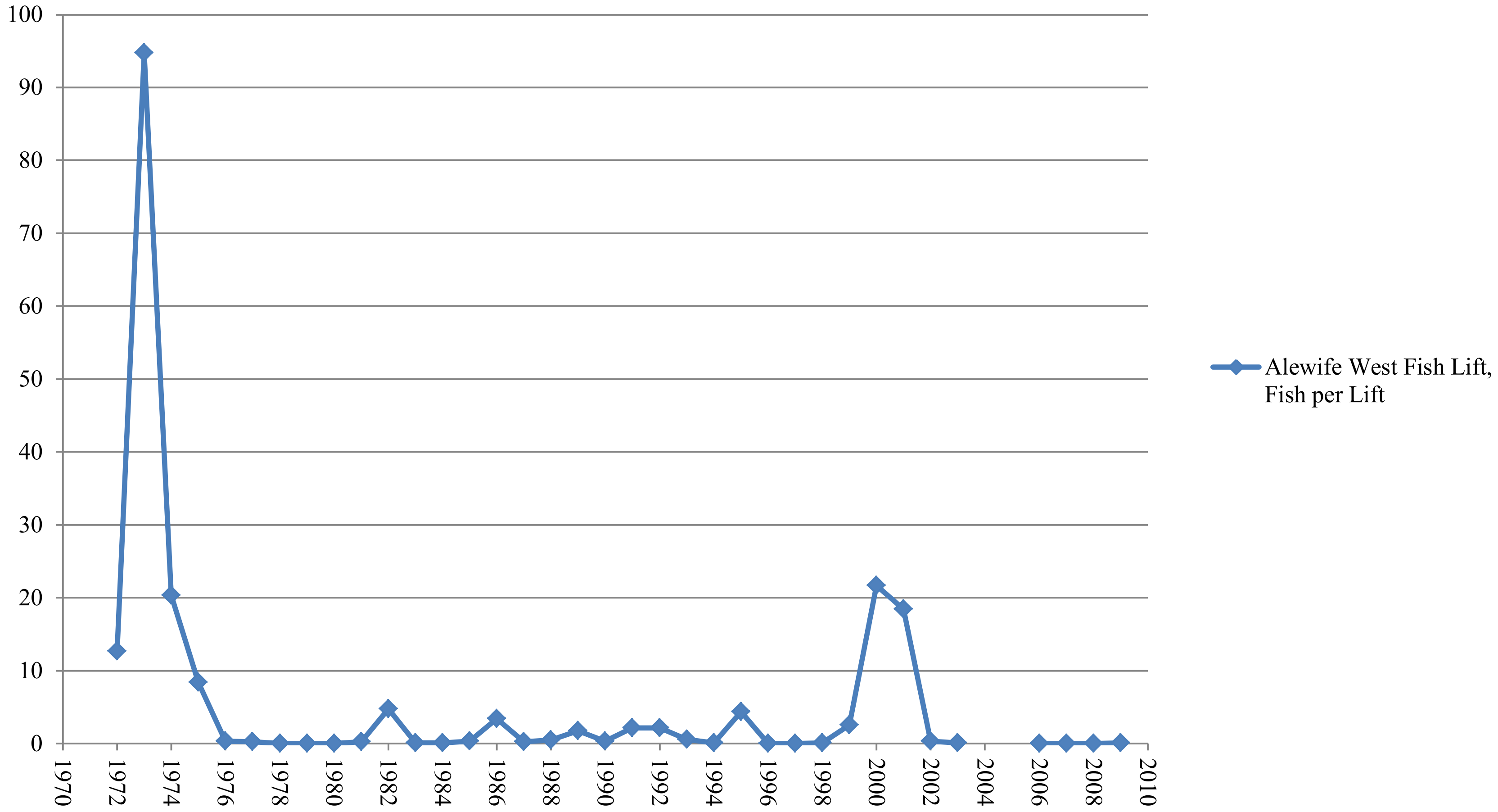
A-12. BLUEBACK HERRING (ALOSA AESTIVALIS) WEST FISH LIFT, FISH PER LIFT



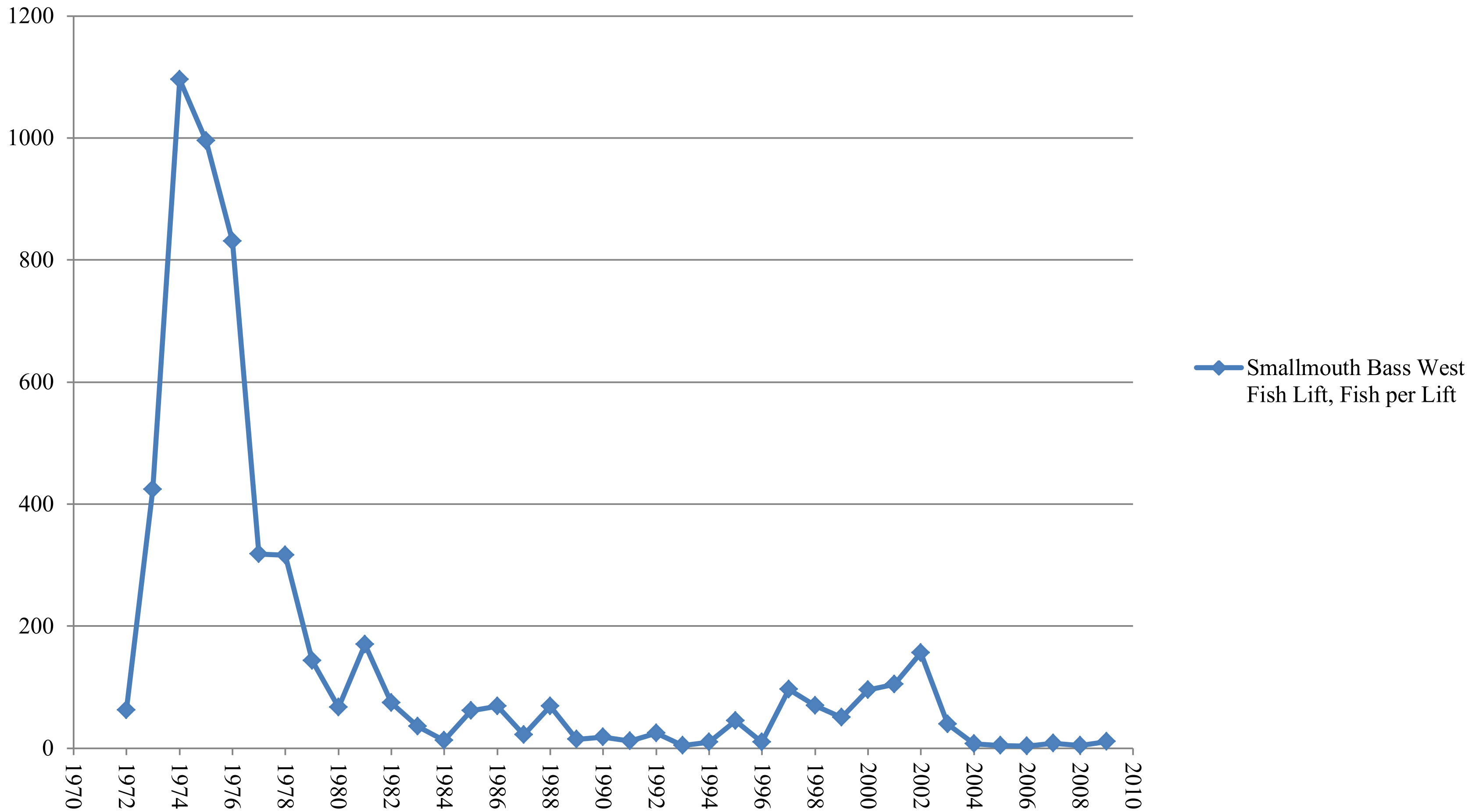
A-13. AMERICAN SHAD (ALOSA SAPIDISSIMA) WEST FISH LIFT, FISH PER LIFT



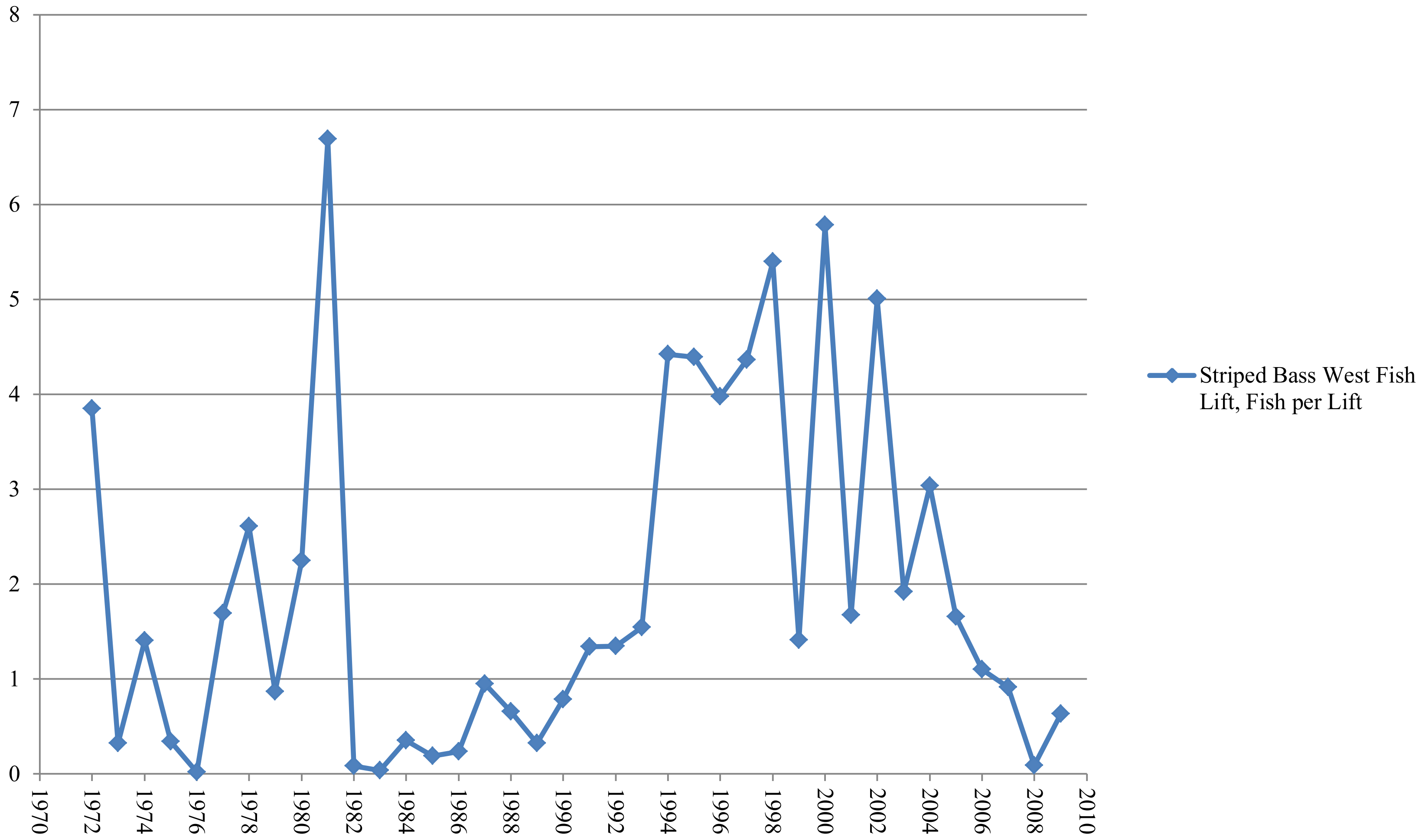
A-14. ALEWIFE (ALOSA PSEUDOHARENGUS) WEST FISH LIFT, FISH PER LIFT



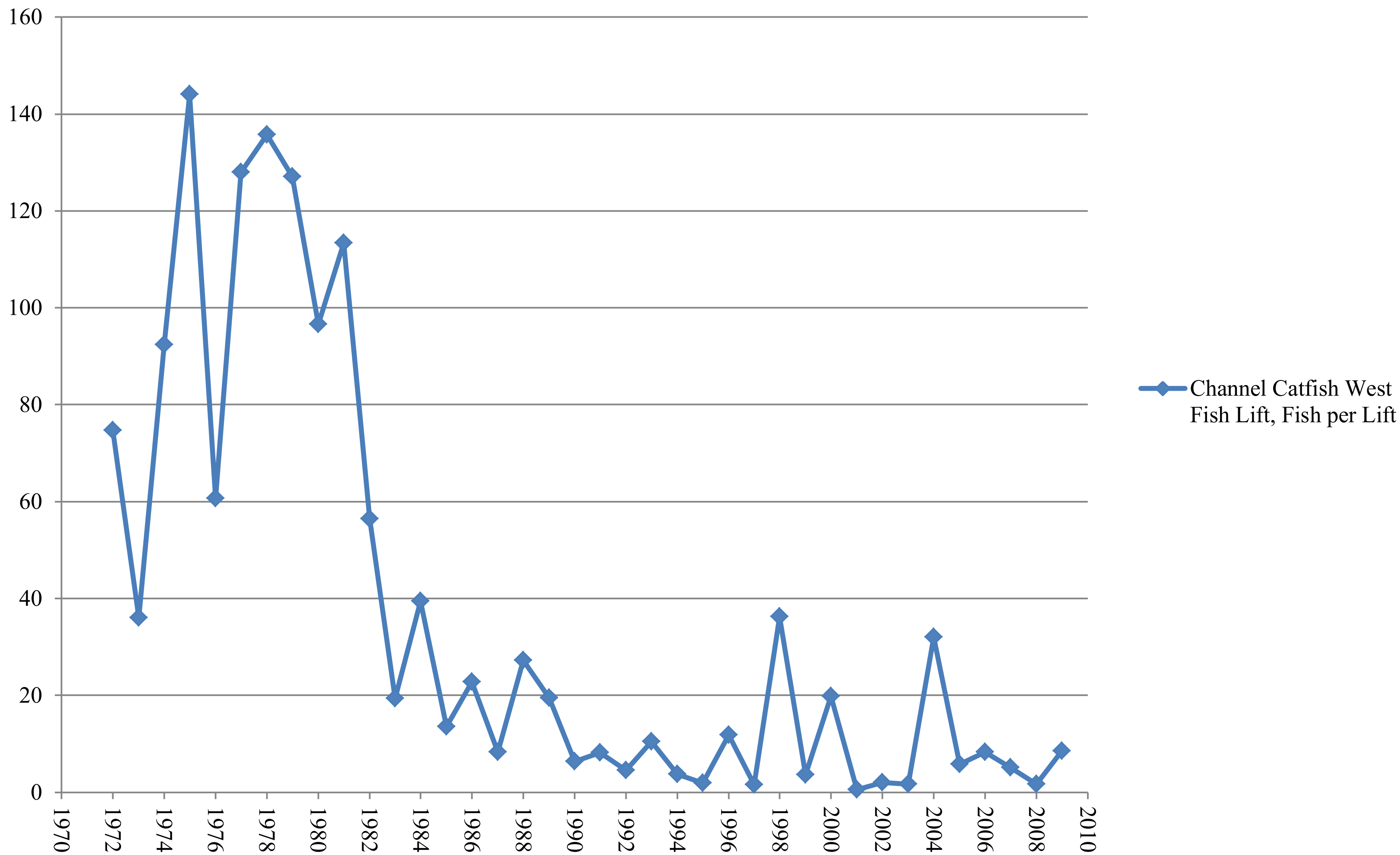
A-15. WHITE PERCH (MORONE AMERICANA) WEST FISH LIFT, FISH PER LIFT



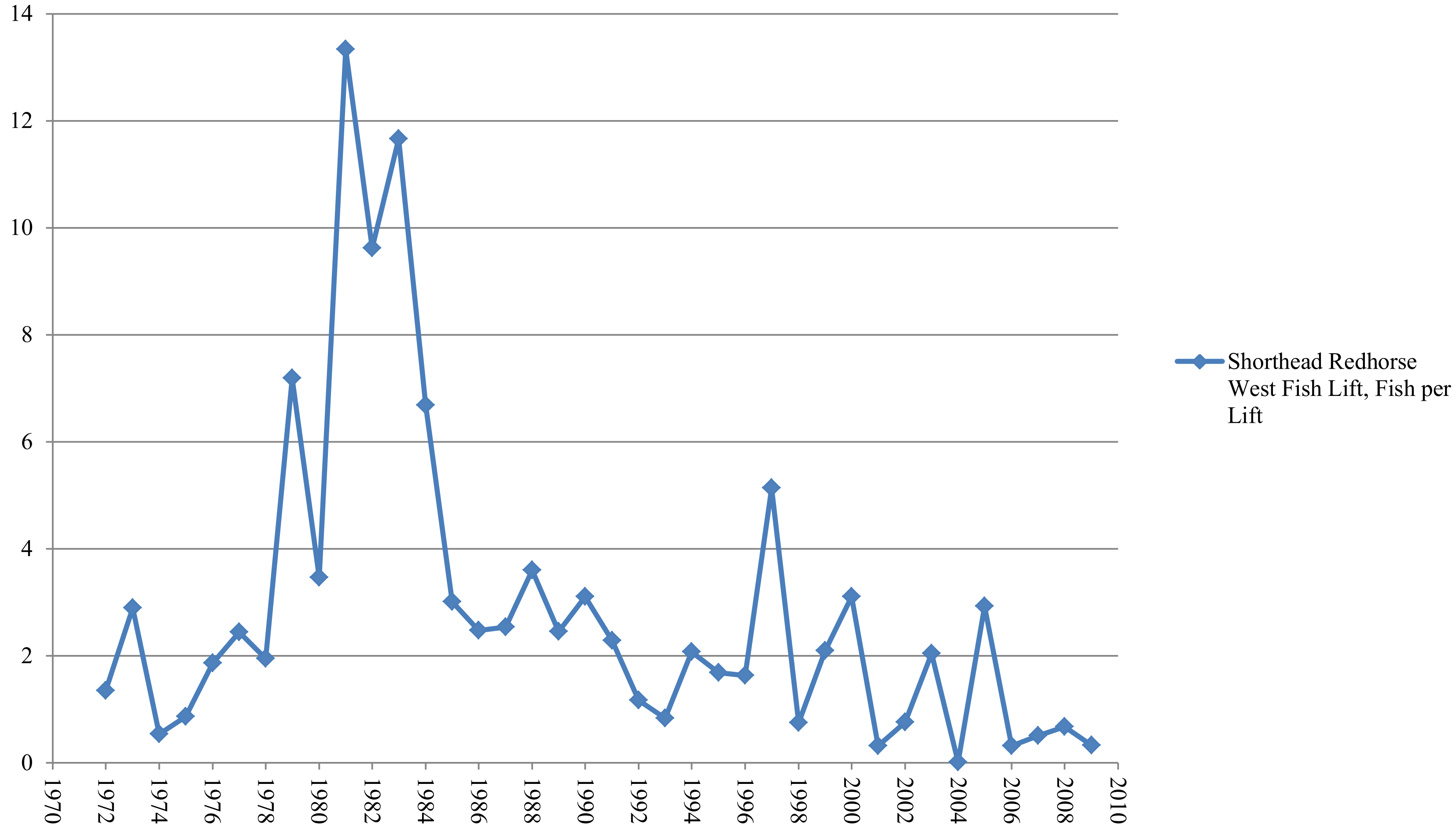
A-16. STRIPED BASS (MORONE SAXATILIS) WEST FISH LIFT, FISH PER LIFT



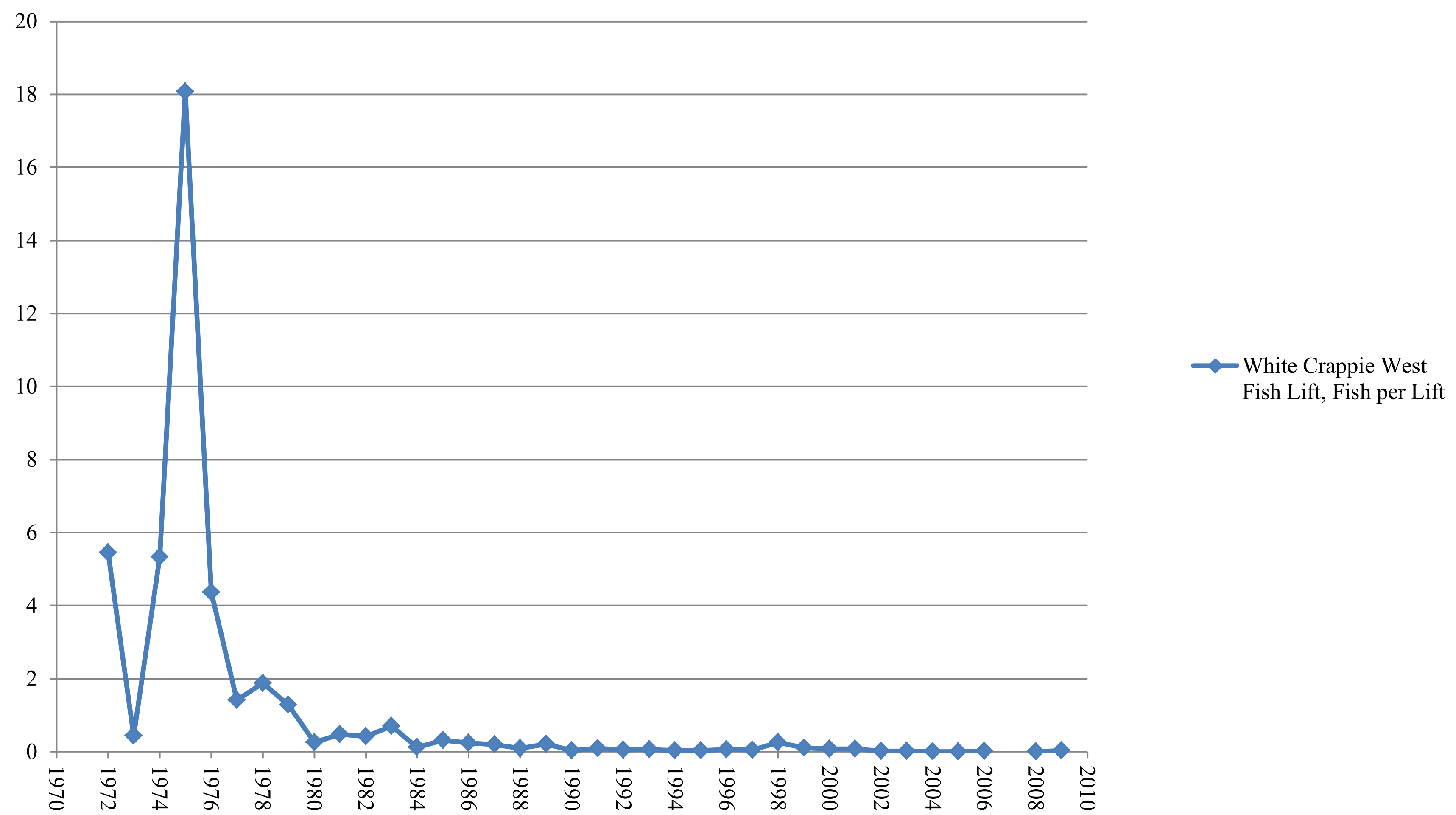
A-17.CHANNEL CATFISH (ICTALURUS PUNCTATUS) WEST FISH LIFT, FISH PER LIFT



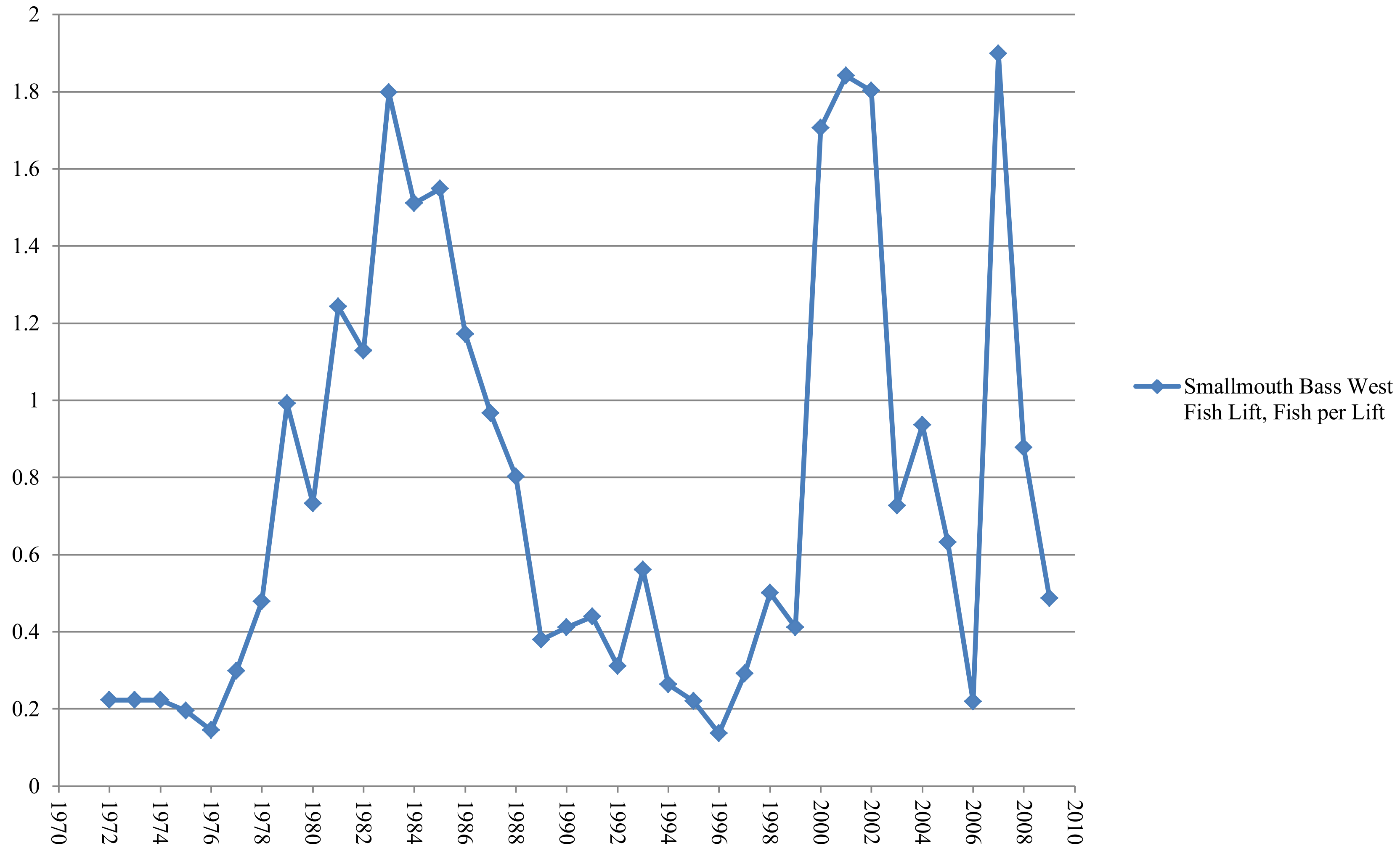
A-18. SHORTHEAD REDHORSE (MOXOSTOMA MACROEPIDOTUM) WEST FISH LIFT, FISH PER LIFT



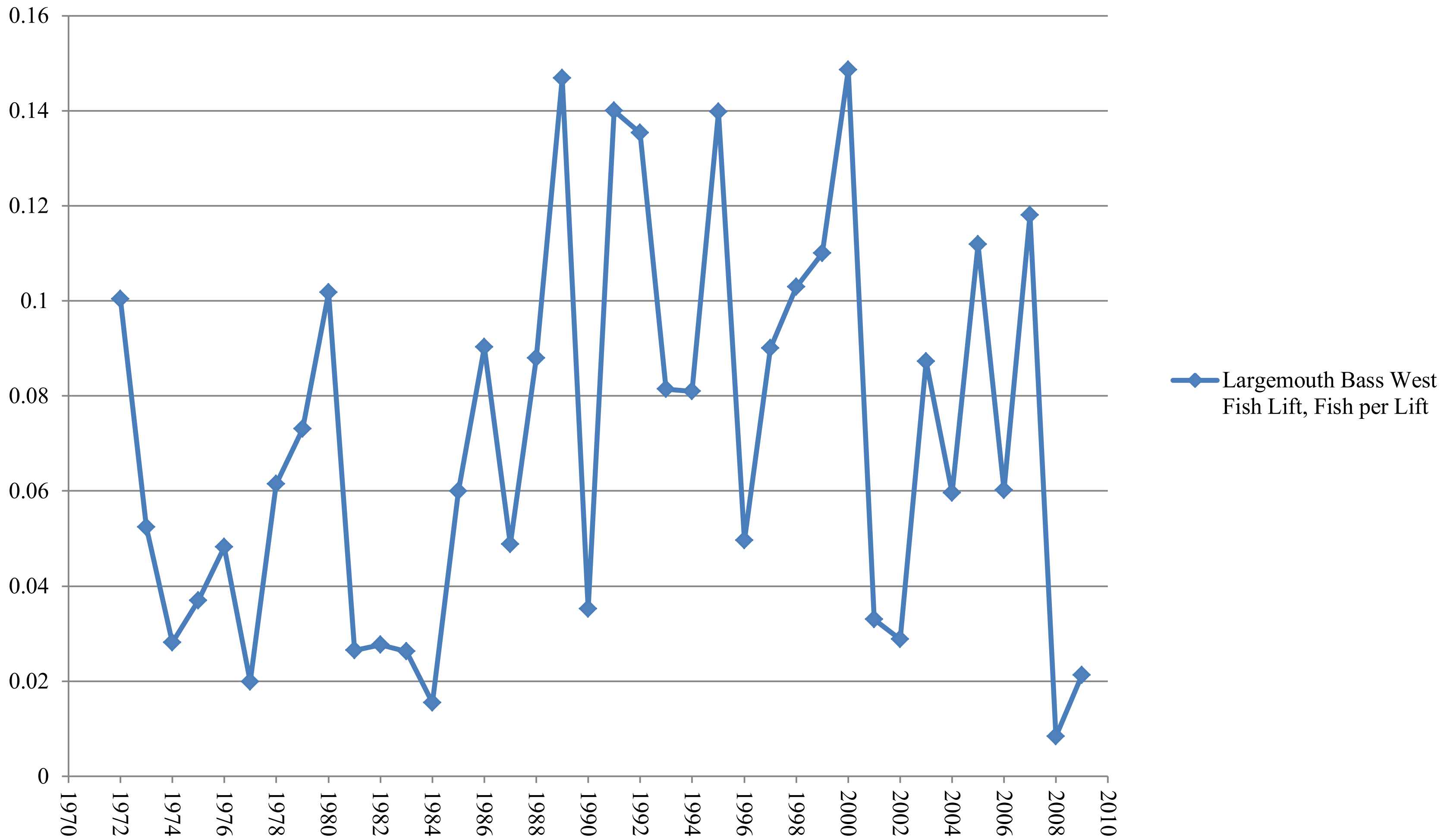
A-19. WHITE CRAPPIE (POMOXIS ANNULARIS) WEST FISH LIFT, FISH PER LIFT



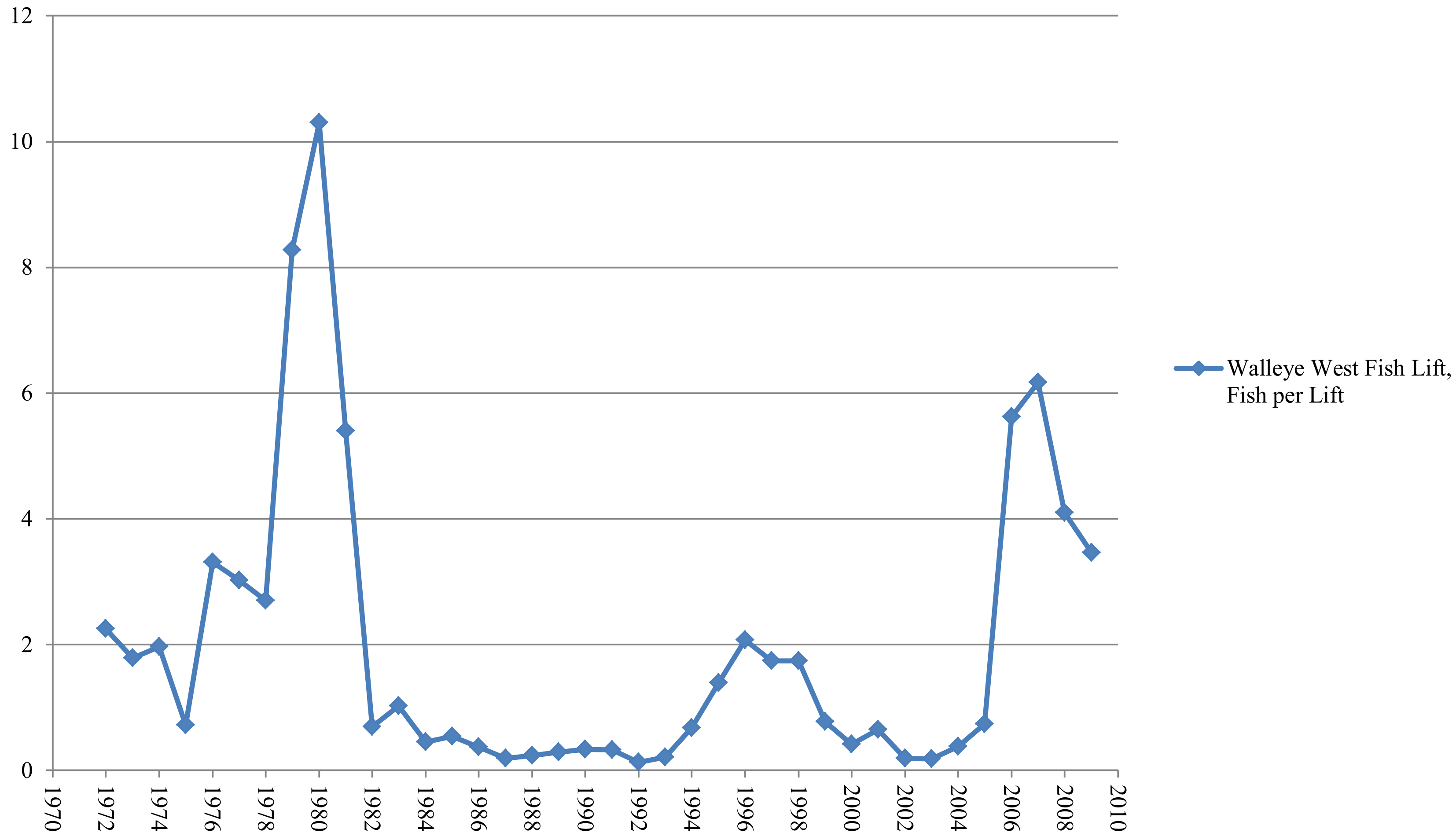
A-20. SMALLMOUTH BASS (MICROPTERUS DOLOMIEU) WEST FISH LIFT, FISH PER LIFT



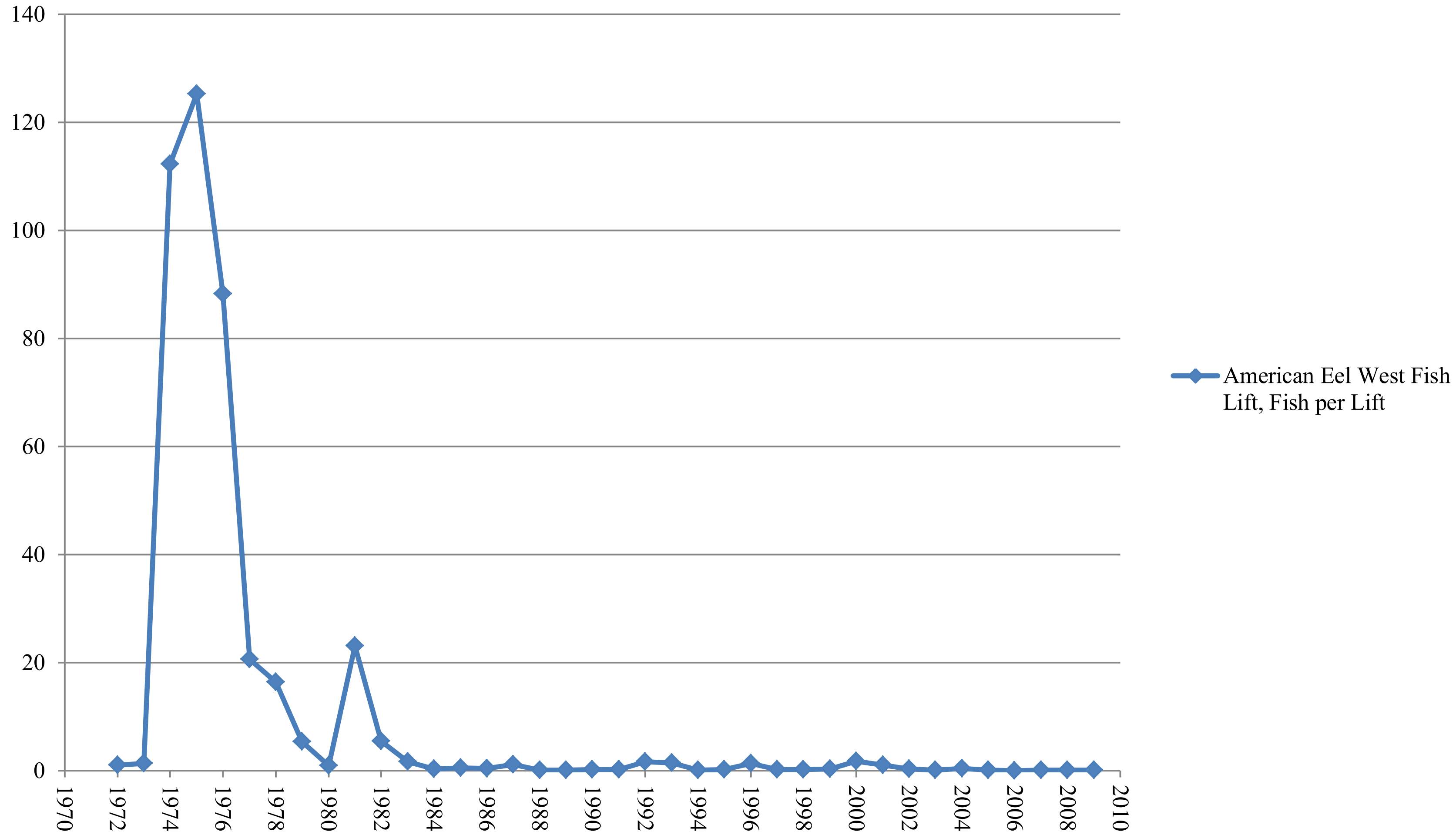
A-21. LARGEMOUTH BASS (MICROPTERUS SALMOIDES) WEST FISH LIFT, FISH PER LIFT



A-22. WALLEYE (SANDER VITREUS) WEST FISH LIFT, FISH PER LIFT



A-23. AMERICAN EEL (ANGUILLA ROSTRATA) WEST FISH LIFT, FISH PER LIFT



A-24. MONTHLY CATCH WEST FISH LIFT 1982 & 1984

Month	Apr-82	May-82	Jun-82	Jul-82	Aug-82	Sep-82	Oct-82	Nov-82	Dec-82
Total Lifts	**119**	**486**	**83**	**46**	**29**	**78**	**49**	**15**	**5**
Min. Fished	**3104**	**14564**	**2655**	**1378**	**1150**	**2995**	**1090**	**315**	**150**
Hours Fished	**51.7**	**242.7**	**44.3**	**23.0**	**19.2**	**49.9**	**18.2**	**5.3**	**2.5**
Average Temp	**56**	**66.7**	**67.7**	**81.2**	**82**	**74.9**	**68.2**	**51.9**	**50**
No. of Species	**32**	**43**	**34**	**26**	**26**	**26**	**18**	**8**	**8**
Monthly Catch	**Fish per lift**	**Fish per lift**	**Fish per lift**	**Fish per lift**	**Fish per lift**	**Fish per lift**	**Fish per lift**	**Fish per lift**	**Fish per lift**
Gizzard shad	1,169.0	1,964.5	1,543.1	408.4	216.2	942.8	2,187.2	3,585.0	1,251.0
Channel catfish	14.5	36.3	147.2	43.3	42.1	86.3	251.3	40.3	-
Creek Chubsucker	-	0.005	-	-	-	-	-	-	149.0
American eel	0.1	6.0	2.1	69.1	6.8	4.1	9.5	32.3	4.0
Carp	0.8	24.5	43.8	23.7	4.0	3.9	1.7	-	1.0
White perch	5.7	40.6	8.8	1.2	0.5	0.3	-	-	-
Blueback herring	0.1	51.4	0.9	0.1	-	0.1	-	-	-
Comely shiner	0.01	29.0	0.05	11.2	0.9	0.8	-	0.3	-
Bluegill	0.03	1.8	1.2	5.3	8.8	16.1	6.2	-	-
Quillback	0.5	3.1	1.7	20.7	1.3	-	-	-	0.6
Shorthead redhorse	9.9	11.8	0.05	-	0.03	-	-	-	-
Yellow perch	0.2	1.2	0.3	1.6	5.7	4.6	1.0	-	5.0
Redbreast sunfish	-	1.9	1.3	4.4	6.5	3.8	0.8	-	-
Striped bass	0.03	0.03	0.5	7.0	8.6	0.1	-	-	-
Alewife	10.4	4.5	0.04	-	-	-	-	-	-
Pumpkinseed	-	1.1	0.9	3.6	2.0	3.8	1.9	-	-
Spotfin shiner	-	1.1	1.3	3.0	0.9	0.8	-	-	-
White crappie	0.1	0.5	0.4	2.5	1.6	1.1	0.4	0.2	-

A-24. Cont.

Month	Apr-82	May-82	Jun-82	Jul-82	Aug-82	Sep-82	Oct-82	Nov-82	Dec-82
Monthly Catch	Fish per lift	Fish per lift	Fish per lift	Fish per lift	Fish per lift	Fish per lift	Fish per lift	Fish per lift	Fish per lift
Walleye	0.7	0.8	0.5	1.1	0.4	0.4	0.3	0.1	0.4
American shad	0.0	4.2	0.05	0.02	0.0	-	-	-	-
Smallmouth bass	0.7	2.1	0.1	0.5	0.2	0.3	0.3	-	-
White catfish	0.01	0.6	2.2	0.8	0.1	-	-	-	-
White sucker	2.8	0.4	0.2	-	-	-	0.04	0.1	0.2
Striped bass X White Bass	0.1	0.3	0.4	0.2	0.4	1.0	0.8	-	-
Brown bullhead	0.5	0.1	0.8	0.3	0.2	0.04	0.02	-	-
Black crappie	-	0.1	0.01	0.2	0.4	0.3	0.1	-	-
Brown trout	0.1	0.4	0.3	-	-	-	-	-	-
Tiger muskie	0.03	0.1	0.01	0.2	0.1	0.1	0.1	0.1	-
Spottail shiner	-	0.6	-	-	-	-	-	-	-
Largemouth bass	0.03	0.03	0.03	0.1	0.1	0.1	0.2	-	-
Golden shiner	0.1	0.2	0.03	0.2	-	-	-	-	-
Rock bass	0.03	0.2	-	-	0.1	0.1	-	-	-
Green sunfish	-	0.1	0.1	0.04	0.1	0.0	-	-	-
Sea lamprey	0.1	0.1	-	-	-	-	-	-	-
Yellow bullhead	0.1	0.005	0.05	-	-	0.03	-	-	-
Rainbow trout	0.01	0.03	0.1	-	-	-	-	-	-
Rosyface shiner	0.1	-	-	-	-	-	-	-	-
White mullet	-	-	-	-	-	-	0.1	-	-
Hickory shad	-	0.03	-	-	-	-	-	-	-
Brook trout	0.01	0.01	-	-	-	-	-	-	-

A-24. Cont.

Month	Apr-82	May-82	Jun-82	Jul-82	Aug-82	Sep-82	Oct-82	Nov-82	Dec-82
Monthly Catch	Fish per lift	Fish per lift	Fish per lift	Fish per lift	Fish per lift	Fish per lift	Fish per lift	Fish per lift	Fish per lift
Margined madton	0.01	0.01	-	-	-	-	-	-	-
Goldfish	-	-	-	-	-	0.01	-	-	-
Hogchoker -	-	-	-	-	-	0.01	-	-	-
Minnows	-	-	0.01	-	-	-	-	-	-
Madtons -	-	-	0.01	-	-	-	-	-	-
Northern pike	-	0.01	-	-	-	-	-	-	-
Muskellunge	-	0.01	-	-	-	-	-	-	-
Shiners	-	0.01	-	-	-	-	-	-	-
Blacknose dace	-	0.005	-	-	-	-	-	-	-
Total	1,216.6	2,189.9	1,758.5	608.9	307.8	1,070.9	2,462.2	3,658.5	1,411.2

Month	Apr-84	May-84	Jun-84	Jul-84	Aug-84	Sep-84	Oct-84	Nov-84
Total Lifts	83	336	89	87	43	41	39	8
Min. Fished	2431	7483	2128	1070	1120	1042	700	70
Hr Fished	40.5	124.7	35.5	17.8	18.7	17.4	11.7	1.2
Average Temp	51.4	62.8	71.4	77	79.8	74.5	66.3	57.3
Monthly Catch	Fish per Lift	Fish per Lift	Fish per Lift	Fish per Lift	Fish per Lift	Fish per Lift	Fish per Lift	Fish per Lift
Gizzard shad	215.27	2,203.54	2,188.54	237.36	485.25	538.74	2,117.46	5,750.00
Channel catfish	1.87	37.78	93.44	36.32	53.72	60.00	97.43	152.50
Carp	0.11	19.28	17.12	8.23	34.42	6.76	0.49	0.25
Striped bass X White Bass	0.65	0.44	3.18	6.25	12.65	13.44	1.26	2.25
American eel	0.08	0.08	0.81	0.63	9.69	2.61	0.15	18.75

A-24. Cont.

Month	Apr-84	May-84	Jun-84	Jul-84	Aug-84	Sep-84	Oct-84	Nov-84
Monthly Catch	Fish per Lift	Fish per Lift	Fish per Lift	Fish per Lift	Fish per Lift	Fish per Lift	Fish per Lift	Fish per Lift
Bluegill	0.01	0.21	1.85	1.12	4.00	11.68	7.67	0.08
Comely shiner	-	0.40	8.26	-	-	2.44	1.04	-
White perch	0.01	4.30	6.44	0.61	0.70	0.05	-	-
Shorthead redhorse	0.57	9.81	1.29	-	-	-	-	0.25
Quillback	0.02	4.86	3.52	2.34	0.40	0.10	0.03	-
Striped bass	-	0.25	3.38	2.05	0.49	0.15	-	-
Pumpkinseed	-	0.09	0.43	0.16	0.33	2.12	0.80	-
Redbreast sunfish	-	0.40	1.21	0.26	0.44	1.36	0.21	-
White crappie	-	0.05	0.45	0.60	1.19	0.56	0.67	0.13
Tiger muskie	-	0.02	0.03	0.01	-	3.44	0.08	-
Yellow perch	0.15	0.84	1.41	0.25	0.49	0.17	0.05	-
Walleye	0.08	0.47	0.80	0.23	0.49	0.76	0.36	0.13
Smallmouth bass	0.12	1.54	0.55	0.22	0.35	0.10	0.08	0.10
Blueback herring	0.03	0.73	0.70	-	-	-	-	-
White catfish	0.02	0.12	0.67	0.22	0.12	0.10	0.10	-
Brown trout	0.02	0.19	0.70	-	-	-	-	-
Brown bullhead	0.07	0.14	0.08	-	0.50	0.05	0.03	-
White sucker	0.24	0.22	0.11	0.03	-	-	0.05	0.12
American shad	-	0.42	0.23	-	-	-	-	-
Blue Tilapia	-	-	-	-	-	0.10	0.36	-
Rock bass	-	0.28	0.14	-	-	-	-	-
Black crappie	0.01	0.01	0.03	-	0.12	0.07	0.13	-
Spotfin shiner	-	-	-	0.29	-	-	-	-
Golden shiner	-	0.02	0.02	0.01	-	0.07	-	0.13
Alewife	0.15	0.04	-	-	-	-	-	-

A-24. Cont.

Month	Apr-84	May-84	Jun-84	Jul-84	Aug-84	Sep-84	Oct-84	Nov-84
Monthly Catch	Fish per Lift	Fish per Lift	Fish per Lift	Fish per Lift	Fish per Lift	Fish per Lift	Fish per Lift	Fish per Lift
Largemouth bass	-	0.01	0.03	0.03	0.05	-	0.05	-
Sea lamprey	0.02	0.12	-	-	-	-	-	-
Green sunfish	-	0.01	0.01	0.02	0.02	-	-	-
Hickory shad	0.06	0.00	-	-	-	-	-	-
Yellow bullhead	-	0.01	0.02	0.02	-	-	-	-
Atlantic Menhaden	-	-	-	-	-	-	0.03	-
Muskellunge	-	-	-	-	-	-	0.03	-
Rainbow trout	-	0.01	-	-	-	-	-	-
Brook trout X Lake Trout	-	0.01	-	-	-	-	-	-
Total	219.57	2,286.72	2,335.47	297.28	605.40	644.87	2,228.54	5,924.68

A-25. CATCH WEST FISH LIFT 1971 - 2009

Year	1972	1972	1973	1973	1974	1974	1975	1975	1976	1976	1977	1977	1978	1978	1979	1979	Totals 1972-1979	Fish Per Lift
No. Days	54		62		58		55		63		61		35		29		**417**	
Lifts	817		1527		819		514		684		707		358		301		**5727**	
Est. Oper. Time(HR)	608		996		500		500		307		375		413		187		**3886**	
Fishing Time (HR)	313		623		222		222		189		252		136		123		**2080**	
#Species	40	Fish per lift	43	Fish per lift	42	Fish per lift	41	Fish per lift	38	Fish per lift	40	Fish per lift	44	Fish per lift	37	Fish per lift		
Gizzard Shad	24849	30.4	45668	29.9	119672	146.1	139222	270.9	382275	558.9	742056	1049.6	55104	153.9	75553	251.0	**1584399**	**276.7**
White Perch	50991	62.4	647493	424.0	897113	1095.4	511699	995.5	568018	830.4	224843	318.0	113164	316.1	43103	143.2	**3056424**	**533.7**
Blueback Herring	58198	71.2	330341	216.3	340084	415.2	69916	136.0	35519	51.9	24395	34.5	13098	36.6	2282	7.6	**873833**	**152.6**
Channel Catfish	61042	74.7	55084	36.1	75663	92.4	74042	144.1	41508	60.7	90442	127.9	48575	135.7	38251	127.1	**484607**	**84.6**
Common Carp	4370	5.3	16362	10.7	34383	42.0	15114	29.4	6755	9.9	16256	23.0	11842	33.1	14946	49.7	**120028**	**21.0**
American Eel	805	1.0	2050	1.3	91937	112.3	64375	125.2	60409	88.3	14601	20.7	5878	16.4	1602	5.3	**241657**	**42.2**
Alewife	10345	12.7	144727	94.8	16675	20.4	4311	8.4	235	0.3	188	0.3	5	0.0	9	0.0	**176495**	**30.8**
American Shad	182	0.2	65	0.0	121	0.1	87	0.2	82	0.1	165	0.2	54	0.2	50	0.2	**806**	**0.1**
Comely Shiner	5	0.0	252	0.2	3870	4.7	2079	4.0	740	1.1	769	1.1	1152	3.2	1707	5.7	**10574**	**1.8**
Quillback	7119	8.7	27780	18.2	14565	17.8	8388	16.3	9882	14.4	6734	9.5	2361	6.6	5134	17.1	**81963**	**14.3**
Shorthead Redhorse	1097	1.3	4420	2.9	434	0.5	445	0.9	1276	1.9	1724	2.4	697	1.9	2163	7.2	**12256**	**2.1**
Spotfin Shiner	103	0.1	40	0.0	3011	3.7	1231	2.4	45879	67.1	7960	11.3	3751	10.5	41	0.1	**62016**	**10.8**
Striped Bass	3142	3.8	495	0.3	1150	1.4	174	0.3	13	0.0	1196	1.7	934	2.6	260	0.9	**7364**	**1.3**
Spottail Shiner	34	0.0	137	0.1	2036	2.5	268	0.5	1743	2.5	8107	11.5	8506	23.8	1533	5.1	**22364**	**3.9**
Redbreast Sunfish	707	0.9	2056	1.3	1398	1.7	3040	5.9	3772	5.5	8277	11.7	4187	11.7	3466	11.5	**26903**	**4.7**
White Catfish	3070	3.8	6394	4.2	2200	2.7	6178	12.0	1451	2.1	3081	4.4	982	2.7	515	1.7	**23871**	**4.2**
Walleye	1840	2.3	2734	1.8	1613	2.0	369	0.7	2267	3.3	2140	3.0	967	2.7	2491	8.3	**14421**	**2.5**
Bluegill	567	0.7	1423	0.9	927	1.1	3058	5.9	2712	4.0	5442	7.7	1361	3.8	813	2.7	**16303**	**2.8**
Striped Bass x White Bass	--		--		--		--		--		--		270	0.8	273	0.9	**543**	**0.1**
White Crappie	4457	5.5	664	0.4	4371	5.3	9290	18.1	2987	4.4	1003	1.4	673	1.9	384	1.3	**23829**	**4.2**
Yellow Perch	5955	7.3	1090	0.7	682	0.8	494	1.0	2904	4.2	735	1.0	526	1.5	379	1.3	**12765**	**2.2**
Brown Bullhead	510	0.6	5328	3.5	1612	2.0	740	1.4	451	0.7	2416	3.4	125	0.3	284	0.9	**11466**	**2.0**
Smallmouth Bass	182	0.2	298	0.2	119	0.1	153	0.3	327	0.5	701	1.0	262	0.7	374	1.2	**2416**	**0.4**
Pumpkinseed	229	0.3	2578	1.7	2579	3.1	1000	1.9	878	1.3	1687	2.4	512	1.4	323	1.1	**9786**	**1.7**
White Sucker	363	0.4	1034	0.7	286	0.3	152	0.3	444	0.6	282	0.4	189	0.5	906	3.0	**3656**	**0.6**
Golden Shiner	165	0.2	430	0.3	437	0.5	751	1.5	1622	2.4	652	0.9	221	0.6	304	1.0	**4582**	**0.8**
Brown Trout	172	0.2	286	0.2	483	0.6	219	0.4	427	0.6	700	1.0	261	0.7	324	1.1	**2872**	**0.5**
Rock Bass	66	0.1	32	0.0	31	0.0	46	0.1	227	0.3	128	0.2	50	0.1	46	0.2	**626**	**0.1**
Hickory Shad	429	0.5	739	0.5	219	0.3	20	0.0	--		1	0.0	--		--		**1408**	**0.2**
Atlantic Menhaden	--		--		112	0.1	--		506	0.7	1596	2.3	--		--		**2214**	**0.4**
Largemouth Bass	82	0.1	80	0.1	23	0.0	19	0.0	33	0.0	14	0.0	22	0.1	22	0.1	**295**	**0.1**
Yellow Bullhead	7	0.0	45	0.0	1	0.0	32	0.1	2	0.0	47	0.1	25	0.1	13	0.0	**172**	**0.0**
Black Crappie	8	0.0	4	0.0	25	0.0	45	0.1	86	0.1	199	0.3	103	0.3	53	0.2	**523**	**0.1**
Rainbow Trout	34	0.0	67	0.0	20	0.0	24	0.0	54	0.1	291	0.4	70	0.2	15	0.0	**575**	**0.1**
Sea Lamprey	--		2	0.0	--		2	0.0	29	0.0	11	0.0	1	0.0	3	0.0	**48**	**0.0**
Green Sunfish	3	0.0	--		4	0.0	39	0.1	81	0.1	168	0.2	25	0.1	--		**320**	**0.1**
Tiger Muskie	--		--		--		--		--		--		13	0.0	132	0.4	**145**	**0.0**
Muskellunge	20	0.0	104	0.1	9	0.0	7	0.0	12	0.0	48	0.1	14	0.0	5	0.0	**219**	**0.0**
Flathead Catfish																		
Shiners	264	0.3	3	0.0	--		--		--		--		--		--		**267**	**0.0**
Atlantic Needlefish	1	0.0	--		--		1	0.0	--		--		--		--		**2**	**0.0**
Brook Trout	1	0.0	3	0.0	4	0.0	1	0.0	--		2	0.0	23	0.1	--		**34**	**0.0**
Bluntnose Minnow	--		--		--		--		--		--		4	0.0	--		**4**	**0.0**

A-25 Cont.

Year	**1972**	**1972**	**1973**	**1973**	**1974**	**1974**	**1975**	**1975**	**1976**	**1976**	**1977**	**1977**	**1978**	**1978**	**1979**	**1979**	**Totals 1972-1979**	**Fish Per Lift**
No. Days	54		62		58		55		63		61		35		29		**417**	
Lifts	817		1527		819		514		684		707		358		301		**5727**	
Est. Oper. Time(HR)	608		996		500		500		307		375		413		187		**3886**	
Fishing Time (HR)	313		623		222		222		189		252		136		123		**2080**	
#Species	40	Fish per lift	43	Fish per lift	42	Fish per lift	41	Fish per lift	38	Fish per lift	40	Fish per lift	44	Fish per lift	37	Fish per lift		
Northern Hog Sucker	--		2	0.0	--		1	0.0	5	0.0	--		3	0.0	6	0.0	**17**	**0.0**
Goldfish	--		27	0.0	1	0.0	9	0.0	4	0.0	1	0.0	--		--		**42**	**0.0**
Tessellated Darter	--		1	0.0	4	0.0	1	0.0	--		--		1	0.0	--		**7**	**0.0**
Logperch	--		--		--		--		--		--		27	0.1	--		**27**	**0.0**
Brook Trout x Lake Trout	--		--		--		--		--		--		--		--			
Northern Pike	--		2	0.0	2	0.0	--		--		2	0.0	2	0.0	4	0.0	**12**	**0.0**
Striped Bass x White Perch	--		--		--		--		--		--		--		--			
Creek Chubsucker	3	0.0	3	0.0	1	0.0	--		--		--		--		--		**7**	**0.0**
Chain Pickerel	--		1	0.0	10	0.0	--		--		1	0.0	--		--		**12**	**0.0**
Margined Madtom	--		--		--		--		--		--		--		--			
Banded Darter	--		--		--		--		--		--		1	0.0	--		**1**	**0.0**
Rosyface Shiner	1	0.0	--		--		1	0.0	--		--		--		--		**2**	**0.0**
Swallowtail Shiner	--		--		--		--		--		--		--		--			
Shield Darter	--		--		--		--		--		--		--		--			
Greenside Darter	--		--		--		--		--		--		--		--			
Longnose Dace	--		--		--		--		--		--		4	0.0	--		**4**	**0.0**
Tadpole Madtom	--		--		--		--		--		--		--		--			
Trouts	1	0.0	--		--		--		--		--		--		--		**1**	**0.0**
Sunfishes	--		--		--		--		--		--		--		--			
Trout	--		--		--		--		--		--		--		--			
Rainbow Smelt	--		--		--		--		--		--		--		--			
Blacknose Dace	--		--		--		--		--		--		--		--			
Mummichog	--		--		--		--		1	0.0	--		--		--		**1**	**0.0**
Lampreys	--		--		--		--		--		--		--		--			
Lake Herring	--		1	0.0	--		--		--		--		--		--		**1**	**0.0**
Striped Mullet	--		--		--		--		--		--		--		--			
Sunfish Hybrids																		
Palomino (Rainbow Trout)	--		--		--		--		--		--		--		--			
Redfin Pickerel	--		--		--		--		--		--		--		--			
Carps and Minnows	--		--		--		--		--		--		--		--			
River Chub	--		--		--		--		--		--		--		--			
Creek Chub	--		--		--		--		--		--		--		--			
Madtoms	--		--		--		--		--		--		--		--			
Bigmouth Buffalo	--		--		--		--		--		--		--		--			
Total	**241419**	295.5	**1300345**	851.6	**1617887**	1975.4	**917043**	1784.1	**1175616**	1718.7	**1169061**	1653.6	**276045**	771.1	**197769**	657.0	**6895185**	**1204.0**

A-25 Cont.

Year	1980	1980	1981	1981	1982	1982	1983	1983	1984	1984	1985	1985	1986	1986	1987	1987	1988	1988	1989	1989	Totals 1980-1989	
No. Days	30	Fish per lift	37		44		29		34		55		59		60		63		51		**462**	
Lifts	403		490		725		648		519		1118		831		1414		1330		1117		**8595**	
Est. Oper. Time(HR)	221		275		502		299		251		542		546		639		637		539		**4451**	
Fishing Time (HR)	117		178		336		224		192		421		449		532		513		457		**3419**	
#Species	42	Fish per lift	48	Fish per lift	46	Fish per lift	40	Fish per lift	35	Fish per lift	41	Fish per lift	43	Fish per lift	46	Fish per lift	49	Fish per lift	45	Fish per lift		Fish per lift
Gizzard Shad	275736	684.2	1156662	2360.5	1226374	1691.6	950252	1466.4	912666	1758.5	2182888	1952.5	1714441	2063.1	2488618	1760.0	1402565	1054.6	926213	829.2	**13236415**	**1540.0**
White Perch	26971	66.9	83363	170.1	53527	73.8	23151	35.7	6402	12.3	68344	61.1	56977	68.6	29995	21.2	90651	68.2	15713	14.1	**455094**	**52.9**
Blueback Herring	502	1.2	618	1.3	25249	34.8	517	0.8	311	0.6	6763	6.0	6327	7.6	5861	4.1	14570	11.0	3598	3.2	**64316**	**7.5**
Channel Catfish	38929	96.6	55528	113.3	40941	56.5	12559	19.4	20479	39.5	15200	13.6	18898	22.7	11699	8.3	36212	27.2	21692	19.4	**272137**	**31.7**
Common Carp	8879	22.0	18313	37.4	15362	21.2	16273	25.1	8012	15.4	6729	6.0	2930	3.5	4607	3.3	8535	6.4	875	0.8	**90515**	**10.5**
American Eel	377	0.9	11329	23.1	3961	5.5	1080	1.7	155	0.3	550	0.5	364	0.4	1662	1.2	103	0.1	157	0.1	**19738**	**2.3**
Alewife	9	0.0	129	0.3	3433	4.7	50	0.1	26	0.1	379	0.3	2822	3.4	357	0.3	647	0.5	1902	1.7	**9754**	**1.1**
American Shad	139	0.3	328	0.7	2039	2.8	413	0.6	167	0.3	1546	1.4	5195	6.3	7667	5.4	5146	3.9	8218	7.4	**30858**	**3.6**
Comely Shiner	761	1.9	281	0.6	14214	19.6	3176	4.9	871	1.7	5141	4.6	582	0.7	21199	15.0	11734	8.8	35239	31.5	**93198**	**10.8**
Quillback	2929	7.3	3622	7.4	1617	2.2	4679	7.2	1942	3.7	957	0.9	2327	2.8	1881	1.3	1578	1.2	170	0.2	**21702**	**2.5**
Shorthead Redhorse	1394	3.5	6533	13.3	6974	9.6	7558	11.7	3467	6.7	3362	3.0	2057	2.5	3583	2.5	4782	3.6	2735	2.4	**42445**	**4.9**
Spotfin Shiner	314	0.8	524	1.1	622	0.9	501	0.8	--		2695	2.4	695	0.8	796	0.6	65	0.0	5381	4.8	**11593**	**1.3**
Striped Bass	904	2.2	3277	6.7	60	0.1	23	0.0	181	0.3	213	0.2	194	0.2	1337	0.9	874	0.7	357	0.3	**7420**	**0.9**
Spottail Shiner	849	2.1	31	0.1	315	0.4	2132	3.3	--		3525	3.2	6247	7.5	155	0.1	55	0.0	282	0.3	**13591**	**1.6**
Redbreast Sunfish	1524	3.8	1007	2.1	1335	1.8	401	0.6	465	0.9	3366	3.0	1433	1.7	1471	1.0	730	0.5	443	0.4	**12175**	**1.4**
White Catfish	605	1.5	2199	4.5	565	0.8	224	0.3	77	0.1	1094	1.0	284	0.3	917	0.6	3849	2.9	1740	1.6	**11554**	**1.3**
Walleye	4153	10.3	2645	5.4	504	0.7	663	1.0	236	0.5	609	0.5	308	0.4	267	0.2	311	0.2	319	0.3	**10015**	**1.2**
Bluegill	942	2.3	1299	2.7	1184	1.6	587	0.9	284	0.5	6048	5.4	1654	2.0	2436	1.7	1107	0.8	1561	1.4	**17102**	**2.0**
Striped Bass x White Bass	2674	6.6	39	0.1	160	0.2	355	0.5	282	0.5	1377	1.2	1713	2.1	5895	4.2	6203	4.7	5243	4.7	**23941**	**2.8**
White Crappie	100	0.2	231	0.5	303	0.4	450	0.7	59	0.1	345	0.3	199	0.2	272	0.2	125	0.1	230	0.2	**2314**	**0.3**
Yellow Perch	373	0.9	1007	2.1	724	1.0	387	0.6	487	0.9	2145	1.9	2267	2.7	632	0.4	815	0.6	310	0.3	**9147**	**1.1**
Brown Bullhead	675	1.7	531	1.1	338	0.5	179	0.3	69	0.1	461	0.4	134	0.2	163	0.1	345	0.3	402	0.4	**3297**	**0.4**
Smallmouth Bass	455	1.1	881	1.8	1095	1.5	1003	1.5	608	1.2	1081	1.0	666	0.8	536	0.4	548	0.4	491	0.4	**7364**	**0.9**
Pumpkinseed	446	1.1	306	0.6	848	1.2	228	0.4	104	0.2	1013	0.9	402	0.5	490	0.3	135	0.1	115	0.1	**4087**	**0.5**
White Sucker	1145	2.8	1394	2.8	582	0.8	412	0.6	109	0.2	776	0.7	853	1.0	263	0.2	540	0.4	410	0.4	**6484**	**0.8**
Golden Shiner	35	0.1	155	0.3	92	0.1	216	0.3	8	0.0	292	0.3	23	0.0	40	0.0	28	0.0	5	0.0	**894**	**0.1**

A-25 Cont.

Year	1980	1980	1981	1981	1982	1982	1983	1983	1984	1984	1985	1985	1986	1986	1987	1987	1988	1988	1989	1989	**Totals 1980-1989**	
No. Days	30	Fish per lift	37		44		29		34		55		59		60		63		51		**462**	
Lifts	403		490		725		648		519		1118		831		1414		1330		1117		**8595**	
Est. Oper. Time(HR)	221		275		502		299		251		542		546		639		637		539		**4451**	
Fishing Time (HR)	117		178		336		224		192		421		449		532		513		457		**3419**	
#Species	42	Fish per lift	48	Fish per lift	46	Fish per lift	40	Fish per lift	35	Fish per lift	41	Fish per lift	43	Fish per lift	46	Fish per lift	49	Fish per lift	45	Fish per lift		Fish per lift
Brown Trout	258	0.6	207	0.4	219	0.3	225	0.3	141	0.3	175	0.2	65	0.1	83	0.1	85	0.1	110	0.1	**1568**	**0.2**
Rock Bass	88	0.2	381	0.8	138	0.2	269	0.4	158	0.3	122	0.1	200	0.2	231	0.2	110	0.1	352	0.3	**2049**	**0.2**
Hickory Shad	1	0.0	1	0.0	15	0.0	5	0.0	6	0.0	9	0.0	45	0.1	35	0.0	64	0.0	28	0.0	**209**	**0.0**
Atlantic Menhaden	16	0.0	42	0.1	--		1	0.0	--		1	0.0	--		--		--		--		**60**	**0.0**
Largemouth Bass	41	0.1	13	0.0	20	0.0	17	0.0	8	0.0	67	0.1	75	0.1	69	0.0	117	0.1	164	0.1	**591**	**0.1**
Yellow Bullhead	18	0.0	36	0.1	61	0.1	10	0.0	7	0.0	21	0.0	35	0.0	41	0.0	80	0.1	445	0.4	**754**	**0.1**
Black Crappie	15	0.0	20	0.0	39	0.1	46	0.1	6	0.0	45	0.0	51	0.1	19	0.0	42	0.0	45	0.0	**328**	**0.0**
Rainbow Trout	23	0.1	219	0.4	20	0.0	2	0.0	5	0.0	70	0.1	9	0.0	14	0.0	10	0.0	4	0.0	**376**	**0.0**
Sea Lamprey	1	0.0	55	0.1	56	0.1	10	0.0	4	0.0	164	0.1	26	0.0	21	0.0	59	0.0	94	0.1	**490**	**0.1**
Green Sunfish	16	0.0	28	0.1	91	0.1	16	0.0	7	0.0	133	0.1	15	0.0	64	0.0	19	0.0	33	0.0	**422**	**0.0**
Tiger Muskie	34	0.1	53	0.1	56	0.1	16	0.0	10	0.0	73	0.1	35	0.0	30	0.0	20	0.0	33	0.0	**360**	**0.0**
Muskellunge	27	0.1	1	0.0	4	0.0	--		--		15	0.0	--		--		1	0.0	--		**48**	**0.0**
Flathead Catfish					--		--		--		--		--		--		--		--			
Shiners	--		--		6	0.0	--		--		--		--		--		--		--		**6**	**0.0**
Atlantic Needlefish	--		2	0.0	--		--		--		--		--		--		2	0.0	--		**4**	**0.0**
Brook Trout	4	0.0	3	0.0	5	0.0	2	0.0	--		1	0.0	--		--		1	0.0	1	0.0	**17**	**0.0**
Bluntnose Minnow	--		--		--		--		--		--		--		--		65	0.0	--		**65**	**0.0**
Northern Hog Sucker	13	0.0	1	0.0	--		--		--		--		2	0.0	4	0.0	1	0.0	1	0.0	**22**	**0.0**
Goldfish	--		1	0.0	--		--		--		--		--		--		1		1	0.0	**3**	**0.0**
Tessellated Darter	--		2	0.0	--		--		--		1	0.0	--		1	0.0	1	0.0	--		**5**	**0.0**
Logperch	--		--		--		--		--		1	0.0	1	0.0	1	0.0	2	0.0	--		**5**	**0.0**
Brook Trout x Lake Trout	--		--		--		--		2	0.0	--		2	0.0	5	0.0	--		1	0.0	**10**	**0.0**
Northern Pike	3	0.0	--		5	0.0	1	0.0	--		--		2	0.0	--		--		--		**11**	**0.0**
Striped Bass x White Perch	--		--		--		--		--		--		10	0.0	19	0.0	1	0.0	3	0.0	**33**	**0.0**
Creek Chubsucker	--		4	0.0	2	0.0	--		--		--		--		5	0.0	1	0.0	--		**12**	**0.0**

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Year	1980	1980	1981	1981	1982	1982	1983	1983	1984	1984	1985	1985	1986	1986	1987	1987	1988	1988	1989	1989	Totals 1980-1989	
No. Days	30	Fish per lift	37		44		29		34		55		59		60		63		51		**462**	
Lifts	403		490		725		648		519		1118		831		1414		1330		1117		**8595**	
Est. Oper. Time(HR)	221		275		502		299		251		542		546		639		637		539		**4451**	
Fishing Time (HR)	117		178		336		224		192		421		449		532		513		457		**3419**	
#Species	42	Fish per lift	48	Fish per lift	46	Fish per lift	40	Fish per lift	35	Fish per lift	41	Fish per lift	43	Fish per lift	46	Fish per lift	49	Fish per lift	45	Fish per lift		Fish per lift
Chain Pickerel	--		1	0.0	--		--		--		--		--		--		--		1	0.0	**2**	**0.0**
Margined Madtom	--		--		7	0.0	--		--		--		3		--		1	0.0	--		**11**	**0.0**
Banded Darter	--		--		--		--		--		--		--		1	0.0	--		--		**1**	**0.0**
Rosyface Shiner	--		--		8	0.0	--		--		--		--		--		--		--		**8**	**0.0**
Swallowtail Shiner	--		3	0.0	--		--		--		--		1	0.0	--		--		--		**4**	**0.0**
Shield Darter	--		1	0.0	--		--		--		--		--		--		--		--		**1**	**0.0**
Greenside Darter																						
Longnose Dace	--		--		--		--		--		--		--		--		--		--			
Tadpole Madtom	--		--		1	0.0	--		--		--		--		--		--		1	0.0	**2**	**0.0**
Trouts	--		2	0.0	--		--		--		--		--		--		--		--		**2**	**0.0**
Sunfishes	--		--		--		--		--		--		--		--		--		--			
Trout	--		2	0.0	--		--		--		--		--		--		--		--		**2**	**0.0**
Rainbow Smelt	--		--		--		--		--		--		--		1	0.0	1	0.0	--		**2**	**0.0**
Blacknose Dace	--		--		2	0.0	--		--		--		--		--		--		--		**2**	**0.0**
Mummichog	--		--		1	0.0	--		--		--		--		--		--		--		**1**	**0.0**
Lampreys	--		--		--		2	0.0	--		--		--		--		--		--		**2**	**0.0**
Lake Herring	--		--		--		1	0.0	--		--		--		--		--		--		**1**	**0.0**
Striped Mullet	--		--		--		--		--		--		--		--		--		2	0.0	**2**	**0.0**
Sunfish Hybrids					--		--		--		--		--		--		--		--			
Palomino (Rainbow Trout)	--		--		--		--		--		--		--		1	0.0	--		--		**1**	**0.0**
Redfin Pickerel	--		--		--		--		--		--		--		1	0.0	--		--		**1**	**0.0**
Carps and Minnows	--		--		1		--		--		--		--		--		--		--		**1**	**0.0**
River Chub	1	0.0	--		--		--		--		--		--		--		--		--		**1**	**0.0**
Creek Chub	--		--		--		--		--		--		--		--		1	0.0	--		**1**	**0.0**
Madtoms	--		--		1	0.0	--		--		--		--		--		--		--		**1**	**0.0**
Bigmouth Buffalo	--		--		--		--		--		--		--		--		--		1	0.0	**1**	**0.0**

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Year	**1980**	**1980**	**1981**	**1981**	**1982**	**1982**	**1983**	**1983**	**1984**	**1984**	**1985**	**1985**	**1986**	**1986**	**1987**	**1987**	**1988**	**1988**	**1989**	**1989**	**Totals 1980-1989**	
No. Days	30	Fish per lift	37		44		29		34		55		59		60		63		51		**462**	
Lifts	403		490		725		648		519		1118		831		1414		1330		1117		**8595**	
Est. Oper. Time(HR)	221		275		502		299		251		542		546		639		637		539		**4451**	
Fishing Time (HR)	117		178		336		224		192		421		449		532		513		457		**3419**	
#Species	42	Fish per lift	48	Fish per lift	46	Fish per lift	40	Fish per lift	35	Fish per lift	41	Fish per lift	43	Fish per lift	46	Fish per lift	49	Fish per lift	45	Fish per lift		Fish per lift
Total	372379	924.0	1353310	2761.9	1403176	1935.4	1028092	1586.6	957821	1845.5	2317797	2073.2	1830569	2202.9	2593445	1834.1	1592938	1197.7	1035121	926.7	14484648	1685.2

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Year	1990	1990	1991	1991	1992	1992	1993	1993	1994	1994	1995	1995	1996	1996	1997	1997	1998	1998	1999	1999	Totals 1990-1999	
No. Days	64		63		64		45		47		68		28		44		41		43		**507**	
Lifts	1363		1257		1559		1032		964		1245		464		611		476		709		**9680**	
Est. Oper. Time(HR)	664		681		698		505.4		534.8		744.3		284.6		348.6		238.6		314.9		**5014.2**	
Fishing Time (HR)	571		547		589		416.7		441.1		651.9		259.2		295.1		225.9		312.6		**4309.5**	
#Species	43	Fish per lift	45	Fish per lift	46	Fish per lift	37	Fish per lift	46	Fish per lift	44	Fish per lift	38	Fish per lift	39	Fish per lift	38	Fish per lift	34	Fish per lift		Fish per lift
Gizzard Shad	1084073	795.4	433108	344.6	1450299	930.3	666010	645.4	511139	530.2	799694	642.3	196019	422.5	126570	207.2	497375	1044.9	652770	920.7	**6417057**	**662.9**
White Perch	24581	18.0	14996	11.9	37521	24.1	3892	3.8	9537	9.9	55719	44.8	4583	9.9	58685	96.0	32891	69.1	35357	49.9	**277762**	**28.7**
Blueback Herring	9658	7.1	15616	12.4	27533	17.7	4052	3.9	2603	2.7	93859	75.4	871	1.9	133257	218.1	5511	11.6	8546	12.1	**301506**	**31.1**
Channel Catfish	8689	6.4	10252	8.2	7070	4.5	10841	10.5	3551	3.7	2432	2.0	5487	11.8	977	1.6	17250	36.2	2564	3.6	**69113**	**7.1**
Common Carp	2761	2.0	8257	6.6	4105	2.6	8488	8.2	7403	7.7	6209	5.0	5726	12.3	2281	3.7	8206	17.2	5124	7.2	**58560**	**6.0**
American Eel	224	0.2	213	0.2	2622	1.7	1487	1.4	128	0.1	204	0.2	640	1.4	110	0.2	89	0.2	234	0.3	**5951**	**0.6**
Alewife	425	0.3	2649	2.1	3344	2.1	572	0.6	70	0.1	5405	4.3	1	0.0	11	0.0	31	0.1	1795	2.5	**14303**	**1.5**
American Shad	15719	11.5	13330	10.6	10335	6.6	5343	5.2	5615	5.8	15588	12.5	11473	24.7	12974	21.2	6577	13.8	9658	13.6	**106612**	**11.0**
Comely Shiner	5798	4.3	18356	14.6	8974	5.8	7358	7.1	13973	14.5	1746	1.4	2180	4.7	576	0.9	570	1.2	515	0.7	**60046**	**6.2**
Quillback	1270	0.9	2990	2.4	132	0.1	746	0.7	1576	1.6	981	0.8	583	1.3	780	1.3	280	0.6	823	1.2	**10161**	**1.0**
Shorthead Redhorse	4228	3.1	2871	2.3	1813	1.2	858	0.8	1994	2.1	2098	1.7	754	1.6	3134	5.1	357	0.8	1485	2.1	**19592**	**2.0**
Spotfin Shiner	135	0.1	2508	2.0	214	0.1	10	0.0	13	0.0	279	0.2	10	0.0	1	0.0	79	0.2	--		**3249**	**0.3**
Striped Bass	1068	0.8	1682	1.3	2094	1.3	1595	1.5	4261	4.4	5467	4.4	1845	4.0	2665	4.4	2570	5.4	1001	1.4	**24248**	**2.5**
Spottail Shiner	112	0.1	635	0.5	156	0.1			6	0.0	249	0.2	--		1041	1.7	--		--		**2199**	**0.2**
Redbreast Sunfish	187	0.1	281	0.2	154	0.1	170	0.2	165	0.2	1045	0.8	179	0.4	430	0.7	259	0.5	123	0.2	**2993**	**0.3**
White Catfish	560	0.4	1284	1.0	152	0.1	97	0.1	187	0.2	403	0.3	293	0.6	140	0.2	216	0.5	--		**3332**	**0.3**
Walleye	460	0.3	411	0.3	203	0.1	217	0.2	653	0.7	1736	1.4	964	2.1	1063	1.7	827	1.7	547	0.8	**7081**	**0.7**
Bluegill	446	0.3	486	0.4	813	0.5	200	0.2	244	0.3	505	0.4	158	0.3	277	0.5	381	0.8	605	0.9	**4115**	**0.4**
Striped Bass x White Bass	1172	0.9	797	0.6	359	0.2	112	0.1	114	0.1	28	0.0	4	0.0	1	0.0	18	0.0	2	0.0	**2607**	**0.3**
White Crappie	33	0.0	106	0.1	74	0.0	62	0.1	36	0.0	33	0.0	25	0.1	30	0.0	119	0.3	72	0.1	**590**	**0.1**
Yellow Perch	124	0.1	502	0.4	127	0.1	318	0.3	48	0.0	462	0.4	180	0.4	102	0.2	109	0.2	134	0.2	**2106**	**0.2**
Brown Bullhead	108	0.1	260	0.2	107	0.1	73	0.1	9	0.0	281	0.2	54	0.1	27	0.0	398	0.8	8	0.0	**1325**	**0.1**
Smallmouth Bass	424	0.3	704	0.6	411	0.3	227	0.2	132	0.1	362	0.3	232	0.5	251	0.4	812	1.7	1306	1.8	**4861**	**0.5**
Pumpkinseed	46	0.0	48	0.0	118	0.1	22	0.0	22	0.0	53	0.0	11	0.0	51	0.1	15	0.0	13	0.0	**399**	**0.0**
White Sucker	161	0.1	113	0.1	83	0.1	59	0.1	36	0.0	105	0.1	20	0.0	7	0.0	14	0.0	27	0.0	**625**	**0.1**
Golden Shiner	2	0.0	7	0.0	11	0.0			6	0.0	87	0.1	40	0.1	1	0.0	1	0.0	1	0.0	**156**	**0.0**

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Year	**1990**	**1990**	**1991**	**1991**	**1992**	**1992**	**1993**	**1993**	**1994**	**1994**	**1995**	**1995**	**1996**	**1996**	**1997**	**1997**	**1998**	**1998**	**1999**	**1999**	**Totals 1990-1999**	
No. Days	64		63		64		45		47		68		28		44		41		43		**507**	
Lifts	1363		1257		1559		1032		964		1245		464		611		476		709		**9680**	
Est. Oper. Time(HR)	664		681		698		505.4		534.8		744.3		284.6		348.6		238.6		314.9		**5014.2**	
Fishing Time (HR)	571		547		589		416.7		441.1		651.9		259.2		295.1		225.9		312.6		**4309.5**	
#Species	43	Fish per lift	45	Fish per lift	46	Fish per lift	37	Fish per lift	46	Fish per lift	44	Fish per lift	38	Fish per lift	39	Fish per lift	38	Fish per lift	34	Fish per lift		Fish per lift
Brown Trout	63	0.0	82	0.1	127	0.1	98	0.1	48	0.0	22	0.0	27	0.1	14	0.0	30	0.1	8	0.0	**519**	**0.1**
Rock Bass	39	0.0	53	0.0	106	0.1	90	0.1	34	0.0	83	0.1	149	0.3	280	0.5	126	0.3	68	0.1	**1028**	**0.1**
Hickory Shad	77	0.1	120	0.1	367	0.2	--		1	0.0	36	0.0	--		118	0.2	6	0.0	32	0.0	**757**	**0.1**
Atlantic Menhaden	--		--		--		--		--		--		--		--		--		--			
Largemouth Bass	48	0.0	176	0.1	211	0.1	84	0.1	78	0.1	174	0.1	23	0.0	55	0.1	49	0.1	78	0.1	**976**	**0.1**
Yellow Bullhead	32	0.0	25	0.0	23	0.0	19	0.0	17	0.0	16	0.0	22	0.0	37	0.1	19	0.0	3	0.0	**213**	**0.0**
Black Crappie	22	0.0	22	0.0	23	0.0	7	0.0	8	0.0	24	0.0	9	0.0	19	0.0	6	0.0	10	0.0	**150**	**0.0**
Rainbow Trout	14	0.0	13	0.0	12	0.0	4	0.0	3	0.0	6	0.0	12	0.0	1	0.0	4	0.0	--		**69**	**0.0**
Sea Lamprey	38	0.0	34	0.0	42	0.0	5	0.0	11	0.0	7	0.0	10	0.0	2	0.0	7	0.0	24	0.0	**180**	**0.0**
Green Sunfish	17	0.0	22	0.0	35	0.0	10	0.0	11	0.0	20	0.0	18	0.0	6	0.0	10	0.0	7	0.0	**156**	**0.0**
Tiger Muskie	10	0.0	5	0.0	3	0.0	2	0.0	1	0.0	2	0.0	1	0.0	--		--		--		**24**	**0.0**
Muskellunge	2	0.0	2	0.0	10	0.0	9	0.0	11	0.0	4	0.0	4	0.0	2	0.0	2	0.0	--		**46**	**0.0**
Flathead Catfish	--		--		--		--		--		--		--		--		--		--			
Shiners	--		--		--		--		--		5	0.0	--		--		--		--		**5**	**0.0**
Atlantic Needlefish	5	0.0	--		3	0.0	--		8	0.0	1	0.0	1	0.0	1	0.0	4	0.0	2	0.0	**25**	**0.0**
Brook Trout	--		7	0.0	5	0.0	--		4	0.0	2	0.0	3	0.0	--		--		--		**21**	**0.0**
Bluntnose Minnow	--		--		--		--		--		--		--		--		--		--		**0**	**0.0**
Northern Hog Sucker	3	0.0	--		5	0.0	--		5	0.0	--		--		--		--		--		**13**	**0.0**
Goldfish	--		--		--		--		--		--		--		--		--		--			
Tessellated Darter	--		6	0.0	2	0.0	--		1	0.0	5	0.0			5	0.0			--		**19**	**0.0**
Logperch	2	0.0	1	0.0	2	0.0	--		--		--		--		--		--		--		**5**	**0.0**
Brook Trout x Lake Trout	--		--		1	0.0	5	0.0	2	0.0			4	0.0	--		--		2	0.0	**14**	**0.0**
Northern Pike	--		5	0.0	--				1	0.0	2	0.0	--		--		--		--		**8**	**0.0**
Striped Bass x White Perch	--		--		--		--		--		--		--		--		--		--			
Creek Chubsucker	1	0.0	--		9	0.0	--		--		--		--		--		--		--		**10**	**0.0**

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Year	1990	1990	1991	1991	1992	1992	1993	1993	1994	1994	1995	1995	1996	1996	1997	1997	1998	1998	1999	1999	Totals 1990-1999	
No. Days	64		63		64		45		47		68		28		44		41		43		**507**	
Lifts	1363		1257		1559		1032		964		1245		464		611		476		709		**9680**	
Est. Oper. Time(HR)	664		681		698		505.4		534.8		744.3		284.6		348.6		238.6		314.9		**5014.2**	
Fishing Time (HR)	571		547		589		416.7		441.1		651.9		259.2		295.1		225.9		312.6		**4309.5**	
#Species	43	Fish per lift	45	Fish per lift	46	Fish per lift	37	Fish per lift	46	Fish per lift	44	Fish per lift	38	Fish per lift	39	Fish per lift	38	Fish per lift	34	Fish per lift		Fish per lift
Chain Pickerel	--		6	0.0	2	0.0	--		3	0.0	4	0.0	--		--		1	0.0	--		**16**	**0.0**
Margined Madtom	--		--		--		12	0.0	3	0.0	--		--		--		1	0.0	--		**16**	**0.0**
Banded Darter	2	0.0	10	0.0	--		--		2	0.0	--		--		--		--		--		**14**	**0.0**
Rosyface Shiner	--		--		--		--		--		--		--		--		--		--			
Swallowtail Shiner	--		--		--		--		--		--		--		--		--		--			
Shield Darter	--		--		--		--		--		--		--		--		--		--			
Greenside Darter					--		--		--		4	0.0	--		1	0.0	--		--		**5**	**0.0**
Longnose Dace	--		--		--		--		--		--		--		--		--		--			
Tadpole Madtom	--		1	0.0	--		--		--		--		--		--		--		1	0.0	**2**	**0.0**
Trouts	--		--		--		--		--		--		--		--		--		--			
Sunfishes	2	0.0	--		1	0.0	--		--		--		--		--		--		--		**3**	**0.0**
Trout	--		--		--		--		--		--		--		--		--		--			
Rainbow Smelt	--		--		--		--		--		--		--		--		--		--			
Blacknose Dace	--		--		--		--		--		--		--		--		--		--			
Mummichog	--		--		--		--		--		--		--		--		--		--			
Lampreys	--		--		--		--		--		--		--		--		--		--			
Lake Herring	--		--		--		--		--		--		--		--		--		--			
Striped Mullet	--		--		--		--		--		--		--		--		--		--			
Sunfish Hybrids	--		--		1	0.0	1	0.0	--		--		--		--		--		--		**2**	**0.0**
Palomino (Rainbow Trout)	--		--		--		--		--		--		--		--		--		--			
Redfin Pickerel	--		--		--		--		--		--		--		--		--		--			
Carps and Minnows	--		--		--		--		--		--		--		--		--		--			
River Chub	--		--		--		--		--		--		--		--		--		--			
Creek Chub	--		--		--		--		--		--		--		--		--		--			
Madtoms	--		--		--		--		--		--		--		--		--		--			
Bigmouth Buffalo	--		--		--		--		--		--		--		--		--		--			
Total	1162841	853.1	533052	424.1	#####	1000.5	713155	691.0	563773	584.8	995447	799.6	232615	501.3	345983	566.3	575220	1208.4	722945	1019.7	**7404845**	**765.0**

A 25 Cont.

Year	2000	2000	2001	2001	2002	2002	2003	2003	2004	2004	2005	2005	2006	2006	2007	2007	2008	2008	2009	2009	Totals 2000-2009	Totals 1972-2009
No. Days	34		41		31		31		14		30		37		29		34		28		**309**	**1695**
Lifts	424		425		417		367		151		295		349		288		481		282		**3479**	**27481**
Est. Oper. Time(HR)					--		--		--		--		--		--		--		--		**0**	
Fishing Time (HR)	206		195		147		171		74		166		215		135		174		144		**1627**	**11436**
#Species	37	Fish per lift	38	Fish per lift	35	Fish per lift	30	Fish per lift	30	Fish per lift	36	Fish per lift	38	Fish per lift	35	Fish per lift	37	Fish per lift	39	Fish per lift		
Gizzard Shad	366099	863.4	218124	513.2	339292	813.6	118852	323.8	22899	151.6	82412	279.4	149250	427.7	146821	509.8	724737	1506.7	210633	746.9	**2379119**	**683.9**
White Perch	40318	95.1	44364	104.4	65031	155.9	14476	39.4	976	6.5	1102	3.7	1001	2.9	2276	7.9	2036	4.2	3095	11.0	**174675**	**50.2**
Blueback Herring	14326	33.8	16320	38.4	428	1.0	183	0.5	1	0.0	0		6	0.0	153	0.5	7	0.0	165	0.6	**31589**	**9.1**
Channel Catfish	8394	19.8	228	0.5	844	2.0	626	1.7	4839	32.0	1692	5.7	2880	8.3	1480	5.1	781	1.6	2393	8.5	**24157**	**6.9**
Common Carp	3236	7.6	994	2.3	225	0.5	1110	3.0	2702	17.9	1179	4.0	716	2.1	372	1.3	400	0.8	399	1.4	**11333**	**3.3**
American Eel	735	1.7	437	1.0	144	0.3	20	0.1	61	0.4	25	0.1	12	0.0	27	0.1	26	0.1	37	0.1	**1524**	**0.4**
Alewife	9189	21.7	7824	18.4	141	0.3	16	0.0	--		0		2	0.0	7	0.0	2	0.0	20	0.1	**17201**	**4.9**
American Shad	9785	23.1	10940	25.7	9347	22.4	9802	26.7	3426	22.7	3896	13.2	3970	11.4	4272	14.8	2627	5.5	6534	23.2	**64599**	**18.6**
Comely Shiner	1	0.0	1228	2.9	2	0.0	22	0.1	67	0.4	226	0.8	548	1.6	45	0.2	27	0.1	1	0.0	**2167**	**0.6**
Quillback	154	0.4	76	0.2	13	0.0	91	0.2	52	0.3	848	2.9	289	0.8	73	0.3	52	0.1	2	0.0	**1650**	**0.5**
Shorthead Redhorse	1317	3.1	132	0.3	317	0.8	749	2.0	1	0.0	863	2.9	109	0.3	144	0.5	325	0.7	92	0.3	**4049**	**1.2**
Spotfin Shiner	32	0.1	237	0.6	--		--		15	0.1	230	0.8	1	0.0	--		83	0.2	6	0.0	**604**	**0.2**
Striped Bass	2453	5.8	710	1.7	2086	5.0	703	1.9	458	3.0	489	1.7	383	1.1	263	0.9	42	0.1	179	0.6	**7766**	**2.2**
Spottail Shiner	--		5833	13.7	3	0.0	--		--		5	0.0	15	0.0	986	3.4	76	0.2	2	0.0	**6920**	**2.0**
Redbreast Sunfish	123	0.3	783	1.8	179	0.4	19	0.1	70	0.5	80	0.3	148	0.4	53	0.2	21	0.0	71	0.3	**1547**	**0.4**
White Catfish	351	0.8	36	0.1	49	0.1	7	0.0	271	1.8	24	0.1	9	0.0	5	0.0	5	0.0	5	0.0	**762**	**0.2**
Walleye	177	0.4	274	0.6	79	0.2	68	0.2	57	0.4	217	0.7	1962	5.6	1776	6.2	1971	4.1	977	3.5	**7558**	**2.2**
Bluegill	292	0.7	260	0.6	155	0.4	45	0.1	15	0.1	14	0.0	145	0.4	85	0.3	60	0.1	313	1.1	**1384**	**0.4**
Striped Bass x White Bass	1	0.0	--		--		--		1	0.0	3	0.0	3	0.0	2	0.0	--		--		**10**	**0.0**
White Crappie	30	0.1	29	0.1	6	0.0	5	0.0	1	0.0	1	0.0	6	0.0	--		3	0.0	8	0.0	**89**	**0.0**
Yellow Perch	161	0.4	150	0.4	122	0.3	102	0.3	8	0.1	33	0.1	54	0.2	49	0.2	26	0.1	55	0.2	**760**	**0.2**
Brown Bullhead	94	0.2	136	0.3	26	0.1	104	0.3	1599	10.6	713	2.4	1060	3.0	237	0.8	51	0.1	198	0.7	**4218**	**1.2**
Smallmouth Bass	764	1.8	309	0.7	390	0.9	232	0.6	33	0.2	560	1.9	306	0.9	140	0.5	95	0.2	109	0.4	**2938**	**0.8**
Pumpkinseed	13	0.0	27	0.1	26	0.1	3	0.0	3	0.0	2	0.0	23	0.1	8	0.0	8	0.0	33	0.1	**146**	**0.0**
White Sucker	44	0.1	12	0.0	8	0.0	1	0.0	3	0.0	1	0.0	7	0.0	4	0.0	1	0.0	7	0.0	**88**	**0.0**
Golden Shiner	--		--		1	0.0	--		--		--		--		--		--		2	0.0	**3**	**0.0**

A-25 Cont.

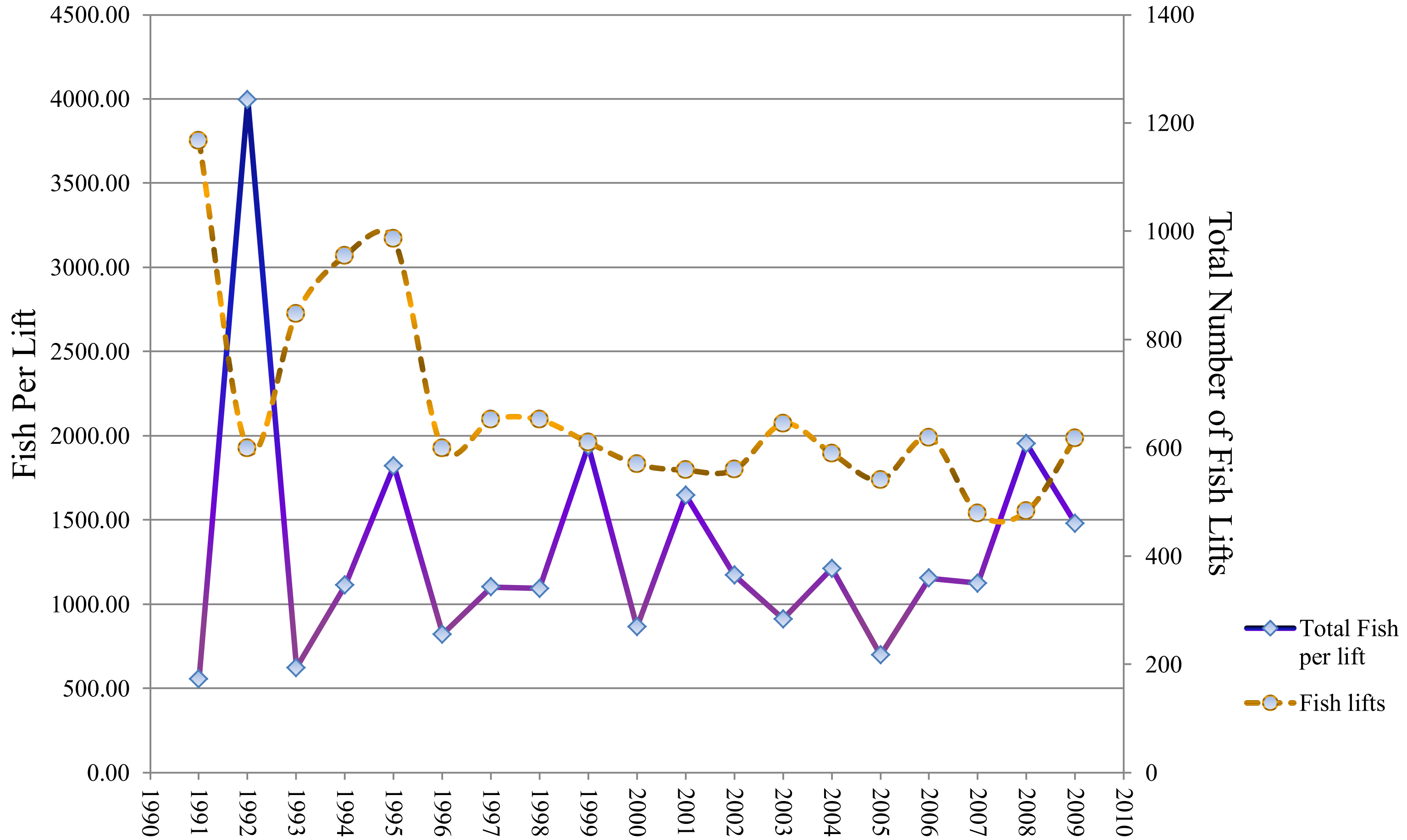
Year	2000	2000	2001	2001	2002	2002	2003	2003	2004	2004	2005	2005	2006	2006	2007	2007	2008	2008	2009	2009	Totals 2000-2009	Totals 1972-2009
No. Days	34		41		31		31		14		30		37		29		34		28		**309**	**1695**
Lifts	424		425		417		367		151		295		349		288		481		282		**3479**	**27481**
Est. Oper. Time(HR)					--		--		--		--		--		--		--		--		**0**	
Fishing Time (HR)	206		195		147		171		74		166		215		135		174		144		**1627**	**11436**
#Species	37	Fish per lift	38	Fish per lift	35	Fish per lift	30	Fish per lift	30	Fish per lift	36	Fish per lift	38	Fish per lift	35	Fish per lift	37	Fish per lift	39	Fish per lift		
Brown Trout	8	0.0	--		7	0.0	--		--		12	0.0	11	0.0	6	0.0	2	0.0	8	0.0	**54**	**0.0**
Rock Bass	119	0.3	188	0.4	65	0.2	100	0.3	9	0.1	35	0.1	51	0.1	30	0.1	18	0.0	116	0.4	**731**	**0.2**
Hickory Shad	1	0.0	36	0.1			1	0.0	--		0		0	0.0	0	0.0	0	0.0	4	0.0	**42**	**0.0**
Atlantic Menhaden	--		--		--		--		--		--		--		--		--		--			
Largemouth Bass	63	0.1	14	0.0	12	0.0	32	0.1	9	0.1	33	0.1	21	0.1	34	0.1	4	0.0	6	0.0	**228**	**0.1**
Yellow Bullhead	16	0.0	12	0.0	2	0.0	3	0.0	--		1	0.0	29	0.1	--		--		--		**63**	**0.0**
Black Crappie	8	0.0	5	0.0	1	0.0	3	0.0	1	0.0	4	0.0	10	0.0	2	0.0	7	0.0	19	0.1	**60**	**0.0**
Rainbow Trout	5	0.0	1	0.0	3	0.0	--		--		--		3	0.0	1	0.0	1	0.0	5	0.0	**19**	**0.0**
Sea Lamprey	11	0.0	43	0.1	75	0.2	7	0.0	--		10	0.0	43	0.1	6	0.0	28	0.1	72	0.3	**295**	**0.1**
Green Sunfish	17	0.0	28	0.1	4	0.0	--		2	0.0	--		2	0.0	1	0.0	1	0.0	9	0.0	**64**	**0.0**
Tiger Muskie	--		--		--		--		--		--		1	0.0	--		--		--		**1**	**0.0**
Muskellunge	--		--		--		--		--		--		--		--		3	0.0	2	0.0	**5**	**0.0**
Flathead Catfish	--		--		--		--		7	0.0	9	0.0	42	0.1	13	0.0	22	0.0	196	0.7	**289**	**0.1**
Shiners	--		--		--		--		1	0.0	--		--		1	0.0	--		--		**2**	**0.0**
Atlantic Needlefish	7	0.0	--		16	0.0	--		--		31	0.1	9	0.0	3	0.0	--		17	0.1	**83**	**0.0**
Brook Trout	--		1	0.0	--		--		--		--		2	0.0	13	0.0	2	0.0	2	0.0	**20**	**0.0**
Bluntnose Minnow	--		--		--		--		--		--		--		--		--		--			
Northern Hog Sucker	2	0.0	--		--		--		--		--		--		--		--		1	0.0	**3**	**0.0**
Goldfish	--		--		--		--		--		--		--		--		1	0.0	--		**1**	**0.0**
Tessellated Darter	--		6	0.0	--		--		--		1	0.0	--		--		1	0.0	--		**8**	**0.0**
Logperch	--		2	0.0	--		--		--		--		--		--		--		--		**2**	**0.0**
Brook Trout x Lake Trout	2	0.0	3	0.0	3	0.0	--		--		3	0.0	2	0.0	--		--		--		**13**	**0.0**
Northern Pike	--		--		--		--		--		--		--		1	0.0	--		1	0.0	**2**	**0.0**
Striped Bass x White Perch	--		--		--		--		--		--		--		--		--		--			
Creek Chubsucker	--		1	0.0	1	0.0	--		--		--		--		--		--		--		**2**	**0.0**

A-25 Cont.

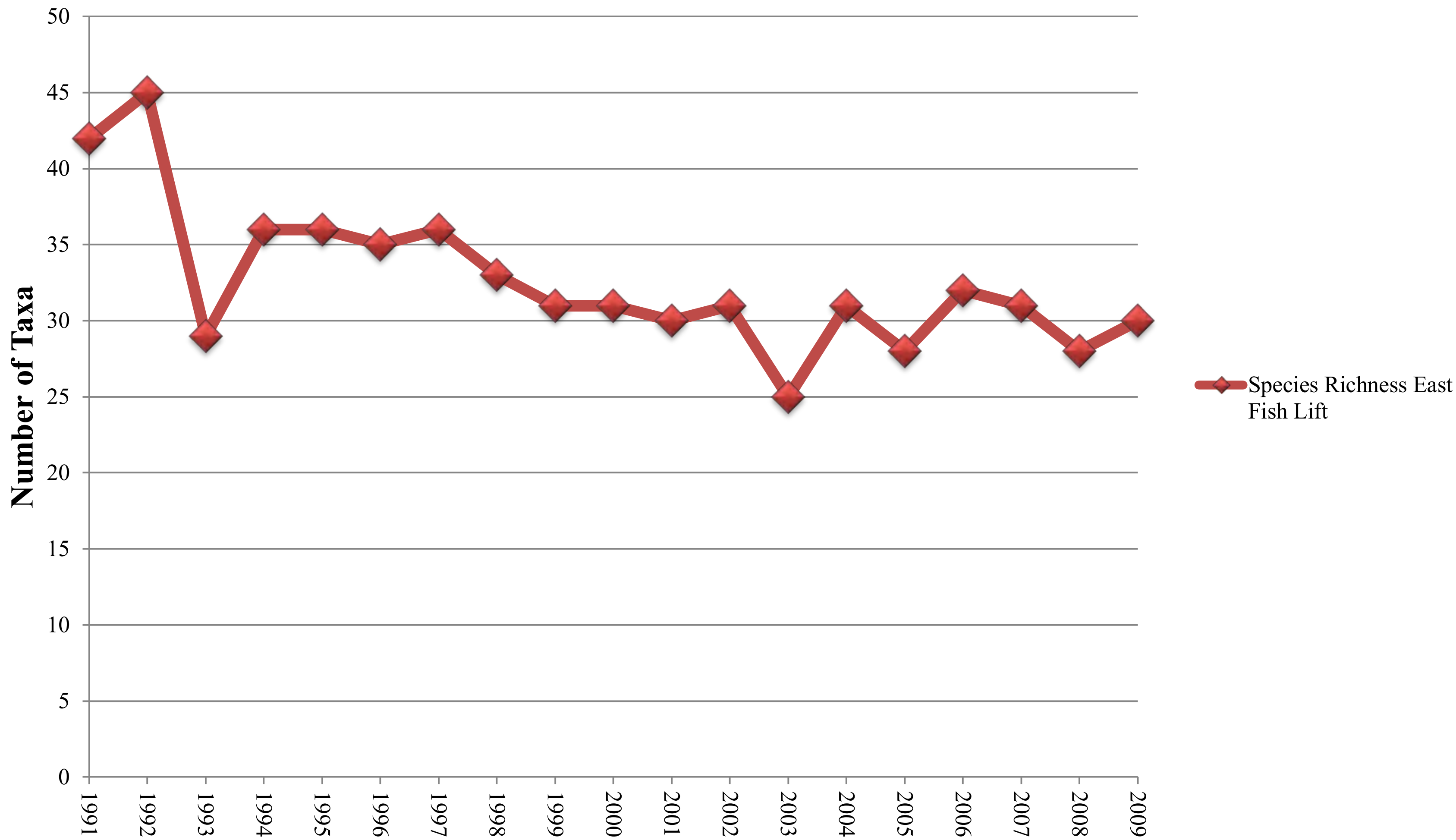
Year	2000	2000	2001	2001	2002	2002	2003	2003	2004	2004	2005	2005	2006	2006	2007	2007	2008	2008	2009	2009	Totals 2000-2009	Totals 1972-2009
No. Days	34		41		31		31		14		30		37		29		34		28		**309**	
Lifts	424		425		417		367		151		295		349		288		481		282		**3479**	
Est. Oper. Time(HR)					--		--		--		--		--		--		--		--		**0**	
Fishing Time (HR)	206		195		147		171		74		166		215		135		174		144		**1627**	
#Species	37	Fish per lift	38	Fish per lift	35	Fish per lift	30	Fish per lift	30	Fish per lift	36	Fish per lift	38	Fish per lift	35	Fish per lift	37	Fish per lift	39	Fish per lift		
Chain Pickerel	--		--		--		--		--		--		--		--		--		--			
Margined Madtom	--		--		--		--		1	0.0	--		--		--		--		--		**1**	**0.0**
Banded Darter	--		1	0.0	--		5	0.0	1	0.0	1	0.0	--		--		--		--		**8**	**0.0**
Rosyface Shiner	--		--		--		--		--		--		--		--		--		--			
Swallowtail Shiner	--		--		--		--		--		5	0.0	--		--		--		--		**5**	**0.0**
Shield Darter	--		--		--		--		--		7	0.0	--		--		--		--		**7**	**0.0**
Greenside Darter	1	0.0	--		--		1	0.0	--		--		--		--		1		--		**3**	**0.0**
Longnose Dace	--		--		--		--		--		--		--		--		--		--			**.**
Tadpole Madtom	--		--		--		--		--		--		--		--		--		--			**.**
Trouts			--		--		--		--		--		--		--		--		--			**.**
Sunfishes	--		--		--		--		--		--		--		--		--		--			**.**
Trout	--		--		--		--		--		--		--		--		--		--			**.**
Rainbow Smelt	--		--		--		--		--		--		--		--		--		--			**.**
Blacknose Dace	--		--		--		--		--		--		--		--		--		--			**.**
Mummichog	--		--		--		--		--		--		--		--		--		--			**.**
Lampreys	--		--		--		--		--		--		--		--		--		--			**.**
Lake Herring	--		--		--		--		--		--		--		--		--		--			**.**
Striped Mullet	--		--		--		--		--		--		--		--		--		--			**.**
Sunfish Hybrids	--		--		--		--		--		--		--		--		--		--			**.**
Palomino (Rainbow Trout)	--		--		--		--		--		--		--		--		--		--			**.**
Redfin Pickerel	--		--		--		--		--		--		--		--		--		--			**.**
Carps and Minnows	--		--		--		--		--		--		--		--		--		--			**.**
River Chub	--		--		--		--		--		--		--		--		--		--			**.**
Creek Chub	--		--		--		--		--		--		--		--		--		--			**.**
Madtoms	--		--		--		--		--		--		--		--		--		--			**.**
Bigmouth Buffalo	--		--		--		--		--		--		--		--		--		--			**.**
Total	458349	1081.0	309804	729.0	419103	1005.0	147388	401.6	37589	248.9	94767	321.2	163131	467.4	159389	553.4	733553	1525.1	225794	800.7	**2748867**	**790.1**

APPENDIX B-EAST FISH LIFT DATA

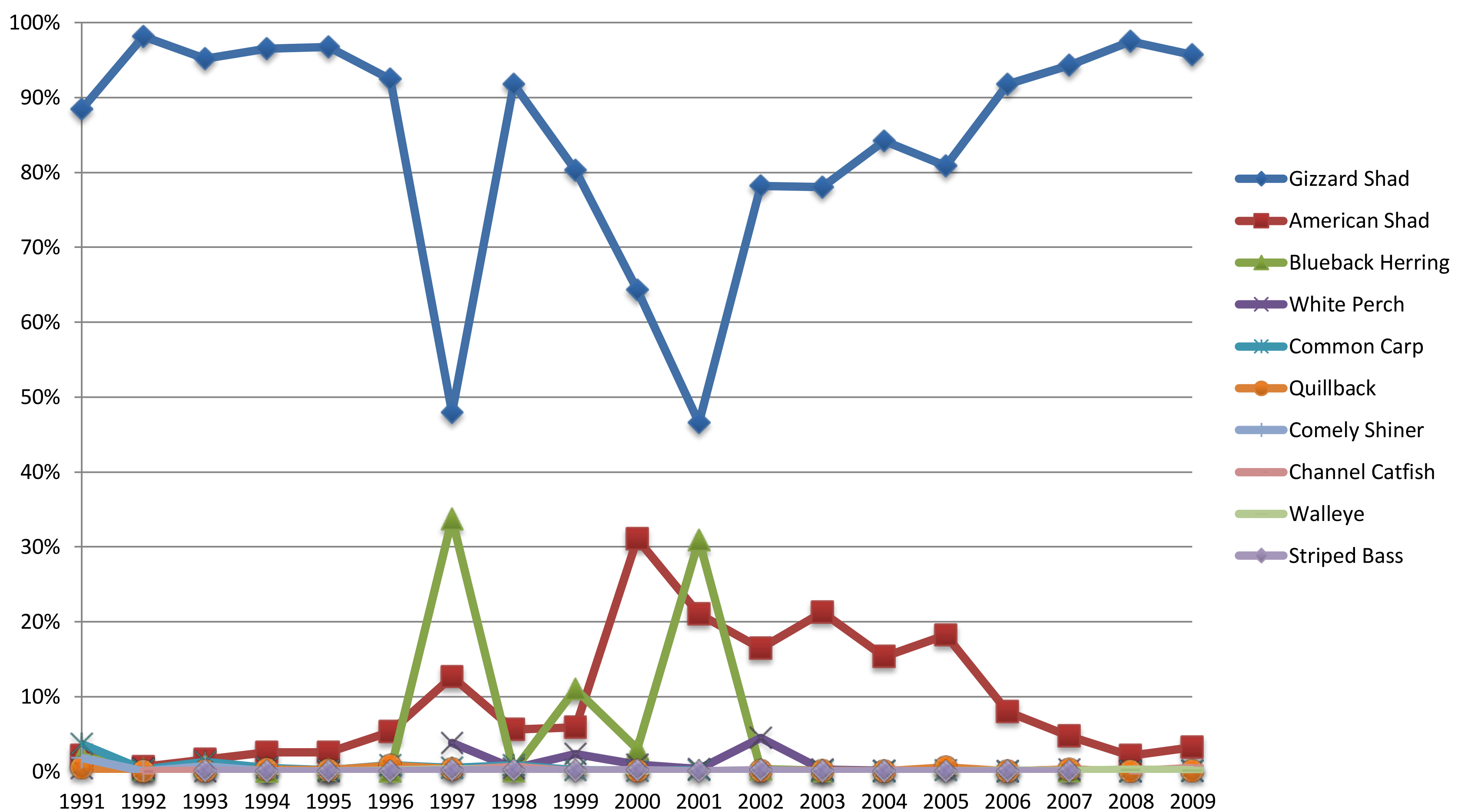
B-1. CONOWINGO EAST FISH LIFT CPUE AND NUMBER OF LIFTS 1991 – 2009



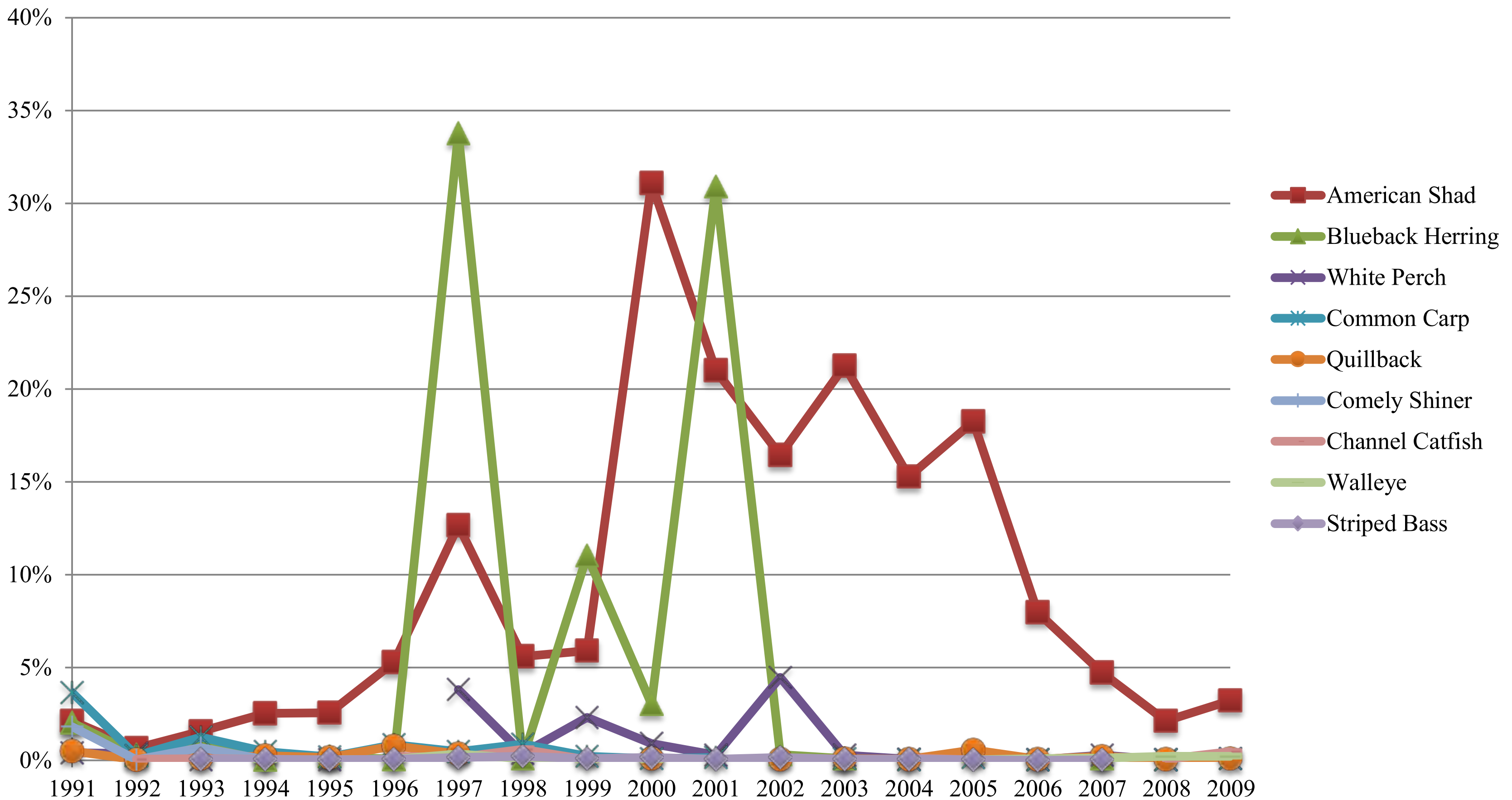
B-2. SPECIES RICHNESS EAST FISH LIFT, NUMBER OF TAXA ANNUALLY 1991- 2009



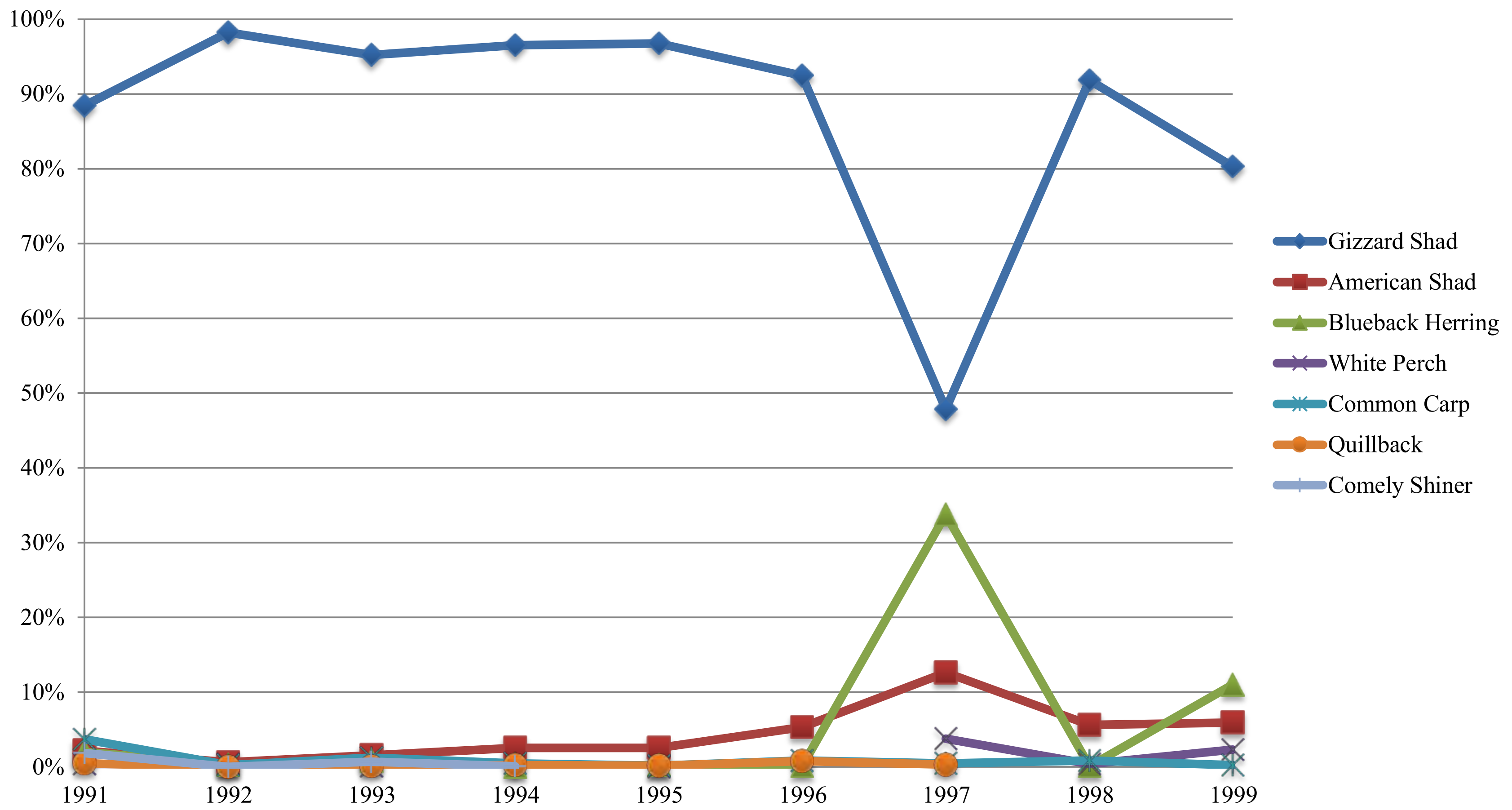
B-3. PROPORTIONAL ABUNDANCE EAST FISH LIFT 1991 – 2009



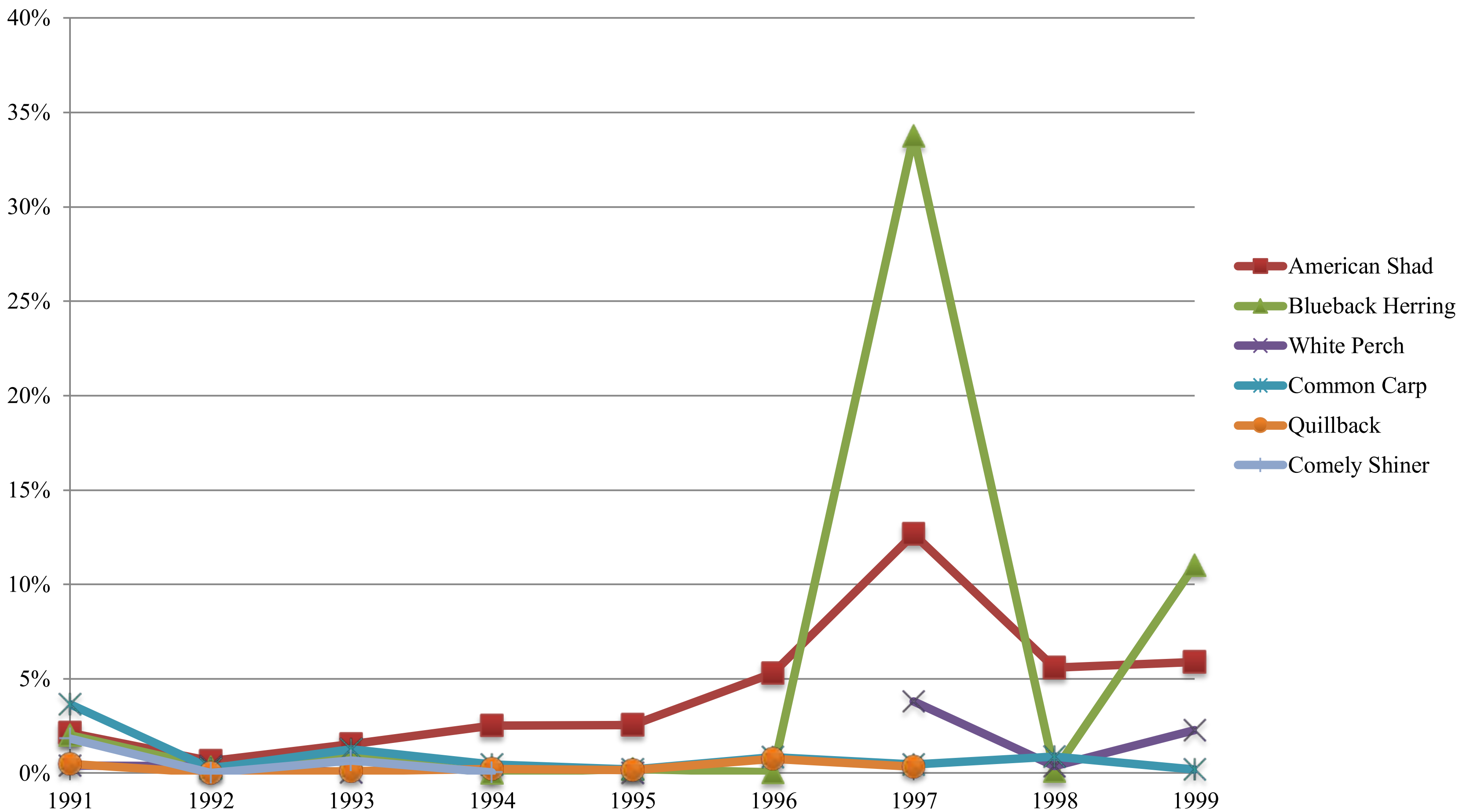
B-4. PROPORTIONAL ABUNDANCE EAST FISH LIFT GIZZARD SHAD REMOVED 1991 – 2009



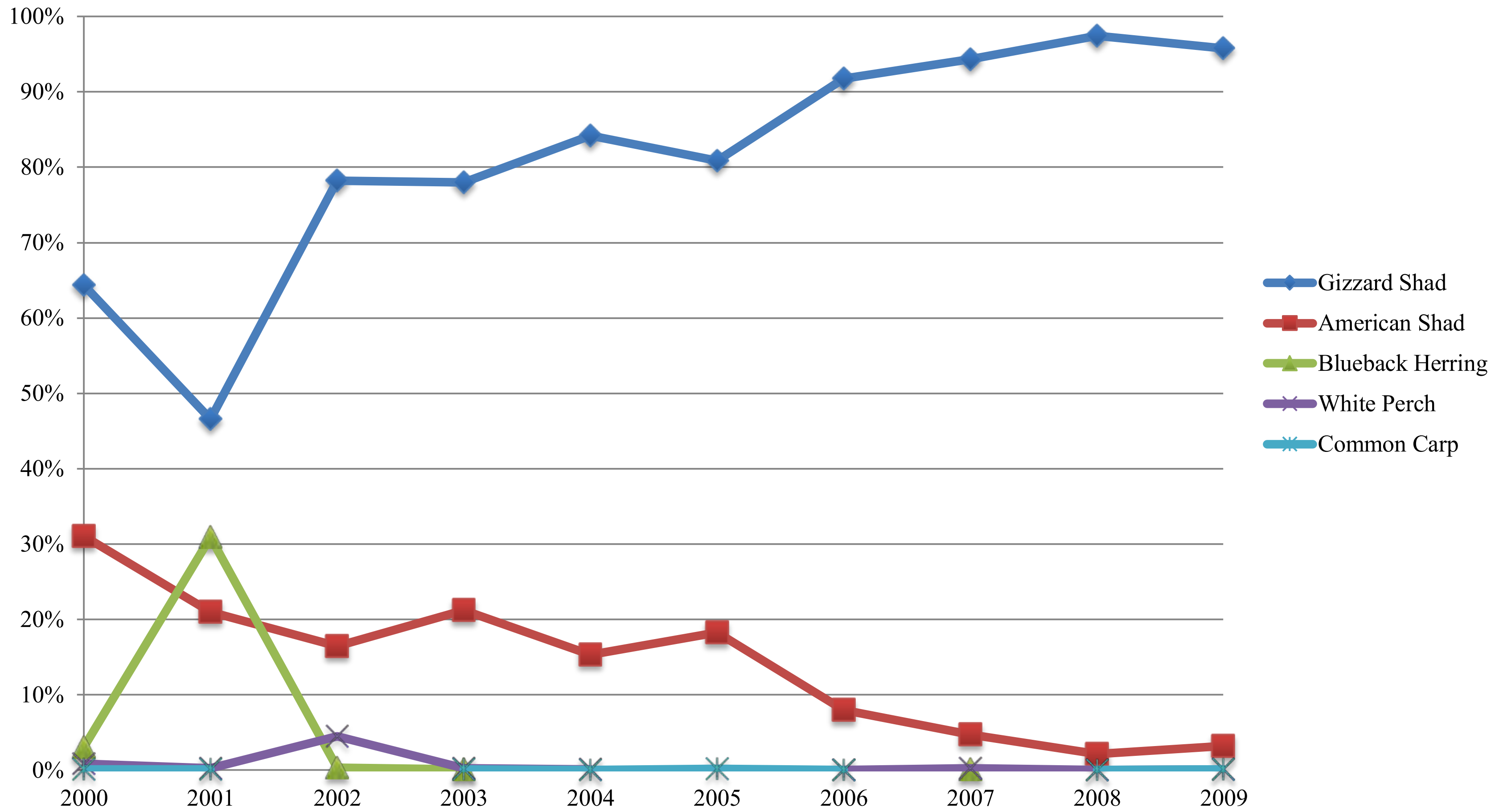
B-5. PROPORTIONAL ABUNDANCE EAST FISH LIFT 1991 - 1999



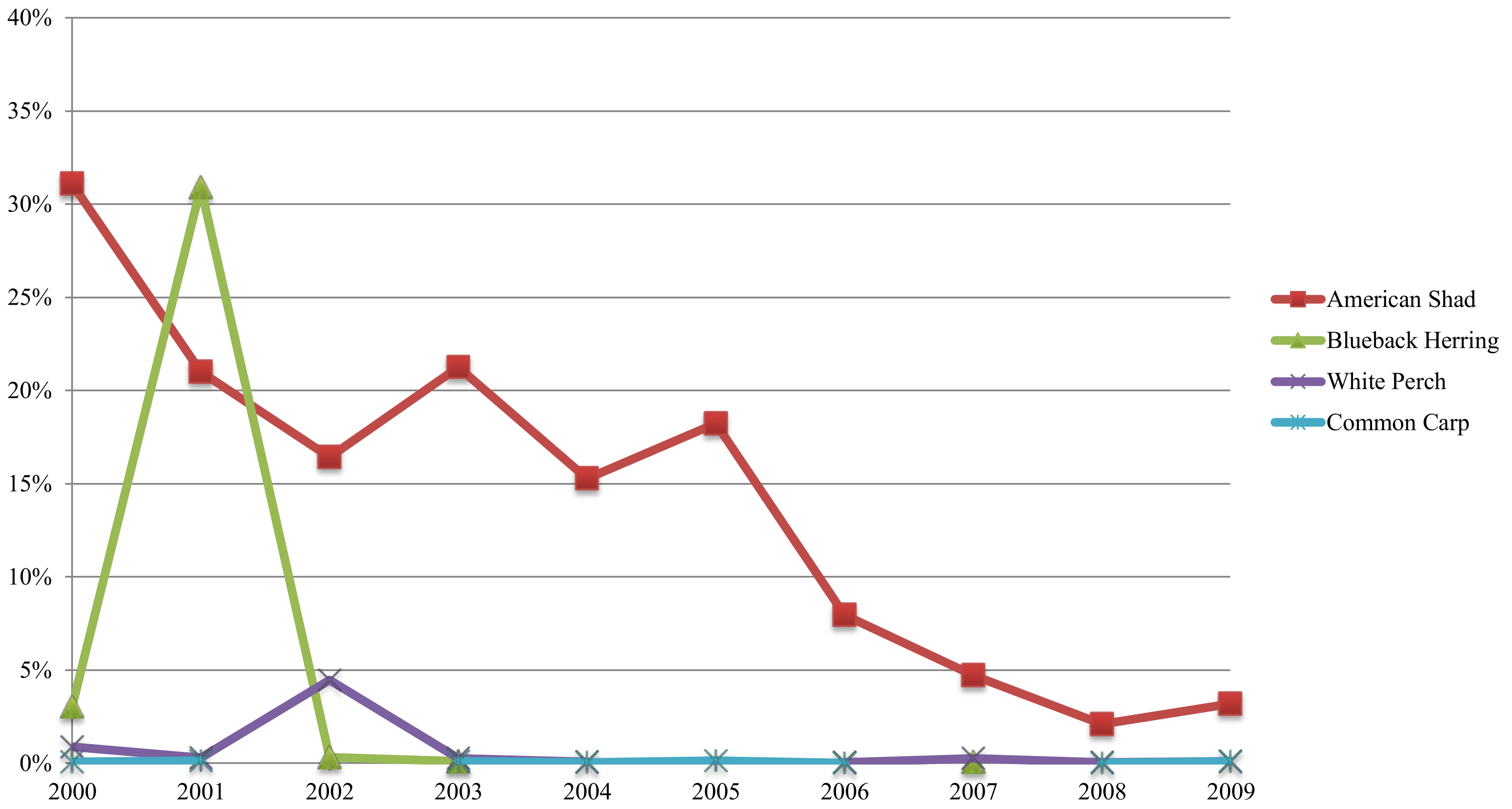
B-6. PROPORTIONAL ABUNDANCE EAST FISH LIFT 1991 – 1999 GIZZARD SHAD REMOVED

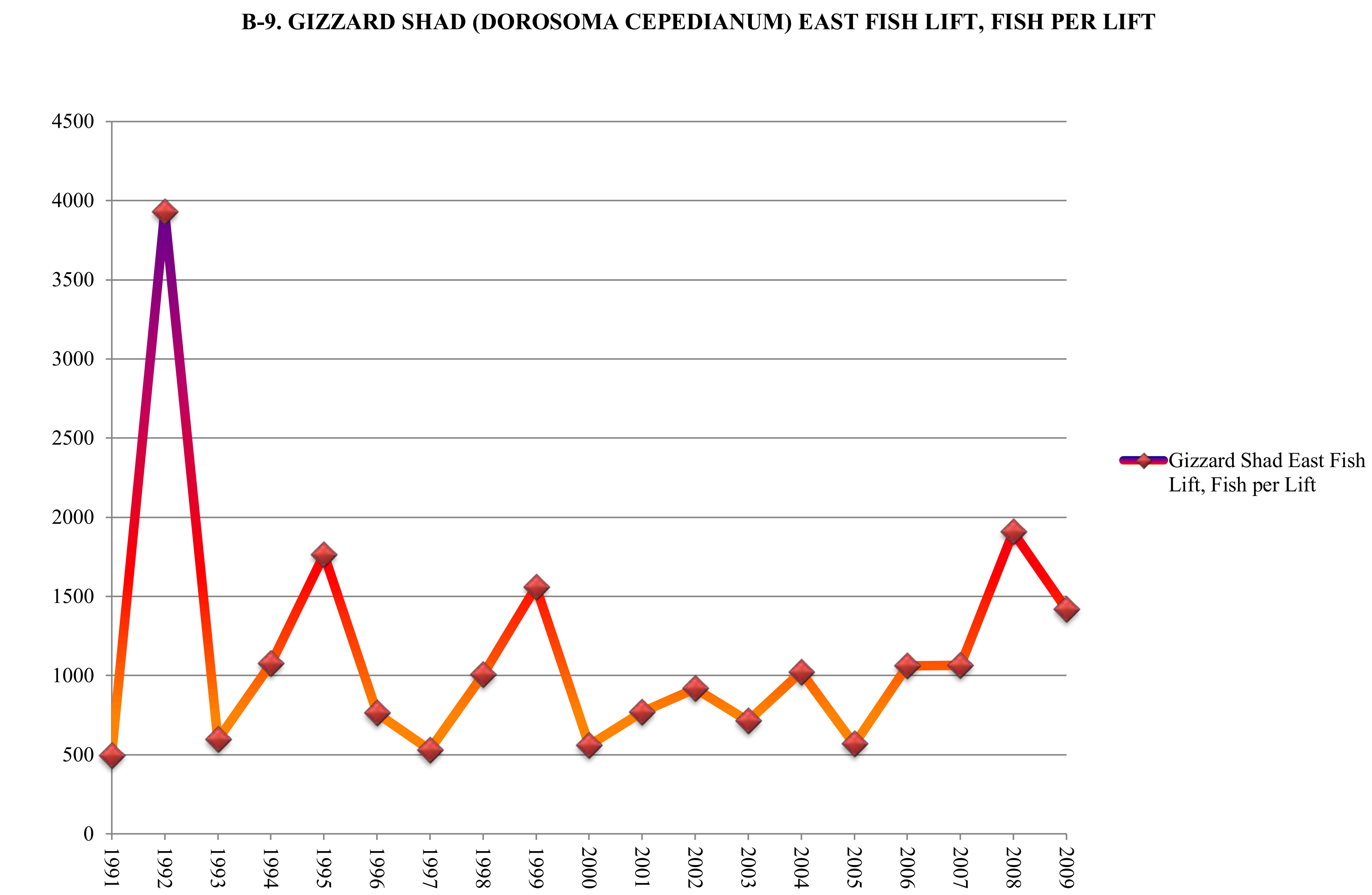


B-7. PROPORTIONAL ABUNDANCE EAST FISH LIFT 2000 – 2009

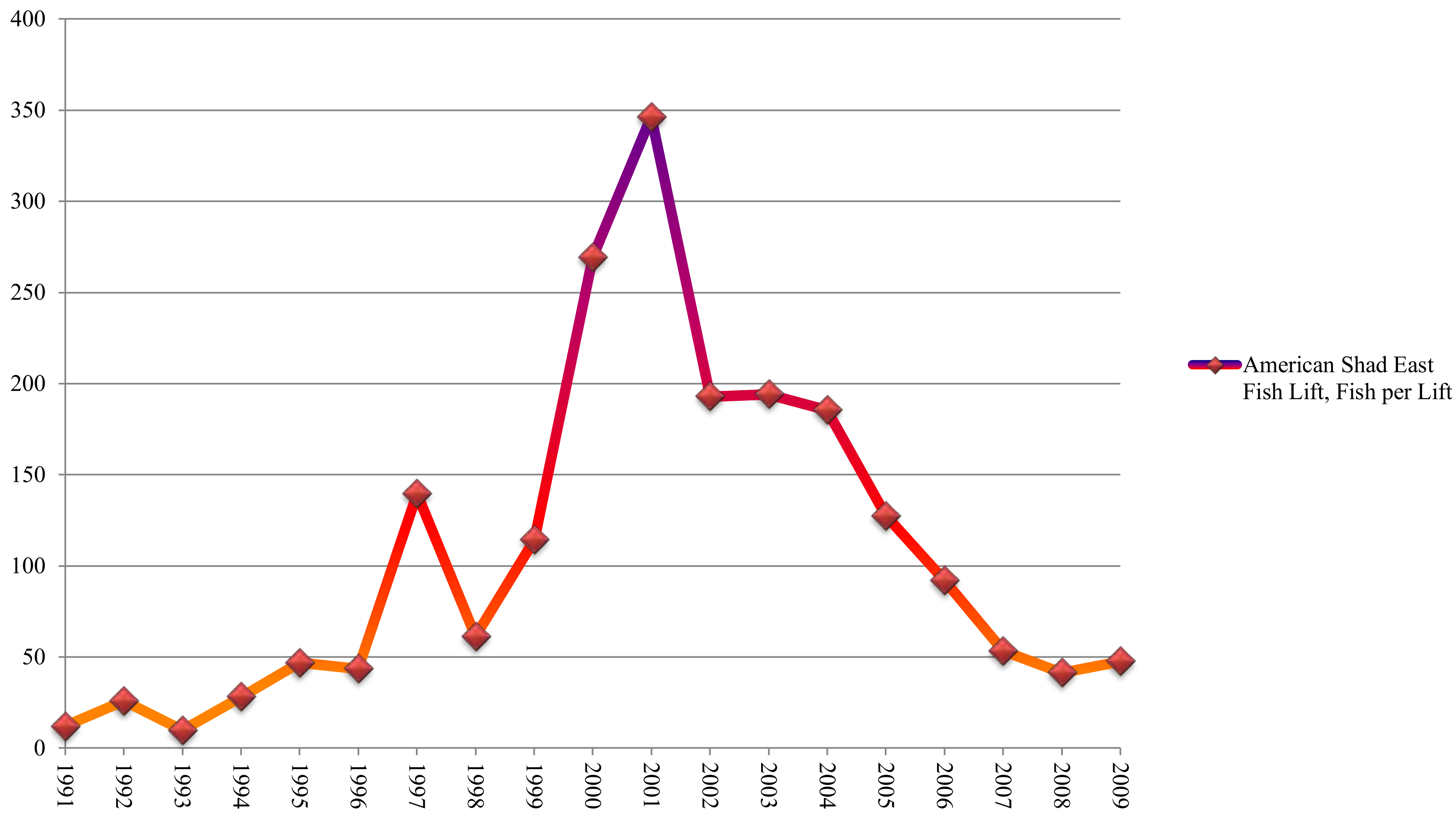


B-8. PROPORTIONAL ABUNDANCE EAST FISH LIFT 2000 – 2009 GIZZARD SHAD REMOVED

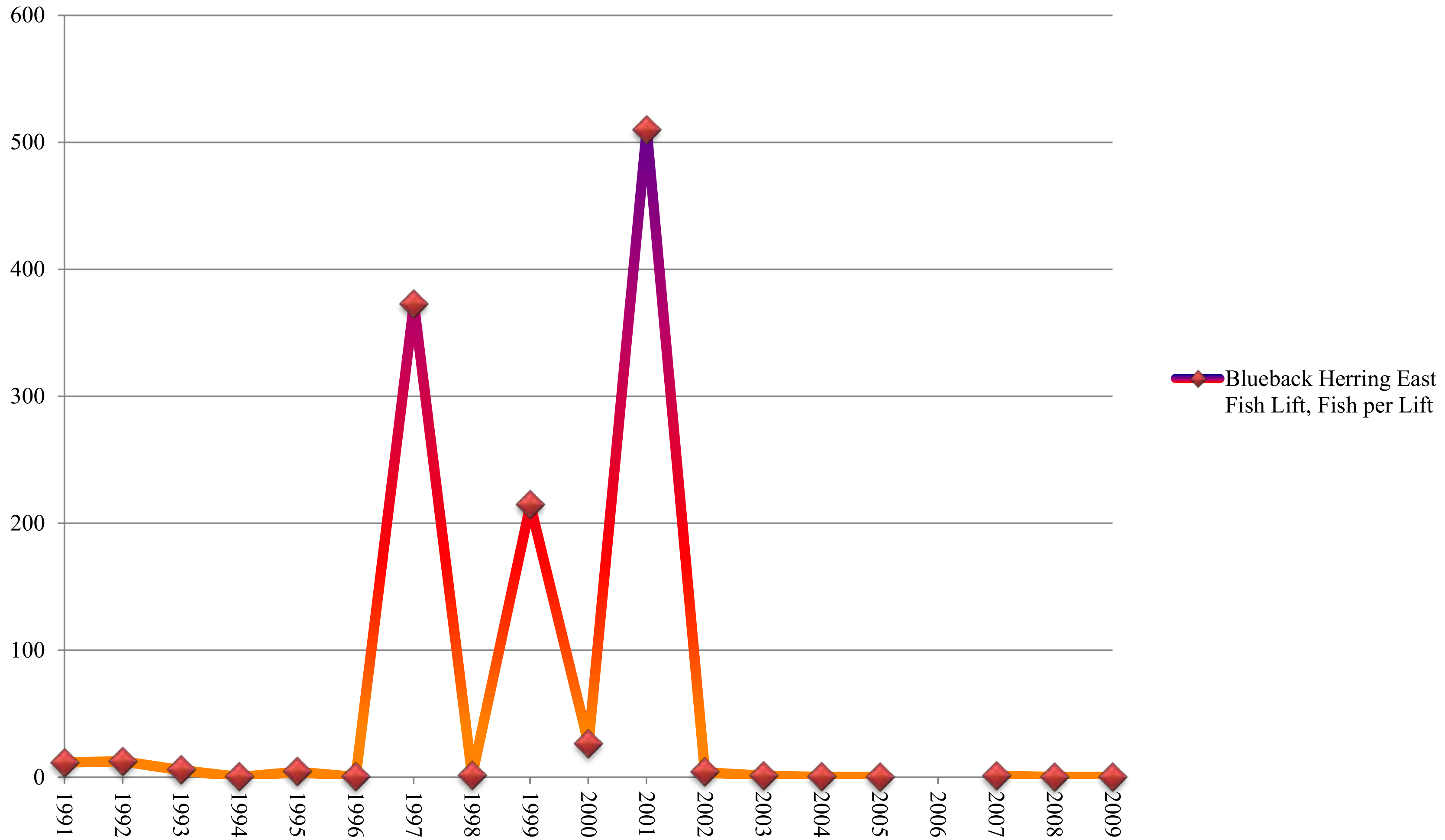



B-9. GIZZARD SHAD (DOROSOMA CEPEDIANUM) EAST FISH LIFT, FISH PER LIFT
4500
4000
3500
3000
2500
2000
1500
1000
500
0
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
Gizzard Shad East Fish Lift, Fish per Lift

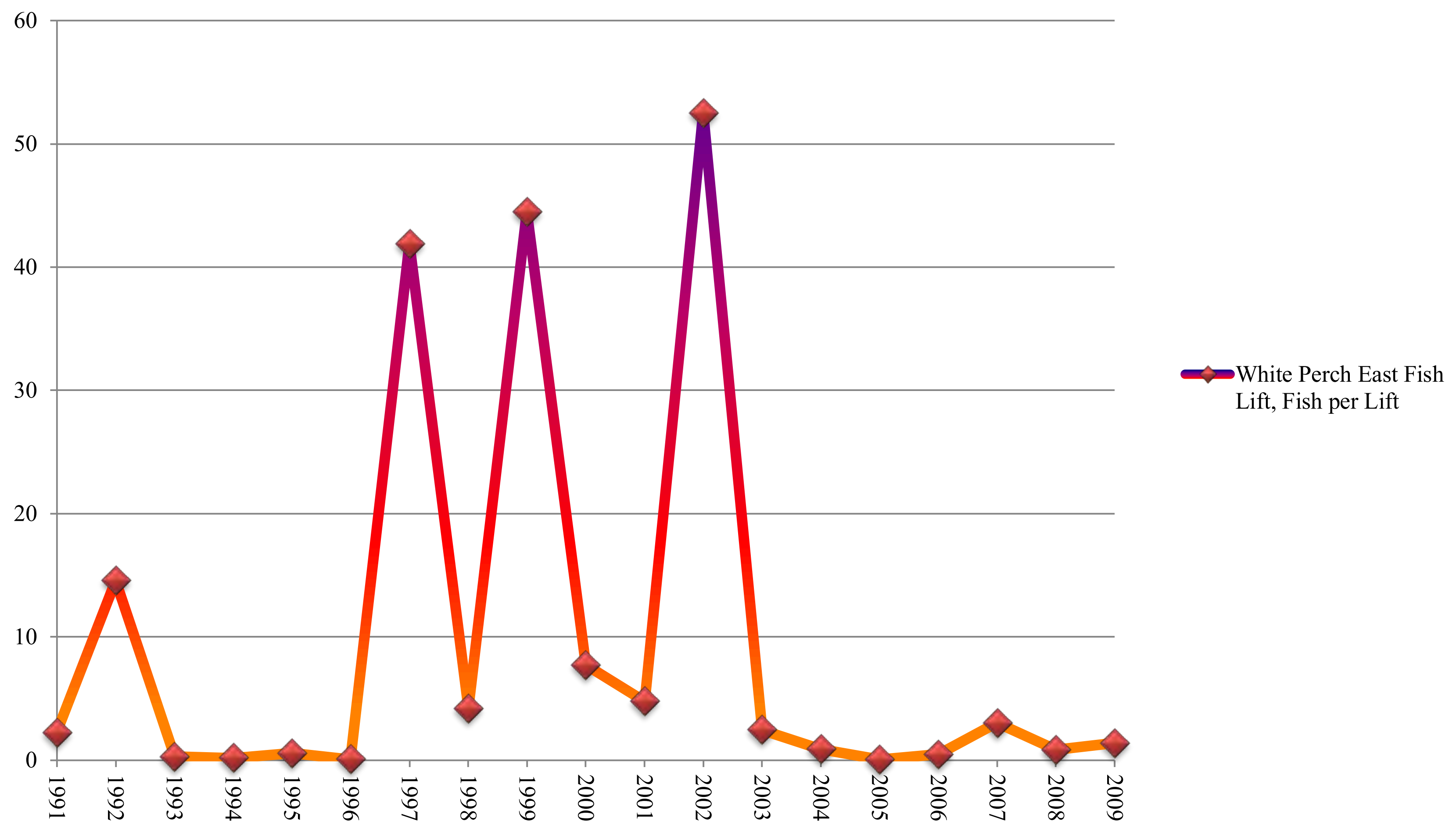
B-10. AMERICAN SHAD (ALOSA SAPIDISSIMA) EAST FISH LIFT, FISH PER LIFT



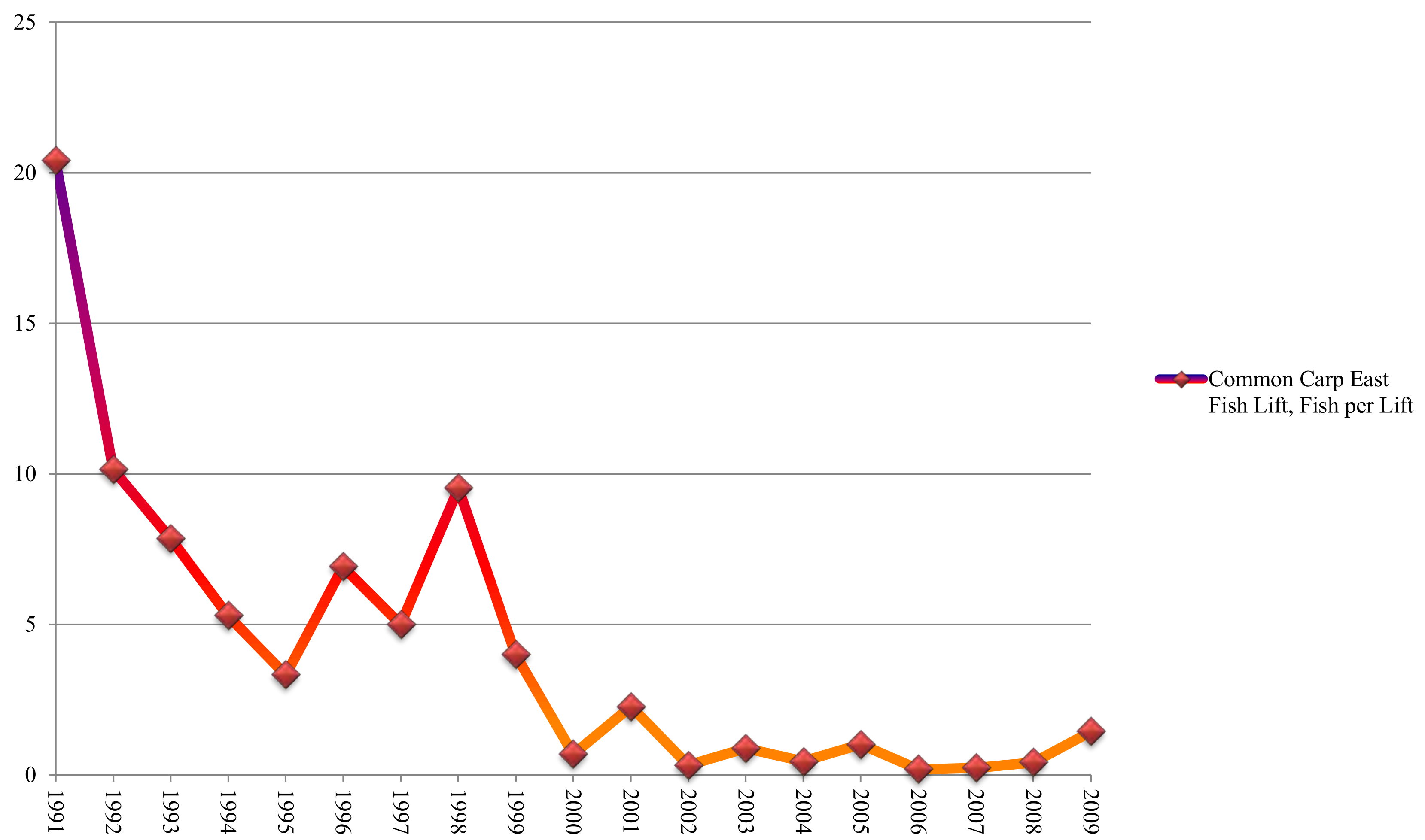
B-11. BLUEBACK HERRING (ALOSA AESTIVALIS) EAST FISH LIFT, FISH PER LIFT



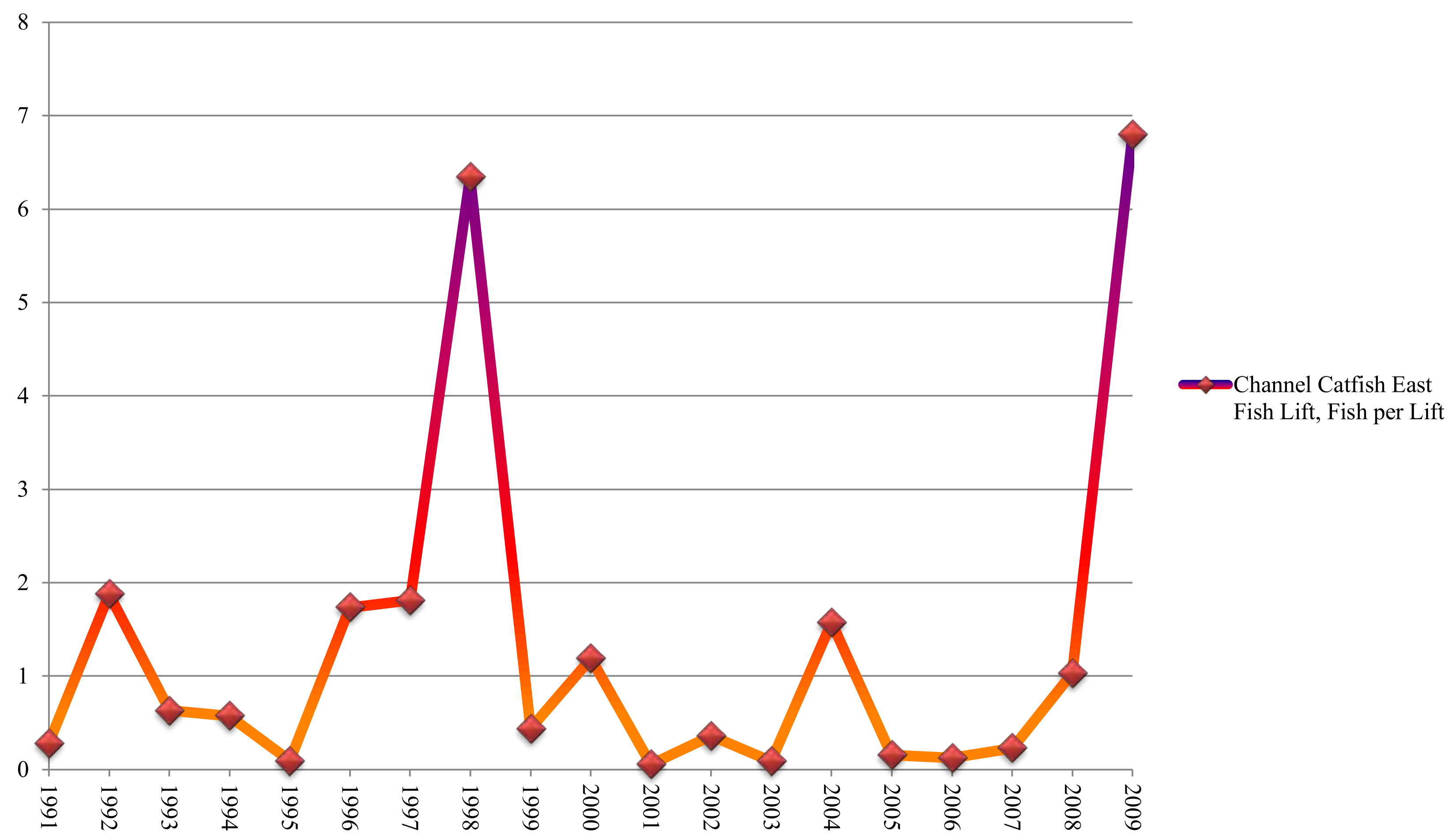
B-12. WHITE PERCH (MORONE AMERICANA) EAST FISH LIFT, FISH PER LIFT



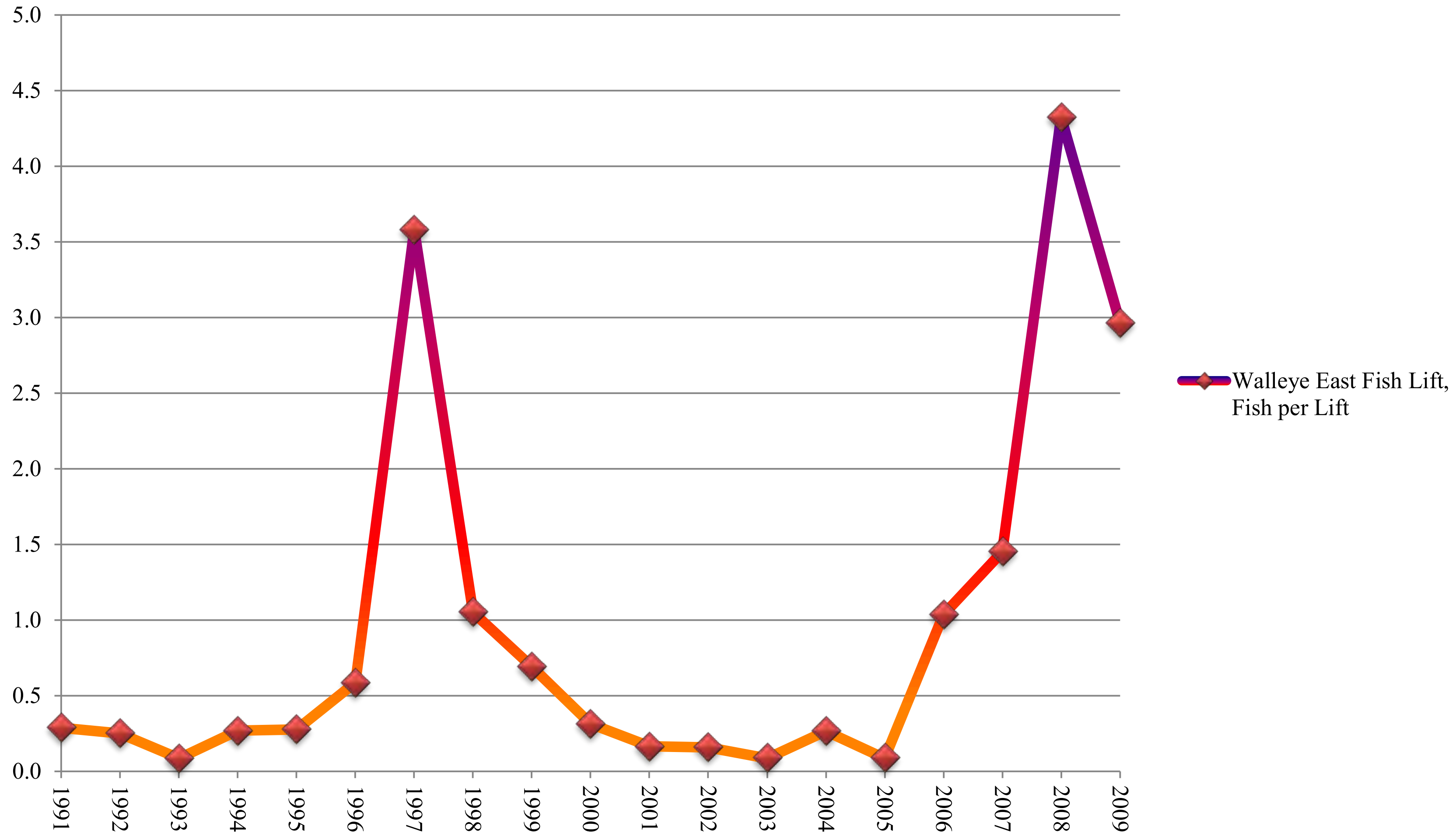
B-13. COMMON CARP (CYPRINUS CARPIO) EAST FISH LIFT, FISH PER LIFT



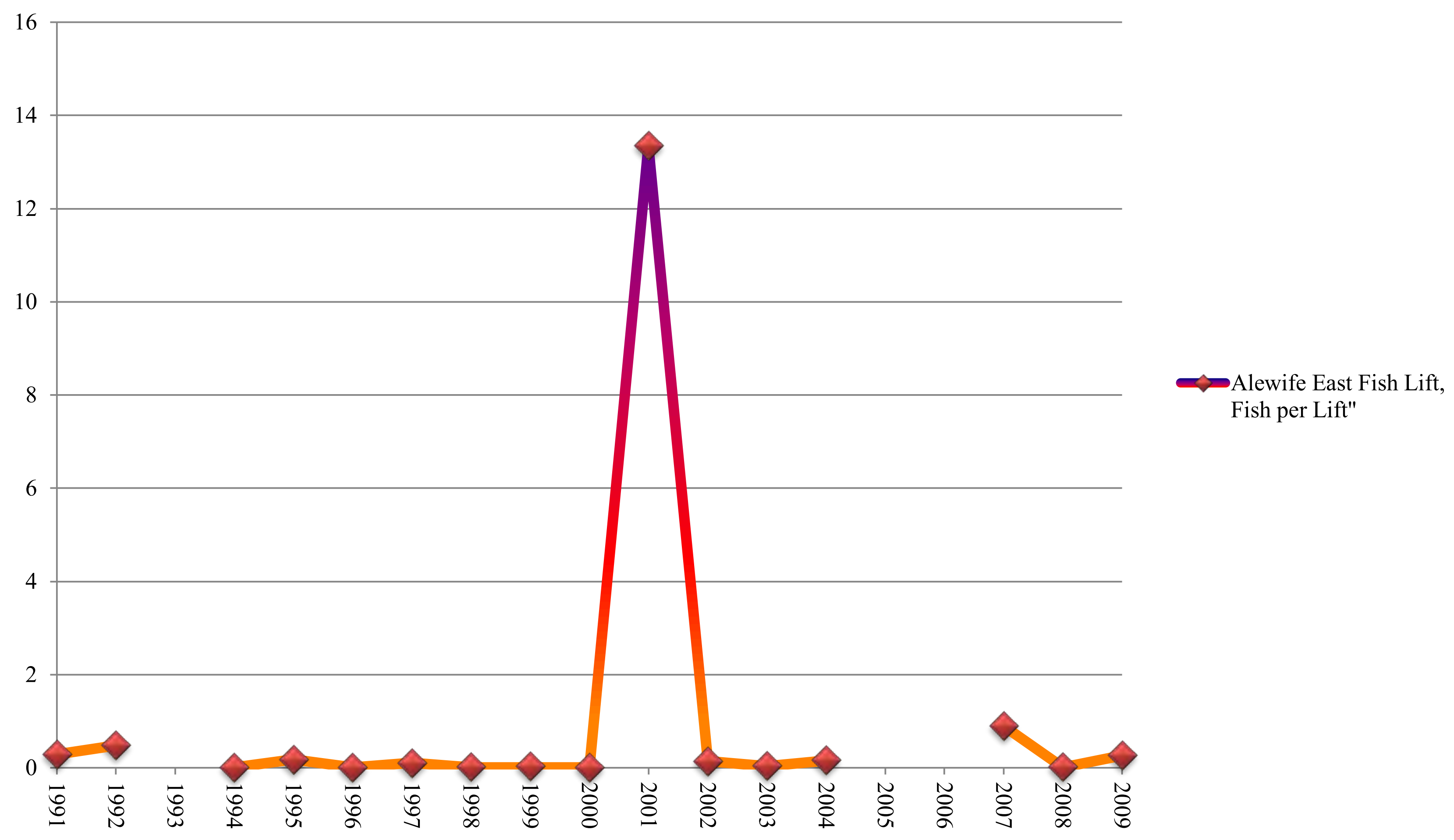
B-14. CHANNEL CATFISH (ICTALURUS PUNCTATUS) EAST FISH LIFT, FISH PER LIFT



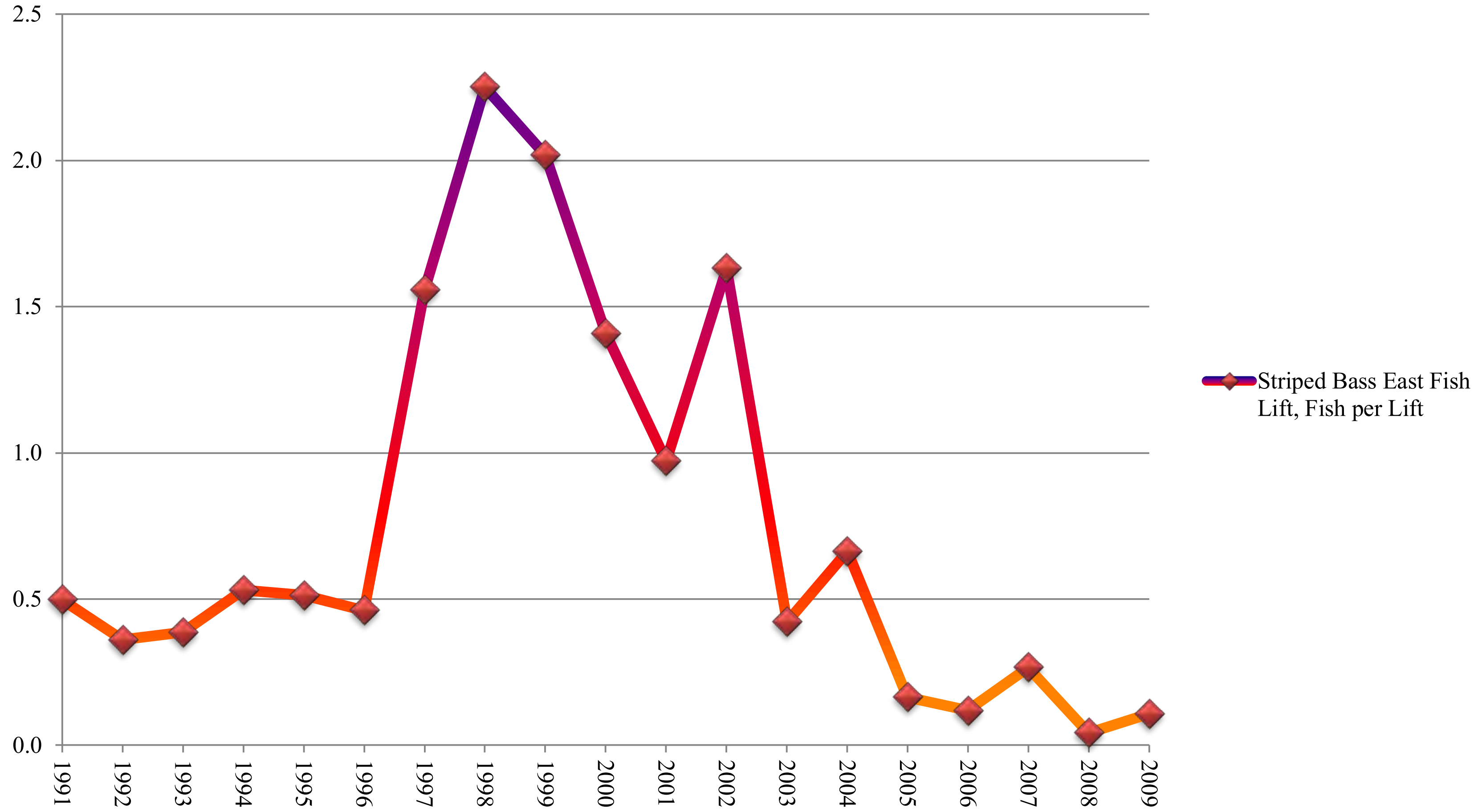
B-16. WALLEYE (SANDER VITREUS) EAST FISH LIFT, FISH PER LIFT



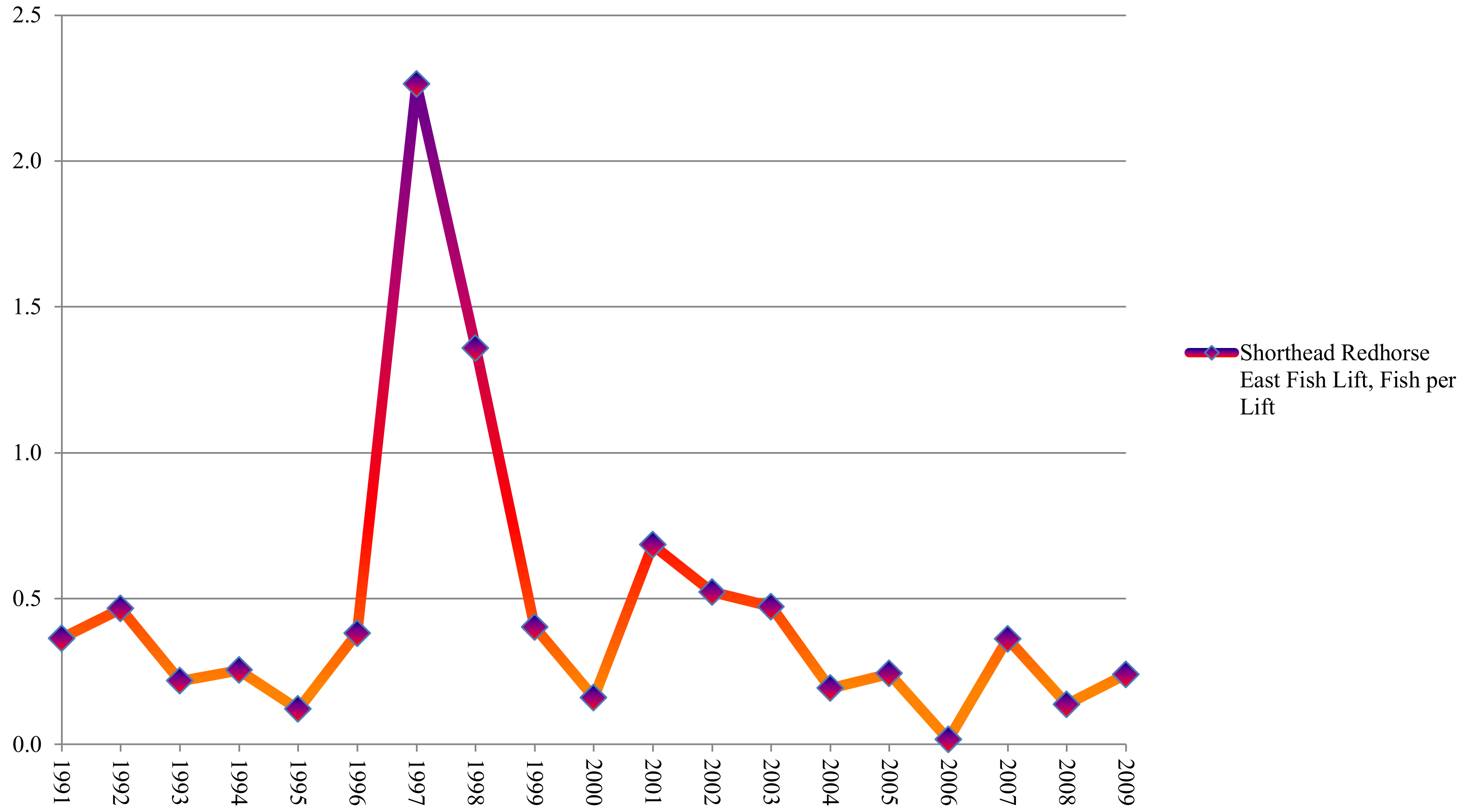
B-16. ALEWIFE (ALOSA PSEUDOHARENGUS) EAST FISH LIFT, FISH PER LIFT



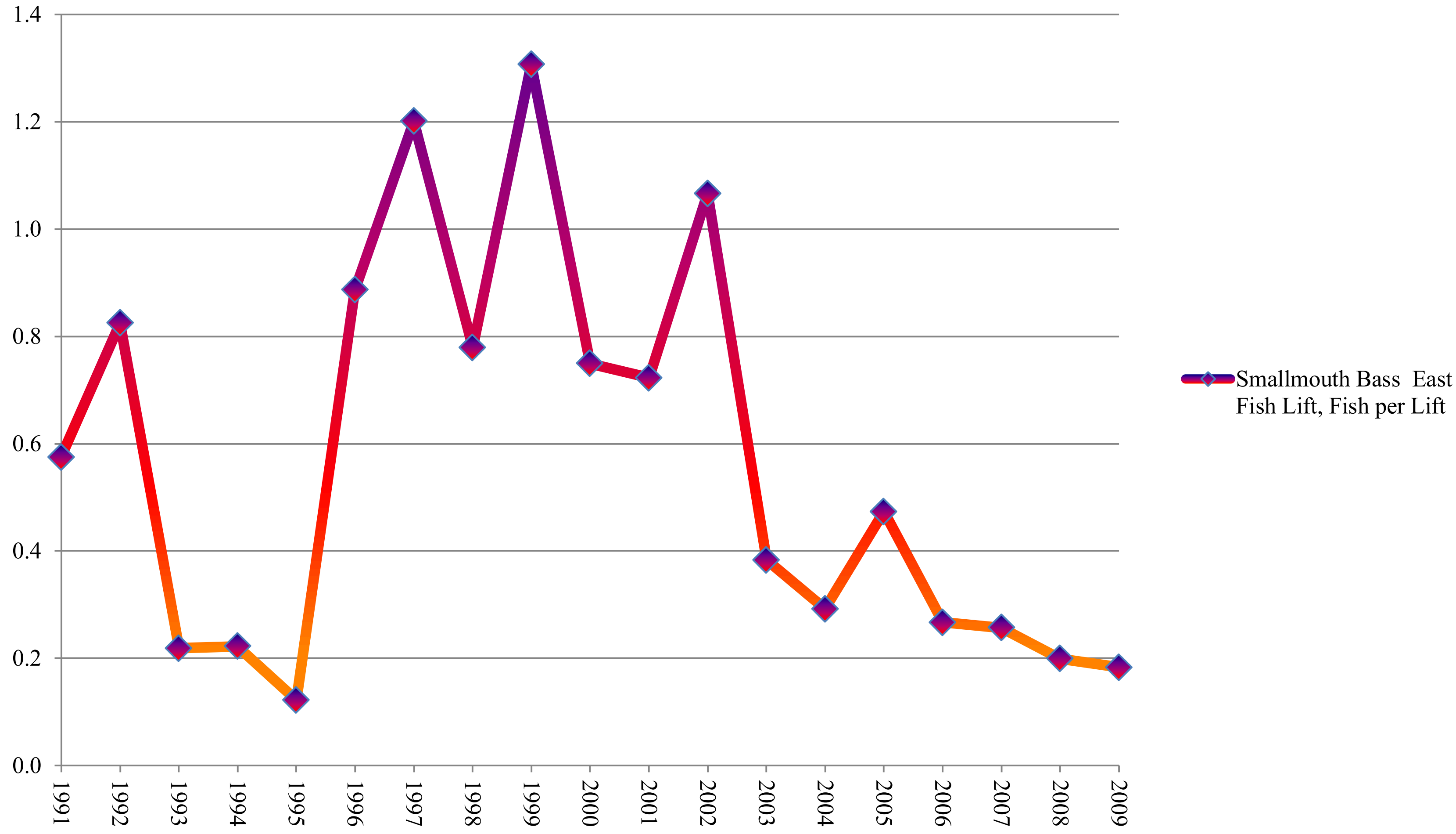
B-17. STRIPED BASS (MORONE SAXATILIS) EAST FISH LIFT, FISH PER LIFT



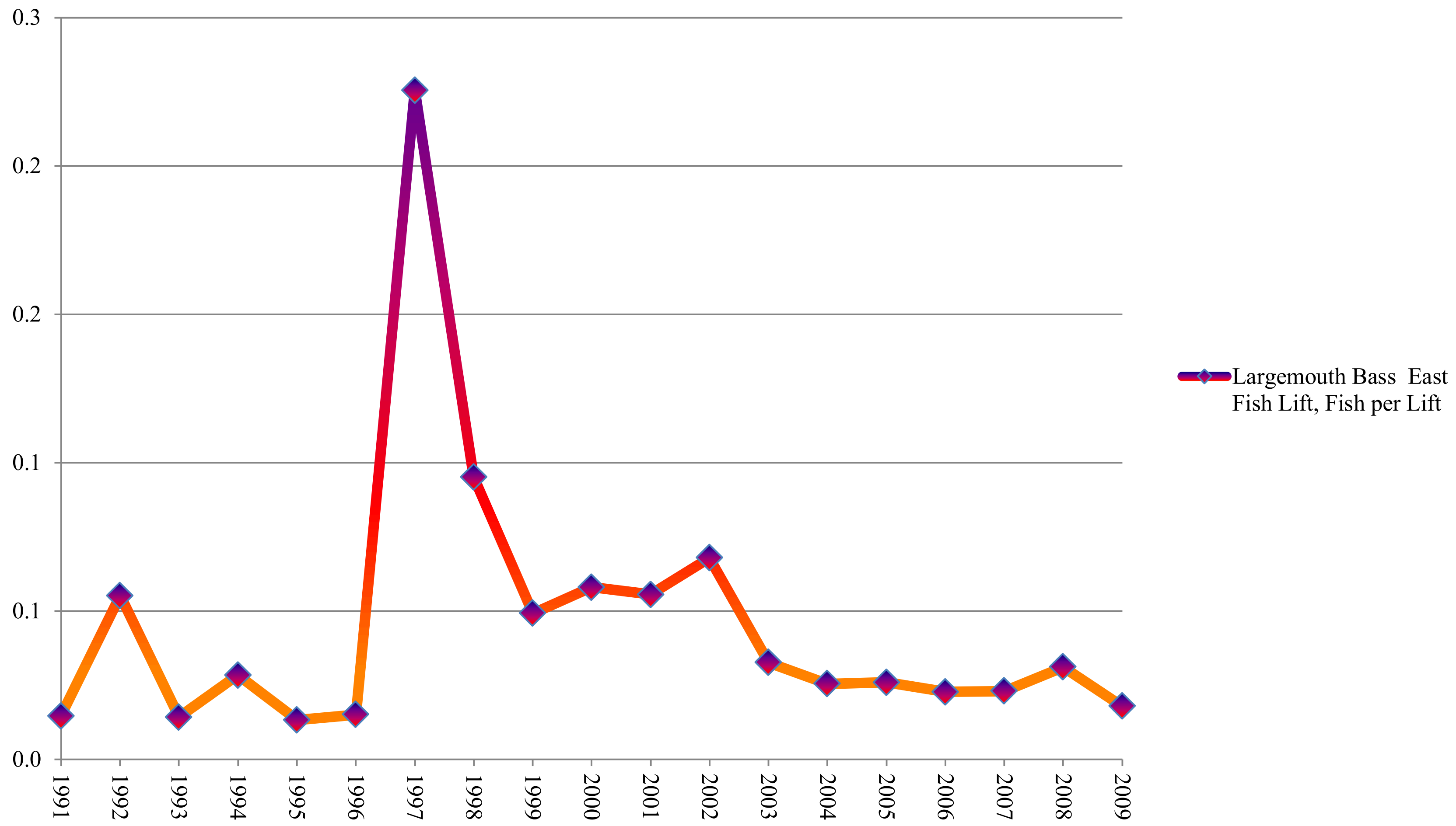
B-18. SHORTHEAD REDHORSE (MOXOSTOMA MACROLEPIDOTUM) EAST FISH LIFT, FISH PER LIFT



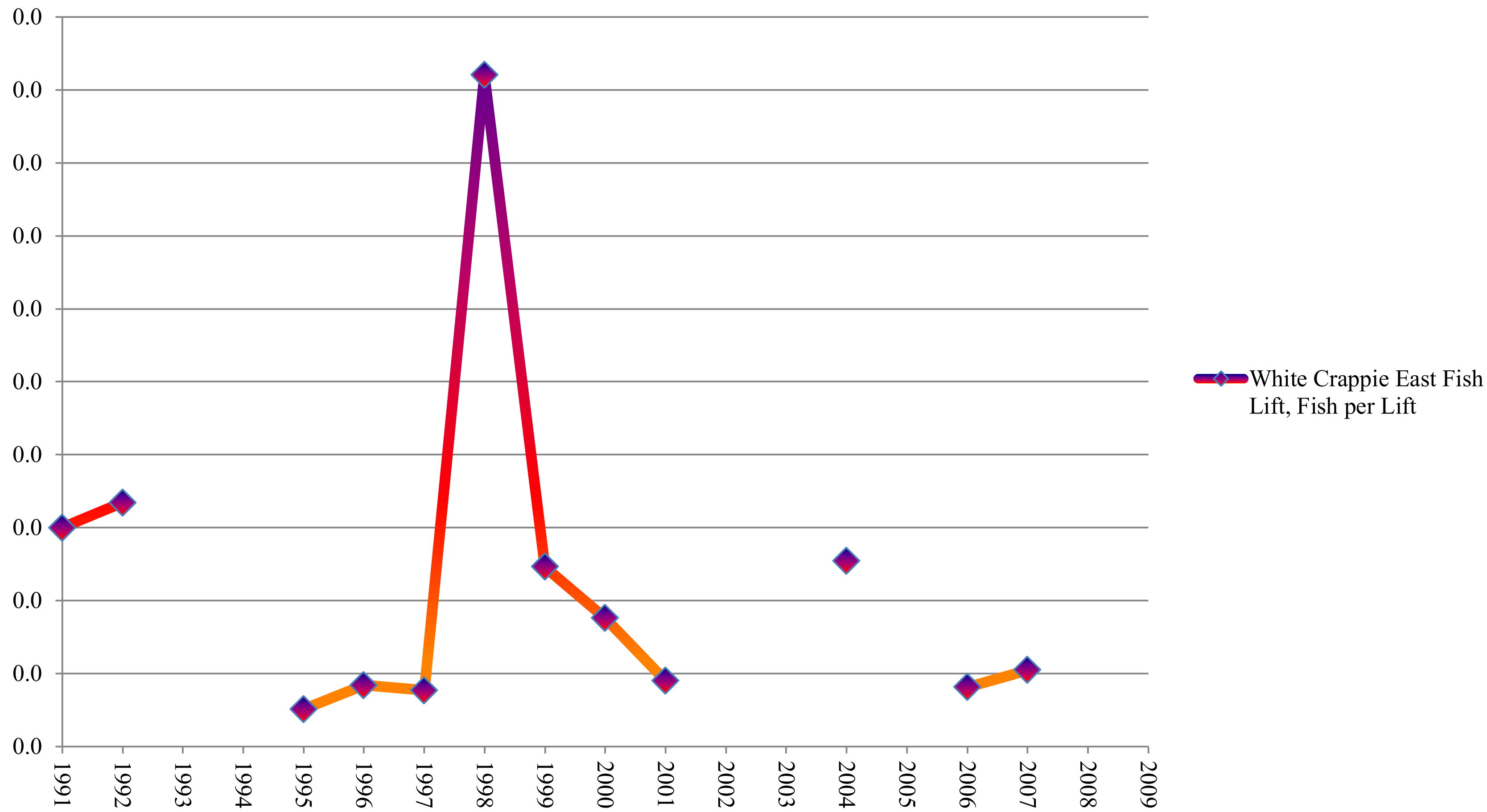
B-19. SMALLMOUTH BASS (MICROPTERUS DOLOMIEU) EAST FISH LIFT, FISH PER LIFT



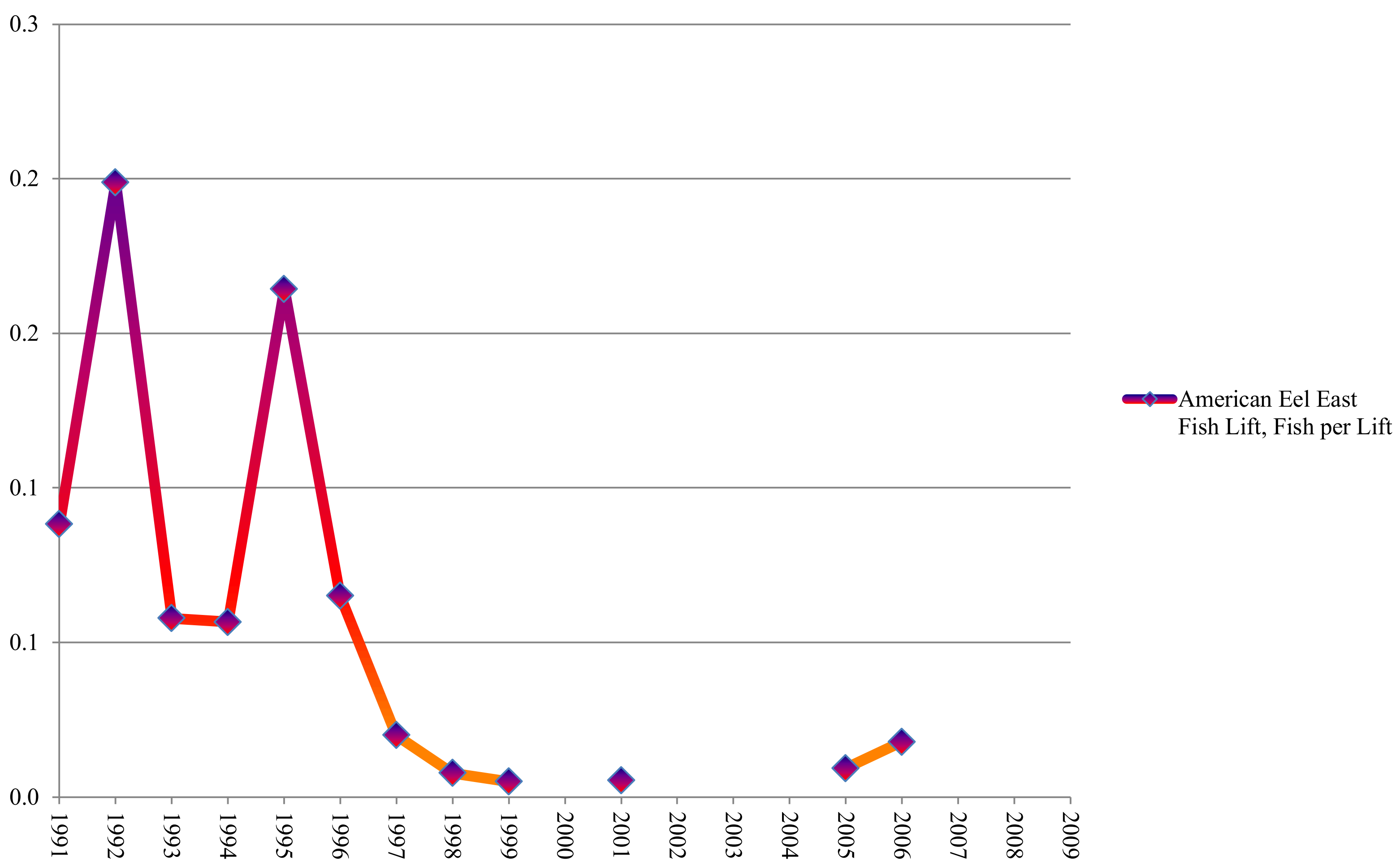
B-20. LARGEMOUTH BASS (MICROPTERUS SALMOIDES) EAST FISH LIFT, FISH PER LIFT



B-21. WHITE CRAPPIE (POMOXIS ANNULARIS) EAST FISH LIFT, FISH PER LIFT



B-22. AMERICAN EEL (ANGUILLA ROSTRATA) EAST FISH LIFT, FISH PER LIFT



B-23. EAST FISH LIFT CATCH 1991 -2009

Year	1991	1991	1991	1992	1992	1992	1993	1993	1993	1994	1994	1994	1995	1995	1995	1996	1996	1996	1997	1997	1997	1998	1998	1998	1999	1999	1999
No. Days	60			49			42			55			68			49			64			50			53		
Lifts	1168			599			848			955			986			599			652			652			610		
Est. Oper. Time(HR)	647.2			454.1			463.5			574.8			706.2			454.1			640			640			467		
Fishing Time (HR)	561.9			731.5			421.2			517.7			653.3			420.6			--						--		
#Species	42	Fish per lift	% comp	45	Fish per lift	% comp	29	Fish per lift	% comp	36	Fish per lift	% comp	36	Fish per lift	% comp	35	Fish per lift	% comp	36	Fish per lift	% comp	33	Fish per lift	% comp	31	Fish per lift	% comp
Gizzard Shad	575505	492.73	88.4%	2351351	3925.4	98.2%	504116	594.48	95.2%	1025418	1073.7	96.5%	1737685	1762.3	96.7%	455317	760.13	92.5%	344332	528.12	47.9%	654575	1003.9	91.8%	950500	1558.2	80.3%
American Shad	13897	11.90	2.1%	15386	25.69	0.6%	8203	9.67	1.5%	26715	27.97	2.5%	46062	46.72	2.6%	26040	43.47	5.3%	90971	139.53	12.6%	39904	61.20	5.6%	69712	114.28	5.9%
Blueback Herring	13149	11.26	2.0%	7347	12.27	0.3%	4574	5.39	0.9%	248	0.26		4004	4.06	0.2%	261	0.44	0.1%	242815	372.42	33.8%	700	1.07	0.1%	130625	214.14	11.0%
White Perch	2610	2.23	0.4%	8725	14.57	0.4%	215	0.25		133	0.14		528	0.54		49	0.08		27312	41.89	3.8%	2731	4.19	0.4%	27133	44.48	2.3%
Common Carp	23833	20.40	3.7%	6072	10.14	0.3%	6649	7.84	1.3%	5042	5.28	0.5%	3262	3.31	0.2%	4139	6.91	0.8%	3256	4.99	0.5%	6205	9.52	0.9%	2430	3.98	0.2%
Quillback	3220	2.76	0.5%	483	0.81		540	0.64	0.1%	2507	2.63	0.2%	2910	2.95	0.2%	3773	6.30	0.8%	2488	3.82	0.3%	218	0.33		144	0.24	
Comely Shiner	11847	10.14	1.8%	650	1.09		3563	4.20	0.7%	433	0.45		163	0.17		117	0.20		140	0.21		164	0.25				
Channel Catfish	321	0.27		1124	1.88		534	0.63	0.1%	544	0.57	0.1%	90	0.09		1037	1.73	0.2%	1178	1.81	0.2%	4135	6.34	0.6%	266	0.44	
Walleye	335	0.29	0.1%	150	0.25		71	0.08		255	0.27		271	0.27		351	0.59	0.1%	2334	3.58	0.3%	685	1.05	0.1%	421	0.69	
Striped Bass	581	0.50	0.1%	216	0.36		327	0.39	0.1%	506	0.53		505	0.51		276	0.46	0.1%	1015	1.56	0.1%	1467	2.25	0.2%	1231	2.02	0.1%
Alewife	323	0.28		285	0.48		--			5	0.01		170	0.17		3	0.01		63	0.10		6	0.01		14	0.02	
Smallmouth Bass	671	0.57	0.1%	494	0.82		185	0.22		212	0.22		120	0.12		531	0.89	0.1%	783	1.20	0.1%	508	0.78	0.1%	797	1.31	0.1%
Shorthead Redhorse	424	0.36	0.1%	278	0.46		184	0.22		242	0.25		118	0.12		228	0.38		1475	2.26	0.2%	885	1.36	0.1%	245	0.40	
Spotfin Shiner	2647	2.27	0.4%	35	0.06		--			--									17	0.03							
Bluegill	149	0.13		399	0.67		58	0.07		45	0.05		46	0.05		37	0.06		334	0.51		354	0.54		159	0.26	
Striped Bass x White Bass	827	0.71	0.1%	413	0.69		64	0.08		53	0.06		8	0.01		4	0.01		1	0.00		4	0.01		5	0.01	
Sea Lamprey	19	0.02		17	0.03		4	0.00		5	0.01		4	0.00		9	0.02		30	0.05		11	0.02		27	0.04	
Redbreast Sunfish	115	0.10		110	0.18		34	0.04		24	0.03		185	0.19		17	0.03		195	0.30		46	0.07		108	0.18	
Yellow Perch	45	0.04		36	0.06		46	0.05		7	0.01		22	0.02		12	0.02		93	0.14		51	0.08		108	0.18	
White Sucker	51	0.04		96	0.16		82	0.10		42	0.04		43	0.04		73	0.12		7	0.01		81	0.12		58	0.10	
Carps and Minnows	100	0.09		554	0.92																						
American Eel	103	0.09		119	0.20		49	0.06		54	0.06		162	0.16		39	0.07		13	0.02		5	0.01		3	0.00	
Largemouth Bass	17	0.01		33	0.06		12	0.01		27	0.03		13	0.01		9	0.02		147	0.23		62	0.10		30	0.05	
Rock Bass	3	0.00		16	0.03		10	0.01		1	0.00		2	0.00		3	0.01		204	0.31		74	0.11		31	0.05	
Brown Bullhead	3	0.00		3	0.01		1	0.00		--			2	0.00		3	0.01		5	0.01		15	0.02		2	0.00	
Brown Trout	44	0.04		76	0.13		53	0.06		42	0.04		13	0.01		22	0.04		19	0.03		61	0.09		9	0.01	
Spottail Shiner	21	0.02		1	0.00					--			37	0.04		2	0.00		3	0.00							
Rainbow Trout	7	0.01		10	0.02		5	0.01		5	0.01		10	0.01		9	0.02		6	0.01		11	0.02		12	0.02	
Pumpkinseed	16	0.01		13	0.02		2	0.00		3	0.00		--			1	0.00		36	0.06		4	0.01		1	0.00	
Green Sunfish	10	0.01		12	0.02		1	0.00		8	0.01		2	0.00		4	0.01		6	0.01		2	0.00		13	0.02	
Golden Shiner	--			--						45	0.05		1	0.00													
Muskellunge	3	0.00		10	0.02		9	0.01		5	0.01					2	0.00		5	0.01		2	0.00				
White Crappie	7	0.01		4	0.01		--			--			1	0.00		1	0.00		1	0.00		12	0.02		3	0.00	
Hickory Shad	--			20	0.03					1	0.00		1	0.00					--								
Yellow Bullhead	--			1	0.00		2	0.00		--												5	0.01				
Herrings	--			29	0.05														--								
Tiger Muskie	3	0.00		2	0.00		1	0.00		--			5	0.01		4	0.01										
Black Crappie	3	0.00		1	0.00		--			1	0.00		--						2	0.00		5	0.01		6	0.01	
Blacknose Dace	--			--																							
White Catfish	--			--			--			--						4	0.01					3	0.00		2	0.00	
Tessellated Darter	10	0.01		2	0.00					--			8	0.01													
Atlantic Needlefish	2	0.00		--						1	0.00		1	0.00								2			4	0.01	
Banded Darter	9	0.01		1	0.00					--			2	0.00													
Brook Trout x Lake Trout	1	0.00		1	0.00		--			1	0.00																
Brook Trout	1	0.00		1	0.00					1	0.00					2	0.00								2	0.00	
Margined Madtom	--			--			--			--																	
Notropis Sp.																			7	0.01							
Logperch	--			1	0.00					1	0.00		3	0.00		1	0.00										
Hybrids	5	0.00		--																							

B-23 Cont.

Year	1991	1991	1991	1992	1992	1992	1993	1993	1993	1994	1994	1994	1995	1995	1995	1996	1996	1996	1997	1997	1997	1998	1998	1998	1999	1999	1999
No. Days	60			49			42			55			68			49			64			50			53		
Lifts	1168			599			848			955			986			599			652			652			610		
Est. Oper. Time(HR)	647.2			454.1			463.5			574.8			706.2			454.1			640			640			467		
Fishing Time (HR)	561.9			731.5			421.2			517.7			653.3			420.6			--						--		
#Species	42	Fish per lift	% comp	45	Fish per lift	% comp	29	Fish per lift	% comp	36	Fish per lift	% comp	36	Fish per lift	% comp	35	Fish per lift	% comp	36	Fish per lift	% comp	33	Fish per lift	% comp	31	Fish per lift	% comp
Northern Hog Sucker	--			--						--						4	0.01										
Creek Chubsucker	--			2	0.00					1	0.00																
Northern Pike	--			--						--			1	0.00													
Flathead Catfish																											
Creek Chub	--			--																							
Salmo Sp.																			2	0.00							
Shield Darter	2	0.00		--																							
Longnose gar																											
Chain Pickerel	--			--						--									1	0.00			0.00				
Esox Sp.																			1	0.00							
Longnose Dace	--			--						1	0.00																
Sunfish Hybrids	--			1	0.00		--																				
Bluntnose Minnow	1	0.00		--																							
Total	**650940**	557.3		**2394583**	3997.6		**529594**	624.5		**1062634**	1112.7		**1796460**	1822.0		**492384**	822.0		**719297**	1103.2		**712993**	1,093.55		**1184101**	1941.15	

Year	2000	2000	2000	2001	2001	2001	2002	2002	2002	2003	2003	2003	2004	2004	2004	2005	2005	2005	2006	2006	2006	2007	2007	2007	2008	2008	2008
No. Days	45			43			51			44			44			52			61			39			51		
Lifts	570			559			560			645			590			541			619			479			483		
Est. Oper. Time(HR)	367.76			359.8			440.7			416.6			390.3			434.32			429.8			335.25			409		
Fishing Time (HR)				--			--			--			--														
#Species	31	Fish per lift	% comp	30	Fish per lift	% comp	31	Fish per lift	% comp	25	Fish per lift	% comp	31	Fish per lift	% comp	28	Fish per lift	% comp	32	Fish per lift	% comp	31	Fish per lift	% comp	28	Fish per lift	% comp
Gizzard Shad	317753	557.46	64.3%	429461	768.27	46.6%	513794	917.49	78.2%	459634	712.61	78.0%	602677	1021.49	84.2%	305378	564.47	80.8%	655990	1059.76	91.8%	508627	1061.85	94.3%	919975	1904.71	97.5%
American Shad	153546	269.38	31.1%	193574	346.29	21.0%	108001	192.86	16.4%	125135	194.01	21.2%	109360	185.36	15.3%	68926	127.40	18.2%	56899	91.92	8.0%	25464	53.16	4.7%	19914	41.23	2.1%
Blueback Herring	14963	26.25	3.0%	284921	509.70	30.9%	2037	3.64	0.3%	530	0.82	0.1%	101	0.17		4	0.01					460	0.96	0.1%	1	0.00	
White Perch	4387	7.70	0.9%	2659	4.76	0.3%	29404	52.51	4.5%	1572	2.44	0.3%	512	0.87	0.1%	15	0.03		277	0.45		1434	2.99	0.3%	388	0.80	
Common Carp	388	0.68	0.1%	1267	2.27	0.1%	172	0.31		561	0.87	0.1%	257	0.44		540	1.00	0.1%	108	0.17		107	0.22		199	0.41	
Quillback	408	0.72	0.1%	241	0.43		400	0.71	0.1%	548	0.85	0.1%	308	0.52		2145	3.96	0.6%	407	0.66	0.1%	1236	2.58	0.2%	400	0.83	
Comely Shiner				4	0.01								291	0.49													
Channel Catfish	677	1.19	0.1%	29	0.05		199	0.36		57	0.09		928	1.57	0.1%	83	0.15		75	0.12		108	0.23		496	1.03	0.1%
Walleye	177	0.31		91	0.16		88	0.16		59	0.09		156	0.26		47	0.09		641	1.04	0.1%	695	1.45	0.1%	2088	4.32	0.2%
Striped Bass	802	1.41	0.2%	543	0.97	0.1%	913	1.63	0.1%	272	0.42		391	0.66	0.1%	89	0.16		73	0.12		127	0.27		20	0.04	
Alewife	2	0.00		7458	13.34	0.8%	74	0.13		21	0.03		89	0.15								429	0.90	0.1%	4	0.01	
Smallmouth Bass	427	0.75	0.1%	404	0.72		597	1.07	0.1%	247	0.38		172	0.29		256	0.47	0.1%	165	0.27		123	0.26		96	0.20	
Shorthead Redhorse	91	0.16		382	0.68		292	0.52		304	0.47	0.1%	113	0.19		131	0.24		10	0.02		173	0.36		66	0.14	
Spotfin Shiner																											
Bluegill	96	0.17		55	0.10		130	0.23		37	0.06		19	0.03		10	0.02		25	0.04		27	0.06		65	0.13	
Striped Bass x White Bass	2	0.00														1	0.00		4	0.01		6	0.01		1	0.00	
Sea Lamprey	23	0.04		268	0.48		316	0.56		68	0.11		58	0.10		35	0.06		128	0.21		22	0.05		11	0.02	
Redbreast Sunfish	20	0.04		46	0.08		51	0.09		4	0.01		8	0.01		19	0.04		5	0.01					3	0.01	
Yellow Perch	31	0.05		33	0.06		258	0.46		37	0.06		5	0.01		24	0.04		26	0.04		5	0.01		4	0.01	
White Sucker	29	0.05		66	0.12		16	0.03		10	0.02		11	0.02		8	0.01		3	0.00		13	0.03				
Carps and Minnows																											
American Eel				3	0.01											5	0.01		11	0.02							
Largemouth Bass	33	0.06		31	0.06		38	0.07		21	0.03		15	0.03		14	0.03		14	0.02		11	0.02		15	0.03	
Rock Bass	25	0.04		33	0.06		41	0.07		18	0.03		7	0.01		5	0.01		14	0.02		17	0.04		14	0.03	
Brown Bullhead	32	0.06		5	0.01		6	0.01		10	0.02		161	0.27		9	0.02		5	0.01		80	0.17		27	0.06	
Brown Trout	8	0.01		8	0.01		12	0.02					3	0.01		4	0.01		6	0.01		17	0.04		6	0.01	
Spottail Shiner				318	0.57		1	0.00											2	0.00					2	0.00	

B-23. Cont

Year	2000	2000	2000	2001	2001	2001	2002	2002	2002	2003	2003	2003	2004	2004	2004	2005	2005	2005	2006	2006	2006	2007	2007	2007	2008	2008	2008
No. Days	45			43			51			44			44			52			61			39			51		
Lifts	570			559			560			645			590			541			619			479			483		
Est. Oper. Time(HR)	367.76			359.8			440.7			416.6			390.3			434.32			429.8			335.25			409		
Fishing Time (HR)				--			--			--			--														
#Species	31	Fish per lift	% comp	30	Fish per lift	% comp	31	Fish per lift	% comp	25	Fish per lift	% comp	31	Fish per lift	% comp	28	Fish per lift	% comp	32	Fish per lift	% comp	31	Fish per lift	% comp	28	Fish per lift	% comp
Rainbow Trout	2	0.00		6	0.01		20	0.04		3	0.00		8	0.01		4	0.01		5	0.01		10	0.02		32	0.07	
Pumpkinseed	3	0.01					14	0.03					1	0.00		1	0.00		4	0.01		2	0.00		4	0.01	
Green Sunfish	2	0.00		6	0.01		5	0.01		2	0.00		1	0.00		1	0.00					1	0.00				
Golden Shiner																			2	0.00							
Muskellunge	1	0.00																	1	0.00		2	0.00		5	0.01	
White Crappie	2	0.00		1	0.00								3	0.01					1	0.00		1	0.00				
Hickory Shad							6	0.01					0						4	0.01					0		
Yellow Bullhead	13	0.02		1	0.00					1	0.00		2	0.00					1	0.00		2	0.00				
Herrings																											
Tiger Muskie																6	0.01		5	0.01		1	0.00				
Black Crappie	2	0.00		1	0.00								1	0.00					1	0.00		1	0.00				
Blacknose Dace										25	0.04																
White Catfish	1	0.00					1	0.00		1	0.00		5	0.01		1	0.00										
Tessellated Darter							1	0.00																			
Atlantic Needlefish							1	0.00											6	0.01					1		
Banded Darter																											
Brook Trout x Lake Trout				1	0.00		4	0.01					1	0.00													
Brook Trout																									1	0.00	
Margined Madtom	7	0.01																									
Notropis Sp.																											
Logperch																											
Hybrids																											
Northern Hog Sucker																											
Creek Chubsucker																											
Northern Pike																											
Flathead Catfish																1	0.00					1	0.00				
Creek Chub							2	0.00																			
Salmo Sp.																											
Shield Darter																											
Longnose gar																						1	0.00				
Chain Pickerel																											
Esox Sp.																											
Longnose Dace																											
Sunfish Hybrids																											
Bluntnose Minnow																											
Total	**493953**	866.58		**921916**	1,649.2		**656894**	1,173.0		**589177**	913.5		**715664**	1213.0		**377762**	698.3		**714918**	1155.0		**539203**	1125.7		**943838**	1954.1	

B-23. Cont.

Year	2009	2009	2009	Total 1991 - 2009	Total fish per lift 1991-2009	% Comp 1991 -2009
No. Days	57			977		
Lifts	618			12733		
Est. Oper. Time(HR)	495.6			9126.03		
Fishing Time (HR)						
#Species	30	Fish per lift	% comp	63	Fish per lift	% comp
Gizzard Shad	876412	1418.14	95.7%	14188500	1114.31	86.5%
American Shad	29272	47.37	3.2%	1226981	96.36	7.5%
Blueback Herring	71	0.11		706811	55.51	4.3%
White Perch	839	1.36	0.1%	110923	8.71	0.7%
Common Carp	886	1.43	0.1%	65373	5.13	0.4%
Quillback	899	1.45	0.1%	23275	1.83	0.1%
Comely Shiner				17372	1.36	0.1%
Channel Catfish	4201	6.80	0.5%	16082	1.26	0.1%
Walleye	1832	2.96	0.2%	10747	0.84	0.1%
Striped Bass	66	0.11		9420	0.74	0.1%
Alewife	160	0.26		9106	0.72	0.1%
Smallmouth Bass	113	0.18		6901	0.54	0.04%
Shorthead Redhorse	148	0.24		5789	0.45	0.04%
Spotfin Shiner				2699	0.21	0.02%
Bluegill	67	0.11		2112	0.17	0.01%
Striped Bass x White Bass	1	0.00		1394	0.11	0.01%
Sea Lamprey	190	0.31		1245	0.10	0.01%
Redbreast Sunfish	1	0.00		991	0.08	0.01%
Yellow Perch	23	0.04		866	0.07	0.01%
White Sucker	16	0.03		705	0.06	0.004%
Carps and Minnows				654	0.05	0.004%
American Eel				566	0.04	0.003%
Largemouth Bass	11	0.02		553	0.04	0.003%
Rock Bass	19	0.03		537	0.04	0.003%
Brown Bullhead	153	0.25		522	0.04	0.003%
Brown Trout	16	0.03		419	0.03	0.003%
Spottail Shiner				387	0.03	0.002%
Rainbow Trout	5	0.01		170	0.01	0.001%
Pumpkinseed	4	0.01		109	0.01	0.001%
Green Sunfish	2	0.00		78	0.01	0.0005%
Golden Shiner				48	0.00	0.0003%
Muskellunge	2	0.00		47	0.00	0.0003%
White Crappie				37	0.00	0.0002%
Hickory Shad				32	0.00	0.0002%
Yellow Bullhead	1	0.00		29	0.00	0.0002%
Herrings				29	0.00	0.0002%
Tiger Muskie				27	0.00	0.0002%
Black Crappie	2	0.00		26	0.00	0.0002%
Blacknose Dace				25	0.00	0.0002%
White Catfish	4	0.01		22	0.00	0.0001%
Tessellated Darter				21	0.00	0.0001%
Atlantic Needlefish				18	0.00	0.0001%
Banded Darter				12	0.00	0.0001%
Brook Trout x Lake Trout				9	0.00	0.0001%
Brook Trout				8	0.00	0.00005%
Margined Madtom				7	0.00	0.00004%
Notropis Sp.				7	0.00	0.00004%
Logperch				6	0.00	0.00004%
Hybrids				5	0.00	0.00003%
Northern Hog Sucker				4	0.00	0.00002%

B-23. Cont.

Year	2009	2009	2009	Total 1991 - 2009	Total fish per lift 1991-2009	% Comp 1991 - 2009
No. Days	57			977		
Lifts	618			12733		
Est. Oper. Time(HR)	495.6			9126.03		
Fishing Time (HR)						
#Species	30	Fish per lift	% comp	63	Fish per lift	% comp
Creek Chubsucker				3	0.00	0.00002%
Northern Pike	1	0.00		2	0.00	0.00002%
Flathead Catfish				2	0.00	0.00001%
Creek Chub				2	0.00	0.00001%
Salmo Sp.				2	0.00	0.00001%
Shield Darter				2	0.00	0.00001%
Longnose gar				1	0.00	0.00001%
Chain Pickerel				1	0.00	0.00001%
Esox Sp.				1	0.00	0.00001%
Longnose Dace				1	0.00	0.00001%
Sunfish Hybrids				1	0.00	0.00001%
Bluntnose Minnow				1	0.00	0.00001%
Total	**915417**	1481.3	10	16411728	1288.9	

APPENDIX C-ICHTHYOPLANKTON

C-1. WEEKLY SUMMARY OF ICHTHYOP1ANKTON (EGGS AND LARVAE) TAKEN BY 0.5 M PLANKTON NET IN THE SUSQUEHANNA RIVER BELOW CONOWINGO HYDROELECTRIC STATION, APRIL THROUGH JUNE 1983.

	A	A	A	M	M	M	M	M	J	J	J	J	
	4/3/1983	4/10/1983	4/17/1983	5/1/1983	5/8/1983	5/15/1983	5/22/1983	5/29/1983	6/5/1983	6/12/1983	6/19/1983	6/26/1983	Total
White perch	8	3	359	2,372	2,583	30,752	14,751	47,660	10,992	2,744	22	3	112,249
Alosa spp.			15	2,168	1,746	6,921	9,187	6,143	601	45		1	26,827
Gizzard Shad			1			208	308	311	1,539	449	627	21	3,464
Unid. Eggs			4	82	55	125	73	48	34	9	1		431
Carp						1	4	12	277	10	2	1	307
Quillback					1	21	130	78	14	20		1	265
Cyprinidae					19	50	115	29	5	2	2		222
American Shad				1		1		135		1			138
Percidae				2		7	11	37	3	3			63
Catostomidae						2	14	6	10	4			36
White crappie							1	2	4	17	5	1	30
Yellow perch				1		1	15	3		1			21
Creek chubsucker				1			1			6			8
Bluegill						1	1			2	3	1	8
Unid. Larvae						5							5
Northern hog sucker							2						2
Shorthead redhorse							2						2
Pumpkinseed										2			2
Centrarchidae						1							1
Largemouth bass											1		1
Tessellated darter				1									1
Walleye					1								1
TOTAL	8	3	379	4,628	4,405	38,096	24,615	54,464	13,479	3,315	663	29	144,084
No. of species	1	1	3	7	5	12	14	11	9	14	7	7	20
No. of samples	1	1	1	2	1	5	6	7	7	6	1	1	39
No./Sample Day	8.0	3.0	379.0	2314.0	4405.0	7619.2	4102.5	7780.6	1925.6	552.5	663.0	29.0	

C-2. WEEKLY SUMMARY OF ICHTHYOP1ANKTON (EGGS AND LARVAE) TAKEN BY 0.5 M PLANKTON NET IN THE SUSQUEHANNA RIVER BELOW CONOWINGO HYDROELECTRIC STATION, APRIL THROUGH JUNE 1984.

	A	A	A	A	M	M	M	M	J	J	J	J	
Common Name	**4/8/1984**	**4/15/1984**	**4/22/1984**	**4/29/1984**	**5/6/1984**	**5/13/1984**	**5/20/1984**	**5/27/1984**	**6/3/1984**	**6/10/1984**	**6/17/1984**	**6/24/1984**	**Total**
White perch	457	1,866	2,436	4,797	6,260	13,726	9,215	2,726	11,639	7,159	883	425	61,589
Alosa spp.		186	33	2,950	1,026	11,794	5,724	1,911	1,821	1,193	30	9	26,677
Gizzard shad		1	1	5	14	12	28	45	16	665	819	280	1,886
Yellow perch		215			1	3		3	5	1		1	229
Suckers					8		25	16	63	37	23	9	181
American shad					3			2	170		4		179
Minnows				1	1	20	27	29	17	32	37	9	173
Carp								2	7	9	99	1	118
Unidentified (eggs)		2	1	3	5	11	21	22	14	19	16		114
Hickory shad			3	6	11	1	1		3				25
Quillback								1	10	2	6	2	21
Perches					1	5	2	1	8	2			19
Bluegill									1	1	6		8
Tessellated darter						1			4	2	1		8
Smallmouth bass											6		6
Creek chubsucker									1			3	4
Sunfish family									2	2			4
White crappie											4		4
Spotfin shiner									1		1		2
Spottail shiner					1	1							2
White sucker							2						2
Largemouth bass												1	1
Pumpkinseed					1								1
Shorthead redhorse									1				1
Walleye					1								1
TOTAL	457	2,270	2,474	7,762	7,333	25,574	15,045	4,758	13,783	9,124	1,935	740	91,255

C-3. NUMBER AND DENSITY (N/M3) OF AMERICAN SHAD EGGS TAKEN BY ANCHORED 0.5M PLANKTON NETS, FISHED NEAR THE BOTTOM, OFF THE NORTHEAST SHORE OF SPENCER LSLAND (X-1075; Y-6825), 14 MAY THROUGH 20 JUNE 1983.

Date	No. Samples	Time Span	Total Sampling Time (min)	Approximate Flow X 10^3 Range (cfs)*	Water Temperature (F)	Eggs Collected		Range of Egg Density (n/m^3)
						No.	Average Density n/m^3	
14-15 May	3	0836-0943	46	10.6-20.7	60.8	2	0.03	0.00-0.04
16-17 May	3	0638-0802	45	5.5-22.3	59.0	1	0.01	0.00-0.01
18-19 May	3	0311-0711	45	16.5-40.7	61.4	10	0.12	0.06-0.31
20-21 May	1	0752-0802	10	50.6	61.2	4	0.04	0.04
24-25 May	1	0124-0139	15	73.0	62.6	2	0.02	0.02
26-27 May	1	0236-0251	15	73.0	62.6	-	0.00	0.00
28-29 May	1	0001-0016	15	66.1	63.4	3	0.06	0.06
1-2 Jun	5	0145-0641	75	5.4-29.5	63.3	18	0.22	0.00-0.84
3-4 Jun	3	2329-1051	45	10.6-53.4	66.0	32	0.26	0.06-0.31
5-6 Jun	2	0718-0802	30	5.3-49.2	66.2	31	0.34	0.29-1.23
7-8 Jun	2	0804-0858	30	5.4-30.1	68.4	1	0.01	0.00-0.01
9-10 Jun	2	0736-0815	30	5.4-30.1	69.9	19	0.14	0.00-0.57
11-12 Jun	1	1318-1333	15	10.7	72.5	1	0.24	0.24
12-13 Jun	3	0827-1002	45	10.7-30.1	72.9	21	0.19	0.13-0.42
19-20 June	2	1118-1203	30	29.6	78.8	-	0.00	0.00

* Flow's from Conowingo Hydroelectric Station approximately 1.5 hr prior to initiation of sampling

C-4. NUMBER AND DENSITY (N/M3) OF AMERICAN SHAD EGGS TAKEN BY ANCHORED 0.5 M PLANKTON NETS FISHED NEAR TELEMETERED AMERICAN SHAD AND/OR SPLASHING ACTIVITY ASSOCIATED WITH SPAWNING BELOW CONOWINGO DAM, 20 MAY THROUGH 6 JUNE 1983.

Date*	Location		Water Temp (F)	Depth		Time Span	Water Velocity Surface (ft/s)	Flow**	Eggs Collected	
	X	Y		Water Column	Net				No.	Density n/m^3
20-21 May	975	7330	60.8	7	-	2210-2220	2.4	51.4	62	0.92
22-23 May	1200	7000	61.2	9	9	0129-0144	-	62.5	3	0.04
28-29 May	1100	8000	63.4	13	13	2115-2130	2.6	66.1	16	0.32
28-29 May	400	900	-	4	4	2209-2224	-	66.1	-	-
28-29 May	-100	1500	-	4	4	2318-2324	-	66.1	-	-
29-30 May	1150	9000	63.4	19	Surface	0135-0150	0.4	30	-	-
30-31 May	970	7650	63.5	7	Surface	2134-2149	1.8	63.6	22	0.22
30-31 May	970	7650	63.5	7	7	2154-2209	1.8	63.6	5	0.33
1-2 Jun	-50	1475	64.3	5	5	21J5-2150	1.6	62.9	2	0.03
1-2 Jun	-50	1475	64.3	4	Surface	2200-2215	0.7	39.1	123	2.79
1-2 Jun[a]	1000	7500	68	-	Surface (tow)	1940-1945	-	62.9	2	0.04
1-2 Jun[a]	1000	7500	68	9	9	2025-2037	-	62.9	24	0.58
1-2 Jun[a]	1000	7500	68	9	9	2048-2100	-	62.9	2	0.03
1-2 Jun[a]	1000	7850	68	10	10	2110-2129	-	62.9	84	2.63
1-2 Jun[a]	1000	7850	68	10	Surface	2133-2147	-	62.9	23	0.41
2-3 Jun	900	7100	64.1	-	Surface	0212-0227	-	5.4	-	-
3-4 Jun	260	1505	66.2	3	Surface	2113-2128	1.8	21.1	1	0.01
5-6 Jun	1000	7750	66.2	8	Surface	2233-2248	1.6	64.4	127	1.34
5-6 Jun	1000	7750	66.2	8	Surface	2256-2311	1.5	64.4	23	0.26
5-6 Jun	1000	7800	66.2	8	8	0827-0842	0.7	49.2	7	0.99
5-6 Jun	1000	7800	66.2	8	8	0848-0903	1	49.2	7	0.87

* Dates are listed by the night time period

** Flows from Conowingo Hydroelectric Station approximately 1.5-hr prior to initiation of sampling, except for samples taken where Y < or =1550 m these are reported as current generation status

a Collected by Delmarva Ecological Laboratory, Inc.

APPENDIX D-ELECTROFISHING

D-1. TOTAL HOURS ELECTROFISHING BY MONTH AND LOCATION

1982: Total Number Hours of Electrofishing: All Locations

1982 Month	Cono Tailrace	Lees Ferry	The Pool	Tidal Zone	Total Hours Shocked
May	1.1	--	--	1.0	2.1
June	1.5	--	--	2.0	3.5
July	1.8	2.0	2.0	2.0	7.8
August	3.8	1.5	2.0	4.9	12.3
September	3.8	1.8	2.0	2.0	9.6
October	3.8	--	--	4.9	8.7
November	1.9	--	--	2.0	3.9
December	1.9	--	--	2.0	3.9
Total	19.7	5.3	6.0	20.9	51.8

1983: Total Number Hours of Electrofishing: All Locations

1983 Month	Cono Tailrace	Lees Ferry	The Pool	Tidal Zone	Total Hours Shocked
January	1.7			1.8	3.6
May	0.8			2.0	2.8
June	2.0			2.0	4.0
July	2.0	1.8	2.0	2.5	8.3
August	2.0	2.0	2.0	2.5	8.5
September	2.0	2.0	2.0	2.5	8.5
October	2.0			2.5	4.5
November	2.0			2.0	4.0
December					
Total	14.5	5.8	6.0	17.8	44.1

D-1. Cont.

1984: Total Number Hours of Electrofishing: All Locations

1984 Month	Cono Tailrace	Lees Ferry	The Pool	Tidal Zone	Total Hours Shocked
January	1.5			1.5	3.0
March	1.9			1.3	3.2
May					
June	1.9			1.9	3.9
July	2.0	2.0	2.0	2.0	8.0
August	1.8	2.0	2.0	2.5	8.3
September	1.9	2.0	2.0	2.5	8.4
October	2.0			2.5	4.5
November	2.0			2.4	4.4
December	1.9			2.0	3.9
Total	17.0	6.0	6.0	18.6	47.5

1985: Total Number Hours of Electrofishing: All Locations

1985 Month	Cono Tailrace	Lees Ferry	The Pool	Tidal Zone	Total Hours Shocked
January					
March					
May					
June	2.0	2.0	2.0	2.0	8.0
July	2.1	2.0	1.9	2.0	7.9
August	2.0	1.5	1.9	2.5	7.9
September	2.0			1.5	3.5
October	2.0			2.0	4.0
November	2.0			2.0	4.0
December	1.8			2.0	3.8
Total	13.8	5.5	5.8	14.0	39.1

D-1. Cont.

1986: Total Number Hours of Electrofishing: All Locations

1986 Month	Cono Tailrace	Lees Ferry	The Pool	Tidal Zone	Total Hours Shocked
January					
March	1.7				1.7
April	1.9				1.9
May	2.0			2.0	3.9
June	2.0	2.0	1.8	2.5	8.3
July	2.0	2.0	2.0	2.0	8.0
August	1.9	2.0	1.9	2.5	8.3
September	1.9	2.0	1.8	2.5	8.3
October	2.0			2.0	4.0
November	1.8			1.3	3.1
December	1.9			1.3	3.3
Total	19.0	8.0	7.6	16.1	50.6

1987: Total Number Hours of Electrofishing: All Locations

1987 Month	Cono Tailrace	Lees Ferry	The Pool	Tidal Zone	Total Hours Shocked
January					
March					
April					
May					
June					
July	2.0			2.0	4.0
August	2.0			2.0	4.0
September	2.2			--	2.2
October	2.0			1.8	3.8
November					
December					
Total	8.1			5.8	13.9

D-2. Electrofishing CPUE (fish per hr) by species and year hightest to lowest

	Species	January	January CPUE	February	Febuary CPUE	March	March CPUE	April	April CPUE	May	May CPUE	June	June CPUE	July	July CPUE	August	August CPUE	September	September CPUE	October	October CPUE	Novmber	November CPUE	December	December CPUE	Total	Totat CPUE
1987	Gizzard Shad													70	35.5	75	37.5	20,264	9,425.1	252	126.6					20,661	2,547.6
1983	Gizzard Shad	16	9.4							149	179.5	377	193.3	315	157.5	206	103.0	143	71.5	171	85.5	5,475	2,737.5			6,852	472.9
1984	Gizzard Shad	114	75.2			3	1.6					1,384	715.9	46	23.0	117	63.8	311	162.3	1,103	560.8	3,703	1,851.5	20	10.3	6,801	400.5
1985	Gizzard Shad											558	279.0	38	18.5	43	21.5	31	15.5	1,921	960.5	1,867	933.5	7	3.9	4,465	322.8
1982	Carp									3,565	32,90.9	105	68.5	60	33.3	251	65.8	157	41.1	75	19.7	64	34.3	84	43.8	4,361	221.9
1983	American Eel	55	32.2							225	271.1	275	141.0	500	25	225	112.5	525	262.5	105	52.5	990	495.0			2,900	200.1
1987	American Eel													305	154.8	320	16	690	320.9	145	72.9					1,460	18
1982	Gizzard Shad									44	40.6	12	7.8	28	15.6	298	78.1	56	14.7	266	69.7	296	158.6	1,907	994.9	2,907	147.9
1984	American Eel	125	82.4			80	42.5					330	170.7	300	15	260	141.8	425	221.7	560	284.7	250	125.0	96	49.7	2,426	142.8
1985	White Perch											411	205.5	618	301.5	301	150.5	477	238.5	155	77.5	7	3.5			1,969	142.4
1982	American Eel									275	253.9	170	110.9	460	255.6	495	129.7	525	137.6	290	76.0	60	32.1	54	28.2	2,329	118.5
1985	American Eel											200	10	325	158.5	185	92.5	270	135.0	325	162.5	250	125.0	80	44.9	1,635	118.2
1986	Gizzard Shad					1	0.6	418	223.5	729	370.1	22	11.0	11	5.5	48	25.0	50	26.0	305	156.4	423	239.0	3	1.6	2,010	106.0
1986	American Eel					53	32.1	230	123.0	375	190.4	175	87.5	152	76.0	200	104.2	240	125.0	225	115.4	49	27.7	195	101.6	1,894	99.8
1985	Yellow Perch											312	156.0	234	114.1	124	62.0	200	10	196	98.0	229	114.5	57	32.0	1,352	97.8
1983	White Perch									273	328.9	295	151.3	237	118.5	113	56.5	295	147.5	70	35.0	4	2.0			1,287	88.8
1987	White Perch													165	83.8	337	168.5	164	76.3	20	10.1					686	84.6
1983	Yellow Perch	27	15.8							45	54.2	189	96.9	89	44.5	75	37.5	81	40.5	210	105.0	419	209.5			1,135	78.3
1986	Yellow Perch					5	3.0	93	49.7	513	260.4	185	92.5	219	109.5	117	60.9	85	44.3	103	52.8	44	24.9	6	3.1	1,370	72.2
1984	White Perch											360	186.2	372	186.0	252	137.5	103	53.7	93	47.3	7	3.5			1,187	69.9
1982	Yellow Perch									104	96.0	46	3	130	72.2	137	35.9	158	41.4	291	76.2	207	110.9	180	93.9	1,253	63.8
1986	White Perch							72	38.5	237	120.3	258	129.0	170	85.0	183	95.3	181	94.3	64	32.8					1,165	61.4
1982	White Perch									103	95.1	216	140.9	88	48.9	294	77.0	320	83.8	114	29.9	17	9.1			1,152	58.6
1983	Pumpkinseed	33	19.3							11	13.3	165	84.6	118	59.0	91	45.5	109	54.5	144	72.0	157	78.5			828	57.1
1983	Bluegill									35	42.2	90	46.2	200	10	84	42.0	187	93.5	189	94.5	34	17.0			819	56.5
1987	Yellow Perch													59	29.9	91	45.5	123	57.2	96	48.2					369	45.5
1985	Channel Catfish											28	14.0	75	36.6	106	53.0	155	77.5	100	5	76	38.0	83	46.6	623	45.0
1983	Channel Catfish	26	15.2							70	84.3	88	45.1	50	25.0	51	25.5	77	38.5	135	67.5	143	71.5			640	44.2
1987	Bluegill													75	38.1	125	62.5	90	41.9	53	26.6					343	42.3
1982	Channel Catfish									30	27.7	48	31.3	23	12.8	41	10.7	290	76.0	193	50.6	75	40.2	115	6	815	41.5
1984	Bluegill											81	41.9	205	102.5	132	72.0	169	88.2	83	42.2	25	12.5	2	1.0	697	41.0
1985	Bluegill											122	61.0	103	50.2	105	52.5	212	106.0	13	6.5	6	3.0	2	1.1	563	40.7
1982	Pumpkinseed									82	75.7	105	68.5	77	42.8	124	32.5	131	34.3	103	27.0	115	61.6	47	24.5	784	39.9
1984	Yellow Perch					10	5.3					136	70.3	55	27.5	42	22.9	57	29.7	235	119.5	110	55.0	9	4.7	654	38.5
1985	Pumpkinseed											150	75.0	96	46.8	96	48.0	103	51.5	30	15.0	31	15.5	9	5.1	515	37.2

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	Species	January	January CPUE	February	Febuary CPUE	March	March CPUE	April	April CPUE	May	May CPUE	June	June CPUE	July	July CPUE	August	August CPUE	September	September CPUE	October	October CPUE	Novmber	November CPUE	December	December CPUE	Total	Totat CPUE
1982	Bluegill									19	17.5	69	45.0	92	51.1	156	40.9	158	41.4	134	35.1	29	15.5	1	0.5	658	33.5
1984	Pumpkinseed	6	4.0			32	17.0					119	61.6	174	87.0	74	40.4	57	29.7	74	37.6	21	10.5	9	4.7	566	33.3
1984	Carp											195	100.9	75	37.5	80	43.6	115	6	45	22.9	16	8.0	26	13.4	552	32.5
1987	Striped Bass													67	34.0	79	39.5	96	44.7	19	9.5					261	32.2
1984	Channel Catfish					103	54.7					100	51.7	40	2	15	8.2	37	19.3	81	41.2	70	35.0	89	46.0	535	31.5
1983	Striped Bass									2	2.4	325	166.7	61	30.5	27	13.5	9	4.5	25	12.5	1	0.5			450	31.1
1986	Channel Catfish					8	4.8	38	20.3	44	22.3	45	22.5	57	28.5	43	22.4	90	46.9	100	51.3	54	30.5	41	21.4	520	27.4
1986	Carp					20	12.1	180	96.3	86	43.7	44	22.0	52	26.0	55	28.6	41	21.4	37	19.0	1	0.6	1	0.5	517	27.3
1983	Green Sunfish	23	13.5							2	2.4	25	12.8	34	17.0	17	8.5	20	1	121	60.5	146	73.0			388	26.8
1985	Carp											138	69.0	46	22.4	42	21.0	64	32.0	31	15.5	14	7.0	32	18.0	367	26.5
1986	Redbreast Sunfish					3	1.8	17	9.1	62	31.5	47	23.5	56	28.0	81	42.2	68	35.4	111	56.9	28	15.8	28	14.6	501	26.4
1983	Carp	60	35.1							80	96.4	56	28.7	70	35.0	28	14.0	32	16.0	32	16.0	20	1			378	26.1
1986	Bluegill					9	5.5	17	9.1	59	29.9	55	27.5	74	37.0	120	62.5	110	57.3	47	24.1			1	0.5	492	25.9
1987	Smallmouth Bass													20	10.2	43	21.5	38	17.7	74	37.2					175	21.6
1987	Carp													29	14.7	40	2	73	34.0	26	13.1					168	20.7
1987	Channel Catfish													33	16.8	40	2	39	18.1	56	28.1					168	20.7
1983	Smallmouth Bass									36	43.4	46	23.6	31	15.5	28	14.0	47	23.5	54	27.0	12	6.0			254	17.5
1986	Smallmouth Bass					1	0.6	80	42.8	21	10.7	13	6.5	19	9.5	39	20.3	63	32.8	64	32.8	13	7.3	13	6.8	326	17.2
1986	Pumpkinseed					13	7.9	20	10.7	46	23.4	71	35.5	43	21.5	33	17.2	36	18.8	36	18.5	11	6.2	15	7.8	324	17.1
1983	Redbreast Sunfish	6	3.5							6	7.2	27	13.8	24	12.0	9	4.5	13	6.5	83	41.5	76	38.0			244	16.8
1987	Redbreast Sunfish													21	10.7	26	13.0	17	7.9	68	34.2					132	16.3
1985	Redbreast Sunfish											33	16.5	21	10.2	21	10.5	22	11.0	57	28.5	51	25.5	10	5.6	215	15.5
1982	Smallmouth Bass									32	29.5	48	31.3	16	8.9	49	12.8	65	17.0	45	11.8	33	17.7	5	2.6	293	14.9
1982	Green Sunfish									6	5.5	2	1.3	4	2.2	7	1.8	89	23.3	97	25.4	43	23.0	34	17.7	282	14.4
1987	Pumpkinseed													40	20.3	39	19.5	13	6.0	24	12.1					116	14.3
1984	Green Sunfish	11	7.3			23	12.2					14	7.2	17	8.5	15	8.2	14	7.3	68	34.6	40	2	30	15.5	232	13.7
1985	Striped Bass											42	21.0	30	14.6	60	3	34	17.0	2	1.0	1	0.5			169	12.2
1984	Smallmouth Bass	1	0.7			4	2.1					41	21.2	49	24.5	13	7.1	29	15.1	46	23.4	20	1	2	1.0	205	12.1
1986	Striped Bass									5	2.5	39	19.5	28	14.0	60	31.3	60	31.3	33	16.9					225	11.9
1982	Striped Bass									1	0.9			4	2.2	77	20.2	64	16.8	72	18.9	1	0.5			219	11.1
1984	Redbreast Sunfish	4	2.6			4	2.1					25	12.9	19	9.5	12	6.5	17	8.9	62	31.5	35	17.5	4	2.1	182	10.7
1982	Redbreast Sunfish									27	24.9	11	7.2	18	1	24	6.3	30	7.9	67	17.6	22	11.8	8	4.2	207	10.5
1984	Striped Bass											25	12.9	71	35.5	33	18.0	16	8.3	13	6.6	1	0.5			159	9.4
1986	Green Sunfish							6	3.2	19	9.6	23	11.5	31	15.5	16	8.3	20	10.4	41	21.0	7	4.0	14	7.3	177	9.3
1986	Spottail Shiner					3	1.8	23	12.3	31	15.7	15	7.5					12	6.3	43	22.1	28	15.8	21	10.9	176	9.3
1985	Spottail Shiner											15	7.5	5	2.4	15	7.5			22	11.0	20	1	39	21.9	116	8.4

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	Species	January	January CPUE	February	Febuary CPUE	March	March CPUE	April	April CPUE	May	May CPUE	June	June CPUE	July	July CPUE	August	August CPUE	September	September CPUE	October	October CPUE	Novmber	November CPUE	December	December CPUE	Total	Totat CPUE
1986	Comely Shiner					19	11.5			20	10.2					2	1.0			20	10.3	18	10.2	79	41.1	158	8.3
1983	White Crappie	1	0.6							4	4.8	28	14.4	6	3.0	1	0.5	22	11.0	39	19.5	18	9.0			119	8.2
1983	Spottail Shiner	49	28.7							10	12.0							2	1.0	22	11.0	26	13.0			109	7.5
1983	Rock Bass									13	15.7	10	5.1	11	5.5	8	4.0	8	4.0	15	7.5	29	14.5			94	6.5
1984	Spottail Shiner	9	5.9			10	5.3							15	7.5	1	0.5	3	1.6	20	10.2	31	15.5	19	9.8	108	6.4
1985	Smallmouth Bass											16	8.0	9	4.4	6	3.0	12	6.0	14	7.0	13	6.5	9	5.1	79	5.7
1984	White Crappie											6	3.1	45	22.5	19	10.4	8	4.2	6	3.1	5	2.5	8	4.1	97	5.7
1983	Quillback									75	90.4	4	2.1							1	0.5					80	5.5
1982	Rock Bass									8	7.4	9	5.9	5	2.8	9	2.4	20	5.2	27	7.1	18	9.6	8	4.2	104	5.3
1985	Green Sunfish											16	8.0	5	2.4	9	4.5	11	5.5	12	6.0	14	7.0	6	3.4	73	5.3
1986	Shad sp							100	53.5																	100	5.3
1987	Rock Bass													2	1.0	7	3.5	9	4.2	24	12.1					42	5.2
1985	Rock Bass											13	6.5	5	2.4	10	5.0	10	5.0	13	6.5	18	9.0	2	1.1	71	5.1
1986	Alewife							96	51.3																	96	5.1
1982	Largemouth Bass									2	1.8	16	10.4	13	7.2	15	3.9	24	6.3	16	4.2	11	5.9	1	0.5	98	5.0
1983	Largemouth Bass									3	3.6	13	6.7	19	9.5	9	4.5	3	1.5	13	6.5	12	6.0			72	5.0
1982	Spotfin Shiner									7	6.5	47	30.7	10	5.6	6	1.6	4	1.0	7	1.8	3	1.6	13	6.8	97	4.9
1986	Rock Bass							12	6.4	27	13.7	9	4.5	5	2.5	9	4.7	14	7.3	11	5.6	3	1.7	2	1.0	92	4.8
1983	Brown Bullhead	4	2.3							7	8.4	4	2.1	6	3.0	13	6.5	7	3.5	10	5.0	19	9.5			70	4.8
1987	Green Sunfish													7	3.6	12	6.0	6	2.8	14	7.0					39	4.8
1982	Spottail Shiner									3	2.8	14	9.1	8	4.4	10	2.6	6	1.6	22	5.8	8	4.3	20	10.4	91	4.6
1982	White Crappie									4	3.7	30	19.6	8	4.4	22	5.8	6	1.6	15	3.9	5	2.7	1	0.5	91	4.6
1982	Brown Bullhead									5	4.6	1	0.7	11	6.1	16	4.2	14	3.7	14	3.7	17	9.1	7	3.7	85	4.3
1984	Comely Shiner	1	0.7			52	27.6					5	2.6	1	0.5									13	6.7	72	4.2
1984	Largemouth Bass											4	2.1	20	1	25	13.6	13	6.8	6	3.1	1	0.5			69	4.1
1984	Rock Bass					3	1.6					9	4.7	4	2.0	2	1.1	6	3.1	28	14.2	14	7.0	3	1.6	69	4.1
1982	Comely Shiner											23	15.0			2	0.5	2	0.5	2	0.5	8	4.3	34	17.7	71	3.6
1983	Comely Shiner	20	11.7							12	14.5			6	3.0					12	6.0	2	1.0			52	3.6
1983	Spotfin Shiner	1	0.6							27	32.5	14	7.2	10	5.0											52	3.6
1987	Hybrid Striped Bass													4	2.0	4	2.0	17	7.9	4	2.0					29	3.6
1986	Spotfin Shiner					3	1.8			17	8.6	14	7.0	14	7.0			2	1.0	6	3.1	2	1.1	5	2.6	63	3.3
1985	Largemouth Bass											10	5.0	11	5.4	9	4.5	11	5.5	2	1.0	2	1.0			45	3.3

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	Species	January	January CPUE	February	Febuary CPUE	March	March CPUE	April	April CPUE	May	May CPUE	June	June CPUE	July	July CPUE	August	August CPUE	September	September CPUE	October	October CPUE	Novmber	November CPUE	December	December CPUE	Total	Totat CPUE
1986	White Sucker					21	12.7	5	2.7	3	1.5	1	0.5					1	0.5	11	5.6	12	6.8	7	3.6	61	3.2
1985	White Sucker																			1	0.5	8	4.0	29	16.3	38	2.7
1985	Brown Bullhead											4	2.0	6	2.9	3	1.5	8	4.0	6	3.0	6	3.0	1	0.6	34	2.5
1983	Yellow Bullhead	1	0.6							1	1.2			4	2.0	4	2.0	3	1.5	10	5.0	12	6.0			35	2.4
1984	Hybrid Striped Bass											8	4.1	2	1.0	9	4.9	5	2.6	9	4.6	7	3.5			40	2.4
1983	Walleye	5	2.9							14	16.9	5	2.6	2	1.0	3	1.5	4	2.0			1	0.5			34	2.3
1987	Largemouth Bass													5	2.5	11	5.5	3	1.4							19	2.3
1982	Yellow Bullhead									2	1.8	2	1.3			6	1.6	13	3.4	14	3.7	5	2.7	2	1.0	44	2.2
1984	Spotfin Shiner	3	2.0			12	6.4					1	0.5	19	9.5	1	0.5	1	0.5	1	0.5					38	2.2
1986	Largemouth Bass							19	10.2	6	3.0	5	2.5	3	1.5	3	1.6	2	1.0	2	1.0	1	0.6			41	2.2
1982	Walleye									3	2.8	5	3.3	1	0.6	1	0.3	4	1.0	4	1.0	14	7.5	10	5.2	42	2.1
1985	Spotfin Shiner											19	9.5	4	2.0	3	1.5	1	0.5			1	0.5	1	0.6	29	2.1
1987	Spottail Shiner																			17	8.5					17	2.1
1985	Comely Shiner											3	1.5							1	0.5			24	13.5	28	2.0
1987	Walleye													2	1.0	3	1.5	9	4.2	1	0.5					15	1.8
1983	Blueback Herring									25	30.1			1	0.5											26	1.8
1986	Blueback Herring							34	18.2																	34	1.8
1985	Hybrid Striped Bass											8	4.0	4	2.0	2	1.0	8	4.0	2	1.0					24	1.7
1986	Walleye					1	0.6	12	6.4	7	3.6	4	2.0	1	0.5	5	2.6					1	0.6			31	1.6
1985	Walleye											16	8.0	2	1.0							3	1.5			21	1.5
1986	Brown Bullhead							9	4.8	8	4.1	3	1.5	1	0.5	2	1.0			3	1.5	1	0.6	1	0.5	28	1.5
1982	Tiger Muskie									4	3.7			4	2.2	1	0.3	4	1.0	9	2.4	6	3.2			28	1.4
1986	Hybrid Striped Bass							1	0.5	1	0.5	11	5.5	1	0.5	3	1.6	1	0.5	8	4.1					26	1.4
1987	Yellow Bullhead													2	1.0	5	2.5			4	2.0					11	1.4
1983	Black Crappie									2	2.4	5	2.6	2	1.0	1	0.5	3	1.5	4	2.0	2	1.0			19	1.3
1986	Shorthead Redhorse							3	1.6	1	0.5	2	1.0	1	0.5			5	2.6	4	2.1	2	1.1	6	3.1	24	1.3
1986	Yellow Bullhead					1	0.6	2	1.1	6	3.0	1	0.5	3	1.5	3	1.6	3	1.6	1	0.5	2	1.1	2	1.0	24	1.3
1985	Golden Shiner											7	3.5	3	1.5	7	3.5									17	1.2
1986	Tessellated Darter					4	2.4							1	0.5			1	0.5					16	8.3	22	1.2
1985	White Catfish											6	3.0	1	0.5			3	1.5			1	0.5	5	2.8	16	1.2
1982	Black Crappie									4	3.7	7	4.6			2	0.5	2	0.5	4	1.0	3	1.6			22	1.1
1983	Golden Shiner											5	2.6	5	2.5	2	1.0			2	1.0	2	1.0			16	1.1

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	Species	January	January CPUE	February	Febuary CPUE	March	March CPUE	April	April CPUE	May	May CPUE	June	June CPUE	July	July CPUE	August	August CPUE	September	September CPUE	October	October CPUE	Novmber	November CPUE	December	December CPUE	Total	Totat CPUE
1984	Brown Bullhead					3	1.6					2	1.0	2	1.0	2	1.1	2	1.0	1	0.5	6	3.0			18	1.1
1984	Walleye					1	0.5					6	3.1	1	0.5	3	1.6	1	0.5	2	1.0	2	1.0	2	1.0	18	1.1
1986	White Catfish							5	2.7	1	0.5	3	1.5	1	0.5	6	3.1	2	1.0			2	1.1			20	1.1
1983	White Catfish	1	0.6							2	2.4	2	1.0	2	1.0	1	0.5	3	1.5	2	1.0	2	1.0			15	1.0
1985	Yellow Bullhead											2	1.0	3	1.5	1	0.5	1	0.5	3	1.5	3	1.5	1	0.6	14	1.0
1985	White Crappie											6	3.0	1	0.5	1	0.5			1	0.5	1	0.5	3	1.7	13	0.9
1982	Golden Shiner									2	1.8	4	2.6	2	1.1	6	1.6	2	0.5	2	0.5					18	0.9
1987	Logperch															5	2.5	1	0.5	1	0.5					7	0.9
1987	Northern Hog Sucker																			7	3.5					7	0.9
1986	White Crappie							2	1.1			2	1.0	2	1.0	1	0.5	3	1.6	4	2.1	2	1.1			16	0.8
1982	White Sucker																			1	0.3			15	7.8	16	0.8
1985	Logperch													1	0.5	3	1.5	7	3.5							11	0.8
1984	Golden Shiner											3	1.6	6	3.0	3	1.6			1	0.5					13	0.8
1984	White Catfish	1	0.7									3	1.6	2	1.0	1	0.5			1	0.5	2	1.0	3	1.6	13	0.8
1984	Yellow Bullhead	1	0.7			1	0.5					2	1.0					1	0.5	5	2.5	2	1.0	1	0.5	13	0.8
1987	Brown Bullhead															1	0.5	4	1.9	1	0.5					6	0.7
1984	Tessellated Darter	7	4.6			4	2.1															1	0.5			12	0.7
1982	White Catfish									1	0.9	3	2.0	3	1.7			3	0.8			1	0.5	2	1.0	13	0.7
1984	Shorthead Redhorse													2	1.0							1	0.5	8	4.1	11	0.6
1986	Golden Shiner							2	1.1	8	4.1			1	0.5			1	0.5							12	0.6
1983	Mummichog																			5	2.5	4	2.0			9	0.6
1987	Spotfin Shiner													3	1.5			2	0.9							5	0.6
1982	Logperch									1	0.9					1	0.3	8	2.1	1	0.3	1	0.5			12	0.6
1984	Quillback											10	5.2													10	0.6
1985	Tessellated Darter																	1	0.5					7	3.9	8	0.6
1986	Quillback									10	5.1															10	0.5
1987	Atlantic Menhaden													2	1.0	1	0.5	1	0.5							4	0.5
1987	Comely Shiner																			4	2.0					4	0.5
1987	Golden Shiner													3	1.5			1	0.5							4	0.5
1987	White Catfish													1	0.5			3	1.4							4	0.5
1983	Tiger Muskie													1	0.5	1	0.5			3	1.5	2	1.0			7	0.5
1983	White Sucker	4	2.3																	2	1.0	1	0.5			7	0.5
1984	Blueback Herring													7	3.5					1	0.5					8	0.5

D-2. Cont.

	Species	January	January CPUE	February	Febuary CPUE	March	March CPUE	April	April CPUE	May	May CPUE	June	June CPUE	July	July CPUE	August	August CPUE	September	September CPUE	October	October CPUE	Novmber	November CPUE	December	December CPUE	Total	Totat CPUE
1982	Mummichog															1	0.3	2	0.5	4	1.0			2	1.0	9	0.5
1985	Quillback													5	2.4									1	0.6	6	0.4
1983	Shorthead Redhorse	2	1.2							4	4.8															6	0.4
1983	Tessellated Darter	2	1.2							1	1.2	2	1.0									1	0.5			6	0.4
1984	Brown Trout											7	3.6													7	0.4
1987	Shorthead Redhorse																			3	1.5					3	0.4
1985	Atlantic Menhaden											3	1.5	1	0.5							1	0.5			5	0.4
1985	Tiger Muskie															1	0.5			3	1.5			1	0.6	5	0.4
1982	Rosyside Dace																	6	1.6					1	0.5	7	0.4
1982	Shorthead Redhorse																			4	1.0	2	1.1	1	0.5	7	0.4
1984	Black Crappie											2	1.0	2	1.0							2	1.0			6	0.4
1983	Hybrid Striped Bass											5	2.6													5	0.3
1982	Shield Darter																	3	0.8	1	0.3	1	0.5	1	0.5	6	0.3
1985	Black Crappie											3	1.5	1	0.5											4	0.3
1985	Blueback Herring											1	0.5	3	1.5											4	0.3
1985	Margined Madtom											2	1.0					1	0.5			1	0.5			4	0.3
1982	Tessellated Darter																	3	0.8	1	0.3			1	0.5	5	0.3
1987	White Crappie													2	1.0											2	0.2
1987	White Sucker															1	0.5			1	0.5					2	0.2
1984	White Sucker					2	1.1					1	0.5					1	0.5							4	0.2
1985	Brown Trout											3	1.5													3	0.2
1985	Cutlips Minnow											1	0.5			1	0.5							1	0.6	3	0.2
1986	Black Crappie									1	0.5	1	0.5					1	0.5	1	0.5					4	0.2
1986	Commom Shiner					1	0.6							1	0.5					1	0.5			1	0.5	4	0.2
1986	Northern Hog Sucker																					1	0.6	3	1.6	4	0.2
1982	Margined Madtom																	1	0.3	2	0.5			1	0.5	4	0.2
1984	Logperch											1	0.5							2	1.0					3	0.2
1984	Tiger Muskie													1	0.5					2	1.0					3	0.2
1986	American Shad									1	0.5							2	1.0							3	0.2
1986	Creek Chub									1	0.5									1	0.5	1	0.6			3	0.2
1986	Cutlips Minnow																	1	0.5	1	0.5			1	0.5	3	0.2
1986	Hickory Shad							3	1.6																	3	0.2
1986	River Chub					2	1.2																	1	0.5	3	0.2

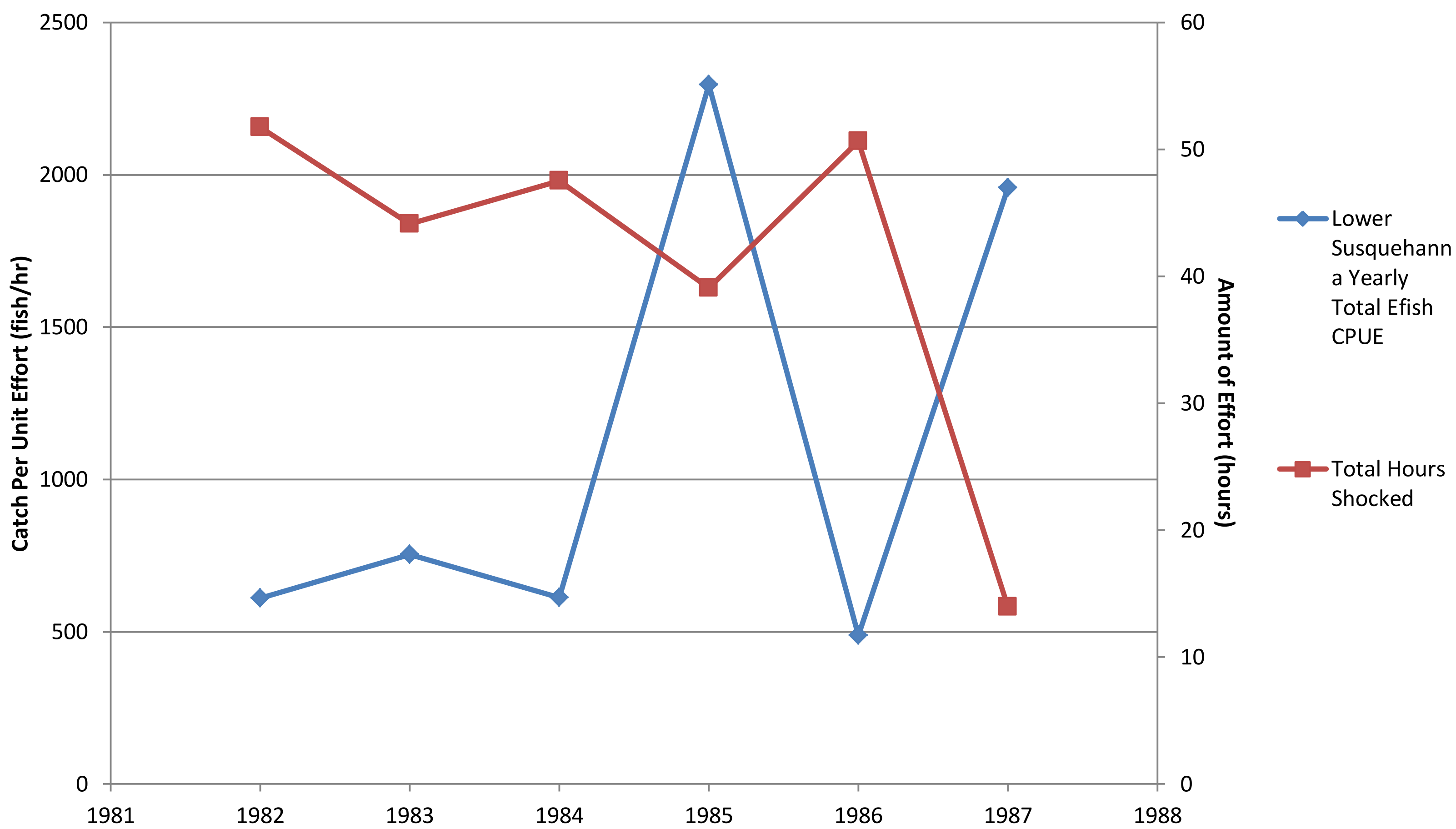
D-2. Cont.

	Species	January	January CPUE	February	Febuary CPUE	March	March CPUE	April	April CPUE	May	May CPUE	June	June CPUE	July	July CPUE	August	August CPUE	September	September CPUE	October	October CPUE	Novmber	November CPUE	December	December CPUE	Total	Totat CPUE
1985	Alewife											1	0.5			1	0.5									2	0.1
1985	Blue Tilapia																			2	1.0					2	0.1
1983	Cutlips Minnow	1	0.6															1	0.5							2	0.1
1983	Logperch	1	0.6																	1	0.5					2	0.1
1983	Margined Madtom	1	0.6																			1	0.5			2	0.1
1987	Tessellated Darter																	1	0.5							1	0.1
1987	Tidewater Silverside																			1	0.5					1	0.1
1984	Alewife													2	1.0											2	0.1
1984	Margined Madtom																					1	0.5	1	0.5	2	0.1
1984	Mummichog																			2	1.0					2	0.1
1984	White Mullet																			1	0.5	1	0.5			2	0.1
1986	Bluntnose Minnow																							2	1.0	2	0.1
1986	Brown Trout							1	0.5															1	0.5	2	0.1
1986	Mummichog							1	0.5									1	0.5							2	0.1
1986	Tiger Muskie																	1	0.5	1	0.5					2	0.1
1982	Brown Trout									1	0.9	1	0.7													2	0.1
1982	Creek Chub																			1	0.3			1	0.5	2	0.1
1982	Cutlips Minnow											1	0.7					1	0.3							2	0.1
1982	Hybrid Striped Bass									1	0.9							1	0.3							2	0.1
1982	Northern Hog Sucker																			1	0.3			1	0.5	2	0.1
1985	Mummichog																					1	0.5			1	0.1
1983	Atlantic Menhaden											1	0.5													1	0.1
1983	Goldfish	1	0.6																							1	0.1
1983	River Chub															1	0.5									1	0.1
1983	Shield Darter	1	0.6																							1	0.1
1984	American Shad																							1	0.5	1	0.1
1984	Blue Tilapia																	1	0.5							1	0.1
1984	Creek Chub	1	0.7																							1	0.1
1984	Cutlips Minnow																			1	0.5					1	0.1
1984	Northern Hog Sucker																							1	0.5	1	0.1
1986	Goldfish							1	0.5																	1	0.1
1986	Hogchoker																	1	0.5							1	0.1
1986	Logperch																	1	0.5							1	0.1
1986	Margined Madtom																			1	0.5					1	0.1
1986	Rosyside Dace					1	0.6																			1	0.1
1986	Shield Darter																							1	0.5	1	0.1

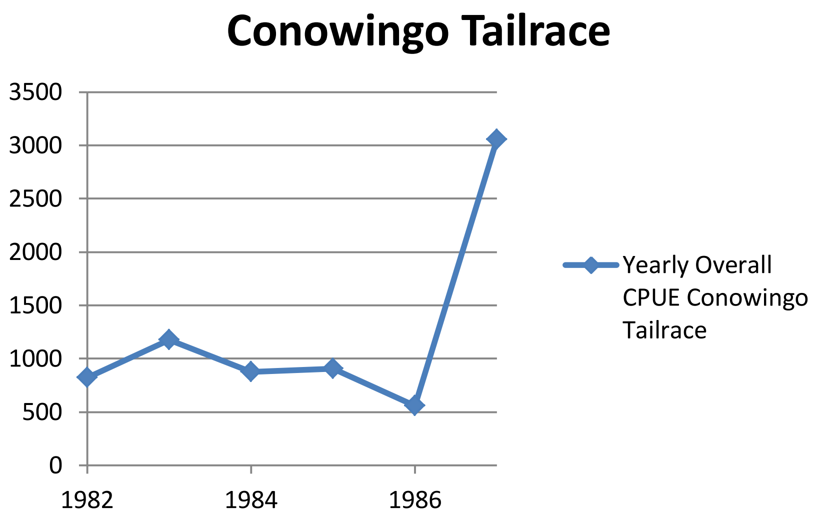
D2. Cont.

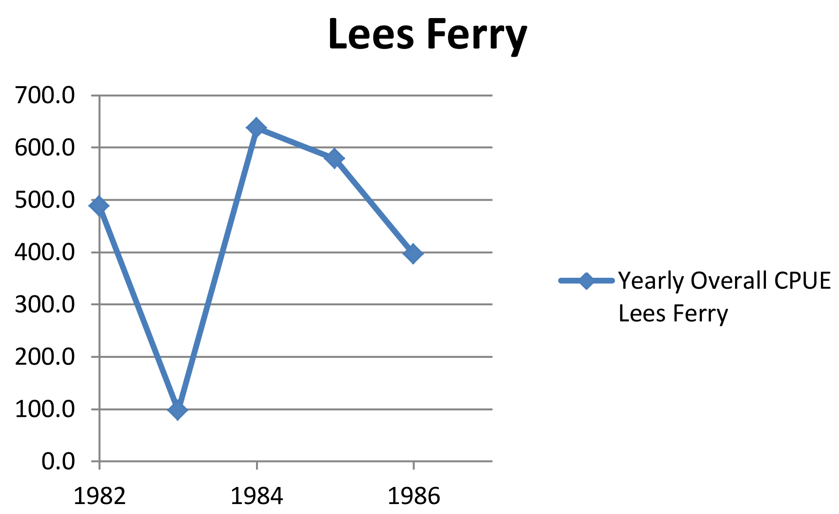
	Species	January	January CPUE	February	Febuary CPUE	March	March CPUE	April	April CPUE	May	May CPUE	June	June CPUE	July	July CPUE	August	August CPUE	September	September CPUE	October	October CPUE	Novmber	November CPUE	December	December CPUE	Total	Totat CPUE
1986	Striped Bass x White Perch													1	0.5											1	0.1
1982	Atlantic Menhaden															1	0.3									1	0.1
1982	Goldfish											1	0.7													1	0.1
1982	Northern Pike																					1	0.5			1	0.1
1982	Quillback															1	0.3									1	0.1
1982	River Chub																			1	0.3					1	0.1
1982	Silvery Minnow																							1	0.5	1	0.1
1982	White Mullet																			1	0.3					1	0.1
1982	Total	0		0		0		0		4,336	4,002.6	996	649.6	1,065	591.7	2,053	537.9	2,172	569.1	1,901	498.1	1,066	571.1	2,558	1,334.6	16,147	
1983	Total	341	199.4	0		0		0		1,134	1,366.3	2,056	1,054.4	1,804	902.0	998	499.0	1,594	797.0	1,480	74	7,611	3,805.5	0		17,018	
1984	Total	284	187.3	0		347	184.2	0		0		2,880	1,489.7	1,554	777.0	1,111	606.0	1,392	726.3	2,552	1,297.6	4374	2,187.0	347	179.5	14,841	
1985	Total	0		0		0		0		0		2,149	1,074.5	1,656	807.8	1,155	577.5	1,642	821.0	2,912	1,456.0	2625	1,312.5	410	230.3	12,549	
1986	Total	0		0		169	102.4	1,502	803.2	2,345	1,190.4	1,048	524.0	948	474.0	1,029	535.9	1,099	572.4	1,285	659.0	706	398.9	466	242.7	10,597	
1987	Total	0		0		0		0		0		0		917	465.5	1,265	632.5	21,664	10,076.3	915	459.8	0		0		24,761	

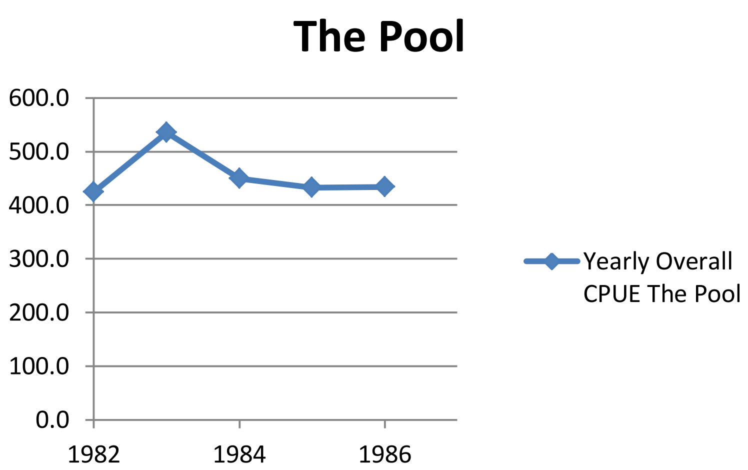
D-3. YEARLY CPUE AND HOURS SAMPLING SUSQUEHANNA RIVER BELOW CONOWINGO DAM 1982 – 1987

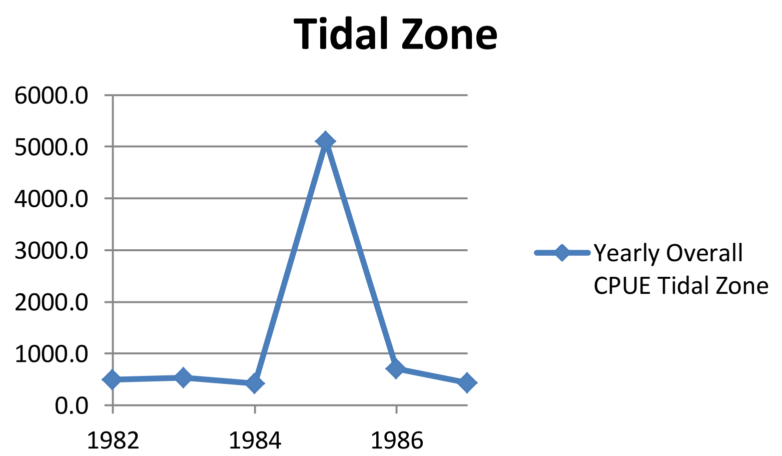


D-4 YEARLY OVERALL CPUE1982 – 1987 AT THE CONOWINGO TAILRACE, LEES FERRY, THE POOL AND TIDAL ZONE.

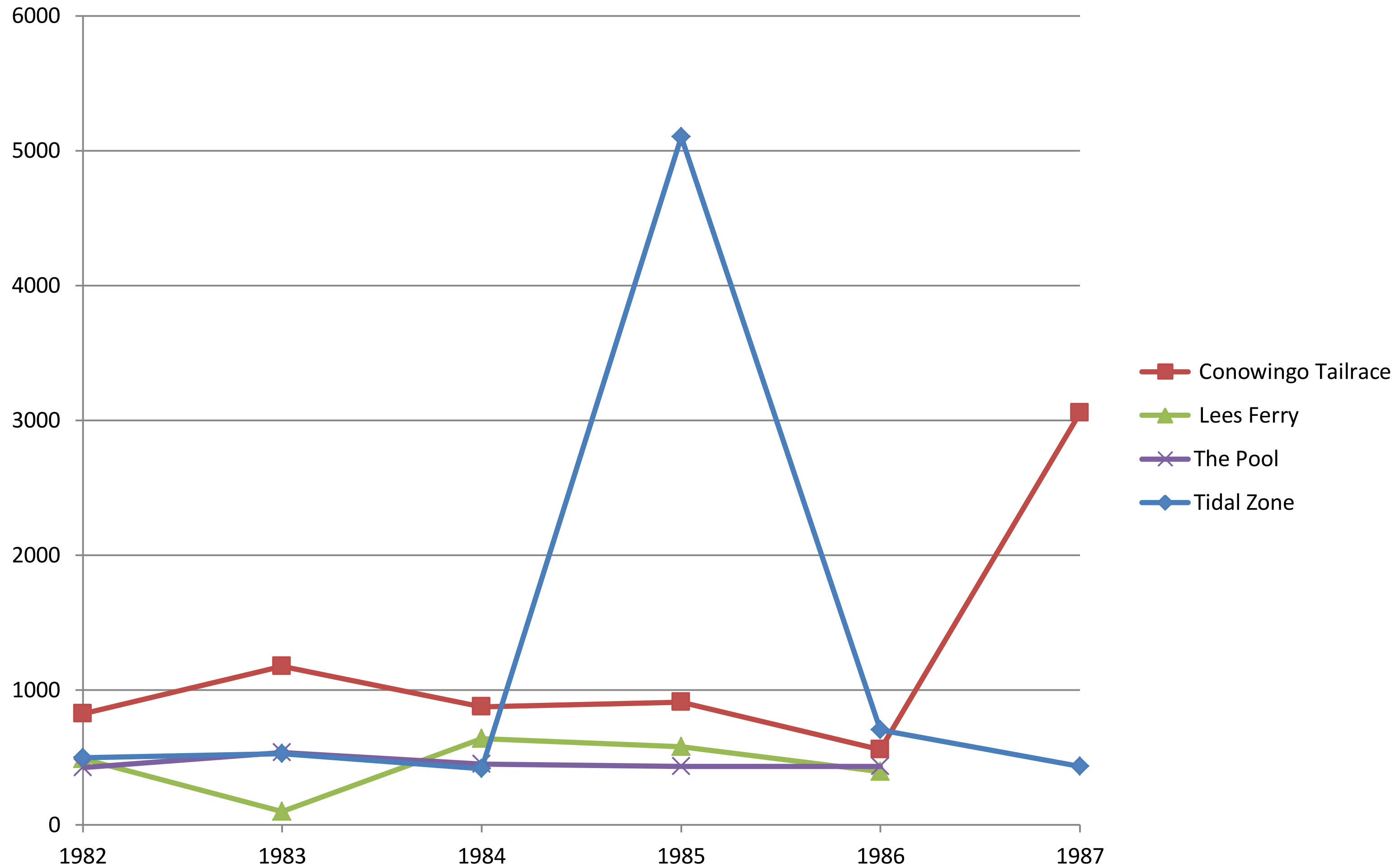




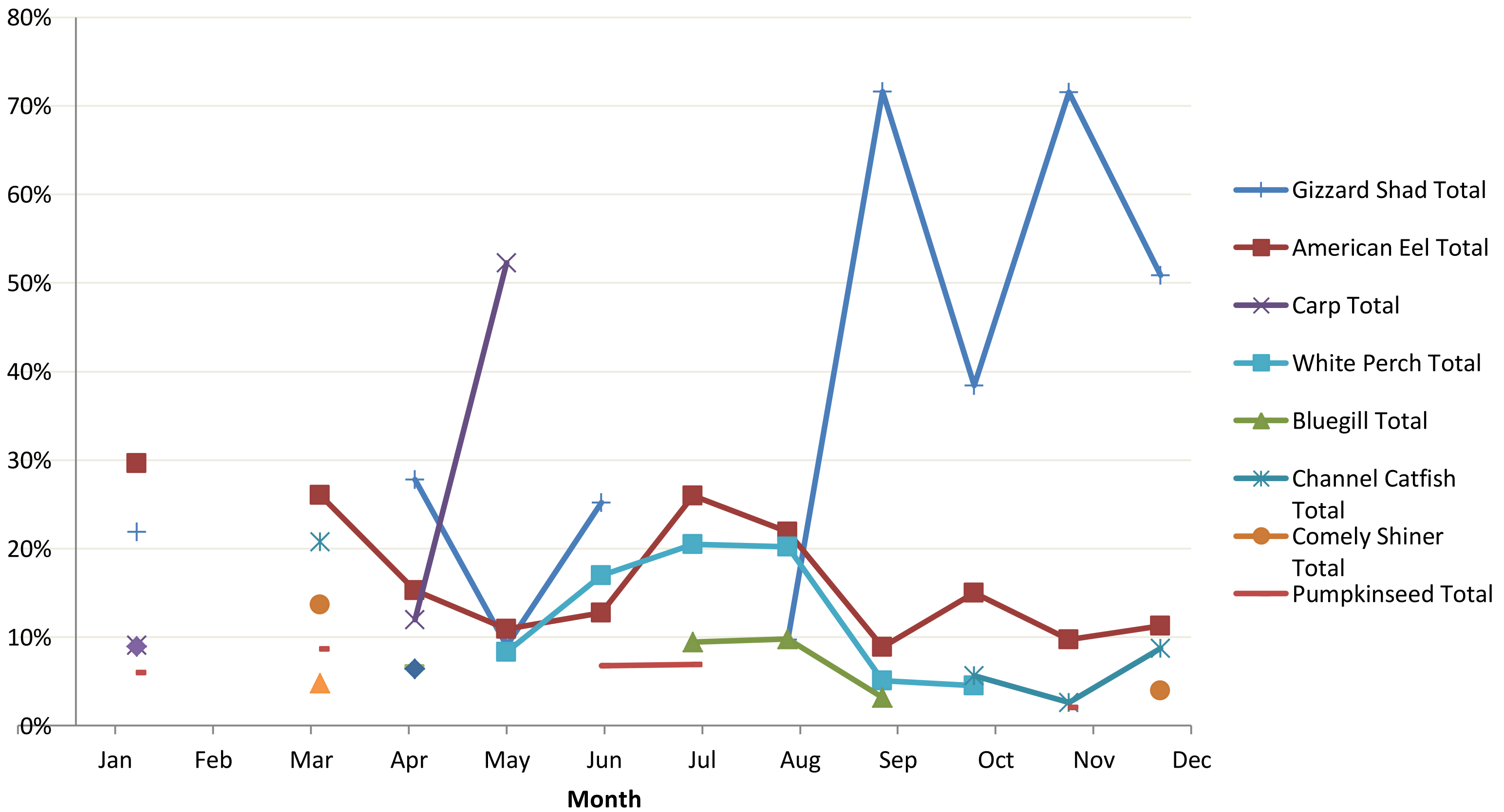




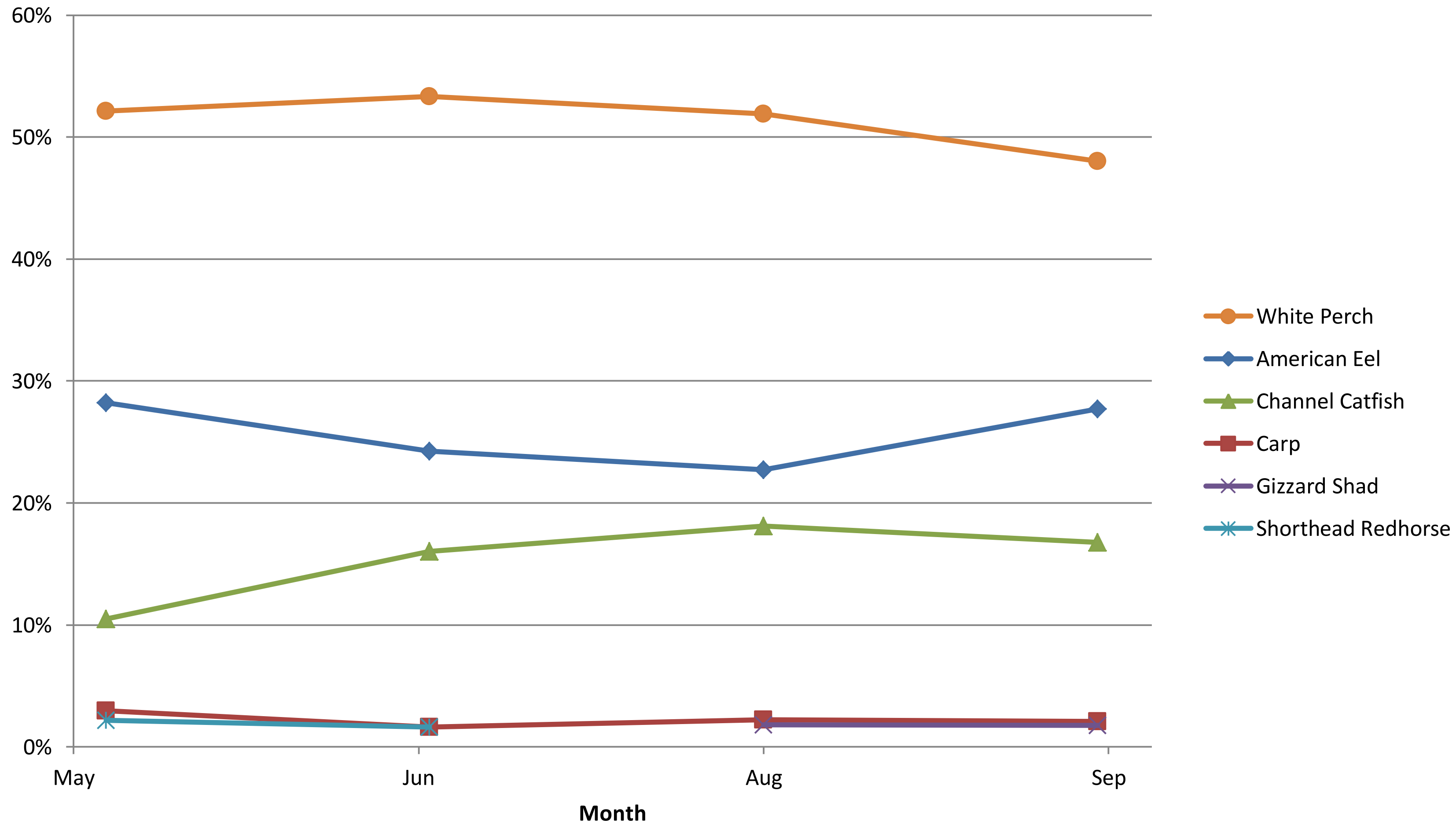
D-5. YEARLY OVERALL CPUE 1982 – 1987 AT THE CONOWINGO TAILRACE, LEES FERRY, THE POOL AND TIDAL ZONE.



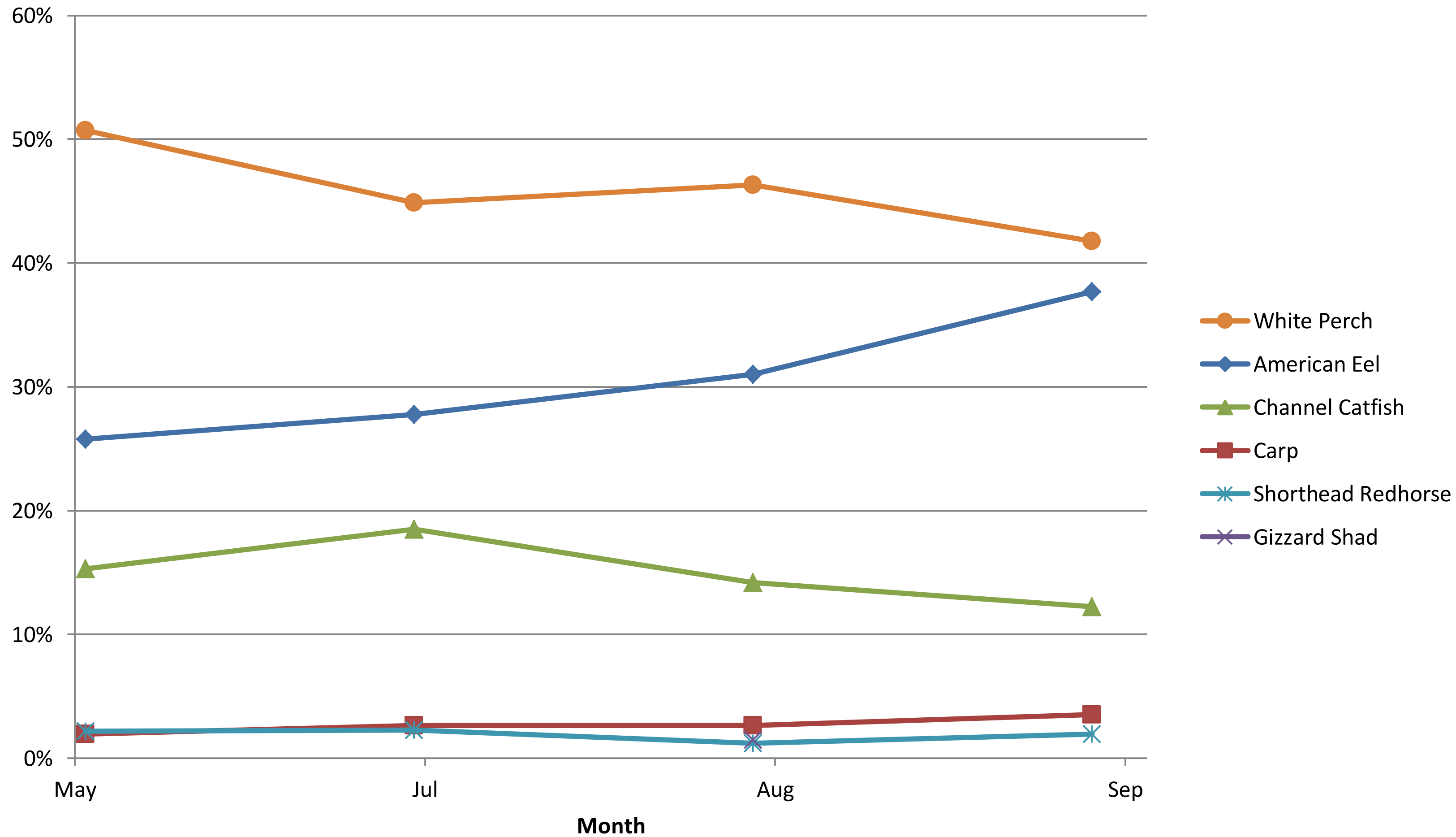
D-6. LOWER SUSQUEHANNA SPECIES COMPOSITION, PROPORTIONAL ABUNDANCE AND SEASONALITY IN THE CONOWINGO TAILRACE, BASED ON CPUE OF FIVE MOST FREQUENTLY COLLECTED SPECIES IN EACH YEAR 1982-87



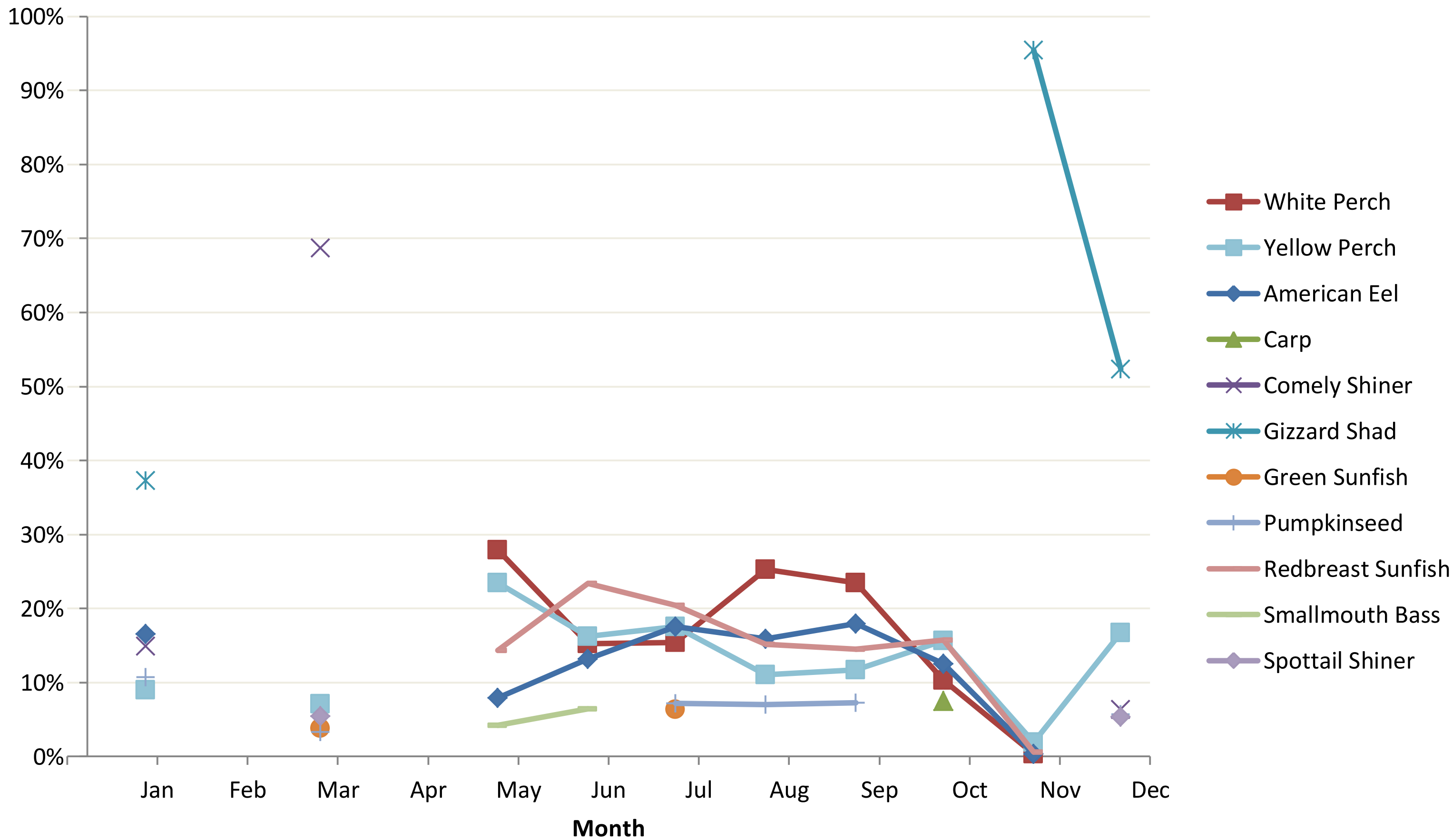
D-7. LOWER SUSQUEHANNA SPECIES COMPOSITION, PROPORTIONAL ABUNDANCE AND SEASONALITY AT LEES FERRY, BASED ON CPUE OF FIVE MOST FREQUENTLY COLLECTED SPECIES IN EACH YEAR 1982-87



D-8. LOWER SUSQUEHANNA SPECIES COMPOSITION, PROPORTIONAL ABUNDANCE AND SEASONALITY AT THE POOL, BASED ON CPUE OF FIVE MOST FREQUENTLY COLLECTED SPECIES IN EACH YEAR 1982-87

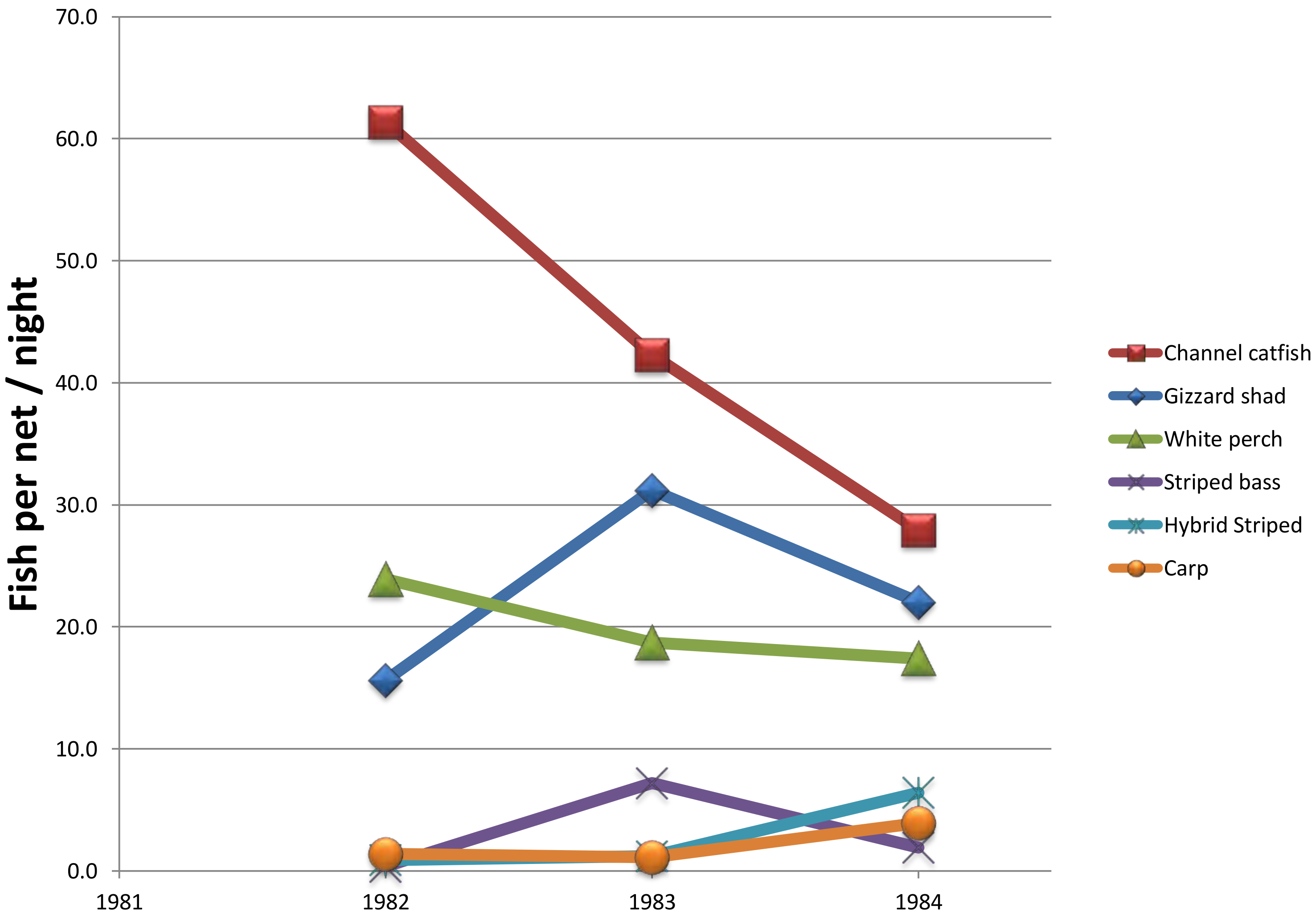


D-9. LOWER SUSQUEHANNA SPECIES COMPOSITION SEASONALITY IN THE TIDAL ZONE, BASED ON CPUE OF FIVE MOST FREQUENTLY COLLECTED SPECIES IN EACH YEAR 1982-87

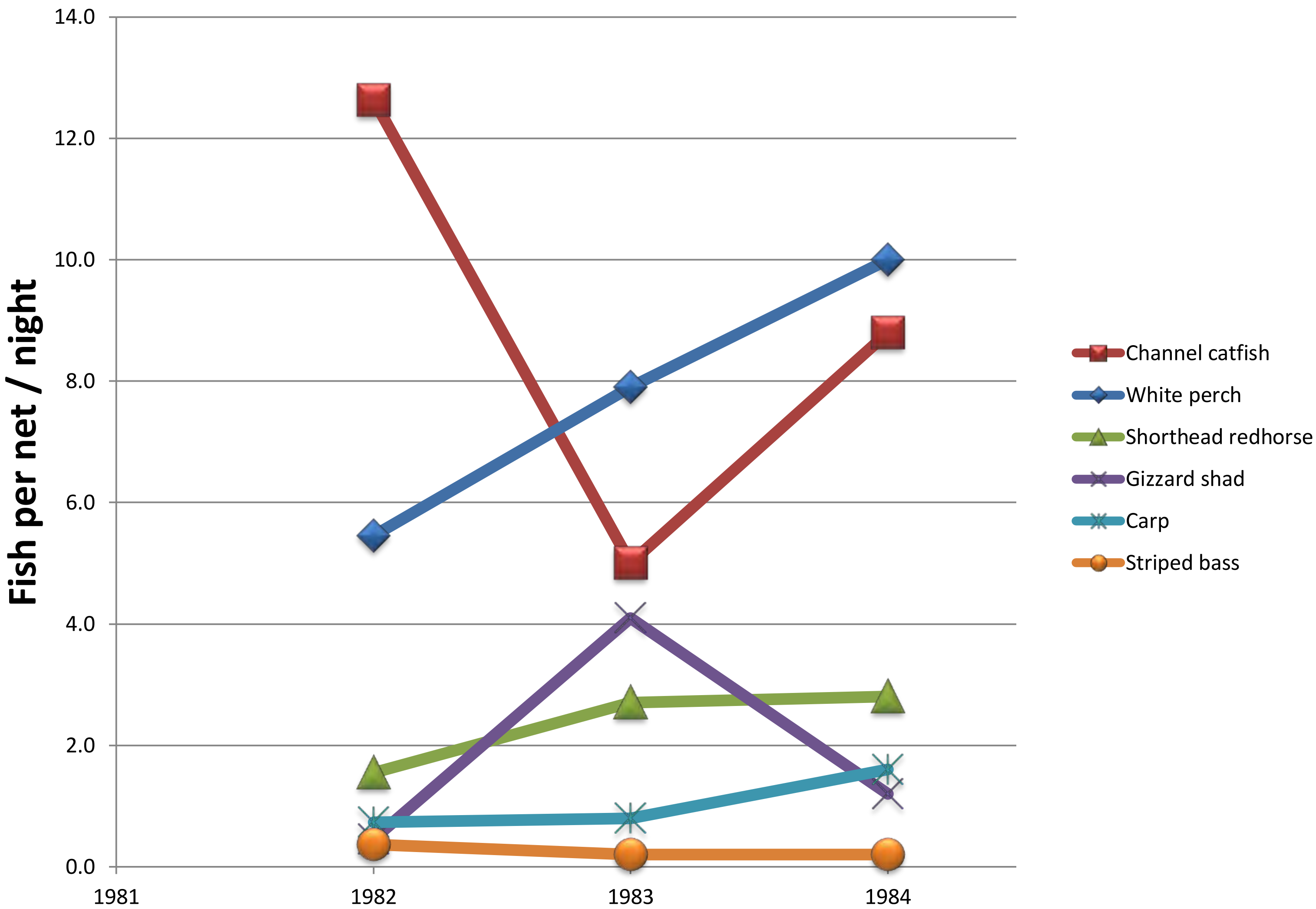


APPENDIX E-GILL NETS

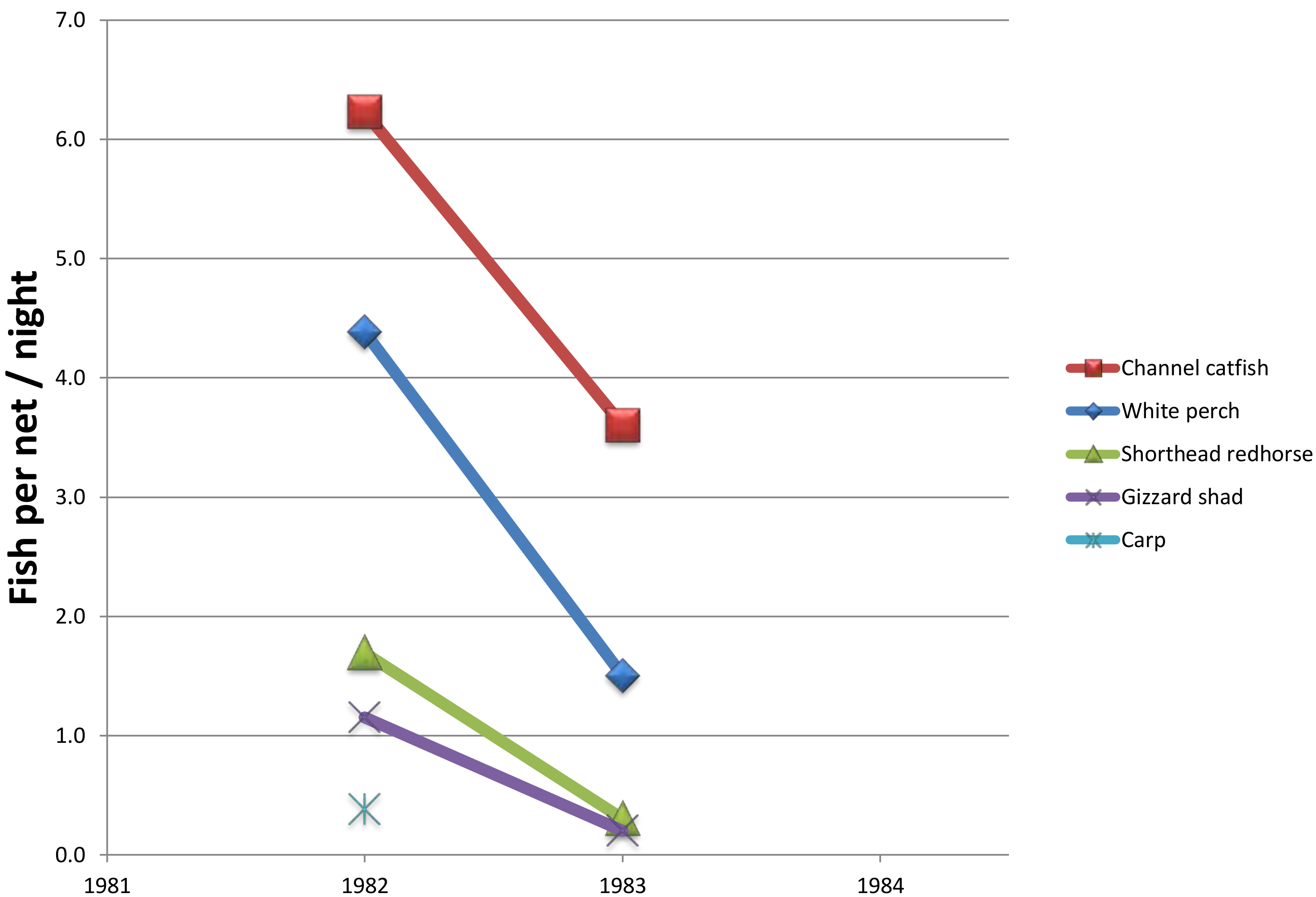
E-1. LOWER SUSQUEHANNA GILL NET CPUE (FISH/NET-NIGHT) IN THE CONOWINGO TAILRACE 1982-84



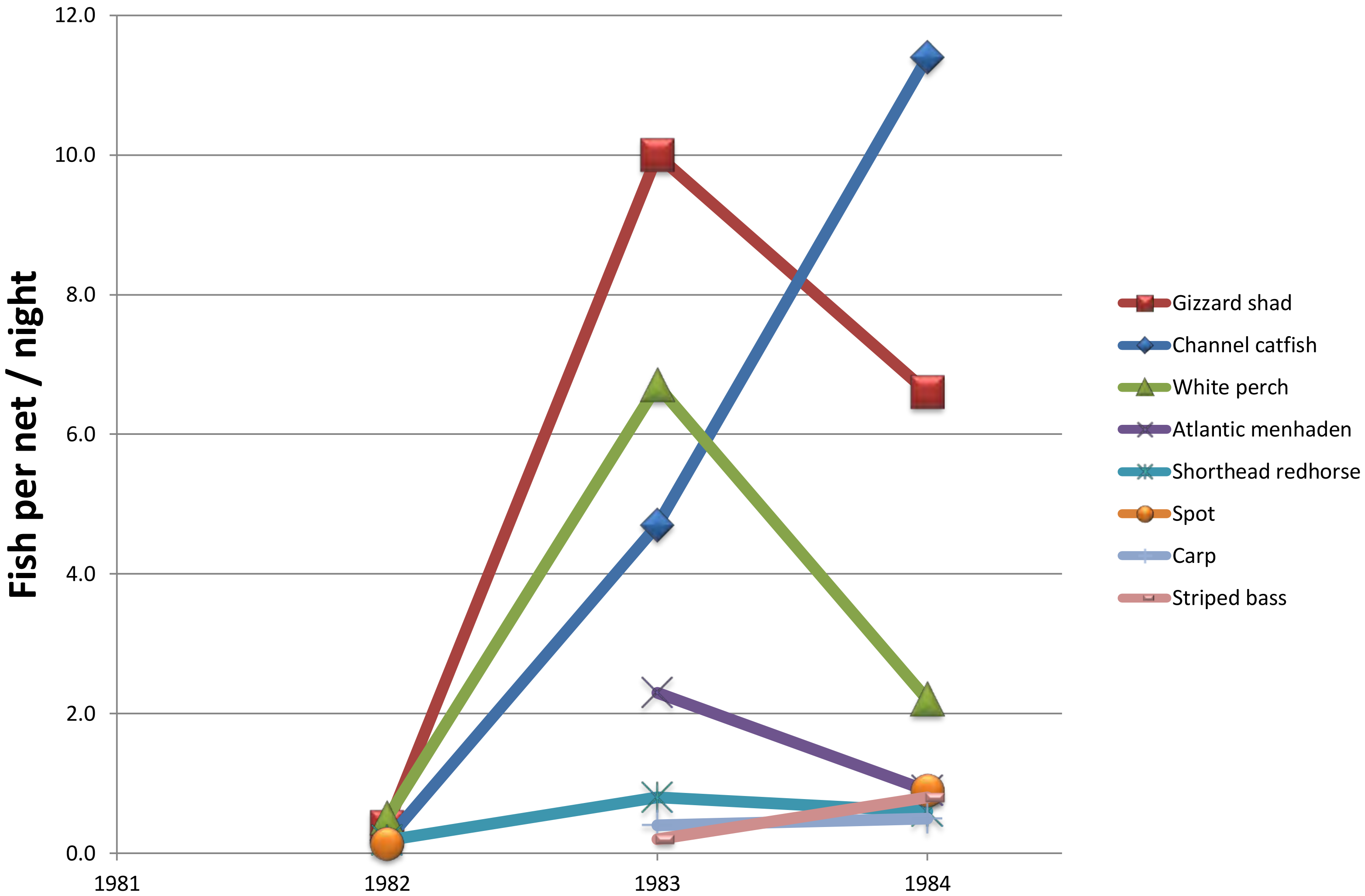
E-2. LOWER SUSQUEHANNA GILL NET CPUE(FISH/NET-NIGHT) AT LEES FERRY 1982-84



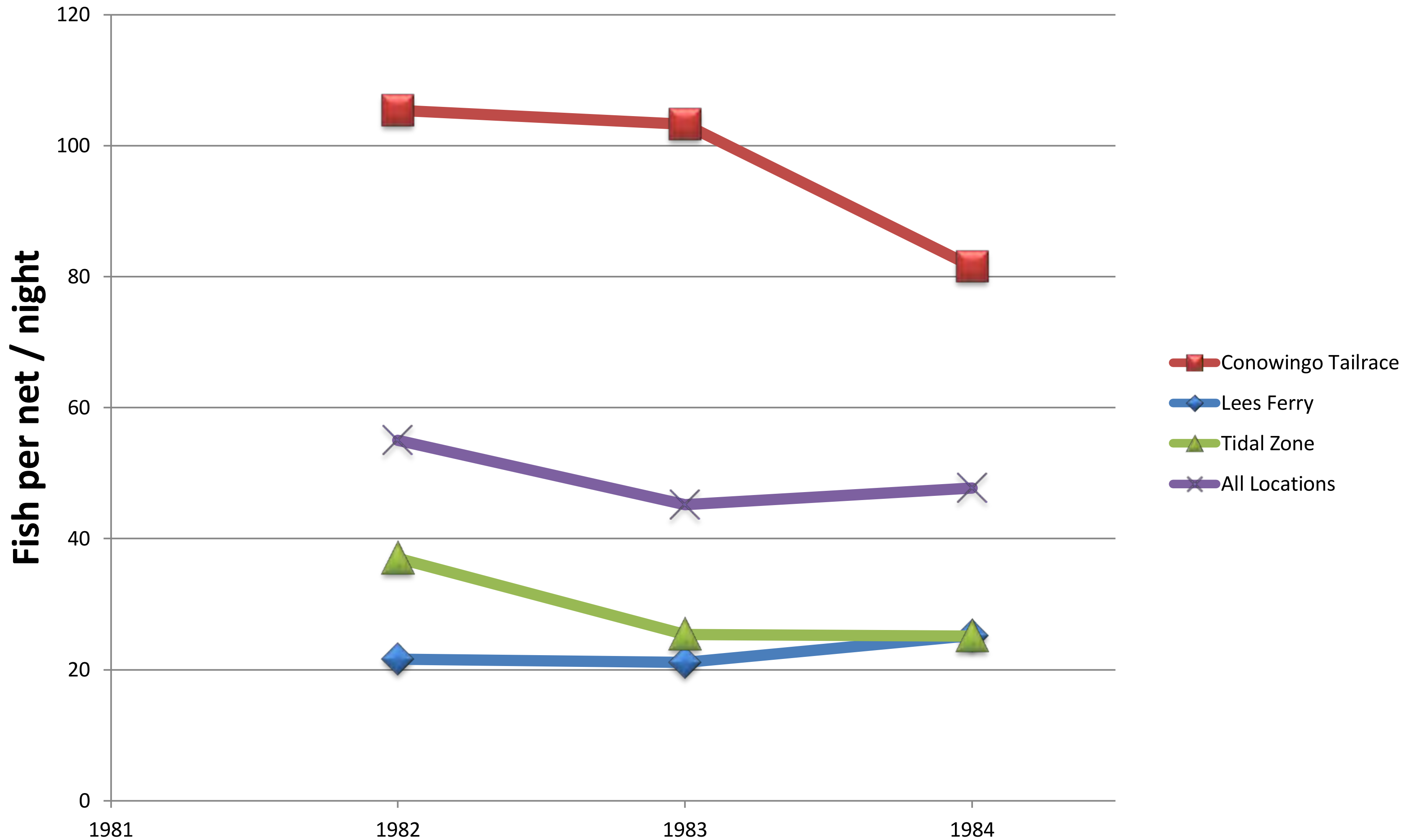
E-3. LOWER SUSQUEHANNA GILL NET CPUE AT (FISH/NET-NIGHT) THE POOL 1982-83



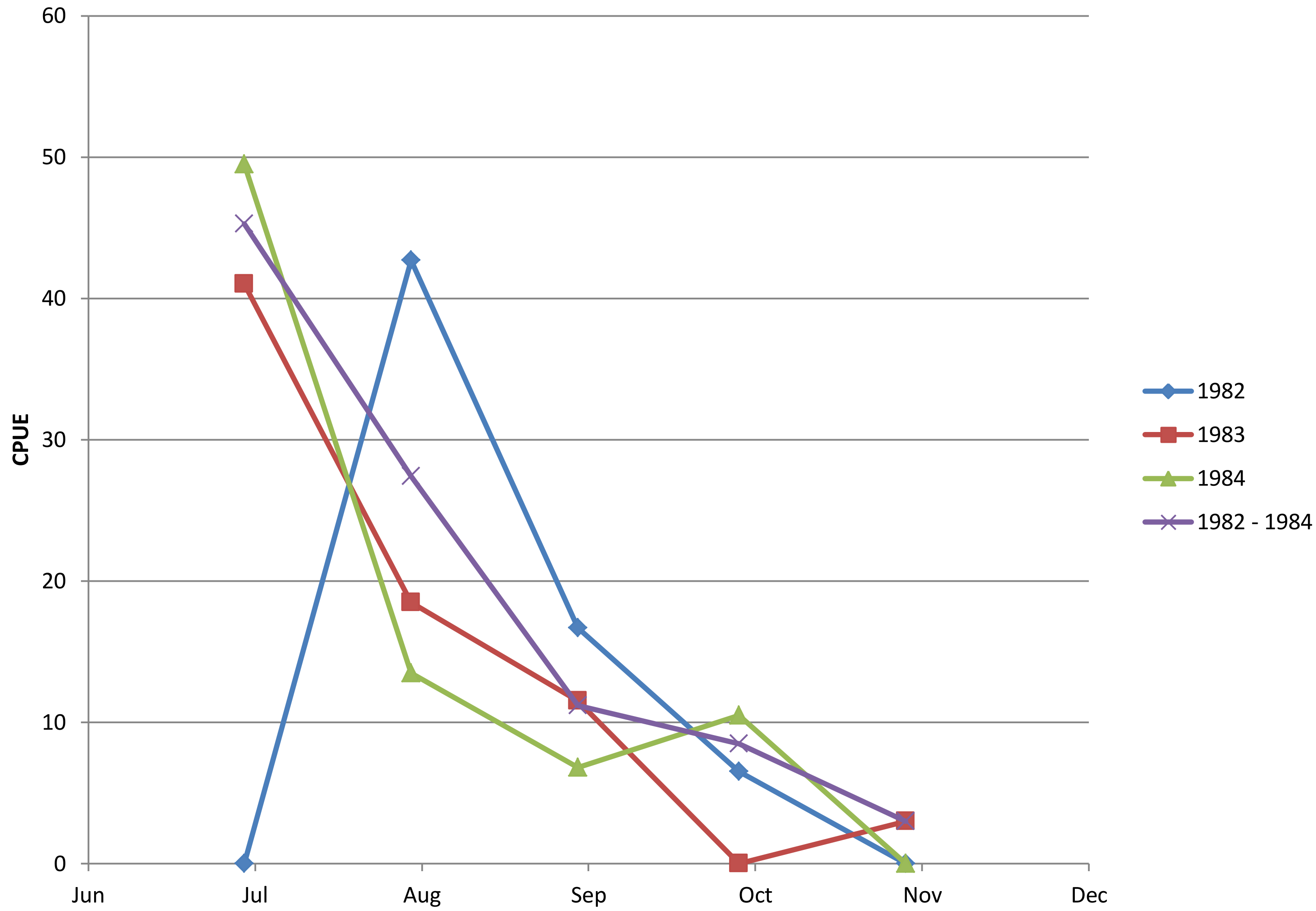
E-4. LOWER SUSQUEHANNA GILL NET CPUE (FISH/NET-NIGHT) AT THE TIDAL ZONE 1982-83



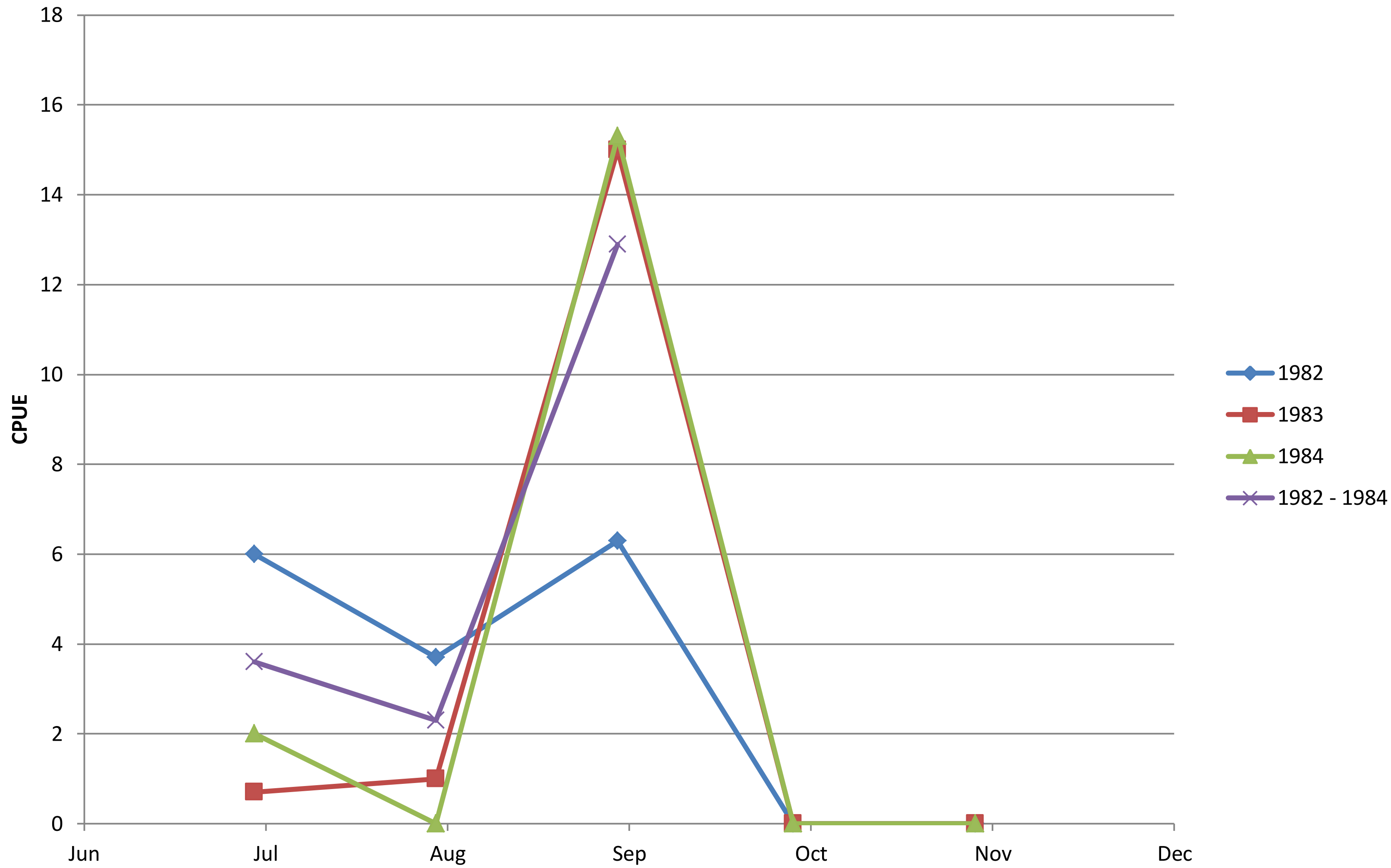
E-5. LOWER SUSQUEHANNA ALL AREAS TOTAL GILL NET CPUE (FISH/NET-NIGHT) 1982-84



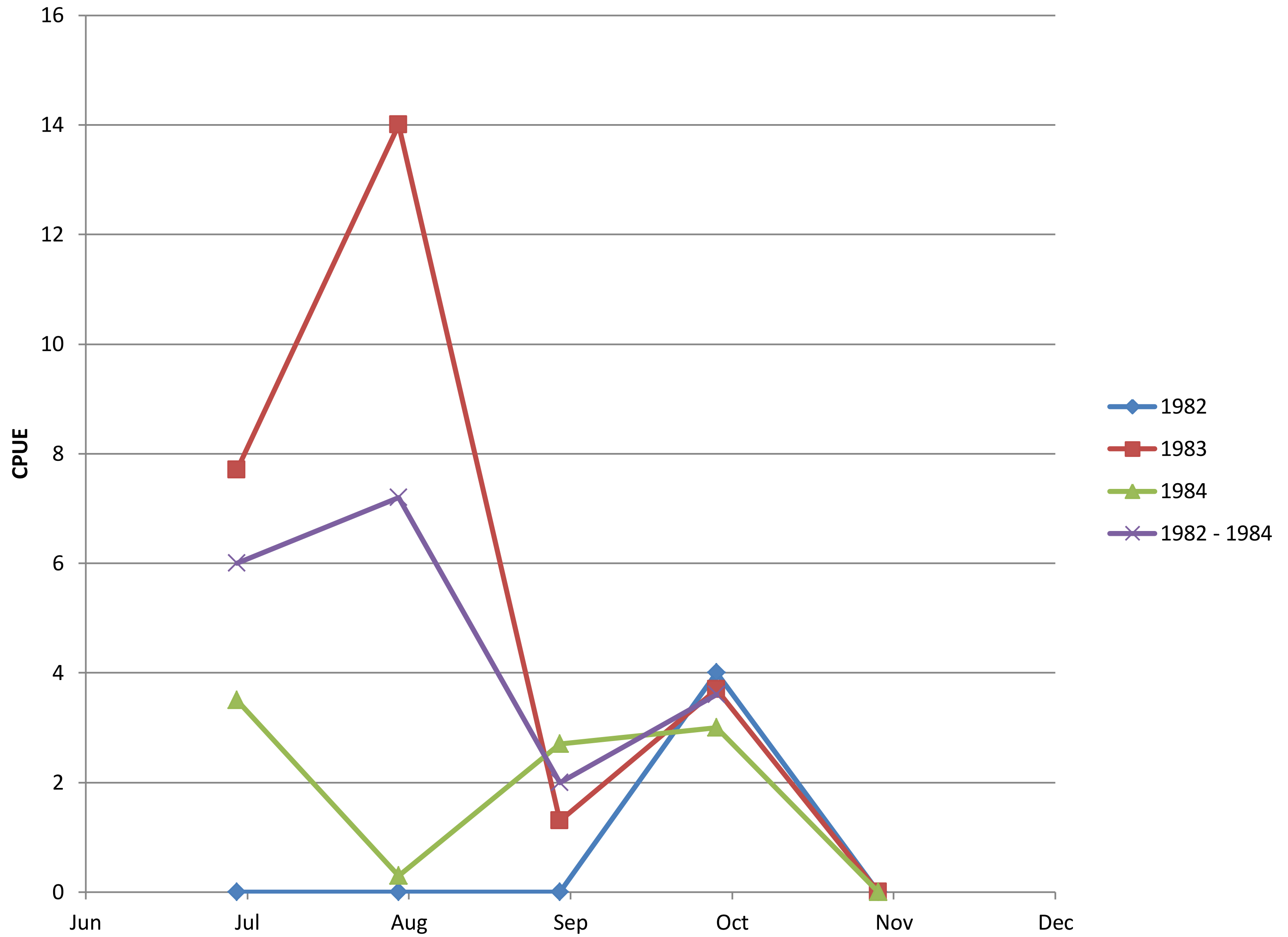
E-6. WHITE PERCH CPUE FISH/NET-NIGHT AT THE CONOWINGO TAILRACE 1982 – 1984.



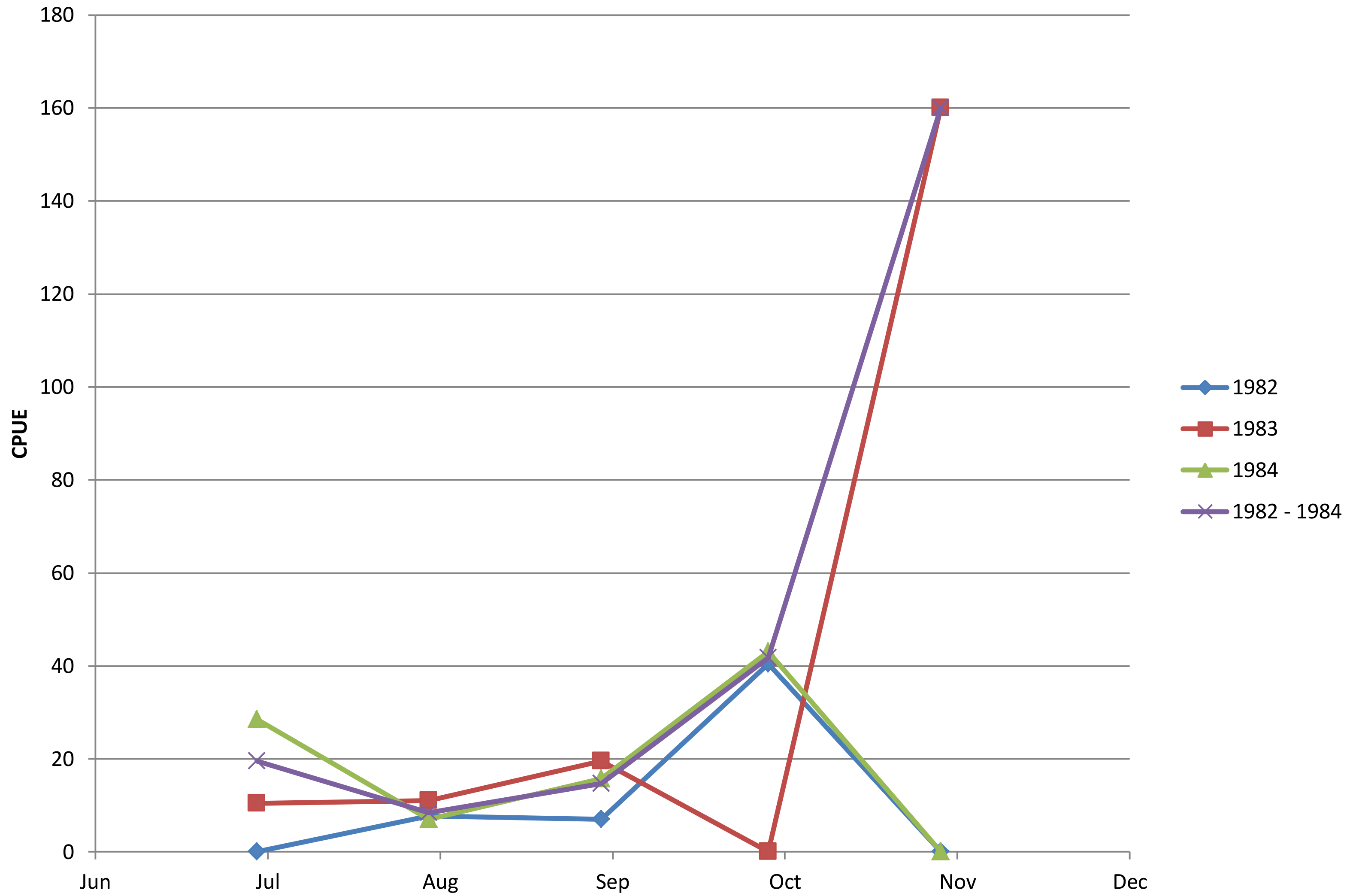
E-7. WHITE PERCH CPUE FISH/NET-NIGHT AT LEE'S FERRY 1982 – 1984.



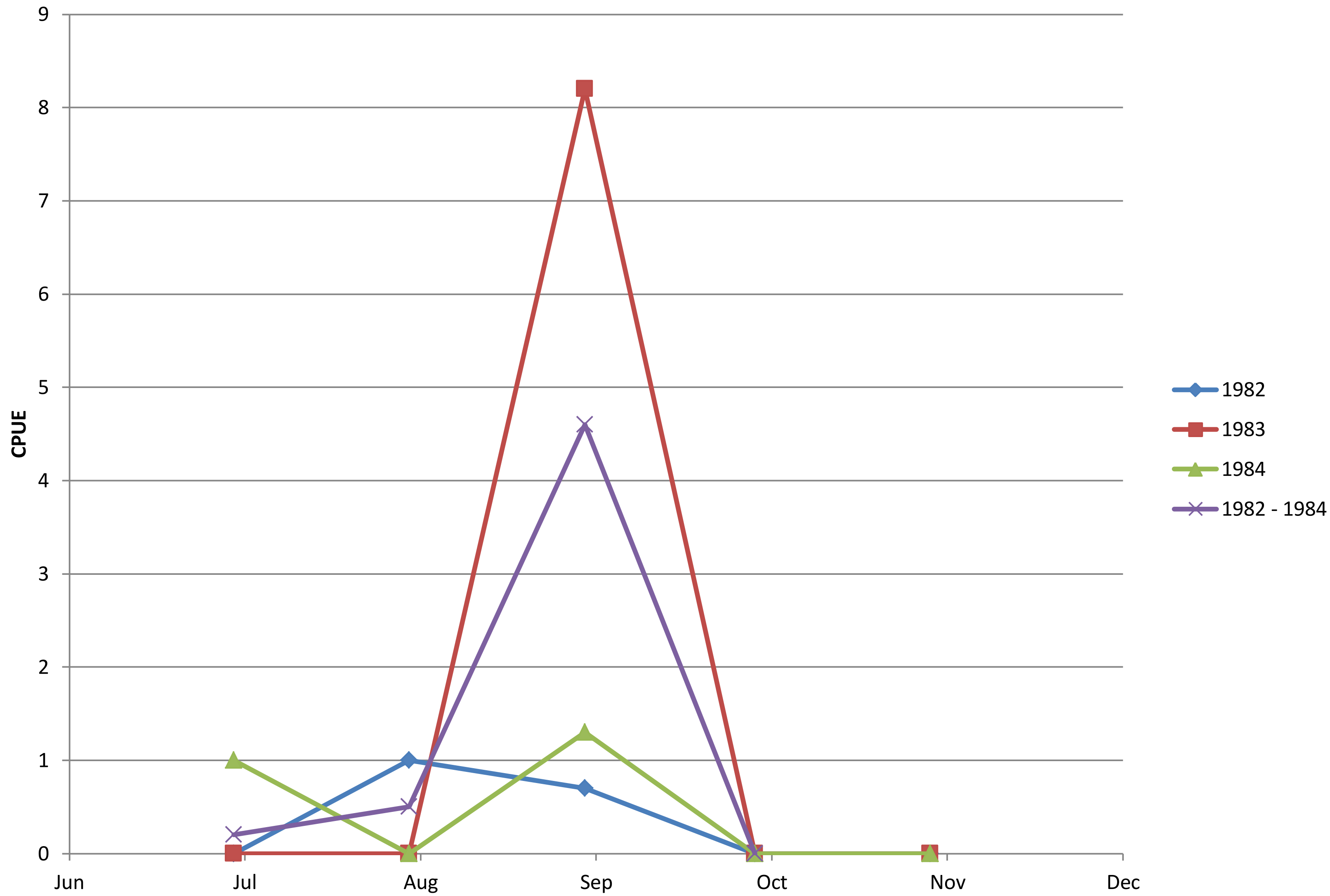
E-8. WHITE PERCH CPUE FISH/NET-NIGHT AT THE TIDAL ZONE 1982 – 1984.



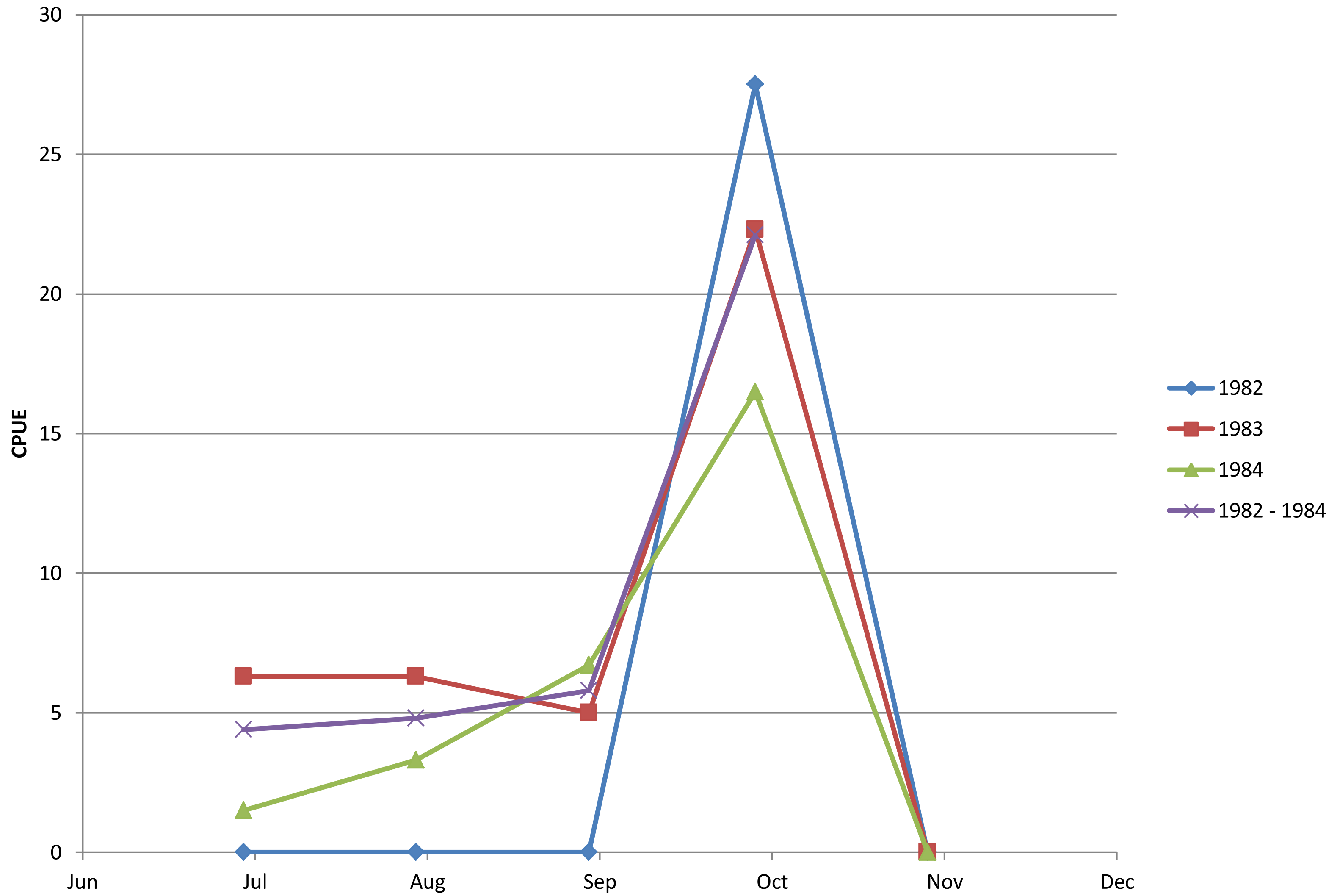
E-9. GIZZARD SHAD CPUE AT CONOWINGO TAILRACE 1982 – 1984



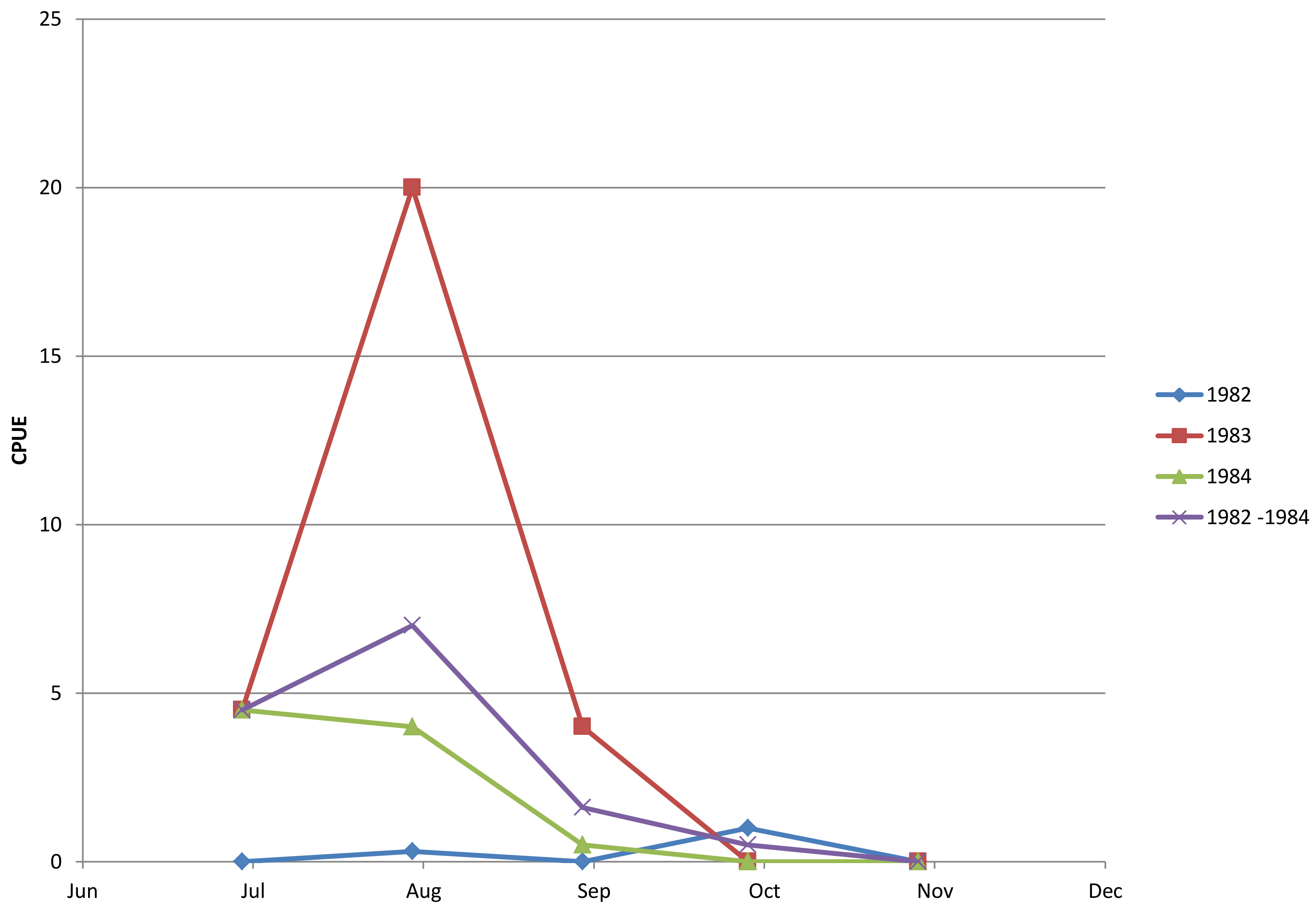
E-10. GIZZARD SHAD CPUE AT LEE'S FERRY 1982 – 1984



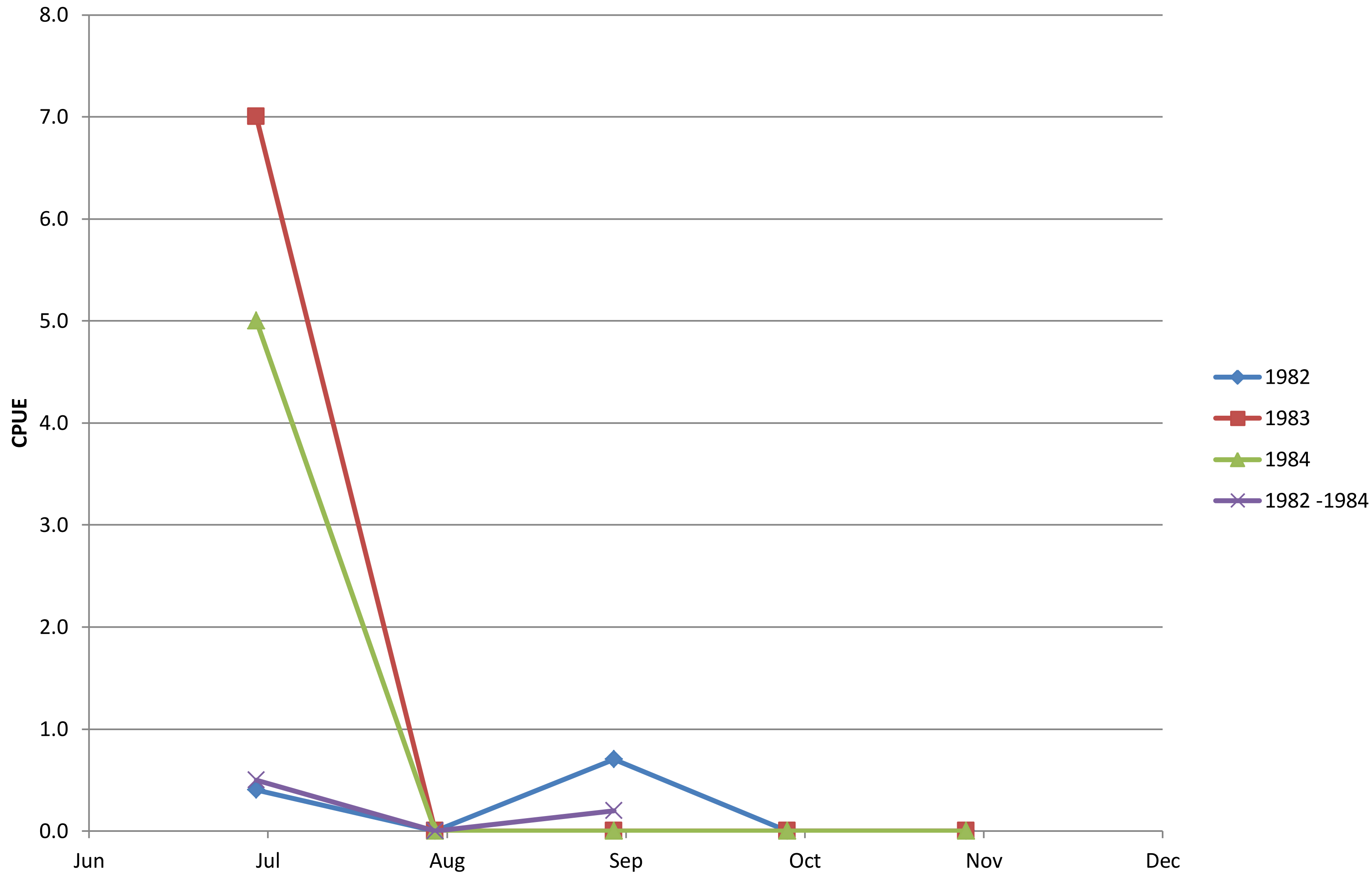
E-11. GIZZARD SHAD CPUE AT THE TIDAL ZONE 1982 – 1984



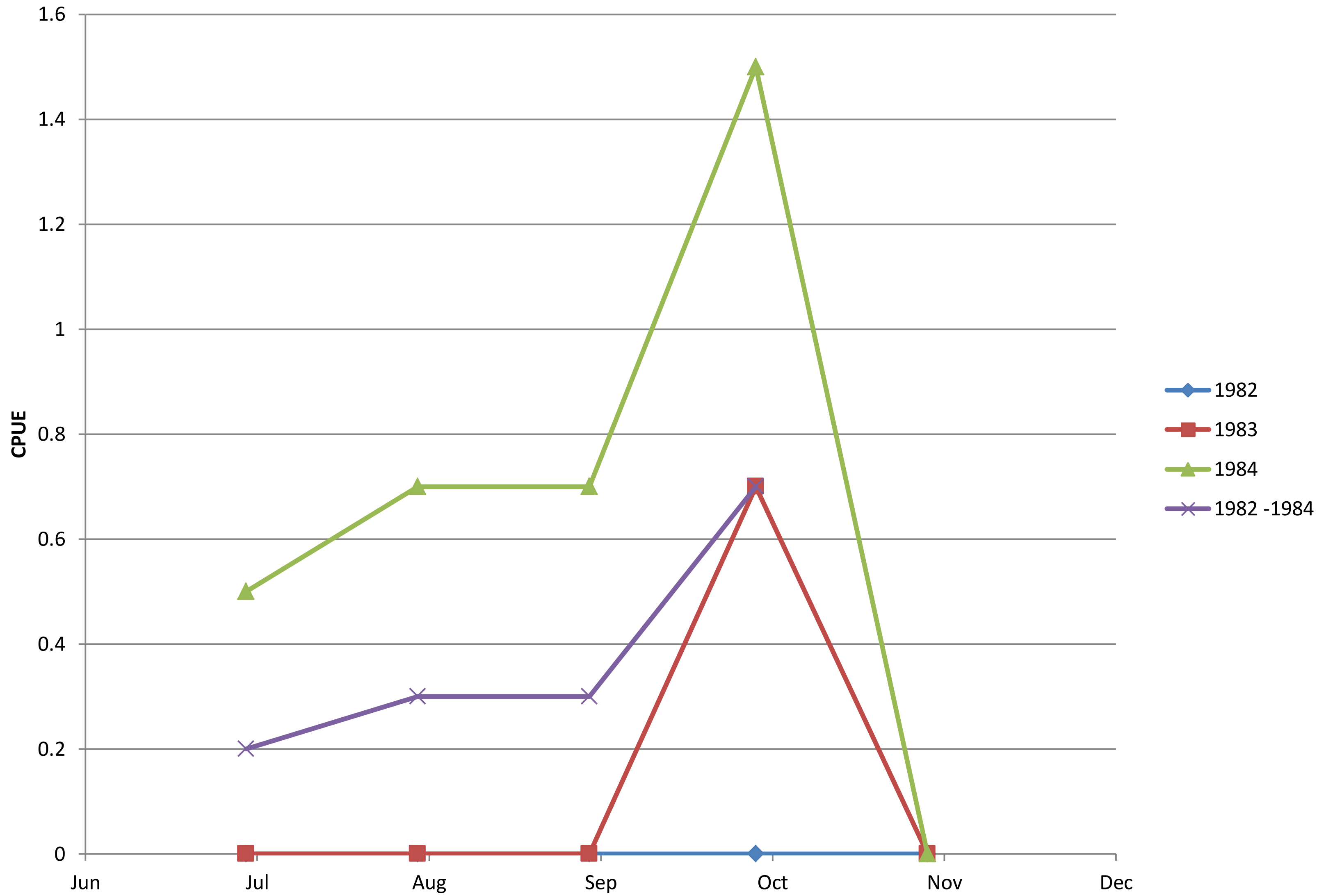
E-12. GIZZARD SHAD CPUE AT CONOWINGO TAILRACE 1982 – 1984.



E-13. GIZZARD SHAD CPUE AT CONOWINGO TAILRACE, LEE'S FERRY AND THE TIDAL ZONE 1982 – 1984.



E-14. GIZZARD SHAD CPUE AT CONOWINGO TAILRACE, LEE'S FERRY AND THE TIDAL ZONE 1982 – 1984.



E-15. NUMBER COLLECTED, PERCENT COMPOSITION, AND CATCH PER EFFORT (NO. PER NET NIGHT) FOR FISHES COLLECTED BY EXPERIMENTAL GILL NETS IN THE LOWER SUSQUEHANNA RIVER, JULY-OCTOBER 1982.

Area	**Tailrace**			**Lee's Ferry**			**Pool**			**Tidal**			**Total**		
No. Nets Set	**8**			**11**			**13**			**16**			**48**		
	No.	**%**	**CPUE[1]**	**No.**	**%**	**CPUE[1]**	**No.**	**%**	**CPUE[1]**	**No.**	**%**	**CPUE[1]**	**No.**	**%**	**CPUE[1]**
Channel catfish	491	58	61	139	58	13	81	44	6	3	4	0.2	714	55%	15
White perch	191	23	24	60	25	5	57	32	4	8	11	1	316	24%	7
Gizzard shad	125	15	16	5	3	0	15	10	1	6	74	0.4	151	12%	3
Shorthead redhorse				17	8	2	22	15	2	3	4	0.2	42	3%	1
Carp	11	2	1	8	3	1	5	3	0.4				24	2%	1
Hybrid Striped	7	1	1				1	1	0.1				8	1%	0.2
Spottail shiner										8	11	0.5	8	1%	0.2
Striped bass	3	1	0.4	4	2	0.4	1	1	0.1				8	1%	0.2
Atlantic menhaden	5	1	1	1	3	0.1							6	0.5%	0.1
White catfish	1	0.4	0.1	4	2	0.4							5	0.4%	0.1
White crappie	3	1	0.4										3	0.2%	0.1
Blueback herring	1	0.3	0.1				2	4	0.2				3	0.2%	0.1
Spot										2	3	0.1	2	0.2%	0.04
White sucker							1	1	0.1	1	1	0.1	2	0.2%	0.04
Yellow perch	2	1	0.3										2	0.2%	0.04
American shad							1	2	0.1				1	0.1%	0.02
Largemouth bass										1	1	0.1	1	0.1%	0.02
Walleye	1	0.3	0.1										1	0.1%	0.02
Yellow bullhead	1	0.4	0.1										1	0.1%	0.02
Totals	**842**		**105**	**238**		**22**	**186**		**14**	**32**		**2**	**1,298**		**27**

[1] In certain instances the CPUE presented here has been altered from data originally reported in "Annual Report (Article 34; Objective 5): 1982 Fisheries Studies for Determination of Flow Needs for Protection and Enhancement of Fish Populations Below Conowingo" to standardize with 1983 and 1984 data where CPUE is determined as No. of Fish Collected / effort (No. nets set) and includes 'zero catches' as part of the effort. In 1982 if a gill net yielded zero fish of a particular species the effort was not included in determining the species specific CPUE. All data presented here as CPUE is number of fish / number of nets set. The 1983 and 1984 data were derived from "Annual Report (Article 34; Objective 5): 1983 Fisheries Studies for Determination of Flow Needs for Protection and Enhancement of Fish Populations Below Conowingo" and "Annual Report (Article 34; Objective 5): 1984 Fisheries Studies for Determination of Flow Needs for Protection and Enhancement of Fish Populations Below Conowingo" respectively.

E-16. CONT. NUMBER, PERCENT COMPOSITION (%). AND CATCH PER EFFORT (CPE: NO. PER NET NIGHT) OF FISHES COLLECTED BY EXPERIMENTAL GILL NET IN THE LOWER SUSQUEHANNA RIVER. JULY THROUGH NOVEMBER 1983.

Area	Tailrace			Lee's Ferry			The Pool			Tidal Zone			Total		
No. of Nets Set	9			12			12			12			45		
	No.	%	CPUE	No.	%	CPUE	No.	%	CPUE	No.	%	CPUE	No.	%	CPUE
Atlantic menhaden	4	0.4	0.4							27	9	2	31	2	1
Gizzard shad	281	30	31.2	49	19	4	2	3	0.2	120	40	10	452	29	10
Carp	10	1	1.1	10	4	1				5	2	0.4	25	2	1
Shorhead redhorse				32	13	3	4	6	0.3	10	3	1	46	3	1
Channel catfish	381	41	42.3	60	24	5	43	60	4	56	18	5	540	35	12
White perch	168	18	18.7	95	38	8	18	25	2	80	26	7	361	23	8
Striped bass	65	7	7.2	2	1	0.2	2	3	0.2	2	1	0.2	71	5	2
Hybrid Striped bass	11	1	1.2				1	1	0.1				12	1	0.3
Other Fishes[1]	14	2	1.6	5	2	0.4	2	3	0.2	4	1.3	0.3	25	2	1
Totals	**934**		**104**	**253**		**21**	**72**		**6**	**304**		**25**	**1563**		**35**

[1]Other species collected were combined under the category 'Other Fishes' in 1983; the species denoted account for the known minimum species richness

E-17. SPECIES COMPOSITION OF FISHES CAUGHT IN THE EXPERIMENTAL GILL NET PROGRAM FROM THE LOWER SUSQUEHANNA RIVER 1984 1

Area	Conowingo Tailrace			Lees Ferry			Tidal Zone			Total		
No. Nets	10			5			10			25		
	No.	%	CPUE	No.	%	CPUE	No.	%	CPUE	No.	%	CPUE
Alewife							1	0.4	0.1	1	0.4	0.04
American shad	1	0.1	0.1				1	0.4	0.1	2	0.2	0.1
Atlantic Menhaden							9	4	1	9	4	0.4
Black Crappie	1	0.1	0.1							1	0.1	0.04
Carp	39	5	4	8	6	1.6	5	2	1	52	4	2
Channel Catfish	279	34	28	44	35	8.8	114	45	11	437	37	17
Gizzard shad	220	27	22	6	5	1.2	66	26	7	292	25	12
Hickory shad							1	0.4	0.1	1	0.4	0.04
Hybrid Striped Bass	64	8	6	2	2	0.4	1	0.4	0.1	67	6	3
Largemouth Bass	1	0.1	0.1							1	0.1	0.04
Quillback	2	0.2	0.2				1	0.4	0.1	3	0.3	0.1
Redbreast Sunfish							1	0.4	0.1	1	0.4	0.04
Shad							2	1	0.2	2	0.2	0.1
Shorthead Redhorse				14	11	2.8	6	2	1	20	5	1
Smallmouth Bass	1	0.1	0.1							1	0.1	0.04
Spot							9	4	1	9	4	0.4
Striped Bass	19	2	2	1	1	0.2	8	3	1	28	2	1
Tiger Musky	1	0.1	0.1							1	0.1	0.04
Walleye	3	0.4	0.3				1	0.4	0.1	4	0.4	0.2
White catfish							3	1	0.3	3	1	0.1
White Crappie	8	1	1							8	1	0.3
White Perch	174	21	17	50	40	10	22	9	2	246	21	10
White sucker	1	0.1	0.1							1	0.1	0.04
Yellow bullhead	1	0.1	0.1							1	0.1	0.04
Yellow perch	1	0.1	0.1	1	1	0.2				2	0.2	0.1
Totals	**816**		**82**	**126**		**25**	**251**		**25**	**1193**		**48**

(1) Because of high river flows in 1984 only one collection was made in the Pool, thus data from this location has been excluded from the analysis.

E-18. ANNUAL CATCH PER EFFORT (NUMBER PER SET) OF ALL FISH CAUGHT IN THE EXPERIMENTAL GILL NET PROGRAM FROM THE LOWER SUSQUEHANNA RIVER.

LOCATION	CPUE		
	1982	1983	1984
Conowingo Tailrace	105	103	82
Lees Ferry	22	21	25
Tidal Zone	37	25	25
All Locations	55	45	48

APPENDIX F-AGE AND GROWTH PLOTS FROM RMC 1985A, B, C. AND LENGTH FREQUENCY CHARTS FROM THE WEST FISH LIFT 2010

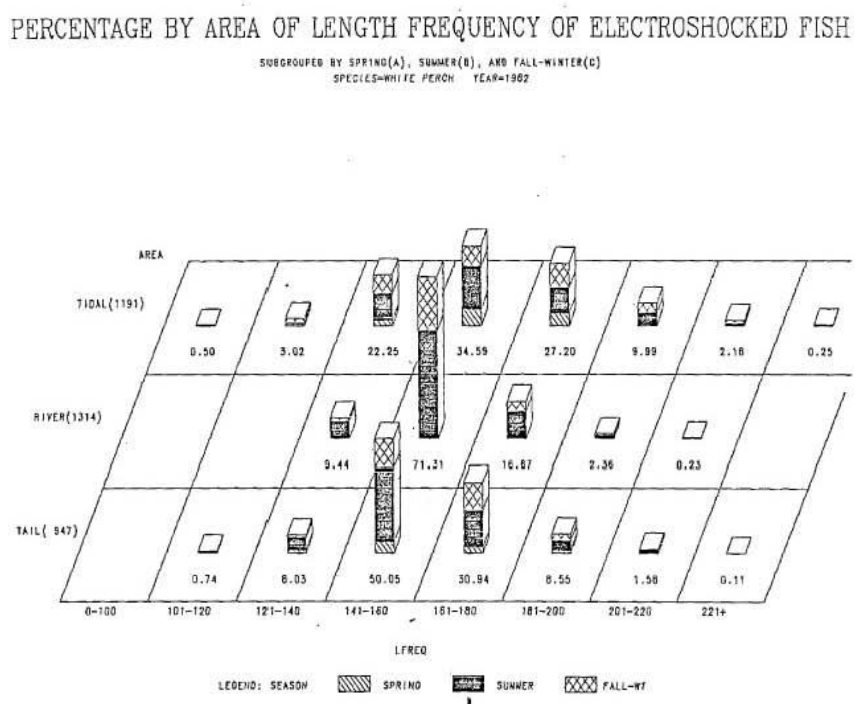

PERCENTAGE BY AREA OF LENGTH FREQUENCY OF ELECTROSHOCKED FISH
SUBGROUPED BY SPRING(A), SUMMER(B), AND FALL-WINTER(C)
SPECIES=WHITE PERCH YEAR=1982
AREA
TIDAL(1191)
RIVER(1314)
TAIL(947)
0.50
3.02
22.25
34.59
27.20
9.99
2.18
0.25
9.44
71.31
16.67
2.36
0.23
0.74
8.03
50.05
30.94
8.55
1.58
0.11
0-100
101-120
121-140
141-160
161-180
181-200
201-220
221+
LFREQ
LEGEND: SEASON
SPRING
SUMMER
FALL-WT

Figure 6.1.2

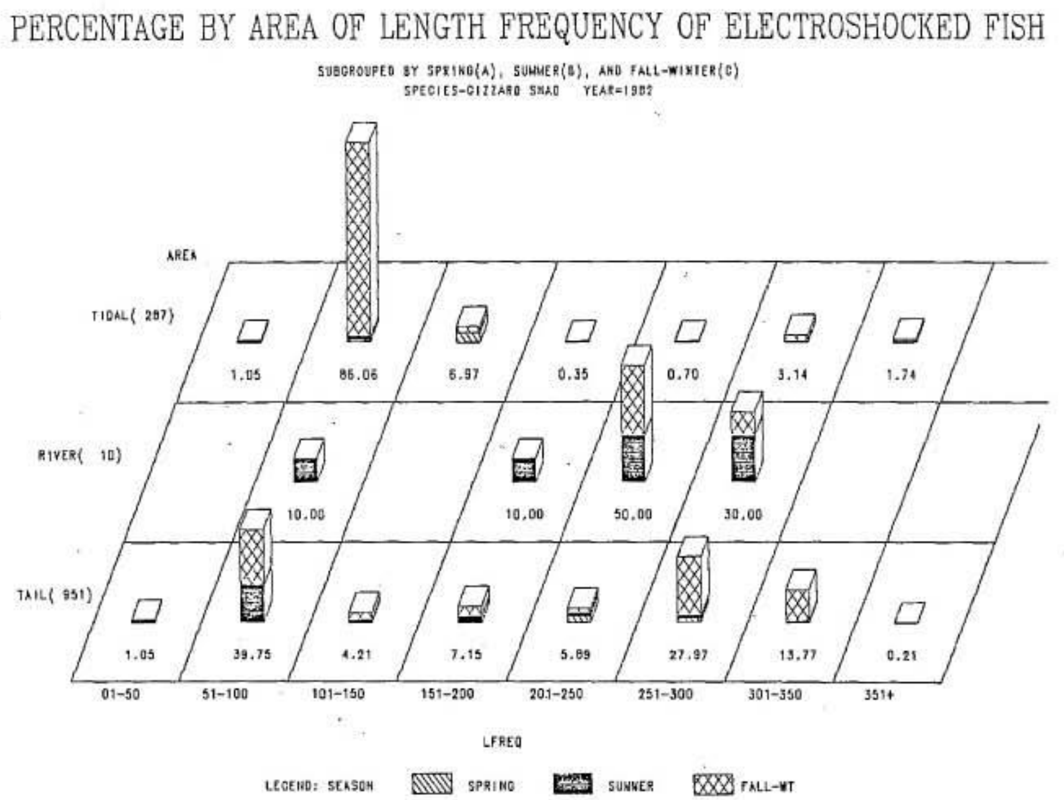

PERCENTAGE BY AREA OF LENGTH FREQUENCY OF ELECTROSHOCKED FISH
SUBGROUPED BY SPRING(A), SUMMER(B), AND FALL-WINTER(C)
SPECIES-GIZZARD SHAD YEAR=1982
AREA
TIDAL(287)
1.05
86.06
6.97
0.35
0.70
3.14
1.74
RIVER(10)
10.00
10.00
50.00
30.00
TAIL(951)
1.05
39.75
4.21
7.15
5.89
27.97
13.77
0.21
01-50
51-100
101-150
151-200
201-250
251-300
301-350
351+
LFREQ
LEGEND: SEASON
SPRING
SUMMER
FALL-WT

Figure 6.1.4

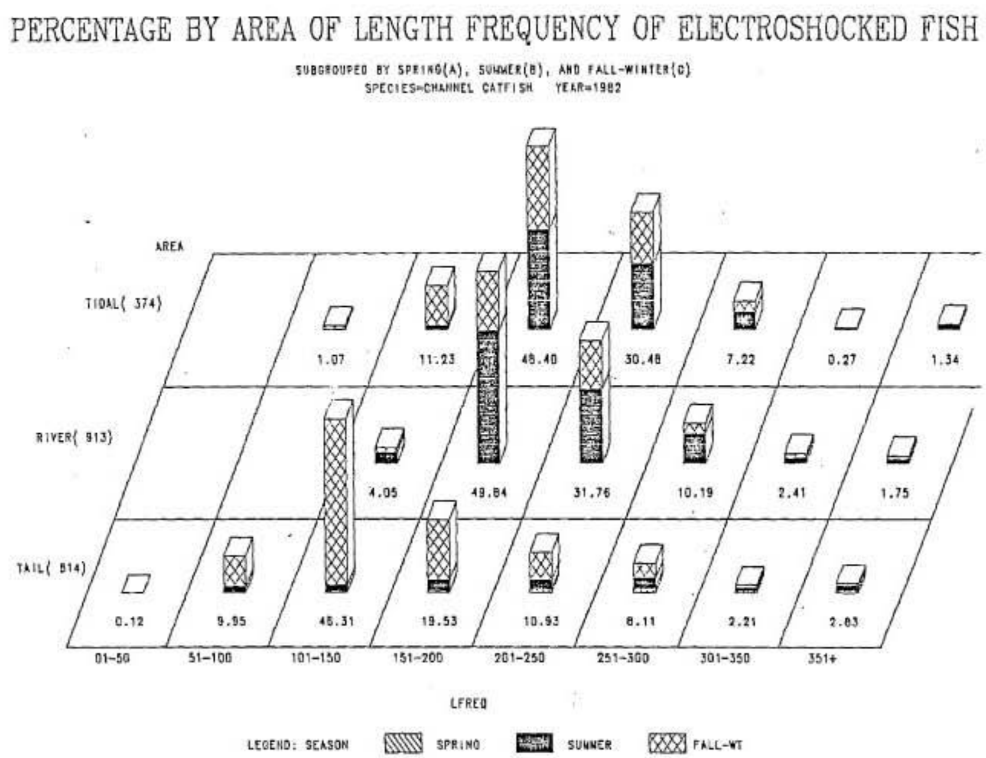

PERCENTAGE BY AREA OF LENGTH FREQUENCY OF ELECTROSHOCKED FISH
SUBGROUPED BY SPRING(A), SUMMER(B), AND FALL-WINTER(C)
SPECIES=CHANNEL CATFISH YEAR=1982
AREA
TIDAL(374)
RIVER(913)
TAIL(814)
1.07
11.23
48.40
30.48
7.22
0.27
1.34
4.05
49.84
31.76
10.19
2.41
1.75
0.12
9.95
48.31
19.53
10.93
6.11
2.21
2.83
01-50
51-100
101-150
151-200
201-250
251-300
301-350
351+
LFREQ
LEGEND: SEASON
SPRING
SUMMER
FALL-WT

Figure 6.1.5

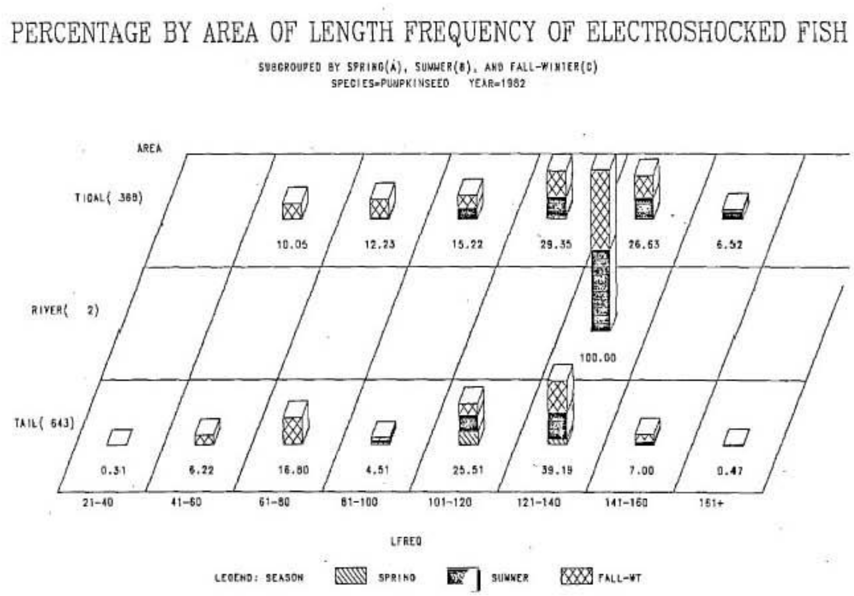
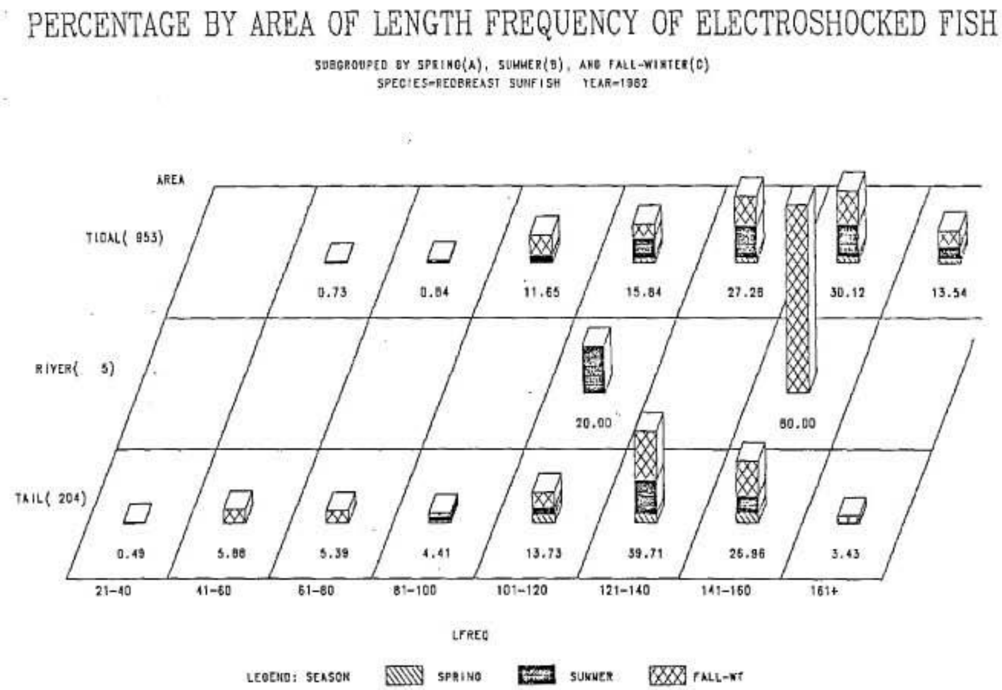

PERCENTAGE BY AREA OF LENGTH FREQUENCY OF ELECTROSHOCKED FISH
SUBGROUPED BY SPRING(A), SUMMER(B), AND FALL-WINTER(C)
SPECIES=PUMPKINSEED YEAR=1982
AREA
TIDAL(369)
RIVER(2)
TAIL(643)
10.05
12.23
15.22
29.35
26.63
6.52
100.00
0.31
6.22
16.80
4.51
25.51
39.19
7.00
0.47
21-40
41-60
61-80
81-100
101-120
121-140
141-160
161+
LFREQ
LEGEND: SEASON
SPRING
SUMMER
FALL-WT

Figure 6.1.6



PERCENTAGE BY AREA OF LENGTH FREQUENCY OF ELECTROSHOCKED FISH
SUBGROUPED BY SPRING(A), SUMMER(B), AND FALL-WINTER(C)
SPECIES=REDBREAST SUNFISH YEAR=1982
AREA
TIDAL(853)
RIVER(5)
TAIL(204)
0.73
0.84
11.65
15.84
27.28
30.12
13.54
20.00
80.00
0.49
5.88
5.39
4.41
13.73
39.71
25.96
3.43
21-40
41-60
61-80
81-100
101-120
121-140
141-160
161+
LFREQ
LEGEND: SEASON
SPRING
SUMMER
FALL-WT

Figure 6.1.7

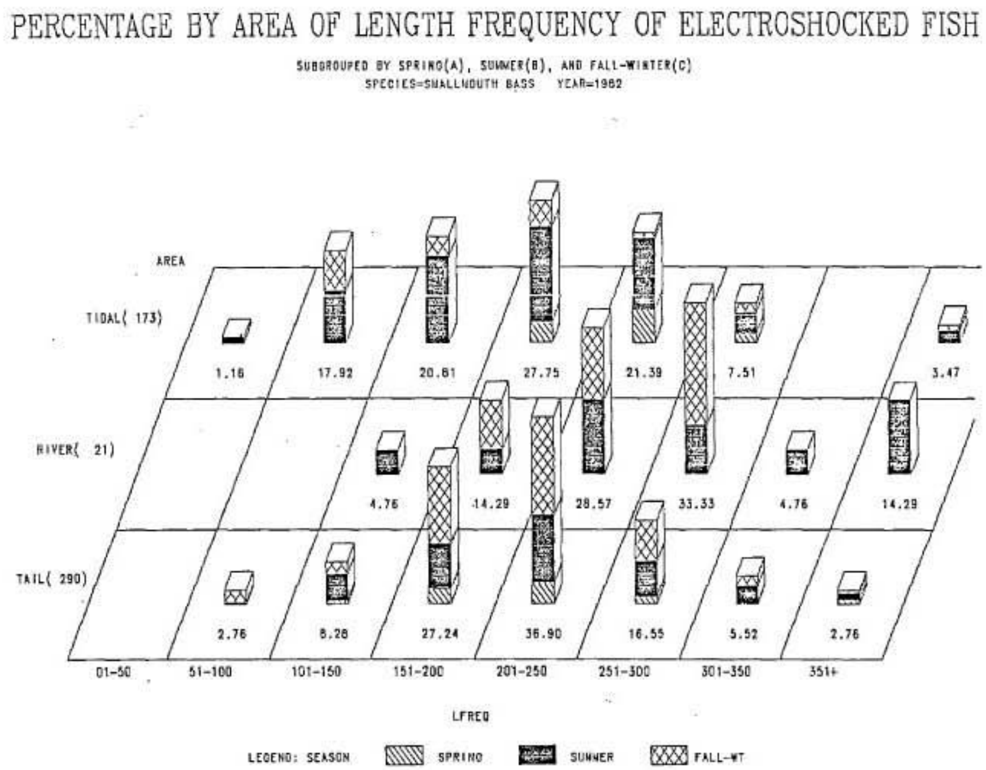

PERCENTAGE BY AREA OF LENGTH FREQUENCY OF ELECTROSHOCKED FISH
SUBGROUPED BY SPRING(A), SUMMER(B), AND FALL-WINTER(C)
SPECIES=SMALLMOUTH BASS YEAR=1982
AREA
TIDAL(173)
RIVER(21)
TAIL(290)
1.16
17.92
20.81
27.75
21.39
7.51
3.47
4.76
14.29
28.57
33.33
4.76
14.29
2.76
8.28
27.24
36.90
16.55
5.52
2.76
01-50
51-100
101-150
151-200
201-250
251-300
301-350
351+
LFREQ
LEGEND: SEASON
SPRING
SUMMER
FALL-WT

Figure 6.1.8

PERCENTAGE BY AREA OF LENGTH FREQUENCY OF ELECTROSHOCKED FISH

SUBGROUPED BY SPRING(A), SUMMER(B), AND FALL-WINTER(C)
SPECIES=STRIPED BASS YEAR=1982

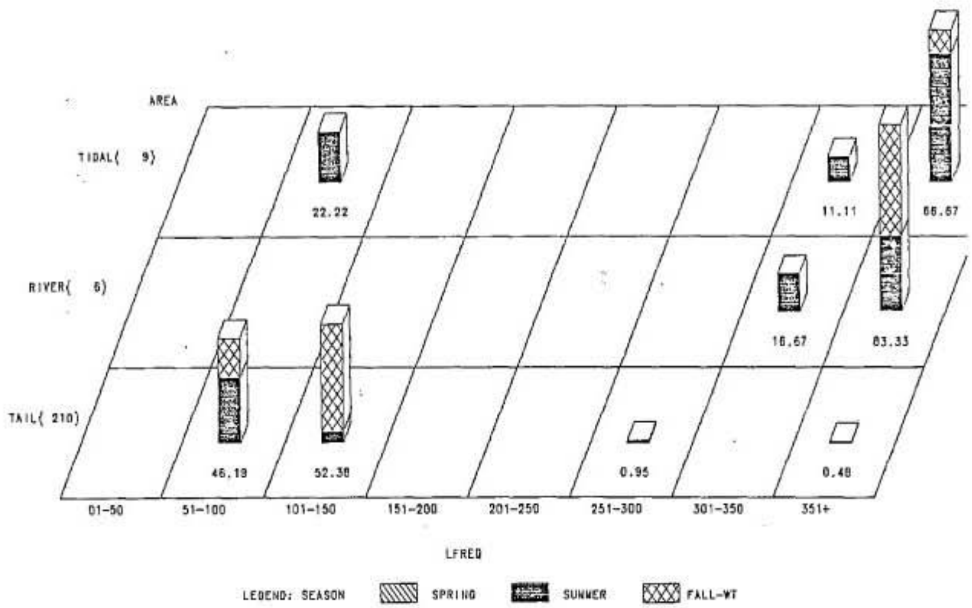


Figure 6.1.9

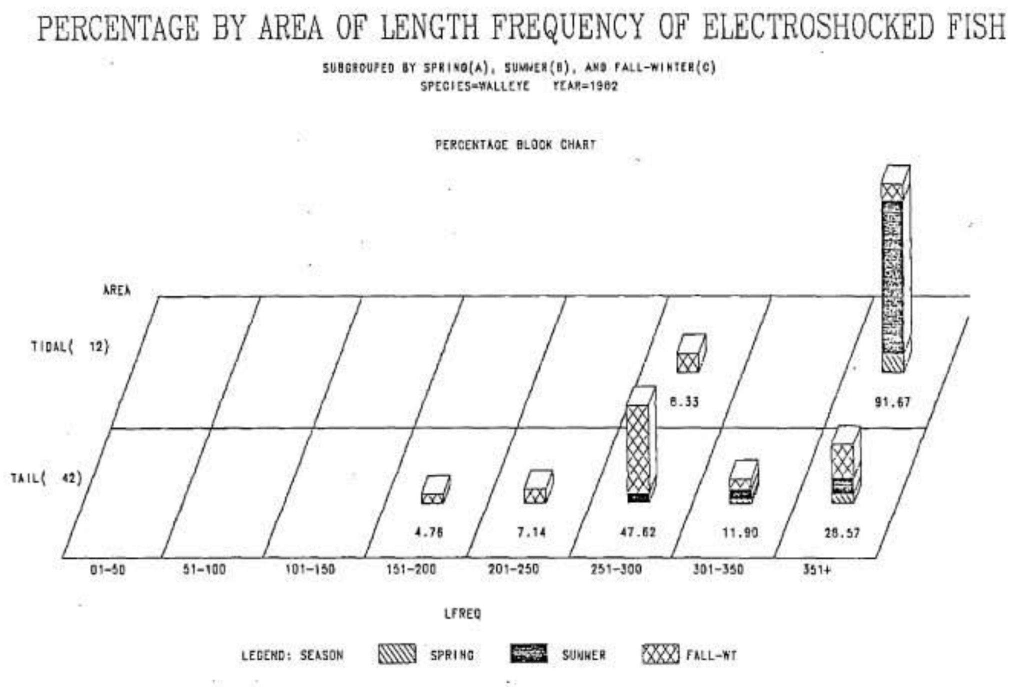

PERCENTAGE BY AREA OF LENGTH FREQUENCY OF ELECTROSHOCKED FISH
SUBGROUPED BY SPRING(A), SUMMER(B), AND FALL-WINTER(C)
SPECIES=WALLEYE YEAR=1982
PERCENTAGE BLOCK CHART
AREA
TIDAL(12)
TAIL(42)
8.33
91.67
4.76
7.14
47.62
11.90
28.57
01-50
51-100
101-150
151-200
201-250
251-300
301-350
351+
LFREQ
LEGEND: SEASON
SPRING
SUMMER
FALL-WT

Figure 6.1.10

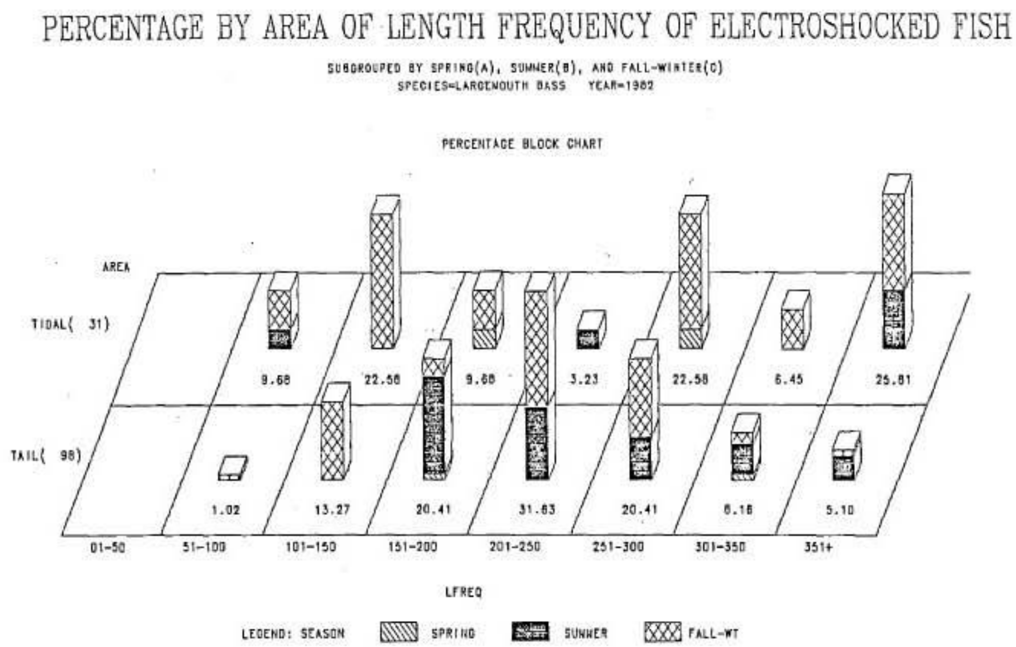

PERCENTAGE BY AREA OF LENGTH FREQUENCY OF ELECTROSHOCKED FISH
SUBGROUPED BY SPRING(A), SUMMER(B), AND FALL-WINTER(C)
SPECIES=LARGEMOUTH BASS YEAR=1982
PERCENTAGE BLOCK CHART
AREA
TIDAL(31)
TAIL(98)
9.68
22.58
9.68
3.23
22.58
6.45
25.81
1.02
13.27
20.41
31.63
20.41
8.16
5.10
01-50
51-100
101-150
151-200
201-250
251-300
301-350
351+
LFREQ
LEGEND: SEASON
SPRING
SUMMER
FALL-WT

Figure 6.1.11

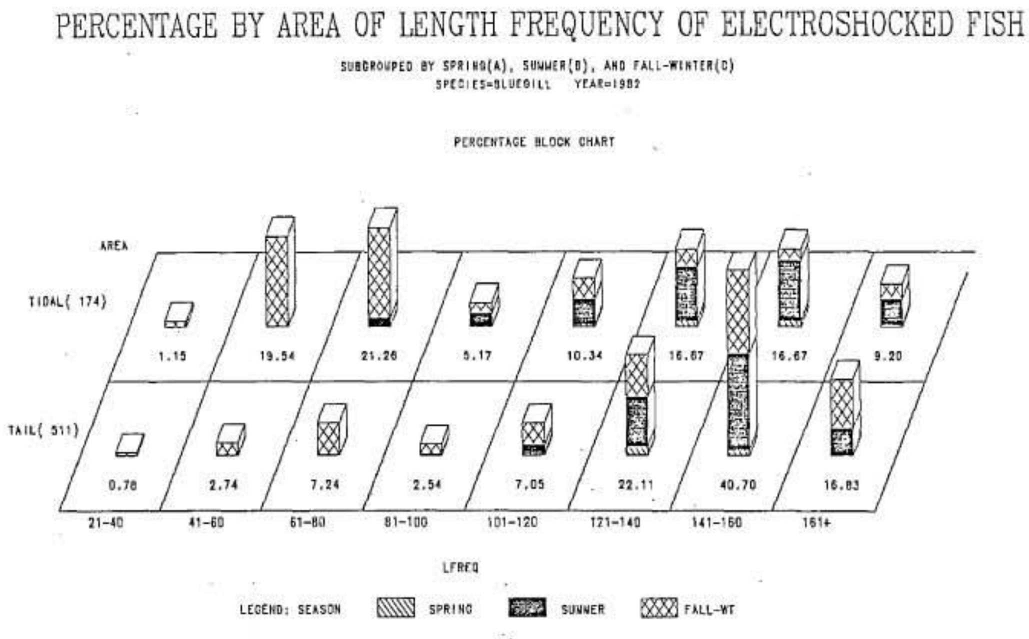

PERCENTAGE BY AREA OF LENGTH FREQUENCY OF ELECTROSHOCKED FISH
SUBGROUPED BY SPRING(A), SUMMER(B), AND FALL-WINTER(C)
SPECIES=BLUEGILL YEAR=1982
PERCENTAGE BLOCK CHART
AREA
TIDAL(174)
TAIL(511)
1.15
19.54
21.26
5.17
10.34
16.67
16.67
9.20
0.78
2.74
7.24
2.54
7.05
22.11
40.70
16.83
21-40
41-60
61-80
81-100
101-120
121-140
141-160
161+
LFREQ
LEGEND: SEASON
SPRING
SUMMER
FALL-WT

Figure 6.1.12

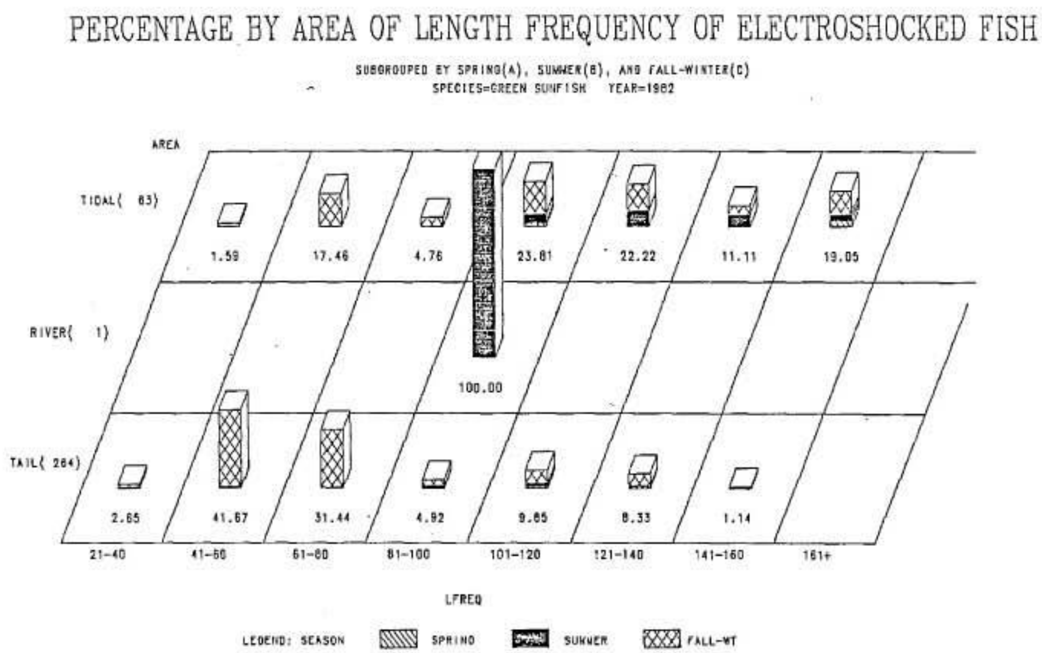

PERCENTAGE BY AREA OF LENGTH FREQUENCY OF ELECTROSHOCKED FISH
SUBGROUPED BY SPRING(A), SUMMER(B), AND FALL-WINTER(C)
SPECIES=GREEN SUNFISH YEAR=1982
AREA
TIDAL(63)
1.59
17.46
4.76
23.81
22.22
11.11
19.05
RIVER(1)
100.00
TAIL(264)
2.65
41.67
31.44
4.92
9.85
8.33
1.14
21-40
41-60
61-80
81-100
101-120
121-140
141-160
161+
LFREQ
LEGEND: SEASON
SPRING
SUMMER
FALL-WT

Figure 6.1.13

5-25

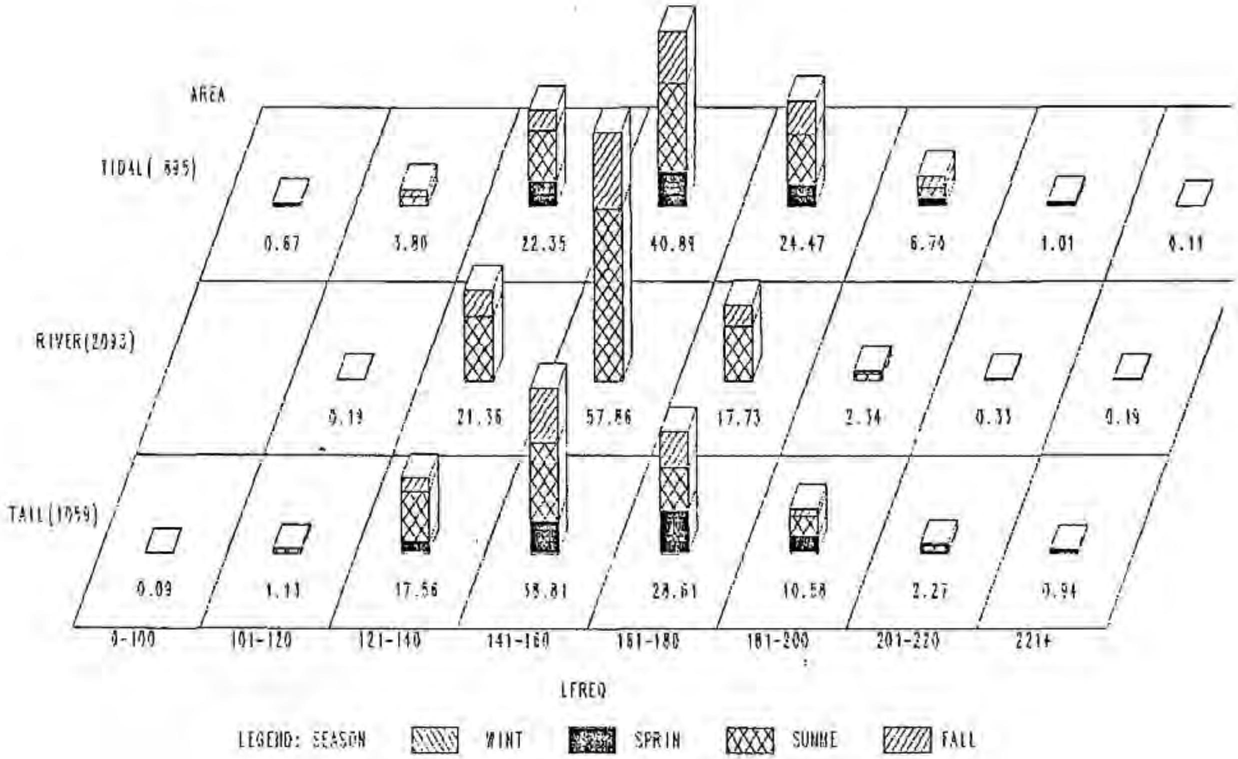


FIGURE 5.1-2.

Seasonal length frequency distribution (expressed as a percentage) of white perch taken by electrofishing below Conowingo Dam, 1983. Lee's Ferry and the Pool areas were combined (River) due to small sample size.

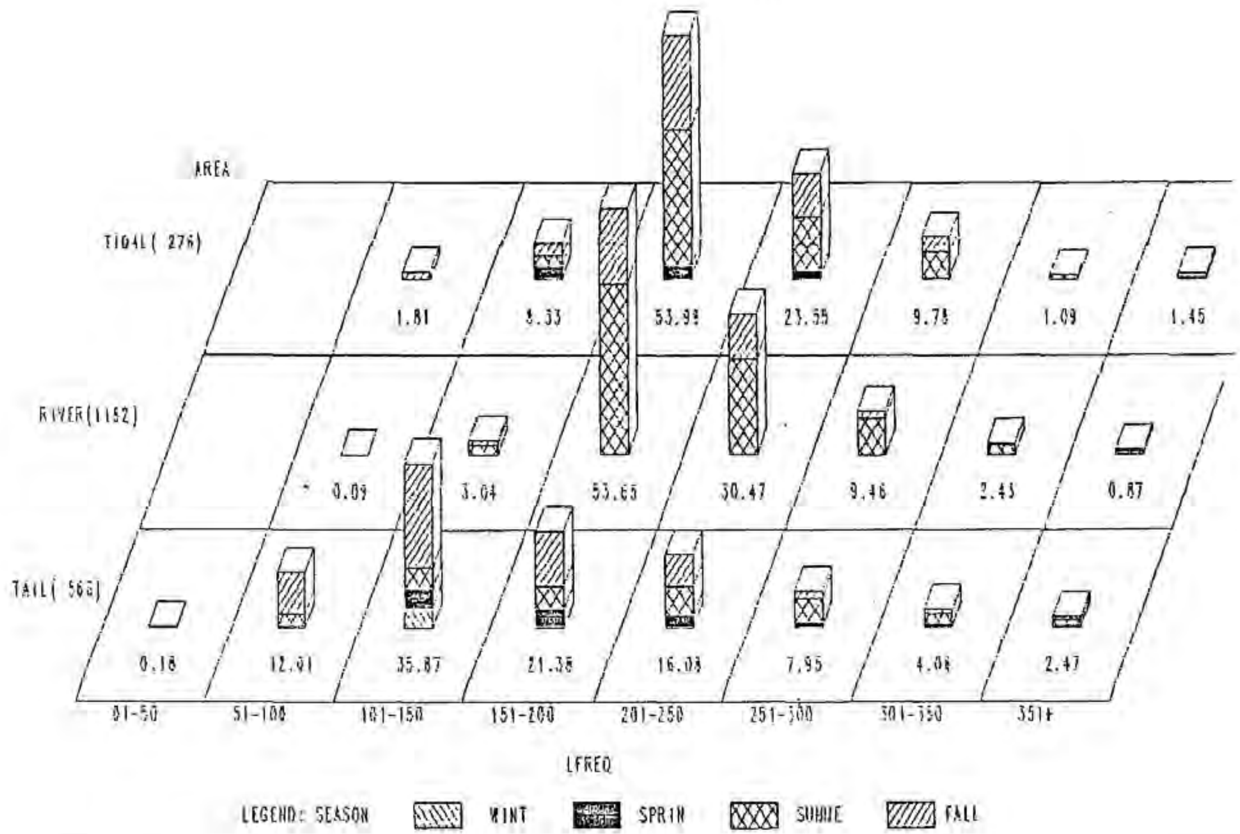


FIGURE 5.1-3.

Seasonal length frequency distribution (expressed as a percentage) of channel catfish taken by electrofishing below Conowingo Dam, 1983. Lee's Ferry and the Pool areas were combined (River) due to small sample size.

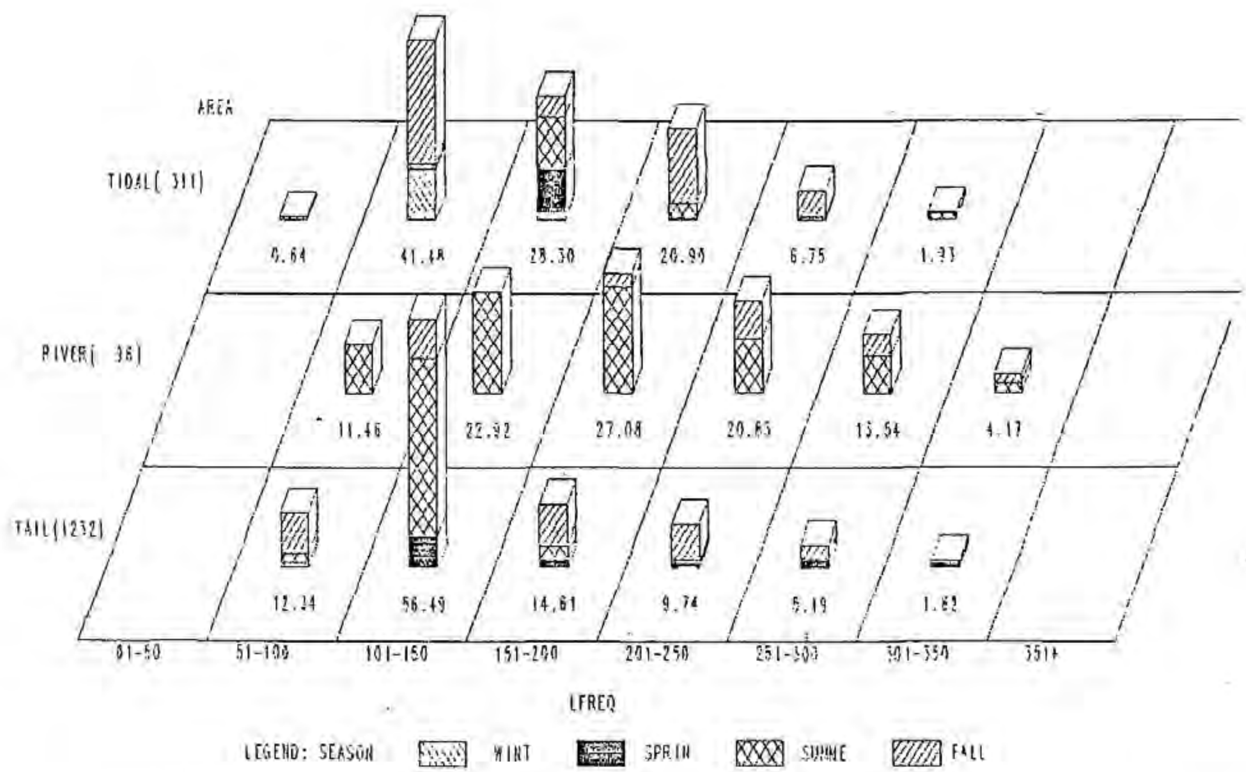


FIGURE 5.1-4.

Seasonal length frequency distribution (expressed as a percentage) of gizzard shad taken by electrofishing below Conowingo Dam, 1983. Lee's Ferry and the Pool areas were combined (River) due to small sample size.

5-27

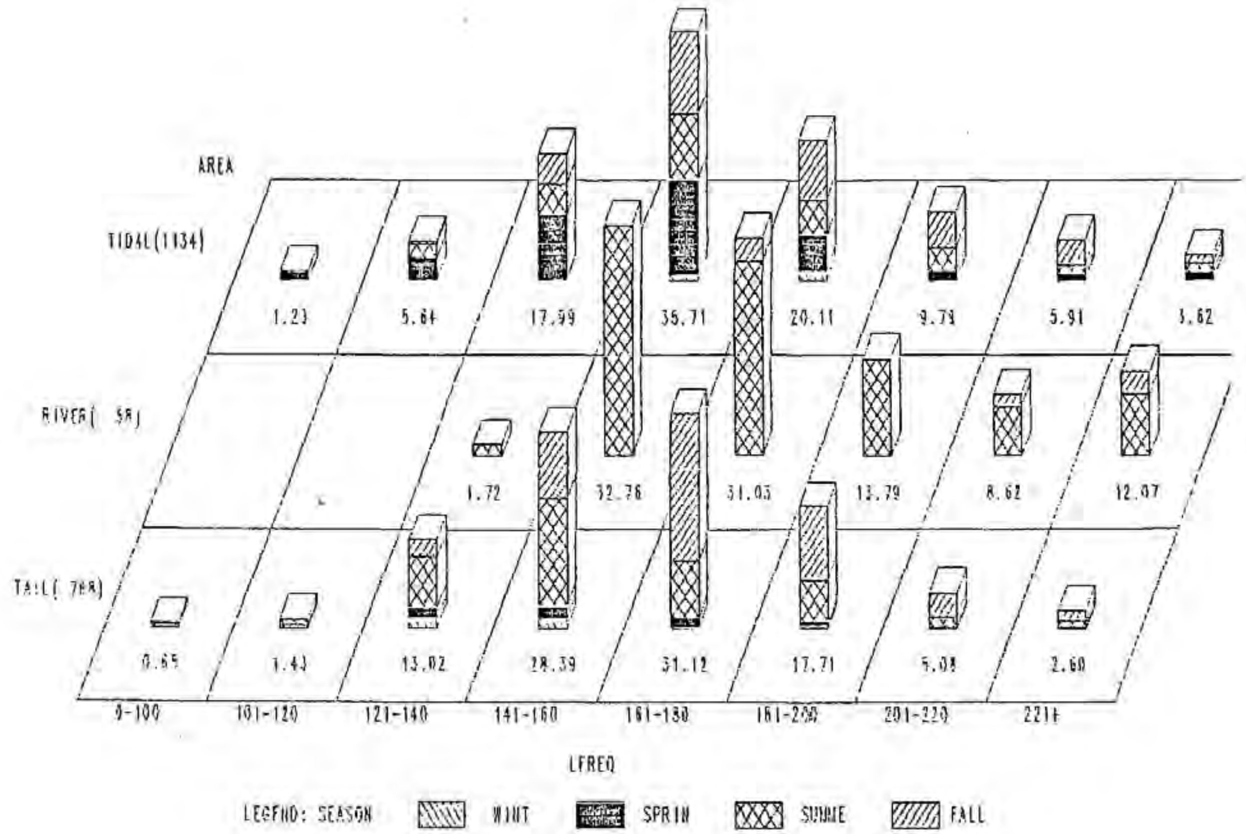


FIGURE 5.1-5.

Seasonal length frequency distribution (expressed as a percentage) of yellow perch taken by electrofishing below Conowingo Dam, 1983. Lee's Ferry and the Pool areas were combined (River) due to small sample size.

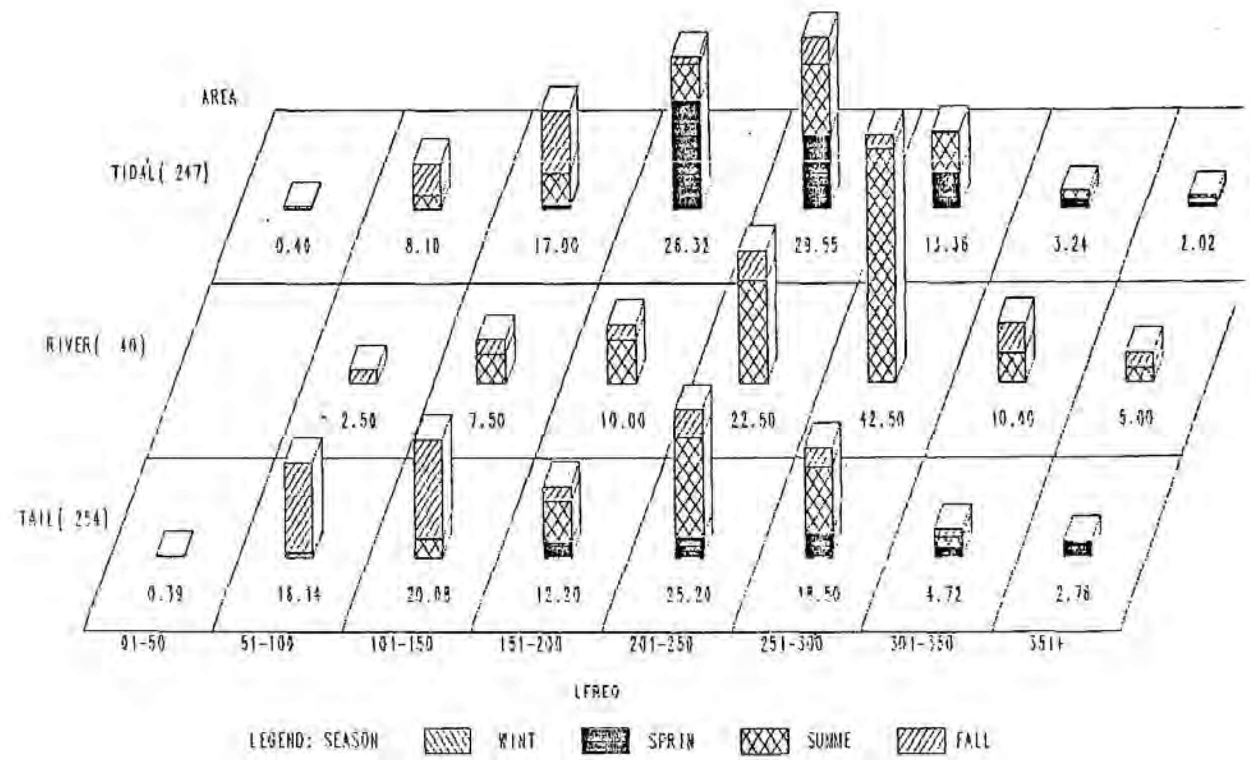


FIGURE 5.1-6.

Seasonal length frequency distribution (expressed as a percentage) of smallmouth bass taken by electrofishing below Conowingo Dam, 1983. Lee's Ferry and the Pool areas were combined (River) due to small sample size.

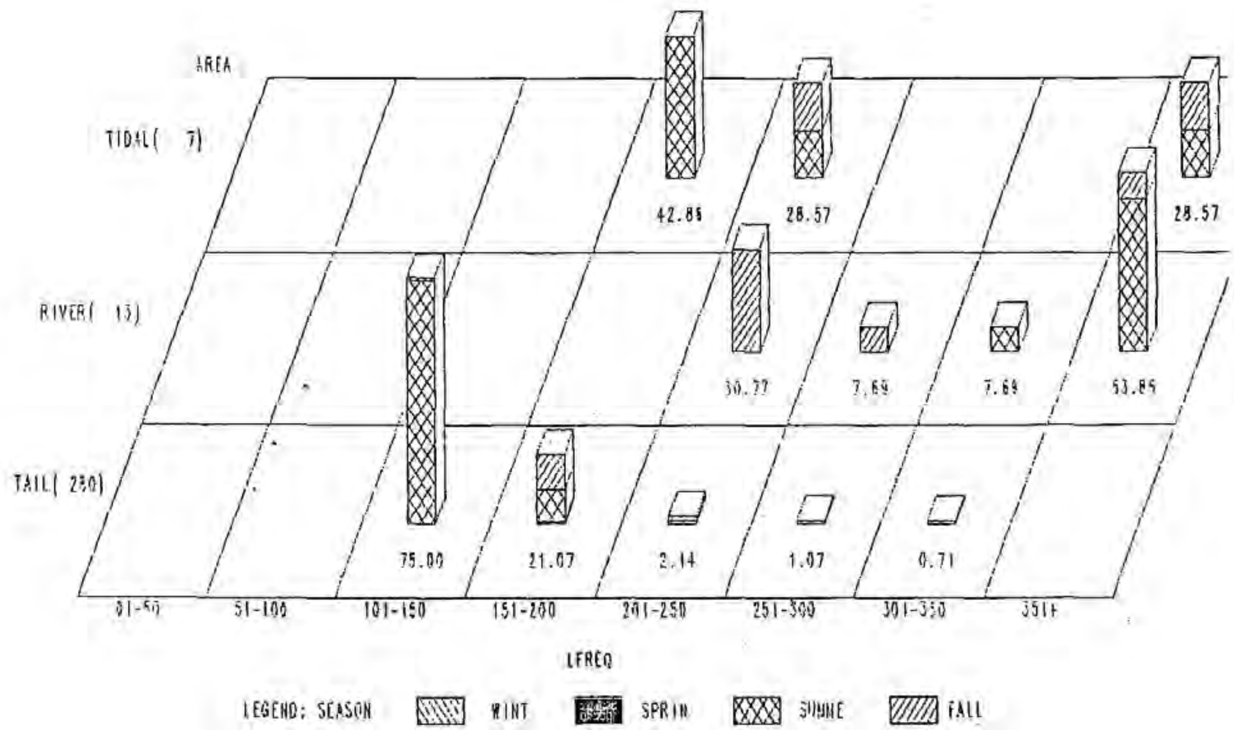


FIGURE 5.1-7.

Seasonal length frequency distribution (expressed as a percentage) of striped bass taken by electrofishing below Conowingo Dam, 1983. Lee's Ferry and the Pool areas were combined (River) due to small sample size.

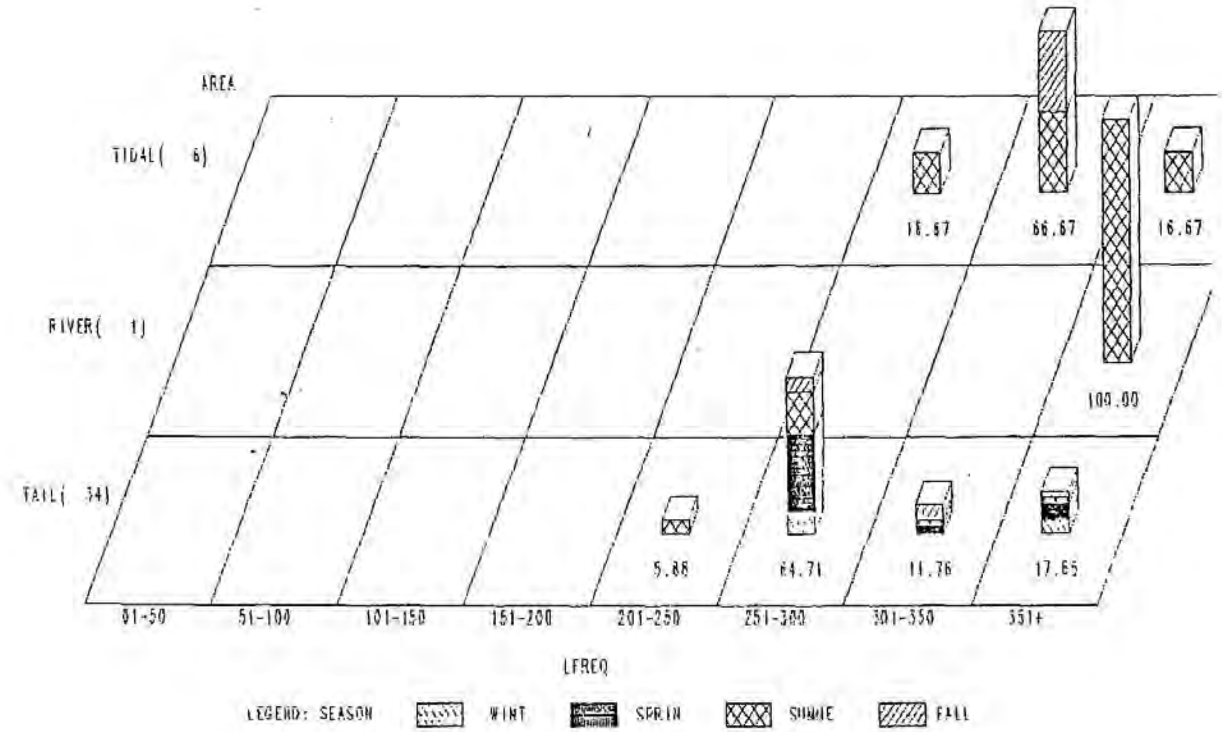


FIGURE 5.1-8.

Seasonal length frequency distribution (expressed as a percentage) of walleye taken by electrofishing below Conowingo Dam, 1983. Lee's Ferry and the Pool areas were combined (River) due to small sample size.

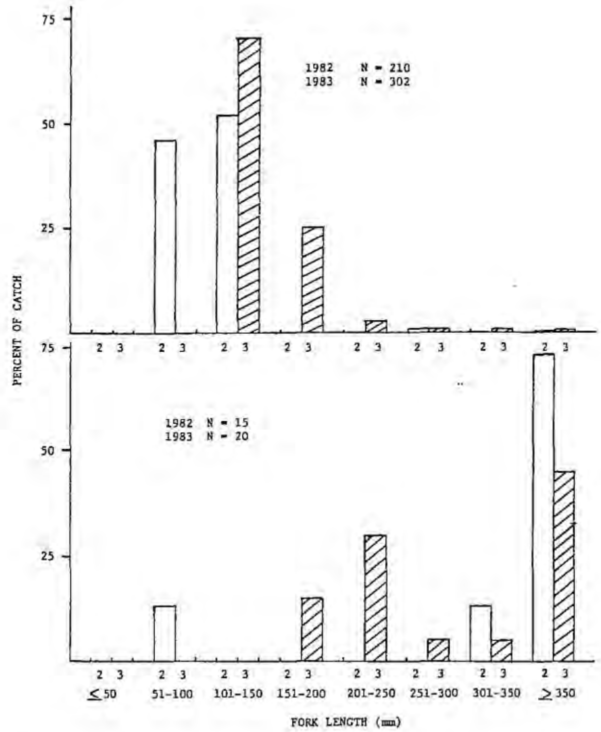


FIGURE 5.1-9.

Length frequencies of striped bass, expressed as a percentage of the total number caught, collected by electrofishing in the Conowingo Tailrace (upper) and Lee's Ferry. The Pool and Tidal Zone (lower) in 1982 (2) and 1983 (3).

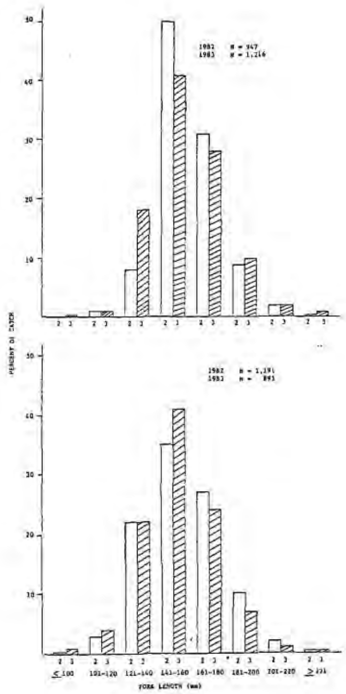


FIGURE 5.1-11.

Length frequencies of white perch, expressed as a percentage of the total number caught, collected by electrofishing in the Conowingo Tailrace (upper) and Tidal Zone (lower) in 1982 (2) and 1983 (3).

5-34

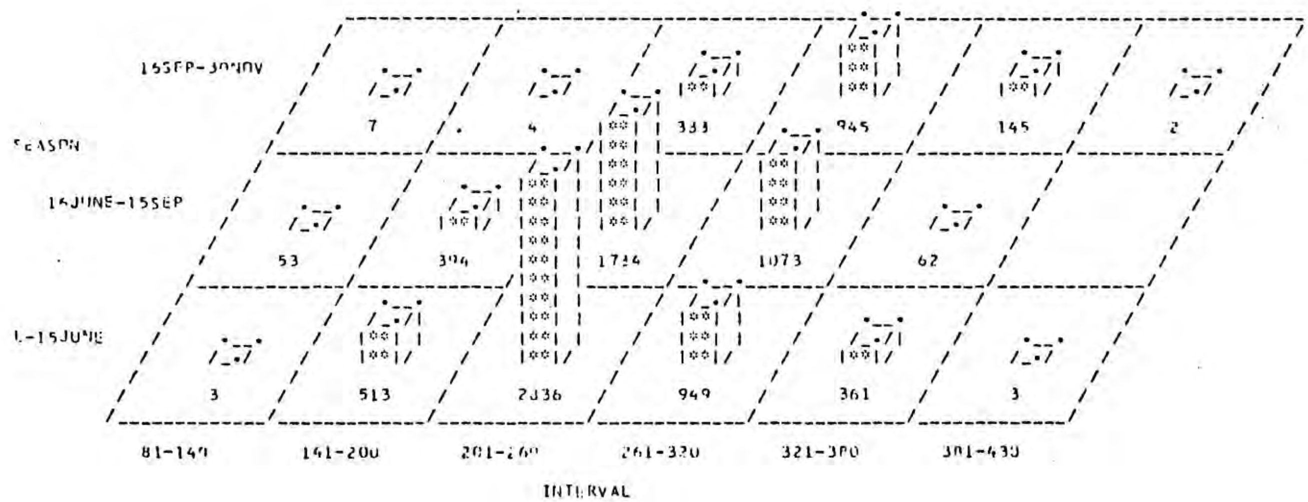


FIGURE 4.1-6.

Seasonal length frequency distribution of gizzard shad collected at the Conowingo Dam Fish Passage Facility in 1984.

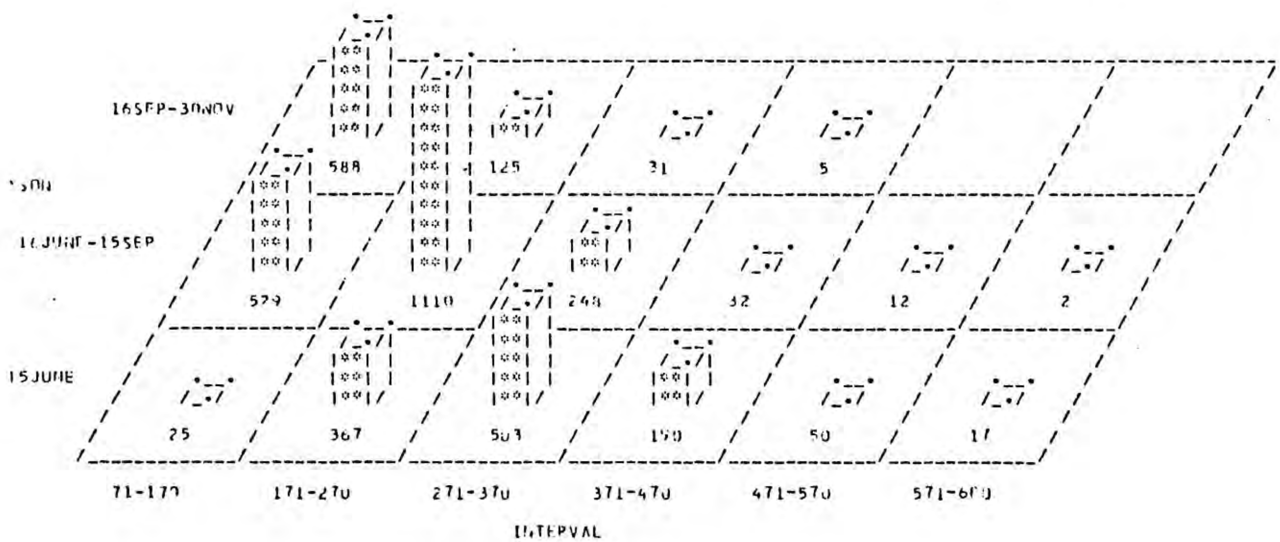


FIGURE 4.1-7.

Seasonal length frequency distribution of channel catfish collected at the Conowingo Dam Fish Passage Facility in 1984.

4-40

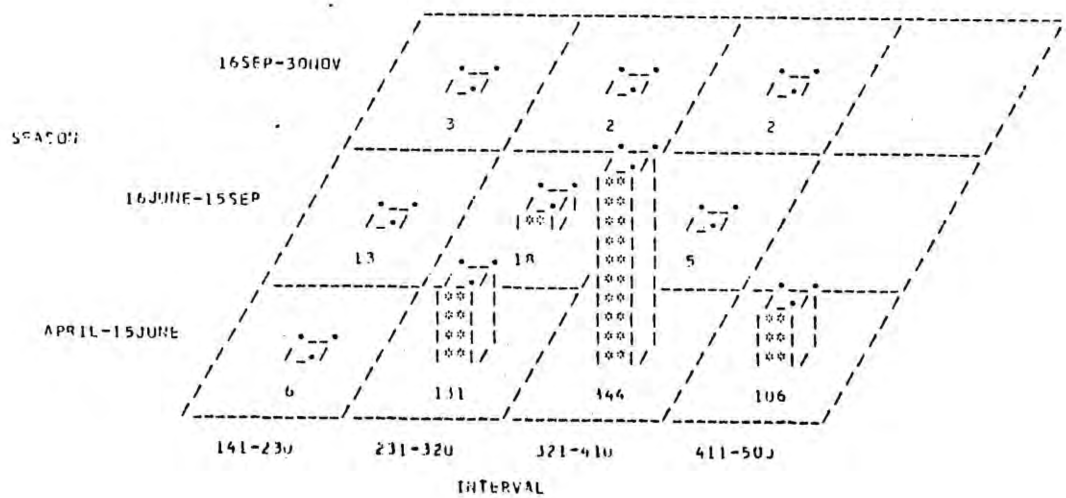


FIGURE 4.1-8.

Seasonal length frequency distribution of smallmouth bass collected at the Conowingo Dam Fish Passage Facility in 1984.

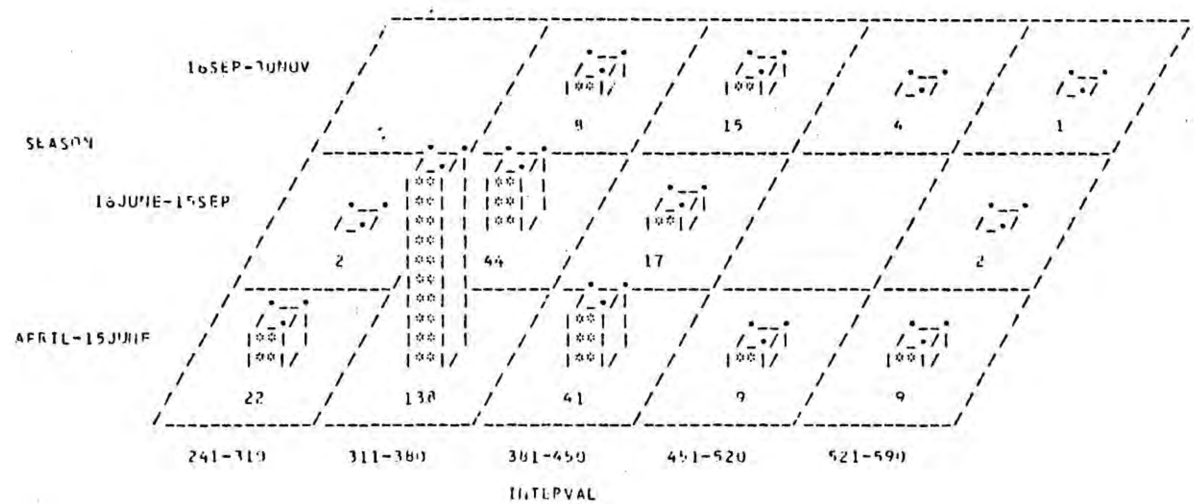


FIGURE 4.1-9.

Seasonal length frequency distribution of walleye collected at the Conowingo Dam Fish Passage Facility in 1984.

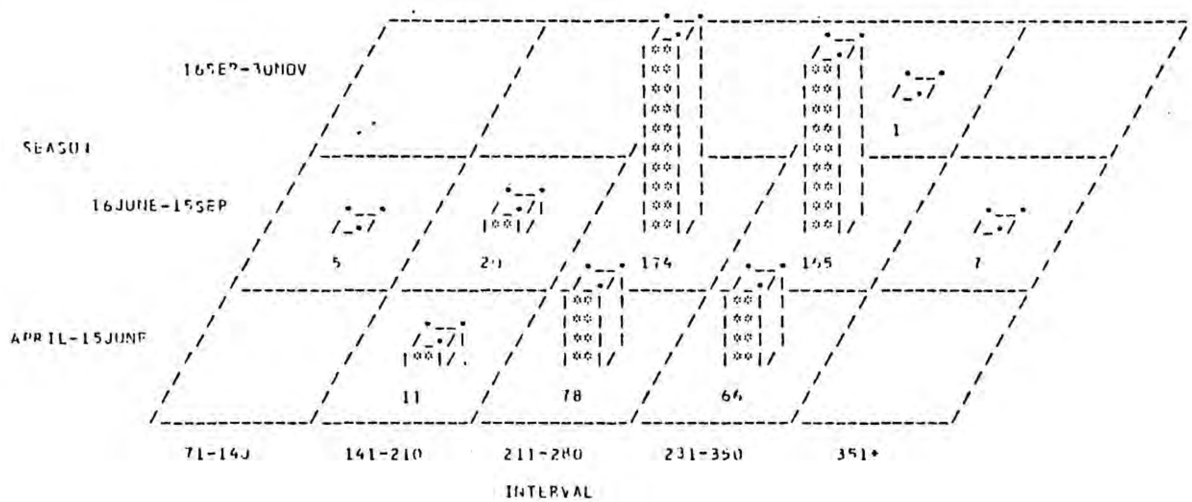


FIGURE 4.1-10.

Seasonal length frequency distribution of striped bass collected at the Conowingo Dam Fish Passage Facility in 1984.

4-43

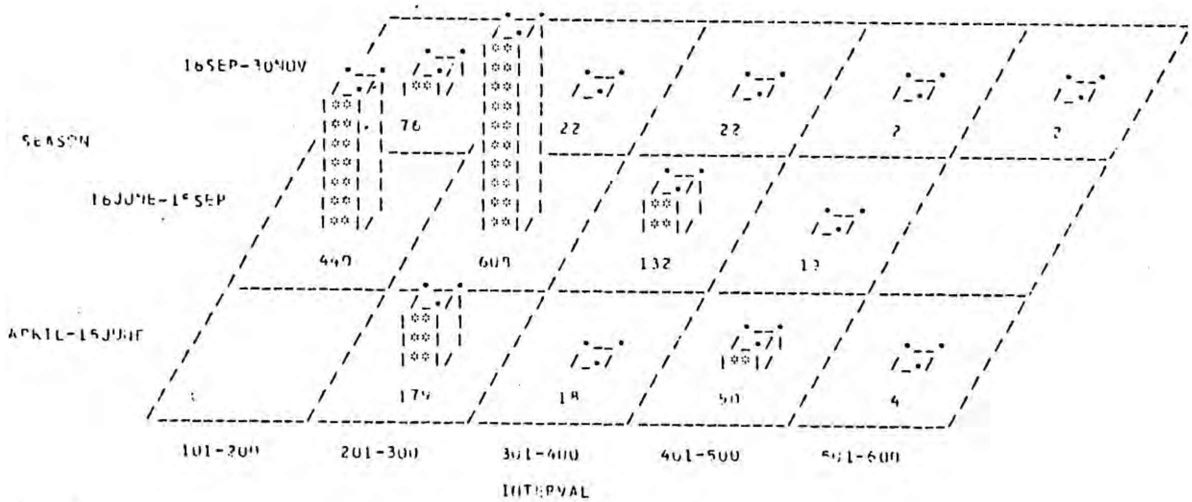


FIGURE 4.1-11.

Seasonal length frequency distribution of striped bass x white bass hybrid collected at the Conowingo Dam Fish Passage Facility in 1984.

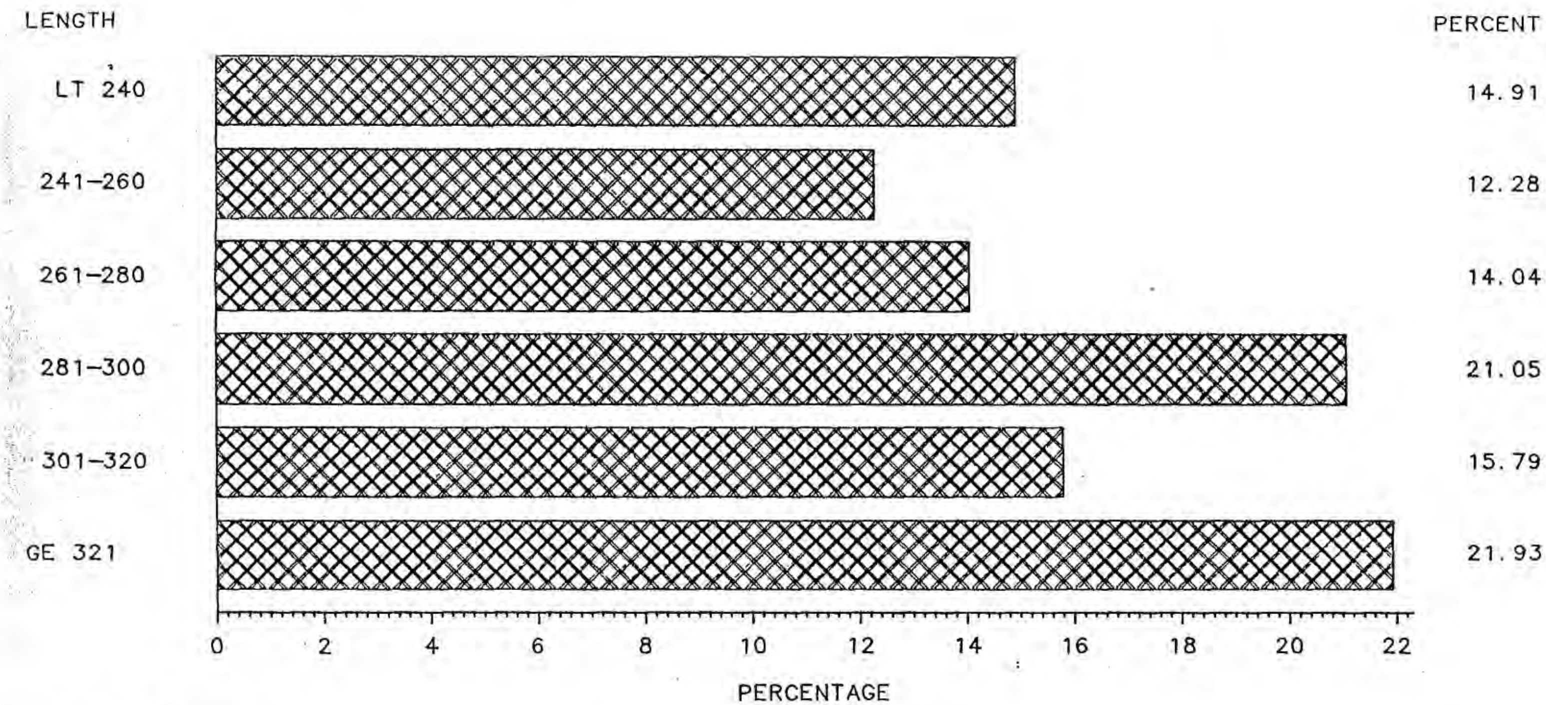


FIGURE 5.2-3.

Percent composition of length groups of gizzard shad collected by experimental gill net in the lower Susquehanna River, July through October, 1984. (N = 289).

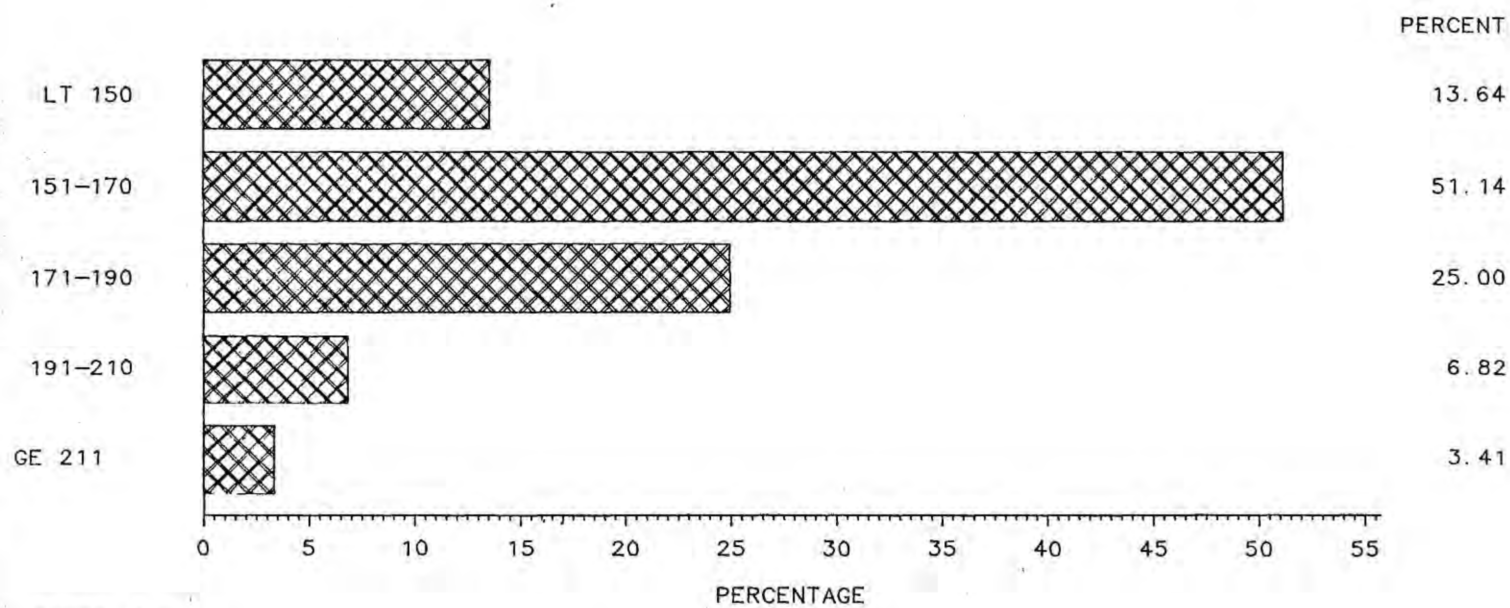


FIGURE 5.2-4.

Percent composition of length groups of white perch collected by experimental gill net in the lower Susquehanna River, 1984. (N = 249).

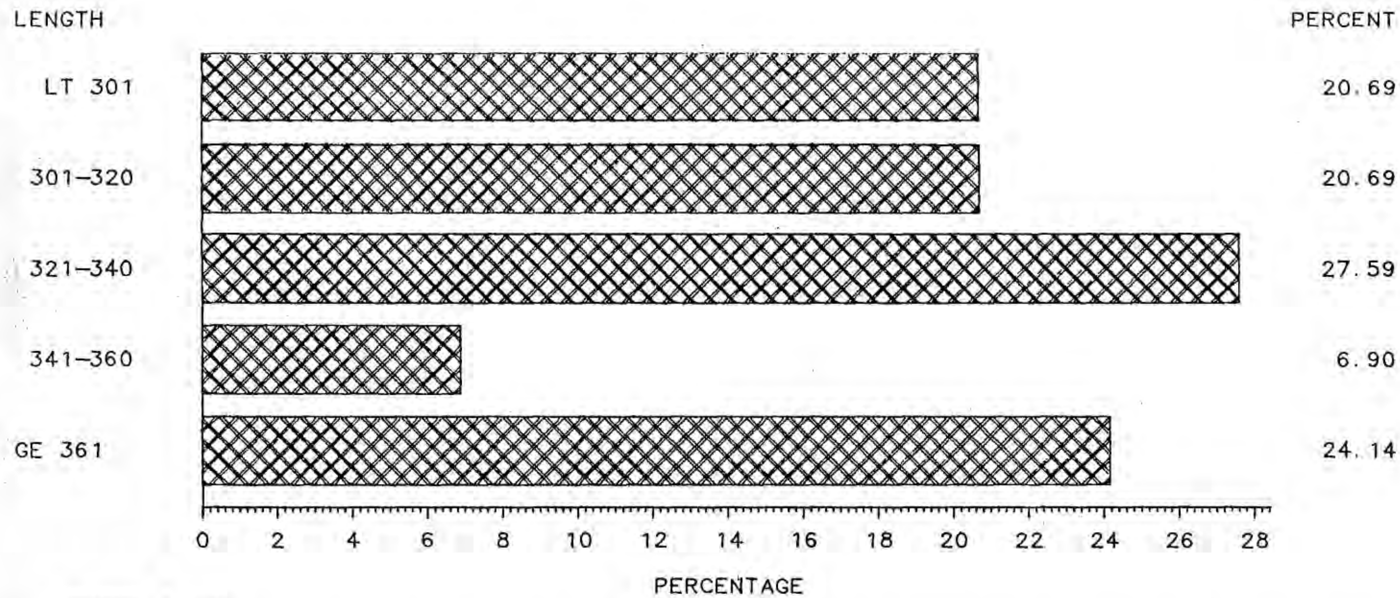
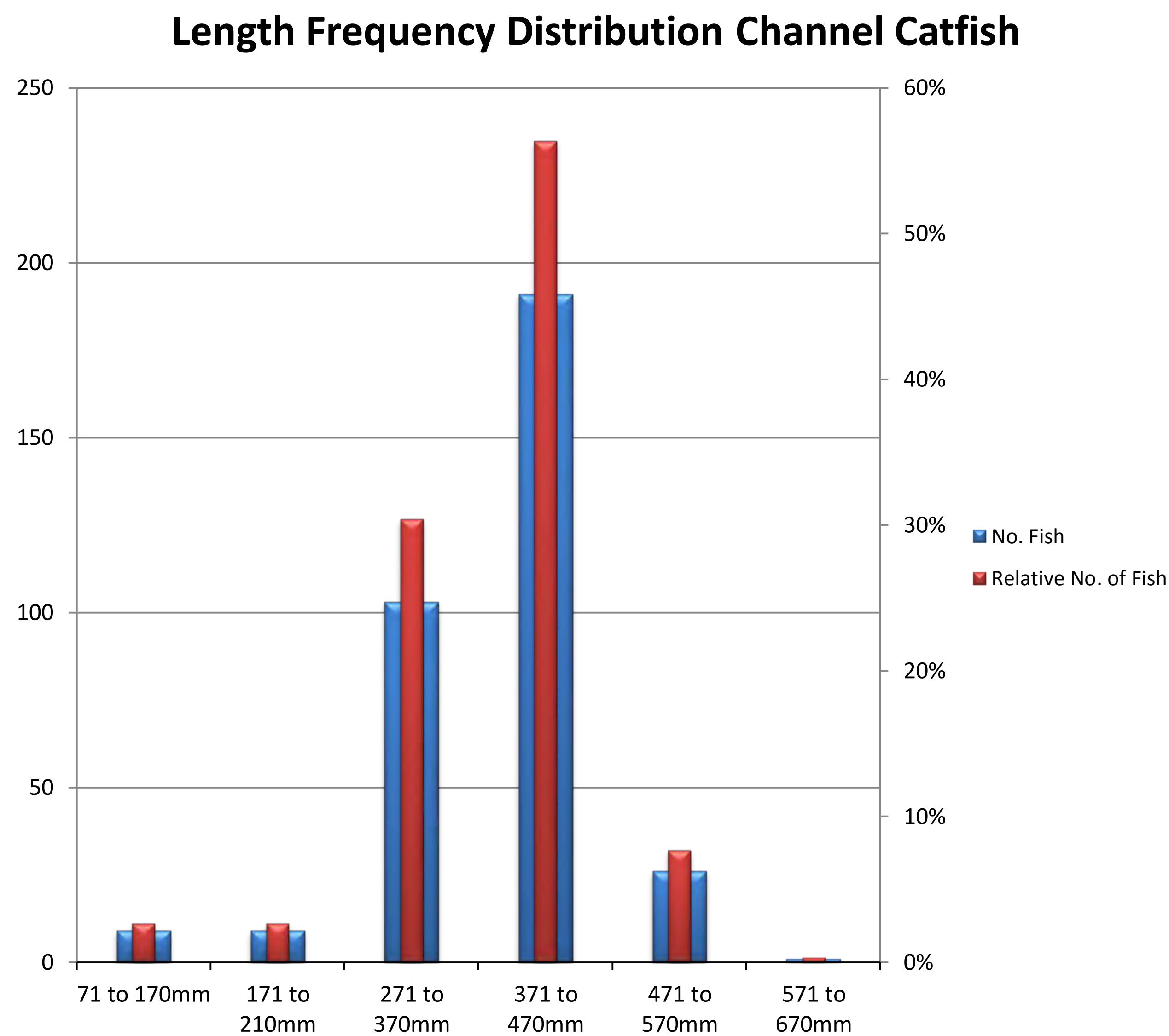


FIGURE 5.2-5.

Percent composition of length groups of striped bass collected by experimental gill net in the lower Susquehanna River, July through October, 1984. (N = 29).

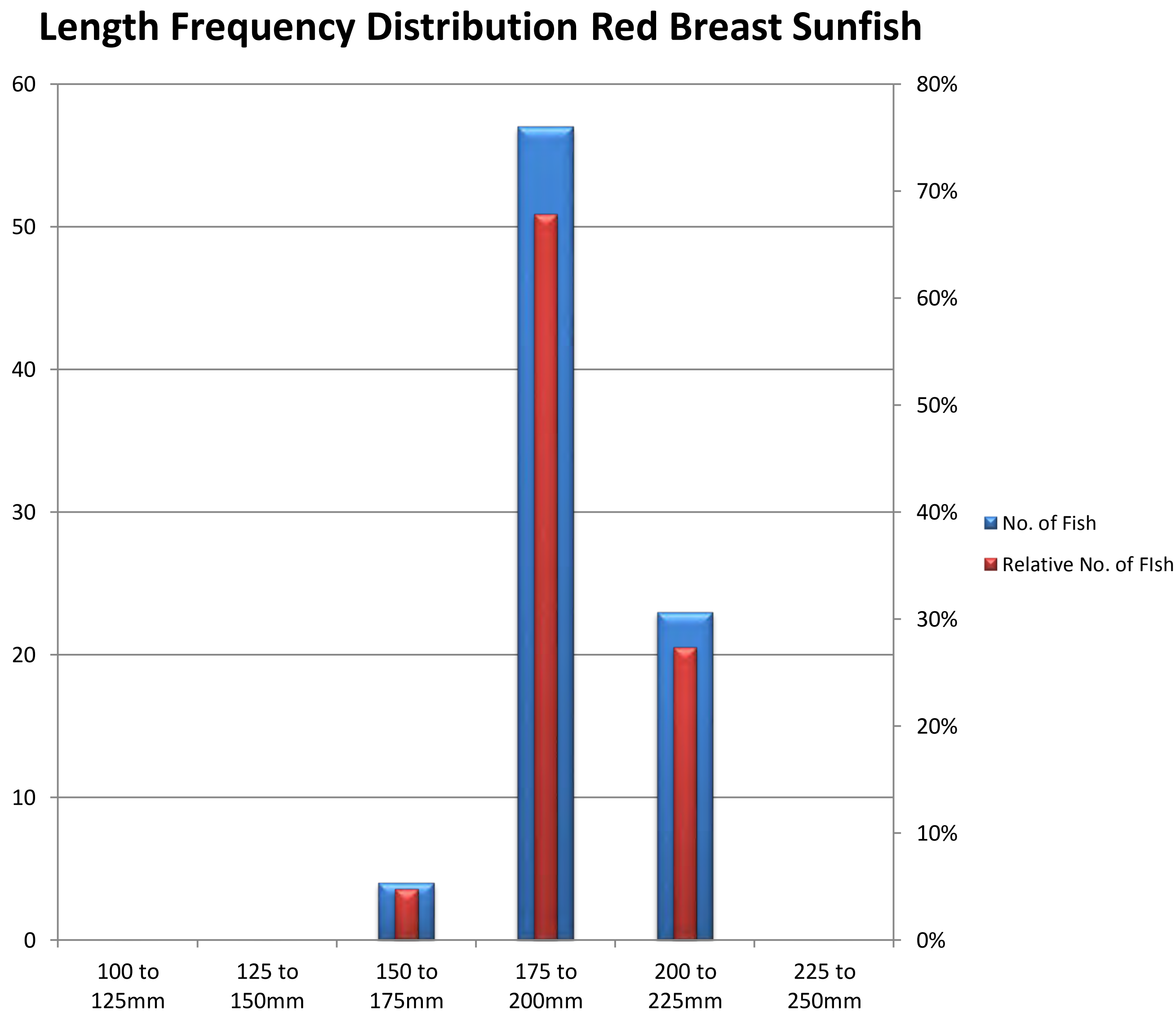
F-30. CHANNEL CATFISH WEST FISH LIFT LENGTH FREQUENCY 2010

Length Class	No. Fish	Relative No. of Fish
71 to 170mm	9	3%
171 to 210mm	9	3%
271 to 370mm	103	30%
371 to 470mm	191	56%
471 to 570mm	26	8%
571 to 670mm	1	0%



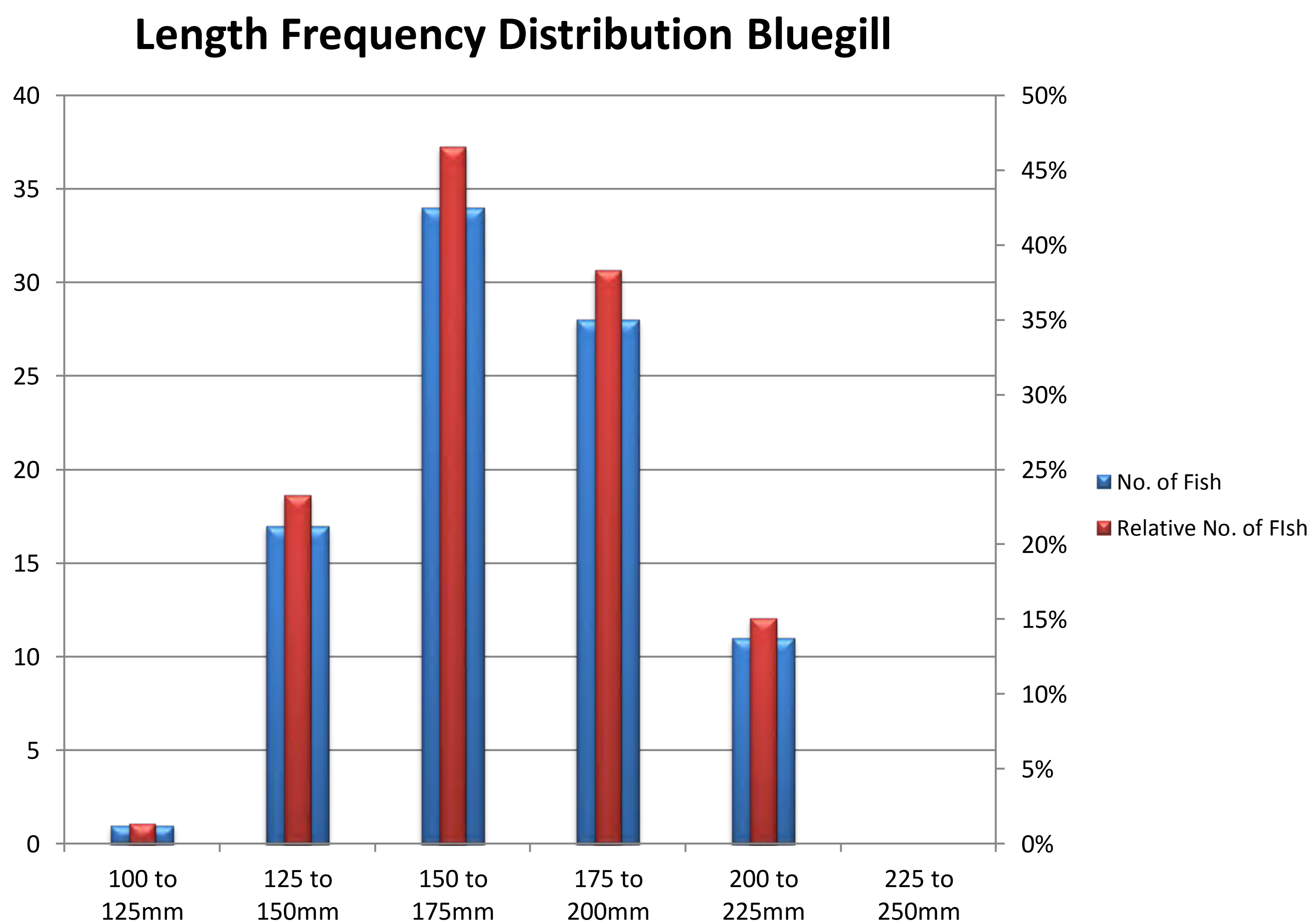
F-31. RED BREAST SUNFISH WEST FISH LIFT LENGTH FREQUENCY 2010

Length Class	No. Fish	Relative No. of Fish
100 to 125mm	0	0%
125 to 150mm	0	0%
150 to 175mm	4	5%
175 to 200mm	57	68%
200 to 225mm	23	27%
225 to 250mm	0	0%



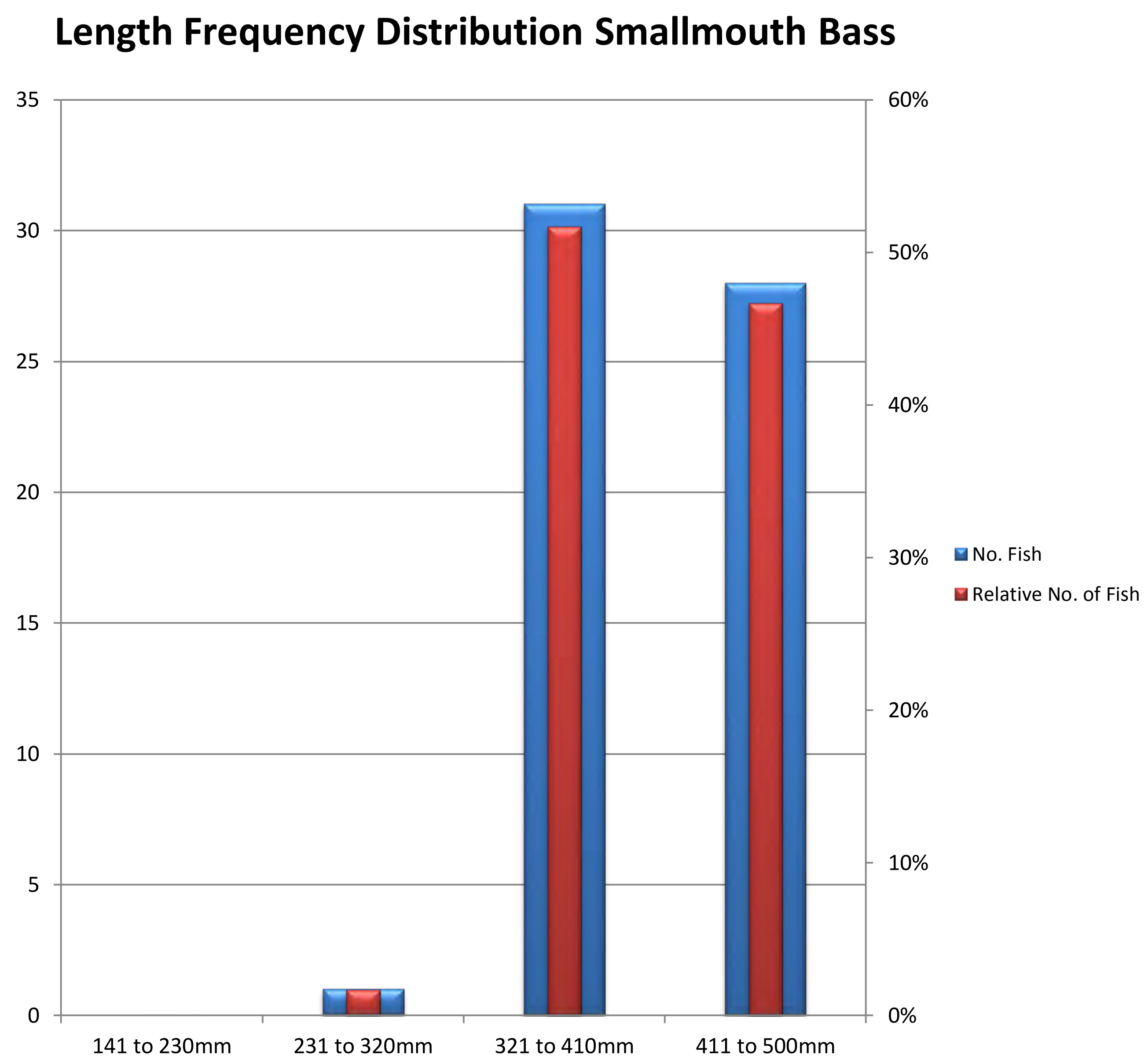
F-32. BLUEGILL WEST FISH LIFT LENGTH FREQUENCY 2010

Length Class	No. Fish	Relative No. of Fish
100 to 125mm	1	1%
125 to 150mm	17	23%
150 to 175mm	34	47%
175 to 200mm	28	38%
200 to 225mm	11	15%
225 to 250mm	0	0%



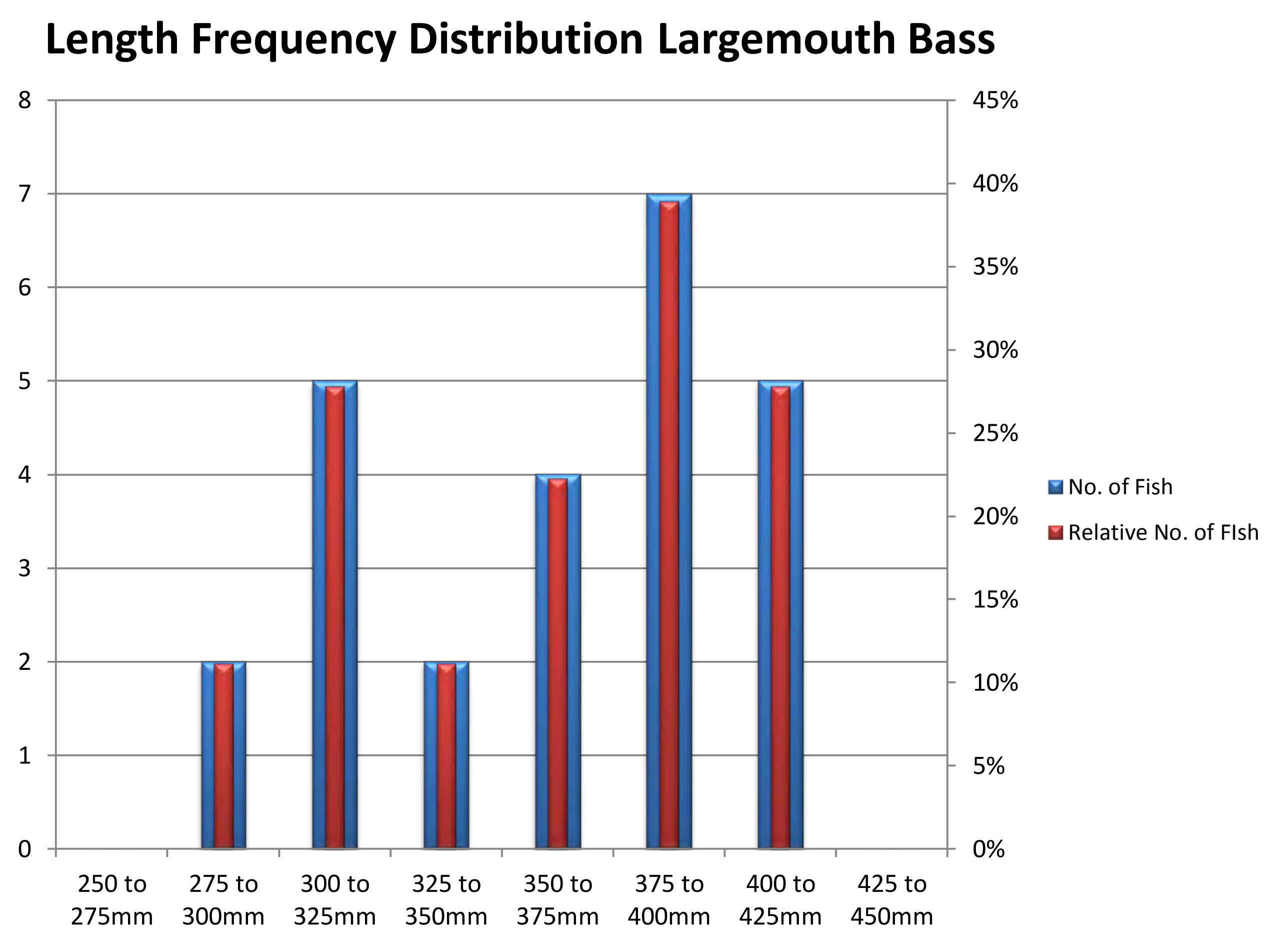
F-33. SMALLMOUTH BASS WEST FISH LIFT LENGTH FREQUENCY 2010

Length Class	No. Fish	Relative No. of Fish
141 to 230mm	0	0%
231 to 320mm	1	2%
321 to 410mm	31	52%
411 to 500mm	28	47%



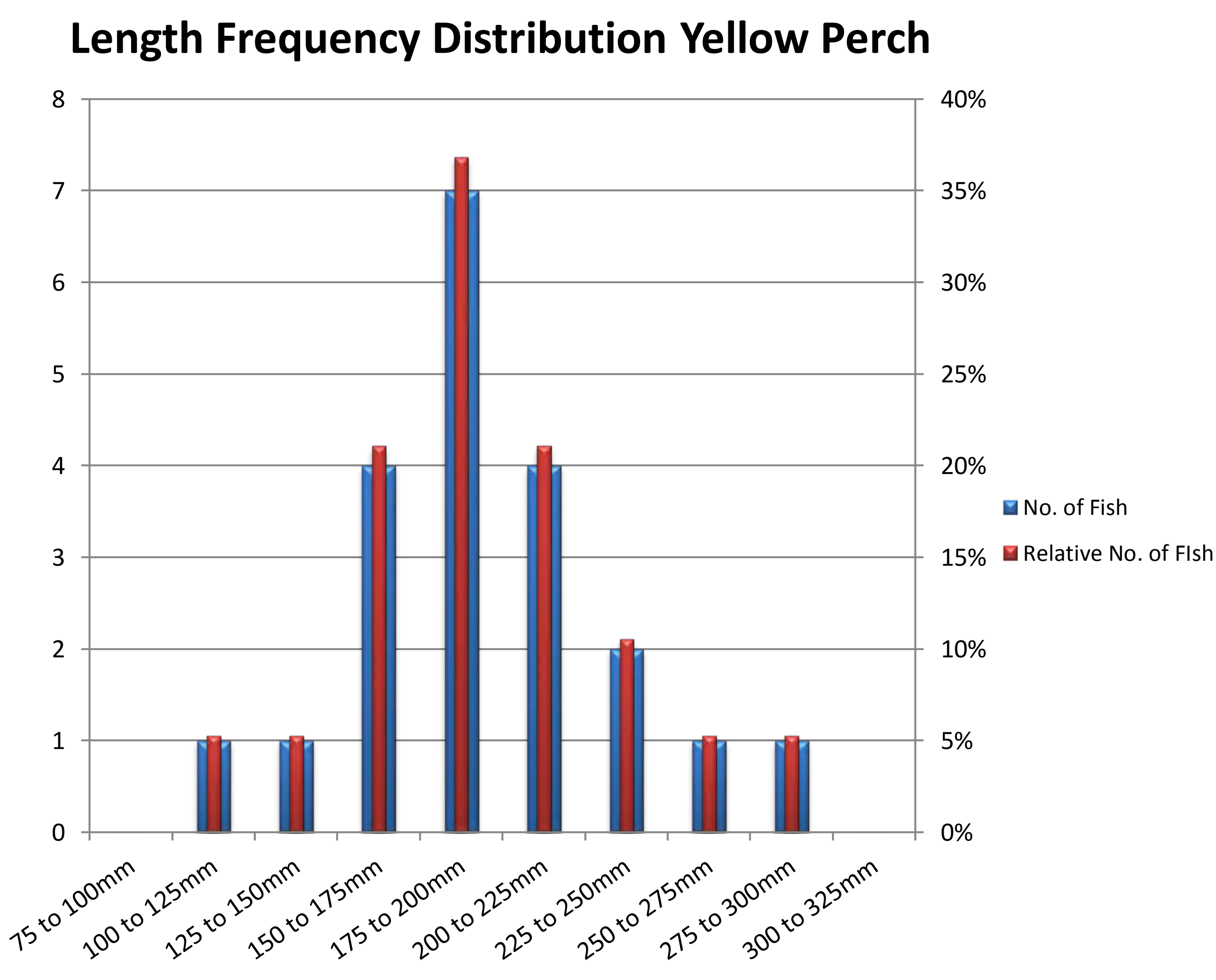
F-34. LARGEMOUTH BASS WEST FISH LIFT LENGTH FREQUENCY 2010

Length Class	No. Fish	Relative No. of Fish
250 to 275mm	0	0%
275 to 300mm	2	11%
300 to 325mm	5	28%
325 to 350mm	2	11%
350 to 375mm	4	22%
375 to 400mm	7	39%
400 to 425mm	5	28%
425 to 450mm	0	0%



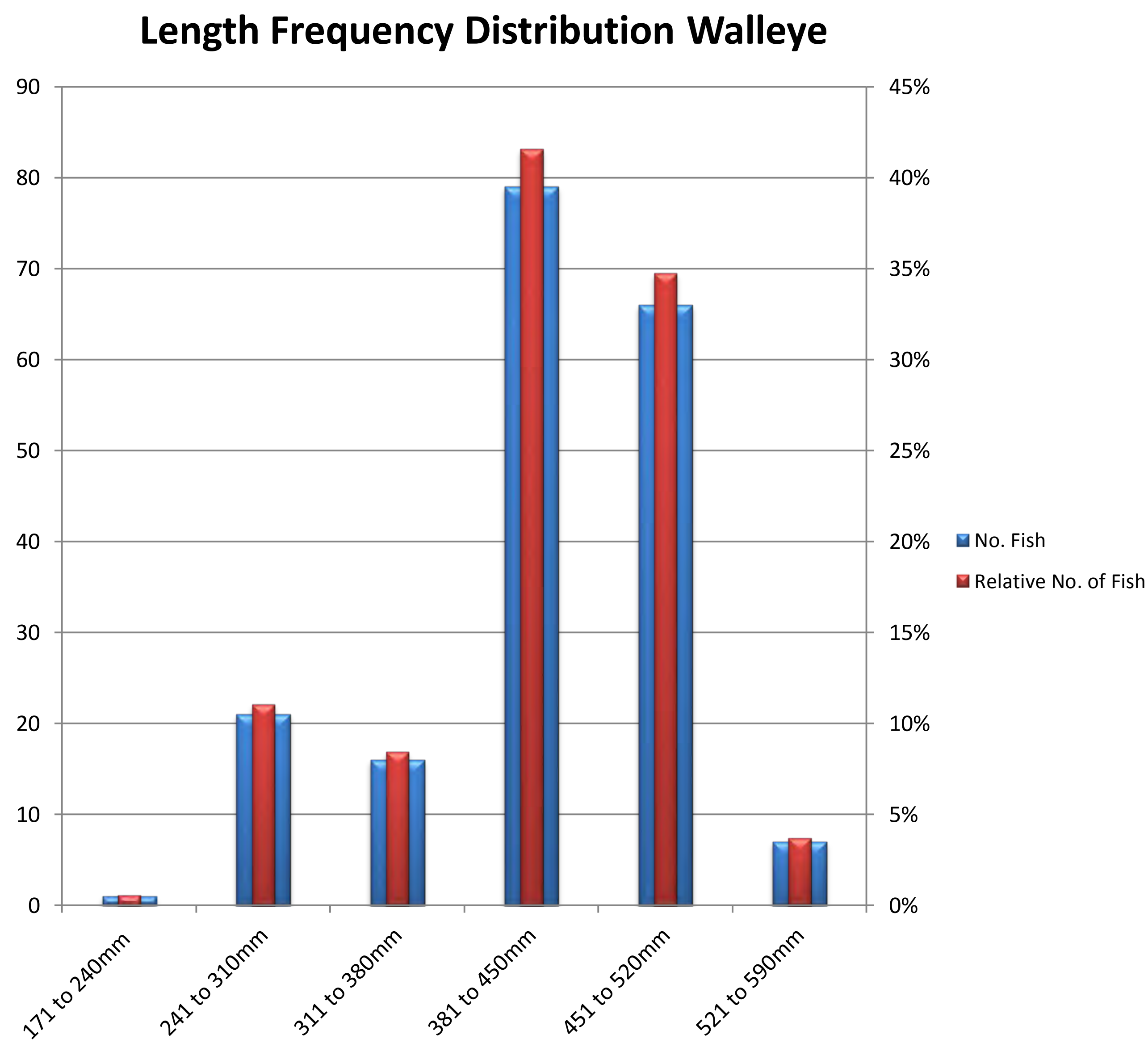
F-35. YELLOW PERCH WEST FISH LIFT LENGTH FREQUENCY 2010

Length Class	No. Fish	Relative No. of Fish
75 to 100mm	0	0%
100 to 125mm	1	5%
125 to 150mm	1	5%
150 to 175mm	4	21%
175 to 200mm	7	37%
200 to 225mm	4	21%
225 to 250mm	2	11%
250 to 275mm	1	5%
275 to 300mm	1	5%
300 to 325mm	0	0%

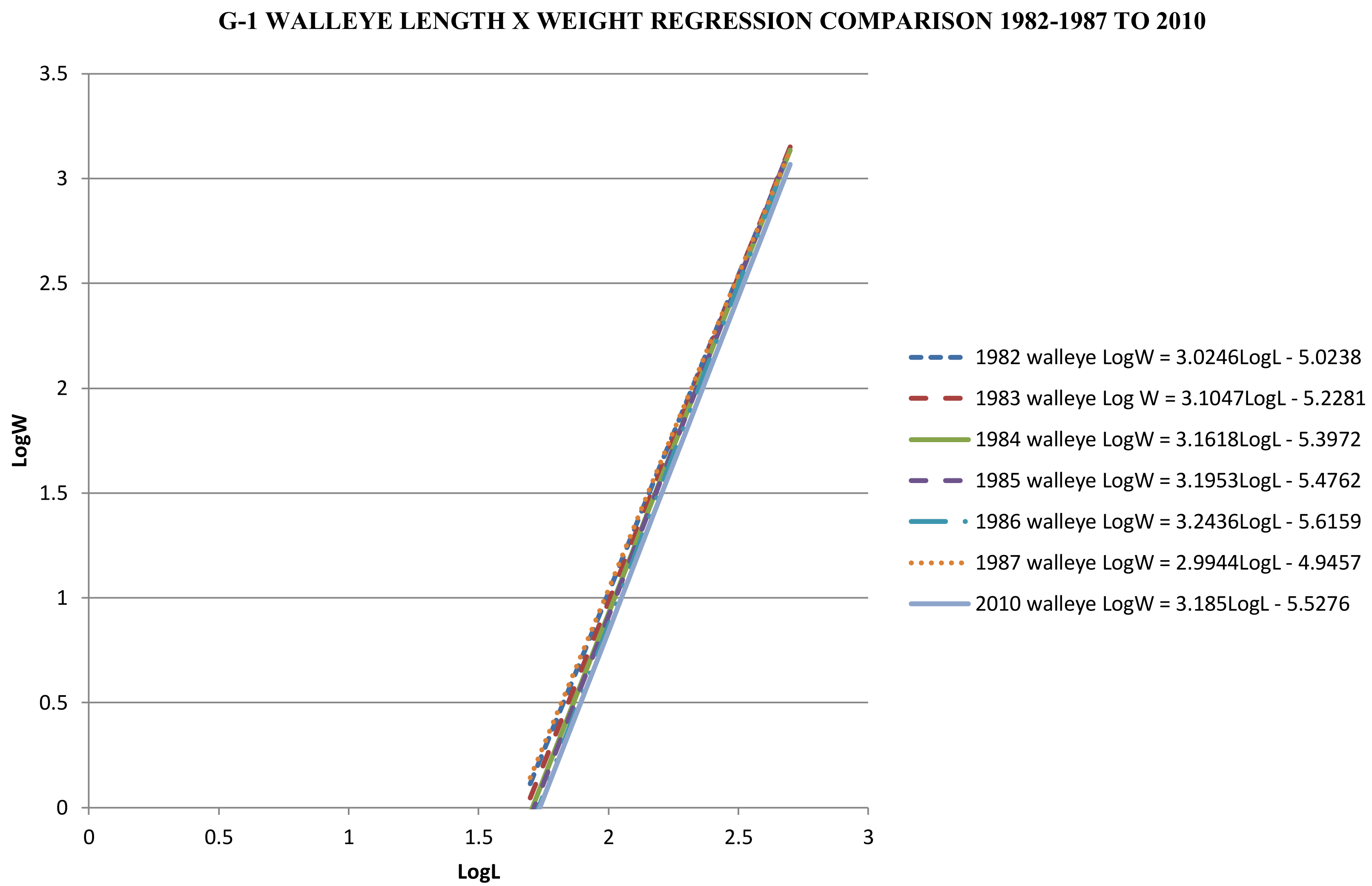


F-36. WALLEYE WEST FISH LIFT LENGTH FREQUENCY 2010

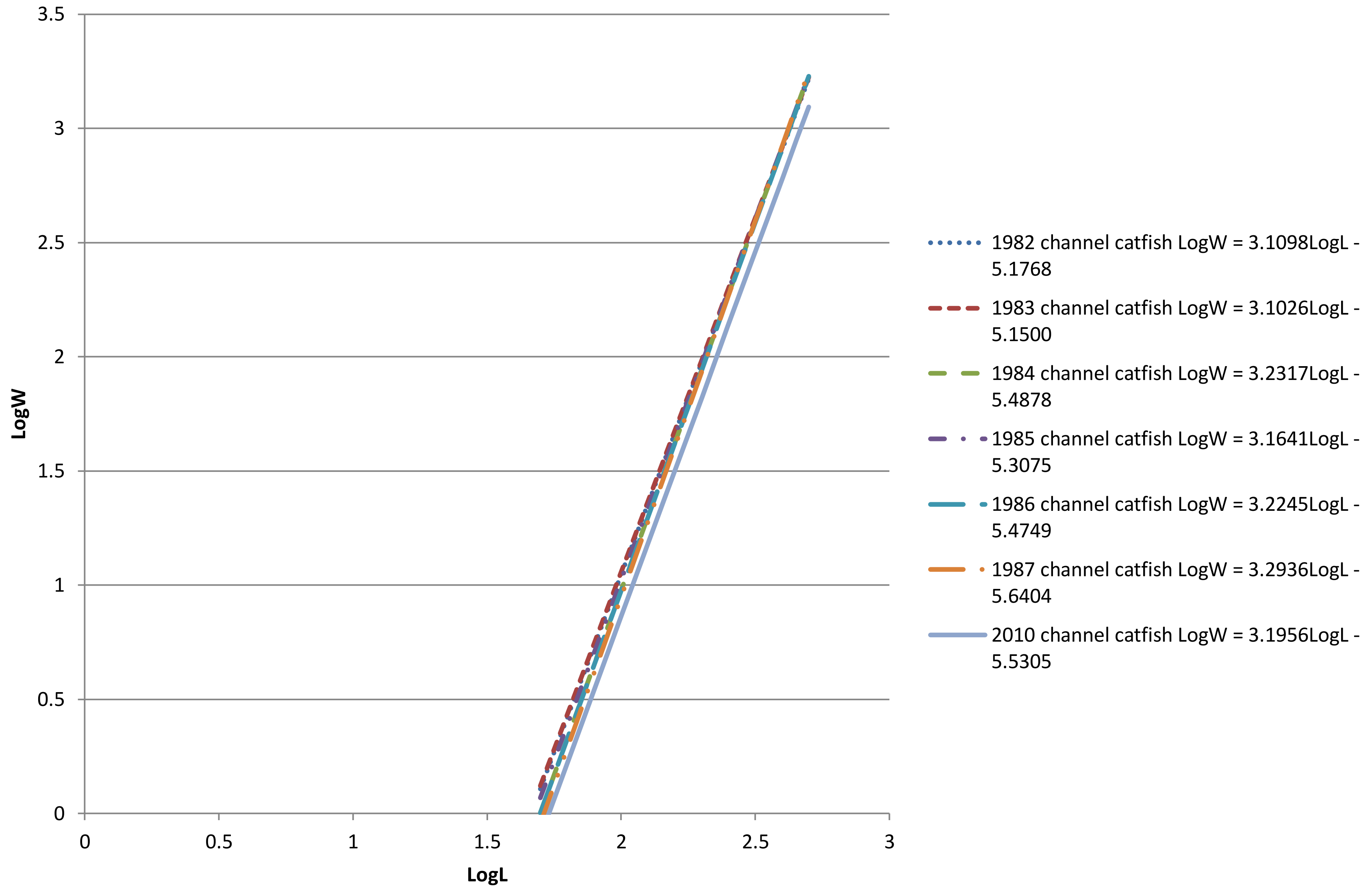
Length Class	No. Fish	Relative No. of Fish
171 to 240mm	1	1%
241 to 310mm	21	11%
311 to 380mm	16	8%
381 to 450mm	79	42%
451 to 520mm	66	35%
521 to 590mm	7	4%



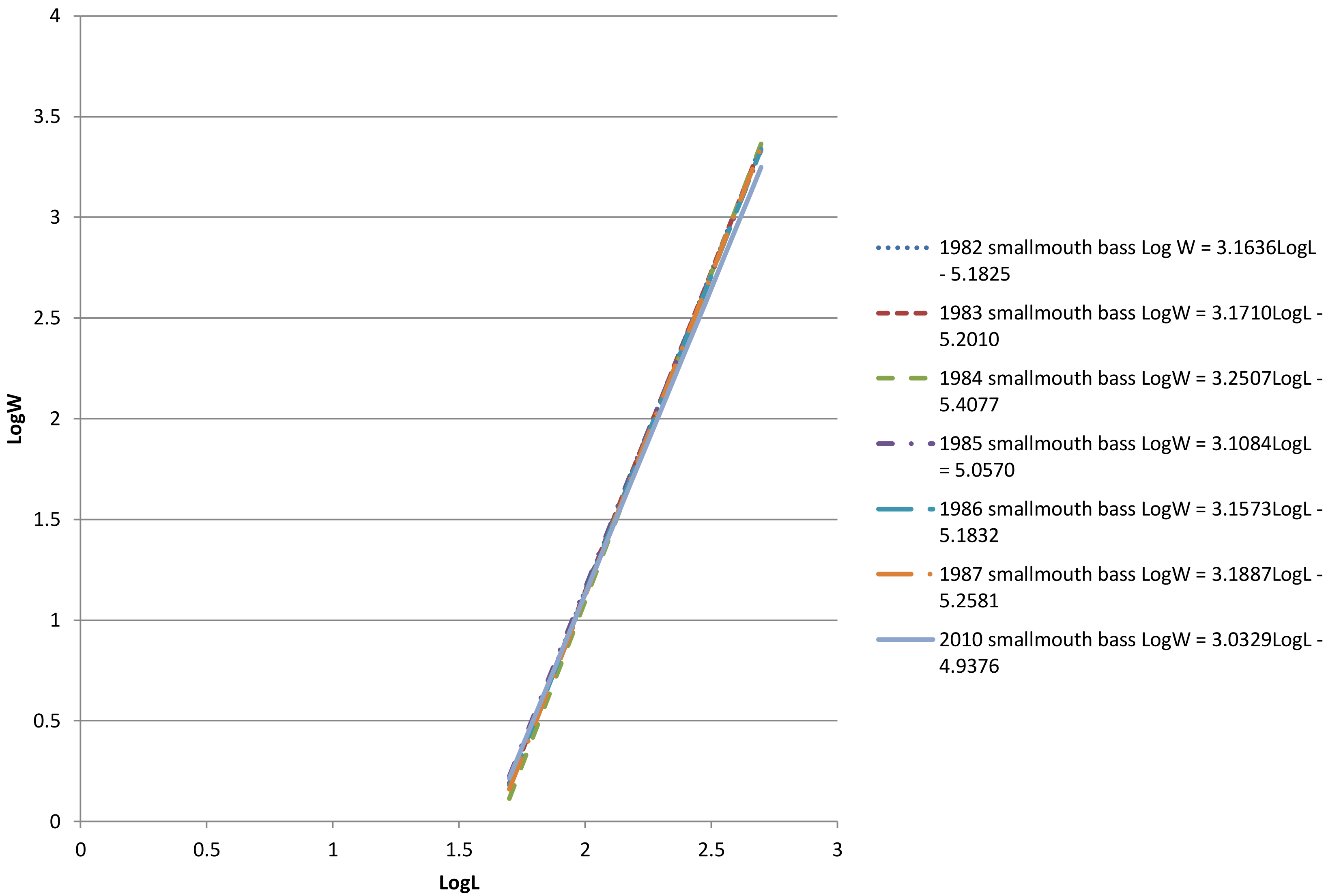
APPENDIX G-LENGTH AND WEIGHT RELATIONSHIPS


G-1 WALLEYE LENGTH X WEIGHT REGRESSION COMPARISON 1982-1987 TO 2010
LogW
LogL
3.5
3
2.5
2
1.5
1
0.5
0
0
0.5
1
1.5
2
2.5
3
1982 walleye LogW = 3.0246LogL - 5.0238
1983 walleye Log W = 3.1047LogL - 5.2281
1984 walleye LogW = 3.1618LogL - 5.3972
1985 walleye LogW = 3.1953LogL - 5.4762
1986 walleye LogW = 3.2436LogL - 5.6159
1987 walleye LogW = 2.9944LogL - 4.9457
2010 walleye LogW = 3.185LogL - 5.5276

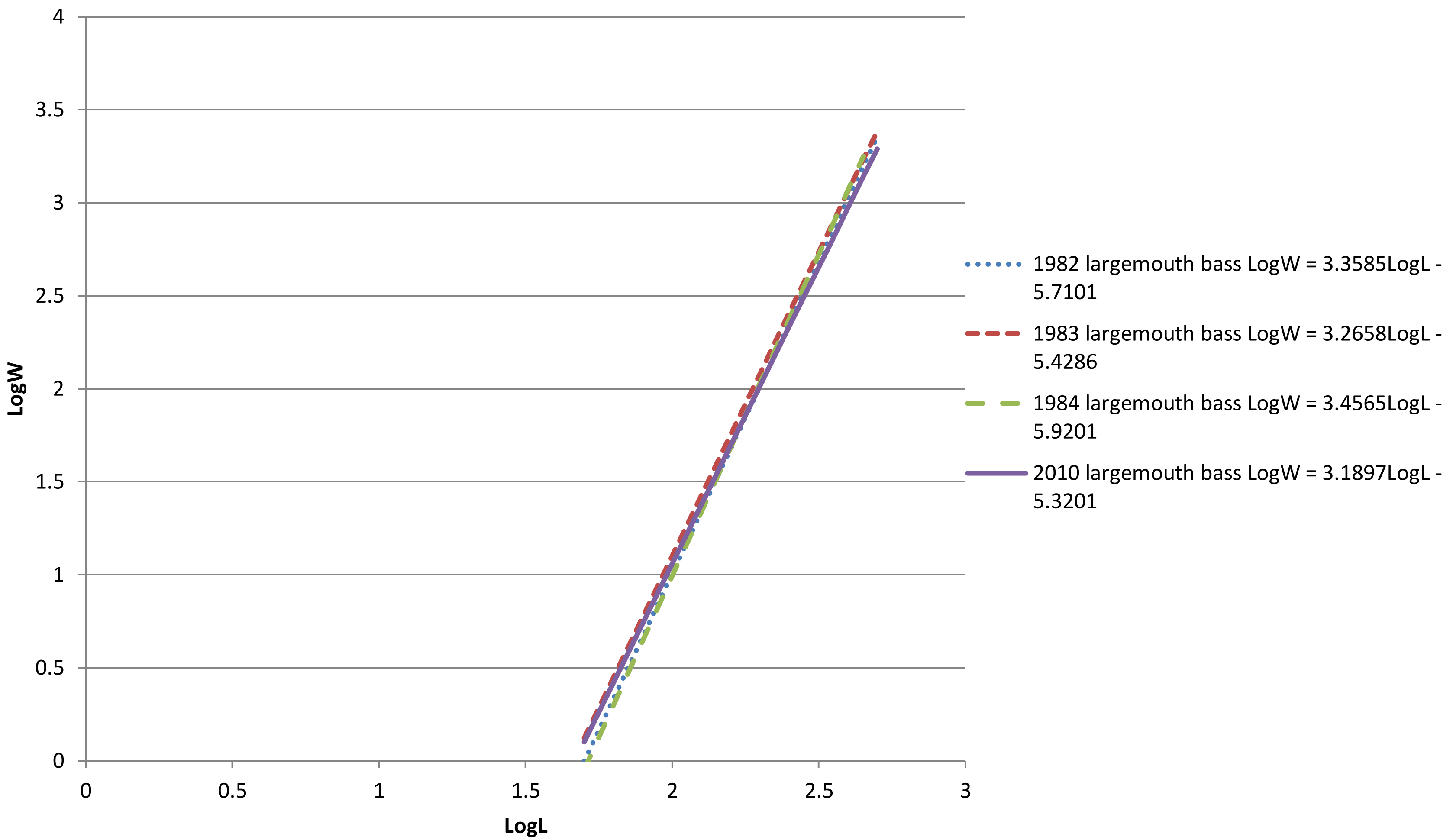
G-2. CHANNEL CATFISH LENGTH X WEIGHT REGRESSION COMPARISON 1982-1987 TO 2010



G-3. SMALLMOUTH BASS LENGTH X WEIGHT REGRESSION COMPARISON 1982-1987 TO 2010



G-4. LARGEMOUTH BASS LENGTH X WEIGHT REGRESSION COMPARISON 1982-1987 TO 2010



G-5. YELLOW PERCH LENGTH X WEIGHT REGRESSION COMPARISON 1982-1987 TO 2010