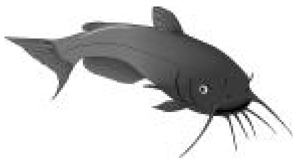
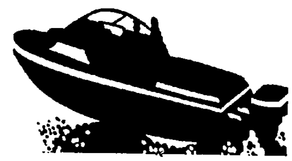
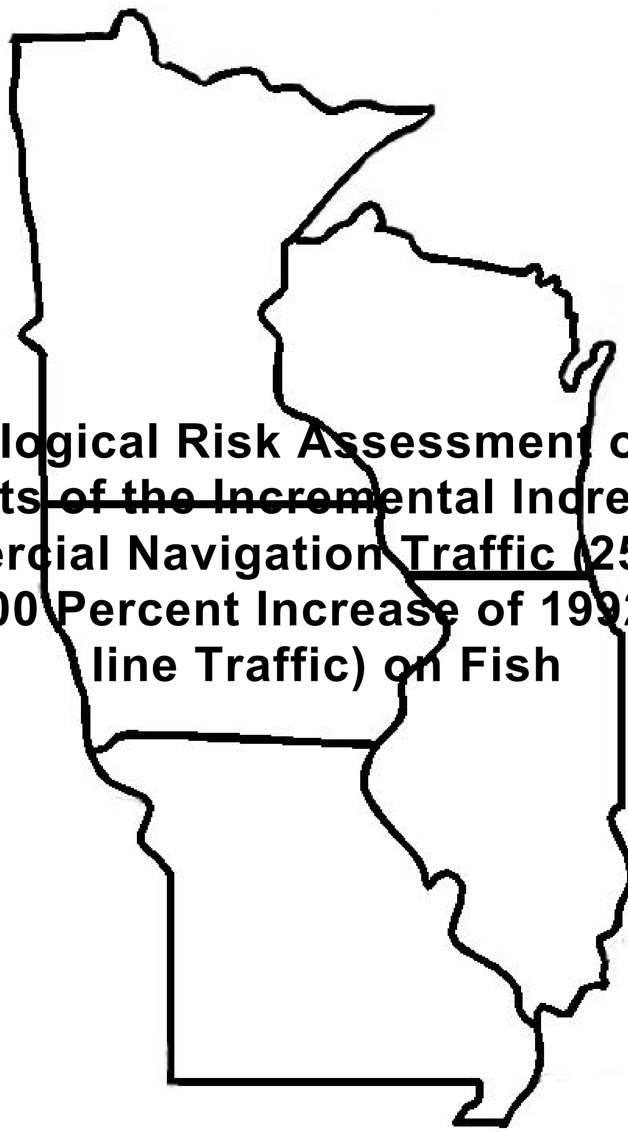
ENV Report 16

Interim Report For The Upper Mississippi River - Illinois Waterway System Navigation Study







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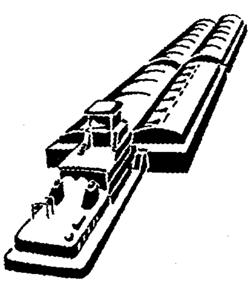

July 2000

US Army Corps
of Engineers

Rock Island District
St. Louis District
St. Paul District

Upper Mississippi River - Illinois Waterway System Navigation Study

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Ecological Risk Assessment of the Effects of the Incremental Increase of Commercial Navigation Traffic (25, 50, 75, and 100 Percent Increase of 1992 Baseline Traffic) on Fish

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Interim report

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[1] This Appendix is published on the CD-ROM furnished with this report.

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Preface

The work reported herein was conducted as part of the Upper Mississippi River - Illinois Waterway (UMR-IWW) System Navigation Study. The information generated for this interim effort will be considered as part of the plan formulation process for the System Navigation Study.

The UMR-IWW System Navigation Study is being conducted by the U.S. Army Engineer Districts of Rock Island, St. Louis, and St. Paul under the authority of Section 216 of the Flood Control Act of 1970. Commercial navigation traffic is increasing, and in consideration of existing system lock constraints, will result in traffic delays that will continue to grow in the future. The system navigation study scope is to examine the feasibility of navigation improvements to the Upper Mississippi River and Illinois Waterway to reduce delays to commercial navigation traffic. The study will determine the location and appropriate sequencing of potential navigation improvements on the system, prioritizing the improvements for the 50-year planning horizon from 2000 through 2050. The final product of the System Navigation Study is a Feasibility Report which is the decision document for processing to Congress.

The authors appreciate the many helpful discussions and comments from Mr. Daniel B. Wilcox, U.S. Army Engineer District, St. Paul; Dr. Thomas M. Keevin, U.S. Army Engineer District, St. Louis; Dr. Steve Gutreuter, U.S. Geological Survey, Upper Mississippi Science Center; Dr. John W. Barko, Center for Water Quality and Aquatic Plant Research and Technology, Environmental Laboratory (EL), U.S. Army Engineer Research and Development Center (ERDC); and Mr. Kenneth A. Barr, U.S. Army Engineer District, Rock Island, during the course of this study. Data were provided by Dr. John Dettmers, Dr. Gutreuter, Dr. Sandra K. Knight, Chief, Navigation Branch, Navigation and Harbors Division, Coastal and Hydraulics Laboratory (CHL), ERDC; Dr. M. Rose Kress, Environmental Characterization Branch, Natural Resources Division, EL; Mr. Kevin J. Landwehr, Rock Island District; and Dr. Stephen T. Maynord, Navigation Branch. The fish distribution and abundance maps and the power plant location map were created by Ms. Cathy Jo Lewis, SENES Oak Ridge, Inc. Project management support was provided by Messrs. Barr and Richard Fristik, Rock Island District, Dr. Keevin, and Mr. Bob Vanderjack, retired, formerly of Rock Island District. Thanks to Ms. Cynthia Lovelock, The Cadmus Group, Inc., for editorial assistance as well as for reviewing and summarizing the large amount of information on power plants with water intake structures located in the Upper Mississippi River and Illinois Waterway, including the fish entrainment and impingement data. Mr. Fristik, Dr. Keevin, Dr. Glenn F. Cada, Environmental Sciences Division, Oak Ridge National Laboratory, Dr. A. L. Jensen, retired, and Bill Bertrand, Illinois Department of Natural Resources, provided helpful review comments on an earlier version of this report.

Mr. Robert C. Gunkel, Jr., EL, ERDC, was responsible for coordinating the necessary activities leading to publication. Dr. John W. Keeley was Acting Director, EL.

At the time of publication of this report, Dr. James R. Houston was Director of ERDC. COL James S. Weller, EN, was Commander.

Summary

The Navigation Study being performed by the U.S. Army Corps of Engineers (USACE) is assessing the potential environmental impacts associated with anticipated increases in commercial navigation traffic on the Upper Mississippi River-Illinois Waterway (UMR-IWW) System. The assessment addresses a period beginning with the present condition (defined as 1992) and continuing through the year 2050. Upon completion, the assessment will fulfill a requirement of the National Environmental Policy Act (NEPA) of 1969, and an Environmental Impact Statement (EIS) will be prepared. This report describes the overall approach adopted for assessing the potential impacts on and risks posed by commercial vessels to larval fishes in the UMR-IWW System and presents initial results for hypothetical percentage increases in traffic over the 1992 baseline data. Specific larval entrainment assessment results for more realistic traffic scenarios will be presented as future reports in the Navigation Study series of technical publications.

The larval fish entrainment component of the Navigation Study was organized according to the framework recommended in the Guidelines for Ecological Risk Assessment developed by the U.S. Environmental Protection Agency (USEPA). An ecological risk is defined as the probability of an adverse impact on an ecological resource. The Guidelines provide guidance for comprehensive, consistent, and coherent ecological risk assessments. The ecological risk assessment process consists of three steps: problem formulation, analysis (characterization of exposure and of ecological effects), and risk characterization. Completing each step may require the collection of new data and information.

The problem formulation component of the Navigation Study Fish Ecological Risk Assessment consists of developing a conceptual model of the entire assessment process. The conceptual model outlines the nature and source of stress to ecological resources, identifies ecological resources potentially at risk, specifies the ecological impacts of concern regarding these resources, identifies relevant data and information, and suggests models and methods of analysis that can be used to estimate risks. The need for discussion and participation among risk managers, risk assessors, and stakeholders in developing the overall design for risk assessment is emphasized in the problem formulation step. The conceptual model outlining the larval fish entrainment risk assessment evolved

through a series of meetings and workshops and continues to be evaluated, modified, and refined by members of the Navigation Study Model Integration and Simulation Team (MIST). Regular meetings with the Navigation Environmental Coordinating Committee (NECC) provide opportunities for review and comments from representatives of state governments, other governmental agencies, environmental organizations, and the concerned public. As a result of these activities, 30 species of fish were identified for inclusion in the assessment.

In this risk assessment, the ecological stressors take the form of the water entrained through the propellers of commercial vessels (i.e., "tows") navigating the UMR-IWW System. To characterize commercial traffic intensity, a baseline number of vessels passing through each pool for each month was developed using 1992 lockage data. For this initial larval fish risk assessment, four future traffic scenarios were constructed assuming 25, 50, 75, and 100 percent increases over the 1992 baseline data. Existing fleet data were also analyzed to construct a data set that describes, by pool and by month, the relative distribution of vessels across categories of vessel direction, size, speed, and load, and whether or not the vessel had a Kort nozzle (a type of propeller). This classification scheme produced 108 possible configurations for commercial vessels operating on the UMR-IWW System. In developing and assessing future traffic scenarios, it was assumed that the current fleet configuration will apply through the year 2050.

The existing data were used to estimate the water entrainment rates associated with each of the 108 possible vessel configurations. These estimates were based on existing models. Model inputs included propeller diameter, applied horsepower, vessel speed, and presence of Kort nozzle technology. Results of calculations for individual vessels were used to estimate the mean (± standard deviation) entrainment rate of water characteristic of each pool for each month on the UMR-IWW System. These values, combined with the corresponding statistics for vessel speed and the projected increase in vessels per day, characterized larval fish exposure to the risk of entrainment. Estimates for individual vessels ranged from 15.4 to 53.7 m^3/sec.

The characterization of ecological effects component in this risk assessment identified commercial traffic-induced increases in larval fish mortality as the principal focus of the assessment. To successfully realize the objective of the Navigation Study Fish Ecological Risk Assessment, methods and tools were developed to translate the baseline traffic and future traffic scenarios into estimates of associated ecological impacts on larval fish entrainment. Potential impacts or risks posed by commercial vessels on fish larvae are being assessed using the Conditional Entrainment Mortality (CEM) model, which is a standard modeling approach for evaluating fish entrainment by power plant water intakes. The results of the entrainment mortality calculations are extrapolated to estimates of future lost adults, recruitment forgone, and production forgone, using published models. The CEM model estimates the mortality rate of newly hatched fish larvae drawn through and subsequently killed by the propeller jet of commercial vessels traversing each pool on the UMR-IWW System during the spawning season of that particular fish species.

The Equivalent Adults Lost (EAL) model extrapolates the calculated larval entrainment mortalities to the number of adult individuals lost from the future population as a result of larval entrainment. The EAL model essentially compares the incremental entrainment mortalities to natural mortalities suffered by fish larvae and juvenile life stages.

The Recruitment Forgone (RF) model represents a more complex extrapolation of entrainment mortalities to lost future recruits. The RF model addresses fish growth, in addition to simply adding to natural mortality. The RF model is important in evaluating the implications of larval entrainment of individual fish that fail to recruit to commercial and recreational fisheries in the UMR-IWW System.

The Production Forgone (PF) model is analogous to the RF model, except that lost future biomass is estimated instead of individual recruits or adults. This model is important for assessing risks posed by commercial vessels to the biomass of important forage species (e.g., gizzard shad (*Dorosoma cepedianum*)), which may indirectly determine the population sizes of future commercial or recreational fisheries in the UMR-IWW System.

Using a combination of published data and information, workshops, unpublished reports, and professional judgment, the necessary data sets were developed for each of the 30 species of fish selected for the ecological risk assessment. These data served as input to the CEM, EAL, RF, and PF models. These input parameters will be the focus of future numerical sensitivity and uncertainty analyses aimed at revising and refining the initial estimates of larval fish entrainment and its extrapolation using the ecological models.

Characterization of potential ecological risks posed by commercial traffic on the UMR-IWW System, the third step in the larval fish risk assessment process, is developed from the integration of the entrainment calculations with the ecological models. The 1992 baseline traffic estimates of larval fish entrainment mortality and subsequent extrapolations to lost adults, lost recruits, and lost biomass are presented for the channel catfish (*Ictalurus punctatus*) for Pools 4, 8, 13, and 26 in the UMR and the La Grange Pool in the IWW. The results suggest that for baseline traffic, on average, from 0.4 to 7 percent of the total larval channel catfish fish standing crop might be killed by entrainment. The higher percentage impacts occurred for more southerly UMR pools with higher traffic intensities (and potentially longer spawning seasons). The impacts of the 25, 50, 75, and 100 percent increase in traffic scenarios resulted in the same percentage increases in larval fish mortality, as demonstrated for channel catfish using July results for Pool 8. The incremental impacts of commercial traffic in UMR Pool 13 were summarized for six selected species during the peak spawning months (June or July). The selected species included emerald shiner (*Notropis atherinoides*), freshwater drum (*Aplodinotus grunniens*), mooneye (*Hiodon tergisus*), gizzard shad, channel catfish, and walleye (*Stizostedion *vitreum*). Depending on the species, the larval entrainment calculations suggest increased mortality ranging from ~100,000 (e.g., walleye) to 100,000,000 (e.g., emerald shiner, gizzard shad) individual larvae for Pool 13 in the peak spawning months. In addition, the numbers of lost future recruits were summed over all pools in the UMR-IWW System for the six species to demonstrate the relative risk ranking for these species associated with a 25 percent increase in traffic intensity. Based on these initial results, the emerald shiner suffered the highest potential losses in future recruits, followed in order by freshwater drum, mooneye, channel catfish, gizzard shad, and walleye. The results of these kinds of analyses can be used to assess the relative impacts of traffic increases on different species and for different pools. The relative impacts can be used to design and evaluate possible plans to avoid or minimize actual impacts or to develop mitigation measures.

One key aspect of ecological risk assessment that distinguishes this process from more historical environmental assessments performed under the NEPA is the explicit identification and quantification of uncertainties that enter into the analysis. Once quantified, these uncertainties are included in the assessment calculations to produce probabilistic estimates of ecological impacts (i.e., risks). In the Navigation Study Fish Ecological Risk Assessment, uncertainties enter the analysis in the form of bias and imprecision in the estimates of future traffic intensity, in the characterization of entrainment volumes for specific vessel configurations, and in the ecological responses to entrainment produced by the ecological models. Uncertainties also take the form of the simplifications and assumptions that are inherent in the modeling process. Numerical analyses of these preliminary results will be used to identify and rank-order the contributions of specific sources of uncertainty to the Navigation Study Fish Ecological Risk Assessment results. Such analyses can be used to design additional studies or to identify additional data collection that will provide the greatest return in reducing bias and imprecision per unit investment of future Navigation Study resources.

1 Introduction

Background

The Mississippi River is an integral part of American heritage, both as a unique resource and as the best example of a multipurpose river in the United States. The Mississippi River drainage basin is nearly 4 million square kilometers, one of the largest and most productive ecosystems in the world (Holland-Bartels et al. 1990b). The river above the confluence of the Ohio River is commonly called the Upper Mississippi River (UMR) (Figure 1) and includes nearly 500,000 km^2 of watershed (Holland-Bartels et al. 1990b). The UMR, including the Illinois Waterway (IWW) (Figure 1), is designated both a nationally significant ecosystem and a nationally significant navigation system, the only inland river in the United States to have such a designation. Many national wildlife refuges exist along the river corridor. The Mississippi Flyway is the migration corridor for 40 percent of North America's waterfowl and shorebirds, as well as an important flyway for raptors and neotropical songbirds. A total of 50 species of freshwater mussels have been recorded in the river system. In addition, the Mississippi River System is noteworthy among the world's large temperate rivers because it supports an unusually large number of fish species; historically, at least 150 species of fish have been reported in the UMR (Gutreuter 1997).

The history of navigation on the UMR-IWW System goes back to the 1820s, when Congress authorized navigation improvement measures by the U.S. Army Corps of Engineers such as the removal of snags and other obstructions in several locations of the Mississippi River and construction of a canal connecting Lake Michigan to the IWW (Fremling and Claflin 1984). Several navigation improvement projects, including the excavation of rocks, closing off of sloughs, construction of the 4.5-foot navigation channel, and construction of the 6-foot navigation channel, continued throughout the early 1900s (Fremling and Claflin 1984). Projects creating the current 9-foot navigation channel were authorized in the 1930s, and most were completed by 1940 by the Corps (Fremling and Claflin 1984). Twenty-nine locks and dams on the Mississippi and eight on the Illinois replaced rapids and falls with a stairway of water or a series of terraced pools for commercial and recreational traffic (Figure 1). Habitats in a typical pool include

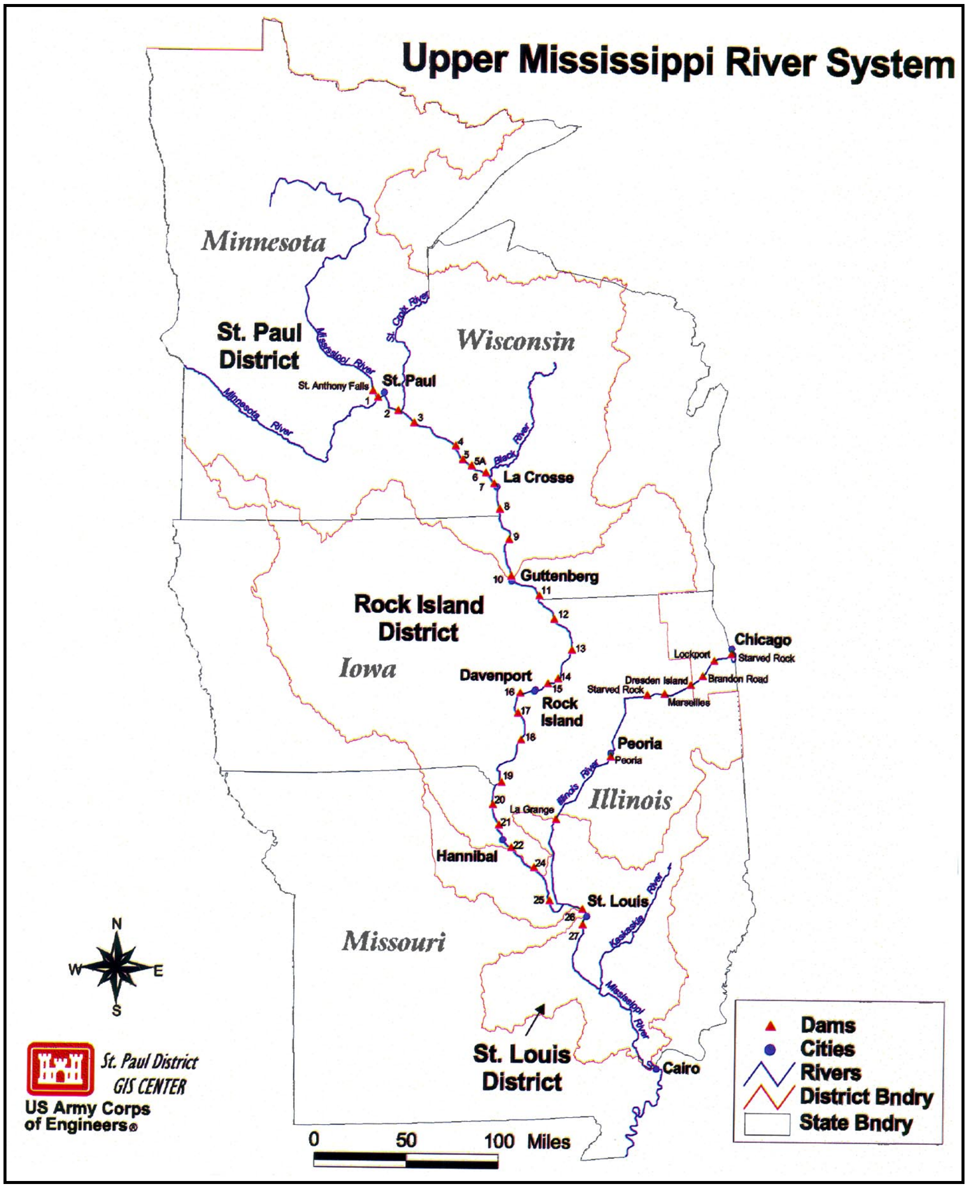

Figure 1. The Upper Mississippi River-Illinois Waterway System (the pool upstream from the dam has the same number or name as the dam)

a braided channel, a lotic area at the head of the pool, and a lentic environment above the impounding lock and dam (Van Vooren 1983). More barge traffic than ever before transports a wide variety of essential goods on the UMR-IWW System; agricultural commodities, petroleum products, and coal are the leading cargoes, with various farm products accounting for approximately half of the total tonnage shipped.

In the UMR-IWW System, a typical commercial "tow" consists of a towboat and 15 barges with the configuration of 3 barges wide by 5 barges long (Holland 1986b). Effects of increased navigation traffic on fish that inhabit the main navigation channel during any stage of their life, including how any navigation-related mortality could affect recruitment, are of the greatest concern (Holland 1986b; Holland-Bartels et al. 1990a). Potential sources of direct navigation-related mortality include turbulence, waves, shear, pressure, entrainment through the towboat propeller, and short-term dewatering of backwater nursery areas (Morgan et al. 1976; Holland 1987; Holland-Bartels et al. 1995; Killgore et al. in preparation; Keevin, Adams, and Killgore in preparation; Keevin et al. in preparation; Adams et al. in preparation). Lentic or backwater areas have usually been considered the primary fishery habitat in the river system, and it was formerly believed that the main navigation channel contributed little to the spawning or nursery needs of fish. However, many studies have shown that the main navigation channel is used extensively by early life stages, as well as by juvenile and adult stages, of several fish species and that the main channel may be critical to the maintenance of certain valuable fisheries (Holland et al. 1984; Holland 1986b; Holland-Bartels et al. 1990a; Gutreuter, Dettmers, and Wahl 1998).

The purpose of the Navigation Study Fish Ecological Risk Assessment is to assess the incremental impact of increased commercial navigation traffic from 2000 to 2050 (in 10-year increments) on fish in the UMR-IWW System. For the writing of this report, future traffic projections were not yet available; therefore, traffic projections increased 25, 50, 75, and 100 percent above the 1992 baseline numbers were used. The estimated incremental navigation impact on the larval stages of 30 fish species due to mortality resulting from entrainment in the propeller zone of a passing tow has been calculated using the Conditional Entrainment Mortality (CEM) model (Boreman et al. 1981). Impacts on early life stages have been extrapolated to estimate the numbers of future equivalent adults lost, using the Equivalent Adults Lost (EAL) model (Horst 1975; Goodyear 1978) and the Recruitment Forgone (RF) model (Jensen 1990), and the fish biomass lost using the Production Forgone (PF) model (Jensen et al. 1988). These models were initially developed to assess the consequences of fish entrainment and impingement at water intakes for power plants.

The U.S. Environmental Protection Agency Framework for Ecological Risk Assessment

This report is written in the framework recommended in the U.S. Environmental Protection Agency (USEPA) Guidelines for Ecological Risk Assessment (USEPA 1998). The USEPA framework was developed to promote consistent approaches to ecological risk assessment, identify key issues, and define the terminology (Bartell 1996). The USEPA framework includes three components: problem formulation, analysis (characterization of exposure and of ecological effects), and risk characterization (USEPA 1998).

In the problem formulation component, the disturbance or stressor is identified, the subject or endpoints of the risk assessment are delineated or defined, and the scope and scale of the ecological risk assessment are presented (Bartell 1996). In the characterization of exposure, the disturbance is described

(USEPA 1998). The ecological effects consistent with the objectives of the assessment are defined and the exposure-response relationships used to translate the exposure profile into risk estimates are presented in the characterization of ecological effects section of the assessment process (USEPA 1998). In the risk characterization section, the available information and data are integrated, the risks are estimated, and the uncertainties and their assessment implications are characterized (Bartell 1996).

2 Problem Formulation

The disturbance or stressor in the Navigation Study Fish Ecological Risk Assessment is the incremental increase in commercial navigation traffic, specifically a tow passing through the river system. Traffic projections are being developed by economists for the future (2000, 2010, 2020, 2030, 2040, and 2050) for the conditions that would occur without any major improvements to the system, referred to as the without-project conditions. Future traffic projections also are being developed for the National Economic Development (NED) Plan for the years 2000-2050 (every 10 years). Traffic that actually occurred on the river system in 1992 is being used as the baseline for comparison. As of this report, traffic projections are still under development. Therefore, for the purposes of presenting the methodology used here, traffic increases were based on the 1992 traffic level and increased in each pool by 25, 50, 75, and 100 percent. For use in the ecological models, traffic projections were broken down into the average number of tows per day by month for each pool.

Since the focus of this risk assessment is on larval fish mortality resulting from entrainment in the propeller zone of a passing tow, knowing the volume of water entrained by a tow is critical. Entrainment volumes have been calculated using a model developed by Maynord (1999). Entrainment volumes were calculated for 108 different tow configurations (e.g., empty/full, going upstream/downstream, Kort nozzle/open wheel propeller type). The volume of water in a particular pool was calculated from bathymetry cross-section data using a geographic information system (GIS) at the U.S. Army Engineer Research and Development Center, Vicksburg, MS.

In order to assess the ecological risks to fish associated with the incremental increase in commercial navigation traffic 25, 50, 75, and 100 percent above 1992 baseline numbers, 30 fish species that inhabit the UMR-IWW System were selected (Table 1). This list of 30 species was assembled as a result of numerous meetings and workshops held throughout the Navigation Study. The fish species selected for this ecological risk assessment include species that have different life history strategies as well as species important to both the commercial and recreational fishery, important forage species, and species listed as threatened or endangered or other similar category. The status of Federal and State listed fish species included in this risk assessment is detailed in Table 2.

Table 1
Fish Species Selected to Assess the Ecological Risks Associated With the Incremental Increase in Commercial Navigation Traffic

Scientific Name	Common Name	Category[1]
Family Acipenseridae - Sturgeons		
Scaphirhynchus platorynchus	Shovelnose sturgeon	Commercial
Scaphirhynchus albus	Pallid sturgeon	Listed
Acipenser fulvescens	Lake sturgeon	Listed
Family Polyodontidae - Paddlefishes		
Polyodon spathula	Paddlefish	Commercial, Listed
Family Lepisosteidae - Gars		
Lepisosteus platostomus	Shortnose gar	Commercial
Family Amiidae - Bowfins		
Amia calva	Bowfin	Commercial
Family Clupeidae - Herrings		
Dorosoma cepedianum	Gizzard shad	Forage
Family Hiodontidae - Mooneyes		
Hiodon alosoides	Goldeye	Listed
Hiodon tergisus	Mooneye	Commercial
Family Esocidae - Pikes		
Esox lucius	Northern pike	Recreational, Listed
Family Cyprinidae - Minnows		
Cyprinus carpio	Common carp	Commercial
Notropis atherinoides	Emerald shiner	Forage
Family Catostomidae - Suckers		
Carpiodes carpio	River carpsucker	Commercial
Cycleptus elongatus	Blue sucker	Listed
Ictiobus bubalus	Smallmouth buffalo	Commercial
Ictiobus cyprinellus	Bigmouth buffalo	Commercial
Minytrema melanops	Spotted sucker	Commercial
Moxostoma macrolepidotum	Shorthead redhorse	Commercial
		(Continued)

[1] Commercial = Of commercial importance
Recreational = Of recreational importance
Listed = State or Federal listed as threatened, endangered, candidate for listing, need of management, etc.

Table 1 (Concluded)		
Scientific Name	**Common Name**	**Category**[1]
Family Ictaluridae - Catfishes		
Ictalurus punctatus	Channel catfish	Commercial, recreational
Ictalurus furcatus	Blue catfish	Commercial, recreational
Pylodictis olivaris	Flathead catfish	Commercial, recreational
Family Moronidae - Temperate Basses		
Morone chrysops	White bass	Recreational
Family Centrarchidae - Sunfishes		
Lepomis macrochirus	Bluegill	Forage, recreational
Micropterus dolomieu	Smallmouth bass	Recreational
Micropterus salmoides	Largemouth bass	Recreational
Pomoxis annularis	White crappie	Recreational
Pomoxis nigromaculatus	Black crappie	Recreational
Family Percidae - Perches		
Stizostedion canadense	Sauger	Recreational
Stizostedion vitreum	Walleye	Recreational
Family Sciaenidae - Drums		
Aplodinotus grunniens	Freshwater drum	Commercial, recreational

Using the CEM model (Boreman et al. 1981), larval fish mortality was calculated by month for each pool; calculations were also combined to give a systemwide mortality value for a particular scenario. The larval mortality of a particular fish species was used to extrapolate the future equivalent adults lost (both numbers of fish and biomass) using the EAL model (Horst 1975; Goodyear 1978), the RF model (Jensen 1990), and the PF model (Jensen et al. 1988). Where assumptions were made regarding the selection of model parameters, the approach was consistently biased toward overestimating impacts and risk.

In evaluating the significance of entrainment mortality, it must be recognized that the basic life history strategy of fishes is to produce large numbers of eggs and larvae, most of which will fail to reach mature adulthood (i.e., recruit stage). In addition, there appear to be density-dependent processes that serve to increase the survivorship of remaining individuals during conditions of increased mortality. This density-dependent or “compensatory” effect has received much attention in relation to the exploitation of fish populations by commercial fishing, as well as to the potential impacts of entrainment by power plants (Van Winkle 1977). The significance of larval entrainment by commercial traffic should be realistically evaluated in terms of how this additional mortality impacts the compensatory reserve of the local population.

Table 2
Threatened and Endangered Fish Species of the Upper Mississippi River and Illinois Waterway Selected for the Modeling Effort to Assess the Ecological Risks Associated with Increased Navigation Traffic

		Status				
Species	**Federal Status**	**Wisconsin**	**Minnesota**	**Iowa**	**Illinois**	**Missouri**
Pallid sturgeon	Endangered					Endangered
Lake sturgeon			Special concern	Endangered	Endangered	Endangered
Paddlefish		Threatened	Threatened			On watch list
Blue sucker		Threatened	Special concern			On watch list
Goldeye		Endangered				
Mooneye						Rare
Northern pike						Rare

Large numbers of fish eggs and larvae can be entrained by power plants and commercial navigation traffic. For example, Jensen (1990) estimated that approximately 128,000,000 yellow perch (*Perca flavescens*) larvae were entrained on an annual basis from the western basin of Lake Erie by the Monroe Power Plant, Monroe, Michigan. While this number appears large, Jensen (1990) further emphasized that natural mortality was high for these larvae and that this additional mortality translated into approximately 9,000 fish that were ultimately lost from the yellow perch population as a result of this magnitude of larval entrainment. However, Jensen's study (1990) is not offered as support for condoning the entrainment of large numbers of fish larvae. The main point is that the population-level implications of entrainment are difficult to interpret from the absolute number (often large) of larvae lost to entrainment.

Finally, for a fish population to remain in a steady-state equilibrium, each mature female needs to produce only one adult female and one adult male during her life span (Goodyear 1978). In other words, a population in equilibrium has a net reproductive rate equal to 1.0. Jensen (1990) speculated that, on average, the net reproductive rates for fish populations do not vary from 1.0 for considerable lengths of time. Otherwise, populations would face either local extinction or reach some upper limit defined by the environmental carrying capacity of the system. In general, fish populations appear to undergo considerable variation in size from year to year. This often reflects the relative success of strong year classes, and these dynamics remain poorly understood for specific populations and ecosystems. Importantly, in spite of these fluctuations, the populations seem rarely to become extinct or excessively abundant.

3 Analysis of Characterization of Exposure

In the Navigation Study Fish Ecological Risk Assessment, the ecological stressors take the form of the physical forces produced directly by commercial vessels (i.e., tows) navigating the UMR-IWW System and the indirect effects that result from these forces. The direct physical forces imposed by operating commercial vessels include increases in river current velocity, wake waves, return currents, or drawdown; pressure changes and shear stresses associated with water entrainment through the propeller jet; shear stresses in the vicinity of the moving barge hulls and on the bed sediments beneath the vessel; and bed shear stresses extending to the channel borders and backwaters.

Stressor Characterization

The primary ecological stressor in this assessment of larval fish impacts is the rate of water entrainment $Q_{p,}$ m^3/sec. As commercial vessels push barges through the UMR-IWW System, water pulled through their rotating propellers exerts shear stresses, velocity changes, and pressure changes that could injure or kill early life stages (e.g., eggs, larvae, young of the year), juvenile, and adult fishes that are coincidentally entrained. The potential impact of shear stresses induced by the hulls of the moving barges on fish early life stage mortality was addressed early in the Navigation Study; however, analysis of the likely magnitudes of these forces suggested that impacts would be negligible (Maynord, in preparation). In addition, Keevin, Adams, and Killgore (in preparation) concluded that pressure changes resulting from rapid displacement within the water column will not be a significant source of mortality for early life stages of fish as the result of commercial navigation. The following sections describe the approaches used to quantify the magnitude, extent, and duration of the entrainment rate in relation to baseline and projected traffic intensity.

Frequency of vessel passage

The frequency of vessels passing any arbitrary location per day in a pool is referred to as traffic intensity (i.e., vessels/day). To characterize current commercial traffic intensity, a baseline number of vessels passing through each pool each month was developed using 1992 lockage data. Table 3 lists the average number of vessels per day by month for UMR Pools 4, 8, 13, and 26 and the La Grange Pool in the IWW. In general, the volume of traffic increases from north to south on pools in the UMR, with more southerly pools also showing a longer navigation season.

Table 3
Baseline Traffic Intensity (Mean Vessels/Day) for UMR-IWW System Long-Term Resource Monitoring Pools Based on 1992 Data

Month	UMR 4	UMR 8	UMR 13	UMR 26	IWW La Grange
January	0.0	0.0	0.0	12.9	10.1
February	0.0	0.0	0.0	14.6	11.0
March	1.9	2.2	5.2	21.3	9.4
April	4.8	5.3	8.4	22.8	9.1
May	5.7	6.2	8.9	22.3	8.5
June	5.4	6.1	8.3	21.7	7.8
July	5.9	6.7	9.2	23.3	8.7
August	5.8	6.4	8.3	21.4	8.2
September	4.7	5.2	6.9	20.7	8.6
October	4.7	5.0	7.0	21.7	9.4
November	3.3	3.8	6.0	20.5	9.4
December	0.0	0.0	0.7	17.8	12.3

For the initial risk assessment, four hypothetical future traffic scenarios were constructed assuming 25, 50, 75, and 100 percent increases over the 1992 baseline data. In each analysis, it was assumed that each vessel traversed the entire pool at constant speed and reached the next lock within the day. In the entrainment calculations, it was also assumed that the vessel remained within the navigation channel while underway and that successive vessels were evenly spaced with the distance between them determined by the number of vessels/day and the navigation length of the pool.

Fleet characteristics

Lockage records for 1992 were analyzed to construct a data set assumed to represent the current commercial fleet on the UMR-IWW System. These data describe, by pool and month, the relative distribution of vessels across categories of direction of travel, size, load, speed and whether or not the vessel had a Kort nozzle. Vessels travel either upbound (U) or downbound (D). Vessel sizes (tugboat plus barges) were classified as small (S), medium (M), or big (B). The following specific lengths and widths were assigned to each size category: small vessels, a length of 178.3 m and a width of 10.7 m; medium vessels, a length of 237.7 m and a width of 21.3 m; and big vessels, a length of 297.2 m and width of 32.0 m.

Barge loads were determined as empty (E), mixed (M), or full (F); a corresponding depth of vessel draft was assigned to each category. Empty barges were assigned a draft depth of 0.61 m, mixed loads drafted 2.13 m, and fully loaded barges drafted 2.74 m.

Vessel speeds were categorized as slow (S), medium (M), or fast (F); however, the actual velocities assigned to these classes differed for the UMR versus the IWW. For vessels navigating the UMR, slow speed was defined as 2.24 m/sec (5 mph), medium speed was 2.91 m/sec (6.5 mph), and fast vessels were assumed to travel at 3.58 m/sec (8 mph). Corresponding vessel speeds assigned to vessels navigating the IWW were 1.34 m/sec (3 mph), 2.24 m/sec (5 mph), and 3.13 m/sec (7 mph).

The preceding classification categories produced 108 possible configurations for commercial vessels operating on the UMR-IWW System. Clearly, not all 108 vessel types occur in each pool each month. Table 4 presents an example of the relative distribution of different vessel types recorded for UMR Pool 8 in August 1992. Separate fleet characteristics files were developed for all pools on the UMR and the IWW. In developing and assessing future traffic scenarios, it was assumed that the current fleet configurations will apply to traffic projections for the remainder of the project period (i.e., the year 2050).

Tow-induced physical forces

The UMR-IWW System Navigation Study has attempted to develop a comprehensive understanding of the physical forces generated by moving commercial vessels in relation to their possible impacts on the early life stages of fish. Separate studies have been performed to characterize the potential magnitude of shear forces in the zone of the rotating propeller, pressure changes associated with rapid water column mixing in the propeller wash, and shear forces induced by the moving hull. In addition, the possible stranding of eggs and larvae as the result of drawdown by passing vessels was studied.

Table 4
Relative Frequency of Different Vessel Types Observed in Pool 8 for the Month of August

Direction	Size	Type	Speed	% Kort	Frequency	Relative Frequency
D	B	E	F	33.33	0.000000	0.00000000
D	B	E	M	33.33	2.647059	0.01557094
D	B	E	S	33.33	0.352886	0.00207612
D	B	L	F	40.00	0.048544	0.00028555
D	B	L	M	40.00	2.087379	0.01227870
D	B	L	S	40.00	2.864078	0.01684752
D	B	M	F	59.09	0.171206	0.00100709
D	B	M	M	59.09	10.957198	0.06445411
D	B	M	S	59.09	10.871595	0.06395056
D	M	E	F	42.86	1.991632	0.01171548
D	M	E	M	42.86	4.158996	0.02446468
D	M	E	S	42.86	0.849372	0.00499631
D	M	L	F	12.50	0.154839	0.00091082
D	M	L	M	12.50	4.438710	0.02611006
D	M	L	S	12.50	3.406452	0.02003795
D	M	M	F	20.00	0.787992	0.00463525
D	M	M	M	20.00	6.510319	0.03829599
D	M	M	S	20.00	2.701689	0.01589229
D	S	E	F	6.25	9.709402	0.05711413
D	S	E	M	6.25	4.923077	0.02895928
D	S	E	S	6.25	1.367521	0.00804424
D	S	L	F	15.38	3.734417	0.02196716
D	S	L	M	15.38	7.433604	0.04372708
D	S	L	S	15.38	1.831978	0.01077634
D	S	M	F	0.00	0.306667	0.00180392
D	S	M	M	0.00	0.493333	0.00290196
D	S	M	S	0.00	0.200000	0.00117647
U	B	E	F	75.00	0.666667	0.00392157
U	B	E	M	75.00	2.666667	0.01568628
U	B	E	S	75.00	0.666667	0.00392157

(Continued)

Table 4 (Concluded)						
Direction	Size	Type	Speed	% Kort	Frequency	Relative Frequency
U	B	L	F	70.59	0.050296	0.00029586
U	B	L	M	70.59	7.594675	0.04467456
U	B	L	S	70.59	9.355030	0.05502959
U	B	M	F	28.57	0.395480	0.00232635
U	B	M	M	28.57	7.514124	0.04420073
U	B	M	S	28.57	6.090395	0.03582585
U	M	E	F	0.00	0.324324	0.00190779
U	M	E	M	0.00	0.459459	0.00270270
U	M	E	S	0.00	0.216216	0.00127186
U	M	L	F	37.50	0.375652	0.00220972
U	M	L	M	37.50	5.259130	0.03093606
U	M	L	S	37.50	2.365217	0.01391304
U	M	M	F	20.00	1.152263	0.00677802
U	M	M	M	20.00	6.460905	0.03800532
U	M	M	S	20.00	2.386831	0.01404018
U	S	E	F	0.00	5.302682	0.03119225
U	S	E	M	0.00	1.839080	0.01081812
U	S	E	S	0.00	0.858238	0.00504846
U	S	L	F	9.09	9.755656	0.05738621
U	S	L	M	9.09	10.253394	0.06031408
U	S	L	S	9.09	1.990950	0.01171147
U	S	M	F	0.00	0.369231	0.00217195
U	S	M	M	0.00	0.553846	0.00325792
U	S	M	S	0.00	0.076923	0.00045249

Killgore et al. (in preparation) measured the mortality of larval and juvenile fish entrained through a scale model of a towboat propeller. Instantaneous and delayed mortality was measured for eggs and larvae of shovelnose sturgeon, lake sturgeon, paddlefish, and blue sucker. Mortality was also measured for juvenile common carp. Experiments were performed at four different propeller speeds. Measured mortalities differed among species and life stages; initial mortalities ranged from 9.3 to 55.7 percent across all species, life stages, and propeller speeds; corresponding delayed mortalities ranged from 14.4 to 87.2 percent. Delayed mortality was observed for all species and life stages, except for juvenile common carp. The highest mortality (87.2 percent) was observed for lake sturgeon larvae at the highest propeller speed. The authors concluded that shear stress created by the propeller jet was probably the principal force contributing to mortality for early life stages of fish entrained by passing commercial vessels.

Keevin, Adams, and Killgore (in preparation) used a laboratory pressure chamber to simulate rapid vertical displacement (i.e., pressurization-depressurization) of bigmouth buffalo and blue catfish larvae, juvenile bluegill, and juvenile largemouth bass. The maximum tested pressure change (345 kPa) was equivalent to a 35.2-m displacement within a water column; this distance exceeds depths in the UMR-IWW navigation channel and represents an extreme test for impacts of pressure changes. No significant mortalities among larvae or juvenile fish were observed in these experiments. Keevin, Adams, and Killgore (in preparation) conclude that pressure changes resulting from rapid displacement within the water column will not be a significant source of mortality for early life stages of fish as the result of commercial navigation.

Keevin et al. (in preparation) used a Couette cell to measure the impacts of fluid shear resulting from the passage of a barge hull through the water column. Mortality was measured for three shear levels at three exposure periods for five fish species: larval shovelnose sturgeon, larval bigmouth buffalo, larval blue catfish, juvenile bluegill, and juvenile largemouth bass. When the measured mortality rates were extrapolated to magnitudes of hull shear calculated for barge hulls (Maynord, in preparation), only the shear (250 dynes/cm^2) of a high-speed tow (4.0 m/sec) with a ratio of depth/draft of 1.22 approached values causing measurable mortality in bigmouth buffalo larvae. The remaining species were not significantly ($P<0.05$) impacted by hull shear stress.

Adams et al. (in preparation) measured the propensity for stranding of fish larvae in relation to drawdown (i.e., dewatering) events simulated under laboratory conditions. The study included larval shovelnose sturgeon, larval paddlefish, larval bigmouth buffalo, juvenile blue catfish, juvenile bluegill, and juvenile largemouth bass. Drawdown events were simulated for 1V:5H and 1V:10H slopes in an experimental flume using three drawdown velocities (0.76, 0.46, and 0.21 cm/sec). The results demonstrated that species typically found in the nearshore areas (i.e., littoral zone) were generally less susceptible to stranding; however, species typically inhabiting the main channel (e.g., sturgeon, paddlefish) exhibited a positive rheotaxis and were more likely to become stranded. Thus, the behavioral response of different species to drawdown would likely have to be considered in assessing the larger scale, longer term impacts of commercial traffic on fish larvae. Adams et al. (in preparation) speculated that the relatively low numbers of larvae of main channel species that would occupy the nearshore area would lessen the impacts of drawdown on these species. Additionally, species commonly occurring in this area appear adapted to dewatering events, including vessel-induced drawdown.

As a result of these studies, the risk assessment has focused on the apparent main source of mortality to larval fishes, namely the direct entrainment of individuals through the propeller zone of passing commercial vessels. The impacts of additional forces (e.g., drawdown, hull shear stress) might be assessed in the future, if additional studies or new information provide compelling reasons to do so.

Magnitude of water entrainment rate

The rate of water entrainment Q_p through the propellers of each of the 108 possible vessel types addressed in this assessment was estimated. Estimates of these flow rates derive from the work of Maynord (1999), the DIFFLARV model (Holley, in preparation), and the equations developed by Toutant (1982).

The equations developed by Toutant (1982) were used to estimate the effective push *Ep* where

a. For vessels with Kort nozzles:

$$Ep_k = 31.82\ Hp^{0.974} - 5.4\ (S^2)\ (Hp)^{0.5} \quad (1)$$

b. For vessels with open wheels:

$$Ep_o = 23.57\ Hp^{0.974} - 2.34\ (S^2)\ (Hp)^{0.5} \quad (2)$$

In these equations, *Hp* is the applied horsepower from both propellers, and *S* is the vessel speed relative to the water. If metric units are used, these equations estimate *Ep* in newtons. One-half of the value of *Ep* defines the term, *T*, in the following equation used to calculate Q_p, m^3/sec, for a single propeller (Maynord 1999):

$$Q_p = \frac{V_a p D^2}{8} + \sqrt{\frac{V_a{}^2 p^2 D^4}{64} + \frac{T p D^2}{4 z r}} \quad (3)$$

where
V_a = the advance velocity of the vessel, m/sec
D = propeller diameter, m
T = ½ *Ep* estimated using Equations 1 or 2
z = 1 for Kort nozzles, 2 for open wheels
ρ = density of water (~1 kg/m^3)

Values of propeller diameter were based on a sample of commercial tugboats operating on the Ohio River (Maynord 1999). Small, medium, and big vessels were assigned corresponding propeller diameters of 1.8, 2.7, and 3.1 m. Advance velocities, calculated as the difference between the ambient current velocity and the speed of the vessel relative to the ground, were defined as positive for upbound vessels and negative for downbound vessels.

Based on Equations 1-3 and the characteristics of 108 vessel types, estimates of entrainment rate ranged from 15.4 m^3/sec for a downbound, small, slow vessel with empty barges and a Kort nozzle to 53.7 m^3/sec for an upbound, medium-speed vessel with full barges and a Kort nozzle. The expected value and variance of the entrainment rate for vessels on each pool and for each month were estimated as a function of the numbers of vessels per day distributed among the various classes of size, speed, load, direction, and open wheel/Kort nozzle features of navigating vessels.

The total volume of water entrained per day was calculated as the product of Q_p times the number of seconds required for a vessel to traverse the pool of interest. To characterize the implications of uncertainty on parameters involved in these calculations, the total entrainment volume was calculated using three combinations of estimated entrainment rate and vessel speed (relative to the water):

a. Combination 1: The mean value of Q_p and vessel speed (i.e., the "average" vessel).

b. Combination 2: The mean + 1 standard deviation of Q_p and the mean - 1 standard deviation of vessel speed (e.g., a slow-moving vessel that entrained a large volume).

c. Combination 3: The mean - 1 standard deviation of Q_p combined with the mean + 1 standard deviation of vessel speed (e.g., an efficient vessel moving quickly and entraining comparatively smaller volumes).

Of these possible combinations of estimated Q_p and reported vessel speeds, Combinations 2 and 3 consistently produced the highest and lowest entrainment volumes, respectively. Table 5 lists the mean and standard deviations estimated for the rate of water entrainment Q_p and vessel speed S for UMR Pools 4, 8, 13, 26, and the IWW La Grange Pool.

In addition, the DIFFLARV model (Holley, in preparation) was used to check the assumption independently that the river segment traversed by a commercial vessel is completely mixed before the next vessel passes. This model was developed to estimate what fraction of water entrained by a vessel was previously entrained by the immediately preceding vessel. Caution was taken in developing and applying the larval entrainment model to avoid killing the same individuals more than once. Analysis of DIFFLARV simulations of selected intensive traffic scenarios suggests that entrainment of water by successive vessels passing through a pool is, at most, a few percent given expected traffic densities. As new traffic projections are developed, the DIFFLARV will be used to reevaluate the underlying assumption of complete channel mixing between successive vessel passages.

Table 5
Estimated Mean and Standard Deviation (SD) of Entrainment Rate Q_p, m^3/sec, and Vessel Speed *S,* m/sec, for Pools 4, 8, 13, and 26 on the Upper Mississippi River and the La Grange Pool on the Illinois Waterway

Pool	Month	Q_p		S	
		Mean	SD	Mean	SD
4	1	0	0	0	0
4	2	0	0	0	0
4	3	17.84	2.227	3.171	0.4887
4	4	43.61	17.18	2.909	0.4779
4	5	46.88	17.25	2.905	0.4702
4	6	45.93	16.24	2.897	0.4653
4	7	43.26	19.46	2.938	0.4802
4	8	43.44	18.92	2.927	0.4798
4	9	41.84	18.29	2.907	0.4766
4	10	44.03	19.46	2.920	0.4827
4	11	38.95	18.88	2.970	0.4889
4	12	0	0	0	0
8	1	0	0	0	0
8	2	0	0	0	0
8	3	51.08	11.83	2.798	0.4237
8	4	45.96	17.98	2.904	0.4714
8	5	49.25	17.61	2.889	0.4611
8	6	49.35	15.97	2.873	0.4529
8	7	47.63	18.96	2.904	0.4668
8	8	45.92	19.40	2.910	0.4748
8	9	43.11	19.11	2.899	0.4757
8	10	47.74	19.65	2.895	0.4707
8	11	44.46	20.88	2.940	0.4812
8	12	0	0	0	0
13	1	0	0	0	0
13	2	0	0	0	0
13	3	42.98	16.86	2.912	0.4746
13	4	46.98	17.62	2.899	0.4683

(Sheet 1 of 3)

Table 5 (Continued)					
		Q_p		S	
Pool	Month	Mean	SD	Mean	SD
13	5	49.29	17.72	2.895	0.4636
13	6	50.75	16.33	2.872	0.4536
13	7	47.42	18.20	2.897	0.4654
13	8	47.99	18.35	2.881	0.4642
13	9	44.13	18.22	2.897	0.4773
13	10	48.94	18.36	2.875	0.4648
13	11	46.65	20.90	2.927	0.4768
13	12	43.12	20.71	2.953	0.4807
26A	1	26.75	16.07	3.088	0.5015
26A	2	26.11	16.68	3.092	0.5001
26A	3	45.83	18.26	2.905	0.4677
26A	4	50.41	18.07	2.887	0.4575
26A	5	52.74	17.33	2.876	0.4524
26A	6	53.38	18.29	2.877	0.4549
26A	7	51.43	19.13	2.887	0.4609
26A	8	48.73	20.51	2.902	0.4707
26A	9	46.12	20.89	2.919	0.4812
26A	10	49.46	19.02	2.882	0.4629
26A	11	53.71	19.48	2.896	0.4624
26A	12	48.76	22.09	2.944	0.4808
26B	1	39.94	14.36	2.938	0.4803
26B	2	29.60	17.06	3.050	0.4973
26B	3	45.91	18.28	2.904	0.4675
26B	4	50.27	18.32	2.890	0.4588
26B	5	52.78	17.27	2.876	0.4522
26B	6	53.61	18.28	2.877	0.4546
26B	7	51.56	19.27	2.888	0.4611
26B	8	48.14	20.55	2.906	0.4717
26B	9	46.62	20.84	2.917	0.4802
26B	10	50.02	18.88	2.881	0.4617
26B	11	49.79	18.64	2.896	0.4624

(Sheet 2 of 3)

Table 5 (Concluded)					
		Q_p		S	
Pool	Month	Mean	SD	Mean	SD
26B	12	45.17	21.02	2.944	0.4808
LG[1]	1	44.77	17.17	2.737	0.4351
LG	2	39.91	15.10	2.786	0.4409
LG	3	41.02	16.69	2.768	0.4480
LG	4	39.20	16.30	2.776	0.4546
LG	5	37.27	16.73	2.813	0.4616
LG	6	37.16	16.70	2.809	0.4512
LG	7	34.59	17.16	2.852	0.4700
LG	8	34.95	17.82	2.858	0.4697
LG	9	33.79	17.81	2.888	0.4723
LG	10	36.37	16.66	2.830	0.4617
LG	11	40.32	16.16	2.777	0.4445
LG	12	42.70	16.18	2.775	0.4394
					(Sheet 3 of 3)

[1] LG = La Grange

Duration

In the Navigation Study Fish Ecological Risk Assessment, larval fish entrainment mortality is considered each month for an entire year. However, actual larval fish entrainment involves the navigation of commercial vessels during the periods of fish spawning. Spawning seasons vary among fish species on the UMR-IWW System, but all species addressed in this risk assessment spawn some time between April and September.

Spatial-Temporal Scale

The spatial scale of the assessment of larval fish entrainment includes the volume of each pool between the main channel borders defined by the UMR-IWW System Aquatic Habitat Classification System (Wilcox 1993). Within the main channel borders, which are defined as the areas between the navigation channel and the riverbank (Wilcox 1993), the analysis focuses on the navigation channel. The navigation channel is the designated navigation channel marked by channel buoys; the navigation channel on most of the UMR-IWW System is 91.4 m (300 ft) wide in straight reaches and 152.4 m (500 ft) wide in bends (Wilcox 1993). Each pool is assumed to be completely mixed with the relative concentration of larvae of different fish species determined by its pool *i* and month *j* specific w_i value.

The larval fish entrainment rates are estimated for each month using an input of average vessels per day corresponding to the month and the pool. The temporal scales of the assessment are determined by pool-specific differences in the number of months in the navigation season and their overlap with the spawning months of the selected 30 fish species in the UMR-IWW System.

Seasonal Pool Volumes

The estimates of larval fish entrainment are influenced by pool volume, which varies seasonally in relation to discharge and operation of dams. In this assessment, pool volumes were estimated using changes in bathymetry associated with seasonal differences in discharge and corresponding stage height. Analyses of existing data were used to estimate the 5th, 50th, and 90th percentiles of discharge for pools on the UMR-IWW System, and these percentiles defined "low," "medium," and "high" stage heights and corresponding pool volumes (Table 6). The seasonally-dependent probability of these stage heights was estimated for each pool.[1] Expected values of pool volume were calculated monthly for each pool as the average of the low, medium, and high pool volumes weighted by their probabilities of occurrence. These volumes were used in estimating *R*, the ratio of entrained volume to total pool volume, in the CEM model.

Exposure Profile for Larval Entrainment by Commercial Navigation

The primary product of the exposure analysis is an "exposure profile" that describes the nature of the stressor and quantifies its frequency, magnitude, extent, and duration in a manner relevant to the ecological effects of concern and the methods selected, as part of the problem formulation process, to characterize ecological impacts and estimate risks (USEPA 1998). For the assessment of larval fish entrainment, the stressor is the amount of water (mean, standard deviation) that passes through the propellers of the commercial vessels that traverse each pool each month. Entrainment volumes were calculated for a reference traffic intensity (i.e., the 1992 baseline) and percentage increases (25, 50, 75, and 100 percent) in the average number of vessels per day over this reference. For the reference traffic and each percentage increase scenario, these entrainment volumes are used to estimate the total number of fish larvae entrained in each pool during each month. The entrainment volume, normalized to the weighted average monthly pool volume, is used to estimate larval entrainment for each pool and month. The number of killed fish larvae are used to estimate losses in future adult fish, future recruitment, and biomass production.

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[1] Kevin Landwehr, personal communication, U.S. Army Engineer District, Rock Island

Table 6
Pool Lengths and Volumes Corresponding to Low, Medium, and High Stage Heights for the UMR-IWW System

		Stage Height, 10^6 m^3		
Pool	**Length, km**	**High**	**Medium**	**Low**
4	71.0	827.4	633.4	586.1
5	23.7	46.3	39.4	23.7
5A	15.5	23.7	18.5	18.1
6	23.3	35.5	27.4	27.8
7	19.3	40.1	34.4	33.2
8	37.0	52.9	52.5	46.0
9	51.5	93.4	68.7	66.9
10	51.5	122.5	86.2	77.5
11	51.5	124.7	102.3	92.3
12	43.5	137.2	108.3	100.8
13	54.7	151.2	121.6	109.9
14	46.7	143.0	117.2	105.7
15	16.3	53.1	45.1	42.3
16	41.4	122.0	89.5	77.5
17	32.4	93.0	63.2	57.2
18	42.8	154.7	119.5	105.5
19	74.5	420.6	350.2	326.1
20	33.8	153.4	104.1	90.2
21	29.5	109.9	74.2	66.3
22	38.1	167.5	113.2	100.5
24	44.7	193.5	148.2	134.0
25	51.5	191.1	138.0	117.2
26A	39.2	111.6	81.9	74.7
26B	26.1	226.7	166.3	151.6
27	24.6	423.1	256.6	159.1
LG[1]	124.7	158.3	91.3	71.6
PE[2]	118.0	196.0	89.2	76.0
SR[3]	21.9	13.9	12.3	11.5
MA[4]	43.3	33.5	24.7	22.8
DI[5]	23.3	17.2	16.0	15.4

[1] LG = La Grange, [2] PE = Peoria, [3] SR = Starved Rock, [4] MA = Marseilles, [5] DI = Dresden Island

4 Analysis of Characterization of Ecological Effects

Habitat and Distribution of Study Fish Species

Brief descriptions of the life histories of the 30 fish species selected for the Navigation Study Fish Ecological Risk Assessment are presented in this section. The fish species include piscivores (fish that eat other fish), planktivores (fish that eat plankton), and omnivores (fish that eat both plants and animals or anything that they can consume). Maps of the current distribution of each fish species were developed using information from Rasmussen (1979), Pitlo (1987), Fremling et al. (1989), Holland-Bartels et al. (1990b), Lerczak et al. (1994), Pitlo et al. (1995), Gutreuter (1992, 1997), Koel et al. (1997), Gutreuter, Dettmers, and Wahl 1998; Gutreuter et al. (1997a, 1977b, 1997c, 1997d, 1998), and Burkhardt et al. (1997, 1998). The maps were reviewed and verified by fisheries biologists familiar with the river systems.[1] Upper Mississippi River Conservation Committee (UMRCC) commercial fisheries statistics were also used to assist in the development of the current distributions of the 30 fish species.

Adequate fish population data are not available for the UMR-IWW System; therefore, the distribution of each of the 30 fish species is described qualitatively. The presence of a species within a particular pool can be rare, occasional, common, or abundant. "Rare" means that the species does not usually appear (or rarely appears) in sample collections, the populations are small, and the species may or may not be on the verge of extirpation (Pitlo et al. 1995). "Occasional" means that the species is occasionally collected, the species is not generally distributed, and local concentrations of the species may occur (Pitlo et al. 1995). "Common" means that the species is commonly collected in most sample collections and that the species can make up a large portion of some samples (Pitlo et al. 1995). "Abundant" means that large numbers are always collected during surveys (Pitlo et al. 1995).

[1] Steve Gutreuter, U.S. Geological Survey, Upper Mississippi Science Center, and Scott Whitney, U.S. Army Engineer District, Rock Island, formerly with the Illinois Natural History Survey.

The general within-pool distribution (main channel, main channel border, or backwaters) of the larval stages, juvenile stages, and adult stages of the 30 fish species selected for this ecological risk assessment was developed using the pertinent references cited in this report and the UMR-IWW System Aquatic Habitat Classification System developed by Wilcox (1993) (Figures 2, 3, and 4). As these figures show, a life stage of a particular fish species can be present in more than one habitat type. This information was used to estimate the w_i value for the CEM model.

Sturgeons

Sturgeons (Family Acipenseridae) and the distantly related paddlefish are generally regarded as the most primitive surviving bony fishes (Etnier and Starnes 1993). They occur only in the northern hemisphere and are the largest freshwater fishes; life spans of the larger species may exceed 150 years (Etnier and Starnes 1993). Sturgeon flesh is now well accepted as food, but these fishes are better known as a principal source of caviar (Etnier and Starnes 1993). Sturgeon were of considerable commercial value during the early 1900s, but overfishing, pollution, and the construction of dams have greatly reduced populations (Pflieger 1997).

Three species of sturgeon (lake sturgeon, pallid sturgeon, and shovelnose sturgeon) are indigenous to parts of the Mississippi River. The lake sturgeon is rare in the entire UMR and in the Alton, La Grange, and Peoria Pools of the IWW (Figure 5). It is listed as endangered in Iowa, Illinois, and Missouri and is a species of special concern in Minnesota (Table 2). As part of the Long Term Resource Monitoring Program (LTRMP), a few lake sturgeon have been collected in regular fish surveys from 1991 through 1997 in UMR Pools 4, 8, 13, and 26 (Burkhardt et al. 1997, 1998; Gutreuter et al. 1997a, 1997b, 1997c, 1997d, 1998). In 1984, the Missouri Department of Conservation initiated a stocking program to reestablish populations of lake sturgeon in Missouri (Pflieger 1997). The pallid sturgeon is absent from most of the UMR-IWW System; it occurs rarely in UMR Pools 26 and 27 and in the open river (Figure 6). Regular fish surveys of UMR Pools 4, 8, 13, 26; the open Mississippi River; and the IWW La Grange Pool since 1991 have resulted in the collection of only three pallid sturgeon/shovelnose sturgeon hybrids from the open river in 1997 (Burkhardt et al. 1997, 1998; Gutreuter et al. 1997a, 1997b, 1997c, 1997d, 1998). The pallid sturgeon is listed as endangered on the Federal Threatened and Endangered Species List as well as for Missouri (Table 2). Only the shovelnose sturgeon is common in the UMR (Figure 7); it is found occasionally in the IWW. The life histories of all three sturgeon species are very similar.

The lake sturgeon is an inhabitant of lakes and rivers, where it occurs primarily over firm, silt-free bottoms of sand, gravel, and rock (Pflieger 1997). The lake sturgeon feeds primarily on benthic organisms; in searching for food, it swims close to the bottom with the ends of its sensitive barbels dragging (Etnier and Starnes 1993; Pflieger 1997). Adults typically migrate up rivers to spawn, and spawning occurs from April through June (Etnier and Starnes 1993). Adults do not spawn every year, and the interval between spawning is 4-9 years for

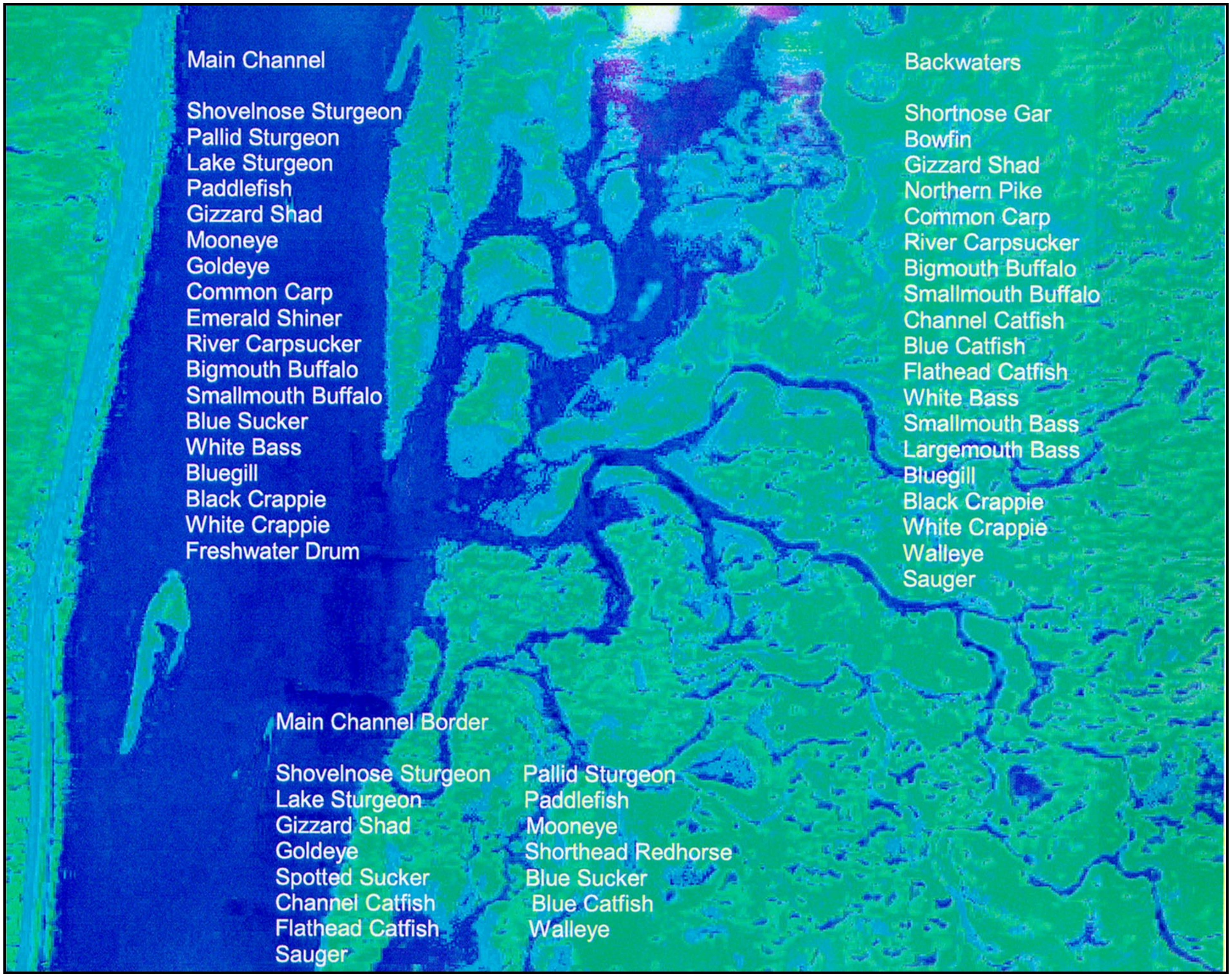

Figure 2. The general within-pool distribution of the larval stages of the study fish species

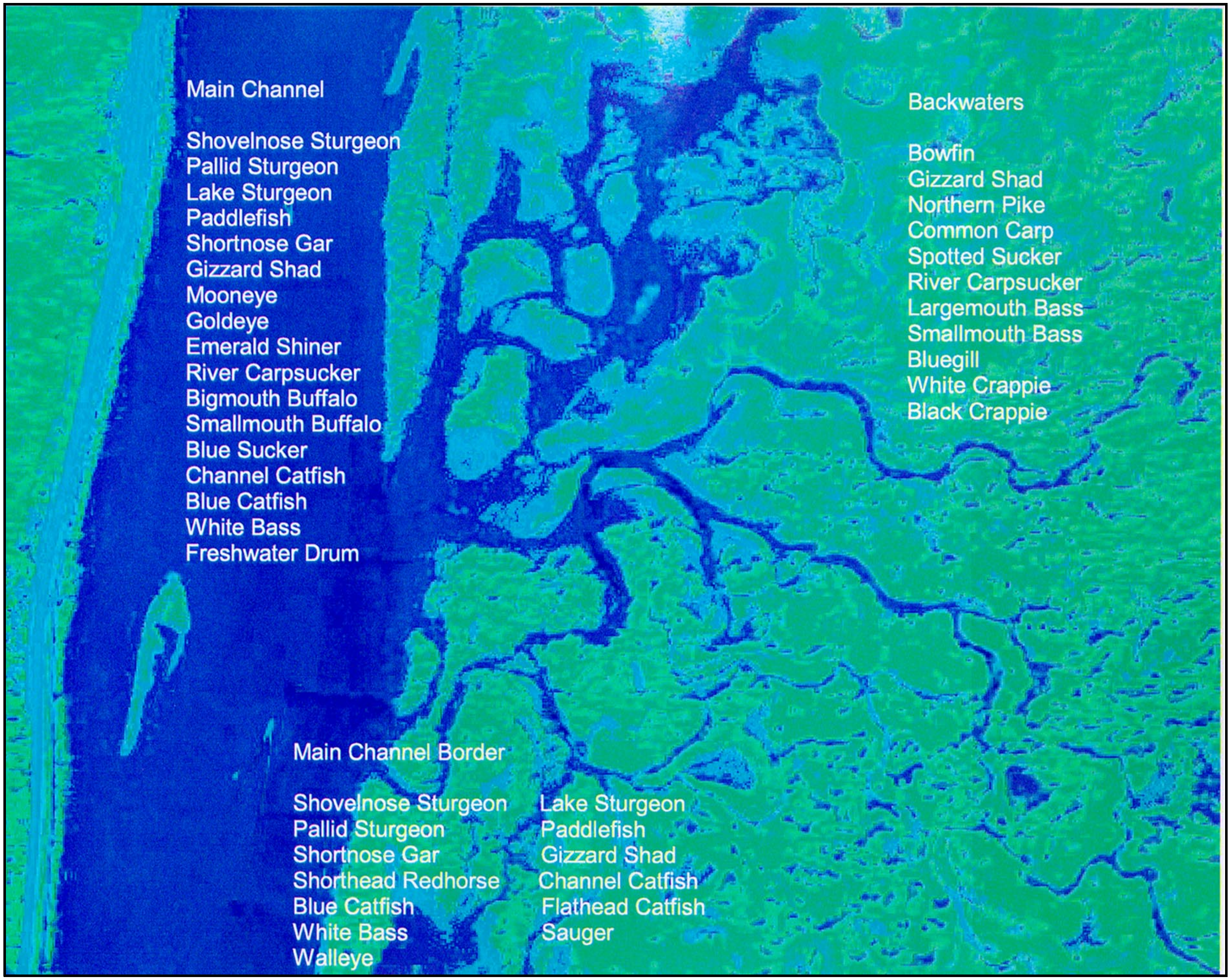

Figure 3. The general within-pool distribution of the juvenile stages of the study fish species

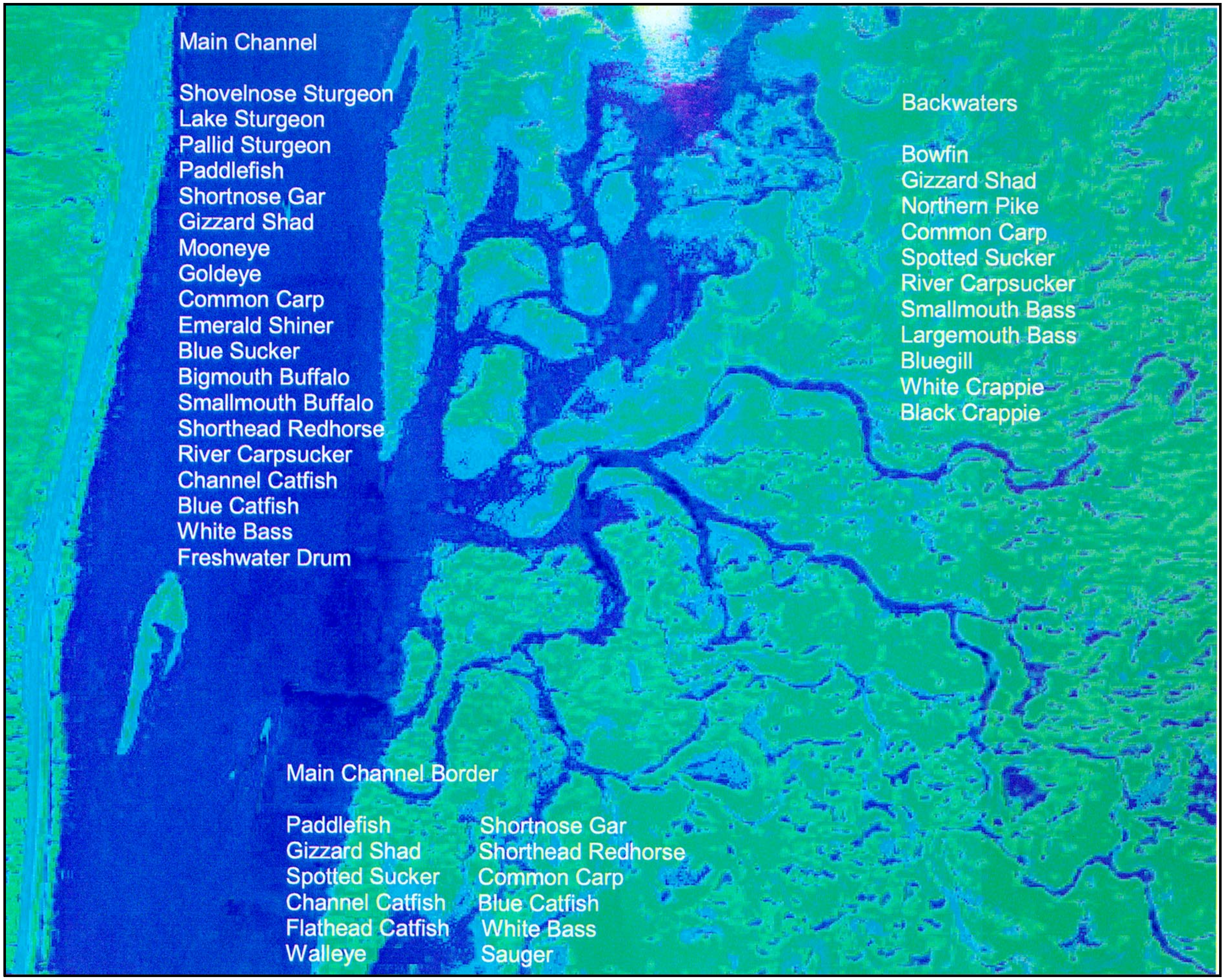

Figure 4. The general within-pool distribution of the adult stages of the study fish species

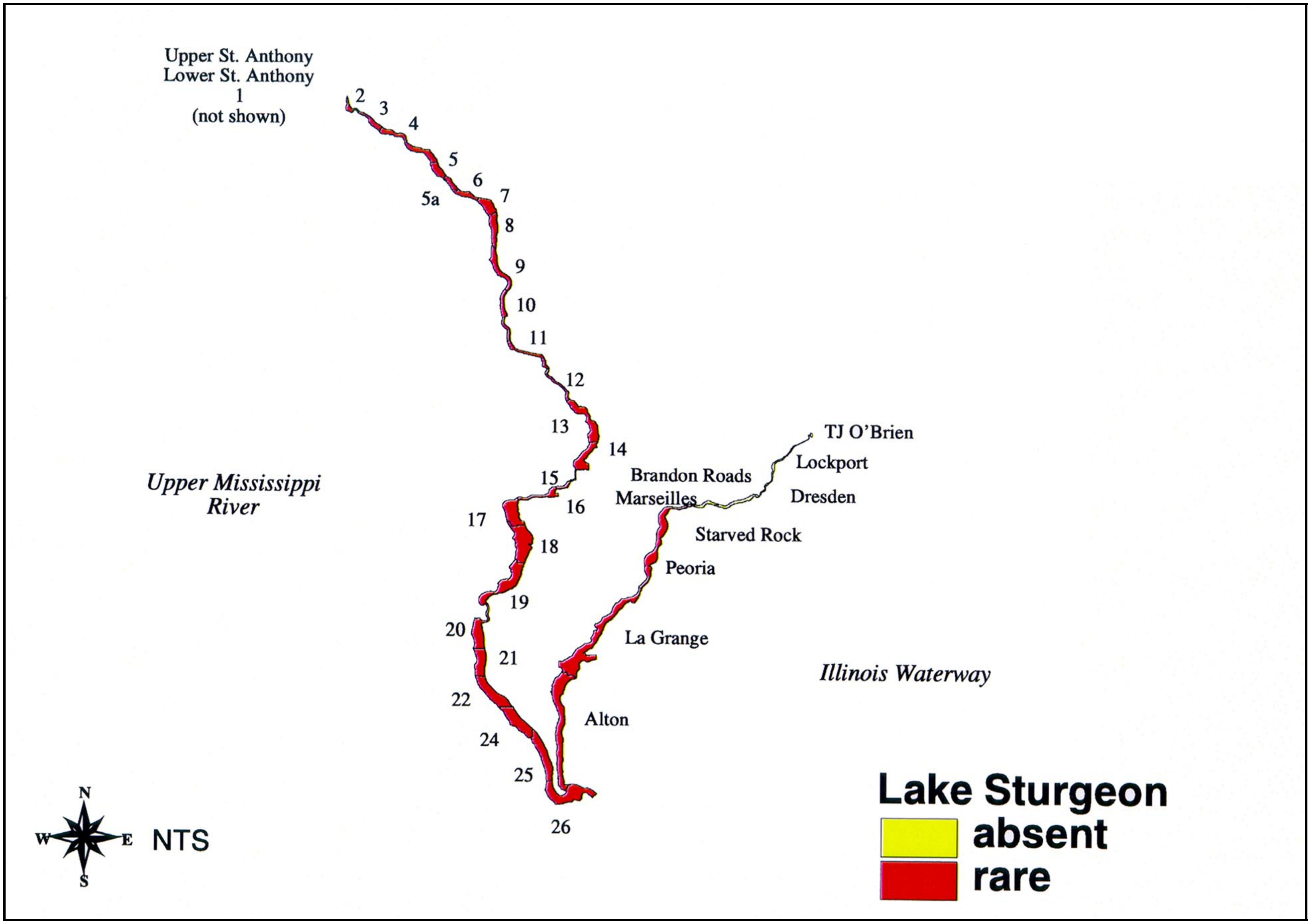

Figure 5. Distribution and abundance of lake sturgeon in the Upper Mississippi River and the Illinois Waterway

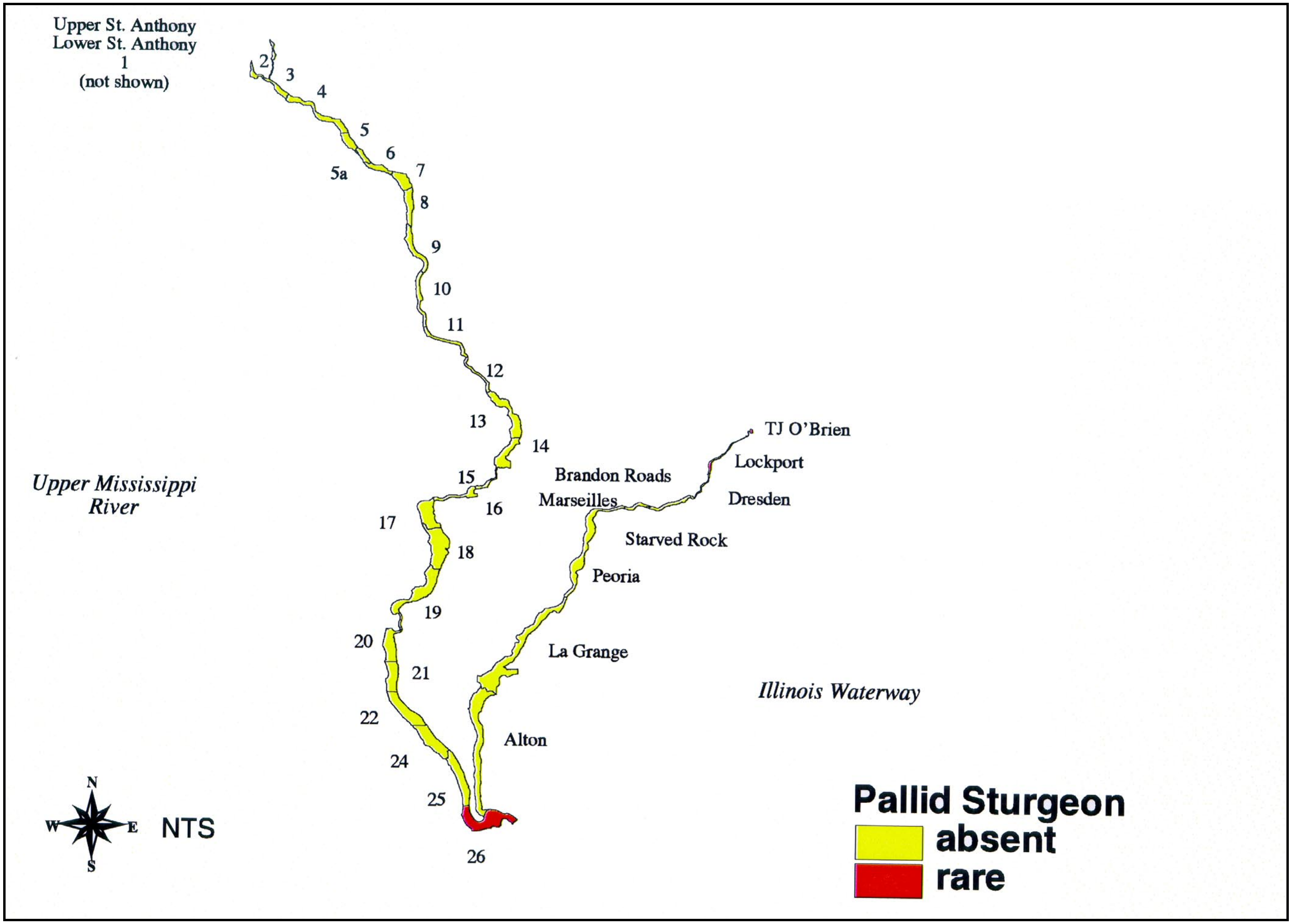

Figure 6. Distribution and abundance of pallid sturgeon in the Upper Mississippi River and the Illinois Waterway

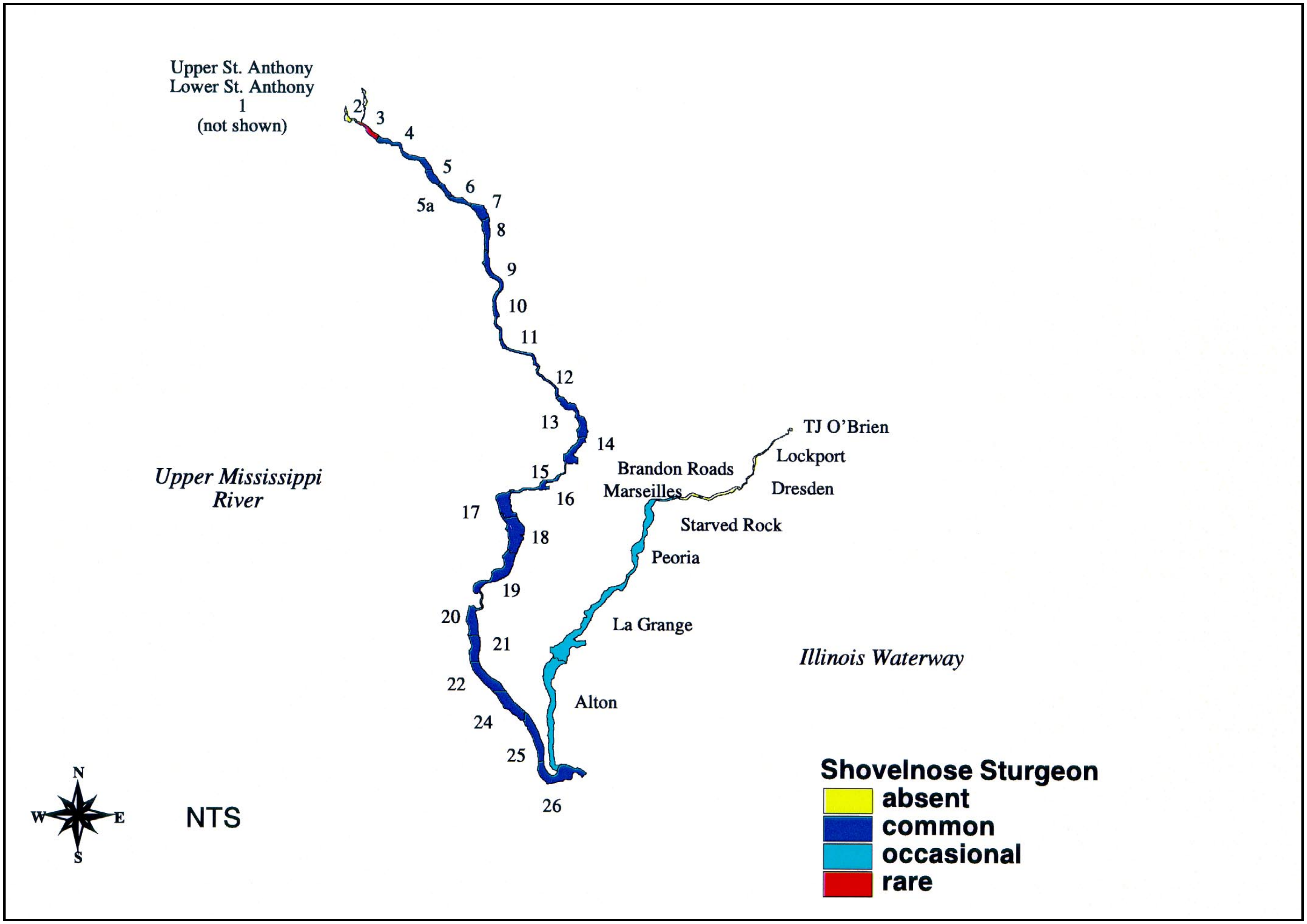

Figure 7. Distribution and abundance of shovelnose sturgeon in the Upper Mississippi River and the Illinois Waterway

females and yearly or in alternate years for males (Etnier and Starnes 1993). The large, adhesive eggs are deposited on the shallow, gravelly riffles of streams or the rocky shoals of lakes (Pflieger 1997). Lake sturgeon grow and mature slowly, with first spawning occurring at about 14-25 years of age (Etnier and Starnes 1993; Pflieger 1997). Males and females have similar growth rates, but females have longer life spans and reach much larger sizes (Etnier and Starnes 1993). Lake sturgeon live to be much older than other North American freshwater fish, with maximum age estimates of as much as 154 years (Etnier and Starnes 1993).

Very little is known concerning the rare pallid sturgeon (Etnier and Starnes 1993). The pallid sturgeon is an inhabitant of the open channels of large, turbid rivers; it lives on the bottom in areas having strong current and firm substrate, along sandbars, and behind wing dikes with deeply scoured trenches (Pflieger 1997). Although the pallid sturgeon often occurs in association with the shovelnose sturgeon, it is more restricted to areas of strong current (Pflieger 1997). The diet of pallid sturgeon consists of immature aquatic insects and small fish (Etnier and Starnes 1993). When and where pallid sturgeon spawn are not known; however, because it hybridizes with shovelnose sturgeon, spawning conditions for the two species must be similar (Etnier and Starnes 1993; Pflieger 1997). Females may spawn for the first time at ages 15 to 20 and at intervals of several years thereafter (Pflieger 1997). The pallid sturgeon is considerably larger than the shovelnose sturgeon (Etnier and Starnes 1993), and studies have shown that it attains an age of at least 41 years (Pflieger 1997).

The shovelnose sturgeon inhabits deep channels of rivers near the bottom (Figure 4), often in areas of swift current with a sand or gravel bottom (Becker 1983; Etnier and Starnes 1993; Pflieger 1997). It is the sixth most abundant species captured near wingdams, closing dams, and other structures that accelerate water flow or direct flow toward the main channel (Pitlo 1981; Becker 1983). Shovelnose sturgeon are omnivores but commonly eat immature stages of aquatic insects (Littlejohn et al. 1985). Young of the year have been collected in the main channel and main channel border areas near wingdams (Farabee 1979) (Figure 3). Larvae have rarely been collected in drift studies on the UMR but are suspected to occur in the main channel drift based on the reproductive strategy of the species (Holland et al. 1984; Holland-Bartels et al. 1990b; Gutreuter, Dettmers, and Wahl 1998). Spawning of shovelnose sturgeon has been reported in late April through early June (Smith 1979, Holland-Bartels et al. 1990b). Spawning is believed to occur in open channels of large rivers in areas of strong current over rocky or gravel bottoms (Pflieger 1997). Upstream migrations into smaller streams for spawning have been reported, and spawning may also occur in the tailwaters of navigation dams (Holland-Bartels et al. 1990b).

Paddlefishes

The primitive freshwater family Polyodontidae contains only two living species: *Polyodon spathula* in the Mississippi-Ohio-Missouri River systems and *Psephurus gladius* in the Yangtze River of China (Pflieger 1997). Paddlefish are commonly found in most of the UMR-IWW System (Figure 8). Paddlefish have been collected in LTRMP fish surveys from 1991 through 1997 in UMR Pools 4

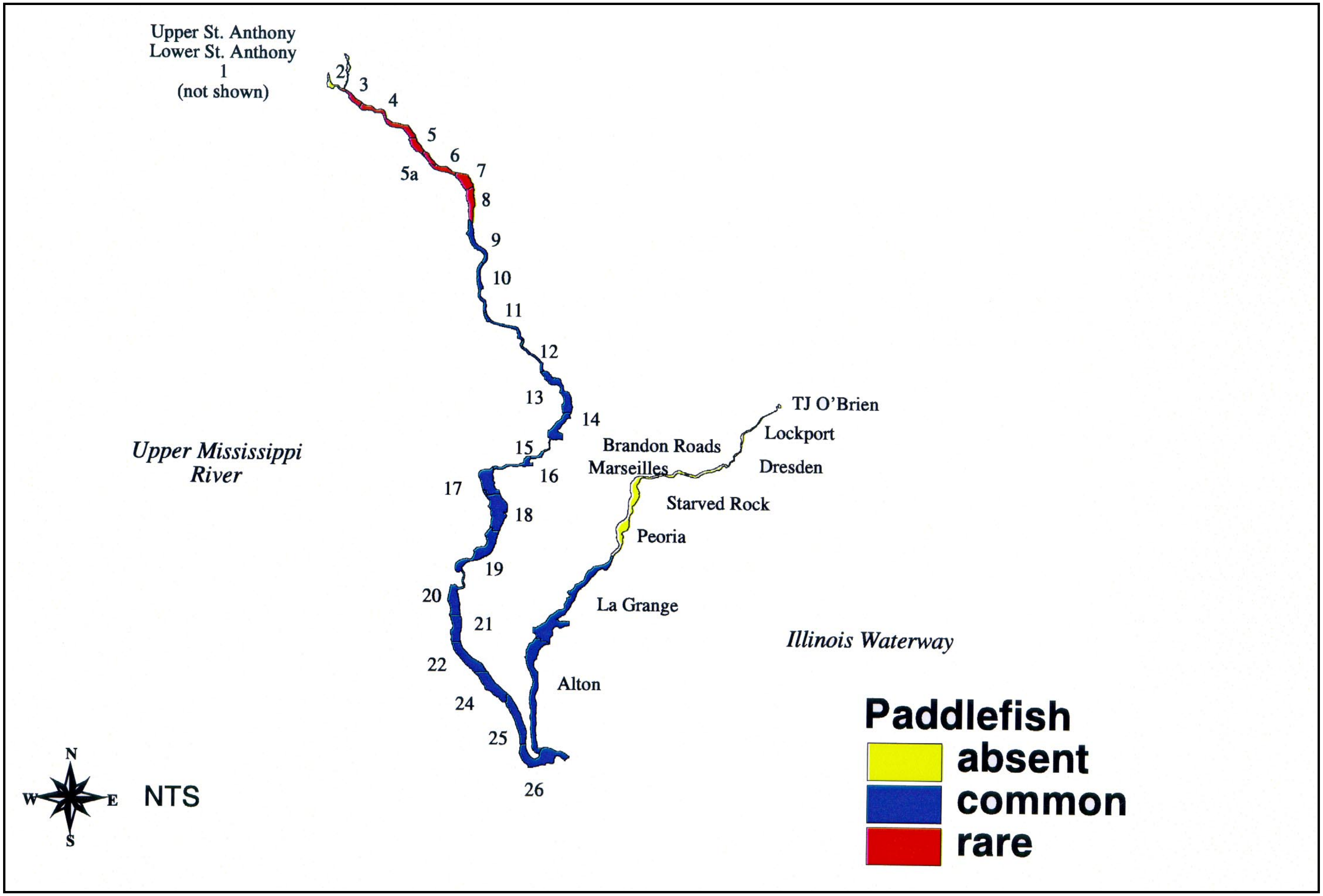

Figure 8. Distribution and abundance of paddlefish in the Upper Mississippi River and the Illinois Waterway

(1), 13 (1), and 26 (3); the open Mississippi River (33); and the IWW La Grange Pool (3) (Burkhardt et al. 1997, 1998; Gutreuter et al. 1997a, 1997b, 1997c, 1997d, 1998). They are listed as threatened by Wisconsin and Minnesota and are on the watch list in Missouri (Table 2). A distinctive feature of the sharklike paddlefish is the long, paddle-shaped snout, whose function is still a matter of debate (Pflieger 1997). While the meat of paddlefish continues to have a ready market, the recent heavy utilization of paddlefish eggs for caviar has dramatically increased the commercial demand (Etnier and Starnes 1993). Paddlefish are apparently more adaptable to impoundments and increased silt deposition than are the sturgeons (Etnier and Starnes 1993).

The paddlefish inhabits quiet, slow-flowing, open waters (Pflieger 1997), most often in main channel border and tailwater habitats (Scott and Crossman 1973; Moen et al. 1992) (Figures 2, 3, and 4). The paddlefish is a continuously swimming, filter-feeding planktivore. It has long, closely spaced gill rakers (Eddy and Underhill 1974). Paddlefish make upstream spawning runs and spawn in large, free-flowing rivers over sand and pebbles near gravel bars that are subject to sustained inundation during spring floods (Holland-Bartels et al. 1990b; Etnier and Starnes 1993). They also successfully use tailwater areas below dams with seasonal success dependent directly on spring water flow levels (Etnier and Starnes 1993). Spawning occurs from March to June, but not all adults spawn every year (Carlander 1969; Holland-Bartels et al. 1990b). Paddlefish larvae have been rarely collected, and little is known of their early life history requirements. However, because of their reproductive strategy, paddlefish larvae are suspected to occur in the main channel drift (Holland et al. 1984; Holland-Bartels et al. 1990b). Paddlefish are long-lived; individuals 20 years old are common, and some live 30 years or more (Pflieger 1997).

Gars

Gars represent the only living family of Lepisosteiformes, an ancient order of bony fishes. This family (Lepisosteidae) has only one existing genus, *Lepisosteus*, for which seven species have been described (Scott and Crossman 1973). Four species occur in the UMR-IWW System, and the shortnose gar is common in most of the system (Van Vooren 1983) (Figure 9).

The shortnose gar, which is a piscivore, inhabits open turbid rivers, quiet pools, backwaters, and oxbows (Holland-Bartels et al. 1990b). It is one of the smaller gars and is somewhat more generalized in its food habits (Pflieger 1997). The shortnose gar is apparently better adapted to murky environments than other species of gar (Pflieger 1997). They spawn in backwaters or grassy, shallow sloughs from May to July (Becker 1983; Holland-Bartels et al. 1990b; Pflieger 1997). Larvae are closely associated with vegetation and are rarely collected in drift studies (Holland-Bartels et al. 1990b) (Figure 2). Little information is available on the ecology of the early life history stages in the UMR.

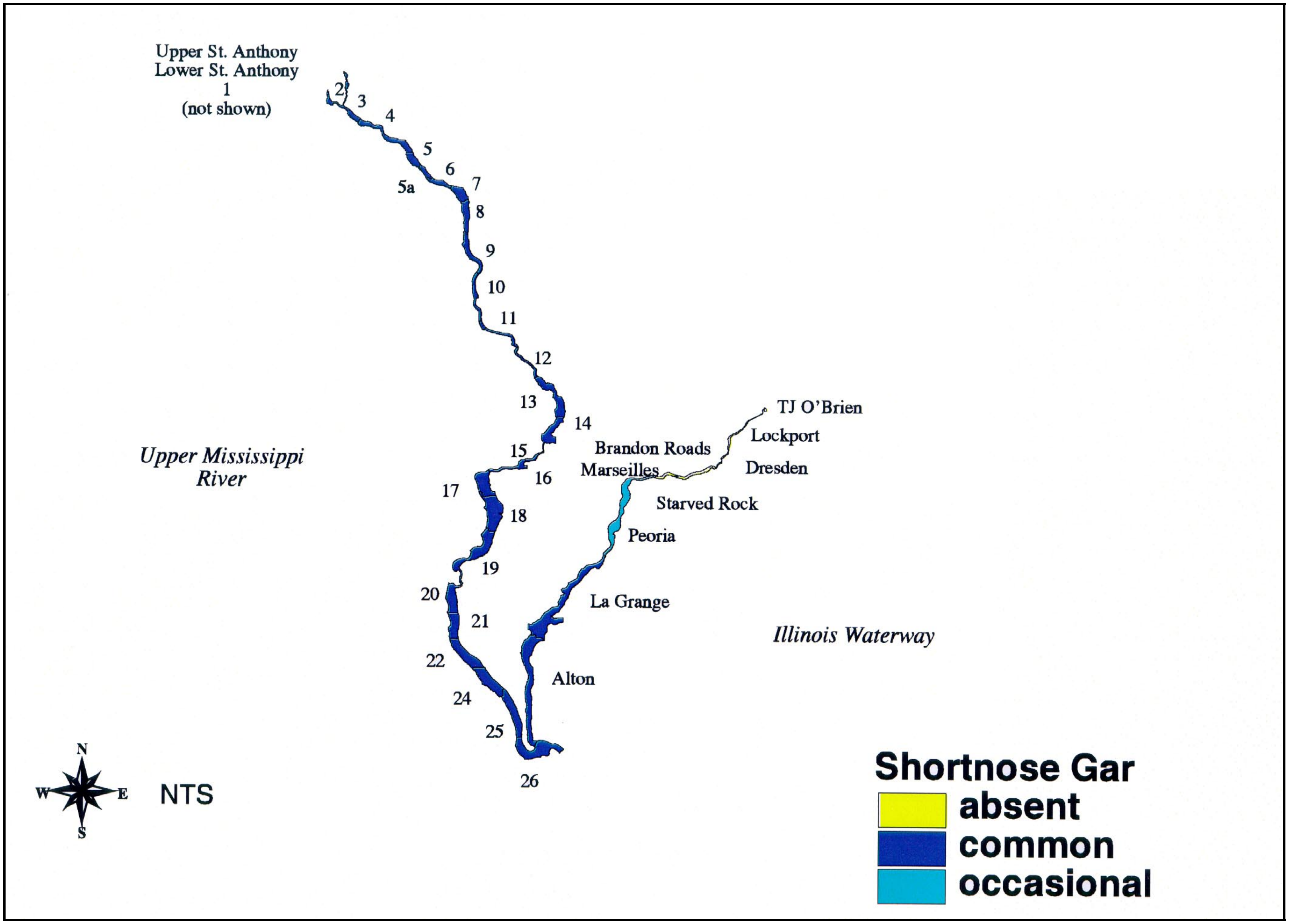

Figure 9. Distribution and abundance of shortnose gar in the Upper Mississippi River and the Illinois Waterway

Bowfins

The bowfin (Family Amiidae) are the only living representatives of the order Amiiformes and only one species, *Amia calva*, exists (Holland-Bartels et al. 1990b). Bowfin are piscivorous and live in sluggish rivers and lakes where the water is clear and the vegetation is abundant (Carlander 1969); their habitat also includes oxbows, marshes, and harbors (Figure 4). They are commonly found in the UMR and occasionally occur in the IWW (Figure 10). Little information is available on the requirements and ecology of the early life stages in the UMR (Holland-Bartels et al. 1990b).

Bowfin spawn in shallow, sluggish, weedy, or stagnant water; nests are constructed and fanned by a male until a clean bed of roots, sand, or gravel is formed (Holland-Bartels et al. 1990b). The nests and fry are vigorously guarded by the male (Becker 1983; Pflieger 1997). Spawning occurs from April to June (Holland-Bartels et al. 1990b; Pflieger 1997).

Herrings

The Clupeidae or herring family is primarily marine and contains only a few freshwater species. Many species are anadromous, spending most of their adult life in salt water but ascending freshwater streams to spawn (Pflieger 1997). Herrings are certainly among the most valuable commercial fishes in the world, being important food fishes in many countries and serving as a chief source of fishmeal for animal feeds; in addition, some species provide an extremely important forage base for game fishes (Etnier and Starnes 1993). Four species (Alabama shad (*Alosa alabamae*), skipjack herring (*Alosa chrysochloris*), gizzard shad, and threadfin shad (*Dorosoma petenense*)) are found in the UMR, but only gizzard shad are common (Van Vooren 1983).

Gizzard shad, which are planktivores, inhabit quiet waters that may range from clear to extremely turbid; they avoid high-gradient streams and prefer waters of high productivity, such as the large, permanent pools in the UMR-IWW System (Pflieger 1997). Gizzard shad travel in large schools near the surface and are considered an important forage species (Scott and Crossman 1973).

Gizzard shad are abundant in all pools of the UMR-IWW System (Figure 11) and are found in virtually all habitats of the river system (Figures 2, 3, and 4). Gizzard shad spawn from April through August in the UMR-IWW System, and spawning occurs in sloughs, ponds, lakes, large rivers, and protected bays over sand, gravel, and boulders (Holland-Bartels et al. 1990b; Etnier and Starnes 1993). Larvae are present in the ichthyoplankton drift in June and July and are much more numerous in backwaters than in main channel areas (Holland-Bartels et al. 1990b; Gutreuter, Dettmers, and Wahl 1998). Larval gizzard shad are twice as abundant at dusk than at any other time (Holland and Sylvester 1983).

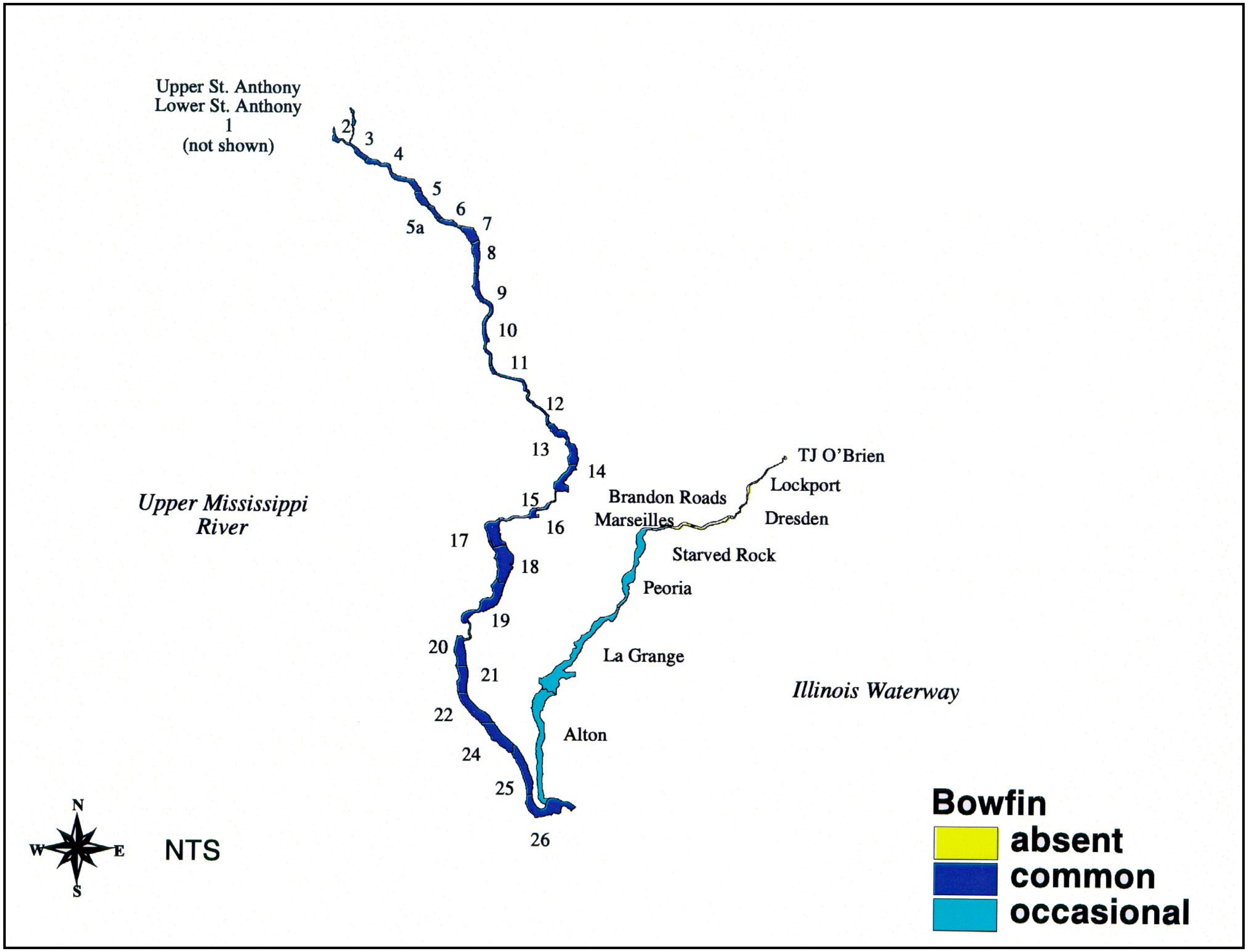

Figure 10. Distribution and abundance of bowfin in the Upper Mississippi River and the Illinois Waterway

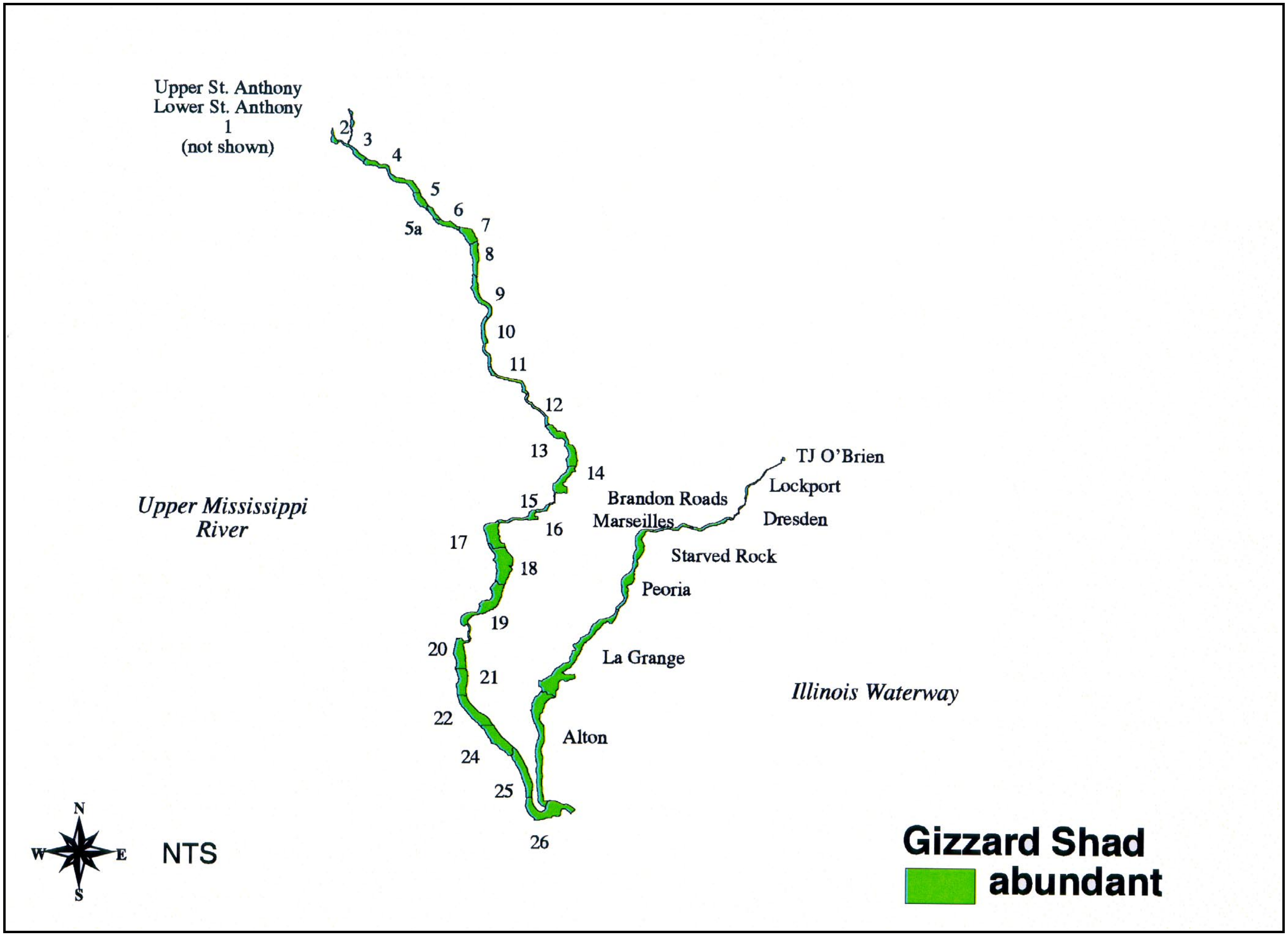

Figure 11. Distribution and abundance of gizzard shad in the Upper Mississippi River and the Illinois Waterway

Mooneyes

The primitive, strictly North American family, Hiodontidae, consists of a single genus containing two omnivorous species: the goldeye and the mooneye (Holland-Bartels et al. 1990b). Adult goldeye inhabit quiet, turbid waters of major rivers; their large eyes are adapted to dim light (Carlander 1969; Becker 1983). The species is rarely to occasionally found in the UMR and common in much of the IWW (Figure 12). Goldeye are listed as endangered by the state of Wisconsin (Table 2). Little information is available on the early life history of the goldeye in the UMR (Holland-Bartels et al. 1990b). Goldeye spawn in April and May in pools or backwater areas of turbid rivers (Scott and Crossman 1973; Holland-Bartels et al. 1990b); only half of females spawn in any given year (Grosslein and Smith 1959).

Mooneye are commonly to occasionally found in the UMR-IWW System (Figure 13); they are listed as rare by the state of Missouri (Table 2). This species inhabits large, quiet pools of streams and lakes and has a lower tolerance for silt than the goldeye (Carlander 1969). Larvae are only rarely collected in the main channel drift and occur in May and June; they are found in vegetation in backwater and main channel border habitats (Holland et al. 1983; Holland-Bartels et al. 1990b). Mooneye migrate up clear streams to spawn in April and May (Becker 1983).

Pikes

Pikes (Family Esocidae) are distributed extensively from the arctic to the subtropical regions of the Northern Hemisphere (Scott and Crossman 1973). Of the five species found in North America, three occur in the UMR-IWW System, but only the northern pike occurs regularly (Holland-Bartels et al. 1990b). Northern pike are commonly found in the upper pools of the UMR, while they occur occasionally in the lower pools of the UMR and the IWW (Figure 14). The northern pike is listed as rare by the state of Missouri (Table 2).

Northern pike inhabit a variety of habitats, including lakes, reservoirs, and large streams (Pflieger 1997). They occur primarily in clear, warm, slow, meandering, heavily vegetated rivers, or in warm, weedy bays of lakes (Holland-Bartels et al. 1990b). Northern pike are piscivorous (Littlejohn et al. 1985), and adults prefer shallow water in the spring and fall and move to deep water during the summer (Scott and Crossman 1973).

Northern pike spawn in heavily vegetated floodplains of rivers, marshes, and bays over plant material (Etnier and Starnes 1993; Pflieger 1997); spawning occurs in March and April (Becker 1983). Newly hatched northern pike attach themselves to flooded emergent vegetation by an adhesive organ on their snout (Holland-Bartels et al. 1990b) (Figure 2). Since they remain in shallow nursery areas, northern pike larvae rarely appear in standard towed or set plankton net collections of ichthyoplankton (Farabee 1979). Juveniles remain in or near submerged vegetation throughout their first summer (Holland and Huston 1984) (Figure 3).

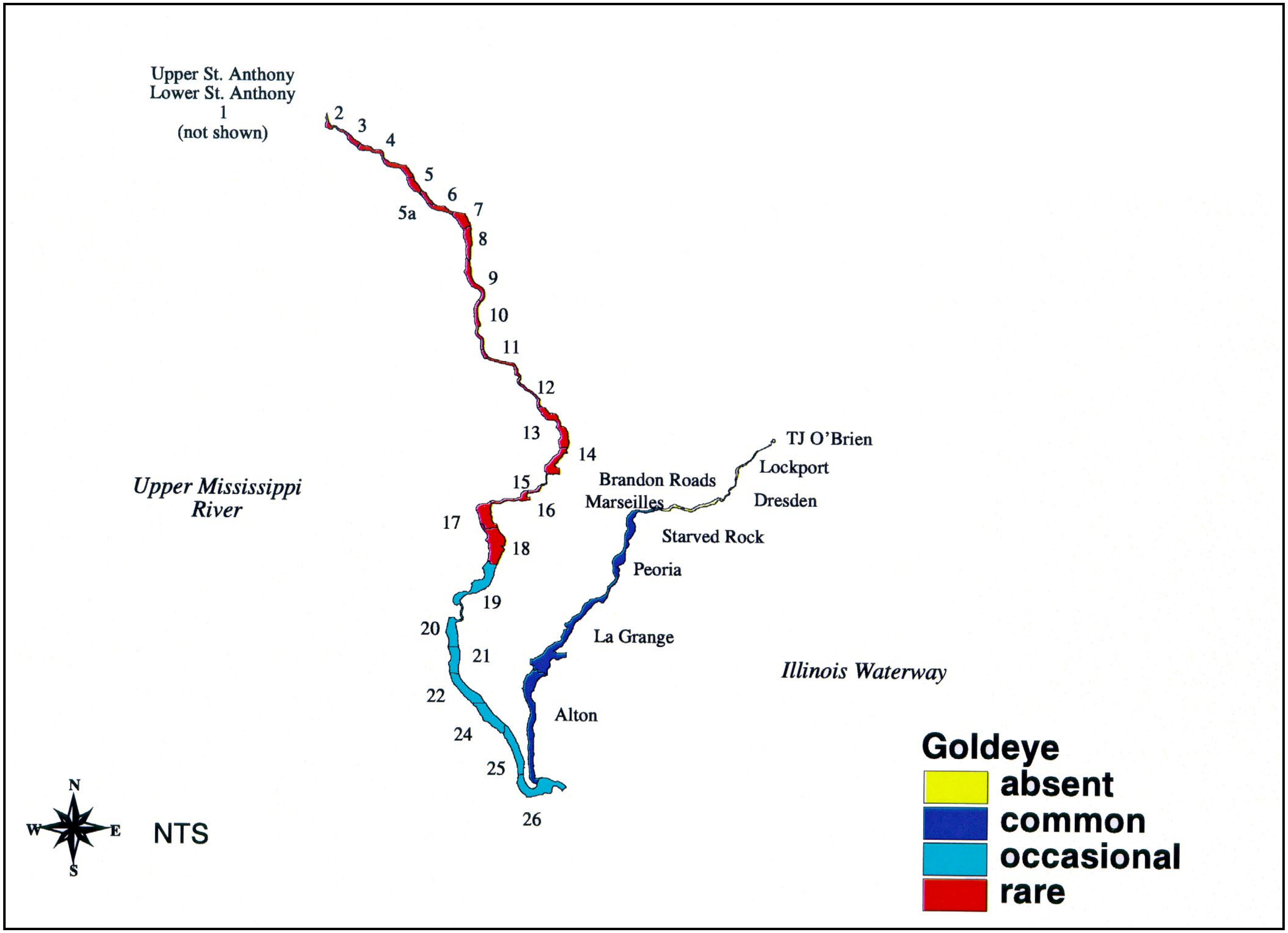

Figure 12. Distribution and abundance of goldeye in the Upper Mississippi River and the Illinois Waterway

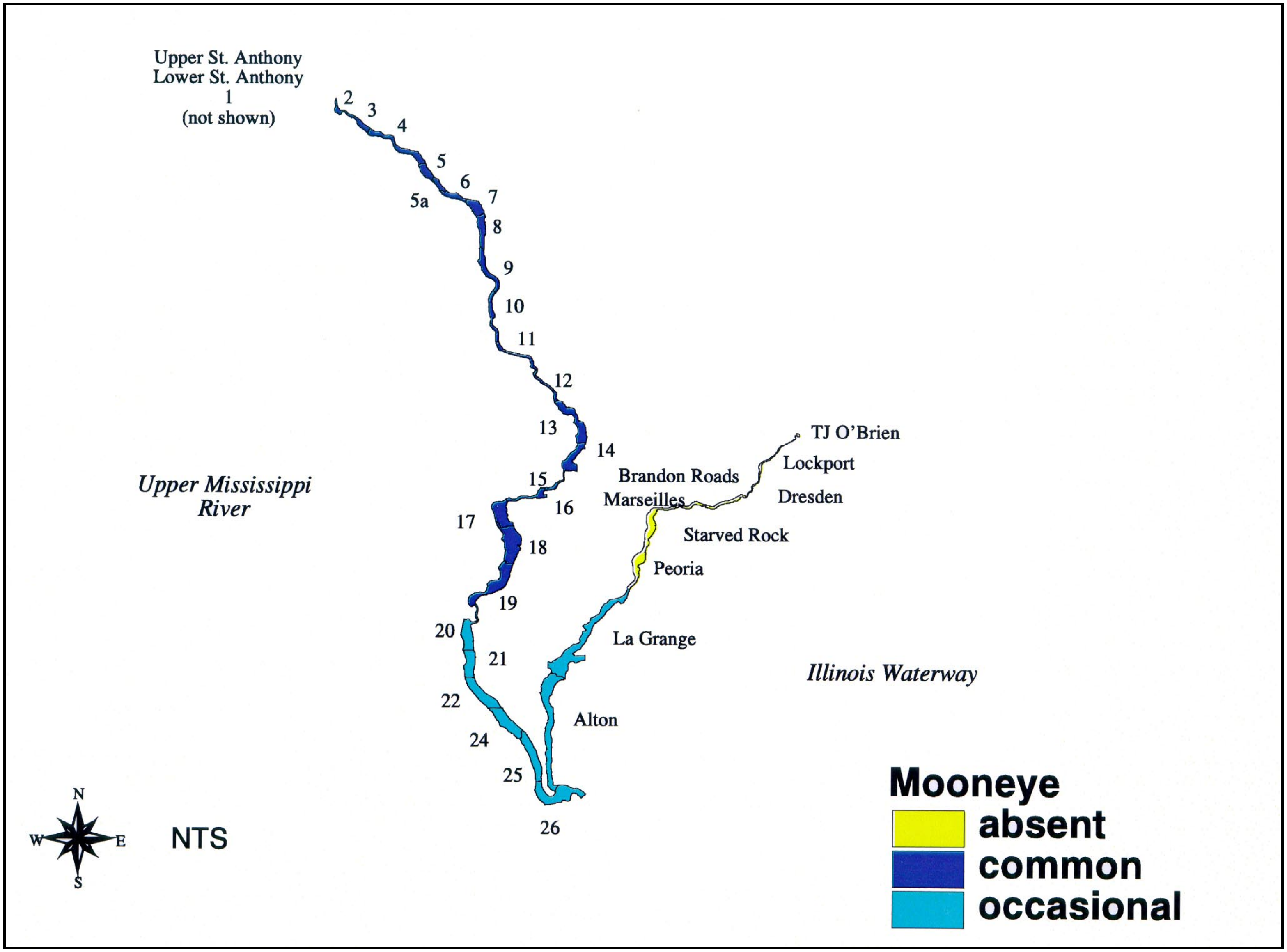

Figure 13. Distribution and abundance of mooneye in the Upper Mississippi River and the Illinois Waterway

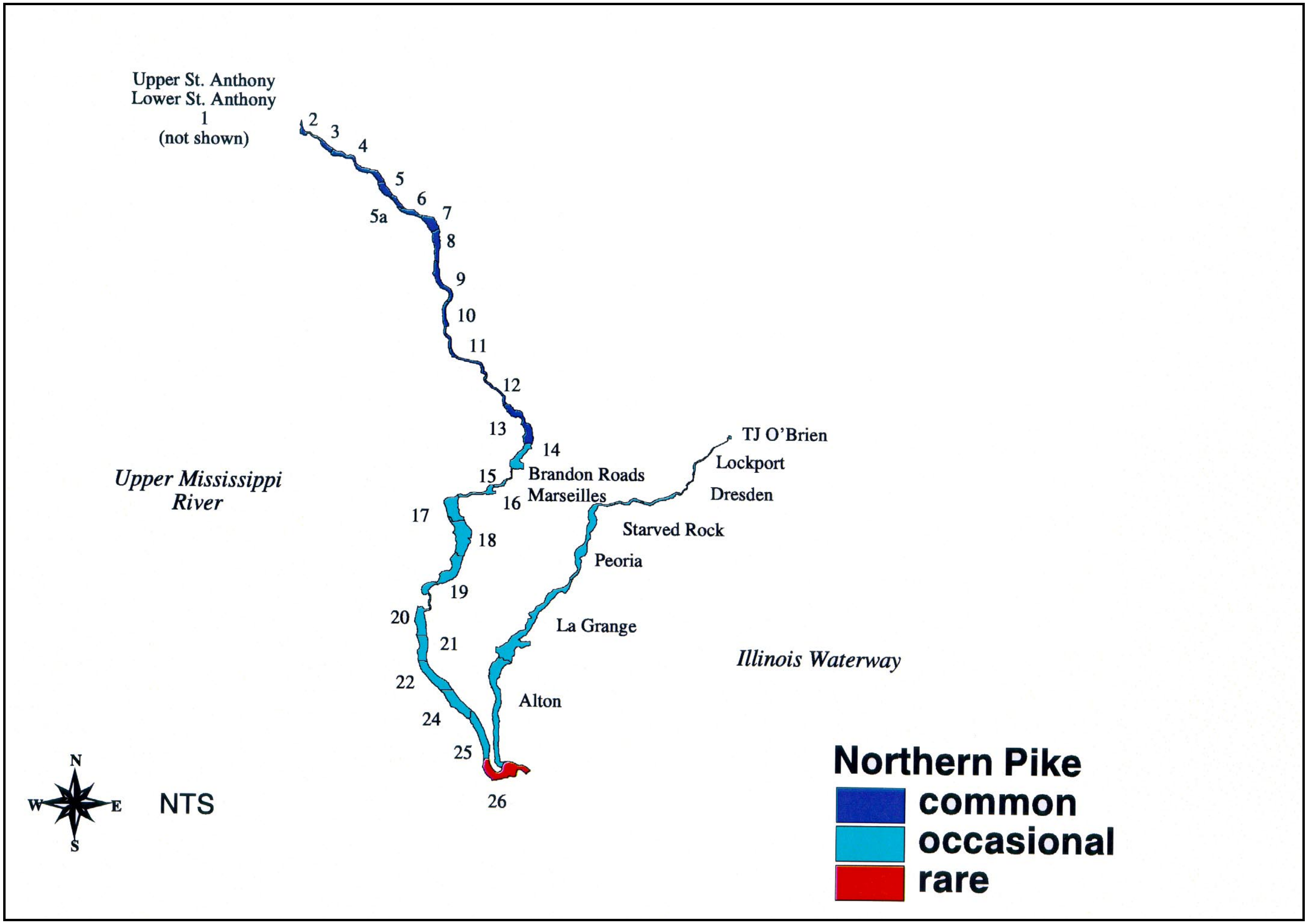

Figure 14. Distribution and abundance of northern pike in the Upper Mississippi River and the Illinois Waterway

Minnows

Minnows (Family Cyprinidae) constitute one of the largest families of fishes in the world; there are more than 1,500 species, and they occur on every continent except South America and Australia (Scott and Crossman 1973; Pflieger 1997). Two minnow species were selected for this ecological risk assessment: the common carp, an important commercial species, and emerald shiner, an important forage species.

Common carp were successfully introduced into North America from Europe in 1877 and have spread throughout many river systems in the United States (Eddy and Underhill 1974). Common carp have become so abundant in suitable habitats that they are often accused of competing for food and space with more desirable fish species; their feeding habits frequently result in a general deterioration of the habitat through increased turbidity and the destruction of aquatic vegetation (Pflieger 1997). The nuisance qualities of common carp may be somewhat exaggerated although a basis exists for being concerned (Pflieger 1997). The common carp is an omnivore found in the main channel, main channel border, and backwater areas (Figure 4); they are abundant in the entire UMR-IWW System (Figure 15). Carp prefer the relatively warm water of shallow, mud-bottomed lakes and large streams (Becker 1983); they are especially prevalent in highly productive lakes, streams, and man-made impoundments (Pflieger 1997). Common carp spawn in shallow, weedy areas of lakes, marshes, and swamps; in ponds and sheltered vegetated areas of streams; or over tree roots, aquatic vegetation, and mud bottoms (Holland-Bartels et al. 1990b). Spawning occurs from May through early August (Swee and McCrimmon 1966; Becker 1983). Larval carp are most abundant in backwaters, but they also occur in the main channel drift; they are present from early May through late August and are at peak densities from mid-June to mid-July (Holland-Bartels et al. 1990b; Gutreuter, Dettmers, and Wahl 1998). Larval carp show a strong diel drift pattern (Holland and Sylvester 1983). Juvenile common carp most often occur in shallow weedy areas but have been collected from a wide variety of habitats (Farabee 1979).

The emerald shiner is the most common minnow in the Mississippi River, and it is abundant throughout the UMR-IWW System (Figure 16). The emerald shiner, which is tolerant of a wide range of turbidity and bottom types, lives in the main, open channels of large, low-gradient streams where there is noticeable current (Etnier and Starnes 1993; Pflieger 1997) (Figures 2, 3, and 4). This species is omnivorous (Littlejohn et al. 1985), and schools of emerald shiner stay close to the surface or at middepths (Trautman 1957). Emerald shiners spawn just beneath the surface in shallow water over sand or firm mud from late May to mid-August (Holland-Bartels et al. 1990b; Pflieger 1997). Larval emerald shiners are particularly common in the main channel drift with peak abundance near mid-June (Holland et al. 1984; Holland-Bartels et al. 1990b).

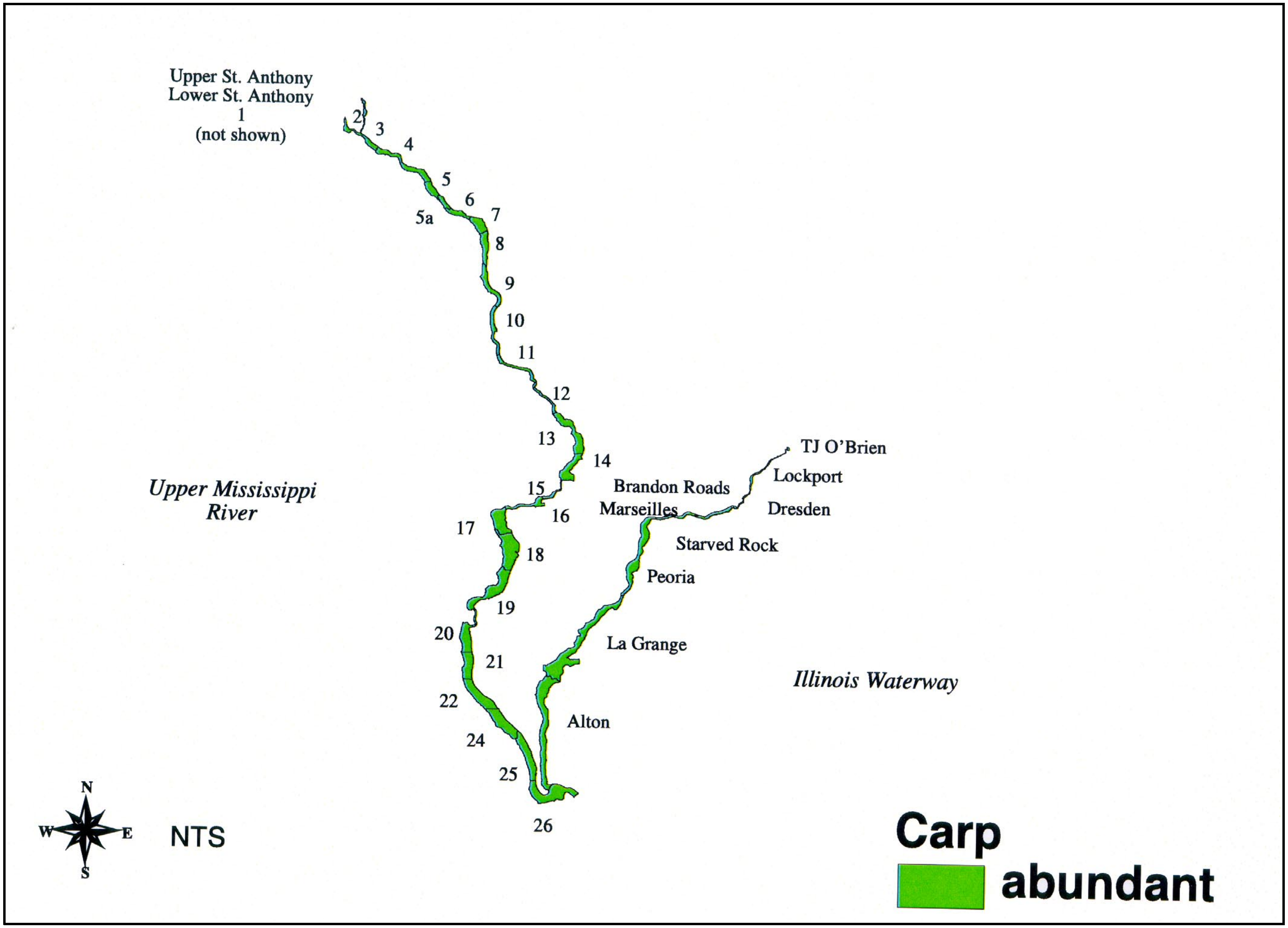

Figure 15. Distribution and abundance of carp in the Upper Mississippi River and the Illinois Waterway

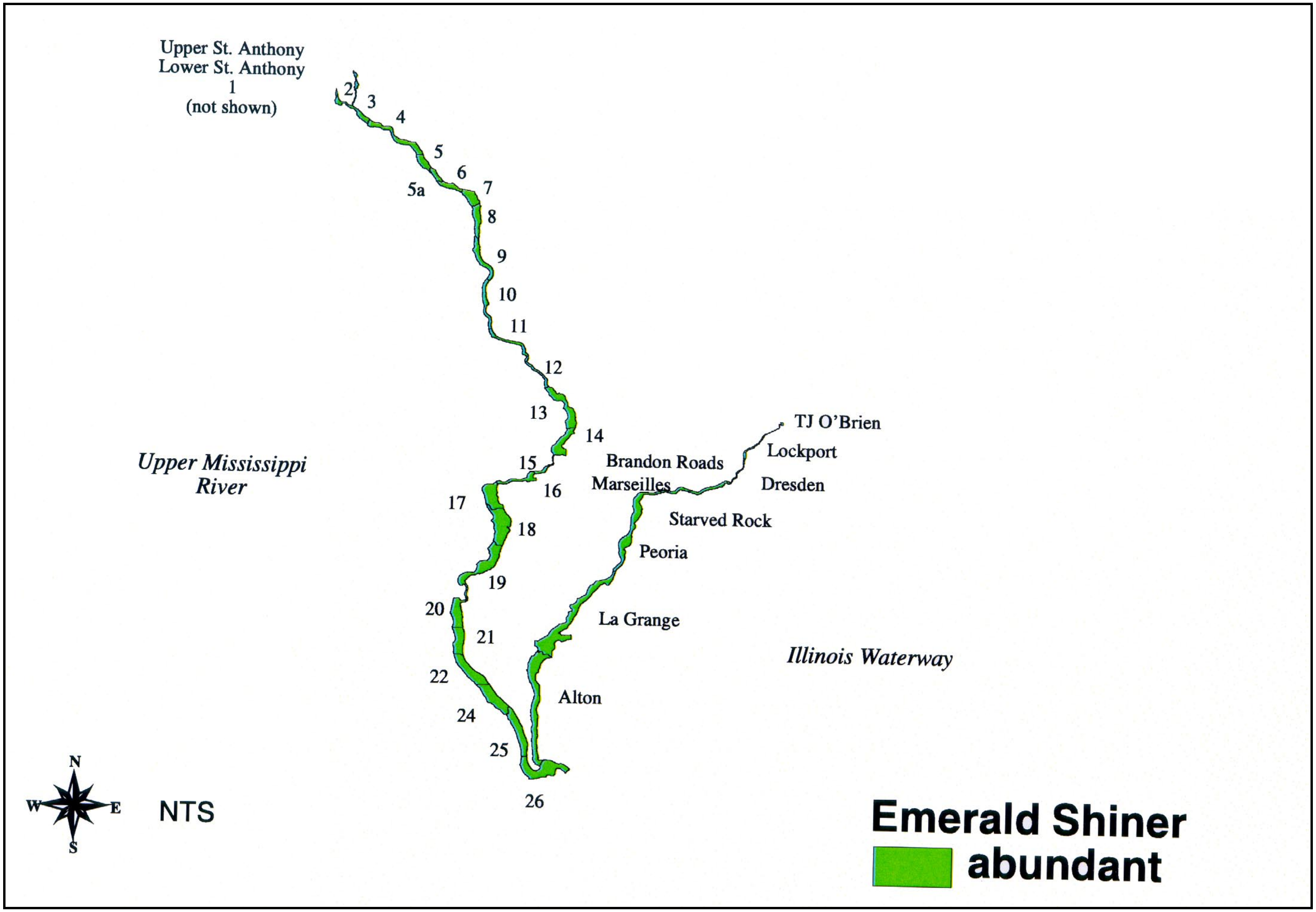

Figure 16. Distribution and abundance of emerald shiner in the Upper Mississippi River and the Illinois Waterway

Suckers

The sucker family (Catostomidae) is a large family of mainly freshwater North American fishes consisting of about 60 species (Becker 1983); eleven species are common in the UMR-IWW System (Van Vooren 1983). Suckers are generally bottom-dwellers and omnivorous (Littlejohn et al. 1985; Holland-Bartels et al. 1990b). Sucker species selected for this ecological risk assessment include the river carpsucker, blue sucker, smallmouth buffalo, bigmouth buffalo, spotted sucker, and shorthead redhorse.

The river carpsucker prefers quiet, still pools, backwaters, and oxbows of large streams with low gradients (Holland-Bartels et al. 1990b) (Figure 4). It occurs in large schools, feeds at the bottom, and seems to prefer turbid water (Pflieger 1997). Adult river carpsuckers have been commonly collected in most of the UMR-IWW System (Figure 17). River carpsuckers spawn from May through July over silt or sand bottoms of rivers or tributaries but not in lakes or reservoirs (Jester 1972; Smith 1979; Holland-Bartels et al. 1990b); they are most successful in years of high water levels when meadows or marshes flood (Walburg 1976). River carpsucker larvae are common in backwater habitats of the UMR and are consistently collected in the main channel drift; peak densities occur in late May (Holland 1985; Holland-Bartels et al. 1990b) (Figure 2).

The blue sucker is listed as threatened in Wisconsin, is a species of special concern in Minnesota, and is on the watch list in Missouri (Table 2). The blue sucker is rare in the UMR and absent from the IWW (Figure 18). Small numbers of blue sucker have consistently been collected in the LTRMP fish surveys in UMR Pools 4, 8, 13, 26 and in the open Mississippi River from 1991 through 1997 (Burkhardt et al. 1997, 1998; Gutreuter et al. 1997a, 1997b, 1997c, 1997d, 1998). This highly mobile fish may be more abundant and widespread than available records suggest because it is not readily captured by the sampling gear and techniques ordinarily used in fish surveys (Pflieger 1997). Dams have likely been detrimental to this migratory species (Pflieger 1997). Blue suckers, which are bottom feeders, inhabit the main river channel in areas that are deep with swift currents over a bottom of sand, gravel, or rock (Etnier and Starnes 1993; Pflieger 1997). Most of these habitats occur where the channel is constricted by natural or artificial obstructions, including bedrock or boulder riffles and the tailwaters of dams, wing dikes, and bridge abutments (Pflieger 1997). The blue sucker is tolerant of high turbidity if there is sufficient current to prevent the deposition of silt (Pflieger 1997). Spawning occurs from late April through June (Rupprecht and Jahn 1980; Pflieger 1997).

Smallmouth buffalo prefer clean, clear, deep waters with a moderate current; they live in pools, oxbows, and the deeper water of large rivers (Becker 1983). Smallmouth buffalo are the most abundant species of *Ictiobus* in the UMR (Holland-Bartels et al. 1990b); the general habitat of this fish is the main channel (Littlejohn et al. 1985) (Figure 4). Smallmouth buffalo are commonly to occasionally found in the UMR-IWW System (Figure 19). They spawn from April through June in shallow areas, randomly over the bottom, and often in vegetation that may be submerged or floating; they prefer to spawn in marshes or

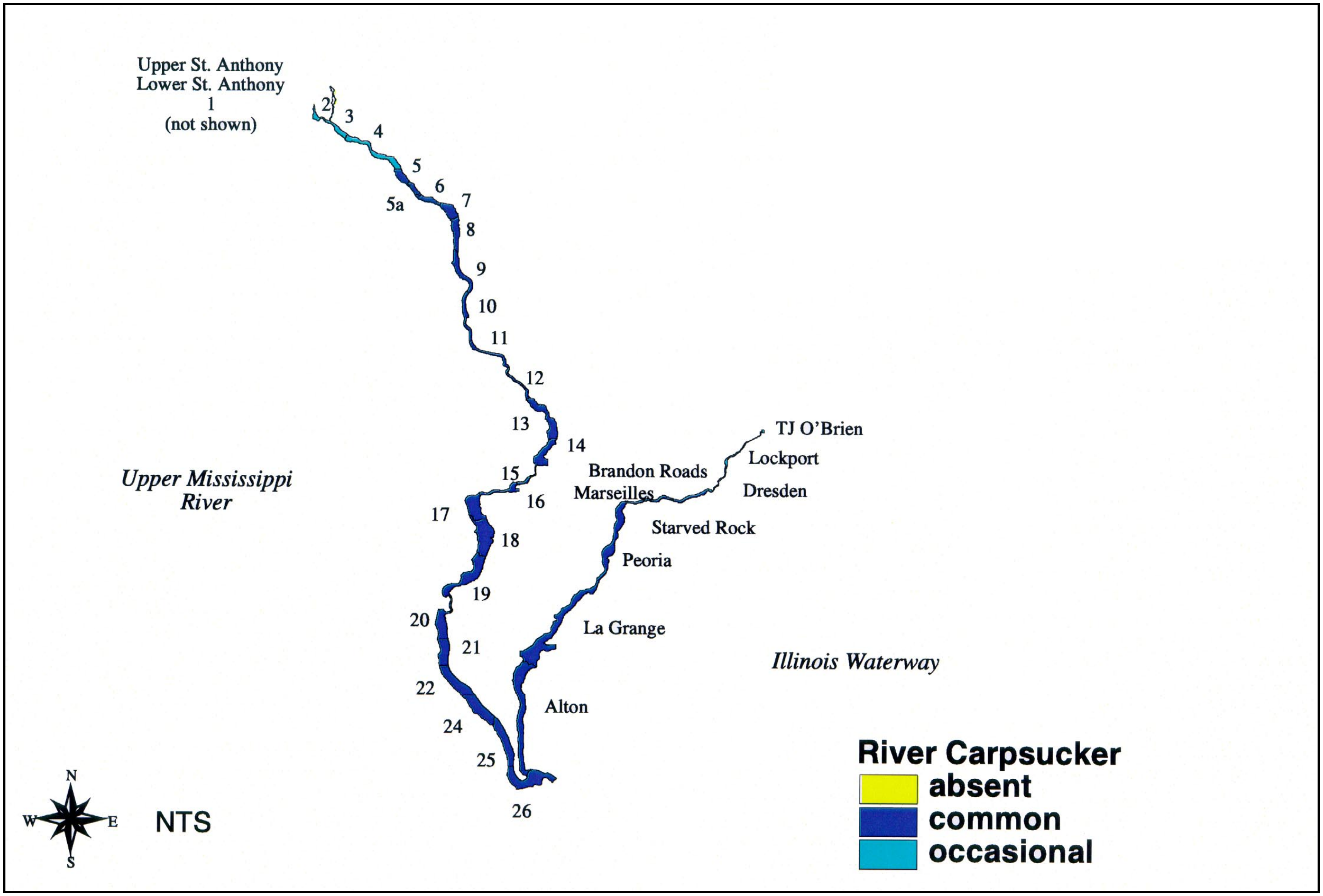

Figure 17. Distribution and abundance of river carpsucker in the Upper Mississippi River and the Illinois Waterway

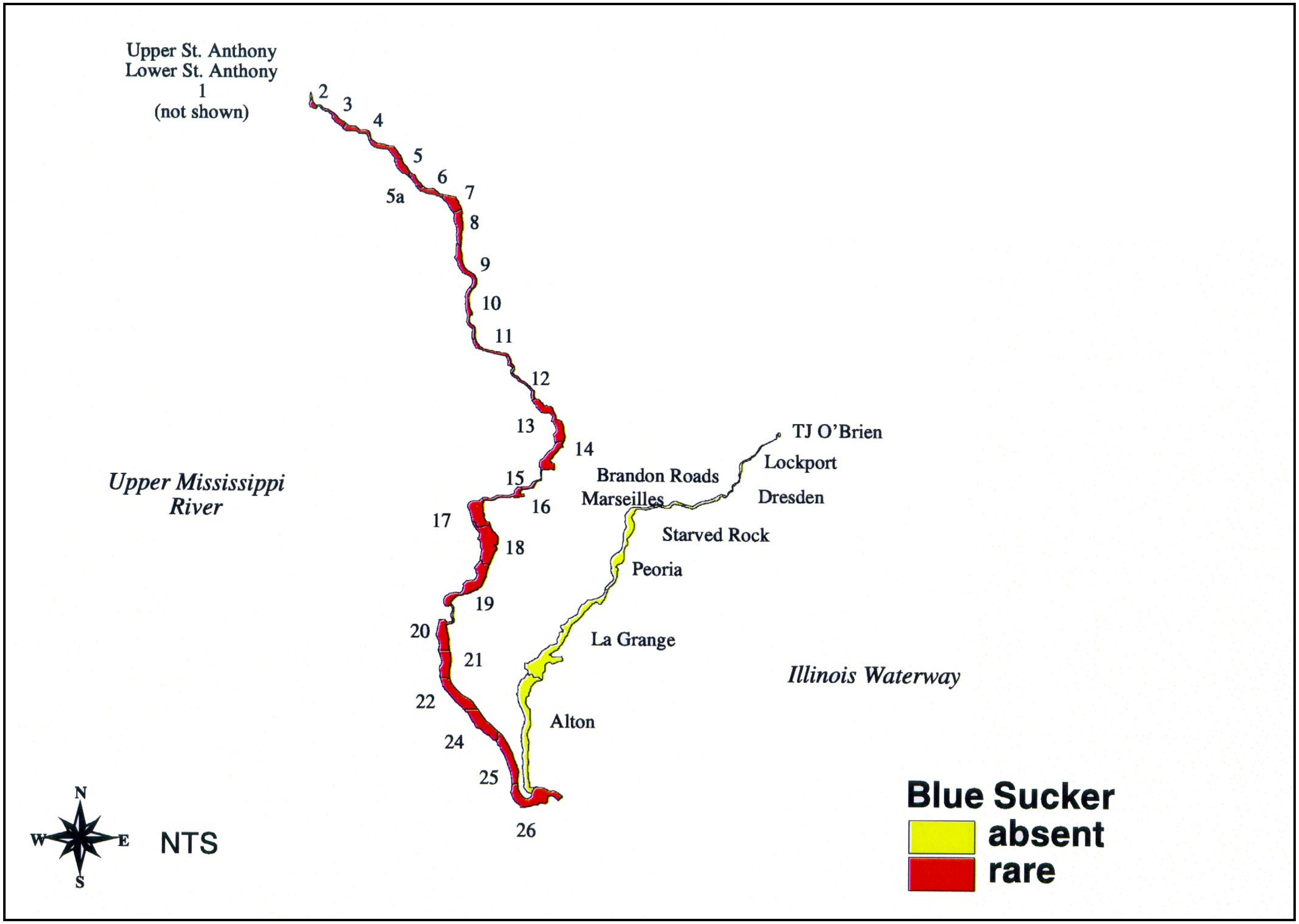

Figure 18. Distribution and abundance of blue sucker in the Upper Mississippi River and the Illinois Waterway

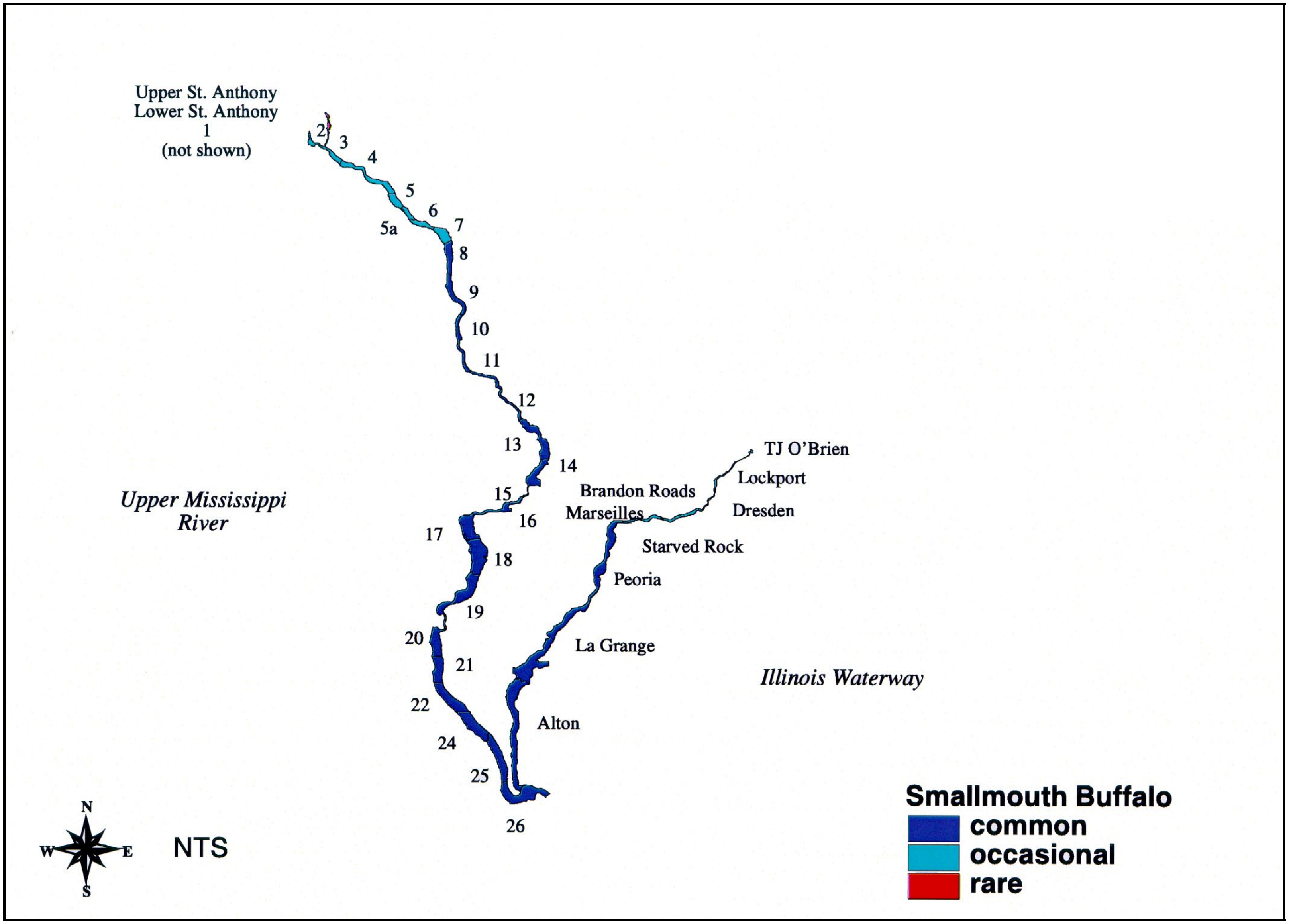

Figure 19. Distribution and abundance of smallmouth buffalo in the Upper Mississippi River and the Illinois Waterway

flooded meadows (Becker 1983; Littlejohn et al. 1985; Holland-Bartels et al. 1990b; Etnier and Starnes 1993). Larvae are common in backwater habitats of the UMR and occur consistently in the main channel drift with peak densities in late May (Holland-Bartels et al. 1990b; Gutreuter, Dettmers, and Wahl 1998) (Figure 2).

Bigmouth buffalo inhabit pools of large streams, lowland lakes, and impoundments, but they occasionally enter small creeks to spawn (Holland-Bartels et al. 1990b). This species is more tolerant of turbidity than other species of *Ictiobus* and inhabits deep, slow, sluggish, or still waters of large rivers and reservoirs such as those found in the UMR (Holland-Bartels et al. 1990b). Bigmouth buffalo often congregate in schools at midwater or near the bottom (Pflieger 1997); they commonly occur in the majority of the UMR-IWW System (Figure 20). Bigmouth buffalo migrate to small streams to spawn on riprap in quiet backwaters, shallow water, over sand or gravel bottoms, or on aquatic vegetation, and spawn from April to May (Holland-Bartels et al. 1990b). Larvae occur in backwater habitats of the UMR and are often in the main channel drift (Figure 2), with peak densities occurring in late May (Holland-Bartels et al. 1990b; Gutreuter, Dettmers, and Wahl 1998).

Spotted suckers prefer clear, warm waters with no noticeable current, abundant aquatic vegetation, and a soft substrate with large amounts of organic debris (Holland-Bartels et al. 1990b; Etnier and Starnes 1993). They are intolerant of turbid water and industrial pollution (Carlander 1969). In the UMR, they are commonly to occasionally found in the upper pools and are rarely found in the lower pools; in addition, they rarely occur in the IWW (Figure 21). Spotted suckers spawn in riffle areas over rubble bottoms, habitat often found in main channel border areas, during April and May (Carlander 1969; Littlejohn et al. 1985; Pflieger 1997).

Shorthead redhorse occur in pools with no noticeable current as well as in moderately large rivers having gravel or rocky bottoms and a permanent, strong flow (Scott and Crossman 1973; Holland-Bartels et al. 1990b; Etnier and Starnes 1993); their general habitat is listed as main channel in Littlejohn et al. (1985) (Figure 4). This species is common in all pools of the UMR and occurs occasionally in pools of the IWW (Figure 22). Shorthead redhorse spawn in April and May in small rivers or streams in shallow riffles or over gravel, sand, stones, or rubble, habitats commonly found in main channel border areas (Burr and Morris 1977; Becker 1983; Littlejohn et al. 1985; Pflieger 1997). Larvae of shorthead redhorse are usually associated with vegetation in backwater areas of the UMR (Holland-Bartels et al. 1990b).

Catfishes

The catfish family Ictaluridae consists of 39 species, all restricted to North America (Pflieger 1997). Catfishes spawn in natural cavities, in excavated nests, or in hollow objects; one or both parents (usually the male) remain with the eggs until they hatch and guard the fry until they leave the nest (Holland-Bartels et al. 1990b). After the young have completely absorbed the yolk sac, they are

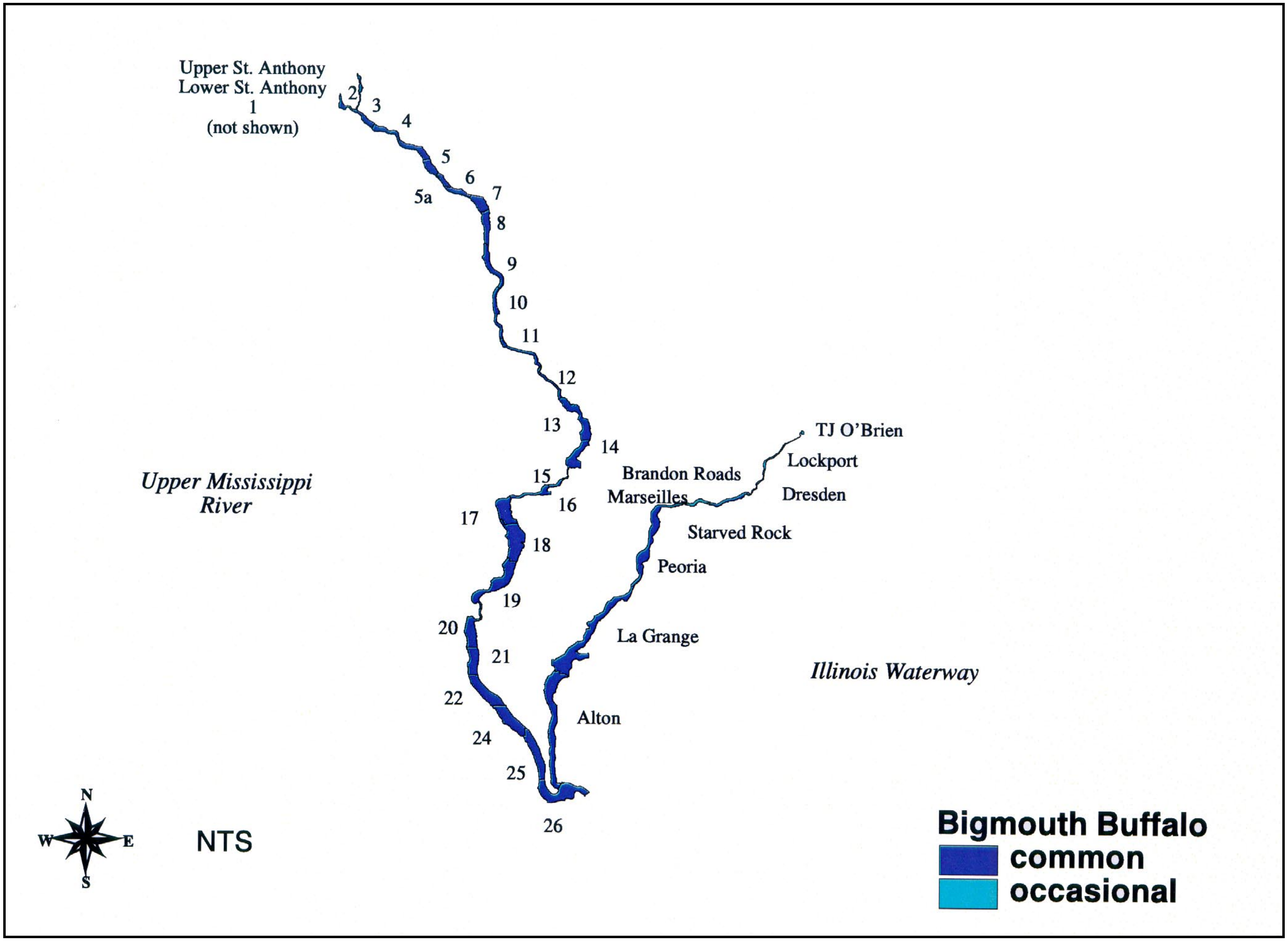

Figure 20. Distribution and abundance of bigmouth buffalo in the Upper Mississippi River and the Illinois Waterway

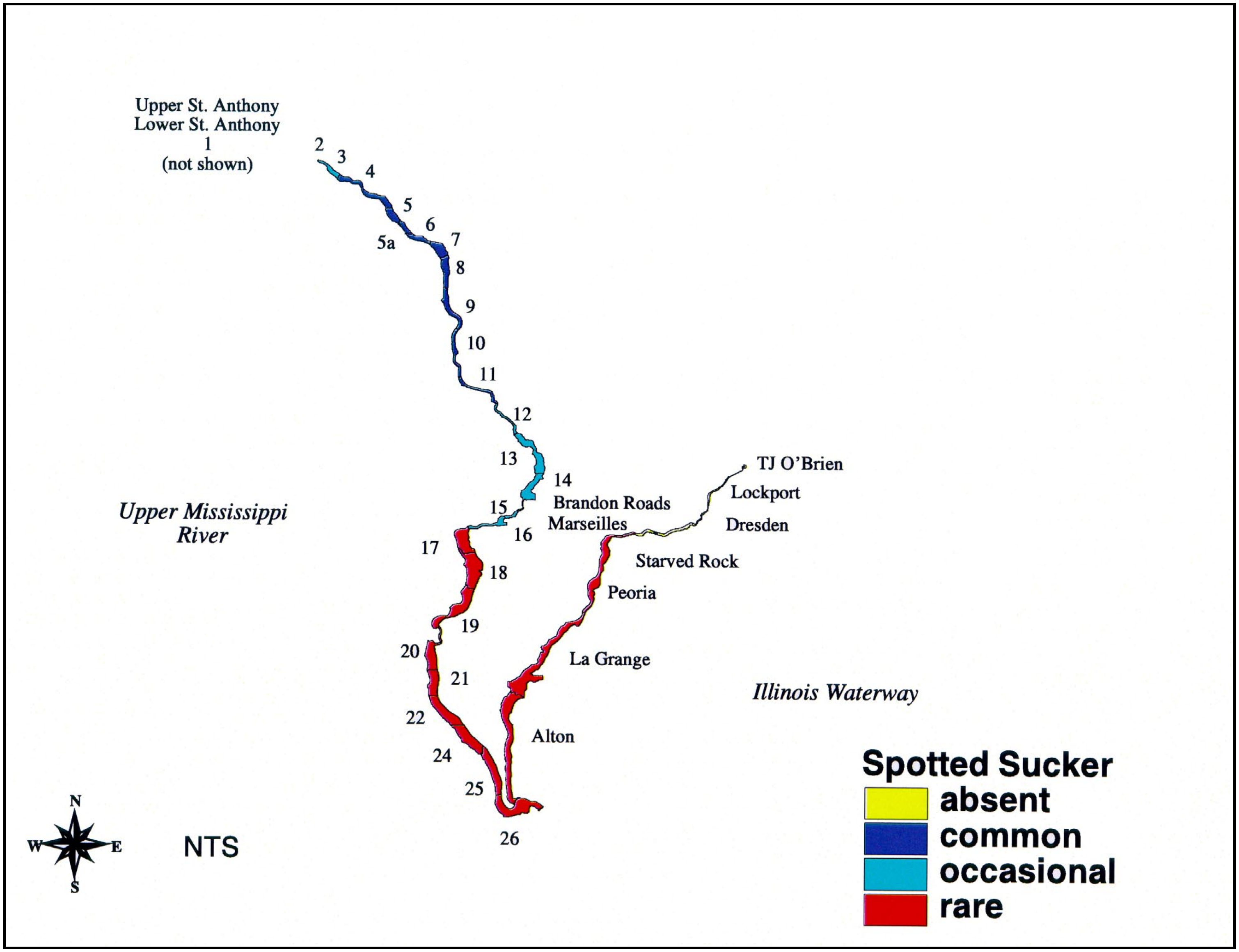

Figure 21. Distribution and abundance of spotted sucker in the Upper Mississippi River and the Illinois Waterway

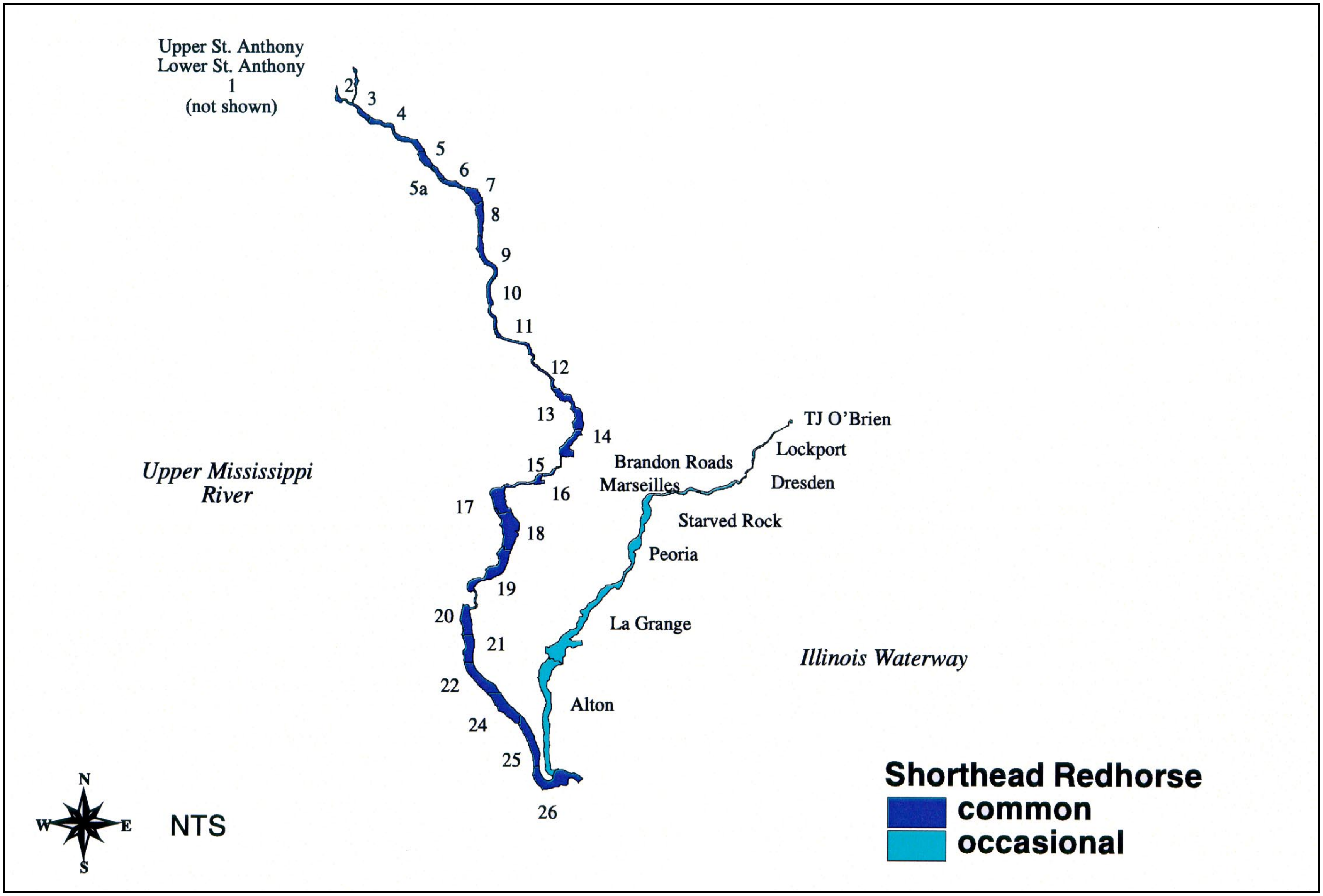

Figure 22. Distribution and abundance of shorthead redhorse in the Upper Mississippi River and the Illinois Waterway

considered to be juveniles and are sometimes called alevins (Holland-Bartels et al. 1990b). Catfishes are most active at night and are secretive during the day (Pflieger 1997). Channel catfish, blue catfish, and flathead catfish were selected for this ecological risk assessment.

Channel catfish are omnivores and are commonly found throughout the UMR-IWW System (Figure 23). Littlejohn et al. (1985) list their general habitat as the main channel (Figure 4). They frequent channels of large rivers in areas with currents that vary from none to swift (Miller 1966). In the UMR-IWW System, they seek cover during the day on or near the bottom in cool, deep waters and are most active in shallow sloughs and along river shores at dusk and dawn (Farabee 1979). Channel catfish nests are made on the bottom in mud or under rock ledges in protected or weedy areas; they spawn from May to July (Holland-Bartels et al. 1990b; Etnier and Starnes 1993; Pflieger 1997). Yolk-sac larvae are rarely collected in main channel drift samples; however, alevins are abundant in the main channel trawl catches and are most commonly collected at night (Holland-Bartels et al. 1990b).

Blue catfish are absent in the upper pools of the UMR and the IWW but are commonly to occasionally found in the lower pools of the UMR (Figure 24). This catfish has nearly disappeared from the Mississippi drainage upstream from the mouth of the Missouri River (Pflieger 1997). The blue catfish is a big river fish; it seldom achieves the high population densities of the channel catfish and is less abundant at most localities than the flathead catfish (Pflieger 1997). The life history of the blue catfish is similar to that of the channel catfish. Blue catfish are found in main channels, along banks and sandbars, and in pools and sloughs; they are uncommon in oxbow and floodplain areas (Baker et al. 1991; Rohde et al. 1994). They are omnivores and prefer deep water, firm substrates, and considerable current (Etnier and Starnes 1993; Rohde et al. 1994). Blue catfish spawn from May through June and nest under logs or undercut river banks (Etnier and Starnes 1993; Rohde et al. 1994).

Flathead catfish are piscivorous and inhabit a variety of streams but avoid those with high gradients or intermittent flows (Littlejohn et al. 1985; Holland-Bartels et al. 1990b). The flathead catfish is a solitary species; adults occur in pools near logs, piles of drift, or other cover, and the young live among rocks in riffle areas and are most active at night (Pflieger 1997). Flathead catfish are common throughout most of the UMR-IWW System (Figure 25). Flathead catfish spawn in June and July, building nests or shallow depressions near submerged objects, in secluded shelters, or in dark areas; males guard the nest and young (Holland-Bartels et al. 1990b).

Temperate basses

The temperate basses are primarily marine in distribution, but a few species occur in fresh water (Pflieger 1997). White bass is the representative of this family (Moronidae) selected for the ecological risk assessment. They prefer open waters of lakes and reservoirs or rivers with moderate current (Becker 1983) and are often found in the main channel of the Mississippi River (Littlejohn et al.

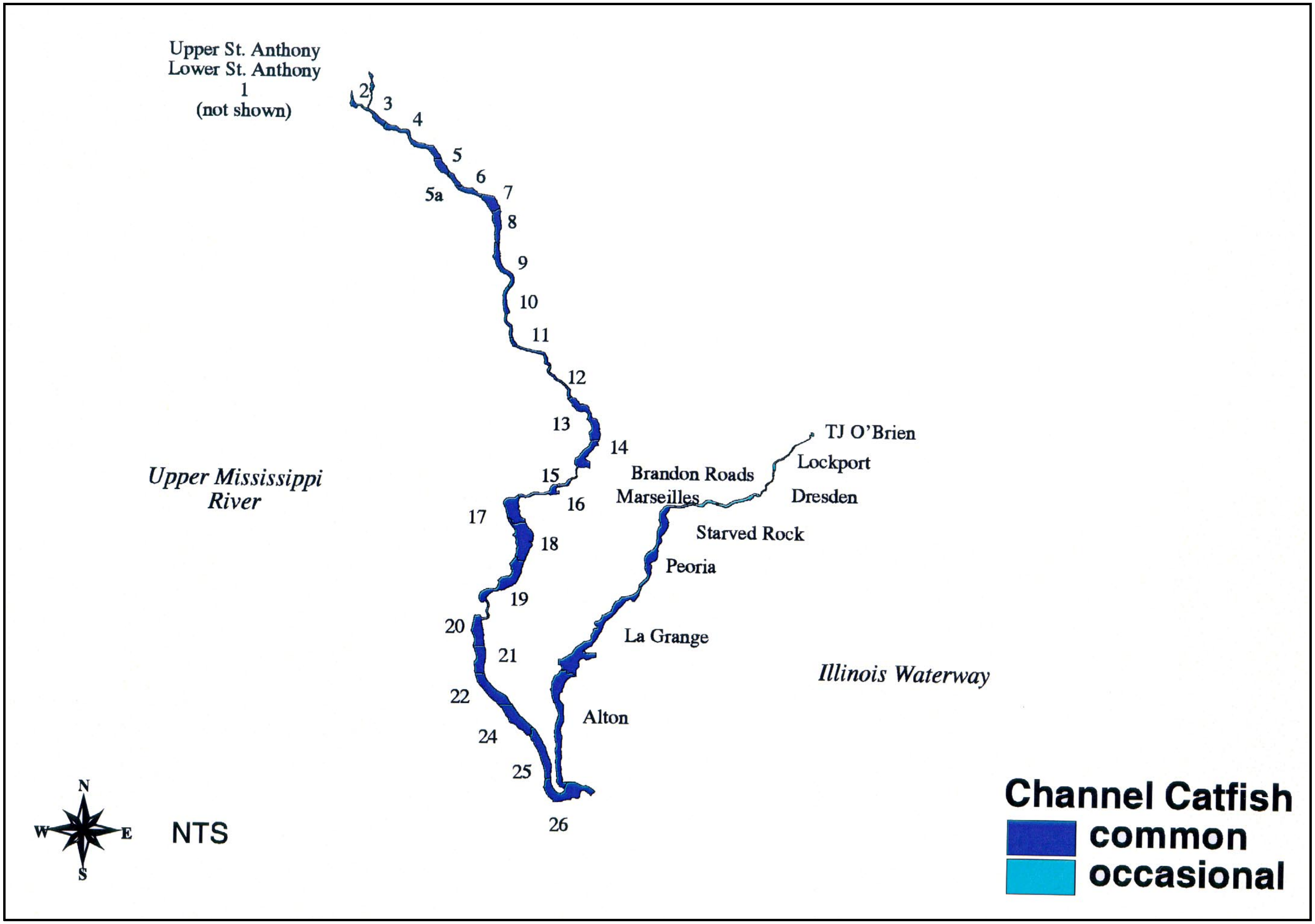

Figure 23. Distribution and abundance of channel catfish in the Upper Mississippi River and the Illinois Waterway

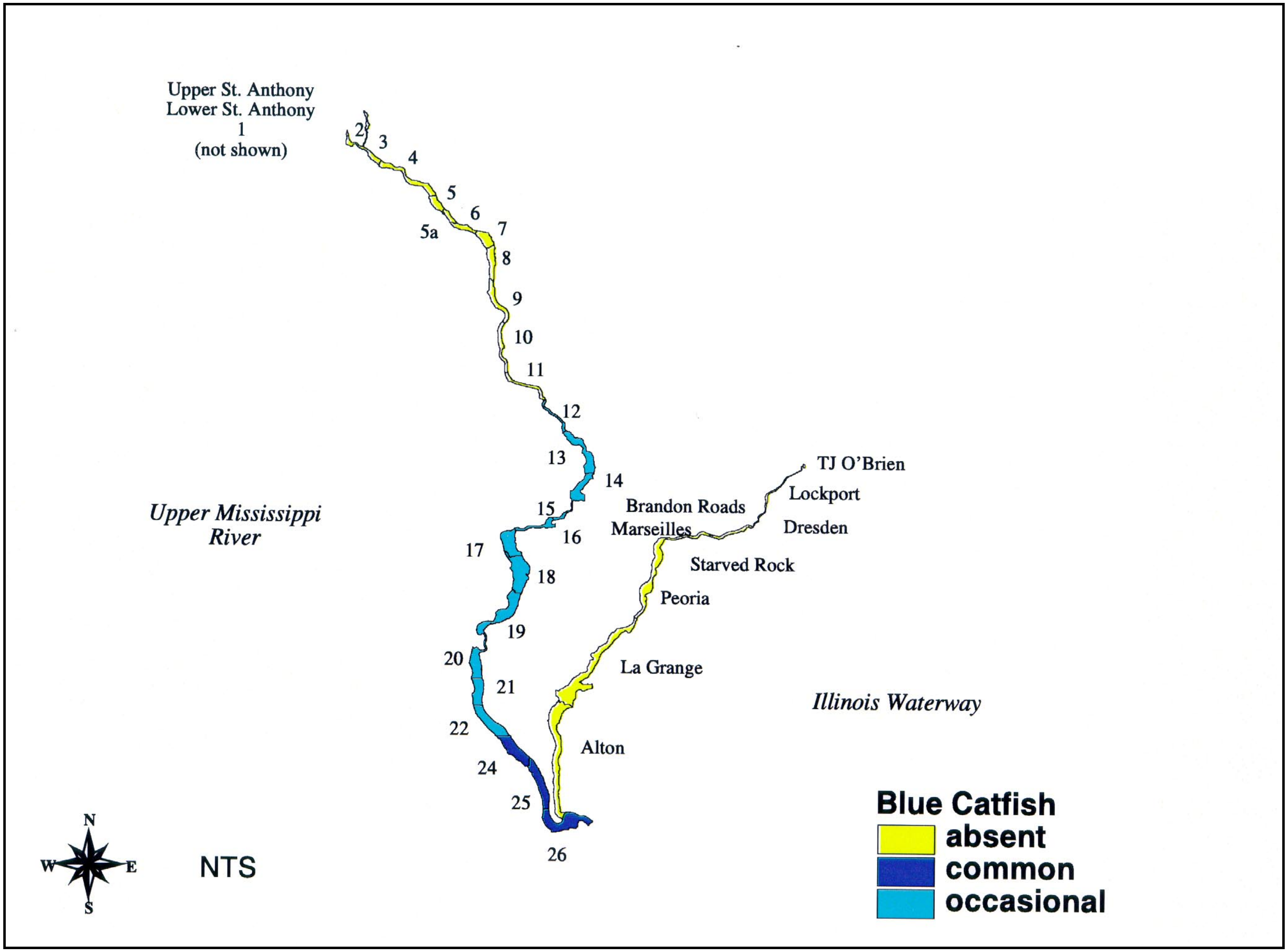

Figure 24. Distribution and abundance of blue catfish in the Upper Mississippi River and the Illinois Waterway

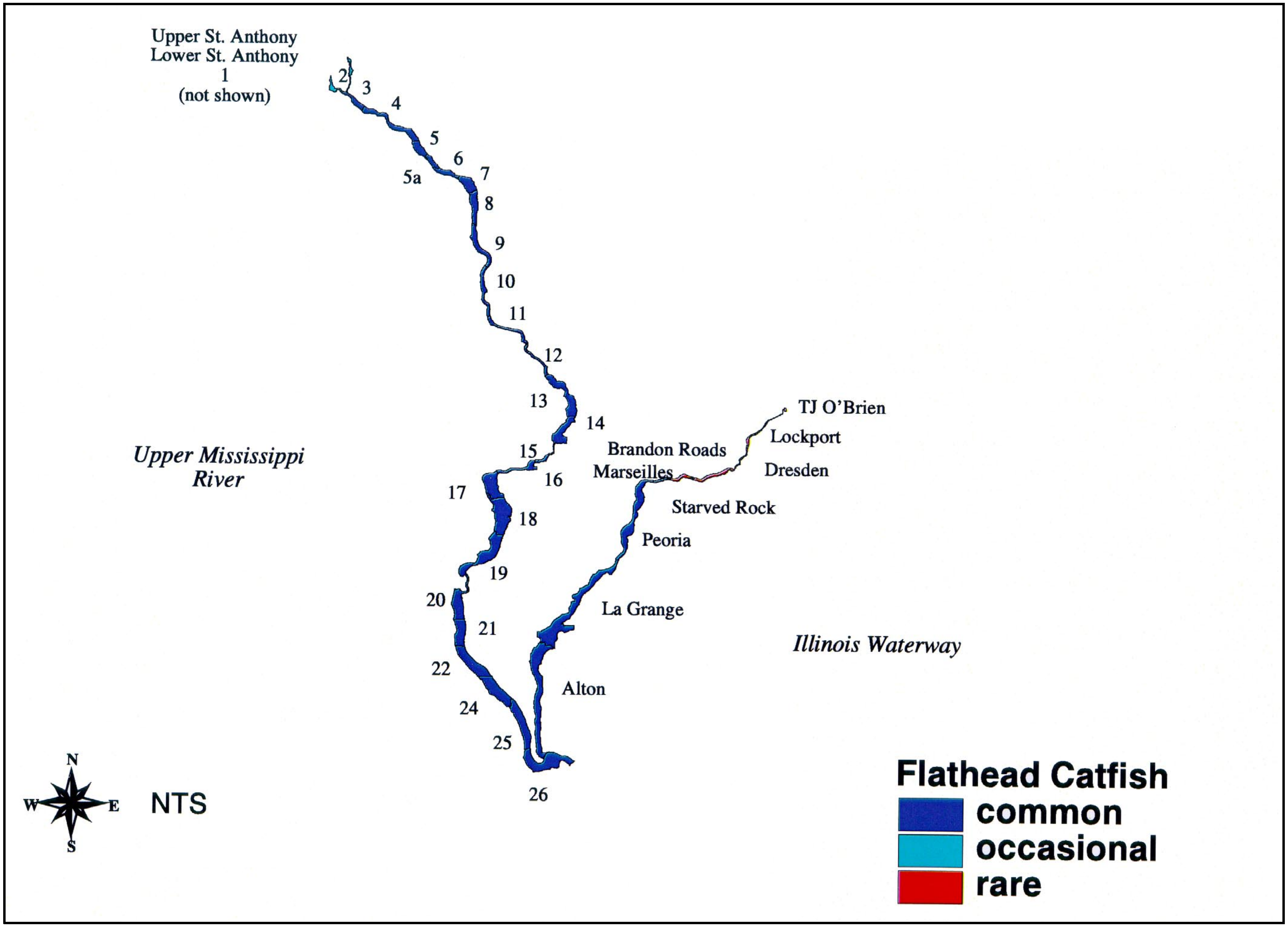

Figure 25. Distribution and abundance of flathead catfish in the Upper Mississippi River and the Illinois Waterway

1985; Holland-Bartels et al. 1990b). White bass are omnivores, travel in large schools, and feed at the surface (Scott and Crossman 1973). They are common throughout most of the UMR-IWW System (Figure 26).

White bass spawn from late April to early June in flowing waters of tributary streams or shallow, shoreward areas with some current; they require a firm bottom of gravel, sand, or rubble (Holland-Bartels et al. 1990b). Due to the abundance of adult white bass and the scarcity of yellow bass (*Morone mississippiensis*), most small *Morone* collected are assumed to be white bass; *Morone* spp. are sometimes predominant in the main channel drift in late May and are often abundant in areas that receive flow from flooded woodlands (Holland-Bartels et al. 1990b; Gutreuter, Dettmers, and Wahl 1998). Juveniles inhabit main channel areas almost exclusively and move into main channel border areas at night, presumably from open water (Scott and Crossman 1973; Smith 1979; Becker 1983; Holland-Bartels et al. 1990b) (Figure 3).

Sunfishes

The sunfish family (Centrarchidae) is a North American family containing 29 species that are sometimes divided into three groups: sunfishes, crappies, and black basses (Etnier and Starnes 1993; Pflieger 1997). One sunfish, two crappies, and two black basses, which have known distributions in the UMR-IWW System, were selected for this risk assessment: bluegill, white crappie, black crappie, smallmouth bass, and largemouth bass. All five species are important to the recreational fishery. Most centrarchids are sedentary fish, remaining much of the time near submerged cover or hovering quietly in the shade of a tree or other object hanging over the water; all species construct a nest (Pflieger 1997). Identification of larvae has been primarily to genus because of difficulty in consistent identification to species without extensive effort, particularly in *Lepomis* and *Pomoxis* spp. (Holland-Bartels et al. 1990b). All genera are much more abundant in backwater areas or border areas than in the main channel; however, centrarchid larvae regularly make up a small part (4 percent) of the main channel drift (Holland et al. 1984; Holland-Bartels et al. 1990b; Gutreuter, Dettmers, and Wahl 1998).

Bluegill are abundant in most of the UMR-IWW System (Figure 27). The bluegill is a schooling species found in lakes, ponds, reservoirs, and streams (Holland-Bartels et al. 1990b). It is common in all habitats, including deep and shallow waters, but it is most abundant in shallow, slow-moving waters (Rasmussen 1979; Farabee 1979). Bluegill are omnivores (Littlejohn et al. 1985). They build nests in the shallows of lentic habitats near shore on sand or gravel (Becker 1983). Spawning occurs in May to early July in the UMR (Carlander 1977; Becker 1983; Holland-Bartels et al. 1990b). Male bluegill clear the nest, defend the nest, and guard the young (Littlejohn et al. 1985). Larvae stay closely associated with the nest bottom until after yolk absorption, then remain in the littoral zone through at least the juvenile stage. Larvae of *Lepomis* (probably mostly bluegills) are abundant in backwater habitats and occur regularly in the main channel ichthyoplankton drift (Figure 2); densities in both backwater and main channel collections peak in late June (Holland-Bartels et al.

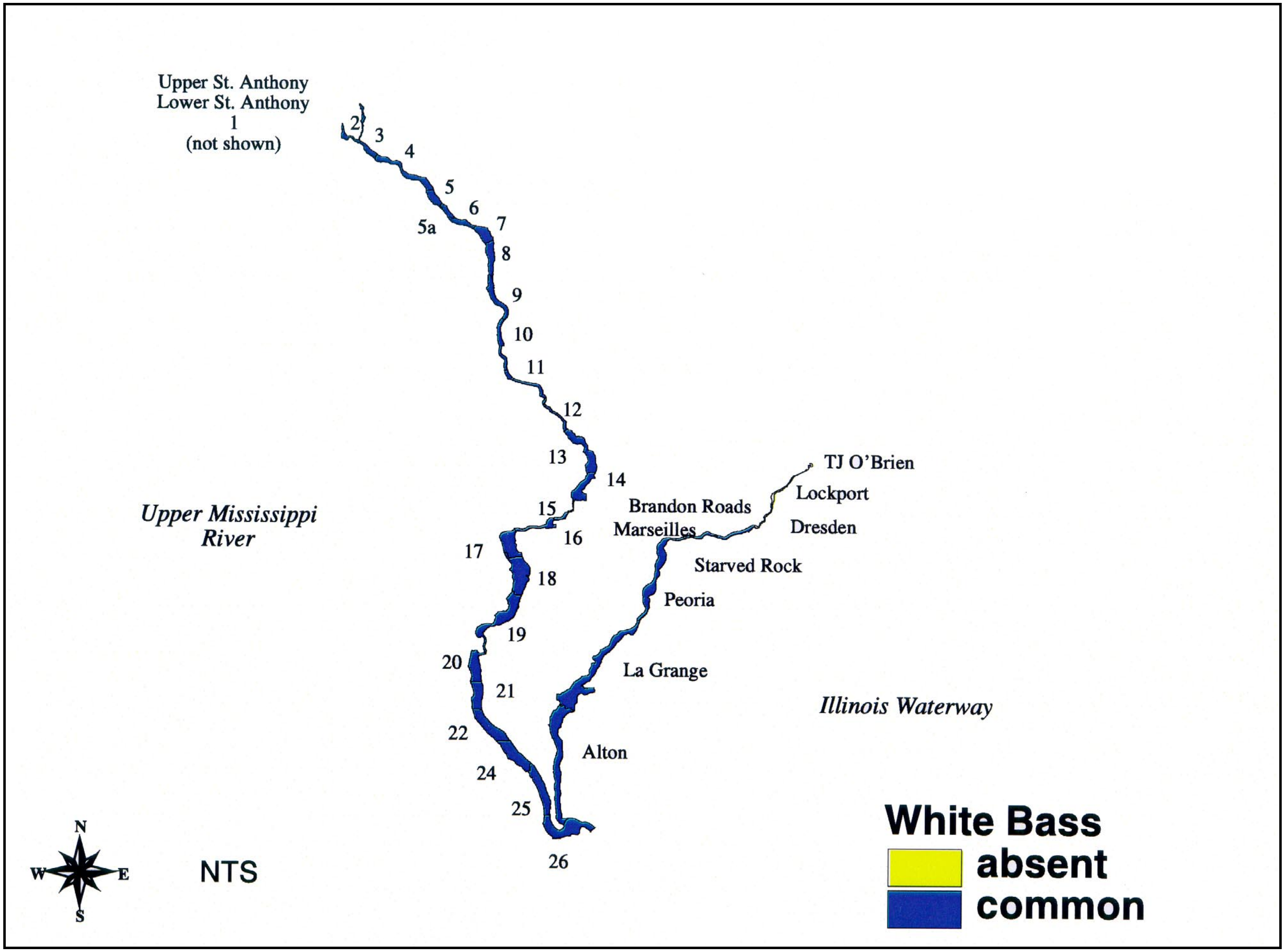

Figure 26. Distribution and abundance of white bass in the Upper Mississippi River and the Illinois Waterway

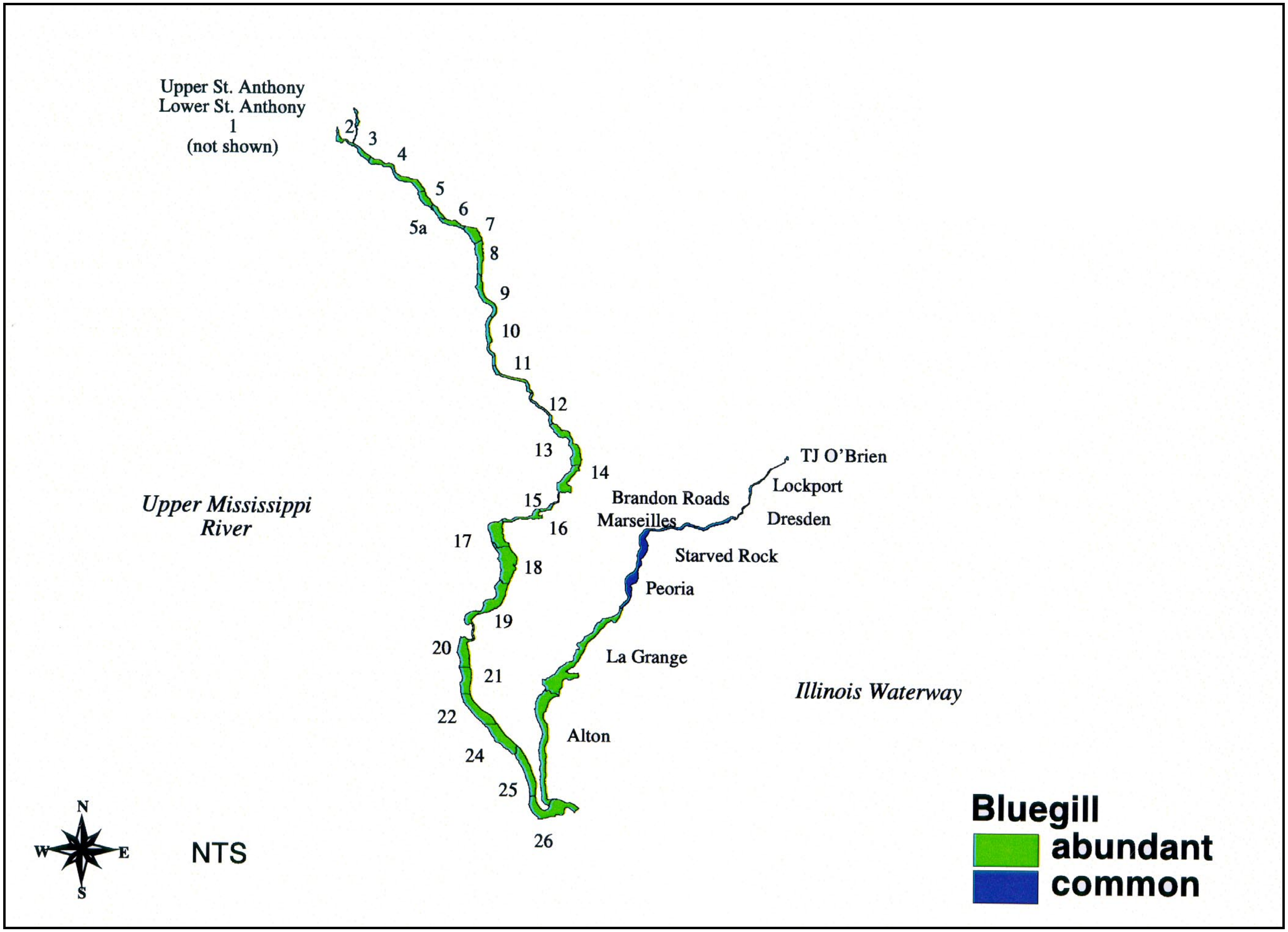

Figure 27. Distribution and abundance of bluegill in the Upper Mississippi River and the Illinois Waterway

1990b). Young of the year are closely associated with submergent vegetation in backwaters in the UMR (Holland and Huston 1985) (Figure 3).

White crappie are omnivores and occur in all habitat types of the UMR but prefer deep, quiet waters (Farabee 1979; Littlejohn et al. 1985). They are common in most pools of the UMR-IWW System (Figure 28). White crappie do not school but congregate in loose aggregations in suitable cover (Holland-Bartels et al. 1990b; Pflieger 1997). They are usually found in silted streams, slow-moving areas of rivers, and impoundments; they avoid areas of excessive turbidity and continuously cool water (Scott and Crossman 1973). White crappie spawn in May and June (Rasmussen 1979) in ponds, lakes, and reservoirs, in deeper water than other centrarchids, over clay, mud, sand, gravel, rocks, or on aquatic vegetation (Becker 1983; Holland-Bartels et al. 1990b). The male selects the spawning area and guards the young (Littlejohn et al. 1985). Larvae occur in ichthyoplankton drift collections in early to mid-May, are most abundant in backwaters, and demonstrate a significant drift into the main channel at dusk (Holland and Sylvester 1983) (Figure 2).

Black crappie are common throughout the majority of the UMR-IWW System (Figure 29). They are found less often than white crappie in turbid environments (Scott and Crossman 1973). Black crappie usually form moderately large schools in association with abundant growths of vegetation over sand to muck bottoms (Holland-Bartels et al. 1990b). They spawn in vegetated areas or in the protection of undercut banks; their nests are constructed in sand, gravel, or mud on bottoms that are softer and muddier than those used by other centrarchids (Scott and Crossman 1973; Eddy and Underhill 1974). Spawning occurs in May and June (Becker 1983; Holland-Bartels et al. 1990b). The male clears the nest, defends the nest, and guards the young (Littlejohn et al. 1985). Larvae occur in ichthyoplankton drift collections in the UMR in May (Holland-Bartels et al. 1990b); they are most abundant in backwaters but tend to drift into the main channel at dusk (Holland and Sylvester 1983) (Figure 2).

Smallmouth bass prefer habitats with rocks and submerged logs, such as areas near wing dams and riprap in the UMR-IWW System; they have less affinity for vegetation than the largemouth bass (Scott and Crossman 1973; Farabee 1979; Etnier and Starnes 1993). It exhibits little tolerance for siltation and turbidity (Pflieger 1997). In the UMR-IWW System, smallmouth bass are common in most pools (Figure 30). Smallmouth bass are piscivores (Littlejohn et al. 1985), and during the day may be observed almost motionless near submerged cover or cruising around their home territory (Pflieger 1997). Male smallmouth bass clear the nest, defend the nest, and guard the young (Littlejohn et al. 1985). Smallmouth bass spawn in sheltered areas with current over clean gravel and sand in May and June (Eddy and Underhill 1974; Farabee 1979; Smith 1979; Becker 1983). Fry leave the nest as a school 6 to 15 days after hatching and are guarded by the male for a few days (Farabee 1979). Larvae are rarely collected in the main channel or associated backwaters of the UMR (Holland-Bartels et al. 1990b).

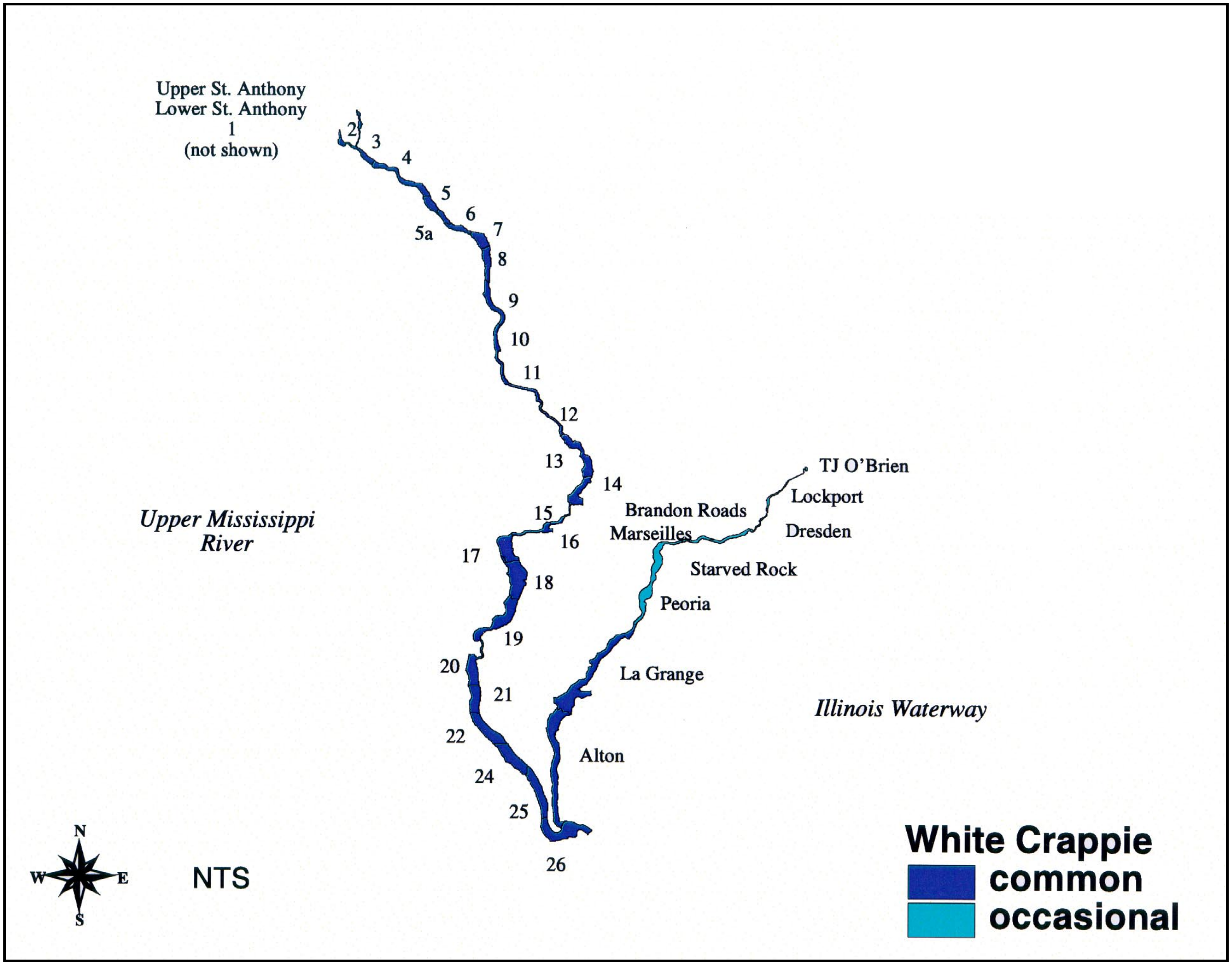

Figure 28. Distribution and abundance of white crappie in the Upper Mississippi River and the Illinois Waterway

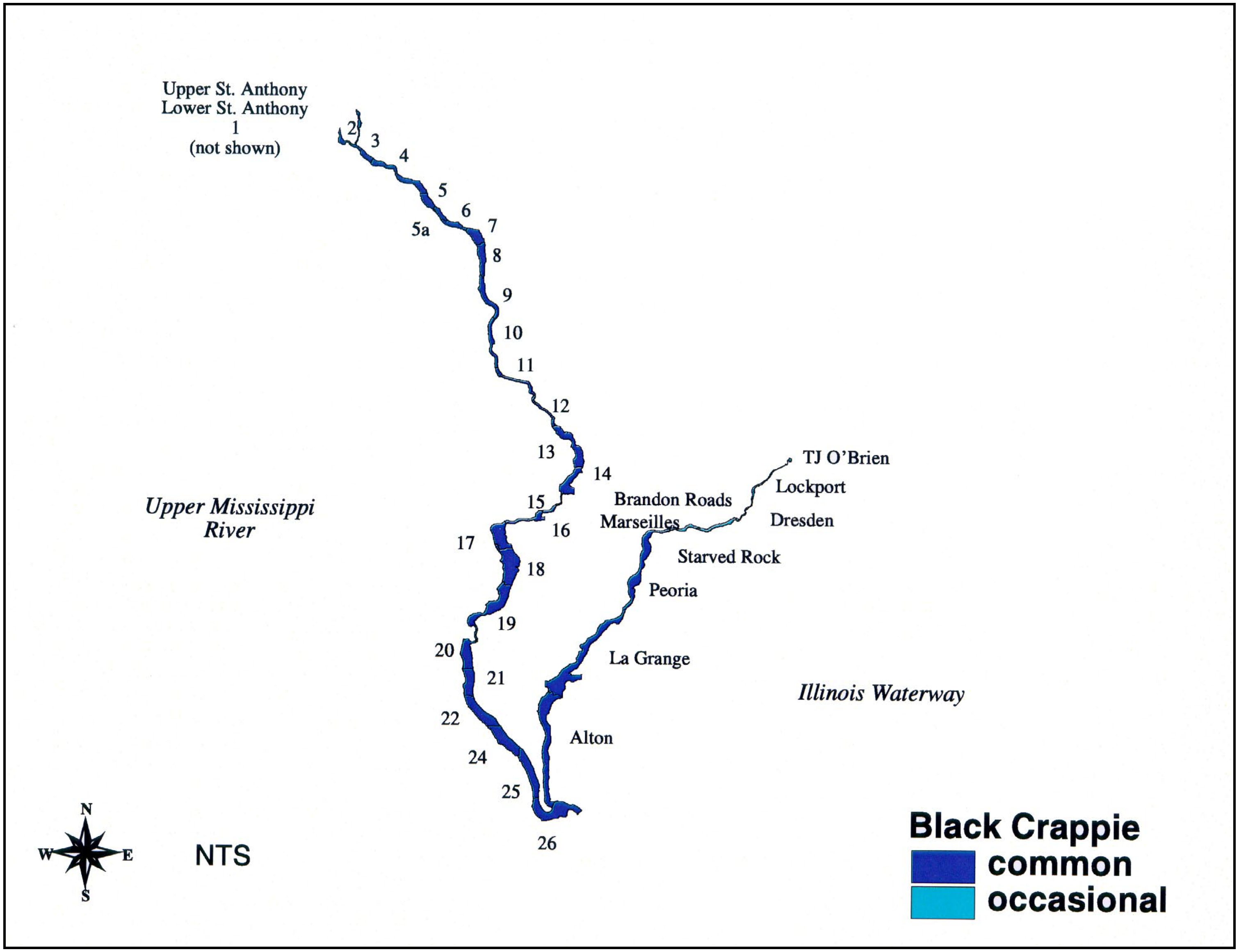

Figure 29. Distribution and abundance of black crappie in the Upper Mississippi River and the Illinois Waterway

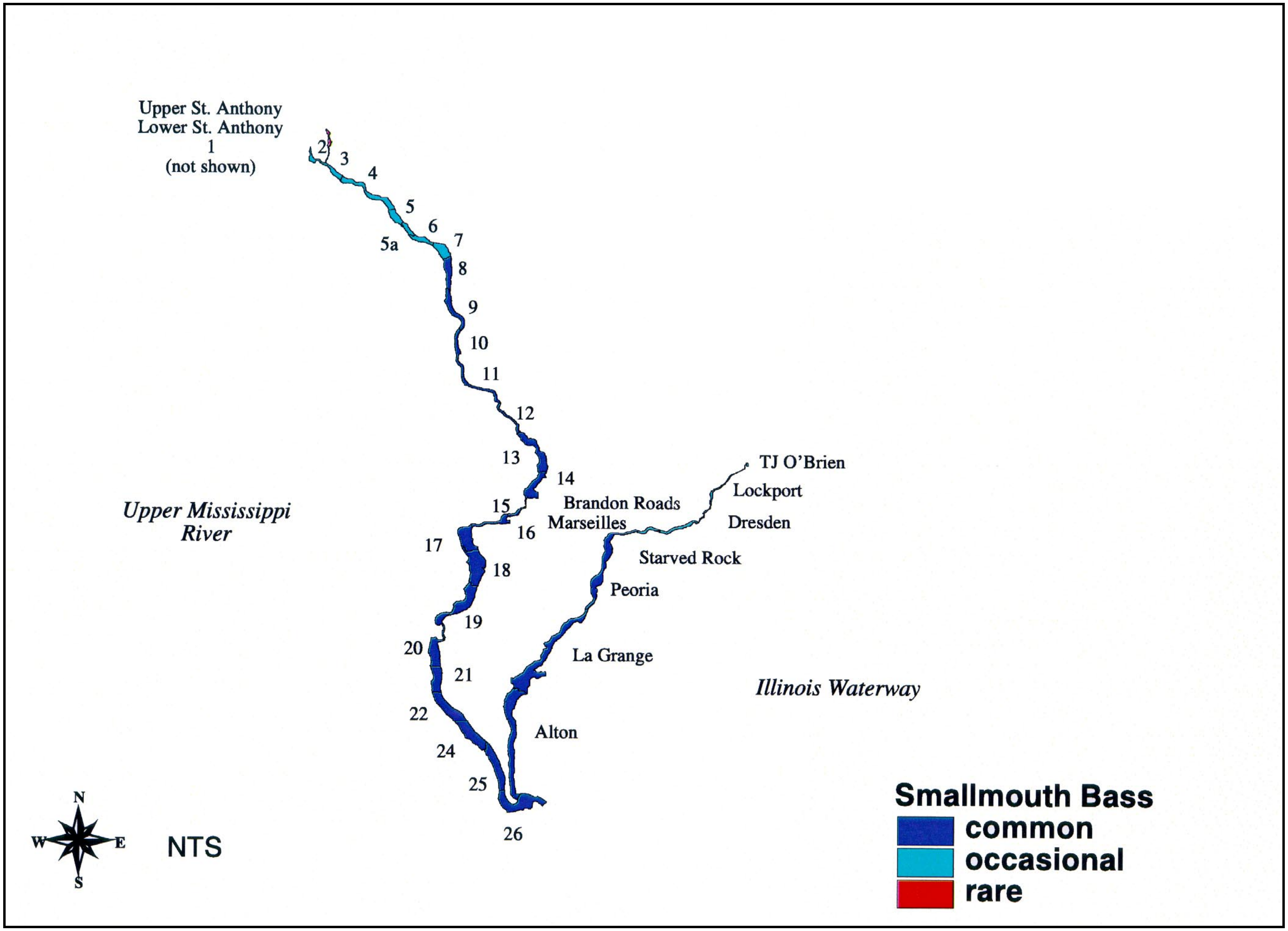

Figure 30. Distribution and abundance of smallmouth bass in the Upper Mississippi River and the Illinois Waterway

Largemouth bass are piscivores (Littlejohn et al. 1985). They are characteristic of natural lowland lakes, man-made impoundments, permanent pools of small streams with low or intermittent flow, and quiet backwaters of large rivers (Carlander 1977; Holland-Bartels et al. 1990b). Largemouth bass are intolerant of excessive turbidity and siltation and thrive in warm, moderately clear water with no noticeable current; they are replaced by one of the other black basses in streams with continuous strong flow (Pflieger 1997). They are frequently associated with soft bottoms, stumps, and extensive growths of emergent and submergent vegetation but can be found in most UMR-IWW System habitat types (Scott and Crossman 1973; Farabee 1979). Largemouth bass are common throughout most of the UMR-IWW System (Figure 31). Male largemouth bass clear the nest, defend the nest, and guard the young (Littlejohn et al. 1985); the male largemouth is a more attentive parent than any of the other sunfishes (Pflieger 1997). Largemouth bass build nests in shallow, quiet water in emergent vegetation on sand, gravel, or marl; they spawn from April through July (Becker 1983; Holland-Bartels et al. 1990b). Larvae remain in the nest until the yolk is absorbed and then form a school that is guarded by the male. In many areas of the UMR, larvae and juveniles are specifically associated with dense beds of submerged vegetation (Holland-Bartels et al. 1990b).

Perches

The perch family (Family Percidae) is one of the largest groups of North American freshwater fishes, including more than 150 named species (Pflieger 1997). Eighteen species of perches are found in the UMR-IWW System. Two piscivorous species that are important to the recreational fishery were selected for this risk assessment: sauger and walleye.

Sauger are common throughout the majority of the UMR-IWW System (Figure 32). Sauger prefer large, turbid, slow-flowing rivers or shallow, turbid lakes. In the UMR, they live in the shallow, more turbid, littoral zones (i.e., main channel borders) (Scott and Crossman 1973; Holland-Bartels et al. 1990b) (Figure 4). They are the most numerous game fish collected from wing dam habitats and are also common in tailwaters (Pitlo 1981). The sauger grows more slowly and does not grow as large as the walleye (Pflieger 1997). Sauger spawn in April or May over shallow shoals or bars in main channel border areas or mussel beds or over rock or gravel substrates (Scott and Crossman 1973; Holland-Bartels et al. 1990b). The photophobic larvae spend much of the time scattered among bottom materials and are rarely collected with standard tow nets (Holland-Bartels et al. 1990b). Young sauger represent a minor component of the total ichthyoplankton drift in the UMR and never exceed 3 percent of the catch, even during their peak densities in early May (Holland 1985; Gutreuter, Dettmers, and Wahl 1998). Juvenile sauger have occasionally been collected on shallow mud flat areas (Farabee 1979).

Walleye commonly occur in upper pools of the UMR, occasionally occur in the lower pools of the UMR, and rarely occur in most of the IWW (Figure 33). Walleye inhabit areas in lakes and large rivers with gravel, bedrock, and firm substrates where the turbidity is low (Scott and Crossman 1973). It is nocturnal,

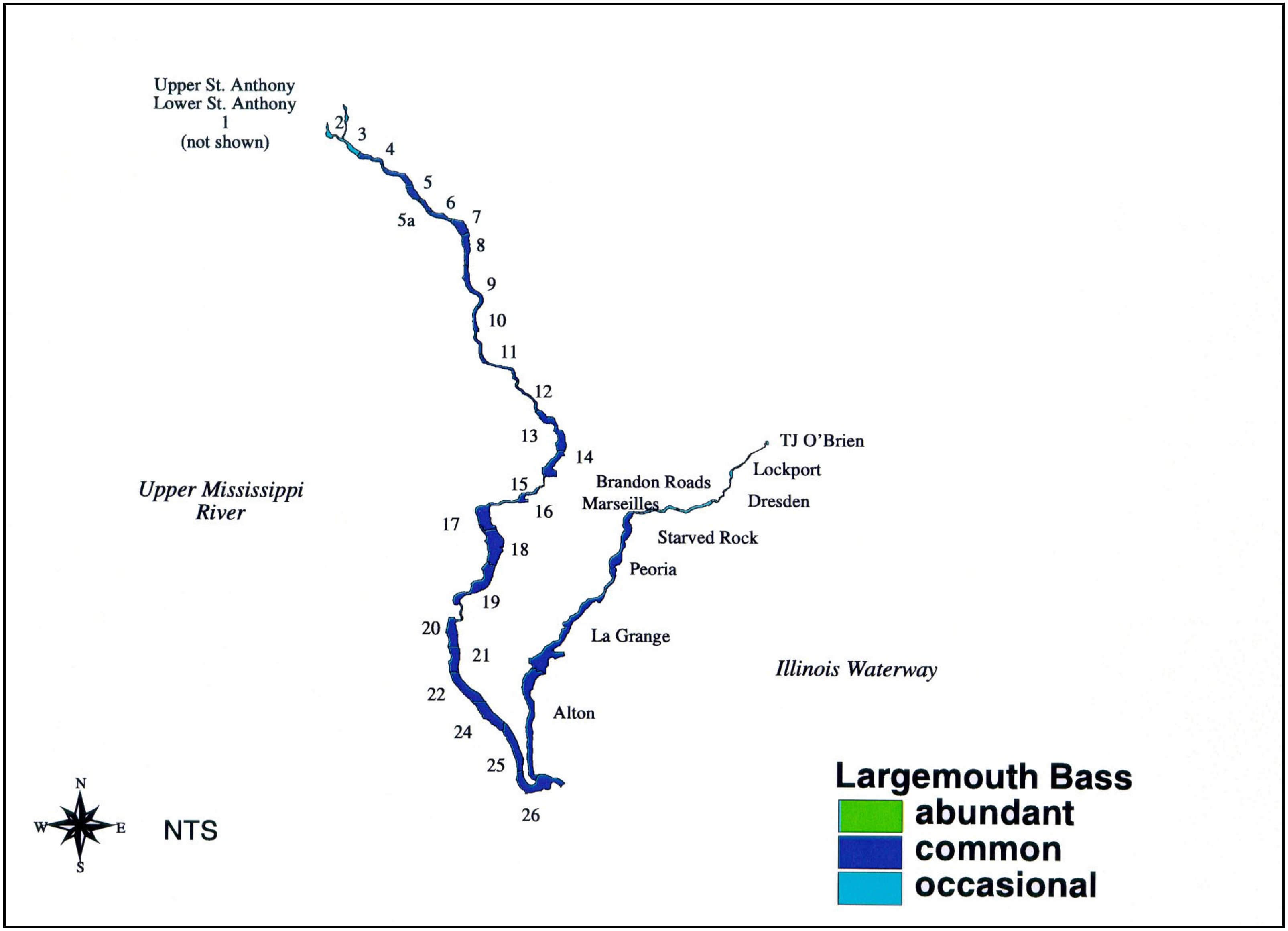

Figure 31. Distribution and abundance of largemouth bass in the Upper Mississippi River and the Illinois Waterway

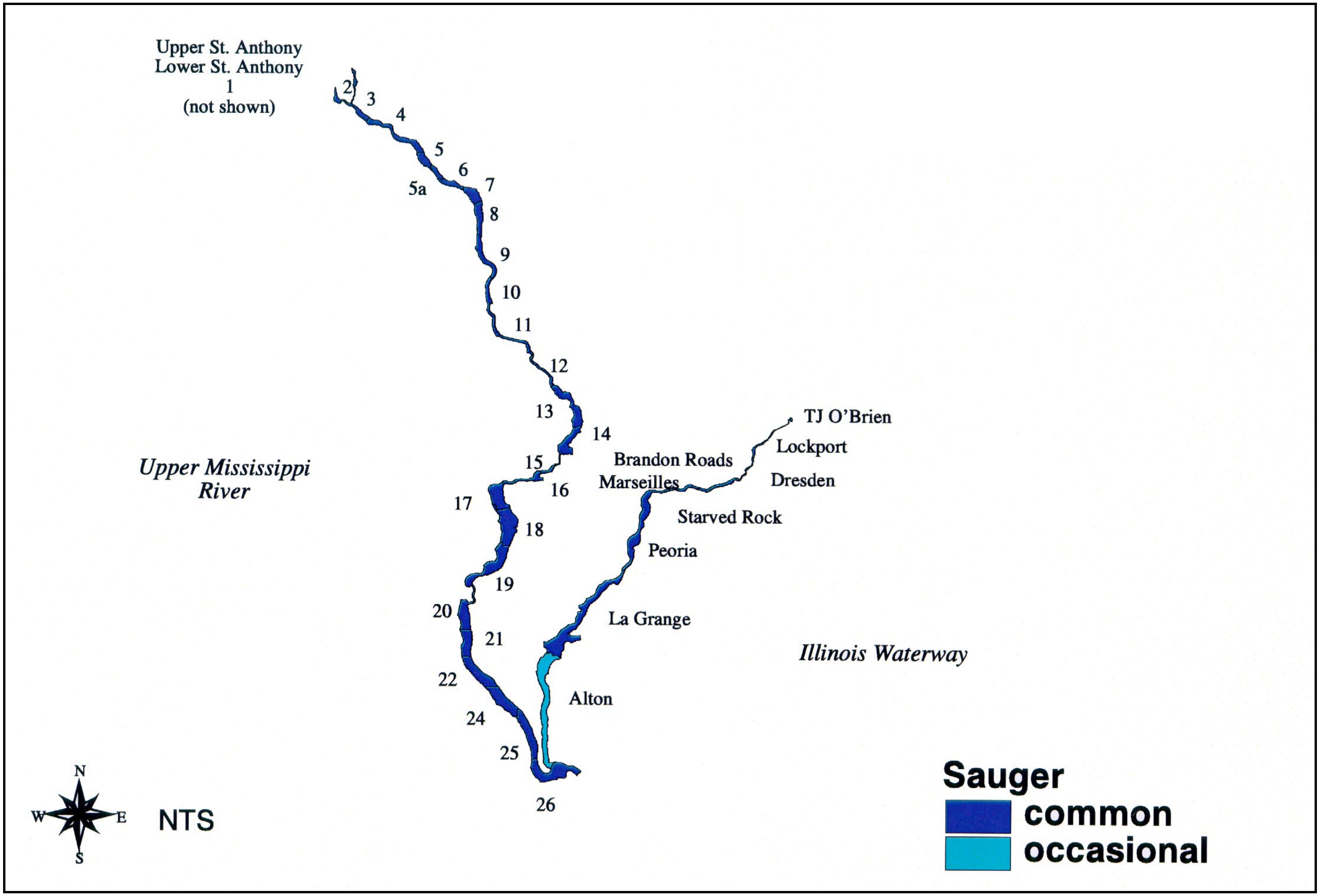

Figure 32. Distribution and abundance of sauger in the Upper Mississippi River and the Illinois Waterway

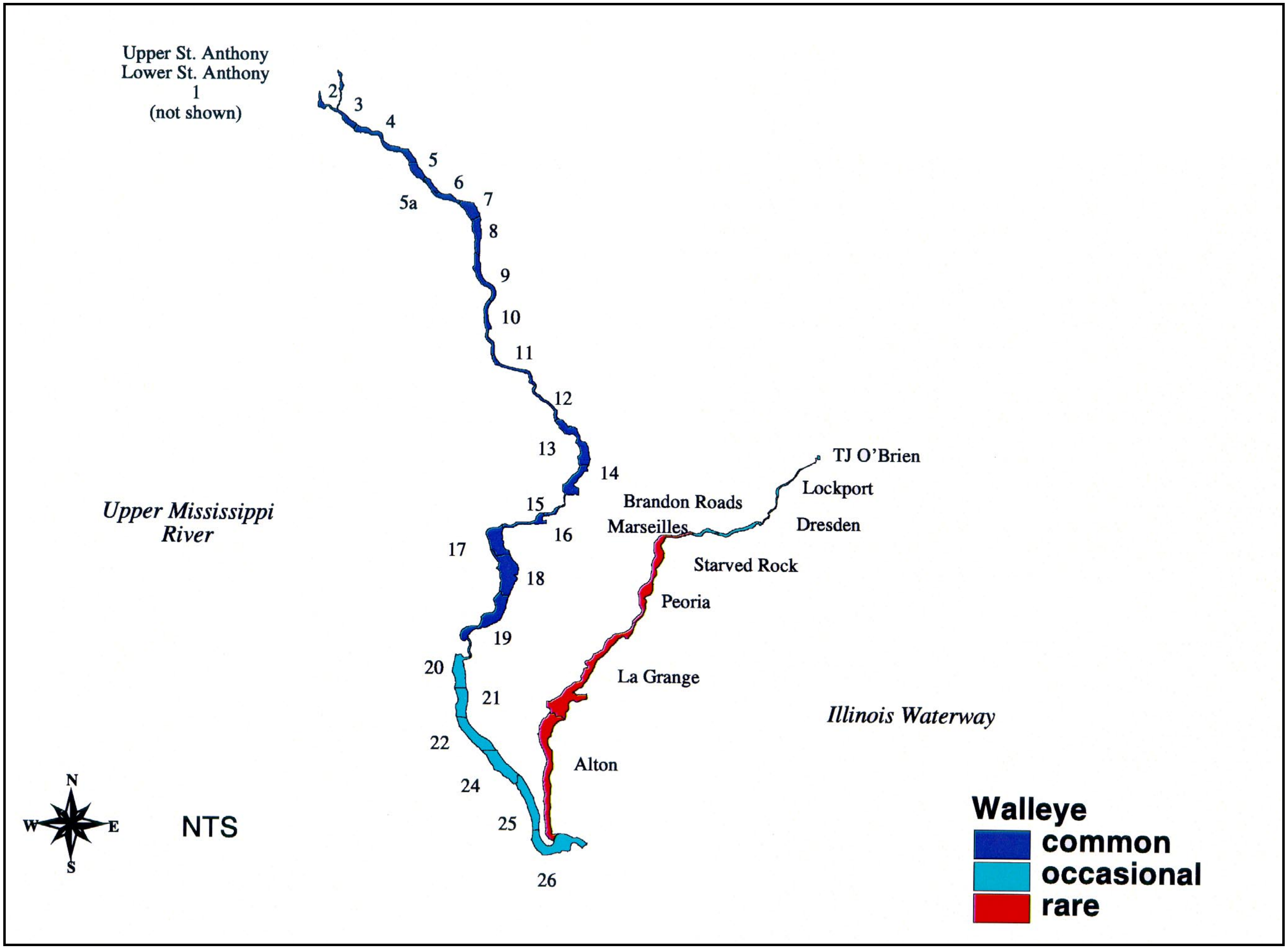

Figure 33. Distribution and abundance of walleye in the Upper Mississippi River and the Illinois Waterway

moving to shoals to feed in late evening and returning to deeper water before daybreak (Pflieger 1997). Both adults and juveniles have been collected in the main channel, main channel border, deep sloughs, and backwater areas of the UMR (Rasmussen 1979), but their general habitat is considered to be the main channel border (Littlejohn et al. 1985) (Figure 4). During high water, walleye may move into stands of flooded timber; during low water, they congregate around wing and closing dams (Holland-Bartels et al. 1990b). Walleye spawn in mid-April to early May over rocky areas below falls and dams, in riprap areas of dam tailwaters and coarse gravel shoals of lakes, or over vegetation (Scott and Crossman 1973; Holland-Bartels et al. 1990b; Etnier and Starnes 1993). In the UMR, spawning sites have been verified in areas of flooded emergent vegetation and in outer bends of the main channel (Holland-Bartels et al. 1990b). Larval walleye are a minor component of ichthyoplankton drift samples; the density of larval walleye in the drift peaks in early May (Holland-Bartels et al. 1990b; Gutreuter, Dettmers, and Wahl 1998).

Drums

The drum family (Sciaenidae) are widely distributed throughout most temperate and tropical continental shelf habitats; of the 160 species described, only 1 completes its life cycle in freshwater in North America: the freshwater drum. The omnivorous freshwater drum lives near the bottom in large rivers, lakes, and impoundments; its general habitat in the UMR is considered to be the main channel (Littlejohn et al. 1985; Pflieger 1997) (Figure 4). In the UMR-IWW System, this fish is abundant in all pools (Figure 34). Adults move into shallow water in the spring and back into deep main channel waters in the late fall (Farabee 1979).

Freshwater drum spawn in open water near the surface from mid-May to mid-July (Holland-Bartels et al. 1990b). Eggs and larvae of the freshwater drum make up a large percentage of the main channel ichthyoplankton drift (Gutreuter, Dettmers, and Wahl 1998). Concentrations of eggs and larvae are greatest in surface waters just upstream of locks and dams; eggs are sometimes five times more abundant here than in other areas of the pools (Holland-Bartels et al. 1990b). Eggs and larvae are also abundant just below the locks and dams, suggesting that a large percentage of eggs and larvae go through or over dams (Holland-Bartels et al. 1990b). Larvae are found in the main channel bottom waters and tend to migrate to the surface at night (Holland-Bartels et al. 1990b).

Model Descriptions

The four models used to assess the impacts of commercial navigation on fish entrainment are described in the following paragraphs.

The Conditional Entrainment Mortality model

The CEM model (e.g., Boreman et al. 1981) has been adapted to estimate the mortality suffered by larvae, young of the year, and adult fishes as a function of

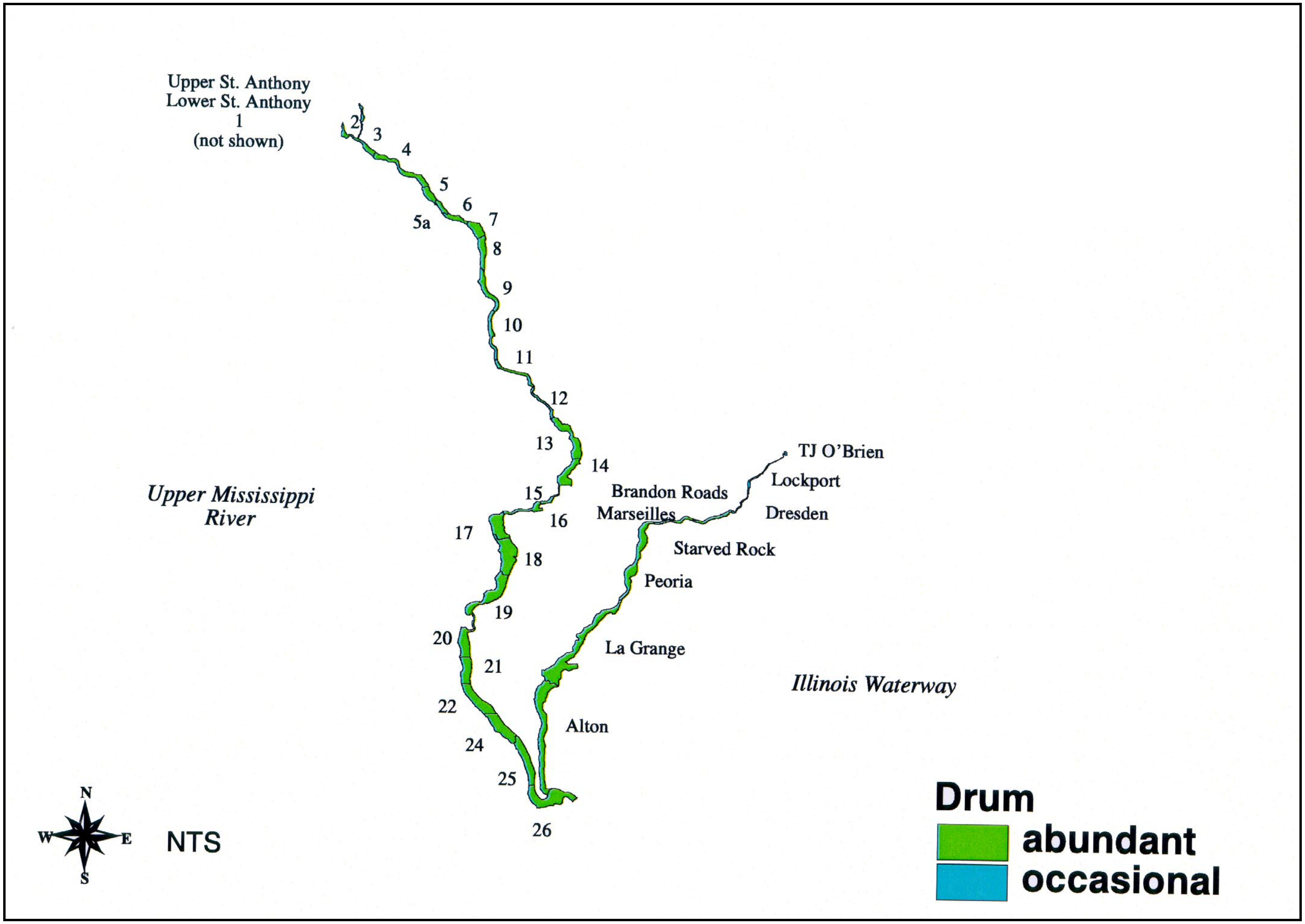

Figure 34. Distribution and abundance of drum in the Upper Mississippi River and the Illinois Waterway

increased commercial traffic on the UMR-IWW System. This model has also been referred to as the Empirical Transport model or the Proportional Mortality model. The CEM has been used mainly to estimate fish mortality associated with entrainment by the cooling systems of electric power generating facilities (e.g., Boreman and Goodyear 1988; Boreman et al. 1981). Adapting this model for the assessment of fish entrainment by commercial traffic required quantification of the volumes of water entrained through the propellers of different commercial vessels and barge configurations that operate on the UMR-IWW System.

Fish mortality due to entrainment in the propeller zone of a passing vessel can be expressed as the fraction of the initial population (or life stage) that would die assuming no other sources of mortality. For a group of fish vulnerable to entrainment, the conditional entrainment mortality rate, m_t, can be defined as (Boreman et al. 1981):

$$m_T = 1 - \sum_{s=1}^{S} R_s \prod_{j=0}^{J} \prod_{l=1}^{L} \sum_{k=1}^{K} D_{l,k} \exp\left(-E_{s+j,l,k}\, C_{j,l}\, t_j\right) \qquad (4)$$

where

R_s = the proportion of total eggs spawned over the entire spawning season S

j = the age group of individuals for J-age groups within each life stage

l = life stage of L total life stages addressed by the model application

k = one of K total regions within the water body subjected to entrainment

$D_{l,k}$ = the proportion of age-j organisms initially occurring in region k

$E_{s+j,l,k}$ = the instantaneous entrainment mortality rate constant (time^{-1}) of life stage-l organisms in region k during time-step $s + j$

$C_{j,l}$ = the fraction of age-j organisms in life stage l

t_j = the duration of age-j

Several simplifying assumptions were made that reduced the complexity of implementing Equation 4 for this assessment. All organisms within each life stage were assumed to be of equal age, $j = 1$. The entrainment calculations focused on the navigation channel as the single region within each UMR-IWW System pool; therefore, k was also 1 and D_{lk} dropped out of the model. Finally, all age-j organisms were assumed to be in the same life stage: $C_{j,l} = 1.0$. Entrainment was calculated each month of the spawning season for each of the selected fish species. Therefore, R_s defined the fraction of total spawning that occurred in month s, and t_j was defined correspondingly as the number of days in each month of the spawning season for each species (Boreman et al. 1981). The resulting reduced form of Equation 4 used in the calculations was:

$$m_t = 1 - \sum_{s=1}^{S} R_s \exp\left(-E_{s+j,} t_j\right) \qquad (5)$$

In this assessment, E_{s+j} defined the instantaneous entrainment mortality rate constant for each life stage and specified time interval (e.g., month). The instantaneous constant E is a function of the amount of water entrained by the propellers per unit time in relation to the volume of river (i.e., hydraulic classification pool volume), the susceptibility of the fish (life stage) to entrainment, and mortality subsequent to entrainment, in general form:

$$E = Qp\, w\, f \;/\; V \tag{6}$$

where

Q_p = volumetric flow rate through the propeller(s)

w = ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume

f = fraction of entrained organisms killed as a result

V = volume of the river pool being modeled

In the adaptation used to assess navigation impacts on fish life stages, Equation 5 was reformulated as:

$$E_i = n\, R\, w_i\;\, f_i\;\, t_i \tag{7}$$

where $R = Q_p/V$, n specifies the number of tows passing through the pool per day, and t_i is the duration of life stage i in days. The parameter w_i estimates the relative concentration of life stage i individuals in the zone of entrainment (i.e., Q_p) compared with the concentration of individuals in the remainder of the main channel. The f_i value defines the fraction of individuals entrained that are killed for life stage i. In this assessment, $i = 1$ for the larval stage, 2 for young of the year, and 3 for adult fish.

Using the model to assess each species of interest, each vessel type, and each pool requires developing estimates for the parameters in Equation 7. The traffic projections, based on economics, produce estimates of n (e.g., vessels/day). The f_i values for larval and young-of-the-year fish derive from the experimental work performed by Killgore et al. (in preparation). The percent mortality (initial and delayed) using the highest propeller velocities from the experiments of Killgore et al. was used. For sturgeon, paddlefish, and blue sucker, f_i values for larval fish were matched up by species; for the remaining species, the highest value of 0.87 was used (Appendix A). Because experiments were performed on only one species of juvenile fish (common carp) (Killgore et al., in preparation), young-of-the-year f_i values were the same for all species (0.225, the mean percent mortality of two experiments on juvenile carp). For the adult life stage of all species, it was assumed that the initial and delayed mortality associated with passing through the propeller was 1.0 (Appendix A). The flow rates through propellers derive from the work of Maynord (1999) and Holley (in preparation). Pool volumes depended on the hydraulic classification and discharge or stage height (e.g., low, medium, high) derived from analysis of historical discharge data.[1]

[1] Kevin Landwehr, personal communication, U.S. Army Engineer District, Rock Island.

A w_i value was estimated for each life stage of each species for each month of the year. The w_i values were derived from the life history information for each species discussed during workshops or obtained from the literature (Appendix A). The w_i value is 0 if the life stage for that particular species does not occur in the main channel in that particular month; 0.25 if the ratio of the average concentration of the life stage of that particular species in the main channel to the average concentration in the main channel river volume for that month is very small, such as the concentration occurring for some bottom-dwelling species or species that spend a majority of time in the backwaters; 0.50 if the average concentration of the life stage of that particular species in the main channel to the average concentration in the main channel river volume for that month is fairly low (this value also applied to some species closely associated with the river bottom); and 1.0 if the concentration of that particular life stage for a species in a given month is evenly distributed across the main channel.

The yearly sum of w_i values for each life stage of the 30 fish species selected for modeling is presented in Table 7; the w_i values were summarized in anticipation of making conservative entrainment calculations. Although the w_i value does not calculate risk, it does provide guidance of the susceptibility of a fish species to entrainment by a commercial tow. The higher the sum of w_i values, the higher the potential risk of the species being affected by increased commercial navigation traffic. The ranking of a fish species provided by the w_i can also be used in the selection of species for analysis. Since the larval stage is the stage most vulnerable to entrainment, the w_i values calculated for this stage are probably the most useful when comparing species susceptibility. In addition, since many adult fish move to avoid passing commercial tows, w_i values estimated for the adult stage may be overestimates. It has been shown that some fishes avoid large vessels in the marine environment (Neproshin 1978; Misund and Aglen 1992; Soria et al. 1996). Todd et al. (1989) observed radio-tagged channel catfish moving in response to oncoming towboats in the IWW. In addition, Lowery et al. (1987) used hydroacoustic sensing to monitor the response of fishes to tow passages in the Cumberland River and found that some fishes moved away from passing tows. However, the strength of the avoidance reaction varied with direction of tow travel and whether or not the barges were loaded, and some fish may not avoid entrainment.

The CEM model can estimate the proportional mortality for three life stages of each species assessed: larvae, young of the year, and adult fishes. However, this assessment addressed only larval mortality for each species and traffic scenario. Larval entrainment data for selected power plants on the UMR-IWW System will be used to provide some context for evaluating the results of the CEM calculations for commercial vessels. The cooling water intakes of power plants located on the UMR-IWW System are additional sources of larval entrainment mortality (Figure 35). Fish larvae are killed because they are entrained in or impinged on the power plant water intake structures. The increase in larval mortality that results from increased commercial traffic will be compared on a pool-by-pool basis with that for larvae entrained by power plants (Appendix C).

Table 7
Sums (Over a Year) and Total Sum of the Monthly Estimated w_i Values for Each Life Stage of the 30 Fish Species Selected for Modeling

Species	Sum of Monthly w_i Value			
	Larval Stage	Young-of-the-year Fish	Adult Fish	Total for All Life Stages
Emerald shiner	4.0	6.0	9.0	19.0
Gizzard shad	4.0	2.5	4.5	11.0
Freshwater drum	4.0	2.0	4.5	10.5
Shorthead redhorse	3.0	3.0	4.5	10.5
Bigmouth buffalo	3.0	2.5	4.5	10.0
Smallmouth buffalo	3.0	2.5	4.5	10.0
White bass	4.0	3.0	2.25	9.25
Spotted sucker	3.0	3.0	2.25	8.25
River carpsucker	4.0	1.5	2.25	7.75
Goldeye	4.0	3.0	0	7.0
Walleye	1.5	3.0	2.25	6.75
Sauger	1.5	3.0	2.25	6.75
Channel catfish	3.0	3.0	0	6.0
Blue catfish	3.0	3.0	0	6.0
Common carp	6.0	0	0	6.0
Mooneye	3.0	2.5	0	5.5
Shovelnose sturgeon	1.0	1.25	2.25	4.5
Lake sturgeon	1.0	1.25	2.25	4.5
Pallid sturgeon	1.0	1.25	2.25	4.5
Paddlefish	0.75	1.5	2.25	4.5
Bluegill	4.0	0	0	4.0
Shortnose gar	1.0	1.5	0	2.5
Blue sucker	0.75	1.5	0	2.25
Flathead catfish	0.75	1.25	0	2.0
Black crappie	2.0	0	0	2.0
White crappie	2.0	0	0	2.0
Northern pike	0.75	0	0	0.75
Largemouth bass	0.75	0	0	0.75
Smallmouth bass	0.75	0	0	0.75
Bowfin	0.75	0	0	0.75

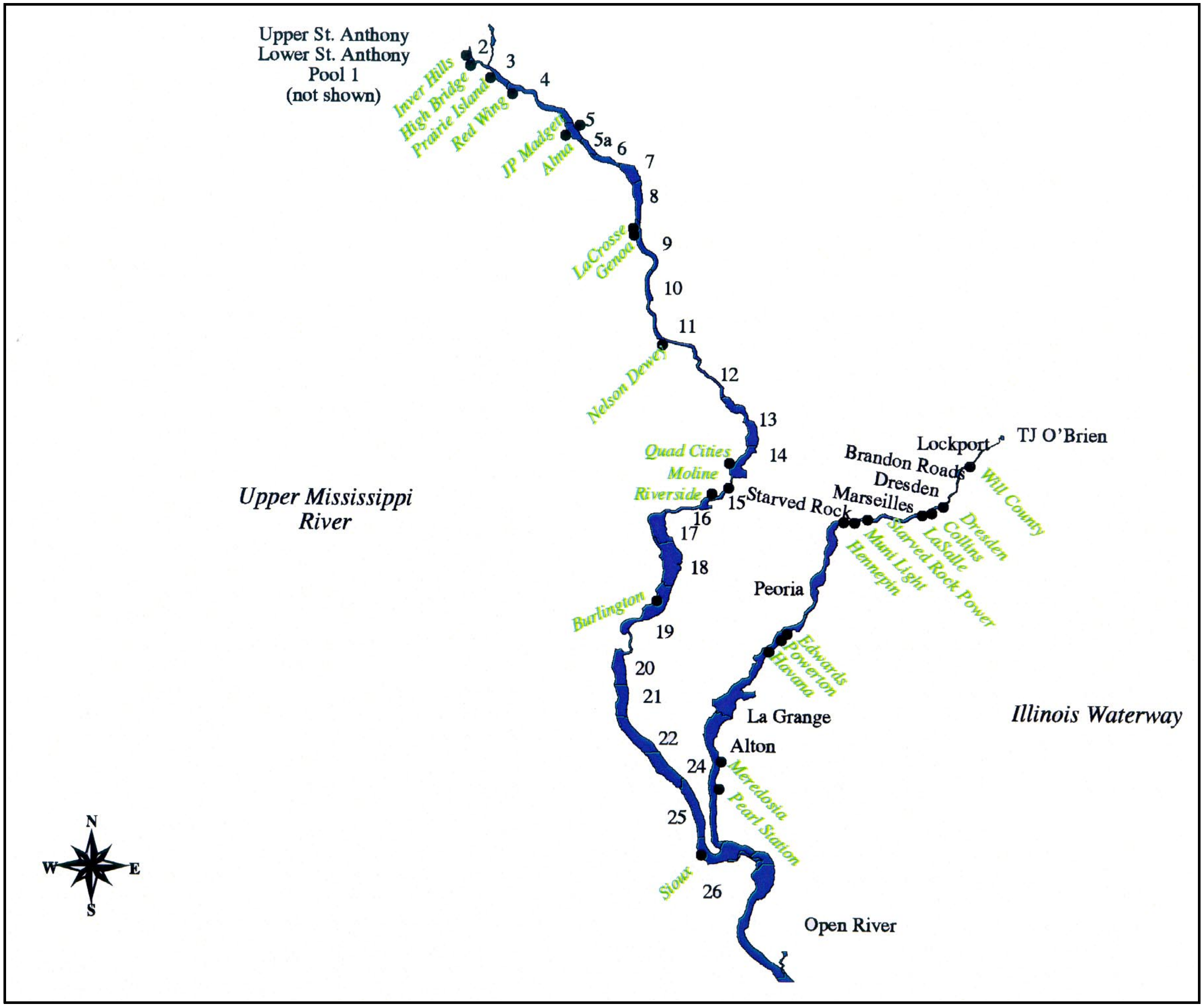

Figure 35. The location of power plants with water intakes on the Upper Mississippi River-Illinois Waterway

The calculated values of proportional mortality define an ecological effect of concern in assessing risks. Functions relating traffic intensity (i.e., vessels/day) to estimates of proportional mortality can be constructed using the model for specific traffic scenarios. More consistent with a probabilistic framework for risk, the uncertainties associated with the parameter values can be quantified and propagated through the calculations to estimate the likelihood that proportional mortality will exceed a specified value (e.g., 0.10). However, probabilistic risk assessments will be deferred to future traffic projections that will be provided by economic models of alternative plans for modifying the navigation infrastructure (e.g., guide walls, mooring cells, lock expansions).

The CEM model has proven useful in assessing the potential impacts of fish entrainment by power plant water intakes (Boreman and Goodyear 1988). Validation of this model as applied to navigation impacts on the UMR-IWW System is constrained by the resources available for field sampling and collection of injured and dead fish following tow passage. The results of trawling activities conducted during the 1996 and 1997 field seasons will be used to evaluate model predictions of entrainment mortality for the adult stages of selected species in the UMR-IWW System (Gutreuter, Dettmers, and Wahl 1998).

The utility of the CEM model for assessing potential navigation impacts on UMR-IWW System fishes is determined in part by the assumptions fundamental to the model. The main assumptions underlying the CEM model include the following: (a) the data describing the spatial-temporal location of the organisms are accurate; (b) the entrainment impacts do not alter the distribution of organisms within the water body; (c) natural mortality is uniform throughout a given life stage; and (d) density-dependent responses are not important (Boreman and Goodyear 1988).

In addition to a direct examination of the CEM estimates for different species, pools, and traffic scenarios, the results of the CEM model also serve as inputs to the EAL model. The EAL model extrapolates entrainment mortalities to estimates of the numbers of future individual adult fish that will be lost from the population as a result of a commercial vessel passage through a pool. Correspondingly, one method of integrating the effects of multiple vessels and pools lies in simply adding the number of future lost adults for each species and traffic scenario.

The Equivalent Adults Lost model

Estimating the impacts of incremental mortality of early life stages in terms of losses in future adults is an important component of this ecological risk assessment. These losses were calculated using the EAL model (Horst 1975; Goodyear 1978). The EAL model translates the proportional mortalities estimated by the CEM model to numbers of lost future fish as the result of entrainment mortality suffered by larvae. The number of future adults lost due to larval entrainment mortalities was estimated using the equation:

$$EAL = L \bullet \left\{ \exp\left(-\sum_{i=1}^{3} Z_i \; t_i \right) - \exp\left[-\sum_{i=1}^{3} \left(Z_i + T_i \right) t_i \right] \right\} \tag{8}$$

where

L = number of entrained and killed larvae

i = 1 (larvae), 2 (young of the year), or 3 (adult)

Z_i = non-tow (natural) mortality rate of life stage i

t_i = duration of life stage i, days

$T_i = n \cdot R_i w_i f_i$ = tow-induced mortality rate of life stage i (see description of the CEM model, Equations 4-7).

Calculation of EAL requires estimates for the same parameters used in the CEM model (Boreman et al. 1981), together with estimates for the non-tow mortality rates for preadult life stages. That is, the tow-induced mortalities will be estimated using the CEM model. Natural mortality rates have been estimated for larvae, young of the year, and adults for 30 species of fishes selected for this risk assessment. These mortality rates were obtained primarily through searching the technical literature, or where data were not available, professional judgment.[1] The sources of the natural mortality rates are listed in the tables in Appendix A. In many cases, species-specific data from other locations or data from similar species were used. Where necessary, daily mortality rates were estimated from reported annual mortality rates.

The nature of the model projections (i.e., future fish lost) makes it difficult to evaluate the performance and reliability of the EAL model. Its validity is influenced not only by the assumptions and limitations specific to this model, but also by the accuracy and precision of the estimates of conditional entrainment mortality that serve as a primary input to the EAL model. It must again be emphasized that the main utility of the EAL model is to put any suspected increase in mortality rate into more concrete terms (i.e., numbers of fish) that can then be used to assess significance, as well as to develop mitigation alternatives. Calculations (future fish lost) resulting from the EAL model for species considered important to the commercial fishery can also be compared to commercial catch data compiled by the UMRCC to evaluate the reasonableness of the larval entrainment estimates and to assess the possible significance of lost future adults (Appendix D).

The calculated values of EAL can be used as ecological effects of concern in assessing risks. Functions relating traffic intensity (i.e., vessels/day) to estimates of EAL can be constructed using the model for specific traffic scenarios. More consistent with a probabilistic framework for risk, the uncertainties associated with the parameter values can be quantified and propagated through the calculations to estimate the likelihood that EAL will exceed a specified value

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[1] Steve Gutreuter, personal communication, U.S. Geological Survey, Upper Mississippi Science Center.

(e.g., 100 fish). Probabilistic estimation of risk is one objective of future refinement and expansion of this risk assessment of commercial navigation.

The key assumption underlying the EAL model is that the fish population of interest is essentially in a steady state, with individuals only replacing themselves throughout their life span. Limitations in the EAL model projections parallel those of the CEM model, given the structural and functional interrelations between the two models. In addition, direct extrapolation of the entrainment mortality model results, using the EAL model calculations, assumes that all other conditions that potentially influence fish population dynamics remain unchanged during the period of extrapolation. It should be recognized that the EAL model provides a first approximation to the severity of potential losses; the model does not necessarily give insights concerning the longer term viability of the impacted population.

The Recruitment Forgone model

Jensen (1990) derived a model for estimating the effect of fish larvae entrainment on the number of individual fish recruited into the fishery. The model is based on a description of the change in the size of a cohort subject to exponential mortality:

$$RF = L\,R_0/Q \tag{9}$$

where

RF = estimate of the number of lost recruits

L = estimated number of larvae killed by entrainment

R_0 = net reproductive rate (assumed = 1.0)

The Q term (not to be confused with entrainment rate, Q_p) adjusts for natural mortality, growth, and fecundity from the time of egg hatching, through the larval, young-of-the-year, and juvenile life stages to the age of maturity (= assumed age of recruitment) according to the following (Jensen 1990):

$$Q = H\,W_{INF}\;P_1\,P_2 \sum_{i=0}^{3} \frac{U_i \exp\left[-iK\left(x_M - x_0\right)\right]}{Z + iK} \left\{1 - \exp\left[-\left(Z + iK\right)\left(x_V - x_M\right)\right]\right\} \tag{10}$$

where

H = number of eggs produced per gram of female biomass

W_{INF} = the asymptotic weight, g

P_1 = fraction of eggs that hatch

P_2 = fraction of females in the population

U_i = 1, -3, 3, and -1 for i = 0, 1, 2, and 3, respectively

i = life stage

K = annual growth coefficient, 1/year
x_M = age at maturity, years
x_0 = theoretical age when length equals zero
Z = instantaneous mortality rate for adults, 1/year
x_v = the oldest age attainable, years

In addition to estimates of the number of entrained larvae, the RF model parameters need only to be estimated for the recruited members of the population (Jensen 1990). This is the main advantage offered by the RF model. It is not necessary to estimate the abundance of fish in different life stages. Data describing fish abundance are largely not available for fish populations on the UMR-IWW System. The RF model simply estimates the number of fishes that will not enter the fishery as a function of the number of fish larvae killed by entrainment.

Jensen (1990) used the RF model to estimate recruitment forgone for a population of yellow perch in the western basin of Lake Erie. These fish were subject to entrainment by the Monroe Power Plant water intake, Monroe, Michigan. However, the projections of RF were not evaluated in relation to any field measurements. As with the EAL model, validation of future projections from the RF model is possible for the UMR-IWW System assessment. This would necessarily involve a substantial investment in monitoring of recruitment classes of the species and pools of interest.

In addition to uncertainties introduced through the process of parameter estimation, an additional and important assumption underlying the RF model is that the fish population of interest is at equilibrium (i.e., net reproductive rate R_0 = 1.0). As indicated by Equation 9, the relation between RF and R_0 is linear with a slope of *L/Q*. Thus, one limitation of this model is that for populations that are rapidly increasing, the assumption of $R_0 = 1$ can lead to underestimation of recruitment forgone in relation to larval entrainment mortality (Jensen 1990).

The Production Forgone model

The Production Forgone (PF) model was proposed by Rago (1984) as an alternative method for assessing the consequences of fish entrainment and impingement losses at water intakes for power plants. The future fish biomass (i.e., metric tons) that would have been produced by the larvae killed by entrainment is estimated by the PF model. Rago (1984) described mortality and growth using simple exponential equations that Ricker (1975) used in the original formulation of production. Jensen et al. (1988) developed a PF model based on the growth and mortality equations of the Beverton and Holt (1957) model wherein the life span of a fish was divided into four stages: larvae, young of the year (age 0), juvenile, and adult.

The PF model of Jensen et al. (1988) is equated as:

$$PF = \sum_{i=1}^{3} \frac{G_i N_i W_i}{G_i - Z_i} \left[e^{(G_i - Z_i)t_i} - 1 \right] \tag{11}$$

where

i = 1 (larvae), 2 (young of year), 3 (adults)

G_i = growth rate of life stage i

$N_i = N_{i-1}$ exp $(-Z_{i-1}t_{i-1})$ = number of life stage i individuals that are killed (i = 2,3)

$W_i = W_{i-1}$ exp $(G_{i-1}t_{i-1})$ = average weight of life stage i individuals (i = 2,3)

Z_i = mortality rate of life stage i

t_i = time duration of life stage i

As with the other models, necessary parameters were derived from existing data and information summarized in the technical literature. Growth rates required by the PF model can also be estimated using regressions of weight-length data (e.g., the von Bertalanffy growth equation) combined with estimates of fish length for each age class. The PF model parameters were estimated for the 30 fish species included in this risk assessment (Appendix A). Particular emphasis was placed on the species identified by the initial CEM model results as being potentially at greater risk.

The PF as a result of entrained fish larval mortality was estimated in relation to alternative traffic scenarios on the UMR-IWW System. These results may be particularly useful for assessing the ecological and economic significance of losses to forage fish species that are not of direct value to the commercial or sport fishery. Lost future biomass calculated using the PF model for species considered important to the commercial fishery will be compared to commercial catch data compiled by the UMRCC (Appendix D).

Jensen et al. (1988) applied the PF model to a population of gizzard shad subject to entrainment by a power plant water intake in western Lake Erie. Extensive sensitivity analysis of the model by Jensen et al. (1988) demonstrated that the estimated survival rate of first-year fishes was a critical model parameter. The key assumption of this modeling approach is that the future growth of the population will be similar to its recent history. In other words, mortality and growth schedules inferred from current population structure will likely apply over future time periods similar to the life span of the species of concern.

Parameter Estimation

Parameter values for the fish entrainment models were developed for each of the 30 species using data and information published in the open scientific literature, books, technical reports, and professional judgment, where necessary. Model parameters for each of the 30 species are presented in Appendix A.

Where particular interpretations or simplifying assumptions were necessary in using available data to estimate model parameter values, attempts were made to bias parameter values toward overestimating potential impacts and risk.

Estimates of larval density (number of larvae/m^3) were central to this assessment of entrainment mortality by commercial navigation. Existing larval density data were collated for as many of the 30 species as possible from technical reports, the open literature, power plant water intake fish entrainment and impingement studies or monitoring reports, and a recent field study on the UMR-IWW System (Gutreuter, Dettmers, and Wahl 1998) (Appendix B). Whenever possible, larval density estimates were matched up on a pool-by-pool basis or within a range of pools when the data sets were developed. If more than one value was available for a particular month, the highest value was selected in developing the data set. However, the lowest larval density estimate was used for blue sucker because it is a rare species. Many of the larval density data have not been classified to the species level. Where necessary, larval density estimates were derived using data from the closest related family or genus. Density data for young-of-the-year and adult fish were not available for the 30 species in the UMR-IWW System. However, for a particular UMR-IWW System pool in which the species was known to occur, representative values were estimated using the distributions maps of each species according to the following assumption: rare = 0.10, occasional = 0.25, common= 0.50, and abundant = 0.99 (number/m^3). Therefore, this assessment addresses larval mortality only.

5 Risk Characterization

Characterizing potential ecological risks posed by commercial traffic on the UMR-IWW System, the third step in the risk assessment process, resulted from the integration of the ecological models for impacts on fish with the results of the exposure analysis that characterized the magnitude of entrainment.

Potential impacts on or risks to fish larvae posed by commercial vessels were assessed using the CEM model (Boreman et al. 1981). The CEM model estimates the number of newly hatched fish larvae that are drawn through and subsequently killed by the propeller jet of commercial vessels traversing each pool on the UMR-IWW System during the spawning season. The results of the entrainment mortality calculations were extrapolated to estimates of future lost adults: EAL, RF, and PF. The EAL model (Horst 1975; Goodyear 1978) essentially compares the incremental entrainment mortalities to natural mortalities suffered by larvae and juvenile life stages. The RF model (Jensen 1990) addresses fish growth, in addition to simply extrapolating mortality, and may be important in evaluating the implications of larval entrainment of individuals that fail to recruit to commercial and recreational fisheries in the UMR-IWW System. The PF model (Rago 1984; Jensen et al. 1988) is analogous to the RF model, except that lost future biomass is estimated instead of individual recruits or adults. This model is important for assessing risks posed by commercial vessels on the biomass of important forage species.

This section of the ecological risk assessment examines the impacts of entrainment associated with percentage increases in commercial navigation for 30 species of fish in the UMR-IWW System. The assessment is large in scope, with results for each species for each month for each pool in the UMR-IWW System. Baseline calculations, estimated impacts, and their incremental differences were produced for each combination of species, month, and pool. The volume of model results precludes their detailed presentation in the body of this report. This section, therefore, focuses on the results for six selected species: emerald shiner, freshwater drum, mooneye, gizzard shad, channel catfish, and walleye. These species were selected on the basis of either recreational value (e.g., walleye), commercial importance (e.g., channel catfish), importance as a forage fish (e.g., gizzard shad) or status as threatened or endangered (e.g., mooneye). Results for the remaining species are summarized as computer files appended in CD-ROM distributed with this report (Appendix E). Instructions on how to run the fish entrainment models are also included in Appendix E.

This risk characterization addresses only the deterministic results of estimated impacts of increased navigation on larval fish entrainment. The results will provide brief examples of baseline impacts on channel catfish, that is, estimates of catfish entrainment mortality using the 1992 traffic data. The results of 25, 50, 75, and 100 percent increases in traffic intensity on channel catfish are presented subsequently. The estimated incremental impacts of the traffic scenarios on all six selected species are presented for Pool 13 using model results for either June or July. Finally, the incremental impacts on RF are summed across the entire UMR-IWW System for all six species as an example of how the results might be used to rank-order species in terms of potential impacts and risks. In all of the following tabulated results, the mean result refers to impacts estimated using the mean entrainment rates determined from the exposure assessment; the HQLS corresponds to the higher larval mortality rates produced by vessels with high entrainment rates traveling at slower speeds; and the LQHS identifies results obtained using the combination of lower entrainment rate and higher vessel speeds. These combinations appear to provide reasonable upper and lower values of estimated impacts.

Baseline Impacts

The results of using the 1992 baseline traffic to estimate impacts of "current" entrainment on channel catfish are listed in Table 8 for UMR Pools 4, 8, 13, 26A, and 26B and the IWW La Grange Pool; channel catfish impacts were also calculated for the remaining pools in the UMR-IWW System. The results demonstrate the potential magnitude of baseline entrainment on channel catfish for the month of July in each pool. Greatest estimated impacts resulted for Pool 26A, where as much as 11.5 percent of larval production might be entrained and killed by commercial traffic over the course of the month. The mean percentage entrainment values for these pools ranged from 0.388 percent in Pool 4 to 7.03 percent in Pool 26A. Lower bound estimates ranged from 0.184 percent to 3.81 percent.

It is important to note that assessing impacts depends in part on the selected ecological measure that characterizes the potential impact. For example, extrapolation of larval entrainment mortality using the RF model usually gives consistently lower numbers of lost recruits compared to extrapolation of the CEM estimates to lost future adults. The models are somewhat different in their extrapolations. While both derive from the same governing equation that extrapolates the longer term impacts of entrainment mortality, the EAL model extrapolates age-specific mortality rates incremented by larval entrainment over the entire life span of the species, as implemented in this assessment. The results of these EAL extrapolations to lost future adults can be interpreted in terms of future population dynamics. The RF model also extrapolates entrainment mortality, but develops an average mortality rate that is used to estimate losses to the recruit (i.e., age at sexual maturity) stage instead of the entire fish life span. The RF estimates are useful for interpreting entrainment mortality in terms of numbers of fish lost to the commercial or recreational fishery for the species. The EAL requires estimates of larval, young-of-the-year, and adult mortality

Table 8
Estimated Impacts for July 1992 Baseline Traffic on Channel Catfish

Pool	Larvae Killed	Percent of Pool Production	EAL #fish	RF #fish	PF tons
UMR 04					
Mean	2,190,000	0.388	523	738	242
HQLS	3,790,000	0.673	1,370	1,280	420
LQHS	1,030,000	0.184	129	349	115
UMR 08					
Mean	1,510,000	4.00	1,070	511	167
HQLS	2,520,000	6.66	1,810	852	277
LQHS	785,000	2.07	499	265	86.8
UMR 13					
Mean	2,820,000	2.72	1,910	954	312
HQLS	4,660,000	4.49	3,310	1,570	514
LQHS	1,500,000	1.44	838	506	166
UMR 26A					
Mean	28,000,000	7.03	19,900	9,470	3,090
HQLS	45,800,000	11.5	32,800	15,500	5,030
LQHS	15,200,000	3.81	98,900	5,130	1,680
UMR 26B					
Mean	32,700,000	4.04	21,600	11,100	3,620
HQLS	53,500,000	6.60	37,800	18,100	5,900
LQHS	17,700,000	2.18	9,450	5,970	1,960
IWW La Grange Pool					
Mean	914,000	0.543	642	309	101
HQLS	1,640,000	0.972	1,170	353	180
LQHS	395,000	0.235	230	134	43.7

Note: to convert tons to kilograms, multiple by 907.1847.

rates in this assessment. The RF model calculates an average mortality rate based on the growth characteristics of the recruit, which are often more easily obtained. If the models are integrated to the same time scale (e.g., fish life span) and the life stage-averaged mortality rates (i.e, EAL model) equal the average mortality rate (i.e, RF model), both models should give similar estimates of numbers of lost fish.

The numbers of channel catfish larvae killed show a general trend of increased impact across more southerly UMR pools. This pattern reflects both the longer navigation season and the greater traffic intensity. A similar pattern results for mortality expressed as a percentage of total larval production, although pool-specific differences in larval densities, duration of the spawning season, and traffic intensities can produce a pattern of percentage impacts somewhat different from that observed for number of larvae killed.

Over the course of the channel catfish spawning season, the values of conditional entrainment mortality ranged from 0.231 to 0.950. These results may emphasize some of the conservative assumptions made concerning the availability of larvae (e.g., the value of w_i in the model and the fact that each vessel per day encounters the same larval density), the fraction of entrained larvae killed (e.g., f_i), and estimates of entrainment rates developed in the exposure analysis. Future evaluation of these results will focus methods of numerical sensitivity on identifying the parameters that produced these very high rates.

Traffic Increase Scenarios

The results showing the projected impacts of percentage increases in commercial traffic on Pool 8 channel catfish are presented in Table 9. The results demonstrate that a percentage increase in traffic volume, without changing the nature of its seasonal distribution or associated fleet characteristics, produces a corresponding percentage increase in the number of larvae killed and their percentage of total larval production in the pool. The same relative impacts resulted for other fish species and other pools; the only factor that changed in the model was the scalar increase in the average number of vessels per day. The entrainment estimates are linear functions of the numbers of vessels per day.

For the traffic increase scenarios, CEM ranged from 0.954 (25 percent) to 0.991 (100 percent). Both the CEMs and the PF values are not simple linear multiples. The CEM rate will approach an asymptotic value of 1.0 as larval survival values become vanishingly small. The PF model represents a nonlinear extrapolation of killed larvae as a function of the species-specific differences between growth and mortality. Again, these initial results partially reflect some of the conservative assumptions underlying the assessment, as well as differences between how the fish assessment models extrapolate numbers of killed larvae or entrainment mortality rate. More detailed analysis of these results is the subject of continuing evaluation of applying these models to the Navigation Study Fish Ecological Risk Assessment.

Table 9 Projected Impacts of Increased Traffic on Channel Catfish in Pool 8 in July					
	Larvae Killed	Percent of Pool Production	EAL #fish	RF #fish	PF tons
25 Percent Traffic Increase					
Mean	1,890,000	5.00	1,350	639	209
HQLS	3,150,000	8.32	2,260	1,060	346
LQHS	981,000	2.59	658	331	108
50 Percent Traffic Increase					
Mean	2,270,000	6.00	1,630	767	250
HQLS	3,780,000	9.99	2,720	1,280	415
LQHS	1,180,000	3.11	813	398	130
75 Percent Traffic Increase					
Mean	2,650,000	7.00	1,900	895	291
HQLS	4,410,000	11.7	3,170	1,490	483
LQHS	1,370,000	3.63	964	464	152
100 Percent Traffic Increase					
Mean	3,030,000	8.00	2,170	1,020	333
HQLS	5,040,000	13.3	3,620	1,700	551
LQHS	1,570,000	4.15	1,110	530	173

It is likely that future traffic projections based on the results of economic models and the dynamics of moving seasonal commodities through the system will result in impacts that are not simple linear multiples of baseline impacts. The larval fish entrainment models appear to have the capability to address these potential alterations in the distribution of seasonal traffic intensity.

Incremental Impacts

The incremental impacts of commercial navigation can be used to assess which species in which pools appear to be at greatest risk. Tables 10-15 summarize the incremental impacts of the traffic percentage increase scenarios for the six selected species. Depending on the species, the larval entrainment calculations suggest increased mortality ranging from ~100,000 (e.g., walleye) to 100,000,000 (e.g., emerald shiner, gizzard shad) individual larvae for Pool 13 in these peak spawning months. However, in terms of differences in mortality expressed as a percent of total larval production, the incremental impacts are ~0.008-2.69 percent; fairly similar percentage differences among several species

Table 10
Incremental Impacts of Increased Commercial Traffic on Emerald Shiner in UMR Pool 13 for the Month of July

	ΔLarvae Killed	ΔPercent	ΔEAL	ΔRF #fish	ΔPF tons
25 Percent Traffic Increase					
Mean	8,770,000	0.0435	135	113,000	0.250
HQLS	14,500,000	0.0717	315	186,000	0.379
LQHS	4,660,000	0.0231	42.8	59,800	0.141
50 Percent Traffic Increase					
Mean	17,500,000	0.0869	292	225,000	0.494
HQLS	28,900,000	0.143	668	372,000	0.740
LQHS	9,320,000	0.0462	93.4	120,000	0.281
75 Percent Traffic Increase					
Mean	26,700,000	0.132	475	343,000	0.741
HQLS	44,100,000	0.218	1,070	566,000	1.10
LQHS	14,200,000	0.0703	154	182,000	0.424
100 Percent Traffic Increase					
Mean	35,500,000	0.176	668	456,000	0.971
HQLS	58,500,000	0.290	1,480	752,000	1.43
LQHS	18,900,000	0.0934	220	242,000	0.559

Table 11
Incremental Impacts of Increased Commercial Traffic on Freshwater Drum in UMR Pool 13 for the Month of July

	ΔLarvae Killed	ΔPercent	ΔEAL	ΔRF #fish	ΔPF tons
25 Percent Traffic Increase					
Mean	862,000	0.0286	1.96	11.0	189
HQLS	1,420,000	0.0472	3.02	18.1	305
LQHS	458,000	0.0152	1.01	58.1	102
50 Percent Traffic Increase					
Mean	1,720,000	0.0572	3.87	21.9	376
HQLS	2,840,000	0.0943	5.98	36.1	606
LQHS	915,000	0.0304	2.04	11.6	203
75 Percent Traffic Increase					
Mean	2,630,000	0.0872	5.83	33.4	571
HQLS	4,330,000	0.144	9.03	55.0	918
LQHS	1,390,000	0.0463	3.14	17.7	309
100 Percent Traffic Increase					
Mean	3,490,000	0.116	7.66	44.3	756
HQLS	5,750,000	0.191	11.9	73.1	1,210
LQHS	1,850,000	0.0615	4.19	23.5	409

Table 12
Incremental Impacts of Increased Commercial Traffic on Mooneye in UMR Pool 13 for the Month of June

	ΔLarvae Killed	ΔPercent	ΔEAL	ΔRF #fish	ΔPF tons
25 Percent Traffic Increase					
Mean	242,000	0.204	155	111	8.42
HQLS	380,000	0.320	230	174	13.0
LQHS	142,000	0.120	95.0	64.9	4.98
50 Percent Traffic Increase					
Mean	484,000	0.408	306	222	16.8
HQLS	760,000	0.641	457	348	25.9
LQHS	284,000	0.239	190	130	9.95
75 Percent Traffic Increase					
Mean	716,000	0.604	448	328	24.8
HQLS	1,120,000	0.948	673	515	38.2
LQHS	420,000	0.345	279	192	14.7
100 Percent Traffic Increase					
Mean	959,000	0.808	594	439	33.0
HQLS	1,500,000	1.27	898	689	50.9
LQHS	562,000	0.473	370	257	19.6

Table 13
Incremental Impacts of Increased Commercial Traffic on Gizzard Shad in UMR Pool 13 for the Month of July

	ΔLarvae Killed	ΔPercent	ΔEAL #fish	ΔRF #fish	ΔPF tons
25 Percent Traffic Increase					
Mean	12,700,000	0.160	1,460	128	287
HQLS	21,000,000	0.264	2,250	210	471
LQHS	6,760,000	0.0850	768	67.8	153
50 Percent Traffic Increase					
Mean	25,500,000	0.320	2,880	255	573
HQLS	42,000,000	0.528	4,460	421	940
LQHS	13,500,000	0.170	1,550	136	306
75 Percent Traffic Increase					
Mean	38,800,000	0.488	4,340	389	873
HQLS	64,000,000	0.804	6,740	641	1,430
LQHS	20,600,000	0.259	2,380	207	466
100 Percent Traffic Increase					
Mean	51,500,000	0.648	5,700	517	1,160
HQLS	84,900,000	1.07	8,910	852	1,900
LQHS	27,400,000	0.344	3,170	274	618

Table 14
Incremental Impacts of Increased Commercial Traffic on Channel Catfish in UMR Pool 13 for the Month of July

	ΔLarvae Killed	ΔPercent	ΔEAL	ΔRF #fish	ΔPF tons
25 Percent Traffic Increase					
Mean	690,000	0.664	540	233	75.9
HQLS	1,140,000	1.10	836	384	125
LQHS	366,000	0.353	296	124	40.4
50 Percent Traffic Increase					
Mean	1,380,000	1.33	1,070	466	152
HQLS	2,270,000	2.19	1,660	768	249
LQHS	732,000	0.706	595	247	80.9
75 Percent Traffic Increase					
Mean	2,100,000	2.03	1,600	710	231
HQLS	3,470,000	3.34	2,520	1,170	379
LQHS	1,120,000	1.08	905	377	123
100 Percent Traffic Increase					
Mean	2,790,000	2.69	2,110	943	307
HQLS	4,600,000	4.43	3,340	1,550	503
LQHS	1,480,000	1.43	1,200	501	164

Table 15
Incremental Impacts of Increased Commercial Traffic on Walleye in UMR Pool 13 for the Month of June

	ΔLarvae Killed	ΔPercent	ΔEAL #fish	ΔRF #fish	ΔPF tons
25 Percent Traffic Increase					
Mean	30,300	0.00755	45.6	0.344	15.1
HQLS	47,500	0.0119	67.3	0.539	23.6
LQHS	17,700	0.00442	27.1	0.201	88.6
50 Percent Traffic Increase					
Mean	60,500	0.0151	90.0	0.687	30.1
HQLS	95,000	0.0237	133	1.08	47.1
LQHS	35,500	0.00884	54.4	0.402	17.7
75 Percent Traffic Increase					
Mean	89,600	0.0223	131	1.02	44.5
HQLS	141,000	0.0351	196	1.60	69.6
LQHS	52,500	0.0131	80.4	0.595	26.2
100 Percent Traffic Increase					
Mean	120,000	0.0299	174	1.36	59.5
HQLS	188,000	0.0469	260	2.13	93.0
LQHS	70,200	0.0175	107	0.796	35.0

for the same month reflect the proportional nature of the traffic increase, although the absolute numbers differ by orders of magnitude among these species. In absolute numbers, the impacts in Pool 13 appear greatest for gizzard shad and emerald shiner. Intermediate impacts in Pool 13 are demonstrated for freshwater drum, mooneye, and channel catfish. Walleye appear least impacted, although 30,300 additional larvae deaths (compared to the 1992 baseline) are estimated on average for a 25 percent traffic increase. The species-specific natural mortalities, growth rates, weights, and fecundities (Appendix A) translate the calculated larval mortalities into different estimates of lost future adults, lost recruits, and unrealized production of fish biomass.

Similarly, the impacts can be summed over the entire UMR-IWW System to develop a larger picture of the potential risks to each of the species of concern. The results of these rank-orders of potential impact might be used to design strategies to avoid or minimize impacts associated with more realistic future traffic scenarios. Table 16 makes such a comparison for the six selected species summarized in this section of the risk assessment. Using the RF model results for the 25 percent traffic increase scenario, the model calculations suggest that the emerald shiner is at greatest risk, with walleye suffering the smallest incremental

Table 16
Comparison of Incremental Impacts on Recruitment Forgone (Numbers of Fish) for Six Selected Fish Species in the UMR-IWW System Based on a 25 Percent Increase in Commercial Traffic

Range of RF Incremental Impacts	UMR	IWW	Total System
Emerald Shiner			
Mean	88,200,000	18,300,000	106,000,000
HQLS	141,000,000	28,200,000	169,000,000
LQHS	49,900,000	8,260,000	58,100,000
Freshwater Drum			
Mean	216,000	15,100	231,000
HQLS	347,000	23,500	370,000
LQHS	122,000	6,710	128,000
Mooneye			
Mean	60,400	1,910	62,300
HQLS	96,200	3,310	99,600
LQHS	34,300	908	35,200
Gizzard Shad			
Mean	46,800	37,700	84,500
HQLS	75,500	58,200	134,000
LQHS	26,000	17,100	43,000
Channel Catfish			
Mean	49,200	3,140	52,300
HQLS	80,600	4,880	85,500
LQHS	26,500	1,400	27,900
Walleye			
Mean	1,420	16.6	1,430
HQLS	2,280	25.7	2,310
LQHS	788	7.50	796

increase in lost future recruits as a result of increased larval mortality. For gizzard shad, the impacts are comparatively similar for the UMR and IWW. For the remaining species, the relatively larger UMR contribution to total lost recruits appears to reflect the larger size of the UMR.

Uncertainties

One key aspect of ecological risk assessment that distinguishes this process from more historical environmental assessments performed under the National Environmental Policy Act is the explicit identification and quantification of uncertainties that enter into the analysis. Once quantified, these uncertainties are included in the assessment calculations to produce probabilistic estimates of ecological impacts (i.e., risks). In the Navigation Study Fish Ecological Risk Assessment, uncertainties enter the analysis in the form of bias and imprecision in the estimates of future traffic intensity, in the characterization of entrainment volumes generated by specific vessel configurations, and in the parameters input into the ecological models. Uncertainties also take the form of the simplifications and assumptions that are inherent in the modeling process.

A future important aspect of this risk assessment process will be application of numerical methods to identify and rank-order the contributions of specific sources of uncertainty to the overall assessment results. Such analyses can be used to design additional studies or identify additional data collection that will provide the greatest return in reducing bias and imprecision per unit investment of future Navigation Study resources.

Verification and Evaluation of Estimated Larval Entrainment

Preliminary results of applying the larval entrainment model and the subsequent extrapolation models to assess the potential impacts of increased commercial traffic on fishes in the UMR-IWW System are summarized in the previous tables and presented in their entirety in Appendix E. Verification and evaluation of these results are important objectives in the continued development of these methods for the forthcoming economics-based traffic projections. In part, the verification process included repeated calculations for selected scenarios to determine if the models have been correctly implemented in computer code (i.e., FORTRAN). For example, setting the standard deviations assigned to Q_p and S to zero correctly produced identical results for the mean, HQLS, and LQHS calculations throughout. With few exceptions that remain the focus of additional analysis, the HQLS and LQHS estimates bracketed the mean values across all calculations, as expected. As discussed previously, the 25, 50, 75, and 100 percent increases in larval entrainment calculated for the corresponding percent increases in traffic also verify the model. At the same time, several of the PF calculations appear inconsistent with the associated number of entrained larvae. These calculations are being further verified to identify the reason for the inconsistency and to correct any remaining errors in coding. Additional verification tests are being designed to provide a thorough testing of the model code prior to assessing the more realistic traffic scenarios.

Data that quantify the entrainment of fish larvae by electric generating facilities (i.e., power plants) located throughout the UMR-IWW System are being collated for comparison (e.g., Appendix C) with the estimated commercial traffic-induced mortality estimates. While it is recognized that the nature of entrainment differs fundamentally between the spatially fixed power plants and the navigating traffic, the power plant entrainment data might nevertheless point out gross discrepancies between the estimated commercial traffic entrainment calculations and observations for power plants on the UMR-IWW System. Depending on the credibility of the navigation entrainment results, the power plant data might also be used to provide some context for assessing the comparative significance of traffic-induced larval mortality (i.e., "power-plant equivalents"). For example, Jensen (1990) estimated entrainment of approximately 128,000,000 yellow perch larvae by the Monroe Power Plant, located on the western basin of Lake Erie. He used the RF model to estimate a corresponding loss of 8,900 future recruits. Jensen's power plant entrainment values compare with the range of 100,000-1,000,000,000 larvae entrained by commercial traffic. His estimate of lost perch recruits compares to the 10-10,000,000 incremental increases in lost recruits estimated for the six species in the UMR-IWW (Tables 10-15). Jensen et al. (1988) estimated power plant impacts on gizzard shad production forgone as 570 metric tons (570,000 kg). This magnitude is similar to the magnitudes of incremental impacts on gizzard shad production estimated for a 50 percent increase in commercial traffic for Pool 13 in this initial assessment (e.g., Table 13). If the entrainment rate for a given power plant is known and values of w_i and f_i for power plant entrainment are assumed, it might also prove possible to calibrate the w_i factor for various species and corresponding pools addressed by the navigation assessment entrainment model.

Commercial fisheries data compiled annually by the UMRCC from the five UMR states of Illinois, Wisconsin, Minnesota, Iowa, and Missouri, despite their well-recognized shortcomings, collated for several species in the UMR-IWW System (Appendix D) might also prove useful for evaluating the larval entrainment calculations, or more exactly, the extrapolation of these values to lost future recruits or biomass. For example, the estimates of navigation-induced production forgone for commercially fished species can be readily compared with commercial catch data after converting the catch data from pounds to metric tons. After an average weight for individual commercially harvested species (e.g., weight at recruitment) is derived, the commercial catch data can be translated into numbers of fish to compare with estimates of recruits lost to larval entrainment. As with the power plant entrainment data, these comparisons may prove useful in evaluating the credibility of the larval entrainment estimates for commercial navigation. Significance of estimated lost recruits or lost biomass might also be estimated in relation to the historical catch data.

The preceding activities are the foci of continued efforts aimed at verifying, evaluating, and refining the Navigation Study Fish Ecological Risk Assessment for the UMR-IWW System.

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13. ABSTRACT ***(Maximum 200 words)***

The number of fish larvae entrained through the propellers of commercial vessels was estimated for anticipated traffic increases on the Upper Mississippi River-Illinois Waterway (UMR-IWW) System. The volume of water entrained by different vessel configurations and operating characteristics was calculated for each month and pool using 1992 commercial traffic data. Hypothetical traffic scenarios were developed as 25, 50, 75, and 100 percent increases over the 1992 data. For each scenario, larval mortality was estimated for 30 fish species as the product of the entrainment volumes, measured larval densities, estimated larval susceptibility to entrainment, and experimentally determined mortality rates of entrained larvae. Using published fisheries assessment models, the estimated larval mortalities were extrapolated to future incremental losses in adult fish, recruitment losses to commercial and sport fisheries, and losses in fish biomass production. Due to the large amount of information, results for six representative species (emerald shiner (*Notropis atherinoides*), freshwater drum (*Aplodinotus grunniens*), mooneye (*Hiodon tergisus*), gizzard shad (*Dorosoma cepedianum*), channel catfish (*Ictalurus punctatus*), and walleye (*Stizostedion vitreum*)) were presented for Pool 13. The incremental increase in larval entrainment ranged from 0.009 to 2.2 percent for the 50 percent traffic scenario for the six species during June or July in Pool 13. Species characterized by high entrainment mortalities in this assessment included emerald shiner and gizzard shad.

14. SUBJECT TERMS
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Appendix A
Fish Model Parameters

References cited in this Appendix are included in the References at the end of the main text.

Table A1
Model Parameters for Lake Sturgeon

Parameter	Parameter Value	References
Recruitment Forgone Model (Jensen 1990)		
Net reproductive rate (R_o)	1.0	Model assumption
Eggs/gram of female (H)	33.33	Carlander 1969
Fraction of hatched eggs (p_1)	0.50	Professional judgment
Fraction of females in population (p_2)	0.50	DeVore et al. 1995
Asymptotic weight (g) (W_{INF})	45,359	Pauly 1980
Age at time of egg hatching (years) (x_0)	0.33	Etnier & Starnes 1993, Carlander 1969, Smith 1979, LaHaye et al. 1992, Becker 1983, Scott & Crossman 1973, Lee et al. 1980
Age at maturity (years) (x_m)	20	Etnier & Starnes 1993, Pflieger 1997, Cross 1967, Scott & Crossman 1973, Carlander 1969, Lee et al. 1980, Russell 1986
Lifespan (years) (x_v)	80	Etnier & Starnes 1993, Pflieger 1997, Cross 1967, Carlander 1969, Lee et al. 1980
Adult mortality rate/year (Z)	0.01	Pauly 1980
Growth coefficient/year (K)	0.05	Pauly 1980
Production Forgone Model (Jensen et al. 1988)		
Initial weight larval stage (W_1)	0.00043	Carlander 1969, Holland-Bartels et al. 1990b
Initial weight young-of-the-year (W_2)	0.0163	Carlander 1969, Scott & Crossman 1973
Initial weight adult (W_3)	68.04	Scott & Crossman 1973
Weight specific growth/day, eggs and larvae (G_1)	0.00066	Carlander 1969, Holland-Bartels et al. 1990b
Weight specific growth/day, young-of-the year (G_2)	0.1995	Carlander 1969, Scott & Crossman 1973

Table A1
Model Parameters for Lake Sturgeon (cont.)

Parameter	Parameter Value	References
Weight specific growth/day, adult (G_3)	1.57265	Scott & Crossman 1973
Natural mortality rate/day, eggs and larvae (Z_1)	0.1919	Professional judgment
Natural mortality rate/day, young-of-the-year (Z_2)	0.0047	Professional judgment
Natural mortality rate/day, adult (Z_3)	0.000003	Beverton & Holt 1959, Pauly 1980
Conditional Entrainment Mortality Model (Boreman et al. 1981) and Equivalent Adults Lost Model (Horst 1975, Goodyear 1978)		
Life stage duration (days), eggs and larvae (t_1)	24	Etnier & Starnes 1993, Becker 1983, Scott & Crossman 1973, Lee et al. 1980
Life stage duration (days), young-of-the-year (t_2)	341	Etnier & Starnes 1993, Pflieger 1997, Cross 1967, Carlander 1969, Lee et al. 1980
Life stage duration (days), adult (t_3)	28,835	Etnier & Starnes 1993, Pflieger 1997, Cross 1967, Carlander 1969, Lee et al. 1980
Fraction of entrained killed, larvae (f_1)	0.87	Killgore et al. (in preparation)
Fraction of entrained killed, young-of-the-year (f_2)	0.225	Killgore et al. (in preparation)
Fraction of entrained killed, adult (f_3)	1.0	Professional judgment
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, eggs and larvae (w_1)	0.25	Priegel & Wirth 1971, Kempinger 1996, Holland et al. 1984, LaHaye et al. 1992, Littlejohn et al. 1985
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, young-of-the-year (w_2)	0.25	Kempinger 1996, Becker 1983
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, adult (w_3)	0.25	Baker et al. 1991, Etnier & Starnes 1993, Becker 1983, Pflieger 1997, Scott & Crossman 1973, Lee et al. 1980, Littlejohn et al. 1985, Trautman 1981

Table A2
Model Parameters for Pallid Sturgeon

Parameter	Parameter Value	References
Recruitment Forgone Model (Jensen 1990)		
Net reproductive rate (R_o)	1.0	Model assumption
Eggs/gram of female (H)	33.33	Carlander 1969
Fraction of hatched eggs (p_1)	0.50	Professional judgment
Fraction of females in population (p_2)	0.50	DeVore et al. 1995
Asymptotic weight (g) (W_{INF})	29,450	Etnier & Starnes 1993
Age at time of egg hatching (years) (x_0)	0.33	Etnier & Starnes 1993, Smith 1979
Age at maturity (years) (x_m)	15	Pflieger 1997
Lifespan (years) (x_v)	40	Etnier & Starnes 1993, Pflieger 1997
Adult mortality rate/year (Z)	0.01	Pauly 1980
Growth coefficient/year (K)	0.05	Pauly 1980
Production Forgone Model (Jensen et al. 1988)		
Initial weight larval stage (g) (W_1)	0.00043	Carlander 1969, Holland-Bartels et al. 1990b
Initial weight young-of-the-year (g) (W_2)	0.0139	Carlander 1969, Holland-Bartels et al. 1990b
Initial weight adult (g) (W_3)	83.99	Carlander 1969
Weight specific growth/day, eggs and larvae (g) (G_1)	0.00056	Carlander 1969, Holland-Bartels et al. 1990b
Weight specific growth/day, young-of-the year (g) (G_2)	0.1995	Carlander 1969, Scott & Crossman 1973
Weight specific growth/day, adult (g) (G_3)	1.1164	Carlander 1969

Table A2
Model Parameters for Pallid Sturgeon (cont.)

Parameter	Parameter Value	References
Natural mortality rate/day, eggs and larvae (Z_1)	0.1919	Professional judgment
Natural mortality rate/day, young-of-the-year (Z_2)	0.0047	Professional judgment
Natural mortality rate/day, adult (Z_3)	0.000009	Beverton & Holt 1959, Pauly 1980
Conditional Entrainment Mortality Model (Boreman et al. 1981) and Equivalent Adults Lost Model (Horst 1975, Goodyear 1978)		
Life stage duration (days), eggs and larvae (t_1)	24	Etnier & Starnes 1993
Life stage duration (days), young-of-the-year (t_2)	341	Etnier & Starnes 1993
Life stage duration (days), adult (t_3)	14,235	Etnier & Starnes 1993, Pflieger 1997
Fraction of entrained killed, larvae (f_1)	0.58	Killgore et al. (in preparation)
Fraction of entrained killed, young-of-the-year (f_2)	0.225	Killgore et al. (in preparation)
Fraction of entrained killed, adult (f_3)	1.0	Professional judgment
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, eggs and larvae (w_1)	0.25	Holland et al. 1984
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, young-of-the-year (w_2)	0.25	Professional judgment
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, adult (w_3)	0.25	Baker et al. 1991, Etnier & Starnes 1993, Pflieger 1997, Cross 1967, Lee et al. 1980

Table A3
Model Parameters for Shovelnose Sturgeon

Parameter	Parameter Value	References
Recruitment Forgone Model (Jensen 1990)		
Net reproductive rate (R_o)	1.0	Model assumption
Eggs/gram of female (H)	33.33	Carlander 1969
Fraction of hatched eggs (p_1)	0.50	Professional judgment
Fraction of females in population (p_2)	0.50	DeVore et al. 1995
Asymptotic weight (g) (W_{INF})	4,275	Etnier & Starnes 1993, Pflieger 1997
Age at time of egg hatching (years) (x_0)	0.33	Smith 1979, Harlan & Speaker 1956
Age at maturity (years) (x_m)	7	Etnier & Starnes 1993, Lee et al. 1980, Becker 1983, Pflieger 1997, Rasmussen 1979
Lifespan (years) (x_v)	30	Etnier & Starnes 1993, Scott & Crossman 1973
Adult mortality rate/year (Z)	0.01	Pauly 1980
Growth coefficient/year (K)	0.05	Pauly 1980
Production Forgone Model (Jensen et al. 1988)		
Initial weight larval stage (g) (W_1)	0.00043	Carlander 1969, Holland-Bartels et al. 1990b
Initial weight young-of-the-year (g) (W_2)	0.0139	Carlander 1969, Holland-Bartels et al. 1990b
Initial weight adult (g) (W_3)	68.04	Scott & Crossman 1973
Weight specific growth/day, eggs and larvae (g) (G_1)	0.00056	Carlander 1969, Holland-Bartels et al. 1990b
Weight specific growth/day, young-of-the year (g) (G_2)	0.1995	Carlander 1969, Scott & Crossman 1973

Table A3
Model Parameters for Shovelnose Sturgeon (cont.)

Parameter	**Parameter Value**	**References**
Weight specific growth/day, adult (g) (G_3)	0.4630	Carlander 1969, Rasmussen 1979, Becker 1983
Natural mortality rate/day, eggs and larvae (Z_1)	0.1919	Professional judgment
Natural mortality rate/day, young-of-the-year (Z_2)	0.0047	Professional judgment
Natural mortality rate/day, adult (Z_3)	0.000009	Beverton & Holt 1959, Pauly 1980
Conditional Entrainment Mortality Model (Boreman et al. 1981) and Equivalent Adults Lost Model (Horst 1975, Goodyear 1978)		
Life stage duration (days), eggs and larvae (t_1)	24	Scott & Crossman 1973, Etnier & Starnes 1993
Life stage duration (days), young-of-the-year (t_2)	341	Scott & Crossman 1973, Etnier & Starnes 1993
Life stage duration (days), adult (t_3)	10,585	Scott & Crossman 1973, Etnier & Starnes 1993
Fraction of entrained killed, larvae (f_1)	0.58	Killgore et al. (in preparation)
Fraction of entrained killed, young-of-the-year (f_2)	0.225	Killgore et al. (in preparation)
Fraction of entrained killed, adult (f_3)	1.0	Professional judgment
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, eggs and larvae (w_1)	0.25	Littlejohn et al. 1985, Holland et al. 1984
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, young-of-the-year (w_2)	0.25	Becker 1983, Rasmussen 1979
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, adult (w_3)	0.25	Littlejohn et al. 1985, Baker et al. 1991, Etnier & Starnes 1993, Becker 1983, Hurley et al. 1987, Pflieger 1997, Cross 1967, Lee et al. 1980

Table A4
Model Parameters for Paddlefish

Parameter	Parameter Value	References
Recruitment Forgone Model (Jensen 1990)		
Net reproductive rate (R_o)	1.0	Model assumption
Eggs/gram of female (H)	16.97	Gengerke 1978
Fraction of hatched eggs (p_1)	0.50	Professional judgment
Fraction of females in population (p_2)	0.50	Rosen et al. 1982
Asymptotic weight (g) (W_{INF})	45,400	Becker 1983, Etnier & Starnes 1993, Pflieger 1997
Age at time of egg hatching (years) (x_0)	0.33	Becker 1983, Carlander 1969, Pflieger 1997, Russell 1986, Rasmussen 1979
Age at maturity (years) (x_m)	10	Etnier & Starnes 1993, Carlander 1969, Gengerke 1978, Rohde et al. 1994, Becker 1983, Rasmussen 1979, Reed et al. 1992, Carlander 1969, Russell 1986
Lifespan (years) (x_v)	30	Etnier & Starnes 1993, Carlander 1969, Pflieger 1997, Rohde et al. 1994, Rasmusssen 1979, Russell 1986, Purkett 1963
Adult mortality rate/year (Z)	0.01	Pauly 1980
Growth coefficient/year (K)	0.05	Pauly 1980
Production Forgone Model (Rago 1984)		
Initial weight larval stage (g) (W_1)	0.0048	Carlander 1969, Holland-Bartels et al. 1990b
Initial weight young-of-the-year (g) (W_2)	0.0069	Carlander 1969, Holland-Bartels et al. 1990b
Initial weight adult (g) (W_3)	614.68	Gengerke 1978
Weight specific growth/day, eggs and larvae (g) (G_1)	0.0000525	Carlander 1969, Holland-Bartels et al. 1990b
Weight specific growth/day, young-of-the year (g) (G_2)	1.89	Carlander 1969, Gengerke 1978, Holland-Bartels et al. 1990b

Table A4
Model Parameters for Paddlefish (cont.)

Parameter	Parameter Value	References
Weight specific growth/day, adult (g) (G_3)	5.07	Gengerke 1978
Natural mortality rate/day, eggs and larvae (Z_1)	0.1151	Professional judgment
Natural mortality rate/day, young-of-the-year (Z_2)	0.0049	Professional judgment
Natural mortality rate/day, adult (Z_3)	0.000023	Gengerke 1978
Conditional Entrainment Mortality Model (Boreman et al. 1981) and Equivalent Adults Lost Model (Horst 1975, Goodyear 1978)		
Life stage duration (days), eggs and larvae (t_1)	40	Becker 1983, Pflieger 1997, Rasmussen 1979, Carlander 1969, Russell 1986
Life stage duration (days), young-of-the-year (t_2)	325	Becker 1983, Pflieger 1997, Rasmussen 1979, Carlander 1969, Russell 1986
Life stage duration (days), adult (t_3)	10,585	Pflieger 1997, Rohde et al. 1994, Rasmussen 1979, Russell 1986, Etnier & Starnes 1993, Carlander 1969, Purkett 1963
Fraction of entrained killed, larvae (f_1)	0.49	Killgore et al. (in preparation)
Fraction of entrained killed, young-of-the-year (f_2)	0.225	Killgore et al. (in preparation)
Fraction of entrained killed, adult (f_3)	1.0	Professional judgment
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, eggs and larvae (w_1)	0.25	Littlejohn et al. 1985, Crance 1987, Moen et al. 1992, Pitman & Parks 1994, Rosen et al. 1982, Holland et al. 1984, Wallus 1986, Pflieger 1997
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, young-of-the-year (w_2)	0.25	Moen et al. 1992, Pitman & Parks 1994, Crance 1987, Rosen et al. 1982
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, adult (w_3)	0.25	Littlejohn et al. 1985, Baker et al. 1991, Crance 1987, Etnier & Starnes 1993, Becker 1983, Southhall & Hubert 1984, Pitman & Parks 1994, Pflieger 1997, Trautman 1981, Cross 1967, Rohde et al. 1994, Russell 1986, Moen et al. 1992, Rosen et al. 1982

Table A5
Model Parameters for Shortnose Gar

Parameter	Parameter Value	References
Recruitment Forgone Model (Jensen 1990)		
Net reproductive rate (R_o)	1.0	Model assumption
Eggs/gram of female (H)	8.9	Becker 1983, Carlander 1969
Fraction of hatched eggs (p_1)	0.5	Professional judgment
Fraction of females in population (p_2)	0.5	Professional judgment
Asymptotic weight (g) (W_{INF})	2,470	Etnier & Starnes 1993
Age at time of egg hatching (years) (x_0)	0.417	Becker 1983, Pflieger 1997
Age at maturity (years) (x_m)	3	Becker 1983, Pflieger 1997, Etnier & Starnes 1993
Lifespan (years) (x_v)	7	Becker 1983
Adult mortality rate/year (Z)	0.01	Pauly 1980
Growth coefficient/year (K)	0.05	Pauly 1980
Production Forgone Model (Jensen et al. 1988)		
Initial weight larval stage (W_1)	0.00025	Becker 1983, Holland-Bartels et al. 1990b, Etnier & Starnes 1993, Johnson & Noltie 1997
Initial weight young-of-the-year (W_2)	0.0099	Etnier & Starnes 1993, Johnson & Noltie 1997
Initial weight adult (W_3)	11.17	Becker 1983, Pflieger 1997, Johnson & Noltie 1997
Weight specific growth/day, eggs and larvae (G_1)	0.0004	Becker 1983, Holland-Bartels et al. 1990b, Etnier & Starnes 1993, Johnson & Noltie 1997
Weight specific growth/day, young-of-the year (G_2)	0.0327	Etnier & Starnes 1993, Johnson & Noltie 1997

Table A5
Model Parameters for Shortnose Gar (cont.)

Parameter	**Parameter Value**	**References**
Weight specific growth/day, adult (G_3)	0.4156	Carlander 1969, Becker 1983, Pflieger 1997, Johnson & Noltie 1997
Natural mortality rate/day, eggs and larvae (Z_1)	0.1248	Professional judgment
Natural mortality rate/day, young-of-the-year (Z_2)	0.0067	Professional judgment
Natural mortality rate/day, adult (Z_3)	0.0003	Professional judgment
Conditional Entrainment Mortality Model (Boreman et al. 1981) and Equivalent Adults Lost Model (Horst 1975, Goodyear 1978)		
Life stage duration (days), eggs and larvae (t_1)	24	Professional judgment
Life stage duration (days), young-of-the-year (t_2)	341	Professional judgment
Life stage duration (days), adult (t_3)	2,190	Becker 1983
Fraction of entrained killed, larvae (f_1)	0.87	Killgore et al. (in preparation)
Fraction of entrained killed, young-of-the-year (f_2)	0.225	Killgore et al. (in preparation)
Fraction of entrained killed, adult (f_3)	1.0	Professional judgment
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, eggs and larvae (w_1)	0.25	Littlejohn et al. 1985, Cross 1967, Carlander 1969, Holland et al. 1984, Holland-Bartels et al. 1990a; 1990b
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, young-of-the-year (w_2)	0.25	Cross 1967, Becker 1983, Carlander 1969, Pflieger 1997, Etnier & Starnes 1993
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, adult (w_3)	0	Littlejohn et al. 1985, Baker et al. 1991, Etnier & Starnes 1993, Becker 1983, Pflieger 1997, LGL 1981, Cross 1967

Table A6
Model Parameters for Bowfin

Parameter	Parameter Value	References
Recruitment Forgone Model (Jensen 1990)		
Net reproductive rate (R_o)	1.0	Model assumption
Eggs/gram of female (H)	12.15	Carlander 1969
Fraction of hatched eggs (p_1)	0.50	Professional judgment
Fraction of females in population (p_2)	0.50	Professional judgment
Asymptotic weight (g) (W_{INF})	9,253	Etnier & Starnes 1993
Age at time of egg hatching (years) (x_0)	0.33	Becker 1983, Scott & Crossman 1973, Pflieger 1997, Etnier & Starnes 1993
Age at maturity (years) (x_m)	3	Etnier & Starnes 1993, Scott & Crossman 1973, Pflieger 1997
Lifespan (years) (x_v)	10	Scott & Crossman 1973, Carlander 1969, Becker 1983, Pflieger 1997
Adult mortality rate/year (Z)	0.01	Pauly 1980
Growth coefficient/year (K)	0.05	Pauly 1980
Production Forgone Model (Jensen et al. 1988)		
Initial weight larval stage (W_1)	0.0029	Carlander 1969, Scott & Crossman 1973, Holland-Bartels et al. 1990b
Initial weight young-of-the-year (W_2)	0.0235	Carlander 1969, Scott & Crossman 1973, Holland-Bartels et al. 1990b
Initial weight adult (W_3)	142.5	Scott & Crossman 1973
Weight specific growth/day, eggs and larvae (G_1)	0.001	Carlander 1969, Scott & Crossman 1973, Holland-Bartels et al. 1990b
Weight specific growth/day, young-of-the year (G_2)	0.4129	Carlander 1969, Scott & Crossman 1973, Holland-Bartels et al. 1990b

Table A6
Model Parameters for Bowfin (cont.)

Parameter	Parameter Value	References
Weight specific growth/day, adult (G_3)	1.443	Scott & Crossman 1973
Natural mortality rate/day, eggs and larvae (Z_1)	0.0047	Professional judgment
Natural mortality rate/day, young-of-the-year (Z_2)	0.0033	Professional judgment
Natural mortality rate/day, adult (Z_3)	0.000068	Professional judgment
Conditional Entrainment Mortality Model (Boreman et al. 1981) and Equivalent Adults Lost Model (Horst 1975, Goodyear 1978)		
Life stage duration (days), eggs and larvae (t_1)	20	Etnier & Starnes 1993, Becker 1983, Rohde et al. 1994, Scott & Crossman 1973, Pflieger 1997
Life stage duration (days), young-of-the-year (t_2)	345	Etnier & Starnes 1993, Becker 1983, Rohde et al. 1994, Scott & Crossman 1973
Life stage duration (days), adult (t_3)	3,285	Pflieger 1997, Scott & Crossman 1973, Becker 1983, Carlander 1969
Fraction of entrained killed, larvae (f_1)	0.87	Killgore et al. (in preparation)
Fraction of entrained killed, young-of-the-year (f_2)	0.225	Killgore et al. (in preparation)
Fraction of entrained killed, adult (f_3)	1	Professional judgment
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, eggs and larvae (w_1)	0.25	Littlejohn et al. 1985, Cross 1967, Becker 1983, Scott & Crossman 1973, Pflieger 1997
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, young-of-the-year (w_2)	0	Becker 1983, Pflieger 1997, Scott & Crossman 1973, Cross 1967
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, adult (w_3)	0	Littlejohn et al. 1985, Baker et al. 1991, Etnier & Starnes 1993, Becker 1983, Rohde et al. 1994, Cross 1967, Scott & Crossman 1973, Smith 1979

Table A7
Model Parameters for Gizzard Shad

Parameter	Parameter Value	References
Recruitment Forgone Model (Jensen 1990)		
Net reproductive rate (R_o)	1.0	Model assumption
Eggs/gram of female (H)	529	Bodola 1966
Fraction of hatched eggs (p_1)	0.50	Professional judgment
Fraction of females in population (p_2)	0.524	Bodola 1966
Asymptotic weight (g) (W_{INF})	2,200.0	Bodola 1966, Becker 1983, Williamson & Nelson 1985, Detroit Edison, Unpublished report
Age at time of egg hatching (years) (x_0)	0.417	Etnier & Starnes 1993, Holland et al. 1984, Becker 1983, Pflieger 1997, Bodola 1966, Miller 1960, Scott & Crossman 1973
Age at maturity (years) (x_m)	2	Bodola 1966, Etnier & Starnes 1993, Pflieger 1997, Jester & Jensen 1972, Carlander 1969, Miller 1960
Lifespan (years) (x_v)	6	Etnier & Starnes 1993, Carlander 1969, Pflieger 1997, Jester & Jensen 1972, Scott & Crossman 1973, Miller 1960, Bodola 1966
Adult mortality rate/year (Z)	0.50	Pauly 1980
Growth coefficient/year (K)	0.42	Detroit Edison, Unpublished report
Production Forgone Model (Jensen et al. 1988)		
Initial weight larval stage (g) (W_1)	0.0000586	Holland-Bartels et al. 1990b, Michaletz 1997a
Initial weight young-of-the-year (g) (W_2)	0.12042	Bodola 1966, Michaletz 1997a; 1997b, Pflieger 1997
Initial weight adult (g) (W_3)	72.47	Bodola 1966, Becker 1983, Williamson & Nelson 1985, Detroit Edison, Unpublished report
Weight specific growth/day, eggs and larvae (g) (G_1)	0.003	Holland-Bartels et al. 1990b, Michaletz 1997a
Weight specific growth/day, young-of-the year (g) (G_2)	0.2226	Bodola 1966, Michaletz 1997a; 1997b, Pflieger 1997

Table A7 **Model Parameters for Gizzard Shad (cont.)**		
Parameter	**Parameter Value**	**References**
Weight specific growth/day, adult (g) (G_3)	1.1616	Bodola 1966, Becker 1983, Williamson & Nelson 1985, Detroit Edison, Unpublished report
Natural mortality rate/day, eggs and larvae (Z_1)	0.0548	Professional judgment
Natural mortality rate/day, young-of-the-year (Z_2)	0.0107	Professional judgment
Natural mortality rate/day, adult (Z_3)	0.002	Leidy & Jenkins 1977
Conditional Entrainment Mortality Model (Boreman et al. 1981) and Equivalent Adults Lost Model (Horst 1975, Goodyear 1978)		
Life stage duration (days), eggs and larvae (t_1)	40	Etnier & Starnes 1993, Becker 1983, Pflieger 1997, Scott & Crossman 1973, Miller 1960
Life stage duration (days), young-of-the-year (t_2)	325	Etnier & Starnes 1993, Becker 1983, Pflieger 1997, Scott & Crossman 1973, Miller 1960, Cross 1967, Williamson & Nelson 1985
Life stage duration (days), adult (t_3)	1,825	Pflieger 1997, Jester & Jensen 1972, Scott & Crossman 1973, Miller 1960, Etnier & Starnes 1993, Carlander 1969, Bodola 1966
Fraction of entrained killed, larvae (f_1)	0.87	Killgore et al. (in preparation)
Fraction of entrained killed, young-of-the-year (f_2)	1.0	Killgore et al. (in preparation), Professional judgment
Fraction of entrained killed, adult (f_3)	1.0	Professional judgment
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, eggs and larvae (w_1)	1.0	Littlejohn et al. 1985, Becker 1983, Holland & Sylvester 1983, Holland 1986a, Welker et al. 1994, Miller 1960, Conner et al. 1983, Williamson & Nelson 1985, Dewey & Jennings 1992, Holland et al. 1984, Allen & DeVries 1993, Holland-Bartels et al. 1990a; 1990b, Pflieger 1997, Jester & Jensen 1972
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, young-of-the-year (w_2)	0.50	Allen & DeVries 1993, Williamson & Nelson 1985, Becker 1983, Holland 1986a, Welker et al. 1994, Cross 1967

Table A7
Model Parameters for Gizzard Shad (cont.)

Parameter	Parameter Value	References
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, adult (w_3)	0.50	Littlejohn et al. 1985, Baker et al. 1991, Scott & Crossman 1973, Pflieger 1997, Becker 1983, Cross 1967, Jester & Jensen 1972, Hubert & O'Shea 1992, Miller 1960, Allen & DeVries 1993, Etnier & Starnes 1993

Table A8
Model Parameters for Goldeye

Parameter	Parameter Value	References
Recruitment Forgone Model (Jensen 1990)		
Net reproductive rate (R_o)	1.0	Model assumption
Eggs/gram of female (H)	32.16	Carlander 1969
Fraction of hatched eggs (p_1)	0.50	Professional judgment
Fraction of females in population (p_2)	0.44	Grosslein & Smith 1959
Asymptotic weight (g) (W_{INF})	1,292.73	Pflieger 1997
Age at time of egg hatching (years) (x_0)	0.417	Smith 1979, Grosslein & Smith 1959, Pflieger 1997, Holland-Bartels et al. 1990a; 1990b, Scott & Crossman 1973, Becker 1983, Carlander 1969
Age at maturity (years) (x_m)	5	Smith 1979, Etnier & Starnes 1993, LGL 1981, Carlander 1969, Grosslein & Smith 1959, Scott & Crossman 1973
Lifespan (years) (x_v)	10	Carlander 1969, Grosslein & Smith 1959, Cross 1967, Lee et al. 1980
Adult mortality rate/year (Z)	0.5	Pauly 1980
Growth coefficient/year (K)	0.242	Pauly 1980
Production Forgone Model (Jensen et al. 1988)		
Initial weight larval stage (g) (W_1)	0.0069	Carlander 1969, Holland-Bartels et al. 1990b
Initial weight young-of-the-year (g) (W_2)	0.997	Carlander 1969, Holland-Bartels et al. 1990b
Initial weight adult (g) (W_3)	17.64	Carlander 1969, Becker 1983
Weight specific growth/day, eggs and larvae (g) (G_1)	0.0283	Carlander 1969, Holland-Bartels et al. 1990b
Weight specific growth/day, young-of-the year (g) (G_2)	0.0504	Carlander 1969, Holland-Bartels et al. 1990b

Table A8
Model Parameters for Goldeye (cont.)

Parameter	Parameter Value	References
Weight specific growth/day, adult (g) (G_3)	0.2487	Carlander 1969, Becker 1983
Natural mortality rate/day, eggs and larvae (Z_1)	0.1316	Professional judgment
Natural mortality rate/day, young-of-the-year (Z_2)	0.0069	Professional judgment
Natural mortality rate/day, adult (Z_3)	0.0002	Professional judgment
Conditional Entrainment Mortality Model (Boreman et al. 1981) and Equivalent Adults Lost Model (Horst 1975, Goodyear 1978)		
Life stage duration (days), eggs and larvae (t_1)	35	Grosslein & Smith 1959
Life stage duration (days), young-of-the-year (t_2)	330	Grosslein & Smith 1959
Life stage duration (days), adult (t_3)	3,285	Cross 1967, Grosslein & Smith 1959, Lee et al. 1980, Carlander 1969
Fraction of entrained killed, larvae (f_1)	0.87	Killgore et al. (in preparation)
Fraction of entrained killed, young-of-the-year (f_2)	0.225	Killgore et al. (in preparation)
Fraction of entrained killed, adult (f_3)	1.0	Professional judgment
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, eggs and larvae (w_1)	1.0	Littlejohn et al. 1985, Brown & Coon 1994, Holland et al. 1984, Holland-Bartels et al. 1990a; 1990b
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, young-of-the-year (w_2)	0.50	Baker et al. 1991, Becker 1983, LGL 1981, Scott & Crossman 1973
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, adult (w_3)	0.0	Littlejohn et al. 1985, Baker et al. 1991, Becker 1983, LGL 1981, Scott & Crossman 1973

Table A9
Model Parameters for Mooneye

Parameter	Parameter Value	References
Recruitment Forgone Model (Jensen 1990)		
Net reproductive rate (R_o)	1.0	Model assumption
Eggs/gram of female (H)	32.16	Carlander 1969
Fraction of hatched eggs (p_1)	0.50	Professional judgment
Fraction of females in population (p_2)	0.44	Grosslein & Smith 1959
Asymptotic weight (g) (W_{INF})	546.0	Becker 1983
Age at time of egg hatching (years) (x_0)	0.417	Etnier & Starnes 1993, Holland-Bartels et al. 1990a; 1990b, Becker 1983
Age at maturity (years) (x_m)	5	Etnier & Starnes 1993, Pflieger 1997, Rohde et al. 1994, LGL 1981, Scott & Crossman 1973
Lifespan (years) (x_v)	8	Scott & Crossman 1973, Lee et al. 1980, Carlander 1969
Adult mortality rate/year (Z)	0.5	Pauly 1980
Growth coefficient/year (K)	0.242	Pauly 1980
Production Forgone Model (Jensen et al. 1988)		
Initial weight larval stage (g) (W_1)	0.0014	Carlander 1969, Holland-Bartels et al. 1990b
Initial weight young-of-the-year (g) (W_2)	0.0494	Carlander 1969, Holland-Bartels et al. 1990b
Initial weight adult (g) (W_3)	82.0	Becker 1983
Weight specific growth/day, eggs and larvae (g) (G_1)	0.00137	Carlander 1969, Holland-Bartels et al. 1990b
Weight specific growth/day, young-of-the year (g) (G_2)	0.2483	Carlander 1969, Holland-Bartels et al. 1990b

Table A9
Model Parameters for Mooneye (cont.)

Parameter	Parameter Value	References
Weight specific growth/day, adult (g) (G_3)	0.1441	Becker 1983
Natural mortality rate/day, eggs and larvae (Z_1)	0.1316	Professional judgment
Natural mortality rate/day, young-of-the-year (Z_2)	0.0069	Professional judgment
Natural mortality rate/day, adult (Z_3)	0.00027	Professional judgment
Conditional Entrainment Mortality Model (Boreman et al. 1981) and Equivalent Adults Lost Model (Horst 1975, Goodyear 1978)		
Life stage duration (days), eggs and larvae (t_1)	35	Professional judgment
Life stage duration (days), young-of-the-year (t_2)	330	Professional judgment
Life stage duration (days), adult (t_3)	2,555	Scott & Crossman 1973, Lee et al. 1980, Etnier & Starnes 1993, Rohde et al. 1994, Pflieger 1997, LGL 1981
Fraction of entrained killed, larvae (f_1)	0.87	Killgore et al. (in preparation)
Fraction of entrained killed, young-of-the-year (f_2)	0.225	Killgore et al. (in preparation)
Fraction of entrained killed, adult (f_3)	1.0	Professional judgment
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, eggs and larvae (w_1)	1.0	Etnier & Starnes 1993, Becker 1983, Littlejohn et al. 1985, Holland et al. 1984, Holland-Bartels et al. 1990a; 1990b
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, young-of-the-year (w_2)	0.50	Rohde et al. 1994, Scott & Crossman 1973, Baker et al. 1991, Becker 1983
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, adult (w_3)	0.0	Baker et al. 1991, Becker 1983, Rohde et al. 1994, Scott & Crossman 1973, Littlejohn et al. 1985

Table A10
Model Parameters for Northern Pike

Parameter	Parameter Value	References
Recruitment Forgone Model (Jensen 1990)		
Net reproductive rate (R_o)	1.0	Model assumption
Eggs/gram of female (H)	31.69	Carlander 1969
Fraction of hatched eggs (p_1)	0.64	Carlander 1969, Rasmussen 1979, Becker 1983
Fraction of females in population (p_2)	0.5	Professional judgment
Asymptotic weight (g) (W_{INF})	13,000	Carlander 1969, Becker 1983
Age at time of egg hatching (years) (x_0)	0.33	Holland-Bartels et al. 1990a; 1990b, Carlander 1969, Becker 1983
Age at maturity (years) (x_m)	3	Becker 1983, Scott & Crossman 1973, Rasmussen 1979, Carlander 1969, Etnier & Starnes 1993
Lifespan (years) (x_v)	14	Rasmussen 1979, Etnier & Starnes 1993, Becker 1983, Lee et al. 1980, Carlander 1969, Pflieger 1997
Adult mortality rate/year (Z)	0.26	Pauly 1980
Growth coefficient/year (K)	0.22	Pauly 1980
Production Forgone Model (Jensen et al. 1988)		
Initial weight larval stage (W_1)	0.0069	Franklin & Smith 1963, Carlander 1969, Scott & Crossman 1973, Becker 1983, Holland-Bartels et al. 1990b
Initial weight young-of-the-year (W_2)	0.3311	Franklin & Smith 1963, Carlander 1969, Bry et al. 1992
Initial weight adult (W_3)	74.36	Carlander 1969, Becker 1983
Weight specific growth/day, eggs and larvae (G_1)	0.0074	Franklin & Smith 1963, Carlander 1969, Scott & Crossman 1973, Becker 1983, Holland-Bartels et al. 1990b
Weight specific growth/day, young-of-the year (G_2)	0.2306	Franklin & Smith 1963, Carlander 1969, Bry et al. 1992

Table A10
Model Parameters for Northern Pike (cont.)

Parameter	Parameter Value	References
Weight specific growth/day, adult (G_3)	2.3604	Carlander 1969, Becker 1983
Natural mortality rate/day, eggs and larvae (Z_1)	0.1047	Carlander 1969, Scott & Crossman 1973, Bry et al. 1995, Massé et al. 1993, Becker 1983
Natural mortality rate/day, young-of-the-year (Z_2)	0.0049	Bry et al. 1995
Natural mortality rate/day, adult (Z_3)	0.00175	Carlander 1969, Navarro & Johnson 1992, Pierce et al. 1995, Leidy & Jenkins 1977
Conditional Entrainment Mortality Model (Boreman et al. 1981) and Equivalent Adults Lost Model (Horst 1975, Goodyear 1978)		
Life stage duration (days), eggs and larvae (t_1)	44	Etnier & Starnes 1993, Harlan & Speaker 1956, Rasmussen 1979, Carlander 1969, Scott & Crossman 1973, Inskip 1982, Becker 1983
Life stage duration (days), young-of-the-year (t_2)	321	Etnier & Starnes 1993, Harlan & Speaker 1956, Rasmussen 1979, Carlander 1969, Scott & Crossman 1973, Inskip 1982, Becker 1983
Life stage duration (days), adult (t_3)	4,745	Carlander 1969, Lee et al. 1980, Inskip 1982, Etnier & Starnes 1993, Becker 1983, Pflieger 1997
Fraction of entrained killed, larvae (f_1)	0.87	Killgore et al. (in preparation)
Fraction of entrained killed, young-of-the-year (f_2)	0.225	Killgore et al. (in preparation)
Fraction of entrained killed, adult (f_3)	1.0	Professional judgment
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, eggs and larvae (w_1)	0.25	Littlejohn et al. 1985, Harlan & Speaker 1956, Becker 1983, Rasmussen 1979, Casselman & Lewis 1996, Scott & Crossman 1973, Holland-Bartels et al. 1990a; 1990b
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, young-of-the-year (w_2)	0	Inskip 1982, Becker 1983, Scott & Crossman 1973, Holland-Bartels et al. 1990a; 1990b

Table A10
Model Parameters for Northern Pike (cont.)

Parameter	Parameter Value	References
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, adult (w_3)	0	Littlejohn et al. 1985, Gutreuter 1997, Becker 1983, Harlan & Speaker 1956, Pflieger 1997, Scott & Crossman 1973, Chapman & Mackay 1990, Casselman & Lewis 1996, Gutreuter et al. 1997a

Table A11
Model Parameters for Common Carp

Parameter	Parameter Value	References
Recruitment Forgone Model (Jensen 1990)		
Net reproductive rate (R_o)	1.0	Model assumption
Eggs/gram of female (H)	216.8	Scott & Crossman 1973, Rasmussen 1979, Carlander 1969, Swee & McCrimmon 1966
Fraction of hatched eggs (p_1)	0.50	Professional judgment
Fraction of females in population (p_2)	0.50	Professional judgment
Asymptotic weight (g) (W_{INF})	39,995	Jester 1974
Age at time of egg hatching (years) (x_0)	0.33	Rasmussen 1979, Becker 1983, Holland-Bartels et al. 1990a; 1990b
Age at maturity (years) (x_m)	3	Becker 1983, Rasmussen 1979, Carlander 1969, Swee & McCrimmon 1966, Jester 1974, Cooper 1987, Lubinski et al. 1986
Lifespan (years) (x_v)	20	Etnier & Starnes 1993, Rohde et al. 1994, Cooper 1987, Scott & Crossman 1973, Jester 1974
Adult mortality rate/year (Z)	0.165	Pauly 1980
Growth coefficient/year (K)	0.233	Pauly 1980
Production Forgone Model (Jensen et al. 1988)		
Initial weight larval stage (g) (W_1)	0.00125	Carlander 1969, Becker 1983, Holland-Bartels et al. 1990b
Initial weight young-of-the-year (g) (W_2)	0.1958	Carlander 1969, Becker 1983, Lubinski et al. 1986
Initial weight adult (g) (W_3)	62.56	Carlander 1969, Becker 1983, Pflieger 1997
Weight specific growth/day, eggs and larvae (g) (G_1)	0.00442	Carlander 1969, Becker 1983, Holland-Bartels et al. 1990b
Weight specific growth/day, young-of-the year (g) (G_2)	0.1943	Carlander 1969, Becker 1983, Pflieger 1997

Table A11
Model Parameters for Common Carp (cont.)

Parameter	Parameter Value	References
Weight specific growth/day, adult (g) (G_3)	2.074	Carlander 1969, Becker 1983, Pflieger 1997
Natural mortality rate/day, eggs and larvae (Z_1)	0.1047	Jester 1974
Natural mortality rate/day, young-of-the-year (Z_2)	0.0093	Professional judgment
Natural mortality rate/day, adult (Z_3)	0.000099	Professional judgment
Conditional Entrainment Mortality Model (Boreman et al. 1981) and Equivalent Adults Lost Model (Horst 1975, Goodyear 1978)		
Life stage duration (days), eggs and larvae (t_1)	44	Etnier & Starnes 1993, Becker 1983, Rohde et al. 1994, Scott & Crossman 1973, Cooper 1987, Lubinski et al. 1986, Edwards & Twomey 1982a, Swee & McCrimmon 1966
Life stage duration (days), young-of-the-year (t_2)	321	Lubinski et al. 1986, Edwards & Twomey 1982a, Etnier & Starnes 1993, Becker 1983, Rohde et al. 1994, Scott & Crossman 1973, Cooper 1987, Swee & McCrimmon 1966
Life stage duration (days), adult (t_3)	6,935	Pflieger 1997, Rohde et al. 1994, Rasmussen 1979, Jester 1974, Cooper 1987, Scott & Crossman 1973, Lubinski et al. 1986
Fraction of entrained killed, larvae (f_1)	0.87	Killgore et al. (in preparation)
Fraction of entrained killed, young-of-the-year (f_2)	0.225	Killgore et al. (in preparation)
Fraction of entrained killed, adult (f_3)	1.0	Professional judgment
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, eggs and larvae (w_1)	1.0	Littlejohn et al. 1985, Becker 1983, Brown & Coon 1994, Pflieger 1997, Rasmussen 1979, Cooper 1987, Lubinski et al. 1986, Holland et al. 1984, Holland-Bartels et al. 1990a; 1990b
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, young-of-the-year (w_2)	0	Brown & Coon 1994, Edwards & Twomey 1982a, Becker 1983, Pflieger 1997, Holland-Bartels et al. 1990a; 1990b

Table A11
Model Parameters for Common Carp (cont.)

Parameter	Parameter Value	References
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, adult (w_3)	0	Littlejohn et al. 1985, Baker et al. 1991, Etnier & Starnes 1993, Becker 1983, Rohde et al. 1994, Rasmussen 1979, Cooper 1987, Lubinski et al. 1986, Hubert & O'Shea 1992, Pflieger 1997

Table A12
Model Parameters for Emerald Shiner

Parameter	Parameter Value	References
Recruitment Forgone Model (Jensen 1990)		
Net reproductive rate (R_o)	1.0	Model assumption
Eggs/gram of female (H)	746.3	Carlander 1969, Pflieger 1997, Etnier & Starnes 1993
Fraction of hatched eggs (p_1)	0.50	Professional judgment
Fraction of females in population (p_2)	0.50	Professional judgment
Asymptotic weight (g) (W_{INF})	4.01	Carlander 1969
Age at time of egg hatching (years) (x_0)	0.417	Etnier & Starnes 1993, Becker 1983, Pflieger 1997, Holland-Bartels et al. 1990a; 1990b
Age at maturity (years) (x_m)	1	Etnier & Starnes 1993, Pflieger 1997
Lifespan (years) (x_v)	3	Etnier & Starnes 1993, Pflieger 1997, Scott & Crossman 1973
Adult mortality rate/year (Z)	1.10	Pauly 1980
Growth coefficient/year (K)	0.58	Pauly 1980
Production Forgone Model (Jensen et al. 1988)		
Initial weight larval stage (g) (W_1)	0.00086	Carlander 1969, Holland-Bartels et al. 1990b
Initial weight young-of-the-year (g) (W_2)	0.00358	Carlander 1969, Holland-Bartels et al. 1990b
Initial weight adult (g) (W_3)	1.112	Carlander 1969, Scott & Crossman 1973, Becker 1983, Pflieger 1997
Weight specific growth/day, eggs and larvae (g) (G_1)	0.00054	Carlander 1969, Holland-Bartels et al. 1990b
Weight specific growth/day, young-of-the year (g) (G_2)	0.0031	Carlander 1969, Holland-Bartels et al. 1990b

Table A12
Model Parameters for Emerald Shiner (cont.)

Parameter	Parameter Value	References
Weight specific growth/day, adult (g) (G_3)	0.004675	Carlander 1969, Scott & Crossman 1973, Becker 1983, Pflieger 1997
Natural mortality rate/day, eggs and larvae (Z_1)	0.92	Professional judgment
Natural mortality rate/day, young-of-the-year (Z_2)	0.0083	Professional judgment
Natural mortality rate/day, adult (Z_3)	0.0041	Professional judgment
Conditional Entrainment Mortality Model (Boreman et al. 1981) and Equivalent Adults Lost Model (Horst 1975, Goodyear 1978)		
Life stage duration (days), larvae (t_1)	5	Etnier & Starnes 1993, Becker 1983, Pflieger 1997
Life stage duration (days), young-of-the-year (t_2)	360	Carlander 1969
Life stage duration (days), adult (t_3)	730	Etnier & Starnes 1993, Pflieger 1997, Scott & Crossman 1973
Fraction of entrained killed, eggs and larvae (f_1)	0.87	Killgore et al. (in preparation)
Fraction of entrained killed, young-of-the-year (f_2)	0.225	Killgore et al. (in preparation)
Fraction of entrained killed, adult (f_3)	1.0	Professional judgment
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, eggs and larvae (w_1)	1.0	Littlejohn et al. 1985, Becker 1983, Pflieger 1997, Holland et al. 1984
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, young-of-the-year (w_2)	1.0	Becker 1983, Pflieger 1997
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, adult (w_3)	1.0	Littlejohn et al. 1985, Etnier & Starnes 1993, Becker 1983, Pflieger 1997, Trautman 1981, Scott & Crossman 1973

Table A13
Model Parameters for River Carpsucker

Parameter	Parameter Value	References
Recruitment Forgone Model (Jensen 1990)		
Net reproductive rate (R_o)	1.0	Model assumption
Eggs/gram of female (H)	104.81	Becker 1983, Carlander 1969, Jester 1972
Fraction of hatched eggs (p_1)	0.5	Professional judgment
Fraction of females in population (p_2)	0.5	Jester 1972
Asymptotic weight (g) (W_{INF})	4,417.5	Etnier & Starnes 1993
Age at time of egg hatching (years) (x_0)	0.33	Carlander 1969, Becker 1983, Holland-Bartels et al. 1990a; 1990b, Smith 1979
Age at maturity (years) (x_m)	3	Etnier & Starnes 1993, Carlander 1969, Smith 1979, Jester 1972, Becker 1983
Lifespan (years) (x_v)	10	Pflieger 1997, Etnier & Starnes 1993, Jester 1972, Carlander 1969, Becker 1983
Adult mortality rate/year (Z)	0.165	Pauly 1980
Growth coefficient/year (K)	0.233	Pauly 1980
Production Forgone Model (Jensen et al. 1988)		
Initial weight larval stage (W_1)	0.0069	Carlander 1969, Holland-Bartels et al. 1990b
Initial weight young-of-the-year (W_2)	0.7291	Carlander 1969, Wrenn & Grinstead 1971
Initial weight adult (W_3)	16.07	Carlander 1969, Jester 1972
Weight specific growth/day, eggs and larvae (G_1)	0.0159	Carlander 1969, Holland-Bartels et al. 1990b
Weight specific growth/day, young-of-the year (G_2)	0.0479	Carlander 1969, Wrenn & Grinstead 1971

Table A13
Model Parameters for River Carpsucker (cont.)

Parameter	Parameter Value	References
Weight specific growth/day, adult (G_3)	0.8625	Carlander 1969, Jester 1972
Natural mortality rate/day, eggs and larvae (Z_1)	0.1023	Professional judgment
Natural mortality rate/day, young-of-the-year (Z_2)	0.0072	Professional judgment
Natural mortality rate/day, adult (Z_3)	0.0015	Leidy & Jenkins 1977
Conditional Entrainment Mortality Model (Boreman et al. 1981) and Equivalent Adults Lost Model (Horst 1975, Goodyear 1978)		
Life stage duration (days), eggs and larvae (t_1)	45	Harlan & Speaker 1956, Becker 1983, Jester 1972
Life stage duration (days), young-of-the-year (t_2)	320	Harlan & Speaker 1956, Becker 1983, Jester 1972
Life stage duration (days), adult (t_3)	3,285	Pflieger 1997, Becker 1983, Jester 1972, Etnier & Starnes 1993, Carlander 1969
Fraction of entrained killed, larvae (f_1)	0.87	Killgore et al. (in preparation)
Fraction of entrained killed, young-of-the-year (f_2)	0.225	Killgore et al. (in preparation)
Fraction of entrained killed, adult (f_3)	1.0	Professional judgment
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, eggs and larvae (w_1)	1.0	Holland et al. 1984, Pflieger 1997, Brown & Coon 1994, Conner et al. 1983, Holland-Bartels et al. 1990a; 1990b, Etnier & Starnes 1993, Becker 1983
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, young-of-the-year (w_2)	0.25	Becker 1983, Holland-Bartels et al. 1990a; 1990b, Etnier & Starnes 1993
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, adult (w_3)	0.25	Baker et al. 1991, Etnier & Starnes 1993, Pflieger 1997, Becker 1983, Harlan & Speaker 1956, Brown & Coon 1994, LGL 1981, Cross 1967, Holland-Bartels et al. 1990a; 1990b

Table A14
Model Parameters for Blue Sucker

Parameter	Parameter Value	References
Recruitment Forgone Model (Jensen 1990)		
Net reproductive rate (R_o)	1.0	Model assumption
Eggs/gram of female (H)	47.51	Rupprecht & Jahn 1980
Fraction of hatched eggs (p_1)	0.50	Professional judgment
Fraction of females in population (p_2)	0.50	Professional judgment
Asymptotic weight (g) (W_{INF})	5,350.0	Rupprecht & Jahn 1980
Age at time of egg hatching (years) (x_0)	0.33	Rupprecht & Jahn 1980
Age at maturity (years) (x_m)	6	Rupprecht & Jahn 1980, Harlan & Speaker 1956
Lifespan (years) (x_v)	10	Rupprecht & Jahn 1980
Adult mortality rate/year (Z)	0.165	Pauly 1980
Growth coefficient/year (K)	0.233	Pauly 1980
Production Forgone Model (Jensen et al. 1988)		
Initial weight larval stage (g) (W_1)	0.00054	Rupprecht & Jahn 1980, Holland-Bartels et al. 1990b
Initial weight young-of-the-year (g) (W_2)	0.1119	Rupprecht & Jahn 1980, Etnier & Starnes 1993
Initial weight adult (g) (W_3)	30.37	Rupprecht & Jahn 1980
Weight specific growth/day, eggs and larvae (g) (G_1)	0.003	Rupprecht & Jahn 1980, Holland-Bartels et al. 1990b
Weight specific growth/day, young-of-the year (g) (G_2)	0.09225	Rupprecht & Jahn 1980, Etnier & Starnes 1993
Weight specific growth/day, adult (g) (G_3)	1.6187	Rupprecht & Jahn 1980

Table A14
Model Parameters for Blue Sucker (cont.)

Parameter	Parameter Value	References
Natural mortality rate/day, eggs and larvae (Z_1)	0.231	Professional judgment
Natural mortality rate/day, young-of-the-year (Z_2)	0.007	Professional judgment
Natural mortality rate/day, adult (Z_3)	0.0015	Leidy & Jenkins 1977
Conditional Entrainment Mortality Model (Boreman et al. 1981) and Equivalent Adults Lost Model (Horst 1975, Goodyear 1978)		
Life stage duration (days), eggs and larvae (t_1)	37	Pflieger 1997, Rupprecht & Jahn 1980
Life stage duration (days), young-of-the-year (t_2)	328	Pflieger 1997, Rupprecht & Jahn 1980
Life stage duration (days), adult (t_3)	3,285	Rupprecht & Jahn 1980, Etnier & Starnes 1993
Fraction of entrained killed, larvae (f_1)	0.78	Killgore et al. (in preparation)
Fraction of entrained killed, young-of-the-year (f_2)	0.225	Killgore et al. (in preparation)
Fraction of entrained killed, adult (f_3)	1.0	Professional judgment
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, eggs and larvae (w_1)	0.25	Brown & Coon 1994, Holland et al. 1984
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, young-of-the-year (w_2)	0.25	Becker 1983
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, adult (w_3)	0.0	Becker 1983, Etnier & Starnes 1993, Trautman 1981, Pflieger 1997

Table A15
Model Parameters for Smallmouth Buffalo

Parameter	Parameter Value	References
Recruitment Forgone Model (Jensen 1990)		
Net reproductive rate (R_o)	1.0	Model assumption
Eggs/gram of female (H)	88.2	Rasmussen 1979
Fraction of hatched eggs (p_1)	0.50	Professional judgment
Fraction of females in population (p_2)	0.50	Professional judgment
Asymptotic weight (g) (W_{INF})	12,927.3	Rasmussen 1979
Age at time of egg hatching (years) (x_0)	0.417	Holland-Bartels et al. 1990a; 1990b, Becker 1983, Harlan & Speaker 1956
Age at maturity (years) (x_m)	3	Etnier & Starnes 1993, Rasmussen 1979, Harlan & Speaker 1956, Carlander 1969
Lifespan (years) (x_v)	15	Etnier & Starnes 1993, Rasmussen 1979, Pflieger 1997, Smith 1979
Adult mortality rate/year (Z)	0.165	Pauly 1980
Growth coefficient/year (K)	0.233	Pauly 1980
Production Forgone Model (Jensen et al. 1988)		
Initial weight larval stage (g) (W_1)	0.00776	Carlander 1969, Wrenn & Grinstead 1971, Holland-Bartels et al. 1990b
Initial weight young-of-the-year (g) (W_2)	0.4289	Carlander 1969, Wrenn & Grinstead 1971
Initial weight adult (g) (W_3)	30.65	Carlander 1969, Elrod & Hassler 1971, Becker 1983, Etnier & Starnes 1993

Table A15
Model Parameters for Smallmouth Buffalo (cont.)

Parameter	Parameter Value	References
Weight specific growth/day, eggs and larvae (g) (G_1)	0.00752	Carlander 1969, Wrenn & Grinstead 1971, Holland-Bartels et al. 1990b
Weight specific growth/day, young-of-the year (g) (G_2)	0.0978	Carlander 1969, Wrenn & Grinstead 1971
Weight specific growth/day, adult (g) (G_3)	0.6595	Carlander 1969, Elrod & Hassler 1971, Becker 1983, Etnier & Starnes 1993
Natural mortality rate/day, eggs and larvae (Z_1)	0.0598	Professional judgment
Natural mortality rate/day, young-of-the-year (Z_2)	0.0104	Professional judgment
Natural mortality rate/day, adult (Z_3)	0.0015	Leidy & Jenkins 1977
Conditional Entrainment Mortality Model (Boreman et al. 1981) and Equivalent Adults Lost Model (Horst 1975, Goodyear 1978)		
Life stage duration (days), eggs and larvae (t_1)	77	Becker 1983, Harlan & Speaker 1956, Wrenn & Grinstead 1971
Life stage duration (days), young-of-the-year (t_2)	288	Becker 1983, Harlan & Speaker 1956, Wrenn & Grinstead 1971
Life stage duration (days), adult (t_3)	6,935	Etnier & Starnes 1993, Rasmussen 1979, Harlan & Speaker 1956, Carlander 1969
Fraction of entrained killed, larvae (f_1)	0.87	Killgore et al. (in preparation)
Fraction of entrained killed, young-of-the-year (f_2)	0.225	Killgore et al. (in preparation)
Fraction of entrained killed, adult (f_3)	1.0	Professional judgment
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, eggs and larvae (w_1)	1.0	Littlejohn et al. 1985; Brown & Coon 1994, Holland et al. 1984, Holland-Bartels et al. 1990a; 1990b, Rasmussen 1979, Etnier & Starnes 1993, Becker 1983, Harlan & Speaker 1956

Table A15
Model Parameters for Smallmouth Buffalo (cont.)

Parameter	Parameter Value	References
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, young-of-the-year (w_2)	0.50	Baker et al. 1991, Becker 1983, Carlander 1969, Etnier & Starnes 1993, Edwards & Twomey 1982b, Pflieger 1997
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, adult (w_3)	0.50	Littlejohn et al. 1985, Baker et al. 1991, Becker 1983, Carlander 1969, Gutreuter et al. 1997a, Pflieger 1997, Etnier & Starnes 1993

Table A16
Model Parameters for Bigmouth Buffalo

Parameter	Parameter Value	References
Recruitment Forgone Model (Jensen 1990)		
Net reproductive rate (R_o)	1.0	Model assumption
Eggs/gram of female (H)	88.2	Rasmussen 1979
Fraction of hatched eggs (p_1)	0.50	Professional judgment
Fraction of females in population (p_2)	0.50	Professional judgment
Asymptotic weight (g) (W_{INF})	34,200	Pflieger 1997
Age at time of egg hatching (years) (x_0)	0.417	Becker 1983, Rasmussen 1979, Scott & Crossman 1973
Age at maturity (years) (x_m)	3	Etnier & Starnes 1993, Rohde et al. 1994, Rasmussen 1979, Carlander 1969
Lifespan (years) (x_v)	15	Pflieger 1997, Rasmussen 1979, Scott & Crossman 1973
Adult mortality rate/year (Z)	0.165	Pauly 1980
Growth coefficient/year (K)	0.233	Pauly 1980
Production Forgone Model (Jensen et al. 1988)		
Initial weight larval stage (W_1)	0.0019	Carlander 1969, Holland-Bartels et al. 1990b
Initial weight young-of-the-year (W_2)	0.2228	Carlander 1969, Wrenn & Grinstead 1971
Initial weight adult (W_3)	46.07	Carlander 1969, Becker 1983
Weight specific growth/day, eggs and larvae (G_1)	0.0035	Carlander 1969, Holland-Bartels et al. 1990b
Weight specific growth/day, young-of-the year (G_2)	0.1523	Carlander 1969, Wrenn & Grinstead 1971

Table A16
Model Parameters for Bigmouth Buffalo (cont.)

Parameter	Parameter Value	References
Weight specific growth/day, adult (G_3)	2.5848	Carlander 1969, Becker 1983
Natural mortality rate/day, eggs and larvae (Z_1)	0.0719	Professional judgment
Natural mortality rate/day, young-of-the-year (Z_2)	0.0099	Professional judgment
Natural mortality rate/day, adult (Z_3)	0.0015	Leidy & Jenkins 1977
Conditional Entrainment Mortality Model (Boreman et al. 1981) and Equivalent Adults Lost Model (Horst 1975, Goodyear 1978)		
Life stage duration (days), eggs and larvae (t_1)	64	Becker 1983, Rasmussen 1979, Scott & Crossman 1973
Life stage duration (days), young-of-the-year (t_2)	301	Becker 1983, Rasmussen 1979, Scott & Crossman 1973
Life stage duration (days), adult (t_3)	5,110	Pflieger 1997, Rasmussen 1979, Scott & Crossman 1973
Fraction of entrained killed, larvae (f_1)	0.87	Killgore et al. (in preparation)
Fraction of entrained killed, young-of-the-year (f_2)	0.225	Killgore et al. (in preparation)
Fraction of entrained killed, adult (f_3)	1.0	Professional judgment
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, eggs and larvae (w_1)	1.0	Littlejohn et al. 1985, Becker 1983, Pflieger 1997, Holland-Bartels et al. 1990a; 1990b, Holland et al. 1984, Scott & Crossman 1973, Etnier & Starnes 1993, Rasmussen 1979, Rohde et al. 1994, Cross 1967
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, young-of-the-year (w_2)	0.50	Pflieger 1997, Etnier & Starnes 1993, Becker 1983, Scott & Crossman 1973
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, adult (w_3)	0.50	Littlejohn et al. 1985, Baker et al. 1991, Etnier & Starnes 1993, Becker 1983, Pflieger 1997, Rohde et al. 1994, Cross 1967, Scott & Crossman 1973, Smith 1979

Table A17
Model Parameters for Spotted Sucker

Parameter	Parameter Value	References
Recruitment Forgone Model (Jensen 1990)		
Net reproductive rate (R_o)	1.0	Model assumption
Eggs/gram of female (H)	104.81	Becker 1983, Carlander 1969, Jester 1972
Fraction of hatched eggs (p_1)	0.5	Professional judgment
Fraction of females in population (p_2)	0.5	Professional judgment
Asymptotic weight (g) (W_{INF})	2139.0	Carlander 1969, Becker 1983
Age at time of egg hatching (years) (x_0)	0.33	Becker 1983, Etnier & Starnes 1993, Pflieger 1997, Carlander 1969
Age at maturity (years) (x_m)	3	Pflieger 1997, Etnier & Starnes 1993, Rohde et al. 1994
Lifespan (years) (x_v)	6	Smith 1979, Pflieger 1997, Rohde et al. 1994, Scott & Crossman 1973
Adult mortality rate/year (Z)	0.165	Pauly 1980
Growth coefficient/year (K)	0.233	Pauly 1980
Production Forgone Model (Jensen et al. 1988)		
Initial weight larval stage (W_1)	0.0027	Carlander 1969, Holland-Bartels et al. 1990b
Initial weight young-of-the-year (W_2)	0.2073	Carlander 1969, Wrenn & Grinstead 1971
Initial weight adult (W_3)	29.54	Carlander 1969, Etnier & Starnes 1993
Weight specific growth/day, eggs and larvae (G_1)	0.0027	Carlander 1969, Holland-Bartels et al. 1990b
Weight specific growth/day, young-of-the year (G_2)	0.1019	Carlander 1969, Wrenn & Grinstead 1971

Table A17 Model Parameters for Spotted Sucker (cont.)		
Parameter	**Parameter Value**	**References**
Weight specific growth/day, adult (G_3)	1.1558	Carlander 1969, Etnier & Starnes 1993
Natural mortality rate/day, eggs and larvae (Z_1)	0.0598	Professional judgment
Natural mortality rate/day, young-of-the-year (Z_2)	0.0104	Professional judgment
Natural mortality rate/day, adult (Z_3)	0.0015	Leidy & Jenkins 1977
Conditional Entrainment Mortality Model (Boreman et al. 1981) and Equivalent Adults Lost Model (Horst 1975, Goodyear 1978)		
Life stage duration (days), eggs and larvae (t_1)	77	Etnier & Starnes 1993, Rohde et al. 1994, Carlander 1969
Life stage duration (days), young-of-the-year (t_2)	288	Etnier & Starnes 1993, Rohde et al. 1994, Carlander 1969
Life stage duration (days), adult (t_3)	1,825	Pflieger 1997, Rohde et al. 1994, Smith 1979, Scott & Crossman 1973
Fraction of entrained killed, larvae (f_1)	0.87	Killgore et al. (in preparation)
Fraction of entrained killed, young-of-the-year (f_2)	0.225	Killgore et al. (in preparation)
Fraction of entrained killed, adult (f_3)	1.0	Professional judgment
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, eggs and larvae (w_1)	1.0	Littlejohn et al. 1985, Holland et al. 1984, Etnier & Starnes 1993, Becker 1983, Holland-Bartels et al. 1990a; 1990b, Rohde et al. 1994
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, young-of-the-year (w_2)	0.5	Littlejohn et al. 1985, Etnier & Starnes 1993, Becker 1983, Pflieger 1997, Scott & Crossman 1973
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, adult (w_3)	0.25	Littlejohn et al. 1985, Baker et al. 1991, Harlan & Speaker 1956, Etnier & Starnes 1993, Becker 1983, Pflieger 1997, Rohde et al. 1994, Scott & Crossman 1973

Table A18
Model Parameters for Shorthead Redhorse

Parameter	Parameter Value	References
Recruitment Forgone Model (Jensen 1990)		
Net reproductive rate (R_o)	1.0	Model assumption
Eggs/gram of female (H)	19.79	Becker 1983
Fraction of hatched eggs (p_1)	0.5	Professional judgment
Fraction of females in population (p_2)	0.5	Professional judgment
Asymptotic weight (g) (W_{INF})	2,584	Becker 1983
Age at time of egg hatching (years) (x_0)	0.33	Pflieger 1997, Becker 1983, Holland-Bartels et al. 1990a; 1990b
Age at maturity (years) (x_m)	3	Carlander 1969, Scott & Crossman 1973
Lifespan (years) (x_v)	11	Pflieger 1997, Becker 1983, Etnier & Starnes 1993, Lee et al. 1980, Scott & Crossman 1973
Adult mortality rate/year (Z)	0.165	Pauly 1980
Growth coefficient/year (K)	0.233	Pauly 1980
Production Forgone Model (Jensen et al. 1988)		
Initial weight larval stage (g) (W_1)	0.00982	Carlander 1969, Holland-Bartels et al. 1990b
Initial weight young-of-the-year (g) (W_2)	0.22068	Carlander 1969, Wrenn & Grinstead 1971
Initial weight adult (g) (W_3)	5.782	Carlander 1969, Scott & Crossman 1973, Becker 1983, Etnier & Starnes 1993, Pflieger 1997
Weight specific growth/day, eggs and larvae (g) (G_1)	0.0035	Carlander 1969, Holland-Bartels et al. 1990b
Weight specific growth/day, young-of-the year (g) (G_2)	0.0152	Carlander 1969, Wrenn & Grinstead 1971

Table A18
Model Parameters for Shorthead Redhorse (cont.)

Parameter	Parameter Value	References
Weight specific growth/day, adult (g) (G_3)	0.3532	Carlander 1969, Scott & Crossman 1973, Becker 1983, Etnier & Starnes 1993, Pflieger 1997
Natural mortality rate/day, eggs and larvae (Z_1)	0.0767	Professional judgment
Natural mortality rate/day, young-of-the-year (Z_2)	0.0098	Professional judgment
Natural mortality rate/day, adult (Z_3)	0.0015	Leidy & Jenkins 1977
Conditional Entrainment Mortality Model (Boreman et al. 1981) and Equivalent Adults Lost Model (Horst 1975, Goodyear 1978)		
Life stage duration (days), eggs and larvae (t_1)	60	Professional judgment
Life stage duration (days), young-of-the-year (t_2)	305	Professional judgment
Life stage duration (days), adult (t_3)	3,650	Pflieger 1997, Rohde et al. 1994, Lee et al. 1980, Scott & Crossman 1973, Becker 1983
Fraction of entrained killed, larvae (f_1)	0.87	Killgore et al. (in preparation)
Fraction of entrained killed, young-of-the-year (f_2)	0.225	Killgore et al. (in preparation)
Fraction of entrained killed, adult (f_3)	1.0	Professional judgment
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, eggs and larvae (w_1)	1.0	Littlejohn et al. 1985, Etnier & Starnes 1993, Becker 1983, Pflieger 1997, LGL 1981, Scott & Crossman 1973
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, young-of-the-year (w_2)	0.5	Etnier & Starnes 1993, Becker 1983, Pflieger 1997, Scott & Crossman 1973
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, adult (w_3)	0.5	Littlejohn et al. 1985, Gutreuter 1997, Etnier & Starnes 1993, Becker 1983, Pflieger 1997, LGL 1981, Scott & Crossman 1973, Hubert & O'Shea 1992, Gutreuter et al. 1997a

Table A19
Model Parameters for Channel Catfish

Parameter	Parameter Value	References
Recruitment Forgone Model (Jensen 1990)		
Net reproductive rate (R_o)	1.0	Model assumption
Eggs/gram of female (H)	13.42	Rasmussen 1979
Fraction of hatched eggs (p_1)	0.50	Professional judgment
Fraction of females in population (p_2)	0.50	Appleget & Smith 1950
Asymptotic weight (g) (W_{INF})	10,782.5	Rasmussen 1979
Age at time of egg hatching (years) (x_0)	0.5	Holland-Bartels et al. 1990a; 1990b, Becker 1983, Pflieger 1997, Rasmussen 1979
Age at maturity (years) (x_m)	4	Pflieger 1997, Carlander 1969, Etnier & Starnes 1993, Rasmussen 1979, Rohde et al. 1994
Lifespan (years) (x_v)	12	Smith 1979, Carlander 1969, Pflieger 1997, Rohde et al. 1994, Cross 1967, Etnier & Starnes 1993, Rasmussen 1979
Adult mortality rate/year (Z)	0.314	Leidy and Jenkins 1977
Growth coefficient/year (K)	0.06	Beverton & Holt 1959
Production Forgone Model (Jensen et al. 1988)		
Initial weight larval stage (g) (W_1)	0.00016	Carlander 1969, Holland-Bartels et al. 1990b
Initial weight young-of-the-year (g) (W_2)	0.0021	Carlander 1969, Holland-Bartels et al. 1990b
Initial weight adult (g) (W_3)	2.049	Carlander 1969, Scott & Crossman 1973, Rasmussen 1979, Becker 1983, Brummett, Unpublished data
Weight specific growth/day, eggs and larvae (g) (G_1)	0.00004	Carlander 1969, Holland-Bartels et al. 1990b
Weight specific growth/day, young-of-the year (g) (G_2)	0.0064	Carlander 1969, Holland-Bartels et al. 1990b

Table A19
Model Parameters for Channel Catfish (cont.)

Parameter	Parameter Value	References
Weight specific growth/day, adult (g) (G_3)	1.2069	Carlander 1969, Scott & Crossman 1973, Rasmussen 1979, Becker 1983, Brummett, Unpublished data
Natural mortality rate/day, eggs and larvae (Z_1)	0.049	Professional judgment
Natural mortality rate/day, young-of-the-year (Z_2)	0.0051	Professional judgment
Natural mortality rate/day, adult (Z_3)	0.00086	Leidy & Jenkins 1977, Carlander 1969
Conditional Entrainment Mortality Model (Boreman et al. 1981) and Equivalent Adults Lost Model (Horst 1975, Goodyear 1978)		
Life stage duration (days), eggs and larvae (t_1)	47	Becker 1983, Rasmussen 1979, Harlan & Speaker 1956
Life stage duration (days), young-of-the-year (t_2)	318	Becker 1983, Rasmussen 1979, Harlan & Speaker 1956
Life stage duration (days), adult (t_3)	4,015	Pflieger 1997, Rohde et al. 1994, Cross 1967, Smith 1979, Carlander 1969, Etnier & Starnes 1993
Fraction of entrained killed, larvae (f_1)	0.87	Killgore et al. (in preparation)
Fraction of entrained killed, young-of-the-year (f_2)	0.225	Killgore et al. (in preparation)
Fraction of entrained killed, adult (f_3)	1.0	Professional judgment
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, eggs and larvae (w_1)	1.0	Holland-Bartels & Duval 1988, Littlejohn et al. 1985, Becker 1983, Harlan & Speaker 1956, Brown & Coon 1994, Cross 1967, Holland et al. 1984, Holland-Bartels et al. 1990a; 1990b, Pflieger 1997, Rasmussen 1979, Etnier & Starnes 1993
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, young-of-the-year (w_2)	1.0	Becker 1983, Harlan & Speaker 1956, Jackson 1995, Pflieger 1997, Rasmussen 1979, Cross 1967, Gutreuter et al. 1997a, Holland et al. 1984
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, adult (w_3)	0.0	Littlejohn et al. 1985, Baker et al. 1991, Etnier & Starnes 1993, Rohde et al. 1994, Hubert & O'Shea 1992, Gutreuter et al. 1997a

Table A20
Model Parameters for Blue Catfish

Parameter	Parameter Value	References
Recruitment Forgone Model (Jensen 1990)		
Net reproductive rate (R_o)	1.0	Model assumption
Eggs/gram of female (H)	13.42	Rasmussen 1979
Fraction of hatched eggs (p_1)	0.50	Professional judgment
Fraction of females in population (p_2)	0.50	Appleget & Smith 1950
Asymptotic weight (g) (W_{INF})	21,375	Smith 1979
Age at time of egg hatching (years) (x_0)	0.5	Holland-Bartels et al. 1990a; 1990b, Becker 1983, Pflieger 1997, Rasmussen 1979
Age at maturity (years) (x_m)	4	Pflieger 1997, Carlander 1969, Etnier & Starnes 1993, Rasmussen 1979, Rohde et al. 1994
Lifespan (years) (x_v)	20	Smith 1979, Carlander 1969, Pflieger 1997, Rohde et al. 1994, Cross 1967, Etnier & Starnes 1993
Adult mortality rate/year (Z)	0.314	Leidy & Jenkins 1977
Growth coefficient/year (K)	0.06	Beverton & Holt 1959
Production Forgone Model (Jensen et al. 1988)		
Initial weight larval stage (W_1)	0.00016	Carlander 1969, Holland-Bartels et al. 1990b
Initial weight young-of-the-year (W_2)	0.0021	Carlander 1969, Holland-Bartels et al. 1990b
Initial weight adult (W_3)	2.049	Carlander 1969, Scott & Crossman 1973, Rasmussen 1979, Becker 1983, Brummett, Unpublished data
Weight specific growth/day, eggs and larvae (G_1)	0.00004	Carlander 1969, Holland-Bartels et al. 1990b
Weight specific growth/day, young-of-the year (G_2)	0.0064	Carlander 1969, Holland-Bartels et al. 1990b

Table A20
Model Parameters for Blue Catfish (cont.)

Parameter	Parameter Value	References
Weight specific growth/day, adult (G_3)	1.2069	Carlander 1969, Scott & Crossman 1973, Rasmussen 1979, Becker 1983, Brummett, Unpublished data
Natural mortality rate/day, eggs and larvae (Z_1)	0.049	Professional judgment
Natural mortality rate/day, young-of-the-year (Z_2)	0.0051	Professional judgment
Natural mortality rate/day, adult (Z_3)	0.00086	Leidy & Jenkins 1977, Carlander 1969
Conditional Entrainment Mortality Model (Boreman et al. 1981) and Equivalent Adults Lost Model (Horst 1975, Goodyear 1978)		
Life stage duration (days), eggs and larvae (t_1)	47	Becker 1983, Rasmussen 1979, Harlan & Speaker 1956
Life stage duration (days), young-of-the-year (t_2)	318	Becker 1983, Rasmussen 1979, Harlan & Speaker 1956
Life stage duration (days), adult (t_3)	6,935	Rohde et al. 1994, Etnier & Starnes 1993, Cross 1967, Smith 1979, Carlander 1969
Fraction of entrained killed, larvae (f_1)	0.87	Killgore et al. (in preparation), Pflieger 1997
Fraction of entrained killed, young-of-the-year (f_2)	0.225	Killgore et al. (in preparation)
Fraction of entrained killed, adult (f_3)	1.0	Professional judgment
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, eggs and larvae (w_1)	1.0	Holland-Bartels & Duval 1988, Littlejohn et al. 1985, Becker 1983, Harlan & Speaker 1956, Brown & Coon 1994, Cross 1967, Holland et al. 1984, Rohde et al. 1994, Holland-Bartels et al. 1990a; 1990b, Pflieger 1997, Rasmussen 1979, Etnier & Starnes 1993
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, young-of-the-year (w_2)	1.0	Becker 1983, Harlan & Speaker 1956, Jackson 1995, Pflieger 1997, Rasmussen 1979, Cross 1967, Gutreuter et al. 1997a, Holland et al. 1984
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, adult (w_3)	0.0	Littlejohn et al. 1985, Baker et al. 1991, Etnier & Starnes 1993, Rohde et al. 1994, Hubert & O'Shea 1992, Gutreuter et al. 1997a, Pflieger 1997, Jackson 1995

Table A21
Model Parameters for Flathead Catfish

Parameter	Parameter Value	References
Recruitment Forgone Model (Jensen 1990)		
Net reproductive rate (R_o)	1.0	Model assumption
Eggs/gram of female (H)	26.3	Carlander 1969, Minckley & Deacon 1959
Fraction of hatched eggs (p_1)	0.50	Professional judgment
Fraction of females in population (p_2)	0.50	Minckley & Deacon 1959
Asymptotic weight (g) (W_{INF})	53,865	Carlander 1969
Age at time of egg hatching (years) (x_0)	0.417	Lee & Terrell 1987, Carlander 1969, Etnier & Starnes 1993
Age at maturity (years) (x_m)	4	Minckley & Deacon 1959, Carlander 1969, Smith 1979, Harlan & Speaker 1956, Pflieger 1997, Lee & Terrell 1987, Etnier & Starnes 1993, Rohde et al. 1994, LGL 1981, Cross 1967
Lifespan (years) (x_v)	20	Rohde et al. 1994, Etnier & Starnes 1993, Lee & Terrell 1987, Smith 1979
Adult mortality rate/year (Z)	0.314	Leidy & Jenkins 1977
Growth coefficient/year (K)	0.06	Beverton & Holt 1959
Production Forgone Model (Jensen et al. 1988)		
Initial weight larval stage (W_1)	0.0113	Carlander 1969, Becker 1983, Holland-Bartels et al. 1990b
Initial weight young-of-the-year (W_2)	0.2101	Minckley & Deacon 1959, Carlander 1969
Initial weight adult (W_3)	5.0	Carlander 1969, Brummett, Unpublished data
Weight specific growth/day, eggs and larvae (G_1)	0.0042	Carlander 1969, Becker 1983, Holland-Bartels et al. 1990b
Weight specific growth/day, young-of-the year (G_2)	0.0151	Minckley & Deacon 1959, Carlander 1969

Table A21
Model Parameters for Flathead Catfish (cont.)

Parameter	Parameter Value	References
Weight specific growth/day, adult (G_3)	1.4836	Carlander 1969, Brummett, Unpublished data
Natural mortality rate/day, eggs and larvae (Z_1)	0.049	Professional judgment
Natural mortality rate/day, young-of-the-year (Z_2)	0.0016	Carlander 1969
Natural mortality rate/day, adult (Z_3)	0.00086	Professional judgment
Conditional Entrainment Mortality Model (Boreman et al. 1981) and Equivalent Adults Lost Model (Horst 1975, Goodyear 1978)		
Life stage duration (days), eggs and larvae (t_1)	47	Becker 1983, Harlan & Speaker 1956, Rasmussen 1979
Life stage duration (days), young-of-the-year (t_2)	318	Becker 1983, Harlan & Speaker 1956, Rasmussen 1979
Life stage duration (days), adult (t_3)	6,935	Rohde et al. 1994, Etnier & Starnes 1993, Lee & Terrell 1987, Smith 1979
Fraction of entrained killed, larvae (f_1)	0.87	Killgore et al. (in preparation)
Fraction of entrained killed, young-of-the-year (f_2)	0.225	Killgore et al. (in preparation)
Fraction of entrained killed, adult (f_3)	1.0	Professional judgment
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, eggs and larvae (w_1)	0.25	Littlejohn et al. 1985, Becker 1983, Rohde et al. 1994, Cross 1967, Holland et al. 1984, Holland-Bartels et al. 1990a; 1990b, Lee & Terrell 1987, Carlander 1969, Etnier & Starnes 1993, Minckley & Deacon 1959
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, young-of-the-year (w_2)	0.25	Etnier & Starnes 1993, Becker 1983, Cross 1967
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, adult (w_3)	0.0	Littlejohn et al. 1985, Baker et al. 1991, Rohde et al. 1994, LGL 1981, Cross 1967, Gutreuter et al. 1997a, Pflieger 1997

Table A22
Model Parameters for White Bass

Parameter	Parameter Value	References
Recruitment Forgone Model (Jensen 1990)		
Net reproductive rate (R_o)	1.0	Model assumption
Eggs/gram of female (H)	622.81	Rasmussen 1979, Becker 1983, Scott & Crossman 1973
Fraction of hatched eggs (p_1)	0.5	Professional judgment
Fraction of females in population (p_2)	0.5	Professional judgment
Asymptotic weight (g) (W_{INF})	958	Detroit Edison, Unpublished report
Age at time of egg hatching (years) (x_0)	0.33	Smith 1979, Scott & Crossman 1973, Holland-Bartels et al. 1990a; 1990b, Becker 1983
Age at maturity (years) (x_m)	3	Rasmussen 1979, Rohde et al. 1994, Becker 1983, Scott & Crossman 1973, Etnier & Starnes 1993
Lifespan (years) (x_v)	8	Scott & Crossman 1973, Etnier & Starnes 1993, Becker 1983
Adult mortality rate/year (Z)	0.3175	Leidy & Jenkins 1977
Growth coefficient/year (K)	0.55	Detroit Edison, Unpublished report
Production Forgone Model (Jensen et al. 1988)		
Initial weight larval stage (W_1)	0.000043	Ruelle 1971, Becker 1983, Holland-Bartels et al. 1990b
Initial weight young-of-the-year (W_2)	0.1745	Becker 1983, Detroit Edison, Unpublished report
Initial weight adult (W_3)	17.55	Ruelle 1971, Rasmussen 1979, Becker 1983, Willis et al. 1997, Detroit Edison, Unpublished report
Weight specific growth/day, eggs and larvae (G_1)	0.0058	Ruelle 1971, Becker 1983, Holland-Bartels et al. 1990b
Weight specific growth/day, young-of-the year (G_2)	0.0519	Becker 1983, Detroit Edison, Unpublished report

Table A22
Model Parameters for White Bass (cont.)

Parameter	Parameter Value	References
Weight specific growth/day, adult (G_3)	0.3333	Ruelle 1971, Rasmussen 1979, Becker 1983, Willis et al. 1997, Detroit Edison, Unpublished report
Natural mortality rate/day, eggs and larvae (Z_1)	0.1073	Professional judgment
Natural mortality rate/day, young-of-the-year (Z_2)	0.01375	Professional judgment
Natural mortality rate/day, adult (Z_3)	0.00084	Professional judgment
Conditional Entrainment Mortality Model (Boreman et al. 1981) and Equivalent Adults Lost Model (Horst 1975, Goodyear 1978)		
Life stage duration (days), eggs and larvae (t_1)	30	Becker 1983, Rasmussen 1979, Etnier & Starnes 1993, Scott & Crossman 1973
Life stage duration (days), young-of-the-year (t_2)	335	Becker 1983, Rasmussen 1979, Etnier & Starnes 1993, Scott & Crossman 1973
Life stage duration (days), adult (t_3)	2,555	Rohde et al. 1994, Scott & Crossman 1973, Becker 1983, Etnier & Starnes 1993
Fraction of entrained killed, larvae (f_1)	0.87	Killgore et al. (in preparation)
Fraction of entrained killed, young-of-the-year (f_2)	0.225	Killgore et al. (in preparation)
Fraction of entrained killed, adult (f_3)	1.0	Professional judgment
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, eggs and larvae (w_1)	1.0	Littlejohn et al. 1985, Etnier & Starnes 1993, Becker 1983, Holland et al. 1984, Holland-Bartels et al. 1990a; 1990b
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, young-of-the-year (w_2)	0.50	Becker 1983, Rasmussen 1979, Holland-Bartels et al. 1990a; 1990b
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, adult (w_3)	0.25	Littlejohn et al. 1985, Baker et al. 1991, Etnier & Starnes 1993, Becker 1983, Pflieger 1997, Rasmussen 1979, Rohde et al. 1994, Gutreuter et al. 1997a, Holland-Bartels et al. 1990a; 1990b

Table A23
Model Parameters for Bluegill

Parameter	Parameter Value	References
Recruitment Forgone Model (Jensen 1990)		
Net reproductive rate (R_o)	1.0	Model assumption
Eggs/gram of female (H)	96.3	Scott & Crossman 1973
Fraction of hatched eggs (p_1)	0.76	Carlander 1977
Fraction of females in population (p_2)	0.50	Carlander 1977
Asymptotic weight (g) (W_{INF})	1,292	Etnier & Starnes 1993, Pflieger 1997
Age at time of egg hatching (years) (x_0)	0.33	Holland-Bartels et al. 1990a; 1990b, Pflieger 1997, Carlander 1977, Becker 1983
Age at maturity (years) (x_m)	2	Rasmussen 1979, Becker 1983, Scott & Crossman 1973
Lifespan (years) (x_v)	11	Scott & Crossman 1973, Carlander 1977, Rasmussen 1979, Smith 1979
Adult mortality rate/year (Z)	0.5909	Leidy & Jenkins 1977
Growth coefficient/year (K)	0.28	Pauly 1980
Production Forgone Model (Jensen et al. 1988)		
Initial weight larval stage (W_1)	0.000084	Scott & Crossman 1973, Carlander 1977, Becker 1983, Holland-Bartels et al. 1990b
Initial weight young-of-the-year (W_2)	0.0781	Carlander 1977
Initial weight adult (W_3)	1.82	Carlander 1977, Rasmussen 1979, Becker 1983, Etnier & Starnes 1993, Pflieger 1997

Table A23
Model Parameters for Bluegill (cont.)

Parameter	Parameter Value	References
Weight specific growth/day, eggs and larvae (G_1)	0.0019	Scott & Crossman 1973, Carlander 1977, Becker 1983, Holland-Bartels et al. 1990b
Weight specific growth/day, young-of-the year (G_2)	0.0054	Carlander 1977
Weight specific growth/day, adult (G_3)	0.0712	Carlander 1977, Rasmussen 1979, Becker 1983, Etnier & Starnes 1993, Pflieger 1997
Natural mortality rate/day, eggs and larvae (Z_1)	0.0576	Professional judgment
Natural mortality rate/day, young-of-the-year (Z_2)	0.0142	Professional judgment
Natural mortality rate/day, adult (Z_3)	0.0016	Leidy & Jenkins 1977
Conditional Entrainment Mortality Model (Boreman et al. 1981) and Equivalent Adults Lost Model (Horst 1975, Goodyear 1978)		
Life stage duration (days), eggs and larvae (t_1)	40	Becker 1983, Post et al. 1995, Scott & Crossman 1973
Life stage duration (days), young-of-the-year (t_2)	325	Becker 1983, Post et al. 1995, Scott & Crossman 1973
Life stage duration (days), adult (t_3)	3,650	Scott & Crossman 1973, Carlander 1977, Smith 1979, Rasmussen 1979
Fraction of entrained killed, larvae (f_1)	0.87	Killgore et al. (in preparation)
Fraction of entrained killed, young-of-the-year (f_2)	0.225	Killgore et al. (in preparation)
Fraction of entrained killed, adult (f_3)	1.0	Professional judgment
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, eggs and larvae (w_1)	1.0	Littlejohn et al. 1985, Becker 1983, Post et al. 1995, Connor et al. 1983, Holland-Bartels et al. 1990a; 1990b, Holland et al. 1984

Table A23
Model Parameters for Bluegill (cont.)

Parameter	Parameter Value	References
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, young-of-the-year (w_2)	0	Welker et al. 1994, Rasmussen 1979, Putnum et al. 1995, Knights et al. 1995, Becker 1983, Holland-Bartels et al. 1990a; 1990b, Scott & Crossman 1973
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, adult (w_3)	0	Littlejohn et al. 1985, Baker et al. 1991, Etnier & Starnes 1993, Gutreuter et al. 1997a, Becker 1983, Pflieger 1997, Rasmussen 1979, Scott & Crossman 1973, Putnum et al. 1995, Knights et al. 1995, Holland-Bartels et al. 1990a; 1990b

Table A24
Model Parameters for White Crappie

Parameter	Parameter Value	References
Recruitment Forgone Model (Jensen 1990)		
Net reproductive rate (R_o)	1.0	Model assumption
Eggs/gram of female (H)	129.30	Rasmussen 1979, Becker 1983, Carlander 1977
Fraction of hatched eggs (p_1)	0.5	Professional judgment
Fraction of females in population (p_2)	0.5	Professional judgment
Asymptotic weight (g) (W_{INF})	2,185	Etnier & Starnes 1993
Age at time of egg hatching (years) (x_0)	0.33	Smith 1979, Pflieger 1997, Carlander 1977, Etnier & Starnes 1993, Rasmussen 1979, Becker 1983, Holland-Bartels et al. 1990a; 1990b
Age at maturity (years) (x_m)	2	Rohde et al. 1994, Rasmussen 1979, Becker 1983, Carlander 1977, Etnier & Starnes 1993, Pflieger 1997, Scott & Crossman 1973
Lifespan (years) (x_v)	9	Rohde et al. 1994, Scott & Crossman 1973, Etnier & Starnes 1993, Pflieger 1997, Carlander 1977
Adult mortality rate/year (Z)	0.4875	Carlander 1977, Becker 1983, Allen & Miranda 1995
Growth coefficient/year (K)	0.28	Pauly 1980
Production Forgone Model (Jensen et al. 1988)		
Initial weight larval stage (W_1)	0.00001	Carlander 1977, Holland-Bartels et al. 1990b
Initial weight young-of-the-year (W_2)	0.0764	Carlander 1977, Becker 1983
Initial weight adult (W_3)	2.88	Carlander 1977
Weight specific growth/day, eggs and larvae (G_1)	0.0016	Carlander 1977, Holland-Bartels et al. 1990b
Weight specific growth/day, young-of-the year (G_2)	0.0088	Carlander 1977, Becker 1983

Table A24
Model Parameters for White Crappie (cont.)

Parameter	Parameter Value	References
Weight specific growth/day, adult (G_3)	0.1961	Carlander 1977
Natural mortality rate/day, eggs and larvae (Z_1)	0.0489	Kranz et al. 1978
Natural mortality rate/day, young-of-the-year (Z_2)	0.0092	Professional judgment
Natural mortality rate/day, adult (Z_3)	0.0016	Leidy & Jenkins 1977
Conditional Entrainment Mortality Model (Boreman et al. 1981) and Equivalent Adults Lost Model (Horst 1975, Goodyear 1978)		
Life stage duration (days), eggs and larvae (t_1)	47	Scott & Crossman 1973, Post et al. 1995, Becker 1983
Life stage duration (days), young-of-the-year (t_2)	318	Scott & Crossman 1973, Post et al. 1995, Becker 1983
Life stage duration (days), adult (t_3)	2,920	Pflieger 1997, Rohde et al. 1994, Scott & Crossman 1973, Etnier & Starnes 1993, Carlander 1977
Fraction of entrained killed, larvae (f_1)	0.87	Killgore et al. (in preparation)
Fraction of entrained killed, young-of-the-year (f_2)	0.225	Killgore et al. (in preparation)
Fraction of entrained killed, adult (f_3)	1.0	Professional judgment
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, eggs and larvae (w_1)	0.5	Littlejohn et al. 1985, Pflieger 1997, Brown & Coon 1994, Holland-Bartels et al. 1990a; 1990b, Holland et al. 1984
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, young-of-the-year (w_2)	0	Pflieger 1997, Brown & Coon 1994, Scott & Crossman 1973, Rasmussen 1979
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, adult (w_3)	0	Littlejohn et al. 1985, Baker et al. 1991, Gutreuter et al. 1997a, Etnier & Starnes 1993, Pflieger 1997, Rohde et al. 1994

Table A25
Model Parameters for Black Crappie

Parameter	Parameter Value	References
Recruitment Forgone Model (Jensen 1990)		
Net reproductive rate (R_o)	1.0	Model assumption
Eggs/gram of female (H)	129.30	Rasmussen 1979, Becker 1983, Carlander 1977
Fraction of hatched eggs (p_1)	0.5	Professional judgment
Fraction of females in population (p_2)	0.5	Professional judgment
Asymptotic weight (g) (W_{INF})	1,900	Becker 1983
Age at time of egg hatching (years) (x_0)	0.33	Scott & Crossman 1973, Holland-Bartels et al. 1990a; 1990b, Rasmussen 1979, Becker 1983
Age at maturity (years) (x_m)	2	Becker 1983, Rasmussen 1979, Rohde et al. 1994, Scott & Crossman 1973
Lifespan (years) (x_v)	9	Scott & Crossman 1973, Carlander 1977
Adult mortality rate/year (Z)	0.6583	Carlander 1977, Becker 1983
Growth coefficient/year (K)	0.28	Pauly 1980
Production Forgone Model (Jensen et al. 1988)		
Initial weight larval stage (W_1)	0.00004	Carlander 1977, Holland-Bartels et al. 1990b
Initial weight young-of-the-year (W_2)	0.1130	Carlander 1977, Becker 1983
Initial weight adult (W_3)	4.84	Carlander 1977, Becker 1983
Weight specific growth/day, eggs and larvae (G_1)	0.0024	Carlander 1977, Holland-Bartels et al. 1990b
Weight specific growth/day, young-of-the year (G_2)	0.0149	Carlander 1977, Becker 1983

Table A25
Model Parameters for Black Crappie (cont.)

Parameter	Parameter Value	References
Weight specific growth/day, adult (G_3)	0.0732	Carlander 1977, Becker 1983
Natural mortality rate/day, eggs and larvae (Z_1)	0.0489	Professional judgment
Natural mortality rate/day, young-of-the-year (Z_2)	0.0092	Professional judgment
Natural mortality rate/day, adult (Z_3)	0.0016	Leidy & Jenkins 1977
Conditional Entrainment Mortality Model (Boreman et al. 1981) and Equivalent Adults Lost Model (Horst 1975, Goodyear 1978)		
Life stage duration (days), eggs and larvae (t_1)	47	Scott & Crossman 1973, Post et al. 1995, Becker 1983
Life stage duration (days), young-of-the-year (t_2)	318	Scott & Crossman 1973, Post et al. 1995, Becker 1983
Life stage duration (days), adult (t_3)	2,920	Rohde et al. 1994, Scott & Crossman 1973, Carlander 1977
Fraction of entrained killed, larvae (f_1)	0.87	Killgore et al. (in preparation)
Fraction of entrained killed, young-of-the-year (f_2)	0.225	Killgore et al. (in preparation)
Fraction of entrained killed, adult (f_3)	1.0	Professional judgment
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, eggs and larvae (w_1)	0.5	Littlejohn et al. 1985, Post et al. 1995, Holland et al. 1984, Holland-Bartels et al. 1990a; 1990b
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, young-of-the-year (w_2)	0	Becker 1983, Knights et al. 1995, Scott & Crossman 1973, Rasmussen 1979
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, adult (w_3)	0	Littlejohn et al. 1985, Baker et al. 1991, Gutreuter 1992, Becker 1983, Pflieger 1997, Rasmussen 1979, Rohde et al. 1994, Scott & Crossman 1973, Knights et al. 1995

Table A26
Model Parameters for Smallmouth Bass

Parameter	Parameter Value	References
Recruitment Forgone Model (Jensen 1990)		
Net reproductive rate (R_o)	1.0	Model assumption
Eggs/gram of female (H)	18.67	Scott & Crossman 1973, Carlander 1977
Fraction of hatched eggs (p_1)	0.5	Professional judgment
Fraction of females in population (p_2)	0.5	Professional judgment
Asymptotic weight (g) (W_{INF})	2,370	Pflieger 1997
Age at time of egg hatching (years) (x_0)	0.33	Etnier & Starnes 1993, Pflieger 1997
Age at maturity (years) (x_m)	3	Rohde et al. 1994, Pflieger 1997, Smith 1979, Becker 1983, Carlander 1977, Rasmussen 1979, Scott & Crossman 1973
Lifespan (years) (x_v)	12	Carlander 1977, Smith 1979, Becker 1983, Scott & Crossman 1973
Adult mortality rate/year (Z)	0.3175	Leidy & Jenkins 1977
Growth coefficient/year (K)	0.28	Pauly 1980
Production Forgone Model (Jensen et al. 1988)		
Initial weight larval stage (W_1)	0.00289	Scott & Crossman 1973, Holland-Bartels et al. 1990b
Initial weight young-of-the-year (W_2)	0.2148	Becker 1983, Knotek & Orth 1998
Initial weight adult (W_3)	14.26	Carlander 1977, Becker 1983, Pflieger 1997, Beamesderfer & North 1995
Weight specific growth/day, eggs and larvae (G_1)	0.0064	Scott & Crossman 1973, Holland-Bartels et al. 1990b
Weight specific growth/day, young-of-the year (G_2)	0.0423	Becker 1983, Knotek & Orth 1998

Table A26
Model Parameters for Smallmouth Bass (cont.)

Parameter	Parameter Value	References
Weight specific growth/day, adult (G_3)	0.5248	Carlander 1977, Becker 1983, Pflieger 1997, Beamesderfer & North 1995
Natural mortality rate/day, eggs and larvae (Z_1)	0.1287	Carlander 1977
Natural mortality rate/day, young-of-the-year (Z_2)	0.0132	Carlander 1977
Natural mortality rate/day, adult (Z_3)	0.00084	Carlander 1977, Leidy & Jenkins 1977
Conditional Entrainment Mortality Model (Boreman et al. 1981) and Equivalent Adults Lost Model (Horst 1975, Goodyear 1978)		
Life stage duration (days), eggs and larvae (t_1)	33	Etnier & Starnes 1993, Becker 1983, Pflieger 1997, Rasmussen 1979, Scott & Crossman 1973, Carlander 1977
Life stage duration (days), young-of-the-year (t_2)	332	Etnier & Starnes 1993, Becker 1983, Pflieger 1997, Rasmussen 1979, Scott & Crossman 1973, Carlander 1977
Life stage duration (days), adult (t_3)	4,015	Carlander 1977, Pflieger 1997, Rohde et al. 1994, Scott & Crossman 1973, Becker 1983, Smith 1979
Fraction of entrained killed, larvae (f_1)	0.87	Killgore et al. (in preparation)
Fraction of entrained killed, young-of-the-year (f_2)	0.225	Killgore et al. (in preparation)
Fraction of entrained killed, adult (f_3)	1.0	Professional judgment
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, eggs and larvae (w_1)	0.25	Littlejohn et al. 1985, Harlan & Speaker 1956, Newcomb et al. 1995, Carlander 1977, Holland et al. 1984, Holland-Bartels et al. 1990a; 1990b
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, young-of-the-year (w_2)	0	Leonard & Orth 1988, Newcomb et al. 1995, Carlander 1977, Becker 1983

Table A26
Model Parameters for Smallmouth Bass (cont.)

Parameter	Parameter Value	References
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, adult (w_3)	0	Littlejohn et al, 1985, Gutreuter et al. 1997a, Etnier & Starnes 1993, Becker 1983, Harlan & Speaker 1956, Pflieger 1997, Leonard & Orth 1988, Rasmussen 1979, Rohde et al. 1994, Scott & Crossman 1973, Newcomb et al. 1995, Carlander 1977

Table A27
Model Parameters for Largemouth Bass

Parameter	Parameter Value	References
Recruitment Forgone Model (Jensen 1990)		
Net reproductive rate (R_o)	1.0	Model assumption
Eggs/gram of female (H)	29.52	Carlander 1977
Fraction of hatched eggs (p_1)	0.5	Carlander 1977
Fraction of females in population (p_2)	0.5	Professional judgment
Asymptotic weight (g) (W_{INF})	2,850	Becker 1983, Etnier & Starnes 1993, Pflieger 1997
Age at time of egg hatching (years) (x_0)	0.33	Rasmussen 1979, Becker 1983, Smith 1979, Pflieger 1997, Holland-Bartels et al. 1990a; 1990b
Age at maturity (years) (x_m)	2	Rasmussen 1979, Carlander 1977, Rohde et al. 1994, Smith 1979
Lifespan (years) (x_v)	10	Etnier & Starnes 1993, Carlander 1977, Smith 1979, Becker 1983
Adult mortality rate/year (Z)	0.3175	Leidy & Jenkins 1977
Growth coefficient/year (K)	0.28	Pauly 1980
Production Forgone Model (Jensen et al. 1988)		
Initial weight larval stage (W_1)	0.0009	Scott & Crossman 1973, Carlander 1977, Becker 1983, Holland-Bartels et al. 1990b
Initial weight young-of-the-year (W_2)	2.48	Carlander 1977, Becker 1983, Pflieger 1997
Initial weight adult (W_3)	22.53	Carlander 1977, Rasmussen 1979, Etnier & Starnes 1993, Beamesderfer & North 1995, Pflieger 1997, Brummett, Unpublished data
Weight specific growth/day, eggs and larvae (G_1)	0.069	Scott & Crossman 1973, Carlander 1977, Becker 1983, Holland-Bartels et al. 1990b
Weight specific growth/day, young-of-the year (G_2)	0.061	Carlander 1977, Becker 1983, Pflieger 1997

Table A27
Model Parameters for Largemouth Bass (cont.)

Parameter	Parameter Value	References
Weight specific growth/day, adult (G_3)	0.5232	Carlander 1977, Rasmussen 1979, Etnier & Starnes 1993, Beamesderfer & North 1995, Pflieger 1997, Brummett, Unpublished data
Natural mortality rate/day, eggs and larvae (Z_1)	0.0894	Professional judgment
Natural mortality rate/day, young-of-the-year (Z_2)	0.0139	Professional judgment
Natural mortality rate/day, adult (Z_3)	0.00084	Leidy & Jenkins 1977
Conditional Entrainment Mortality Model (Boreman et al. 1981) and Equivalent Adults Lost Model (Horst 1975, Goodyear 1978)		
Life stage duration (days), eggs and larvae (t_1)	36	Carlander 1977, Scott & Crossman 1973, Becker 1983
Life stage duration (days), young-of-the-year (t_2)	329	Carlander 1977, Scott & Crossman 1973, Becker 1983
Life stage duration (days), adult (t_3)	3,285	Carlander 1977, Rohde et al. 1994, Etnier & Starnes 1993, Smith 1979, Becker 1983
Fraction of entrained killed, larvae (f_1)	0.87	Killgore et al. (in preparation)
Fraction of entrained killed, young-of-the-year (f_2)	0.225	Killgore et al. (in preparation)
Fraction of entrained killed, adult (f_3)	1.0	Professional judgment
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, eggs and larvae (w_1)	0.25	Littlejohn et al. 1985, Becker 1983, Scott & Crossman 1973, Carlander 1977, Etnier & Starnes 1993, Harlan & Speaker 1956, Rasmussen 1979, Rohde et al. 1994, Holland et al. 1984, Holland-Bartels et al. 1990a; 1990b
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, young-of-the-year (w_2)	0	Scott & Crossman 1973, Holland-Bartels et al. 1990a; 1990b, Becker 1983, Etnier & Starnes 1993, Carlander 1977
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, adult (w_3)	0	Littlejohn et al. 1985, Baker et al. 1991, Gutreuter et al. 1997a, Becker 1983, Rasmussen 1979, Rohde et al. 1994, Carlander 1977, Etnier & Starnes 1993, Holland-Bartels et al. 1990a; 1990b, Scott & Crossman 1973

Table A28
Model Parameters for Sauger

Parameter	Parameter Value	References
Recruitment Forgone Model (Jensen 1990)		
Net reproductive rate (R_o)	1.0	Model assumption
Eggs/gram of female (H)	65.25	Becker 1983
Fraction of hatched eggs (p_1)	0.50	Professional judgment
Fraction of females in population (p_2)	0.549	Becker 1983
Asymptotic weight (g) (W_{INF})	1,430.0	Rasmussen 1979, Becker 1983, Pflieger 1997
Age at time of egg hatching (years) (x_0)	0.33	Holland-Bartels et al. 1990a; 1990b, Scott & Crossman 1973, Etnier & Starnes 1993, Becker 1983, Rasmussen 1979
Age at maturity (years) (x_m)	4	Becker 1983, Rasmussen 1979, Scott & Crossman 1973, Rohde et al. 1994, Etnier & Starnes 1993
Lifespan (years) (x_v)	8	Rohde et al. 1994, Pflieger 1997, Becker 1983, Scott & Crossman 1973, Etnier & Starnes 1993
Adult mortality rate/year (Z)	0.44	Pauly 1980
Growth coefficient/year (K)	0.35	Detroit Edison, Unpublished report
Production Forgone Model (Jensen et al. 1988)		
Initial weight larval stage (g) (W_1)	0.00049	Forney 1976, Scott & Crossman 1973, Becker 1983, Holland-Bartels et al. 1990b, Etnier & Starnes 1993, Detroit Edison, Unpublished report
Initial weight young-of-the-year (g) (W_2)	0.04498	Rasmussen 1979, Becker 1983, Pitlo 1992, Lyons & Welke 1996, Pflieger 1997, Detroit Edison, Unpublished report
Initial weight adult (g) (W_3)	31.72	Rasmussen 1979, Becker 1983, Detroit Edison, Unpublished report

Table A28
Model Parameters for Sauger (cont.)

Parameter	Parameter Value	References
Weight specific growth/day, eggs and larvae (g) (G_1)	0.00074	Forney 1976, Scott & Crossman 1973, Becker 1983, Holland-Bartels et al. 1990b, Etnier & Starnes 1993, Detroit Edison, Unpublished report
Weight specific growth/day, young-of-the year (g) (G_2)	0.1038	Rasmussen 1979, Becker 1983, Pitlo 1992, Lyons & Welke 1996, Pflieger 1997, Detroit Edison, Unpublished report
Weight specific growth/day, adult (g) (G_3)	0.6372	Rasmussen 1979, Becker 1983, Detroit Edison, Unpublished report
Natural mortality rate/day, eggs and larvae (Z_1)	0.0767	Scott & Crossman 1973, Forney 1976, Johnson 1961
Natural mortality rate/day, young-of-the-year (Z_2)	0.0053	Forney 1976
Natural mortality rate/day, adult (Z_3)	0.00063	Leidy & Jenkins 1977
Conditional Entrainment Mortality Model (Boreman et al. 1981) and Equivalent Adults Lost Model (Horst 1975, Goodyear 1978)		
Life stage duration (days), eggs and larvae (t_1)	60	Pflieger 1997, Scott & Crossman 1973, Becker 1983, Etnier & Starnes 1993, Rasmussen 1979
Life stage duration (days), young-of-the-year (t_2)	305	Pflieger 1997, Scott & Crossman 1973, Becker 1983, Etnier & Starnes 1993, Rasmussen 1979
Life stage duration (days), adult (t_3)	2,555	Rohde et al. 1994, Scott & Crossman 1973, Pflieger 1997, Becker 1983, Etnier & Starnes 1993
Fraction of entrained killed, larvae (f_1)	0.87	Killgore et al. (in preparation)
Fraction of entrained killed, young-of-the-year (f_2)	0.225	Killgore et al. (in preparation)
Fraction of entrained killed, adult (f_3)	1.0	Professional judgment
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, eggs and larvae (w_1)	0.50	Littlejohn et al. 1985, Etnier & Starnes 1993, Becker 1983, Holland et al. 1984, Holland-Bartels et al. 1990a; 1990b

Table A28
Model Parameters for Sauger (cont.)

Parameter	Parameter Value	References
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, young-of-the-year (w_2)	0.50	Becker 1983, Rasmussen 1979, Holland et al. 1984, Etnier & Starnes 1993
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, adult (w_3)	0.25	Littlejohn et al. 1985, Baker et al. 1991, Etnier & Starnes 1993, Becker 1983, Rasmussen 1979, Rohde et al. 1994, Gutreuter et al. 1997a

Table A29
Model Parameters for Walleye

Parameter	Parameter Value	References
Recruitment Forgone Model (Jensen 1990)		
Net reproductive rate (R_o)	1.0	Model assumptions
Eggs/gram of female (H)	63.61	Becker 1983
Fraction of hatched eggs (p_1)	0.56	Holland 1986a
Fraction of females in population (p_2)	0.50	Professional judgment
Asymptotic weight (g) (W_{INF})	4,233	Detroit Edison, Unpublished report
Age at time of egg hatching (years) (x_0)	0.33	Etnier & Starnes 1993, Harlan & Speaker 1956, Becker 1983, Rasmussen 1979, Scott & Crossman 1973, Rohde et al. 1994, Pflieger 1997
Age at maturity (years) (x_m)	4	Becker 1983, Rasmussen 1979, Rohde et al. 1994, Scott & Crossman 1973
Lifespan (years) (x_v)	12	Becker 1983, Rasmussen 1979, Etnier & Starnes 1993, Pflieger 1997, Rohde et al. 1994, Scott & Crossman 1973
Adult mortality rate/year (Z)	0.44	Pauly 1980, Beverton & Holt 1959
Growth coefficient/year (K)	0.35	Detroit Edison, Unpublished report
Production Forgone Model (Jensen et al. 1988)		
Initial weight larval stage (g) (W_1)	0.00148	Forney 1976, Johnson et al. 1988, Holland-Bartels et al. 1990b, Detroit Edison, Unpublished report
Initial weight young-of-the-year (g) (W_2)	0.04624	Johnson et al. 1988, Pitlo 1992, Mayer & Wahl 1997, Detroit Edison, Unpublished report
Initial weight adult (g) (W_3)	92.895	Scott & Crossman 1973, Becker 1983

Table A29
Model Parameters for Walleye (cont.)

Parameter	Parameter Value	References
Weight specific growth/day, eggs and larvae (g) (G_1)	0.00075	Forney 1976, Johnson et al. 1988, Holland-Bartels et al. 1990b, Detroit Edison, Unpublished report
Weight specific growth/day, young-of-the year (g) (G_2)	0.3044	Johnson et al. 1988, Pitlo 1992, Mayer & Wahl 1997, Detroit Edison, Unpublished report
Weight specific growth/day, adult (g) (G_3)	0.8549	Scott & Crossman 1973, Becker 1983
Natural mortality rate/day, eggs and larvae (Z_1)	0.0767	Scott & Crossman 1973, Forney 1976, Johnson 1961
Natural mortality rate/day, young-of-the-year (Z_2)	0.0053	Forney 1976
Natural mortality rate/day, adult (Z_3)	0.00013	Leidy & Jenkins 1977
Conditional Entrainment Mortality Model (Boreman et al. 1981) and Equivalent Adults Lost Model (Horst 1975, Goodyear 1978)		
Life stage duration (days), eggs and larvae (t_1)	60	Pflieger 1997, Scott & Crossman 1973, Becker 1983, Etnier & Starnes 1993, Rasmussen 1979
Life stage duration (days), young-of-the-year (t_2)	305	Pflieger 1997, Scott & Crossman 1973, Becker 1983, Etnier & Starnes 1993, Rasmussen 1979
Life stage duration (days), adult (t_3)	4,015	Rohde et al. 1994, Scott & Crossman 1973, Becker 1983, Rasmussen 1979, Etnier & Starnes 1993, Pflieger 1997
Fraction of entrained killed, larvae (f_1)	0.87	Killgore et al. (in preparation)
Fraction of entrained killed, young-of-the-year (f_2)	0.225	Killgore et al. (in preparation)
Fraction of entrained killed, adult (f_3)	1.0	Professional judgment
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, eggs and larvae (w_1)	0.50	Littlejohn et al. 1985, Becker 1983, Johnson et al. 1988, Etnier & Starnes 1993, Rasmussen 1979, Holland et al. 1984, Holland-Bartels et al. 1990a; 1990b

Table A29
Model Parameters for Walleye (cont.)

Parameter	Parameter Value	References
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, young-of-the-year (w_2)	0.50	Etnier & Starnes 1993, Becker 1983, Rasmussen 1979, Scott & Crossman 1973
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, adult (w_3)	0.25	Littlejohn et al. 1985, Etnier & Starnes 1993, Hubert & O'Shea 1992, Becker 1983, Rohde et al. 1994

Table A30
Model Parameters for Freshwater Drum

Parameter	Parameter Value	References
Recruitment Forgone Model (Jensen 1990)		
Net reproductive rate (R_o)	1.0	Model assumption
Eggs/gram of female (H)	97.58	Swedberg & Walburg 1970
Fraction of hatched eggs (p_1)	0.50	Professional judgment
Fraction of females in population (p_2)	0.50	Professional judgment
Asymptotic weight (g) (W_{INF})	6,803.85	Rasmussen 1979
Age at time of egg hatching (years) (x_0)	0.417	Daiber 1953, Etnier & Starnes 1993, Scott & Crossman 1973, Becker 1983, Rasmussen 1979
Age at maturity (years) (x_m)	5	Daiber 1953, Rasmussen 1979
Lifespan (years) (x_v)	11	Pflieger 1997, Etnier & Starnes 1993
Adult mortality rate/year (Z)	0.30	Pauly 1980
Growth coefficient/year (K)	0.128	Pauly 1980
Production Forgone Model (Jensen et al. 1988)		
Initial weight larval stage (g) (W_1)	0.000134	Swedberg & Walburg 1970, Holland-Bartels et al. 1990b, Dreves et al. 1996
Initial weight young-of-the-year (g) (W_2)	0.00932	Swedberg & Walburg 1970, Etnier & Starnes 1993, Dreves et al. 1996
Initial weight adult (g) (W_3)	15.1	Butler and Smith 1950, Becker 1983, Dreves et al. 1996
Weight specific growth/day, eggs and larvae (g) (G_1)	0.000248	Swedberg & Walburg 1970, Holland-Bartels et al. 1990b, Dreves et al. 1996
Weight specific growth/day, young-of-the year (g) (G_2)	0.046	Becker 1983, Dreves et al. 1996

Table A30
Model Parameters for Freshwater Drum (cont.)

Parameter	Parameter Value	References
Weight specific growth/day, adult (g) (G_3)	0.80245	Butler & Smith 1950, Becker 1983, Dreves et al. 1996
Natural mortality rate/day, eggs and larvae (Z_1)	0.227	Zigler & Jennings 1993
Natural mortality rate/day, young-of-the-year (Z_2)	0.007	Professional judgment
Natural mortality rate/day, adult (Z_3)	0.0007	Leidy & Jenkins 1977
Conditional Entrainment Mortality Model (Boreman et al. 1981) and Equivalent Adults Lost Model (Horst 1975, Goodyear 1978)		
Life stage duration (days), eggs and larvae (t_1)	37	Etnier & Starnes 1993, Becker 1983, Rasmussen 1979, Scott & Crossman 1973, Post et al. 1995
Life stage duration (days), young-of-the-year (t_2)	328	Etnier & Starnes 1993, Becker 1983, Rasmussen 1979, Scott & Crossman 1973, Post et al. 1995
Life stage duration (days), adult (t_3)	3,650	Pflieger 1997, Etnier & Starnes 1993
Fraction of entrained killed, larvae (f_1)	0.87	Killgore et al. (in preparation)
Fraction of entrained killed, young-of-the-year (f_2)	0.225	Killgore et al. (in preparation)
Fraction of entrained killed, adult (f_3)	1.0	Professional judgment
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, eggs and larvae (w_1)	1.0	Littlejohn et al. 1985, Becker 1983, Holland & Sylvester 1983, Holland 1986a, Pflieger 1997, Post et al. 1995, Conner et al. 1983, Holland et al. 1984, Brown & Coon 1994, Holland-Bartels et al. 1990a; 1990b
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, young-of-the-year (w_2)	0.50	Becker 1983, Pflieger 1997, Etnier & Starnes 1993, Rasmussen 1979, Scott & Crossman 1973
Ratio of the average concentration of the life stage in the entrained water to the average concentration in the river volume, adult (w_3)	0.50	Littlejohn et al. 1985, Pflieger 1997, Etnier & Starnes 1993, Becker 1983, Rasmussen 1979, Scott & Crossman 1973, Gutreuter et al. 1997a

Appendix B
Larval Density Data

References cited in this Appendix are included in the References at the end of the main text.

Table B1
Available Larval Density Data in the Upper Mississippi River-Illinois Waterway System for Shovelnose Sturgeon and Paddlefish

Location	Date	Density (No./m^3)	Reference
Shovelnose Sturgeon			
UMR Open River	April-August 1978	<0.001	Union Electric Company 1979
Paddlefish			
UMR Open River	April-August 1978	<0.001	Union Electric Company 1979

Table B2
Available Larval Density Data in the Upper Mississippi River-Illinois Waterway System for Shortnose Gar/Lepisostidae and Bowfin

Location	Date	Density (No./m^3)	Reference
Shortnose Gar			
UMR Pool 14	May 1978	0.001	Holland et al. 1984, Hazleton 1978
UMR Pool 14	May 1978	0.02	Hazleton 1979
UMR Pool 14	July 1984	0.024	LMSE 1985
UMR Pool 26	May 1996	0.0086	Gutreuter, Dettmers, and Wahl 1998
	June 1996	0.0038	
	July 1997	0.0018	
IWW LaGrange Pool	May 1996	0.0025	Gutreuter, Dettmers, and Wahl 1998
Bowfin			
UMR Pool 26	June 1996	0.0014	Gutreuter, Dettmers, and Wahl 1998

Table B3
Available Larval Density Data in the Upper Mississippi River-Illinois Waterway System for Gizzard Shad

Location	Date	Density (No./m^3)	Reference
UMR Pool 2	April 1976	0.0798	HDR 1977a
	May 1976	1.239	
	June 1976	1.218	
	July 1976	1.23	
	August 1976	0.0094	
UMR Pool 3	April-Sept. 1975	0.04	Dahlberg et al. 1976
UMR Pool 3	June 1978	0.47	Holland et al. 1984, HDR 1979
UMR Pool 5	June 1975	0.05	Holland et al. 1984, Wapora, Inc. 1976a
UMR Pool 5	1981	0.029	Kowalski et al. 1984
	1982	0.118	
UMR Pool 7	May 1981	0.004	Holland et al. 1984, Holland & Sylvester 1983
	June 1981	0.04	
	July 1981	0.04	
UMR Pool 8	May 1982	0.22	Holland et al. 1984, Holland et al. 1983
	June 1982	0.52	
	July 1982	0.08	
UMR Pool 8	June-Aug. 1989	0.313	Holland-Bartels et al. 1990a
UMR Pool 8	June 1989	0.477	Holland-Bartels et al. 1990a, Holland-Bartels et al. 1995
	July 1989	0.724	
	August 1989	0.002	
UMR Pool 13	June-Aug. 1989	0.084	Holland-Bartels et al. 1990a
UMR Pool 13	June 1989	0.098	Holland-Bartels et al. 1990a, Holland-Bartels et al. 1995
	July 1989	0.251	
UMR Pool 13	April-Aug. 1983	0.164	Sheaffer & Nickum 1986
UMR Pool 14	May 1975	0.03	Holland et al. 1984, Nalco 1976
	June 1975	0.076	
	July 1975	0.002	
	August 1975	0.201	
UMR Pool 14	May 1976	0.01	Holland et al. 1984, Nalco 1977
	June 1976	0.57	
	July 1976	0.108	
UMR Pool 14	April 1977	0.001	Holland et al. 1984, Hazleton 1978

Table B3
Available Larval Density Data in the Upper Mississippi River-Illinois Waterway System for Gizzard Shad (cont.)

Location	Date	Density (No./m^3)	Reference
	May 1977	0.028	
	June 1977	0.06	
	July 1977	0.005	
UMR Pool 14	May 1978	0.016	Holland et al. 1984, Hazleton 1978
	June 1978	0.104	
	July 1978	0.021	
UMR Pool 14	May 1981	0.152	Holland et al. 1984, ERT 1982
	June 1981	2.022	
	July 1981	0.011	
UMR Pool 14	May 1978	0.1	Hazleton 1979
	June 1978	0.79	
	July 1978	0.15	
UMR Pool 14	May 1979	0.05	Commonwealth Edison 1980
	June 1979	0.54	
	July 1979	0.1	
UMR Pool 14	May 1980	0.006	ERT 1981
	June 1980	0.154	
	July 1980	0.030	
UMR Pool 14	May 1982	0.012	ERT 1984
	June 1982	0.061	
	July 1982	0.029	
UMR Pool 14	May 1984	0.051	LMSE 1985
	June 1984	1.070	
	July 1984	0.131	
UMR Pool 14	May 1985	0.19	LMSE 1986
	June 1985	0.2	
	July 1985	0.04	
UMR Pool 26	June-Aug., 1989	1.922	Holland-Bartels et al. 1990a
UMR Pool 26	June 1989	3.93	Holland-Bartels et al. 1990a, Holland-Bartels et al. 1995
	July 1989	1.258	
	August 1989	0.275	
UMR Pool 26	May 1997	0.0030	Gutreuter et al. 1998b
	May 1996	0.5782	
	June 1997	0.2067	

Table B3
Available Larval Density Data in the Upper Mississippi River-Illinois Waterway System for Gizzard Shad (cont.)

Location	Date	Density (No./m^3)	Reference
	June 1996	1.234	
	July 1996	0.0989	
	July 1997	0.0201	
IWW LaGrange Pool	June-Aug., 1989	6.535	Holland-Bartels et al. 1990a
IWW LaGrange Pool	June 1989	17.489	Holland-Bartels et al. 1990a, Holland-Bartels et al. 1995
	July 1989	0.383	
IWW LaGrange Pool	May 1996	0.2695	Gutreuter et al. 1998b
	May 1997	0.8759	
	June 1996	2.856	
	June 1997	0.0867	
	July 1996	0.0835	
	July 1997	0.04678	
IWW LaGrange Pool	June 1978	<0.01	Wapora, Inc. 1981
	June 1979	0.55	
	July 1979	0.05	
	June 1980	0.10	
	July 1980	0.17	
Dorosoma spp. or *Alosa* spp.			
IWW LaGrange Pool	June 1978	9.0	Wapora, Inc. 1981
	July 1978	1.87	
	August 1978	<0.01	
	April 1979	<0.01	
	May 1979	14.89	
	June 1979	9.51	
	July 1979	0.38	
	August 1979	<0.01	
	April 1980	0.02	

Table B3
Available Larval Density Data in the Upper Mississippi River-Illinois Waterway System for Gizzard Shad (cont.)

Location	Date	Density (No./m^3)	Reference
	May 1980	3.23	
	June 1980	37.64	
	July 1980	0.51	
	August 1980	0.01	

Table B4
Available Larval Density Data in the Upper Mississippi River-Illinois Waterway System for Mooneye/*Hiodon* spp.

Location	Date	Density (No./m^3)	Reference
UMR Pool 1	May 1980	0.001	Holland et al. 1984, Heberling et al. 1981
	June 1980	0.001	
UMR Pool 3	April-Sept. 1975	0.0032	Dahlberg et al. 1976
UMR Pool 5	1981	0.0005	Kowalski et al. 1984
	1982	0.009	
UMR Pool 7	June 1981	0.004	Holland et al. 1984, Holland & Sylvester 1983
UMR Pool 8	June-Aug. 1989	0.001	Holland-Bartels et al. 1990a
UMR Pool 8	June 1989	0.002	Holland-Bartels et al. 1990a, Holland-Bartels et al. 1995
UMR Pool 13	June-Aug. 1989	0.001	Holland-Bartels et al. 1990a
UMR Pool 13	June 1989	0.001	Holland-Bartels et al. 1990a, Holland-Bartels et al. 1995
UMR Pool 13	April-Aug. 1983	0.007	Sheaffer & Nickum 1986
UMR Pool 14	May 1975	0.031	Holland et al. 1984, Nalco 1976
	June 1975	0.014	
	September 1975	0.001	
UMR Pool 14	April 1976	0.009	Holland et al. 1984, Nalco 1977
	May 1976	0.087	
	June 1976	0.02	
UMR Pool 14	April 1977	0.004	Holland et al. 1984, Hazleton 1978
	May 1977	0.011	
	June 1977	0.001	
UMR Pool 14	May 1978	0.082	Holland et al. 1984, Hazleton 1978
	June 1978	0.008	
UMR Pool 14	May 1981	0.02	Holland et al. 1984, ERT 1982
	June 1981	0.01	
UMR Pool 14	May 1978	0.26	Hazleton 1979
	June 1978	0.06	
	July 1978	0.03	
UMR Pool 14	May 1979	0.12	Commonwealth Edison 1980
	June 1979	0.1	
UMR Pool 14	May 1980	0.041	ERT 1981
UMR Pool 14	May 1983	0.149	
UMR Pool 14	May 1984	0.282	LMSE 1985
	June 1984	0.101	

Table B4
Available Larval Density Data in the Upper Mississippi River-Illinois Waterway System for Mooneye/*Hiodon* spp. (cont.)

Location	Date	Density (No./m^3)	Reference
	July 1984	0.055	
UMR Pool 14	April 1985	0.08	LMSE 1986
	May 1985	0.03	
UMR Pool 26	April 1997	0.0019	Gutreuter et al. 1998b
	May 1997	0.0428	
	May 1996	0.0043	
	June 1997	0.0037	
	June 1996	0.0041	
	July 1997	0.0010	
IWW LaGrange Pool	June 1978	<0.01	Wapora, Inc. 1981
	May 1979	<0.01	
	June 1979	<0.01	
	June 1980	<0.01	

Table B5
Available Larval Density Data in the Upper Mississippi River-Illinois Waterway System for Northern Pike

Location	Date	Density (No./m^3)	Reference
Upper St. Anthony/ Lower St. Anthony (up from UMR Pool 1)	May 1975	0.0204	Minnesota Power and Light 1977
UMR Pool 5	June 1975	0.05	Holland et al. 1984, Wapora, Inc. 1976a
UMR Pool 14	May 1975	0.001	Holland et al. 1984, Nalco 1976
UMR Pool 14	April 1976	0.001	Holland et al. 1984, Nalco 1977
UMR Pool 14	May 1984	0.026	LMSE 1985

Table B6
Available Larval Density Data in the Upper Mississippi River-Illinois Waterway System for Common Carp

Location	Date	Density (No./m^3)	Reference
UMR Pool 1	May 1980	0.01	Holland et al. 1984, Heberling et al. 1981
	June 1980	0.005	
	July 1980	0.003	
UMR Pool 2	May 1976	0.0294	HDR 1977a
	June 1976	0.0752	
	July 1976	0.2758	
	August 1976	0.0038	
	September 1976	0.0004	
UMR Pool 3	April-Sept. 1975	0.0136	Dalhberg et al. 1976
UMR Pool 3	June 1978	0.15	Holland et al. 1984, HDR 1979
UMR Pool 5	1982	0.002	Kowalski et al. 1984
UMR Pool 5	June 1976	0.01	Holland et al. 1984, Wapora, Inc. 1976a
UMR Pool 7	May 1981	0.004	Holland et al. 1984, Holland & Sylvester 1983
	June 1981	0.052	
	July 1981	0.04	
UMR Pool 8	May 1982	0.02	Holland et al. 1984, Holland et al. 1983
	June 1982	0.04	
	July 1982	0.18	
UMR Pool 8	June-Aug. 1989	0.026	Holland-Bartels et al. 1990a
UMR Pool 8	June 1989	0.07	Holland-Bartels et al. 1990a, Holland-Bartels et al. 1995
	July 1989	0.009	
UMR Pool 13	June-Aug. 1989	0.046	Holland-Bartels et al. 1990a
UMR Pool 13	June 1989	0.197	Holland-Bartels et al. 1990a, Holland-Bartels et al. 1995
	July 1989	0.002	
UMR Pool 13	April-Aug. 1983	0.031	Sheaffer & Nickum 1986
UMR Pool 14	May 1975	1.08	Holland et al. 1984, Nalco 1976
	June 1975	0.104	
	July 1975	0.251	
	August 1975	0.036	
	September 1975	0.001	
UMR Pool 14	April 1976	0.014	Holland et al. 1984, Nalco 1977
	May 1976	0.003	
	June 1976	0.504	
	July 1976	0.219	
	August 1976	0.001	

Table B6
Available Larval Density Data in the Upper Mississippi River-Illinois Waterway System for Common Carp (cont.)

Location	Date	Density (No./m^3)	Reference
UMR Pool 14	April 1977	0.082	Holland et al. 1984, Hazleton 1978
	May 1977	0.033	
	June 1977	0.894	
	July 1977	0.212	
	August 1977	0.003	
UMR Pool 14	May 1978	1.425	Holland et al. 1984, Hazleton 1978
	June 1978	1.098	
	July 1978	0.162	
UMR Pool 14	May 1981	0.021	Holland et al. 1984, ERT 1982
	June 1981	1.664	
	July 1981	0.122	
UMR Pool 14	May 1978	4.86	Hazleton 1979
	June 1978	6.07	
	July 1978	0.61	
UMR Pool 14	May 1979	0.97	Commonwealth Edison 1980
	June 1979	1.56	
	July 1979	1.02	
UMR Pool 14	May 1980	0.047	ERT 1981
	June 1980	0.986	
	July 1980	1.073	
UMR Pool 14	May 1983	0.032	ERT 1984
	June 1983	1.251	
	July 1983	0.369	
UMR Pool 14	May 1984	1.300	LMSE 1985
	June 1984	3.617	
	July 1984	0.610	
UMR Pool 14	April 1985	0.02	LMSE 1986
	May 1985	0.44	
	June 1985	0.09	
	July 1985	0.05	
UMR Pool 26	June-Aug. 1989	0.031	Holland-Bartels et al. 1990a
UMR Pool 26	June 1989	0.121	Holland-Bartels et al. 1990a, Holland-Bartels et al. 1995

Table B6
Available Larval Density Data in the Upper Mississippi River-Illinois Waterway System for Common Carp (cont.)

Location	Date	Density (No./m^3)	Reference
UMR Pool 26	April 1997	0.00048	Gutreuter et al. 1998b
	May 1996	5.168	
	May 1997	0.0028	
	June 1996	0.5509	
	June 1997	0.0089	
	July 1996	0.0074	
	July 1997	0.0011	
IWW LaGrange Pool	June-Aug. 1989	0.121	Holland-Bartels et al. 1990a
IWW LaGrange Pool	June 1989	0.363	Holland-Bartels et al. 1990a, Holland-Bartels et al. 1995
IWW LaGrange Pool	May 1996	2.250	Gutreuter et al. 1998b
	May 1997	0.0023	
	June 1996	1.097	
	June 1997	0.3218	
	July 1996	0.0061	
IWW LaGrange Pool	June 1978	0.10	Wapora, Inc. 1981
	July 1978	<0.10	
	August 1978	<0.10	
	May 1979	0.31	
	June 1979	0.08	
	July 1979	<0.01	
	April 1980	<0.01	
	May 1980	0.04	
	June 1980	3.60	
	July 1980	0.01	
	August 1980	<0.01	

Table B7
Available Larval Density Data in the Upper Mississippi River-Illinois Waterway System for Emerald Shiner/Cyprinidae (Excluding Common Carp)

Location	Species	Date	Density (No./m^3)	Reference
UMR Pool 2	Emerald shiner	May 1976	0.0016	HDR 1977a
		June 1976	0.0153	
		July 1976	0.0855	
		August 1976	0.034	
		September 1976	0.0065	
UMR Pool 2	Cyprinidae	May 1976	0.0307	HDR 1977a
		June 1976	0.065	
		July 1976	0.001	
UMR Pool 3	Cyprinidae	April-Sept. 1975	0.0051	Dahlberg et al. 1976
UMR Pool 3	Emerald shiner	April-Sept. 1975	0.0436	Dahlberg et al. 1976
UMR Pool 5	Emerald shiner	1981	0.089	Kowalski et al. 1984
		1982	0.005	
UMR Pool 5	Cyprinidae	1981	0.013	Kowalski et al. 1984
		1982	0.004	
UMR Pool 5	Emerald shiner	June 1975	0.04	Holland et al. 1984, Wapora, Inc. 1976a
		July 1975	0.03	
UMR Pool 5	Cyprinidae	May 1975	0.11	Holland et al. 1984, Wapora, Inc. 1976a
		June 1975	0.32	
UMR Pool 7	Cyprinidae	May 1981	0.004	Holland et al. 1984, Holland & Sylvester 1983
		June 1981	0.144	
		July 1981	0.008	
		August 1981	0.004	
UMR Pool 8	Cyprinidae	July-Aug. 1989	0.693	Holland-Bartels et al. 1990a
UMR Pool 8	Cyprinidae	June 1989	0.137	Holland-Bartels et al. 1990a, Holland-Bartels et al. 1995
		July 1989	2.148	
		August 1989	1.115	
UMR Pool 8	Emerald shiner	June 1982	0.04	Holland et al. 1984, Holland et al. 1983
UMR Pool 8	Cyprinidae	July 1982	0.18	Holland et al. 1984, Holland et al. 1983
UMR Pool 9	Cyprinidae	June 1980	6.706	Holland et al. 1984
UMR Pool 13	Emerald shiner	April-Aug. 1983	0.28	Sheaffer & Nickum 1986
UMR Pool 13	Cyprinidae	April-Aug. 1983	0.035	Sheaffer & Nickum 1986
UMR Pool 13	Cyprinidae	June-Aug. 1989	0.735	Holland-Bartels et al. 1990a
UMR Pool 13	Cyprinidae	June 1989	3.022	Holland-Bartels et al. 1990a, Holland-Bartels et al. 1995
		July 1989	0.267	
		August 1989	0.24	
UMR Pool 14	Emerald shiner	August 1977	0.013	Holland et al. 1984, Hazleton 1978

Table B7
Available Larval Density Data in the Upper Mississippi River-Illinois Waterway System for Emerald Shiner/Cyprinidae (Excluding Common Carp) (cont.)

Location	Species	Date	Density (No./m^3)	Reference
UMR Pool 14	Emerald shiner	June 1981	0.31	Holland et al. 1984, ERT 1982
		July 1981	0.04	
UMR Pool 14	Cyprinidae	May 1975	0.017	Holland et al. 1984, Nalco 1976
		June 1975	0.296	
		July 1975	0.045	
UMR Pool 14	Cyprinidae	May 1976	0.006	Holland et al. 1984, Nalco 1977
		June 1976	0.236	
		July 1976	0.011	
		August 1976	0.017	
		September 1976	0.011	
UMR Pool 14	Cyprinidae	April 1977	0.143	Holland et al. 1984, Hazleton 1978
		May 1977	0.011	
		June 1977	0.013	
		July 1977	1.609	
		August 1977	0.152	
UMR Pool 14	Cyprinidae	May 1978	0.186	Holland et al. 1984, Hazleton 1978
		June 1978	3.751	
		July 1978	0.532	
UMR Pool 14	Cyprinidae	May 1981	0.006	Holland et al. 1984, ERT 1982
		June 1981	0.124	
		July 1981	0.048	
UMR Pool 14	Cyprinidae	May 1978	1.21	Hazleton 1979
	Cyprinidae	June 1978	27.3	
	Cyprinidae	July 1978	6.21	
UMR Pool 14	Cyprinidae	May 1979	0.03	Commonwealth Edison 1980
		June 1979	7.35	
		July 1979	1.39	
UMR Pool 14	Cyprinidae	May 1980	0.011	ERT 1981
		July 1980	0.006	
UMR Pool 14	Emerald shiner	June 1983	1.246	ERT 1984
		July 1983	0.027	
UMR Pool 14	Cyprinidae	May 1983	0.013	ERT 1984
		June 1983	0.293	
		July 1983	0.101	
UMR Pool 14	Emerald shiner	June 1984	10.124	LMSE 1985
		July 1984	0.92	
UMR Pool 14	Cyprinidae	May 1984	0.047	LMSE 1985

Table B7
Available Larval Density Data in the Upper Mississippi River-Illinois Waterway System for Emerald Shiner/Cyprinidae (Excluding Common Carp)(cont.)

Location	Species	Date	Density ($No./m^3$)	Reference
		June 1984	0.546	
		July 1984	0.378	
UMR Pool 14	Cyprinidae	April 1985	0.01	LMSE 1986
		May 1985	0.08	
		June 1985	0.12	
		July 1985	0.24	
UMR Pool 14	Emerald shiner	May 1985	1.322	LMSE 1986
		June 1985	5.725	
		July 1985	0.173	
UMR Pool 26	Cyprinidae	June-Aug. 1989	0.265	Holland-Bartels et al. 1990a
UMR Pool 26	Cyprinidae	June 1989	0.183	Holland-Bartels et al. 1990a, Holland-Bartels et al. 1995
		July 1989	0.68	
		August 1989	0.057	
UMR Pool 26	Cyprinidae	May 1997	0.0045	Gutreuter et al. 1998b
		June 1997	0.0204	
		July 1997	0.0989	
IWW LaGrange Pool	Cyprinidae	June-Aug. 1989	0.04	Holland-Bartels et al. 1990a
IWW LaGrange Pool	Cyprinidae	June 1989	0.103	Holland-Bartels et al. 1990a, Holland-Bartels et al. 1995
IWW LaGrange Pool	Cyprinidae	June 1997	0.0022	Gutreuter et al. 1998b
		July 1997	0.0092	
IWW LaGrange Pool	Cyprinidae	June 1978	29.65	Wapora, Inc. 1981
		July 1978	0.16	
		August 1978	<0.01	
		April 1979	<0.01	
		May 1979	1.85	
		June 1979	6.35	
		July 1979	0.37	
		August 1979	0.03	
		May 1980	1.01	
		June 1980	1.55	
		July 1980	0.11	

Table B7
Available Larval Density Data in the Upper Mississippi River-Illinois Waterway System for Emerald Shiner/Cyprinidae (Excluding Common Carp)(cont.)

Location	Species	Date	Density (No./m^3)	Reference
		August 1980	<0.01	
IWW LaGrange Pool	Emerald Shiner	June 1978	2.14	Wapora, Inc. 1981
		April 1979	<0.01	
		May 1979	<0.01	
		June 1979	0.12	
		July 1979	0.13	
		August 1979	<0.01	
		May 1980	<0.01	
		June 1980	0.30	
		July 1980	0.40	
		August 1980	<0.01	

Table B8
Available Larval Density Data in the Upper Mississippi River-Illinois Waterway System for Suckers/Catostomidae

Location	Date	Density (No./m^3)	Reference
UMR Pool 1	May 1980	0.013	Holland et al. 1984, Heberling et al. 1981
	June 1980	0.053	
	July 1980	0.001	
UMR Pool 2	April 1976	0.0003	HDR 1977a
	May 1976	0.0057	
	June 1976	0.0003	
	July 1976	0.0002	
UMR Pool 3	June 1978	0.08	Holland et al. 1984, HDR 1979
UMR Pool 3	April-Sept. 1975	0.0245	Dahlberg et al. 1976
UMR Pool 5	1981	0.003	Kowalski et al. 1984
	1982	0.013	
UMR Pool 7	May 1981	0.024	Holland et al. 1984, Holland & Sylvester 1983
UMR Pool 8	June-Aug. 1989	0.002	Holland-Bartels et al. 1990a
UMR Pool 8	June 1989	0.009	Holland-Bartels et al. 1990a, Holland-Bartels et al. 1995
UMR Pool 8	June 1982	0.02	Holland et al. 1984, Holland et al. 1983
	July 1982	0.02	
UMR Pool 13	June-Aug. 1989	0.001	Holland-Bartels et al. 1990a
UMR Pool 13	June 1989	0.002	Holland-Bartels et al. 1990a, Holland-Bartels et al. 1995
	July 1989	0.004	
UMR Pool 14	May 1975	0.038	Holland et al. 1984, Nalco 1976
	June 1975	0.07	
	July 1975	0.007	
UMR Pool 14	May 1976	0.005	Holland et al. 1984, Nalco 1976
	June 1976	0.018	
UMR Pool 14	April 1977	0.698	Holland et al. 1984, Hazleton 1978
	May 1977	0.022	
	June 1977	0.004	
	July 1977	0.003	
UMR Pool 14	May 1978	3.408	Holland et al. 1984, Hazleton 1978
	June 1978	0.184	
	July 1978	0.16	
UMR Pool 14	May 1978	5.79	Hazleton 1979
	June 1978	0.71	
	July 1978	0.66	

Table B8
Available Larval Density Data in the Upper Mississippi River-Illinois Waterway System for Suckers/Catostomidae (cont.)

Location	Date	Density (No./m^3)	Reference
UMR Pool 14	May 1979	1.24	Commonwealth Edison 1980
	June 1979	0.18	
	June 1979	0.18	
	July 1979	0.08	
UMR Pool 14	July 1983	0.012	ERT 1984
UMR Pool 14	May 1984	0.155	LMSE 1985
	June 1984	0.516	
	July 1984	0.076	
UMR Pool 26	June-Aug. 1989	0.001	Holland-Bartels et al. 1990a
UMR Pool 26	June 1989	0.004	Holland-Bartels et al. 1990a, Holland-Bartels et al. 1995
UMR Pool 26	April 1997	0.0024	Gutreuter et al. 1998b
	May 1997	0.0457	
	May 1996	0.1853	
	June 1997	0.2104	
	June 1996	0.1354	
	July 1997	0.0116	
	July 1996	0.0156	
IWW LaGrange Pool	May 1996	0.0744	Gutreuter et al. 1998b
	June 1997	0.9587	
	June 1996	0.0027	
	July 1997	0.0976	
	July 1996	0.0601	
IWW LaGrange Pool	June 1978	<0.01	Wapora, Inc. 1981
	July 1978	<0.01	
	May 1979	<0.01	
	July 1979	<0.01	
	May 1980	<0.01	
	July 1980	<0.01	

Table B9
Available Larval Density Data in the Upper Mississippi River-Illinois Waterway System for River Carpsucker/*Carpiodes* spp.

Location	Date	Density (No./m^3)	Reference
UMR Pool 2	May 1976	0.0018	HDR 1977a
	June 1976	0.0048	
	July 1976	0.0014	
UMR Pool 3	April-Sept. 1975	0.0044	Dahlberg et al. 1976
UMR Pool 8	May 1982	0.04	Holland et al. 1984, Holland et al. 1983
UMR Pool 8	June-Aug. 1989	0.005	Holland-Bartels et al. 1990a
UMR Pool 8	June 1989	0.006	Holland-Bartels et al. 1990a, Holland-Bartels et al. 1995
	July 1989	0.011	
	August 1989	0.001	
UMR Pool 13	June-Aug. 1989	0.003	Holland-Bartels et al. 1990a
UMR Pool 13	June 1989	0.012	Holland-Bartels et al. 1990a, Holland-Bartels et al. 1995
	July 1989	0.001	
	August 1989	0.001	
UMR Pool 13	April-Aug. 1983	0.012	Sheaffer & Nickum 1986
UMR Pool 14	June 1981	0.02	Holland et al. 1984, ERT 1982
	July 1981	0.094	
UMR Pool 14	May 1980	0.259	ERT 1981
	June 1980	0.084	
	July 1980	0.043	
UMR Pool 14	May 1983	0.026	ERT 1984
	June 1983	0.045	
	July 1983	0.027	
UMR Pool 14	May 1984	0.101	LMSE 1985
	June 1984	0.158	
	July 1984	0.088	
UMR Pool 14	April 1985	0.02	LMSE 1985
	May 1985	0.07	
	June 1985	0.02	
	July 1985	0.03	
UMR Pool 26	June-Aug. 1989	0.001	Holland-Bartels et al. 1990a
UMR Pool 26	June 1989	0.003	Holland-Bartels et al. 1990a, Holland-Bartels et al. 1995
IWW LaGrange Pool	June-Aug. 1989	0.007	Holland-Bartels et al. 1990a

Table B9
Available Larval Density Data in the Upper Mississippi River-Illinois Waterway System for River Carpsucker/*Carpiodes* spp. (cont.)

IWW LaGrange Pool	June 1989	0.018	Holland-Bartels et al. 1990a, Holland-Bartels et al. 1995
IWW LaGrange Pool	June 1978	0.02	Wapora, Inc. 1981
	July 1978	0.02	
	April 1979	<0.01	
	May 1979	0.08	
	June 1979	<0.01	
	July 1979	<0.01	
	August 1979	<0.01	
	April 1980	<0.01	
	May 1980	0.03	
	June 1980	0.10	
	July 1980	<0.01	

Table B10
Available Larval Density Data in the Upper Mississippi River-Illinois Waterway System for Buffalo/*Ictiobus* spp.

Location	Date	Density (No./m^3)	Reference
UMR Pool 3	April-Sept. 1975	0.0062	Dahlberg et al. 1976
UMR Pool 7	June 1981	0.004	Holland et al. 1984, Holland & Sylvester 1983
	July 1981	0.004	
UMR Pool 8	May 1982	0.1	Holland et al. 1984, Holland et al. 1983
UMR Pool 8	June-Aug. 1989	0.001	Holland-Bartels et al. 1990a
UMR Pool 8	June 1989	0.002	Holland-Bartels et al. 1990a, Holland-Bartels et al. 1995
	July 1989	0.003	
UMR Pool 13	April-Aug. 1983	0.006	Sheaffer & Nickum 1986
UMR Pool 13	June-Aug. 1989	0.003	Holland-Bartels et al. 1990a
UMR Pool 13	June 1989	0.007	Holland-Bartels et al. 1990a, Holland-Bartels et al. 1995
	July 1989	0.001	
UMR Pool 14	May 1975	0.176	Holland et al. 1984, Nalco 1976
	June 1975	0.004	
UMR Pool 14	April 1976	0.119	Holland et al. 1984, Nalco 1977
	May 1976	0.36	
	June 1976	0.001	
UMR Pool 14	May 1981	0.067	Holland et al. 1984, ERT 1982
UMR Pool 14	May 1981	0.011	ERT 1982
UMR Pool 14	May 1983	0.344	ERT 1984
	June 1983	0.103	
UMR Pool 14	May 1984	0.664	LMSE 1985
	June 1984	0.352	
	July 1984	0.103	
UMR Pool 14	April 1985	0.73	LMSE 1986
	May 1985	0.06	
	June 1985	0.01	
UMR Pool 26	May 1996	0.1917	Gutreuter et al. 1998b
	June 1996	0.0314	
IWW LaGrange Pool	June-Aug. 1989	0.004	Holland-Bartels et al. 1990a
IWW LaGrange Pool	June 1989	0.011	Holland-Bartels et al. 1990a, Holland-Bartels et al. 1995
IWW LaGrange Pool	June 1996	0.0238	Gutreuter et al. 1998b

Table B10
Available Larval Density Data in the Upper Mississippi River-Illinois Waterway System for Buffalo/*Ictiobus* spp. (cont.)

Location	Date	Density (No./m^3)	Reference
IWW LaGrange Pool	June 1978	0.02	Wapora, Inc. 1981
	July 1978	0.02	
	April 1979	<0.01	
	May 1979	0.08	
	June 1979	<0.01	
	July 1979	<0.01	
	August 1979	<0.01	
	April 1980	<0.01	
	May 1980	0.03	
	June 1980	0.10	
	July 1980	<0.01	

Table B11
Available Larval Density Data in the Upper Mississippi River-Illinois Waterway System for Redhorse/*Moxostoma* spp.

Location	Date	Density (No./m^3)	Reference
UMR Pool 7	July 1981	0.004	Holland et al. 1984, Holland & Sylvester 1983
UMR Pool 8	June-Aug. 1989	0.006	Holland-Bartels et al. 1990a
UMR Pool 8	June 1989	0.028	Holland-Bartels et al. 1990a, Holland-Bartels et al. 1995
UMR Pool 13	July 1989	0.001	Holland-Bartels et al. 1990a, Holland-Bartels et al. 1995
IWW LaGrange Pool	June 1978	<0.01	Wapora, Inc. 1981

Table B12
Available Larval Density Data in the Upper Mississippi River-Illinois Waterway System for Spotted Sucker

Location	Date	Density (No./m^3)	Reference
UMR Pool 13	April-Aug. 1983	0.002	Sheaffer & Nickum 1986

Table B13
Available Larval Density Data in the Upper Mississippi River-Illinois Waterway System for Channel Catfish/Flathead Catfish/Ictaluridae

Location	Date	Density (No./m^3)	Reference
Channel Catfish			
UMR Pool 1	June 1980	0.008	Holland et al. 1984, Heberling et al. 1981
	July 1980	0.033	
UMR Pool 2	May 1976	0.0004	HDR 1977a
	June 1976	0.0108	
	July 1976	0.0136	
	August 1976	0.0063	
	September 1976	0.0002	
UMR Pool 3	April-Sept. 1975	0.0009	Dahlberg et al. 1976
UMR Pool 5	1981	0.0002	Kowalski et al. 1984
UMR Pool 14	June 1975	0.002	Holland et al. 1984, Nalco 1976
	July 1975	0.007	
UMR Pool 14	July 1976	0.001	Holland et al. 1984, Nalco 1977
UMR Pool 14	June 1977	0.002	Holland et al. 1984, Hazleton 1978
	July 1977	0.003	
UMR Pool 14	June 1978	0.002	Holland et al. 1984, Hazleton 1978
	July 1978	0.018	
UMR Pool 14	1978	0.03	Hazleton 1979
UMR Pool 14	July 1978	0.12	Hazleton 1979
UMR Pool 14	June 1981	0.038	Holland et al. 1984, ERT 1982
UMR Pool 14	July 1983	0.006	ERT 1984
UMR Pool 14	July 1984	0.060	LMSE 1985
IWW LaGrange Pool	July 1996	0.00281	Gutreuter et al. 1998b
IWW LaGrange Pool	August 1978	<0.01	Wapora, Inc. 1981
	May 1979	<0.01	
	July 1979	<0.01	
	August 1979	<0.01	
	July 1980	<0.01	
Flathead Catfish			
IWW LaGrange Pool	July 1979	<0.01	Wapora, Inc. 1981

Table B13
Available Larval Density Data in the Upper Mississippi River-Illinois Waterway System for Channel Catfish/Flathead Catfish/Ictaluridae (cont.)

Location	Date	Density (No./m^3)	Reference
Catfish/Ictaluridae			
Pool 14	June 1978	0.02	Hazleton 1979
Pool 14	June 1979	0.06	Commonwealth Edison 1980
	July 1979	0.02	
Pool 14	July 1984	0.022	LMSE 1985
IWW LaGrange Pool	June 1978	<0.01	Wapora, Inc. 1981
	July 1979	<0.01	

Table B14
Available Larval Density Data in the Upper Mississippi River-Illinois Waterway System for White Bass

Location	Date	Density (No./m^3)	Reference
UMR Pool 2	April 1976	0.0013	HDR 1977a
	May 1976	0.0242	
	June 1976	0.0177	
	July 1976	0.0003	
UMR Pool 3	May-Sept. 1975	0.0226	Dahlberg et al. 1976
UMR Pool 3	June 1978	0.05	Holland et al. 1984, HDR 1979
UMR Pool 5	1981	0.003	Kowalski et al. 1984
	1982	0.044	
UMR Pool 5	May 1975	0.23	Holland et al. 1984, Wapora, Inc. 1976a
	June 1975	0.31	
UMR Pool 7	May 1981	0.008	Holland et al. 1984, Holland & Sylvester 1983
	June 1981	0.004	
	July 1981	0.004	
UMR Pool 8	June-Aug. 1989	0.023	Holland-Bartels et al. 1990a
UMR Pool 8	June 1989	0.117	Holland-Bartels et al. 1990a, Holland-Bartels et al. 1995
UMR Pool 8	May 1982	0.44	Holland et al. 1984, Holland et al. 1983
	June 1982	0.32	
	July 1982	0.16	
UMR Pool 13	April-Aug. 1983	0.003	Sheaffer & Nickum 1986
UMR Pool 13	June 1989	0.002	Holland-Bartels et al. 1990a, Holland-Bartels et al. 1995
UMR Pool 13	June-Aug. 1989	0.001	Holland-Bartels et al. 1990a
UMR Pool 14	May 1975	0.154	Holland et al. 1984, Nalco 1976
	June 1975	0.401	
	July 1975	0.005	
UMR Pool 14	May 1976	0.008	Holland et al. 1984, Nalco 1976
	June 1976	0.017	
UMR Pool 14	May 1977	0.007	Holland et al. 1984, Hazleton 1978
UMR Pool 14	May 1978	0.01	Holland et al. 1984, Hazleton 1978
	June 1978	0.022	
	July 1978	0.001	
UMR Pool 14	May 1981	0.006	Holland et al. 1984, ERT 1982
	June 1981	0.08	
UMR Pool 14	May 1978	0.05	Hazleton 1979
	June 1978	0.18	

Table B14
Available Larval Density Data in the Upper Mississippi River-Illinois Waterway System for White Bass (cont.)

Location	Date	Density (No./m³)	Reference
	July 1978	0.02	
UMR Pool 14	May 1979	0.1	Commonwealth Edison 1980
	June 1979	0.32	
	July 1979	0.08	
UMR Pool 14	May 1980	0.025	ERT 1981
UMR Pool 14	May 1983	0.017	ERT 1984
	June 1983	0.011	
UMR Pool 14	May 1984	0.263	LMSE 1985
	June 1984	0.380	
	July 1984	0.024	
UMR Pool 14	April 1985	0.02	LMSE 1986
	May 1985	0.04	
	June 1985	0.01	
UMR Pool 26	June 1989	0.031	Holland-Bartels et al. 1990a, Holland-Bartels et al. 1995
UMR Pool 26	June-Aug. 1989	0.006	Holland-Bartels et al. 1990a
UMR Pool 26	May 1996	0.0091	Gutreuter et al. 1998b
	May 1997	0.0013	
	June 1996	0.0125	
	June 1997	0.0047	
	July 1996	0.0017	
IWW LaGrange Pool	June-Aug. 1989	0.002	Holland-Bartels et al. 1990a
IWW LaGrange Pool	June 1989	0.006	Holland-Bartels et al. 1990a, Holland-Bartels et al. 1995
IWW LaGrange Pool	May 1996	0.0152	Gutreuter et al. 1998b
	May 1997	0.1329	
	June 1996	0.0148	
	June 1997	0.0075	
	July 1996	0.0088	
IWW LaGrange Pool	June 1978	<0.01	Wapora, Inc. 1981
	July 1978	<0.01	
	August 1978	<0.01	
	May 1979	0.13	
	June 1979	0.03	

Table B14
Available Larval Density Data in the Upper Mississippi River-Illinois Waterway System for White Bass (cont.)

Location	Date	Density (No./m^3)	Reference
	July 1979	<0.01	
	August 1979	<0.01	
	April 1980	<0.01	
	May 1980	0.04	
	June 1980	0.13	
	July 1980	<0.01	
	August 1980	<0.01	

Table B15
Available Larval Density Data in the Upper Mississippi River-Illinois Waterway System for Bluegill/*Lepomis* spp.

Location	Date	Density (No./m^3)	Reference
UMR Pool 1	June 1980	0.001	Holland et al. 1984, Heberling et al. 1981
	July 1980	0.002	
UMR Pool 2	June 1976	0.0034	HDR 1977a
	July 1976	0.0048	
	August 1976	0.0008	
UMR Pool 3	April-Sept. 1975	0.0026	Dahlberg et al. 1976
UMR Pool 5	1981	0.0002	Kowalski et al. 1984
	1982	0.002	
UMR Pool 5	June 1975	0.08	Holland et al. 1984, Wapora, Inc. 1976a
UMR Pool 7	June 1981	0.028	Holland et al. 1984, Holland & Sylvester 1983
	July 1981	0.008	
UMR Pool 8	June-Aug. 1989	0.069	Holland-Bartels et al. 1990a
UMR Pool 8	June 1989	0.014	Holland-Bartels et al. 1990a, Holland-Bartels et al. 1995
	July 1989	0.316	
	August 1989	0.006	
UMR Pool 8	June 1982	0.1	Holland et al. 1984, Holland et al. 1983
	July 1982	0.26	
UMR Pool 13	June-Aug. 1989	0.276	Holland-Bartels et al. 1990a
UMR Pool 13	June 1989	0.145	Holland-Bartels et al. 1990a, Holland-Bartels et al. 1995
	July 1989	0.753	
	August 1989	0.38	
UMR Pool 13	April-Aug. 1983	0.036	Sheaffer & Nickum 1986
UMR Pool 14	June 1975	0.021	Holland et al. 1984, Nalco 1976
	July 1975	0.014	
UMR Pool 14	June 1976	0.027	Holland et al. 1984, Nalco 1977
	July 1976	0.035	
	August 1976	0.005	
UMR Pool 14	May 1977	0.003	Holland et al. 1984, Hazleton 1978
	June 1977	0.132	
	July 1977	0.096	
	August 1977	0.011	
	September 1977	0.001	
UMR Pool 14	June 1978	0.053	Holland et al. 1984, Hazleton 1978
	July 1978	0.014	

Table B15
Available Larval Density Data in the Upper Mississippi River-Illinois Waterway System for Bluegill/*Lepomis* spp. (cont.)

Location	Date	Density (No./m^3)	Reference
UMR Pool 14	June 1981	0.02	Holland et al. 1984, ERT 1982
UMR Pool 14	June 1978	0.25	Hazleton 1979
UMR Pool 14	July 1978	0.07	
UMR Pool 14	June 1979	0.21	Commonwealth Edison 1980
	July 1979	0.22	
UMR Pool 14	June 1980	0.037	ERT 1981
	July 1980	0.006	
UMR Pool 14	June 1983	0.013	ERT 1984
	July 1983	0.016	
UMR Pool 14	June 1984	1.840	LMSE 1985
	July 1984	0.560	
UMR Pool 14	May 1985	0.04	LMSE 1986
	June 1985	0.06	
	July 1985	0.04	
UMR Pool 26	June-Aug. 1989	0.627	Holland-Bartels et al. 1990a
UMR Pool 26	June 1989	0.061	Holland-Bartels et al. 1990a, Holland-Bartels et al. 1995
	July 1989	1.759	
	August 1989	1.527	
UMR Pool 26	May 1996	0.0213	Gutreuter et al. 1998b
	May 1997	0.0026	
	June 1996	0.0545	
	Jule 1996	0.0017	
	July 1997	0.0011	
IWW LaGrange Pool	June-Aug. 1989	0.006	Holland-Bartels et al. 1990a
IWW LaGrange Pool	June 1989	0.003	Holland-Bartels et al. 1990a, Holland-Bartels et al. 1995
	July 1989	0.012	
IWW LaGrange Pool	May 1996	0.0551	Gutreuter et al. 1998b
	June 1996	0.0301	
	June 1997	0.00093	
	July 1996	0.0040	
	July 1997	0.0020	
IWW LaGrange Pool	June 1978	<0.01	Wapora, Inc. 1981
	July 1978	<0.01	

Table B15
Available Larval Density Data in the Upper Mississippi River-Illinois Waterway System for Bluegill/*Lepomis* spp. (cont.)

Location	Date	Density (No./m^3)	Reference
	August 1978	<0.01	
	May 1979	<0.01	
	June 1979	0.01	
	July 1979	<0.01	
	August 1979	<0.01	
	May 1980	<0.01	
	June 1980	0.02	
	July 1980	0.02	
	August 1980	<0.01	

Table B16
Available Larval Density Data in the Upper Mississippi River-Illinois Waterway System for Black Crappie/White Crappie/*Pomoxis* spp.

Location	Date	Density (No./m^3)	Reference
Upper St. Anthony/Lower St. Anthony (up from UMR Pool 1)	May 1975	0.1212	Minnesota Power and Light 1977
	June 1975	0.0115	
UMR Pool 1	May 1980	0.001	Holland et al. 1984, Heberling et al. 1981
	June 1980	0.001	
UMR Pool 2	June 1976	0.0013	HDR 1977a
	July 1976	0.0013	
UMR Pool 3	April-Sept. 1975	0.0012	Dahlberg et al. 1976
UMR Pool 3	June 1978	0.01	Holland et al. 1984, HDR 1979
UMR Pool 4	June 1981	0.02	Holland et al. 1984
UMR Pool 5	1981	0.0007	Kowalski et al. 1984
	1982	0.009	
UMR Pool 7	May 1981	0.088	Holland et al. 1984, Holland & Sylvester 1983
	June 1981	0.004	
UMR Pool 8	May 1982	0.06	Holland et al. 1984, Holland et al. 1983
	June 1982	0.04	
UMR Pool 8	June-Aug. 1989	0.001	Holland-Bartels et al. 1990a
UMR Pool 8	June 1989	0.001	Holland-Bartels et al. 1990a, Holland-Bartels et al. 1995
	July 1989	0.002	
UMR Pool 13	April-Aug. 1983	0.011	Sheaffer & Nickum 1986
UMR Pool 13	June-Aug. 1989	0.001	Holland-Bartels et al. 1990a
UMR Pool 13	June 1989	0.003	Holland-Bartels et al. 1990a, Holland-Bartels et al. 1995
UMR Pool 14	May 1975	0.06	Holland et al. 1984, Nalco 1976
	June 1975	0.069	
UMR Pool 14	April 1976	0.001	Holland et al. 1984, Nalco 1977
	May 1976	0.037	
	June 1976	0.009	
UMR Pool 14	April 1977	0.116	Holland et al. 1984, Hazleton 1978
	May 1977	0.027	
	June 1977	0.008	

Table B16
Available Larval Density Data in the Upper Mississippi River-Illinois Waterway System for Black Crappie/White Crappie/*Pomoxis* spp. (cont.)

Location	Date	Density (No./m^3)	Reference
UMR Pool 14	May 1978	0.008	Holland et al. 1984, Hazleton 1978
	June 1978	0.013	
UMR Pool 14	May 1978	0.05	Hazleton 1979
	June 1978	0.08	
UMR Pool 14	May 1979	0.53	Commonwealth Edison 1980
	June 1979	0.24	
UMR Pool 14	May 1980	0.006	ERT 1981
	June 1980	0.027	
UMR Pool 14	June 1981	0.02	ERT 1982, Holland et al. 1984
UMR Pool 14	May 1983	0.012	ERT 1984
	June 1983	0.032	
UMR Pool 14	May 1984	0.178	LMSE 1985
	June 1984	0.050	
	July 1984	0.027	
UMR Pool 14	April 1985	0.01	LMSE 1986
	May 1985	0.16	
UMR Pool 26	June-Aug. 1989	0.001	Holland-Bartels et al. 1990a
UMR Pool 26	June 1989	0.002	Holland-Bartels et al. 1990a, Holland-Bartels et al. 1995
IWW LaGrange Pool	June-Aug. 1989	0.014	Holland-Bartels et al. 1990a
IWW LaGrange Pool	June 1989	0.042	Holland-Bartels et al. 1990a, Holland-Bartels et al. 1995
IWW LaGrange Pool	June 1978	<0.01	Wapora, Inc. 1981
	May 1979	<0.01	
	June 1979	<0.01	
	July 1979	<0.01	
	August 1979	<0.01	
	May 1980	<0.01	
	June 1980	<0.01	
	July 1980	<0.01	

Table B17
Available Larval Density Data in the Upper Mississippi River-Illinois Waterway System for Smallmouth Bass and Largemouth Bass/Centrarchidae

Location	Date	Density (No./m^3)	Reference
Smallmouth Bass			
UMR Pool 1	May 1980	0.003	Holland et al. 1984, Heberling et al. 1981
	June 1980	0.004	
IWW LaGrange Pool	June 1979	<0.01	Wapora, Inc. 1981
Largemouth Bass			
UMR Pool 1	June 1980	0.001	Holland et al. 1984, Heberling et al. 1981
***Micropterus* spp.**			
IWW LaGrange Pool	May 1979	<0.01	Wapora, Inc. 1981
	June 1979	<0.01	
Centrarchidae			
UMR Pool 2	July 1976	0.0005	HDR 1977a
UMR Pool 5	1981	0.0002	Kowalski et al. 1984
UMR Pool 14	May 1978	0.03	Hazleton 1979
UMR Pool 14	June 1978	0.11	Hazleton 1979

Table B18
Available Larval Density Data in the Upper Mississippi River-Illinois Waterway System for Walleye/Sauger/*Stizostedion* spp.

Location	Species	Date	Density (No./m^3)	Reference
Upper St. Anthony/Lower St. Anthony (up from UMR Pool 1)	Walleye	May 1975	0.06123	Minnesota Power and Light 1977
		June 1975	0.2128	
UMR Pool 1	Walleye	May 1980	0.001	Holland et al. 1984, Heberling et al. 1981
UMR Pool 2	*Stizostedion* spp.	April 1976	0.031	HDR 1977a
		May 1976	0.0029	
UMR Pool 3	Sauger	April-Sept. 1975	0.0055	Dahlberg et al. 1976
	Walleye	April-Sept. 1975	0.0009	
UMR Pool 7	*Stizostedion* spp.	May 1981	0.004	Holland et al. 1984, Holland & Sylvester 1983
UMR Pool 13	*Stizostedion* spp.	April-Aug. 1983	0.004	Sheaffer & Nickum 1986
UMR Pool 13, Sand Prairie Site, RM 545.5	*Stizostedion* spp.	1994	0.0003	Iowa Department of Natural Resources 1997
		1995	0.0015	
		1996	0.0015	
		1997	0.0021	
UMR Pool 13, Pleasant Creek Site, RM 553.4	*Stizostedion* spp.	1994	0.001	Iowa Department of Natural Resources 1997
		1995	0.0014	
		1996	0.0048	
		1997	0.0021	
UMR Pool 14	*Stizostedion* spp.	May 1975	0.007	Holland et al. 1984, Nalco 1976
		June 1975	0.001	
	Sauger	May 1975	0.002	
	Walleye	May 1975	0.002	
UMR Pool 14	*Stizostedion* spp.	April 1976	0.004	Holland et al. 1984, Nalco 1977
		May 1976	0.007	

Table B18
Available Larval Density Data in the Upper Mississippi River-Illinois Waterway System for Walleye/Sauger/*Stizostedion* spp. (cont.)

Location	Species	Date	Density (No./m^3)	Reference
UMR Pool 14	*Stizostedion* spp.	April 1977	0.211	Holland et al. 1984, Hazleton 1978
		May 1977	0.014	
UMR Pool 14	*Stizostedion* spp.	May 1978	0.013	Holland et al. 1984, Hazleton 1978
UMR Pool 14	*Stizostedion* spp.	April 1981	0.017	Holland et al. 1984, ERT 1982
		May 1981	0.013	
UMR Pool 14	*Stizostedion* spp.	May 1978	0.05	Hazleton 1979
	Stizostedion spp.	June 1978	0.001	
UMR Pool 14	*Stizostedion* spp.	May 1979	0.07	Commonwealth Edison 1980
UMR Pool 14	*Stizostedion* spp.	April 1980	0.011	ERT 1981
		May 1980	0.006	
UMR Pool 14	Sauger	May 1983	0.063	ERT 1984
UMR Pool 14	Sauger	April 1984	0.06	LMSE 1985
UMR Pool 14	*Stizostedion* spp.	April 1984	0.07	LMSE 1985
		May 1984	0.027	
	Sauger	April 1984	0.06	LMSE 1985
		May 1984	0.102	
UMR Pool 14	Sauger	April 1985	0.01	LMSE 1986
UMR Pool 14	*Stizostedion* spp.	April 1985	0.02	LMSE 1986
UMR Pool 26	Percidae	April 1997	0.0013	Gutreuter et al. 1998b
		May 1997	0.0181	
		May 1996	0.0144	
		June 1997	0.0078	
		June 1996	0.0025	
IWW LaGrange Pool	Percidae	May 1997	0.0058	Gutreuter et al. 1998b
IWW LaGrange Pool	*Stizostedion* spp.	July 1978	<0.01	Wapora, Inc. 1981
		April 1979	<0.01	
		May 1979	<0.01	
		April 1980	<0.01	
		May 1980	<0.01	

Table B18
Available Larval Density Data in the Upper Mississippi River-Illinois Waterway System for Walleye/Sauger/*Stizostedion* spp. (cont.)

Location	Species	Date	Density (No./m^3)	Reference
IWW LaGrange Pool	Percidae	July 1978	<0.01	Wapora, Inc. 1981
		April 1980	<0.01	
		May 1980	<0.01	

Table B19
Available Larval Density Data in the Upper Mississippi River-Illinois Waterway System for Freshwater Drum

Location	Date	Density (No./m^3)	Reference
UMR Pool 2	May 1976	0.139	HDR 1977a
	June 1976	0.948	
	July 1976	0.0658	
	Aug. 1976	0.0017	
UMR Pool 3	April-Sept. 1975	0.0103	Dahlberg et al. 1976
UMR Pool 5	May 1975	0.02	Holland et al. 1984, Wapora, Inc. 1976a
	June 1975	0.07	
UMR Pool 5	1981	0.02	Kowalski et al. 1984
	1982	0.194	
UMR Pool 7	July 1975	0.01	
	Aug. 1975	0.01	
UMR Pool 7	June 1981	0.26	Holland et al. 1984, Holland & Sylvester 1983
	July 1981	0.02	
UMR Pool 8	May 1982	0.24	Holland et al. 1984, Holland et al. 1983
	June 1982	0.68	
	July 1982	0.82	
UMR Pool 8	June-Aug. 1989	0.902	Holland-Bartels et al. 1990a
UMR Pool 8	June 1989	1.05	Holland-Bartels et al. 1990a, Holland-Bartels et al. 1995
	July 1989	0.01	
	Aug. 1989	0.001	
UMR Pool 9	June 1980	0.811	Holland-Bartels et al. 1990a
UMR Pool 13	April-Aug. 1983	0.264	Sheaffer & Nickum 1986
UMR Pool 13	June-Aug. 1989	0.463	Holland-Bartels et al. 1990a
UMR Pool 13	June 1989	0.83	Holland-Bartels et al. 1990a, Holland-Bartels et al. 1995
	July 1989	0.017	
	Aug. 1989	0.003	
UMR Pool 14	May 1975	0.797	Holland et al. 1984, Nalco 1976
	June 1975	1.58	

Table B19
Available Larval Density Data in the Upper Mississippi River-Illinois Waterway System for Freshwater Drum (cont.)

Location	Date	Density (No./m^3)	Reference
	July 1975	0.214	
UMR Pool 14	May 1976	0.087	Holland et al. 1984, Nalco 1977
	June 1976	1.78	
	July 1976	0.07	
	Aug. 1976	0.046	
	Sept. 1976	0.007	
UMR Pool 14	May 1977	0.052	Holland et al. 1984, Hazleton 1978
	June 1977	0.199	
	July 1977	0.42	
	Aug. 1977	0.104	
UMR Pool 14	May 1978	0.158	Holland et al. 1984, Hazleton 1978
	June 1978	1.095	
	July 1978	0.122	
UMR Pool 14	May 1981	0.264	Holland et al. 1984, ERT 1982
	June 1981	4.47	
	July 1981	0.296	
UMR Pool 14	May 1978	0.49	Hazleton 1979
	June 1978	5.81	
	July 1978	0.33	
UMR Pool 14	June 1979	8.92	Commonwealth Edison 1980
	July 1979	2.52	
UMR Pool 14	May 1980	0.28	ERT 1981
	June 1980	1.27	
	July 1980	3.04	
UMR Pool 14	June 1983	21.47	ERT 1984
	July 1983	0.301	
UMR Pool 14	May 1984	0.015	LMSE 1985
	June 1984	36.4	
	July 1984	1.13	
UMR Pool 14	May 1985	2.67	LMSE 1986
	June 1985	2.91	
	July 1985	0.23	
UMR Pool 26	June-Aug. 1989	0.319	Holland-Bartels et al. 1990a

Table B19
Available Larval Density Data in the Upper Mississippi River-Illinois Waterway System for Freshwater Drum (cont.)

Location	Date	Density (No./m^3)	Reference
UMR Pool 26	June 1989	1.326	Holland-Bartels et al. 1990a, Holland-Bartels et al. 1995
	July 1989	0.004	
UMR Pool 26	April 1997	0.0032	Gutreuter et al. 1998b
	May 1996	0.0030	
	June 1996	1.424	
	June 1997	1.152	
	July 1996	0.9669	
	July 1997	0.0097	
IWW LaGrange Pool	June-Aug. 1989	1.205	Holland-Bartels et al. 1990a
IWW LaGrange Pool	June 1989	3.037	Holland-Bartels et al. 1990a, Holland-Bartels et al. 1995
IWW LaGrange Pool	May 1997	0.2350	Gutreuter et al. 1998b
	May 1996	0.0816	
	June 1996	0.1179	
	June 1997	3.866	
	July 1996	1.8765	
IWW LaGrange Pool	June 1978	0.25	Wapora, Inc. 1981
	July 1978	<0.01	
	August 1978	<0.03	
	May 1979	0.17	
	June 1979	0.77	
	July 1979	0.02	
	August 1979	<0.01	
	April 1980	<0.01	
	May 1980	0.12	
	June 1980	0.80	
	July 1980	0.06	
	August 1980	0.01	

Appendix C
Power Plant Fish Entrainment and Impingement Data

References cited in this Appendix are included in the References at the end of the main text.

Table C1
Entrainment Losses for Pool 1

Riverside (MN) Generating Plant, 1976 (HDR 1977b)

Species	Predicted Annual Number Entrained
Carp	15,632
Cyprinids (including River Shiner)	224,137
Darter	231,417
Logperch	574,711
Rock Bass	52,107
Shorthead Redhorse	380,842

Riverside (MN) Generating Plant, 1980 (Heberling et al. 1981)

Species	Total Number Entrained in a 24-hr Period for Sample Dates Between 4/17/80 and 8/14/80																	
	4/17	4/24	5/1	5/8	5/15	5/22	5/29	6/5	6/12	6/19	6/26	7/2	7/10	7/17	7/24	7/31	8/7	8/14
Black Crappie																		
(Mesolarvae)								780										
(Metalarvae)									1,330									
(Juvenile)										820	760	1,230						
Bluegill (Prolarvae)										410	760			520	1,080			
(Metalarvae)											760							
(Juvenile)												1,230				690		
Brook Stickleback																		
(Metalarvae)							780	2,660										
(Juvenile)									410									
(Adult)	860																	
Carp (Prolarvae)				710	1,240	1,180	6,970	3,110	660					1,550				
(Mesolarvae)							6,970	780	660					520				
(Metalarvae)								780	1,990	410								
(Juvenile)								780	660	410								

Table C1
Entrainment Losses for Pool 1 (cont.)

Species	Total Number Entrained in a 24-hr Period for Sample Dates Between 4/17/80 and 8/14/80																	
	4/17	**4/24**	**5/1**	**5/8**	**5/15**	**5/22**	**5/29**	**6/5**	**6/12**	**6/19**	**6/26**	**7/2**	**7/10**	**7/17**	**7/24**	**7/31**	**8/7**	**8/14**
Catostomidae																		
(Prolarvae)				5,660	620	2,360	1,390				2,290							
(Mesolarvae)				2,120	1,240	4,730	3,480	4,670										
(Metalarvae)								57,620	25,260	2,470								
(Juvenile)								6,230	4,650	410								
Channel Catfish																		
(Prolarvae)											760							
(Mesolarvae)									660		3,060	3,680						
(Metalarvae)										1,240	2,290	34,980	13,500	3,110	1,080			
(Juvenile)																690		
Coregonus sp.																		
(Mesolarvae)	670																	
Cyrpinidae																		
(Prolarvae)					620		2,790	3,110	660	1,650	1,530	2,450	1,840	7,250	3,230	8,290	1,160	320
(Mesolarvae)							3,480	780	3,320	820	1,530	1,230		2,070	2,690	3,460	2,320	320
(Metalarvae)									1,330	410				520		690		320
(Juvenile)																	580	
Emerald Shiner																		
(Juvenile)																	580	
(Adult)																	580	
Fathead Minnow																		
(Adult)	860							780		410					540			
Johnny Darter																		
(Prolarvae)				1,420	1,240	590	2,790											
Logperch (Prolarvae)							700											
(Mesolarvae)						590	700	2,340										
(Metalarvae)						1,180		1,560	3,990	820								
(Juvenile)									660									
Micropterus sp.																		
(Mesolarvae)									660									
Percidae (Prolarvae)		15,240	7,780	1,860	2,950	700	780											
(Mesolarvae)								660										

Table C1
Entrainment Losses for Pool 1 (cont.)

Species	Total Number Entrained in a 24-hr Period for Sample Dates Between 4/17/80 and 8/14/80																	
	4/17	4/24	5/1	5/8	5/15	5/22	5/29	6/5	6/12	6/19	6/26	7/2	7/10	7/17	7/24	7/31	8/7	8/14
Pimephales sp. (Adult)									660									
Pomoxis sp. (Prolarvae)							700											
(Mesolarvae)									660									
(Metalarvae)									660									
Rock Bass (Mesolarvae)								780	1,330	820								
Smallmouth Bass (Prolarvae)							2,790	780										
(Mesolarvae)							1,390	1,560										
(Metalarvae)									2,660									
(Juvenile)										820								
Tadpole Madtom (Metalarvae)										410	760	610						
Trout Perch (Prolarvae)							700											
(Mesolarvae)						1,180												
Walleye (Prolarvae)			480															

Riverside (MN) Generating Plant, 1980 (Heberling et al. 1981)

Species	Total Number Entrained from 4/14/80 to 8/17/80	
	Larvae	**Adults**
Black Crappie	34,440	
Bluegill	38,150	
Brook Stickleback	26,950	6,020

Table C1
Entrainment Losses for Pool 1 (cont.)

Species	**Total Number Entrained from 4/14/80 to 8/17/80**	
	Larvae	**Adults**
Carp	205,660	
Catostomidae	876,440	
Channel Catfish	455,350	
Coregonus sp.	4,690	
Cyprinidae	425,390	
Emerald Shiner	4,060	4,060
Fathead Minnow		18,130
Johnny Darter	42,280	
Logperch	87,780	
Micropterus sp.	4,620	
Percidae	209,790	
Pimephales sp.		4,620
Pomoxis sp.	14,140	
Rock Bass	20,510	
Smallmouth Bass	70,000	
Tadpole Madtom	12,460	
Trout Perch	13,160	

Table C1
Entrainment Losses for Pool 1 (cont.)

Walleye	3,360	

Table C2
Impingement Losses for Pool 1

Riverside (MN) Generating Plant, 1976 (HDR 1977b)	
Species	**Predicted Annual Number Impinged**
Black Crappie	1,060
Carp	248
Channel Catfish	31
Northern Pike	96
River Shiner	184
Smallmouth Bass	11

Table C3 Entrainment Losses for Pool 2												
High Bridge Generating Plant, 1976 (HDR 1977a)												
Species	**Predicted Annual Number Entrained**											
Carp	3,352,761											
Gizzard Shad	24,774,827											
Stizostedion sp.	6,812											
Hastings Hydroelectric Plant, 1993 (Federal Energy Regulatory Commission 1995)												
Species	**Monthly Entrainment Rate (fish/day)**											
	Jan	**Feb**	**Mar**	**April**	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
Channel Catfish						112.8	31.2	<2.4				
Common Carp									12			
Flathead Catfish			117.6									
Freshwater Drum	36		117.6	355.2		112.8	31.2	9.6		12		112.8
Gizzard Shad	69.6		117.6				96	16.8	316.8	190.4	290.4	
Largemouth Bass												
Quillback Carpsucker						112.8		2.4				
Rosyface Shiner						453.6	261.6	84	69.6	26.4		
Spotted Gar						112.8		2.4				
Sucker Species								9.6				
White Bass							31.2	2.4	12	26.4	144	

Table C4
Impingement Losses for Pool 2

High Bridge Generating Plant, 1976 (HDR 1977a)

Species	Predicted Annual Number Impinged
Carp	457
Channel Catfish	163
Gizzard Shad	33,728
Northern Pike	149
Smallmouth Bass	35

High Bridge Generating Plant, 1976-1976 (HDR 1977a)

Species	Total Number Impinged for Sample Dates Between 9/19/74 and 3/22/75									
	9/19/74	9/27/74	10/3/74	10/10/74	10/16/74	2/14/75	2/24/75	2/28/75	3/7/75	3/22/75
Black Bullhead										
Black Crappie										
Bluegill										
Bluntnose Minnow				1						
Carp	1									
Carpsucker			1							
Channel Catfish										
Common Shiner		3								
Gizzard Shad	2	4	2		1	77	32	16	9	2

Table C4
Impingement Losses for Pool 2 (cont.)

Species	Total Number Impinged for Sample Dates Between 9/19/74 and 3/22/75									
	9/19/74	9/27/74	10/3/74	10/10/74	10/16/74	2/14/75	2/24/75	2/28/75	3/7/75	3/22/75
Logperch									1	
Northern Pike										
Sand Shiner	5						2	1		
Smallmouth Bass										
Trout Perch							1			
Unidentified Fish										
Yellow Bullhead										

High Bridge Generating Plant, 1974-1976 (HDR 1977a)

Species	Total Number Impinged for Sample Dates Between 3/27/75 and 7/24/75									
	3/27/75	4/3/75	4/10/75	4/17/75	6/12/75	6/19/75	7/3/75	7/11/75	7/18/75	7/24/75
Black Bullhead						1	1	3		1
Black Crappie	1							1	8	3
Bluegill									1	1
Bluntnose Minnow										
Carp					1		5	9		
Carpsucker									3	1
Channel Catfish										

Table C4
Impingement Losses for Pool 2 (cont.)

Species	Total Number Impinged for Sample Dates Between 3/27/75 and 7/24/75									
	3/27/75	4/3/75	4/10/75	4/17/75	6/12/75	6/19/75	7/3/75	7/11/75	7/18/75	7/24/75
Common Shiner										
Gizzard Shad	15	14	67	8						
Logperch										
Northern Pike									5	
Sand Shiner			6	48						
Smallmouth Bass										
Trout Perch										
Unidentified Fish									1	2
Yellow Bullhead									1	
High Bridge Generating Plant, 1974-1976 (HDR 1977a)										
Species	**Total Number Impinged for Sample Dates Between 7/31/75 and 11/26/75**									
	7/31/75	**8/14/75**	**8/21/75**	**8/28/75**	**9/4/75**	**9/11/75**	**11/6/75**	**11/13/75**	**11/20/75**	**11/26/75**
Black Bullhead	1		1							
Black Crappie	5		14	2		1				3
Bluegill										
Bluntnose Minnow										
Carp					1					

Table C4
Impingement Losses for Pool 2 (cont.)

Species	Total Number Impinged for Sample Dates Between 7/31/75 and 11/26/75									
	7/31/75	8/14/75	8/21/75	8/28/75	9/4/75	9/11/75	11/6/75	11/13/75	11/20/75	11/26/75
Carpsucker	1	1								
Channel Catfish		1	3					1		
Common Shiner	2									
Gizzard Shad			2		2		1	1		12
Logperch										
Northern Pike			1							
Sand Shiner		1	5	2	1	1				
Smallmouth Bass									1	
Trout Perch										
Unidentified Fish										
Yellow Bullhead										

High Bridge Generating Plant, 1974-1976 (HDR 1977a)

Species	Total Number Impinged for Sample Dates Between 12/4/75 and 2/5/76									
	12/4/75	12/11/75	12/18/75	12/20/75	1/2/76	1/8/76	1/15/76	1/22/76	1/29/76	2/5/76
Black Bullhead										
Black Crappie	1		3	2	1					
Bluegill										

Table C4
Impingement Losses for Pool 2 (cont.)

Species	Total Number Impinged for Sample Dates Between 12/4/75 and 2/5/76									
	12/4/75	12/11/75	12/18/75	12/20/75	1/2/76	1/8/76	1/15/76	1/22/76	1/29/76	2/5/76
Bluntnose Minnow										
Carp	2		1							
Carpsucker										
Channel Catfish	1								1	
Common Shiner										
Gizzard Shad	87	21	134	151	37	157	102	36	94	251
Logperch										
Northern Pike										1
Sand Shiner										
Smallmouth Bass										
Trout Perch										
Unidentified Fish										
Yellow Bullhead										

Table C5
Entrainment Losses for Pool 3

Prairie Island Nuclear Generating Plant, 1975 (Adams et al. 1979)	
Species	**Total Number Entrained**
Carp (Postlarvae) (Mesolarvae) (Metalarvae) (Juvenile)	3,787 940,000 20,000 14,000
Freshwater Drum (Postlarvae) (Mesolarvae) (Metalarvae) (Juvenile)	2,141 973,000 54,000 20,000
Gizzard Shad (Postlarvae) (Mesolarvae) (Metalarvae) (Juvenile)	12,449 1,933,000 271,000 67,000
Sauger (Postlarvae) (Mesolarvae)	1,986 386,000
White Bass (Postlarvae) (Mesolarvae) (Metalarvae) (Juvenile)	1,658 2,884,000 1,654,000 32,000
Prairie Island Nuclear Generating Plant, 1975 (Dahlberg et al. 1976)	
Species	**Total Number Entrained**
Bluegill	742,000
Carp	3,257,000
Carpiodes sp.	4,598,000

Table C5
Entrainment Losses for Pool 3 (cont.)

Species	Total Number Entrained
Channel Catfish	325,000
Cyprinidae	1,575,000
Emerald Shiner	15,961,000
Flathead Catfish	16,000
Freshwater Drum (Eggs) (Larvae)	7,484,000 3,408,000
Gizzard Shad	10,370,000
Ictiobus sp.	6,617,000
Johnny Darter	67,000
Lake Whitefish	4,000
Logperch	88,000
Mooneye	1,221,000
Moxostoma sp.	36,000
Northern Pike	4,000
Percidae	956,000
Pomoxis sp.	480,000
Pumpkinseed	122,000
River Darter	1,711,000
Rock Bass	122,000

Table C5
Entrainment Losses for Pool 3 (cont.)

Species	Total Number Entrained
Sauger	1,881,000
Tadpole Madtom	3,000
Trout Perch	25,000
Unidentifiable (Eggs) (Larvae)	887,000 442,000
Walleye	319,000
White Bass	7,297,000
White Sucker	13,000
Yellow Perch	102,000

Table C6
Impingement Losses for Pool 3

Prairie Island Nuclear Generating Plant, 1974 (Dahlberg et al. 1976)	
Species	**Total Number Impinged**
Channel Catfish	637
Crappie	1,704
Drum	3,143
Gizzard Shad	136,667
Sauger	13
Sauger/Walleye	87
Walleye	5
White Bass	1,367
Prairie Island Nuclear Generating Plant, 1975 (Dahlberg et al. 1976)	
Species	**Total Number Impinged**
Channel Catfish	6,223
Crappie	2,030
Drum	3,789
Gizzard Shad	70,506
Sauger/Walleye	197
White Bass	2,712

Table C6
Impingement Losses for Pool 3 (cont.)

Prairie Island Nuclear Generating Plant, 1975 (Dahlberg et al. 1976)

Species	**Total Number Impinged by Season**			
	Winter 1/3/75 to 3/20/75	**Spring 3/20/75 to 6/19/75**	**Summer 6/19/75 to 9/18/75**	**Fall 9/18/75 to 12/31/75**
Bigmouth Buffalo	1	10	10	1
Black Bullhead	6	2,755	20	16
Bluegill	19	58	56	109
Bluegill x Green Sunfish		1		
Bowfin		7	8	2
Brown Bullhead	1	35	1	1
Buffalo Species			1	
Bullhead Species		804	7	
Burbot	1		2	3
Carp	26	119	265	17
Carpsucker/Buffalo			83	
Carpsucker Species	1	26	79	44
Central Mudminnow		6	2	
Channel Catfish	99	154	975	4,995
Chestnut Lamprey	1	3		4
Crappie Species	31	486	1,171	342

Table C6
Impingement Losses for Pool 3 (cont.)

Species	Total Number Impinged by Season			
	Winter 1/3/75 to 3/20/75	Spring 3/20/75 to 6/19/75	Summer 6/19/75 to 9/18/75	Fall 9/18/75 to 12/31/75
Flathead Catfish	1	4	71	14
Freshwater Drum	373	408	557	2,451
Gar Species			1	1
Gizzard Shad	20,912	2,378	4,965	42,251
Goldeye		3		2
Goldeye/Mooneye			1	
Green Sunfish	6	52	7	46
Johnny Darter		1	1	
Lamprey Species		2		1
Logperch	3	4	2	6
Longnose Gar			8	8
Minnow Species	39	473	647	1,072
Mooneye	1	23	1	1
Northern Pike	1	17	91	1
Rock Bass	1	45	15	15
Sauger	1	59	3	34
Sauger/Walleye	2	22	33	16

Table C6
Impingement Losses for Pool 3 (cont.)

Species	Total Number Impinged by Season			
	Winter 1/3/75 to 3/20/75	Spring 3/20/75 to 6/19/75	Summer 6/19/75 to 9/18/75	Fall 9/18/75 to 12/31/75
Shorthead Redhorse	2	16	12	4
Shortnose Gar		6	3	3
Silver Chub	6	125	92	36
Silver Lamprey		28		8
Smallmouth Bass	1			
Smallmouth Buffalo	3	3	3	2
Tadpole Madtom	4	11	13	5
Trout Perch	2	39	3	1
Undetermined Centrarchid				6
Undetermined Fish	28	16	78	38
Undetermined Ictalurids		4		8
Walleye		11	2	14
White Bass	225	323	1,343	821
White Sucker		14	1	
Yellow Bullhead		4		
Yellow Perch	1	77	1	2

Table C6
Impingement Losses for Pool 3 (cont.)

Prairie Island Nuclear Generating Plant, 1975 (Adams et al. 1979)

Species	Estimated Total Number Impinged
Carp	427
Channel Catfish	6,223
Freshwater Drum	3,789
Gizzard Shad	70,506
Sauger	97
White Bass	2,712

Prairie Island Nuclear Generating Plant, 1984 (Giese & Mueller 1996)

Species	Estimated Total Number Impinged					
	4/16/84	4/18/84	4/23/84	4/25/84	4/27/84	4/30/84
Carp (Postlarvae)		384				
Channel Catfish (Juvenile)				384	384	384
Cyprinids (excluding Carp)						
(Postlarvae)				384		
(Juvenile)					384	
(Adult)						384
Flathead Catfish (Juvenile)						192
Percids (excluding Walleye and Sauger) (Prolarvae)						1,152
Unidentified (Egg)	384		3,840	3,840	2,304	4,416

Table C6
Impingement Losses for Pool 3 (cont.)

Species	Estimated Total Number Impinged					
	4/16/84	**4/18/84**	**4/23/84**	**4/25/84**	**4/27/84**	**4/30/84**
Walleye (Prolarvae)						768

Prairie Island Nuclear Generating Plant, 1985 (Giese & Mueller 1996)

Species	Estimated Total Number Impinged						
	4/19/85	**4/22/85**	**4/23/85**	**4/24/85**	**4/25/85**	**4/26/85**	**4/29/85**
Bullhead Species (Juvenile)	384						
Burbot (Postlarvae)							96
Carp (Prolarvae)							192
Catostomids (Prolarvae)							288
Percids (excluding Walleye and Sauger) (Prolarvae)		1,152		576	192		192
Sauger (Prolarvae)				1,344	1,536	192	
Stizostedion sp. (Prolarvae)					384	192	
Unidentified (Egg)			192	384			
Walleye (Prolarvae)				1,536	576		

Prairie Island Nuclear Generating Plant, 1986 (Giese & Mueller 1996)

Species	Estimated Total Number Impinged					
	4/18/86	**4/23/86**	**4/24/86**	**4/25/86**	**4/28/86**	**4/29/86**
Carp (Prolarvae)	288					

Table C6
Impingement Losses for Pool 3 (cont.)

Species	**Estimated Total Number Impinged**					
	4/18/86	**4/23/86**	**4/24/86**	**4/25/86**	**4/28/86**	**4/29/86**
Cyprinids (excluding Carp)						
(Prolarvae)	288					
(Postlarvae)		288				
(Juvenile)				288		
Percids (excluding Walleye and Sauger) (Unidentified)			1,728			
(Prolarvae)		288				864
Unidentified (Egg)				480		288
Walleye (Prolarvae)						288

Prairie Island Nuclear Generating Plant, 1987 (Giese & Mueller 1996)

Species	**Estimated Total Number Impinged**							
	4/6/87	**4/8/87**	**4/10/87**	**4/13/87**	**4/15/87**	**4/16/87**	**4/27/87**	**4/29/87**
Burbot (Prolarvae)	1,536		2,304	2,304	3,456	576		
Carp (Prolarvae)		576						
Percids (excluding Walleye and Sauger) (Prolarvae)							576	
Sauger (Prolarvae)							576	
(Postlarvae)								2,880
Walleye (Prolarvae)								576

Table C6
Impingement Losses for Pool 3 (cont.)

Prairie Island Nuclear Generating Plant, 1988 (Kuhl & Mueller 1988)

Species	**Estimated Total Number Impinged**
Burbot (Postlarvae) (Prolarvae)	3,136 19,936
Carp (Postlarvae) (Prolarvae)	552,608 536,032
Catostomidae (Juvenile) (Postlarvae) (Prolarvae)	1,344 15,232 145,600
Centrarchidae (Postlarvae) (Prolarvae)	8,736 9,408
Channel Catfish (Juvenile) (Prolarvae)	110,656 18,816
Coregonus sp. (Postlarvae)	448
Cyprinidae (Adult) (Juvenile) (Postlarvae) (Prolarvae)	315,840 6,028,512 7,789,600 525,504
Flathead Catfish (Juvenile)	2,688
Freshwater Drum (Egg) (Juvenile) (Postlarvae) (Prolarvae)	9,782,976 331,968 3,525,984 28,620,928

Table C6
Impingement Losses for Pool 3 (cont.)

Species	Estimated Total Number Impinged
Gizzard Shad (Juvenile) (Postlarvae) (Prolarvae)	5,376 2,464,448 913,024
Lepomis sp. (Juvenile) (Postlarvae) (Prolarvae)	77,952 857,472 370,944
Mooneye (Prolarvae)	448
Percidae (Juvenile) (Postlarvae) (Prolarvae)	4,032 17,472 41,440
Pomoxis sp. (Postlarvae) (Prolarvae)	61,824 2,912
Sauger (Postlarvae) (Prolarvae)	4,480 16,128
Tadpole Madtom (Prolarvae)	1,344
Walleye (Prolarvae)	2,688
White Bass (Juvenile) (Postlarvae) (Prolarvae)	5,376 637,952 478,912

Table C6
Impingement Losses for Pool 3 (cont.)

Prairie Island Nuclear Generating Plant, 1988 (Giese & Mueller 1996)

Species	Estimated Total Number Impinged							
	4/8/88	4/13/88	4/15/88	4/20/88	4/22/88	4/25/88	4/27/88	4/28/88
Burbot (Prolarvae)	768		768	768	1,920	1,152	1,152	384
Unidentified (Egg)		384						

Prairie Island Nuclear Generating Plant, 1989 (Giese & Mueller 1996)

Species	Estimated Total Number Impinged		
	4/6/89	4/13/89	4/27/89
Burbot (Prolarvae)		384	1,152
Cyprinids (excluding Carp) (Adult)		384	
Percids (excluding Walleye and Sauger) (Adults)	384		

Prairie Island Nuclear Generating Plant, 1992 (Giese & Mueller 1996)

Species	Estimated Total Number Impinged		
	4/1/92	4/21/92	4/30/92
Burbot (Prolarvae)		576	
Carp (Postlarvae)	576		
Channel Catfish (Juvenile)			288

Table C6
Impingement Losses for Pool 3 (cont.)

Species	Estimated Total Number Impinged		
	4/1/92	**4/21/92**	**4/30/92**
Cyprinids (excluding Carp) (Prolarvae) (Postlarvae)	 288 288		
Percids (excluding Walleye and Sauger) (Adults)			288

Prairie Island Nuclear Generating Plant, 1993 (Giese & Mueller 1996)

Species	Estimated Total Number Impinged				
	4/6/93	**4/8/93**	**4/15/93**	**4/19/93**	**4/29/93**
Burbot (Prolarvae)	288	288	288		
Unidentified (Egg)		288		1,152	288

Prairie Island Nuclear Generating Plant, 1994 (Giese & Mueller 1996)

Species	Estimated Total Number Impinged					
	4/5/94	**4/7/94**	**4/12/94**	**4/19/94**	**4/26/94**	**4/28/94**
Burbot (Prolarvae)	288	288			288	288
Carp (Prolarvae)	288		288		1,152	
Channel Catfish (Juvenile)	288					
Cyprinids (excluding Carp) (Juvenile)				288		
Sauger (Prolarvae)			288			288

Table C6
Impingement Losses for Pool 3 (cont.)

Species	Estimated Total Number Impinged					
	4/5/94	**4/7/94**	**4/12/94**	**4/19/94**	**4/26/94**	**4/28/94**
Unidentified (Egg)	576					

Prairie Island Nuclear Generating Plant, 1995 (Giese & Mueller 1996)

Species	Estimated Total Number Impinged						
	4/3/95	**4/4/95**	**4/10/95**	**4/17/95**	**4/20/95**	**4/24/95**	**4/26/95**
Burbot (Prolarvae)		288					
Catostomids (Prolarvae)	288		288				
(Juvenile)		576					
Channel Catfish (Juvenile)		576					
Freshwater Drum (Juvenile)		9,792					
Gizzard Shad (Juvenile)		1,152					
Unidentified (Egg)				13,248	2,880	1,152	864
White Bass (Juvenile)		1,152					

Prairie Island Nuclear Generating Plant, 1996 (Giese & Mueller 1996)

Species	Estimated Total Number Impinged					
	4/2/96	**4/4/96**	**4/9/96**	**4/11/96**	**4/23/96**	**4/25/96**
Burbot (Prolarvae)				252		504
Carp (Prolarvae)	252			252		
Emerald Shiner (Juvenile)				504	504	

Table C6
Impingement Losses for Pool 3 (cont.)

Species	Estimated Total Number Impinged					
	4/2/96	4/4/96	4/9/96	4/11/96	4/23/96	4/25/96
Freshwater Drum (Juvenile)				252		
Johnny Darter (Adult)			252			
Shiner (Juvenile)			252			
Unidentified (Egg)		504	252		1,008	

Table C7
Entrainment Losses for Pool 4

Species	Estimated Total Number Entrained
Red Wing Generating Plant, 1975 (NUS Corporation 1975)	
Species	**Estimated Total Number Entrained** (based on sampling from Stations 1, 2, 3, and 4)
Lake Sturgeon, Mooneye, Various Sucker Species, Sauger, Walleye	133,000 (May)
Lake Sturgeon, Gizzard Shad, Mooneye, Carp, Various Minnow and Sucker Species, White Bass, Bluegill, Black Crappie, Sauger, Walleye, Freshwater Drum	1,157,000 (June)
Gizzard Shad, Carp, Various Minnow and Sucker Species, White Bass, Black Crappie, Green Sunfish, Other Sunfish Species, Sauger, Walleye, Freshwater Drum	12,492,000 (July)
Gizzard Shad, Carp, Various Minnow Species, White Bass, Bluegill, Black Crappie, Other Sunfish Species, Freshwater Drum	4,146,000 (August)
Lake Sturgeon, Gizzard Shad, Mooneye, Carp, Various Minnow and Sucker Species, White Bass, Bluegill, Black Crappie, Green Sunfish, Other Sunfish Species, Sauger, Walleye, Freshwater Drum	16,780,000 (Total)
Red Wing Generating Plant, 1975 (NUS Corporation 1975)	
Species	**Estimated Total Number Entrained** (based on sampling from Station 4)
Lake Sturgeon, Mooneye, Various Sucker Species, Sauger, Walleye	192,000 (May)

Table C7 **Entrainment Losses for Pool 4 (cont.)**	
Species	**Estimated Total Number Entrained** (based on sampling from Station 4)
Lake Sturgeon, Gizzard Shad, Mooneye, Carp, Various Minnow and Sucker Species, White Bass, Bluegill, Black Crappie, Sauger, Walleye, Freshwater Drum	64,000 (June)
Gizzard Shad, Carp, Various Minnow and Sucker Species, White Bass, Black Crappie, Green Sunfish, Other Sunfish Species, Sauger, Walleye, Freshwater Drum	655,000 (July)
Gizzard Shad, Carp, Various Minnow Species, White Bass, Bluegill, Black Crappie, Other Sunfish Species, Freshwater Drum	81,000 (August)
Lake Sturgeon, Gizzard Shad, Mooneye, Carp, Various Minnow and Sucker Species, White Bass, Bluegill, Black Crappie, Green Sunfish, Other Sunfish Species, Sauger, Walleye, Freshwater Drum	914,000 (Total)

Table C8
Impingement Losses for Pool 4

Red Wing Generating Plant, 1975 (NUS Corporation 1975)

Species	Total Number Impinged				
	1/10/75	1/17/75	1/24/75	2/28/75	5/23/75
Gizzard Shad	1	1	6	2	
Longnose Gar					1

Red Wing Generating Plant, 1974-1975 (NUS Corporation 1975)

Species	Estimated Total Number Impinged											
	Sept	Oct	Nov	Dec	Jan	Feb	Mar	April	May	June	July	Aug
Gizzard Shad	0 - 9.193	0 - 14.306	0 - 13.144	0 - 12.145	32.847 - 98.232	2.971 - 33.381	0 - 15.566	0 - 8.053	0 - 5.600	0 - 13.393	0 - 14.628	0 - 6.674
Longnose Gar	0 - 9.193	0 - 14.306	0 - 13.144	0 - 12.145	0 - 17.656	0 - 13.607	0 - 15.566	0 - 8.053	0.241 - 10.419	0 - 13.393	0 - 14.628	0 - 6.674

Table C9
Entrainment Losses for Pool 5

John P. Madgett Station, 1981 (Kowalski et al. 1983)

Species	**Total Number Entrained per 24-hr. for Sample Dates Between 3/10/81 and 9/2/81**														
	3/10	**3/25**	**5/12**	**5/22**	**6/4**	**6/11**	**6/25**	**7/2**	**7/9**	**7/23**	**8/6**	**8/13**	**8/20**	**8/27**	**9/2**
Black Crappie											1				
Bullhead Minnow (Adult)	1														
Burbot			1												
Catostomids				10											
Common Carp							1								
Cyprinids (Other)							1	3							
Emerald Shiner					30		25			6	7	27	4	2	1
Freshwater Drum					1	72	14	10	26	4	1				
Gizzard Shad					11	118	19	4	8	16	2		1		
Logperch (Adult)		1													
Mooneye				6											
Spotfin Shiner	1														2
White Bass						47		2							

Table C9
Entrainment Losses for Pool 5 (cont.)

John P. Madgett Station, 1981 (Kowalski et al. 1983)

Species	Projected Daily Entrainment for Dates Between 3/10/81 and 9/2/81														
	3/10	3/25	5/12	5/22	6/4	6/11	6/25	7/2	7/9	7/23	8/6	8/13	8/20	8/27	9/2
Black Crappie											2,442				
Bullhead Minnow (Adult)	2,076														
Burbot			2,442												
Catostomids				19,536											
Common Carp							2,442								
Cyprinids (Other)							2,442	7,325							
Emerald Shiner					73,253		2,442			14,651	17,092	65,928	9,767	4,884	2,442
Freshwater Drum					2,442	175,808	34,185	24,418	63,486	9,767	2,442				
Gizzard Shad					26,860	288,130	46,394	9,767	19,534	39,068	4,884		2,442		
Logperch (Adult)		2,076													
Mooneye				14,651											
Spotfin Shiner	2,076														4,884
White Bass						114,764		4,884							

Table C9
Entrainment Losses for Pool 5 (cont.)

John P. Madgett Station, 1982 (Kowalski et al. 1984)

Species	**Total Number Entrained per 24-hr. for Sample Dates Between 5/13/82 and 9/2/82**														
	5/13	**5/21**	**6/4**	**6/10**	**6/17**	**6/24**	**7/1**	**7/15**	**7/22**	**7/29**	**8/5**	**8/12**	**8/19**	**8/26**	**9/2**
Catostomids	2	13	4	3		5	1								
Common Carp		20		3				1							
Cyprinids (Other)						6	1	1							
Emerald Shiner									6	3	20	57	19	10	2
Flathead Catfish									1						
Freshwater Drum			1	12	13	177	28	232	13	3			1		
Gizzard Shad		1	5	75	7	88	2	85	6			2			
Ichthyomyzon sp.										1					
Lepomis sp.						1			1						
Micropterus sp.		2													
Mooneye	1														
Percids	7	47						1							
Pomoxis sp.		1													
River Shiner (Adult)								1							
Tadpole Madtom										1					
White Bass		339	13	24	4	2									

Table C9
Entrainment Losses for Pool 5 (cont.)

John P. Madgett Station, 1982 (Kowalski et al. 1984)

Species	Projected Daily Entrainment for Dates Between 5/13/82 and 9/2/82														
	5/13	5/21	6/4	6/10	6/17	6/24	7/1	7/15	7/22	7/29	8/5	8/12	8/19	8/26	9/2
Catostomids	4,884	31,746	9,768	7,326		12,210	2,442								
Common Carp		48,841		7,326				2,442							
Cyprinids (Other)						14,652	2,442	2,442							
Emerald Shiner									14,652	7,326	48,841	139,196	46,399	24,420	4,884
Flathead Catfish									2,442						
Freshwater Drum			2,442	29,304	31,746	432,241	68,377	566,553	31,746	7,326			2,442		
Gizzard Shad		2,442	12,210	183,153	17,094	214,899	4,884	207,573	14,652			4,884			
Ichthyomyzon sp.										2,442					
Lepomis sp.						2,442			2,442						
Micropterus sp.		4,884													
Mooneye	2,442														
Percids	17,094	114,776						2,442							
Pomoxis sp.		2,442													
River Shiner (Adult)								2,442							
Tadpole Madtom										2,442					
White Bass		829,072	31,746	58,609	9,768	4,884									

Table C9
Entrainment Losses for Pool 5 (cont.)

John P. Madgett Station, 1982 (Kowalski et al. 1984)

Species	Projected Annual Entrainment	Actual Annual Number Entrained
Catostomids	478,632	28
Common Carp	410,263	24
Cyprinids (Other)	136,752	8
Emerald Shiner	2,000,026	117
Flathead Catfish	17,094	1
Freshwater Drum	8,205,239	480
Gizzard Shad	4,632,537	271
Ichthyomyzon sp.	17,094	1
Lepomis sp.	34,188	2
Micropterus sp.	34,188	2
Mooneye	17,094	1
Percids	940,184	55
Pomoxis sp.	17,094	1
River Shiner (Adult)	17,094	1
Tadpole Madtom	17,094	1
White Bass	6,538,553	382

Table C10
Impingement Losses for Pool 5

John P. Madgett Station, 1981 (Kowalski et al. 1983)	
Species	**Total Number Impinged**
Black Bullhead	2
Black Crappie	20
Bluegill	121
Burbot	1
Channel Catfish	39
Chestnut Lamprey	1
Common Carp	31
Emerald Shiner	3
Fathead Minnow	3
Flathead Catfish	106
Freshwater Drum	156
Gizzard Shad	1,895
Johnny Darter	1
Largemouth Bass	6
Logperch	775
Mud Darter	3
River Darter	7

Table C10
Impingement Losses for Pool 5 (cont.)

Species	Total Number Impinged
River Shiner	1
Rock Bass	4
Sauger	4
Shorthead Redhorse	14
Shortnose Gar	1
Silver Redhorse	2
Spotfin Shiner	2
Spottail Shiner	9
Tadpole Madtom	1
Trout Perch	16
Walleye	5
White Bass	35
White Crappie	4
White Sucker	3
Yellow Bullhead	3
Yellow Perch	576

Table C10
Impingement Losses for Pool 5 (cont.)

John P. Madgett Station, 1982 (Kowalski et al. 1984)

Species	Total Number Impinged
Black Bullhead	6
Black Crappie	14
Bluegill	44
Bullhead Minnow	1
Central Mudminnow	1
Channel Catfish	15
Emerald Shiner	5
Fathead Minnow	3
Flathead Catfish	62
Freshwater Drum	37
Gizzard Shad	965
Green Sunfish	1
Largemouth Bass	7
Logperch	1
Northern Pike	1
Quillback	1
River Shiner	1

Table C10
Impingement Losses for Pool 5 (cont.)

Species	Total Number Impinged
Rock Bass	9
Shorthead Redhorse	29
Silver Lamprey	1
Silver Redhorse	1
Spottail Shiner	11
Spotted Sucker	5
Tadpole Madtom	1
Trout Perch	10
White Bass	8
White Sucker	2
Yellow Bullhead	2
Yellow Perch	72

Table C11
Entrainment Losses for Pool 9

Genoa #3, 1979 and 1980 (McInerny 1980)

Species	Estimated Total Number Entrained	
	1979	1980
Catostomidae	300,000	80,000
Cyprinidae	300,000	700,000
Dorosoma sp.	200,000	30,000
Freshwater Drum	5,000,000	200,000
Hiodon sp.	80,000	0
Morone sp.	1,000,000	600,000
Pomoxis sp.	200,000	0
Stizostedion sp.	0	500,000
Total Eggs	0	0
Total Larval Fish	9,000,000	2,000,000

Genoa #3, 1982 (Kowalski et al. 1984)

Species	Projected Annual Number Entrained
Bluegill	372,365
Bullhead Minnow	167,874
Common Carp	1,263,276
Eggs	13,991,649

Table C11
Entrainment Losses for Pool 9 (cont.)

Species	Projected Annual Number Entrained
Emerald Shiner	857,850
Freshwater Drum	4,066,349
Gizzard Shad	2,638,447
Lepomis sp.	201,586
Mooneye	85,141
Other Catostomids	336,889
Other Cyprinids	2,447,578
Other Percids	135,618
Quillback	17,171
Redhorse or Sucker	39,158
River Shiner	90,293
Rock Bass	21,364
Spotfin Shiner	111,405
Spottail Shiner	19,838
Stizostedion sp.	91,777
Tadpole Madtom	102,242
Unidentifiable Fish	139,496
Western Sand Darter	39,158

Table C11
Entrainment Losses for Pool 9 (cont.)

Species	Projected Annual Number Entrained
White Bass	4,017,930
Yellow Perch	19,320

Genoa #3, 1982 (Kowalski et al. 1984)

Species	Total Number Entrained per 24-hr. for Sample Dates Between 4/6/82 and 8/3/82														
	4/6	4/13	5/11	5/18	5/25	6/2	6/8	6/15	6/22	6/29	7/7	7/13	7/20	7/27	8/3
Bluegill															
Bullhead Minnow															
Common Carp					2	1	1	1		16	8	9	5	29	
Eggs										557	450			3	
Emerald Shiner	3	1								1			28	4	1
Freshwater Drum								6		71	48	81	36	6	
Gizzard Shad						8	1	10	2	125	10	3	9		1
Lepomis sp.							5		2			1	1	1	1
Mooneye					1	2	2								
Other Catostomids						17	3								
Other Cyprinids					1			1		23	4	11	25	11	15
Other Percids					3	2			1		1	1			
Quillback								1							
Redhorse or Sucker			1						1						

Table C11
Entrainment Losses for Pool 9 (cont.)

Species	**Total Number Entrained per 24-hr. for Sample Dates Between 4/6/82 and 8/3/82**														
	4/6	**4/13**	**5/11**	**5/18**	**5/25**	**6/2**	**6/8**	**6/15**	**6/22**	**6/29**	**7/7**	**7/13**	**7/20**	**7/27**	**8/3**
River Shiner							1	1			1				
Rock Bass															1
Spotfin Shiner															
Spottail Shiner									1						
Stizostedion sp.			5												
Tadpole Madtom													2	1	
Unidentifiable Fish										3		1		4	
Western Sand Darter												1	1		
White Bass					45	97	32	53	8	8			1		
Yellow Perch				1											

Genoa #3, 1982 (Kowalski et al. 1984)

Species	**Total Number Entrained per 24-hr. for Sample Dates Between 8/10/82 and 12/21/82**													
	8/10	**8/17**	**8/24**	**8/31**	**9/8**	**9/15**	**9/21**	**10/26**	**11/2**	**11/12**	**11/16**	**11/23**	**11/30**	**12/21**
Bluegill	2							1		12		1		
Bullhead Minnow						3	4							2
Common Carp	1													
Eggs														
Emerald Shiner	4			1		1	2						1	

Table C11
Entrainment Losses for Pool 9 (cont.)

Species	Total Number Entrained per 24-hr. for Sample Dates Between 8/10/82 and 12/21/82													
	8/10	8/17	8/24	8/31	9/8	9/15	9/21	10/26	11/2	11/12	11/16	11/23	11/30	12/21
Freshwater Drum														
Gizzard Shad									1		1			
Lepomis sp.														
Mooneye														
Other Catostomids														
Other Cyprinids	14	15	9		1	1								
Other Percids														
Quillback														
Redhorse or Sucker														
River Shiner	1	1												
Rock Bass														
Spotfin Shiner	3	1								1				
Spottail Shiner														
Stizostedion sp.														
Tadpole Madtom	1		1											
Unidentifiable Fish														
Western Sand Darter														
White Bass														

Table C11
Entrainment Losses for Pool 9 (cont.)

Species	Total Number Entrained per 24-hr. for Sample Dates Between 8/10/82 and 12/21/82													
	8/10	8/17	8/24	8/31	9/8	9/15	9/21	10/26	11/2	11/12	11/16	11/23	11/30	12/21
Yellow Perch														

Genoa #3, 1982 (Kowalski et al. 1984)

Species	Projected Daily Entrainment for Sample Dates Between 4/6/82 and 8/3/82														
	4/6	4/13	5/11	5/18	5/25	6/2	6/8	6/15	6/22	6/29	7/7	7/13	7/20	7/27	8/3
Bluegill															
Bullhead Minnow															
Common Carp					4,633	2,471	2,453	2,453		33,792	14,643	24,151	13,462	79,358	
Eggs										1,170,746	819,558			8,503	
Emerald Shiner	1,962	2,760								2,180			76,524	10,628	3,052
Freshwater Drum								14,103		149,341	87,388	215,289	98,489	16,297	
Gizzard Shad						19,149	2,453	23,914	5,668	262,709	18,422	8,280	24,799		3,052
Lepomis sp.							11,650		5,668			2,760	2,834	2,834	3,052
Mooneye					2,316	4,942	4,905								
Other Catostomids						40,769	7,358								
Other Cyprinids					2,316			2,453		48,509	7,085	28,981	68,021	29,759	44,257
Other Percids					6,949	4,942			2,834		1,889	2,760			
Quillback								2,453							
Redhorse or Sucker			2,760						2,834						

Table C11
Entrainment Losses for Pool 9 (cont.)

Species	Projected Daily Entrainment for Sample Dates Between 4/6/82 and 8/3/82														
	4/6	4/13	5/11	5/18	5/25	6/2	6/8	6/15	6/22	6/29	7/7	7/13	7/20	7/27	8/3
River Shiner							2,453	2,453			1,889				
Rock Bass															3,052
Spotfin Shiner															
Spottail Shiner									2,834						
Stizostedion sp.			13,111												
Tadpole Madtom													5,668	2,834	
Unidentifiable Fish										6,540		2,760		10,628	
Western Sand Darter												2,760	2,834		
White Bass					100,764	231,024	75,420	125,087	21,965	16,896			2,834		
Yellow Perch				2,760											

Genoa #3, 1982 (Kowalski et al. 1984)

Species	Projected Daily Entrainment for Sample Dates Between 8/10/82 and 12/21/82													
	8/10	8/17	8/24	8/31	9/8	9/15	9/21	10/26	11/2	11/12	11/16	11/23	11/30	12/21
Bluegill	6,104							3,185		42,622		654		
Bullhead Minnow						9,157	11,446							3,379
Common Carp	3,502													
Eggs														
Emerald Shiner	11,446			3,052		3,052	6,104						1,790	

Table C11
Entrainment Losses for Pool 9 (cont.)

Species	Projected Daily Entrainment for Sample Dates Between 8/10/82 and 12/21/82													
	8/10	8/17	8/24	8/31	9/8	9/15	9/21	10/26	11/2	11/12	11/16	11/23	11/30	12/21
Freshwater Drum														
Gizzard Shad									4,360		4,115			
Lepomis sp.														
Mooneye														
Other Catostomids														
Other Cyprinids	41,205	44,257	26,707		3,052	3,052								
Other Percids														
Quillback														
Redhorse or Sucker														
River Shiner	3,052	3,052												
Rock Bass														
Spotfin Shiner	9,157	3,052								3,706				
Spottail Shiner														
Stizostedion sp.														
Tadpole Madtom	3,052		3,052											
Unidentifiable Fish														
Western Sand Darter														
White Bass														

Table C11
Entrainment Losses for Pool 9 (cont.)

Species	Projected Daily Entrainment for Sample Dates Between 8/10/82 and 12/21/82													
	8/10	8/17	8/24	8/31	9/8	9/15	9/21	10/26	11/2	11/12	11/16	11/23	11/30	12/21
Yellow Perch														

Table C12
Impingement Losses for Pool 9

Genoa #3, 1978-1980 (McInerny 1980)

Species	**Estimated Total Number Impinged**		
	1978-1979	**1979-1980**	**1978-1980**
Black Crappie	748	2,784	3,360
Bluegill	1,170	14,225	15,375
Channel Catfish	526	4,674	5,136
Emerald Shiner	34	702	728
Flathead Catfish	288	1,414	1,632
Freshwater Drum	4,514	8,732	12,619
Gizzard Shad	454	5,686	5,872
Logperch	206	470	650
Mooneye	216	456	482
Others	152	1,849	1,890
River Darter	143	268	372
Rock Bass	121	182	289
Sauger	110	264	374
Shorthead Redhorse	149	227	372
Silver Chub	83	591	674
Spottail Shiner	390	571	788

Table C12
Impingement Losses for Pool 9 (cont.)

Species	Estimated Total Number Impinged		
	1978-1979	**1979-1980**	**1978-1980**
Tadpole Madtom	27	246	270
Walleye	64	214	265
White Bass	178	2,007	2,084
Yellow Perch	793	324	1,117

Table C13
Entrainment Losses for Pool 14

Quad Cities Station, 1984 and 1985 (LMSE 1985, 1986)

Species	Total Number Entrained	
	1984	1985
Buffalo Species	49	24
Bullhead-Fathead Minnows		14
Carp	115	69
Carpsuckers	10	6
Crappies	8	3
Darter	2	
Emerald Shiner	1,547	1,081
Freshwater Drum	1,571	405
Gizzard Shad	59	25
Johnny Darter		1
Minnows	100	157
Mooneye	54	30
Other Buffalo		11
Sauger	7	1
Sauger-Walleye	1	8
Suckers	8	1

Table C13
Entrainment Losses for Pool 14 (cont.)

Species	Total Number Entrained	
	1984	1985
Sunfishes	16	19
White Bass	29	12
Yellow Perch	40	54

Table C14
Impingement Losses for Pool 14

Quad Cities Station, 1973 (LMSE 1995, LMSE 1996a)

Species	Estimated Number Impinged
Freshwater Drum	131,000
Gizzard Shad	984,000
Other Species	255,000

Quad Cities Station, 1973 (LMSE 1996b, LMSE 1997b)

Species	Estimated Number Impinged											
	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Freshwater Drum	727	1,706	3,679	11,362	2,748	466	6,303	25,131	2,909	82,188	1,186	1,132

Quad Cities Station, 1974 (LMSE 1995, LMSE 1996a)

Species	Estimated Number Impinged
Freshwater Drum	110,000
Gizzard Shad	231,000
Other Species	24,000

Quad Cities Station, 1974 (LMSE 1996b, LMSE 1997b)

Species	Estimated Number Impinged											
	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Freshwater Drum	1,052	3,985	13,466	21,540	7,373	891	19,758	4,397	4,466	24,358	5,485	909

Table C14
Impingement Losses for Pool 14 (cont.)

Quad Cities Station, 1975 (LMSE 1995, LMSE 1996a)

Species	Estimated Number Impinged
Freshwater Drum	24,000
Gizzard Shad	198,000
Other Species	10,000

Quad Cities Station, 1975 (LMSE 1996b, LMSE 1997b)

Species	Estimated Number Impinged											
	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Freshwater Drum	1,453	3,423	2,917	9,125	2,442	348	2,752	248	276	1,864	2,863	925

Quad Cities Station, 1976 (LMSE 1995, LMSE 1996a)

Species	Estimated Number Impinged
Freshwater Drum	31,000
Gizzard Shad	260,000
Other Species	7,000

Quad Cities Station, 1976 (LMSE 1996b, LMSE 1997b)

Species	Estimated Number Impinged											
	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Freshwater Drum	17	228	975	788	335	35	3,363	1,797	1,625	494	16,173	1,001

Table C14
Impingement Losses for Pool 14 (cont.)

Quad Cities Station, 1977 (LMSE 1995, LMSE 1996a)

Species	Estimated Number Impinged
Freshwater Drum	63,000
Gizzard Shad	489,000
Other Species	28,000

Quad Cities Station, 1977 (LMSE 1996b, LMSE 1997b)

Species	Estimated Number Impinged											
	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Freshwater Drum	2,446	9,787	6,090	1,864	747	143	20,210	660	1,185	2,993	2,003	1,489

Quad Cities Station, 1978 (LMSE 1995, LMSE 1996a)

Species	Estimated Number Impinged
Freshwater Drum	67,000
Gizzard Shad	275,000
Other Species	41,000

Quad Cities Station, 1978 (LMSE 1996b, LMSE 1997b)

Species	Estimated Number Impinged											
	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Freshwater Drum	1,798	5,012	9,544	16,432	2,180	123	7,133	386	4,763	2,071	6,515	2,312

Table C14
Impingement Losses for Pool 14 (cont.)

Quad Cities Station, 1979 (LMSE 1995, LMSE 1996a)												
Species	**Estimated Number Impinged**											
Freshwater Drum	21,000											
Gizzard Shad	35,000											
Other Species	14,000											
Quad Cities Station, 1979 (LMSE 1996b, LMSE 1997b)												
Species	**Estimated Number Impinged**											
	Jan	**Feb**	**March**	**April**	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
Freshwater Drum	187	648	1,105	1,784	1,048	47	395	822	325	4,049	3,739	1,878
Quad Cities Station, 1980 (LMSE 1995, LMSE 1996a)												
Species	**Estimated Number Impinged**											
Freshwater Drum	23,000											
Gizzard Shad	75,000											
Other Species	7,000											
Quad Cities Station, 1980 (LMSE 1996b, LMSE 1997b)												
Species	**Estimated Number Impinged**											
	Jan	**Feb**	**March**	**April**	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
Freshwater Drum	855	1,898	3,862	3,096	1,532	679	12	2,034	880	1,161	1,298	1,442

Table C14
Impingement Losses for Pool 14 (cont.)

Quad Cities Station, 1981 (LMSE 1995, LMSE 1996a)

Species	Estimated Number Impinged
Freshwater Drum	8,000
Gizzard Shad	46,000
Other Species	5,000

Quad Cities Station, 1981 (LMSE 1996b, LMSE 1997b)

Species	Estimated Number Impinged											
	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Freshwater Drum	853	769	672	981	1,004	394	1,571	539	5,667	2,274	129	56

Quad Cities Station, 1982 (LMSE 1995, LMSE 1996a)

Species	Estimated Number Impinged
Freshwater Drum	8,000
Gizzard Shad	49,000
Other Species	7,000

Quad Cities Station, 1982 (LMSE 1996b, LMSE 1997b)

Species	Estimated Number Impinged											
	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Freshwater Drum	443	192	331	374	593	90	16	54	188	742	1,026	901

Table C14
Impingement Losses for Pool 14 (cont.)

Quad Cities Station, 1983 (LMSE 1995, LMSE 1996a)

Species	Estimated Number Impinged
Freshwater Drum	33,000
Gizzard Shad	81,000
Other Species	9,000

Quad Cities Station, 1983 (LMSE 1996b, LMSE 1997b)

Species	Estimated Number Impinged											
	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Freshwater Drum	43	56	3,974	2,321	5,324	713	645	124	113	1,320	666	487

Quad Cities Station, 1984 (LMSE 1995, LMSE 1996a)

Species	Estimated Number Impinged
Freshwater Drum	112,000
Gizzard Shad	453,000
Other Species	36,000

Quad Cities Station, 1984 (LMSE 1996b, LMSE 1997b)

Species	Estimated Number Impinged											
	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Freshwater Drum	2,052	14,599	4,917	6,870	6,718	1,568	610	673	2,726	28,109	26,913	5,384

Table C14
Impingement Losses for Pool 14 (cont.)

Quad Cities Station, 1985 (LMSE 1995, LMSE 1996a)

Species	Estimated Number Impinged
Freshwater Drum	57,000
Gizzard Shad	163,000
Other Species	32,000

Quad Cities Station, 1985 (LMSE 1996b, LMSE 1997b)

Species	Estimated Number Impinged											
	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Freshwater Drum	2,572	7,492	13,010	11,196	2,772	1,852	409	886	1,562	11,319	7,881	740

Quad Cities Station, 1986 (LMSE 1995, LMSE 1996a)

Species	Estimated Number Impinged
Freshwater Drum	84,000
Gizzard Shad	416,000
Other Species	40,000

Quad Cities Station, 1986 (LMSE 1996b, LMSE 1997b)

Species	Estimated Number Impinged											
	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Freshwater Drum	1,128	2,717	5,007	24,408	2,779	No Sample	No Sample	No Sample	6,358	25,483	9,736	958

Table C14
Impingement Losses for Pool 14 (cont.)

Quad Cities Station, 1987 (LMSE 1995, LMSE 1996a)	
Species	**Estimated Number Impinged**
Freshwater Drum	62,000
Gizzard Shad	111,000
Other Species	59,000

Quad Cities Station, 1987 (LMSE 1996b, LMSE 1997b)												
Species	**Estimated Number Impinged**											
	Jan	**Feb**	**March**	**April**	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
Freshwater Drum	5,410	3,679	7,558	4,875	2,487	2,703	7,378	4,140	2,208	2,077	1,802	1,566

Quad Cities Station, 1988 (LMSE 1995, LMSE 1996a)	
Species	**Estimated Number Impinged**
Freshwater Drum	124,000
Gizzard Shad	1,065,000
Other Species	297,000

Quad Cities Station, 1988 (LMSE 1996b, LMSE 1997b)												
Species	**Estimated Number Impinged**											
	Jan	**Feb**	**March**	**April**	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
Freshwater Drum	2,598	9,662	38,270	39,931	1,246	447	4,338	2,275	4,346	2,992	5,058	3,035

Table C14
Impingement Losses for Pool 14 (cont.)

Quad Cities Station, 1989 (LMSE 1995, LMSE 1996a)

Species	Estimated Number Impinged
Freshwater Drum	310,000
Gizzard Shad	2,551,000
Other Species	128,000

Quad Cities Station, 1989 (LMSE 1996b, LMSE 1997b)

Species	Estimated Number Impinged											
	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Freshwater Drum	11,943	33,904	104,068	102,085	19,443	2,678	1,100	5,025	6,676	5,098	5,382	3,101

Quad Cities Station, 1990 (LMSE 1995, LMSE 1996a)

Species	Estimated Number Impinged
Freshwater Drum	419,000
Gizzard Shad	854,000
Other Species	79,000

Quad Cities Station, 1990 (LMSE 1996b, LMSE 1997b)

Species	Estimated Number Impinged											
	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Freshwater Drum	5,735	12,135	32,565	31,414	3,384	2,403	38,853	215,887	23,447	56,475	8,509	1,401

Table C14
Impingement Losses for Pool 14 (cont.)

Quad Cities Station, 1991 (LMSE 1995, LMSE 1996a)

Species	Estimated Number Impinged
Freshwater Drum	173,000
Gizzard Shad	563,000
Other Species	76,000

Quad Cities Station, 1991 (LMSE 1996b, LMSE 1997b)

Species	Estimated Number Impinged											
	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Freshwater Drum	2,726	10,430	24,575	4,910	2,241	446	15,366	6,150	13,711	28,635	34,622	4,362

Quad Cities Station, 1992 (LMSE 1995, LMSE 1996a)

Species	Estimated Number Impinged
Freshwater Drum	188,000
Gizzard Shad	350,000
Other Species	76,000

Quad Cities Station, 1992 (LMSE 1996b, LMSE 1997b)

Species	Estimated Number Impinged											
	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Freshwater Drum	6,240	18,575	26,722	106,791	10,169	333	5,291	1,308	6,517	6,588	1,421	1,778

Table C14
Impingement Losses for Pool 14 (cont.)

Quad Cities Station, 1993 (LMSE 1995, LMSE 1996a)												
Species	**Estimated Number Impinged**											
Freshwater Drum	45,000											
Gizzard Shad	241,000											
Other Species	28,000											
Quad Cities Station, 1993 (LMSE 1996b, LMSE 1997b)												
Species	**Estimated Number Impinged**											
	Jan	**Feb**	**March**	**April**	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
Freshwater Drum	3,019	4,476	8,283	3,904	3,845	1,669	345	7,289	5,941	9,273	1,678	788
Quad Cities Station, 1994 (LMSE 1995, LMSE 1996a)												
Species	**Estimated Number Impinged**											
Freshwater Drum	366,000											
Gizzard Shad	498,000											
Other Species	69,000											
Quad Cities Station, 1994 (LMSE 1996b, LMSE 1997b)												
Species	**Estimated Number Impinged**											
	Jan	**Feb**	**March**	**April**	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
Freshwater Drum	1,022	2,540	2,167	2,445	416	1,836	27,371	25,515	182,168	76,401	39,453	4,104

Table C14
Impingement Losses for Pool 14 (cont.)

Quad Cities Station, 1995 (LMSE 1996b)

Species	**Total Number Impinged (January)**										
	1/3-1/4	**1/4-1/5**	**1/9-1/10**	**1/10-1/11**	**1/16-1/17**	**1/17-1/18**	**1/23-1/24**	**1/24-1/25**	**1/30-1/31**	**Total Number**	**Projected Number**
Bigmouth Buffalo						3				3	11
Black Bullhead									1	1	4
Black Crappie		2	2		2				2	8	29
Bluegill						5	5	3	1	14	51
Carpsucker Species							1			1	4
Channel Catfish	1	5	6	2	2	5	5	2	11	39	143
Emerald Shiner				1						1	4
Freshwater Drum	9	168	86	57	198	174	122	139	190	1,143	4,195
Gizzard Shad	895	3,819	12,510	6,467	18,592	20,036	1,573	2,723	8,282	74,897	1,622,598
Green Sunfish						3				3	11
Largemouth Bass		1							1	2	7
Logperch		1				3	1			5	18
Mooneye		2	6	2		8		1	5	24	88
Orangespotted Sunfish						3			1	4	15
Pumpkinseed					2	3				5	18
Sauger					2					2	7
Shorthead Redhorse					2				1	3	11

Table C14
Impingement Losses for Pool 14 (cont.)

Species	Total Number Impinged (January)										
	1/3-1/4	1/4-1/5	1/9-1/10	1/10-1/11	1/16-1/17	1/17-1/18	1/23-1/24	1/24-1/25	1/30-1/31	Total Number	Projected Number
Silver Chub		2	2	1			1			6	22
Smallmouth Buffalo	2		2	2			1	3		10	37
Stonecat						3			1	4	15
Walleye									1	1	4
White Bass		5	2	4	14	16	12	15	14	82	301
White Crappie									1	1	4
Yellow Bass								1		1	4

Species	Total Number Impinged (February)									
	1/31-2/1	2/6-2/7	2/7-2/8	2/13-2/14	2/14-2/15	2/20-2/21	2/21-2/22	2/27-2/28	Total Number	Projected Number
Black Bullhead							3		3	11
Black Crappie	2					2			4	14
Bluegill	2	5	3	3	4	2		1	20	70
Carpsucker Species							6	1	7	25
Channel Catfish	6		3	6	7	2	12	1	37	130
Emerald Shiner						4	3		7	25
Freshwater Drum	184	234	269	579	494	374	813	91	3,038	10,633
Gizzard Shad	8,111	10,252	10,494	8,223	9,926	5,458	8,316	156	60,936	213,276
Largemouth Bass			3				3		6	21

Table C14
Impingement Losses for Pool 14 (cont.)

Species	Total Number Impinged (February)									
	1/31-2/1	2/6-2/7	2/7-2/8	2/13-2/14	2/14-2/15	2/20-2/21	2/21-2/22	2/27-2/28	Total Number	Projected Number
Logperch							6		6	21
Mooneye	3	8	3				6	1	21	74
River Shiner						2			2	7
Shorthead Redhorse		3							3	11
Silver Chub	2	3			4		3		12	42
Smallmouth Buffalo		3				2			5	18
Stonecat					4				4	14
Tadpole Madtom					4				4	14
Walleye	1	3	8						12	42
White Bass	14	8	17	15	14	20	27	6	121	424
White Crappie				3		2			5	18

Species	Total Number Impinged (March)										
	2/28-3/1	3/6-3/7	3/7-3/8	3/13-3/14	3/14-3/15	3/20-3/21	3/21-3/22	3/27-3/28	3/28-3/29	Total Number	Projected Number
Bigmouth Buffalo		1					1			2	7
Black Bullhead						3	8	2	2	15	52
Black Crappie		3	1	1		5	4	3	1	18	62
Bluegill	3		3	4		4	14	2	3	33	114
Carp	1		1			1	3		1	7	24

Table C14
Impingement Losses for Pool 14 (cont.)

Species	Total Number Impinged (March)										
	2/28-3/1	3/6-3/7	3/7-3/8	3/13-3/14	3/14-3/15	3/20-3/21	3/21-3/22	3/27-3/28	3/28-3/29	Total Number	Projected Number
Carpsucker Species	1	2	1	2		1	3			10	34
Channel Catfish	11	22	11	21	2	20	16	6	13	122	420
Emerald Shiner							1			1	3
Fathead Minnow			1				1			2	7
Flathead Catfish		1		1		1		1		4	14
Freshwater Drum	1,045	1,257	815	936	32	1,708	2,126	4,685	2,896	15,500	53,320
Gizzard Shad	1,058	1,031	1,569	501	5	187	132	89	128	4,700	16,168
Golden Redhorse							1			1	3
Golden Shiner				1				5	9	15	52
Grass Pickerel						1			1	2	7
Green Sunfish						4				4	14
Hybrid Striped Bass				1						1	3
Largemouth Bass		1	1				1			3	10
Logperch	1					9	1	2	8	21	72
Longnose Gar							1	2		3	10
Mooneye	2	5	3	3		3	3	3	3	25	86
Mud Darter				1					1	2	7
Orangespotted Sunfish		1								1	3

Table C14
Impingement Losses for Pool 14 (cont.)

Species	Total Number Impinged (March)										
	2/28-3/1	3/6-3/7	3/7-3/8	3/13-3/14	3/14-3/15	3/20-3/21	3/21-3/22	3/27-3/28	3/28-3/29	Total Number	Projected Number
Pumpkinseed							4			4	14
River Darter							2	1		3	10
River Shiner				1						1	3
Sauger		1				2	1	1		5	17
Shorthead Redhorse							2		2	4	14
Silver Chub	2	1	1	1		1	2		1	9	31
Silvery Minnow		1				3	4	1	2	11	38
Smallmouth Buffalo	6	6	5	11		3	4	3	2	40	138
Spottail Shiner						2	13	4	7	26	89
Stonecat								1	1	2	7
Walleye	2	2	5			5			2	16	55
Warmouth									1	1	3
White Bass	33	22	16	36	1	96	88	121	147	560	1,926
White Crappie	1	1				1	4	1		8	28
Yellow Bass						4	25	26	51	106	365
Yellow Bullhead			1			1				2	7
Yellow Perch				1		4	4	1	1	11	38

Table C14
Impingement Losses for Pool 14 (cont.)

Species	Total Number Impinged (April)									
	4/3-4/4	4/4-4/5	4/10-4/11	4/11-4/12	4/17-4/18	4/18-4/19	4/26-4/27	4/27-4/28	Total Number	Projected Number
Bigmouth Buffalo			2	2	1				5	20
Black Bullhead	1	4	2	4	1	8			20	80
Black Crappie			1	1	2	2			6	24
Bluegill	4	5	3	4	1	12	1	5	35	139
Bowfin		1							1	4
Carp		2			1	4		3	10	40
Carpsucker Species	2	3	2					3	10	40
Channel Catfish	7	10	7	8		6	3	8	49	195
Emerald Shiner				1					1	4
Flathead Catfish	1					2			3	12
Freshwater Drum	4,448	5,512	6,223	4,154	6,560	13,316	1,663	5,978	47,854	190,459
Gizzard Shad	214	271	869	722	161	348	66	178	2,829	11,259
Golden Shiner	3		3	2	1	6			15	60
Hybrid Striped Bass			1						1	4
Largemouth Bass			1						1	4
Logperch	12	12	3	7	52	64	5		155	617
Longnose Gar	4				1	2			7	28
Mooneye	4	3	8	12	3	4	1	3	38	151

Table C14
Impingement Losses for Pool 14 (cont.)

Species	Total Number Impinged (April)									
	4/3-4/4	4/4-4/5	4/10-4/11	4/11-4/12	4/17-4/18	4/18-4/19	4/26-4/27	4/27-4/28	Total Number	Projected Number
Mud Darter	2								2	8
Pumpkinseed	1	2				4			7	28
River Carpsucker				4					4	16
River Darter		1				2		3	6	24
River Shiner			3						3	12
Shorthead Redhorse		1	5	2	1	2			11	44
Silver Chub	2		1	4			1	3	11	44
Silvery Minnow			5	3	5	2			15	60
Slenderhead Darter						2			2	8
Smallmouth Buffalo	5	4	2	8	7	10			36	143
Spottail Shiner		2			7	8		5	22	88
Stonecat					1				1	4
Walleye			1					3	4	16
White Bass	225	60	234	121	170	358	60	188	1,416	5,636
White Crappie			1			2			3	12
White Sucker					2	2			4	16
Yellow Bass	31	24	24	8	4	12	8	15	126	501
Yellow Perch					1				1	4

Table C14
Impingement Losses for Pool 14 (cont.)

Species	**Total Number Impinged (May)**										
	5/2-5/3	**5/3-5/4**	**5/8-5/9**	**5/9-5/10**	**5/15-5/16**	**5/16-5/17**	**5/22-5/23**	**5/23-5/24**	**5/30-5/31**	**Total Number**	**Projected Number**
Bigmouth Buffalo	1									1	3
Black Bullhead		1	2	1	2	4			1	11	38
Black Crappie							1			1	3
Bluegill	3	2	10	8	4	14	1	2	3	47	162
Blue Sucker							1			1	3
Carp	1			1	2		1	1		6	21
Carpsucker Species						1			1	2	7
Channel Catfish	4	3	6	7	4	2	10	2	2	40	138
Emerald Shiner							1			1	3
Freshwater Drum	4,142	3,327	1,825	2,471	1,541	1,373	1,739	1,471	667	18,556	63,833
Gizzard Shad	247	176	80	78	38	32	28	24	7	710	2,442
Green Sunfish					2	1				3	10
Hybrid Striped Bass		1								1	3
Largemouth Bass							1		1	2	7
Logperch	1	3	8	3		1		3		19	65
Mooneye	5	4	2	4	10	3	4	6	4	42	144
Orangespotted Sunfish			2	1	3	10		1		17	58
Pumpkinseed		1					1			2	7

Table C14
Impingement Losses for Pool 14 (cont.)

Species	Total Number Impinged (May)										
	5/2-5/3	5/3-5/4	5/8-5/9	5/9-5/10	5/15-5/16	5/16-5/17	5/22-5/23	5/23-5/24	5/30-5/31	Total Number	Projected Number
Redhorse Species								1		1	3
River Carpsucker								1		1	3
River Darter				1		1				2	7
River Shiner							2			2	7
Sauger				1	1	5	2	2		11	38
Shorthead Redhorse	1	3	5	3	5	6	6	1		30	103
Silver Chub		2			2	2			1	7	24
Silvery Minnow	1			2						3	10
Slenderhead Darter							1			1	3
Smallmouth Buffalo	3	3		2	8	9	15	11	3	54	186
Spottail Shiner		3	4	2	6	5	1		1	22	76
Spotted Sucker	1		1							2	7
Stonecat		1	1			3		1	1	7	24
Tadpole Madtom				1				1		2	7
Walleye								1		1	3
White Bass	161	137	69	106	142	130	77	49	9	880	3,027
White Crappie				1	1	1				3	10
White Sucker	1			2			1		1	5	17

Table C14
Impingement Losses for Pool 14 (cont.)

Species	Total Number Impinged (May)										
	5/2-5/3	5/3-5/4	5/8-5/9	5/9-5/10	5/15-5/16	5/16-5/17	5/22-5/23	5/23-5/24	5/30-5/31	Total Number	Projected Number
Yellow Bass	10	11	12	1	3	1				38	131
Yellow Perch					1		1			2	7
Species	**Total Number Impinged (June)**										
	5/31-6/1	6/5-6/6	6/6-6/7	6/12-6/13	6/13-6/14	6/19-6/20	6/20-6/21	6/26-6/27	6/27-6/28	Total Number	Projected Number
Black Bullhead	1	1	2		1					5	17
Black Crappie		1	1			20	7	3	9	41	137
Bluegill	3	1		15	10	147	48	39	33	296	986
Bowfin								1	1	2	7
Carp			1		1				1	3	10
Channel Catfish	3	1	5		1	6	4	1	5	26	87
Emerald Shiner	1	1		2			4	1	2	11	37
Flathead Catfish			1							1	3
Freshwater Drum	774	569	529	193	171	340	156	22	11	2,765	9,207
Gizzard Shad	9	11	6	6	5	15	15	8	7	82	273
Golden Shiner							4	3	3	10	33
Grass Pickerel					3			1		4	13
Green Sunfish									1	1	3
Largemouth Bass			1			2	4	1		8	27

Table C14
Impingement Losses for Pool 14 (cont.)

Species	Total Number Impinged (June)										
	5/31-6/1	6/5-6/6	6/6-6/7	6/12-6/13	6/13-6/14	6/19-6/20	6/20-6/21	6/26-6/27	6/27-6/28	Total Number	Projected Number
Logperch	1		1	3	1					6	20
Mooneye	1	4		1	2	4	5	1	1	19	63
Northern Pike						11	13	3	4	31	103
Orangespotted Sunfish		1		5	3	6	5	1	1	22	73
Pumpkinseed					1			1		2	7
Quillback			1							1	3
Redhorse Species				1			7		1	9	30
River Carpsucker			2		2					4	13
River Shiner			2							2	7
Sauger						9	2	1		12	40
Shorthead Redhorse	2	2		4	6	15	11		1	41	137
Silver Chub							2	1	1	4	13
Silver Lamprey	1									1	3
Smallmouth Buffalo	3					2		4	5	14	47
Spotfin Shiner								1		1	3
Spottail Shiner		3			1	7	20	1	1	33	110
Spotted Sucker						2				2	7
Stonecat	1					2				3	10

Table C14
Impingement Losses for Pool 14 (cont.)

Species	Total Number Impinged (June)										
	5/31-6/1	6/5-6/6	6/6-6/7	6/12-6/13	6/13-6/14	6/19-6/20	6/20-6/21	6/26-6/27	6/27-6/28	Total Number	Projected Number
Walleye			1			6	7	1		15	50
White Bass	5	4	5		2	4	2	2	3	27	90
White Crappie	2			1			2			5	17
White Sucker	1									1	3
Yellow Perch						2			1	3	10

Species	Total Number Impinged (July)									
	7/5-7/6	7/6-7/7	7/10-7/11	7/11-7/12	7/17-7/18	7/18-7/19	7/24-7/25	7/25-7/26	Total Number	Projected Number
Bigmouth Buffalo		2							2	8
Black Bullhead	1								1	4
Black Crappie	10	14	14	4	18	14	3	4	81	314
Bluegill	48	47	50	172	406	182	14	5	924	3,585
Bowfin			2						2	8
Carp		2					1		3	12
Carpsucker Species	1	4	2				2	1	10	39
Channel Catfish	9	15	14	14	4	8	19	23	106	411
Emerald Shiner		3	2						5	19
Flathead Catfish							2	1	3	12
Freshwater Drum	12	12	64	58	14	12	26	33	231	896

Table C14
Impingement Losses for Pool 14 (cont.)

Species	Total Number Impinged (July)									
	7/5-7/6	7/6-7/7	7/10-7/11	7/11-7/12	7/17-7/18	7/18-7/19	7/24-7/25	7/25-7/26	Total Number	Projected Number
Gizzard Shad	26	46	22	62	6	12	29	26	229	889
Golden Redhorse	1								1	4
Golden Shiner		2	2	12	8	2			26	101
Highfin Carpsucker	1								1	4
Hybrid Striped Bass				2					2	8
Largemouth Bass					2				2	8
Logperch		1							1	4
Longnose Gar	1	4		2	4	2	3	3	19	74
Mooneye	2	5	6	2	2	2	5	6	30	116
Northern Pike	1	5							6	23
Orangespotted Sunfish	3	2							5	19
Pumpkinseed				2	2				4	16
Sauger						2	1		3	12
Shorthead Redhorse	4	6	2			4	1	1	18	70
Shortnose Gar		2		2			1	1	6	23
Silver Chub							2	1	3	12
Smallmouth Buffalo	2	7	4	4	2				19	74
Spottail Shiner	2	2	2				1	1	8	31

Table C14
Impingement Losses for Pool 14 (cont.)

Species	Total Number Impinged (July)									
	7/5-7/6	7/6-7/7	7/10-7/11	7/11-7/12	7/17-7/18	7/18-7/19	7/24-7/25	7/25-7/26	Total Number	Projected Number
Walleye		3	4	4	2		1	4	18	70
White Bass	24	27	10	8	42	42	100	88	341	1,323
White Crappie		1		2			1		4	16
Yellow Perch								1	1	4

Species	Total Number Impinged (August)											
	7/31-8/1	8/1-8/2	8/7-8/8	8/8-8/9	8/14-8/15	8/15-8/16	8/21-8/22	8/22-8/23	8/28-8/29	8/29-8/30	Total Number	Projected Number
Bigmouth Buffalo				1					1		2	6
Black Bullhead			1	2	1					1	5	16
Black Crappie	8			1				2	6	1	18	56
Bluegill	8	8	4	6	27	30	48	58	69	63	321	995
Bowfin									1	1	2	6
Buffalo Species							2			2	4	12
Carp	1	1		1	1	1		4	1	1	11	34
Carpsucker Species						1	14	5	8	7	35	109
Channel Catfish	15	16	28	30	22	19	40	49	56	41	316	980
Emerald Shiner	2	2	1	1	1		4	7	5	6	29	90
Flathead Catfish	1	1	1		1				1	2	7	22

Table C14
Impingement Losses for Pool 14 (cont.)

Species	Total Number Impinged (August)											
	7/31-8/1	8/1-8/2	8/7-8/8	8/8-8/9	8/14-8/15	8/15-8/16	8/21-8/22	8/22-8/23	8/28-8/29	8/29-8/30	Total Number	Projected Number
Freshwater Drum	15	11	23	15	22	42	1,704	686	531	386	3,435	10,649
Gizzard Shad	35	27	42	58	69	47	436	284	520	768	2,286	7,087
Golden Shiner			1		3	2				2	8	25
Highfin Carpsucker								2			2	6
Largemouth Bass					1		6		3	3	13	40
Longnose Gar	6	1	1	1	1						10	31
Mooneye	6	9	4	7	3	6	6	7	3		51	158
Northern Pike				1			2		1		4	12
Pumpkinseed			1								1	3
River Carpsucker		1									1	3
River Darter										1	1	3
River Shiner									3	1	4	12
Sauger		1			1	1	2		4	3	12	37
Shorthead Redhorse		1			1	1	4	9	2	2	20	62
Shortnose Gar								2			2	6
Silver Chub	6	8	3	9	6	15	26	21	18	16	128	397
Smallmouth Buffalo			1	2					1		4	12

Table C14
Impingement Losses for Pool 14 (cont.)

Species	Total Number Impinged (August)											
	7/31-8/1	8/1-8/2	8/7-8/8	8/8-8/9	8/14-8/15	8/15-8/16	8/21-8/22	8/22-8/23	8/28-8/29	8/29-8/30	Total Number	Projected Number
Spotfin Shiner							2				2	6
Spottail Shiner		1					2	4	3	1	11	34
Stonecat									1	1	2	6
Tadpole Madtom		1									1	3
Walleye	5	1	1	1	11	5	6	4	3	2	39	121
White Bass	61	28	17	15	41	28	136	82	93	67	568	1,761
White Crappie				1		1				1	3	9

Species	Total Number Impinged (September)									
	9/5-9/6	9/6-9/7	9/11-9/12	9/12-9/13	9/18-9/19	9/19-9/20	9/25-9/26	9/26-9/27	Total Number	Projected Number
Black Bullhead				1					1	4
Black Crappie	2	5	3	4		2	4	4	24	90
Bluegill	60	35	107	55	25	41	73	88	484	1,815
Bowfin	1								1	4
Carp	1	2		2		1			6	23
Carpsucker Species	5		2			1			8	30
Channel Catfish	53	44	59	34	10	52	84	84	420	1,575
Emerald Shiner	4	2	2	1	1	4		2	16	60

Table C14
Impingement Losses for Pool 14 (cont.)

Species	Total Number Impinged (September)									
	9/5-9/6	9/6-9/7	9/11-9/12	9/12-9/13	9/18-9/19	9/19-9/20	9/25-9/26	9/26-9/27	Total Number	Projected Number
Flathead Catfish						1			1	4
Freshwater Drum	218	190	377	167	77	111	1,032	920	3,092	11,595
Gizzard Shad	272	381	3,451	1,415	202	729	8,109	5,908	20,467	76,751
Golden Shiner				1	1		2		4	15
Highfin Carpsucker				1					1	4
Hybrid Striped Bass		1							1	4
Largemouth Bass	6	6	2	2	1	3	11	12	43	161
Longnose Gar			1			1		6	8	30
Mooneye	7	3	5	1	4	9	15	26	70	263
Northern Pike						1			1	4
Paddlefish						1			1	4
Pumpkinseed	1							6	7	26
River Carpsucker				1					1	4
River Darter	1								1	4
River Shiner		3	1					2	6	23
Sauger			1						1	4
Shorthead Redhorse	2	1	3	1	1	1			9	34
Shortnose Gar							4		4	15

Table C14
Impingement Losses for Pool 14 (cont.)

Species	Total Number Impinged (September)									
	9/5-9/6	9/6-9/7	9/11-9/12	9/12-9/13	9/18-9/19	9/19-9/20	9/25-9/26	9/26-9/27	Total Number	Projected Number
Silver Chub	15	14	7	2	1	1		4	44	165
Smallmouth Buffalo		4	3	1		3	7	4	22	83
Stonecat	1								1	4
Tadpole Madtom	1								1	4
Walleye	1	2	5	1	1	2	2		14	53
White Bass	73	49	46	46	41	95	180	198	728	2,730
White Crappie	1						2	2	5	19
Yellow Bass							2		2	8

Species	Total Number Impinged (October)										
	10/2-10/3	10/3-10/4	10/9-10/10	10/10-10/11	10/16-10/17	10/17-10/18	10/23-10/24	10/24-10/25	10/30-10/31	Total Number	Projected Number
Black Bullhead				2	13	21	47	17		100	344
Black Crappie		2			6		6	3	2	19	65
Bluegill	143	94	115	104	89	45	83	143		816	2,807
Carp		2	4	6	2					14	48
Carpsucker Species								9		9	31
Channel Catfish	40	48	7	14	4	8	16	9		146	502
Emerald Shiner	2	4	2	2			3	3		16	55

Table C14
Impingement Losses for Pool 14 (cont.)

Species	Total Number Impinged (October)										
	10/2-10/3	10/3-10/4	10/9-10/10	10/10-10/11	10/16-10/17	10/17-10/18	10/23-10/24	10/24-10/25	10/30-10/31	Total Number	Projected Number
Flathead Catfish		2								2	7
Freshwater Drum	210	232	461	454	5,176	1,349	1,877	6,236	838	16,833	57,906
Gizzard Shad	3,356	1,988	3,548	2,762	973	1,349	1,520	12,104	1,316	28,916	99,471
Golden Redhorse									2	2	7
Golden Shiner						2	7			9	31
Highfin Carpsucker		2								2	7
Largemouth Bass	5	2	9	10	9	4	37	10	2	88	303
Logperch			4	2						6	21
Longnose Gar			4	2	4	4	6	3	2	25	86
Mooneye	18	24	25	38	33	13	17	20	5	193	664
Pumpkinseed	2				2	2		3		9	31
Quillback									5	5	17
River Carpsucker			2		2	2			5	11	38
River Shiner				2						2	7
Sauger					2					2	7
Shorthead Redhorse		2			2	2	3	10		19	65
Shortnose Gar			2		2					4	14

Table C14
Impingement Losses for Pool 14 (cont.)

Species	Total Number Impinged (October)										
	10/2-10/3	10/3-10/4	10/9-10/10	10/10-10/11	10/16-10/17	10/17-10/18	10/23-10/24	10/24-10/25	10/30-10/31	Total Number	Projected Number
Silver Chub			7	4	2	2		3		18	62
Smallmouth Buffalo	5	2	7	2	9		3	14	5	47	162
Spotted Sucker				2						2	7
Stonecat		6		2						8	28
Walleye	2			4	4	6	3	3	5	27	93
White Bass	461	478	320	232	273	215		320	156	2,455	8,445
White Crappie	2	2	2	6						12	41
Yellow Bass					2					2	7

Species	Total Number Impinged (November)										
	10/31-11/1	11/6-11/7	11/9-11/10	11/13-11/14	11/14-11/15	11/20-11/21	11/21-11/22	11/27-11/28	11/28-11/29	Total Number	Projected Number
Black Bullhead						2	4			6	20
Black Crappie						4	2		1	7	23
Bluegill		3			2	20	10	3	3	41	137
Carpsucker Species		9	4			2	2	3		20	67
Channel Catfish	6	30	10	9	5	2	3		2	67	223
Emerald Shiner			2				2			4	13
Flathead Catfish			2				1			3	10

Table C14
Impingement Losses for Pool 14 (cont.)

Species	Total Number Impinged (November)										
	10/31-11/1	11/6-11/7	11/9-11/10	11/13-11/14	11/14-11/15	11/20-11/21	11/21-11/22	11/27-11/28	11/28-11/29	Total Number	Projected Number
Freshwater Drum	939	1,473	1,484	550	540	140	258	107	90	5,581	18,585
Gizzard Shad	2,539	1,734	1,126	2,251	2,554	744	919	1,409	912	14,188	47,246
Green Sunfish						2		1		3	10
Highfin Carpsucker					2					2	7
Largemouth Bass	6	3				10	5	3	2	29	97
Longnose Gar	2		2		2					6	20
Mooneye	20	6	6	13	11	4	7	4	5	76	253
Orangespotted Sunfish									1	1	3
Pumpkinseed						2	2		1	5	17
Shorthead Redhorse	2	6							1	9	30
Shortnose Gar						4				4	13
Silver Chub			2				1			3	10
Smallmouth Buffalo	4	3	8	2	2	4	7	1	2	33	110
Walleye				2	2			1		5	17
White Bass	148	225	94	36	22	54	58	42	16	695	2,314
White Crappie								1		1	3

Table C14
Impingement Losses for Pool 14 (cont.)

Species	Total Number Impinged (December)									
	12/4-12/5	12/5-12/6	12/12-12/13	12/13-12/14	12/18-12/19	12/19-12/20	12/26-12/27	12/27-12/28	Total Number	Projected Number
Black Bullhead		2	1						3	12
Black Crappie	2	6	3		3				14	54
Bluegill	16	20	10	8	5	6	10	10	85	327
Bowfin					1				1	4
Carpsucker Species	1	2	7	1	10	3	2	1	27	104
Channel Catfish	2		2		2		1	2	9	35
Emerald Shiner		1			2				3	12
Flathead Catfish	1		1						2	8
Freshwater Drum	81	99	111	62	82	137	133	124	829	3,192
Gizzard Shad	1,501	726	825	716	1,197	1,470	2,579	2,469	11,483	44,210
Golden Shiner		2		1					3	12
Largemouth Bass	5	7	2		1				15	58
Mooneye	5	2	2	3	5	5	3	5	30	116
Orangespotted Sunfish		1		1					2	8
Shorthead Redhorse		1		1					2	8
Silver Chub	1		1						2	8
Silver Lamprey							1		1	4

Table C14
Impingement Losses for Pool 14 (cont.)

Species	Total Number Impinged (December)									
	12/4-12/5	12/5-12/6	12/12-12/13	12/13-12/14	12/18-12/19	12/19-12/20	12/26-12/27	12/27-12/28	Total Number	Projected Number
Smallmouth Buffalo	2	1		3	3	5		4	18	69
Spottail Shiner		1							1	4
Walleye	1	1	1		4	2			9	35
White Bass	27	42	6	3	4	7	3	6	98	377
Yellow Perch					1				1	4

Quad Cities Station, 1995 (LMSE 1996a)

Species	Estimated Number Impinged											
	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Bigmouth Buffalo	3		2	5	1		2	2				
Black Bullhead	1	3	15	20	11	5	1	5	1	100	6	3
Black Crappie	8	4	18	6	1	41	81	18	24	19	7	14
Bluegill	14	20	33	35	47	296	924	321	484	816	41	85
Blue Sucker					1							
Bowfin				1		2	2	2	1			1
Buffalo Species								4				
Carp			7	10	6	3	3	11	6	14		
Carpsucker Species	1	7	10	10	2		10	35	8	9	20	27

Table C14
Impingement Losses for Pool 14 (cont.)

Species	Estimated Number Impinged											
	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Channel Catfish	39	37	122	49	40	26	106	316	420	146	67	9
Emerald Shiner	1	7	1	1	1	11	5	29	16	16	4	3
Fathead Minnow			2									
Flathead Catfish			4	3		1	3	7	1	2	3	2
Freshwater Drum	1,143	3,038	15,500	47,854	18,556	2,765	231	3,435	3,092	16,833	5,581	829
Gizzard Shad	74,897	60,936	4,700	2,829	710	82	229	2,286	20,467	28,916	14,188	11,483
Golden Redhorse			1				1			2		
Golden Shiner			15	15		10	26	8	4	9		3
Grass Pickerel			2			4						
Green Sunfish	3		4		3	1					3	
Highfin Carpsucker							1	2	1	2	2	
Hybrid Striped Bass			1	1	1		2		1			
Largemouth Bass	2	6	3	1	2	8	2	13	43	88	29	15
Logperch	5	6	21	155	19	6	1			6		
Longnose Gar			3	7			19	10	8	25	6	
Mooneye	24	21	25	38	42	19	30	51	70	193	76	30
Mud Darter			2	2								

Table C14
Impingement Losses for Pool 14 (cont.)

Species	Estimated Number Impinged											
	Jan	**Feb**	**March**	**April**	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
Northern Pike						31	6	4	1			
Orangespotted Sunfish	4		1		17	22	5				1	2
Paddlefish									1			
Pumpkinseed	5		4	7	2	2	4	1	7	9	5	
Quillback						1				5		
Redhorse Species					1	9						
River Carpsucker				4	1	4		1	1	11		
River Darter			3	6	2			1	1			
River Shiner		2	1	3	2	2		4	6	2		
Sauger	2		5		11	12	3	12	1	2		
Shorthead Redhorse	3	3	4	11	30	41	18	20	9	19	9	2
Shortnose Gar							6	2	4	4	4	
Silver Chub	6	12	9	11	7	4	3	128	44	18	3	2
Silver Lamprey						1						1
Silvery Minnow			11	15	3							
Slenderhead Darter				2	1							
Smallmouth Buffalo	10	5	40	36	54	14	19	4	22	47	33	18

Table C14
Impingement Losses for Pool 14 (cont.)

Species	Estimated Number Impinged											
	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Spotfin Shiner						1		2				
Spottail Shiner			26	22	22	33	8	11				1
Spotted Sucker					2	2				2		
Stonecat	4	4	2	1	7	3		2	1	8		
Tadpole Madtom		4			2			1	1			
Walleye	1	12	16	4	1	15	18	39	14	27	5	9
Warmouth			1									
White Bass	82	121	560	1,416	880	27	341	568	728	2,455	695	98
White Crappie	1	5	8	3	3	5	4	3	5	12	1	
White Sucker				4	5	1						
Yellow Bass	1		106	126	38				2	2		
Yellow Bullhead			2									
Yellow Perch			11	1	2	3	1					1

Table C14
Impingement Losses for Pool 14 (cont.)

Quad Cities Station, 1995 (LMSE 1996a, LMSE 1997b)

Species	Estimated Number Impinged											
	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Bluegill	51	70	114	139	162	986	3,585	995	1,815	2,807	137	327
Channel Catfish	143	130	420	195	138	87	411	980	1,575	502	223	35
Freshwater Drum	4,195	10,633	53,320	190,459	63,833	9,207	896	10,649	50,853	57,906	18,585	3,192
Gizzard Shad	274,872	213,276	16,168	11,259	2,442	273	889	7,087	76,751	99,471	47,246	44,210
Others	312	353	1,327	2,114	1,042	1,055	1,102	1,338	1,140	2,246	722	515
White Bass	301	424	1,926	5,636	3,027	90	1,323	1,761	2,730	8,445	2,314	377

Quad Cities Station, 1995 (LMSE 1996a)

Species	Estimated Number Impinged
Bigmouth Buffalo	55
Black Bullhead	599
Black Crappie	872
Bluegill	11,188
Blue Sucker	3
Bowfin	32
Buffalo Species	12
Carp	211

Table C14
Impingement Losses for Pool 14 (cont.)

Species	Estimated Number Impinged
Carpsucker Species	488
Channel Catfish	4,837
Emerald Shiner	325
Fathead Minnow	7
Flathead Catfish	91
Freshwater Drum	434,469
Gizzard Shad	793,944
Golden Redhorse	14
Golden Shiner	328
Grass Pickerel	20
Green Sunfish	48
Highfin Carpsucker	27
Hybrid Striped Bass	22
Largemouth Bass	743
Logperch	838
Longnose Gar	279
Mooneye	2,176
Mud Darter	15

Table C14
Impingement Losses for Pool 14 (cont.)

Species	Estimated Number Impinged
Northern Pike	143
Orangespotted Sunfish	180
Paddlefish	4
Pumpkinseed	166
Quillback	21
Redhorse Species	33
River Carpsucker	77
River Darter	48
River Shiner	78
Sauger	162
Shortnose Gar	72
Shorthead Redhorse	587
Silver Chub	829
Silver Lamprey	7
Silvery Minnow	108
Slenderhead Darter	11
Smallmouth Buffalo	1,077
Spotfin Shiner	10

Table C14
Impingement Losses for Pool 14 (cont.)

Species	Estimated Number Impinged
Spottail Shiner	432
Spotted Sucker	20
Stonecat	111
Tadpole Madtom	28
Walleye	557
Warmouth	3
White Bass	28,354
White Crappie	176
White Sucker	36
Yellow Bass	1,015
Yellow Bullhead	7
Yellow Perch	66

Quad Cities Station, 1996 (LMSE 1997b)

Species	Total Number Impinged (January)										
	1/2-1/3	1/3-1/4	1/8-1/9	1/10-1/11	1/15-1/16	1/18	1/22-1/23	1/23-1/24	1/29-1/30	Total Number	Projected Number
Black Crappie				3		3			5	11	55
Bluegill	10		15	6	3					34	171
Carp			3							3	15
Carpsucker Species	2		3							5	25

Table C14
Impingement Losses for Pool 14 (cont.)

Species	Total Number Impinged (January)										
	1/2-1/3	1/3-1/4	1/8-1/9	1/10-1/11	1/15-1/16	1/18	1/22-1/23	1/23-1/24	1/29-1/30	Total Number	Projected Number
Channel Catfish	6	2	3	3			3	9	5	31	156
Flathead Catfish	2		3		3					8	40
Freshwater Drum	166	219	348	264	144	51	434	330	525	2,481	12,479
Gizzard Shad	6,666	4,923	17,362	16,710	8,919	3,636	6,880	5,843	2,445	73,384	369,122
Golden Redhorse	2									2	10
Largemouth Bass	2									2	10
Mooneye	4	4	9	3	6		3			29	146
Quillback		2								2	10
River Carpsucker	2									2	10
Shorthead Redhorse		2								2	10
Silver Chub								4		4	20
Smallmouth Buffalo	4									4	20
Walleye	2									2	10
White Bass	4	13	22	9			3	4		55	277
Species	**Total Number Impinged (February)**										
	2/1-2/2	2/6-2/7	2/7-2/8	2/12-2/13	2/13-2/14	2/19-2/20	2/20-2/21	2/26-2/27	2/27-2/28	Total Number	Projected Number
Black Bullhead		1					1	2	1	5	19
Black Crappie	2		3			2	1			8	30

Table C14
Impingement Losses for Pool 14 (cont.)

Species	Total Number Impinged (February)										
	2/1-2/2	2/6-2/7	2/7-2/8	2/12-2/13	2/13-2/14	2/19-2/20	2/20-2/21	2/26-2/27	2/27-2/28	Total Number	Projected Number
Bluegill				1			1	2	3	7	26
Carpsucker Species	2		1			4	4		2	13	49
Central Mudminnow	1									1	4
Channel Catfish	1	3	8	7	4	8	6	3	10	50	187
Emerald Shiner							1		8	9	34
Flathead Catfish	1	3	1	2	6	2	1	7	6	29	108
Freshwater Drum	932	785	685	638	1,150	819	665	630	351	6,655	24,890
Gizzard Shad	1,852	2,599	2,296	779	628	102	74	15	47	8,392	31,386
Golden Redhorse									1	1	4
Golden Shiner								1	1	2	7
Largemouth Bass					1				1	2	7
Mooneye	2	3	5	3		2	4	3	1	23	86
Quillback				1						1	4
River Carpsucker				1						1	4
Shorthead Redhorse									2	2	7
Silver Chub				1	1			1		3	11
Silver Lamprey					1			1		2	7
Smallmouth Buffalo	2	2	3	2	4	1	5	1	1	21	79

Table C14
Impingement Losses for Pool 14 (cont.)

Species	Total Number Impinged (February)										
	2/1-2/2	2/6-2/7	2/7-2/8	2/12-2/13	2/13-2/14	2/19-2/20	2/20-2/21	2/26-2/27	2/27-2/28	Total Number	Projected Number
Stonecat	1									1	4
Tadpole Madtom							1			1	4
Walleye				1				1		2	7
White Bass	11	11	12	11	11	8	9	10	6	89	333
White Sucker									1	1	4
Yellow Bass									1	1	4

Species	Total Number Impinged (March)									
	3/4-3/5	3/5-3/6	3/11-3/12	3/12-3/13	3/20-3/21	3/21-3/22	3/25-3/26	3/26-3/27	Total Number	Projected Number
Black Bullhead	1		1		3	3	15	12	35	134
Black Crappie	1	1		1	1	2	1	1	8	31
Bluegill	1			1	22	25	116	30	195	749
Carp					1				1	4
Carpsucker Species	6	10	8	5	1	4	1	5	40	154
Central Mudminnow						2			2	8
Channel Catfish	7	6	4	6	9	11	14	10	67	257
Emerald Shiner		1			2	1			4	15
Flathead Catfish	4	9	1		3	2	2	4	25	96
Freshwater Drum	675	541	251	329	726	763	1,644	1,411	6,340	24,346

Table C14
Impingement Losses for Pool 14 (cont.)

Species	Total Number Impinged (March)									
	3/4-3/5	3/5-3/6	3/11-3/12	3/12-3/13	3/20-3/21	3/21-3/22	3/25-3/26	3/26-3/27	Total Number	Projected Number
Gizzard Shad	16	13	5	10	22	14	35	38	153	588
Golden Shiner					1		1		2	8
Grass Pickerel					1				1	4
Green Sunfish						1			1	4
Largemouth Bass					1		4	3	8	31
Logperch							1		1	4
Mooneye	2				4	19	10	5	40	154
Orangespotted Sunfish					1	1	3	1	6	23
Pumpkinseed	1				18	24	48	17	108	415
River Carpsucker			1						1	4
River Shiner	1	1						1	3	12
Shorthead Redhorse		1				1			2	8
Shortnose Gar		1		1	1	1	2		6	23
Silver Chub			1				1		2	8
Silvery Minnow								1	1	4
Smallmouth Buffalo		1	2	2	2	3	7	3	20	77
Spottail Shiner				1	1				2	8
Stonecat	1				2				3	12

Table C14
Impingement Losses for Pool 14 (cont.)

Species	Total Number Impinged (March)									
	3/4-3/5	3/5-3/6	3/11-3/12	3/12-3/13	3/20-3/21	3/21-3/22	3/25-3/26	3/26-3/27	Total Number	Projected Number
Tadpole Madtom					1				1	4
Walleye	1			1	3	2	2	1	10	38
White Bass	13	5	1	1	17	16	66	27	146	561
White Crappie					1		2		3	12
Yellow Bass								1	1	4
Yellow Bullhead					1				1	4
Yellow Perch							2	2	4	15

Species	Total Number Impinged (April)										
	4/1-4/2	4/2-4/3	4/8-4/9	4/9-4/10	4/15-4/16	4/16-4/17	4/22-4/23	4/23-4/24	4/29-4/30	Total Number	Projected Number
Bigmouth Buffalo				1						1	3
Black Bullhead	3	11	1		1		3	1		20	69
Black Crappie			2			1		1	1	5	17
Bluegill	6	9	3	2	8	3	12	14	27	84	291
Carpsucker Species	6	10		2		1	1			20	69
Central Mudminnow				1						1	3
Channel Catfish	11	16	12	10	8	15	12	15	12	111	384
Emerald Shiner		1		1						2	7
Fathead Minnow	1									1	3

Table C14
Impingement Losses for Pool 14 (cont.)

Species	Total Number Impinged (April)										
	4/1-4/2	4/2-4/3	4/8-4/9	4/9-4/10	4/15-4/16	4/16-4/17	4/22-4/23	4/23-4/24	4/29-4/30	Total Number	Projected Number
Flathead Catfish	4	5	1	1	2	2		2	2	19	66
Freshwater Drum	856	712	592	408	723	692	1,724	1,606	3,003	10,316	35,693
Gizzard Shad	12	18	18	20	27	20	16	9	10	150	519
Golden Shiner		2							3	5	17
Johnny Darter									1	1	3
Largemouth Bass		2			1					3	10
Logperch		1	4		5	4	3	3	1	21	73
Longnose Gar			1		2			1		4	14
Mooneye	10	7	9	3	4	6	9	9	2	59	204
Orangespotted Sunfish	1									1	3
Pumpkinseed	5	9	4	2	1	3	1	5	4	34	118
River Shiner			1						1	2	7
Shorthead Redhorse							1	2		3	10
Shortnose Gar				1		3				4	14
Silvery Minnow				1						1	3
Slenderhead Darter									1	1	3
Smallmouth Buffalo	3	6	2	4	3	4	5	5	9	41	142
Spottail Shiner	2							2		4	14

Table C14
Impingement Losses for Pool 14 (cont.)

Species	Total Number Impinged (April)										
	4/1-4/2	4/2-4/3	4/8-4/9	4/9-4/10	4/15-4/16	4/16-4/17	4/22-4/23	4/23-4/24	4/29-4/30	Total Number	Projected Number
Stonecat		1			1			1		3	10
Walleye				1						1	3
White Bass	52	60	32	22	39	30	31	14	27	307	1,062
White Crappie								1		1	3
Yellow Bass			2		2	1	1	5	4	15	52
Yellow Bullhead		1								1	3
Yellow Perch			1			1	1		2	5	17

Species	Total Number Impinged (May)					
	5/6-5/7	5/13-5/14	5/20-5/21	5/28-5/29	Total Number	Projected Number
Black Bullhead		4	6	1	11	85
Black Crappie	1	1		1	3	23
Bluegill	10	9	11	2	32	248
Carpsucker Species	1	1	2	1	5	39
Channel Catfish	5	4	8	11	28	217
Emerald Shiner				2	2	16
Flathead Catfish		1		2	3	23
Freshwater Drum	1,087	333	214	133	1,767	13,694
Gizzard Shad	7		1	1	9	70

Table C14
Impingement Losses for Pool 14 (cont.)

Species	Total Number Impinged (May)					
	5/6-5/7	5/13-5/14	5/20-5/21	5/28-5/29	Total Number	Projected Number
Logperch	1			1	2	16
Mooneye	6	4		5	15	116
Orangespotted Sunfish	1		2	1	4	31
Pumpkinseed	2		2		4	31
Redhorse Species			2	2	4	31
River Carpsucker				2	2	16
River Darter	1				1	8
River Shiner	1	18		3	22	171
Shorthead Redhorse			3	1	4	31
Smallmouth Buffalo	10	7	5	12	34	264
Spottail Shiner			1		1	8
Walleye		1			1	8
White Bass	15	15	4	3	37	287
White Crappie	1	1			2	16
White Sucker			1		1	8

Table C14
Impingement Losses for Pool 14 (cont.)

Species	Total Number Impinged (June)					
	6/3-6/4	6/10-6/11	6/17-6/18	6/24-6/25	Total Number	Projected Number
Black Bullhead	3	2	1		6	46
Black Crappie	3	1			4	31
Bluegill	8	9	2	1	20	153
Channel Catfish	32	5	1		38	291
Emerald Shiner	1	1		1	3	23
Flathead Catfish	1				1	8
Freshwater Drum	81	110	44	6	241	1,846
Gizzard Shad	1				1	8
Highfin Carpsucker			1		1	8
Largemouth Bass	2				2	15
Mooneye	3	3			6	46
Orangespotted Sunfish	1				1	8
Quillback	1				1	8
Redhorse Species		1			1	8
River Carpsucker	2				2	15
River Shiner	8				8	61
Sauger	1				1	8

Table C14
Impingement Losses for Pool 14 (cont.)

Species	Total Number Impinged (June)					
	6/3-6/4	6/10-6/11	6/17-6/18	6/24-6/25	Total Number	Projected Number
Shorthead Redhorse	4	3	2		9	69
Silver Chub	1				1	8
Smallmouth Buffalo	15	5			20	153
Spottail Shiner			1		1	8
Stonecat			1		1	8
White Bass	1	2	1	1	5	38
White Sucker	1	1	1		3	23
Species	**Total Number Impinged (July)**					
	7/2-7/3	**7/8-7/9**	**7/15-7/16**	**7/22-7/23**	**Total Number**	**Projected Number**
Black Crappie	2		1		3	25
Bluegill				2	2	17
Carp			1		1	8
Channel Catfish		4	4	4	12	100
Freshwater Drum	9	1	3	6	19	159
Gizzard Shad			1	5	6	50
Largemouth Bass		2			2	17
Longnose Gar			1	2	3	25
Mooneye			1		1	8

Table C14
Impingement Losses for Pool 14 (cont.)

Species	Total Number Impinged (July)					
	7/2-7/3	7/8-7/9	7/15-7/16	7/22-7/23	Total Number	Projected Number
Northern Pike	1	1			2	17
Orangespotted Sunfish		1			1	8
Pumpkinseed	1				1	8
Shortnose Gar		1		1	2	17
Spotfin Shiner	1				1	8
Spottail Shiner	1				1	8
White Bass		2	12	22	36	301

Species	Total Number Impinged (August)						
	7/31-8/1	8/6-8/7	8/13-8/14	8/20-8/21	8/27-8/28	Total Number	Projected Number
Black Bullhead					1	1	6
Black Crappie	2			2	2	4	25
Bluegill	2	1	4	2	3	12	74
Buffalo Species		1				1	6
Carp	2		1			3	19
Carpsucker Species	1		1			2	12
Channel Catfish	16	10	42	84	23	175	1,085
Emerald Shiner			1	3	3	7	43
Freshwater Drum	10	2	9	8	5	34	211

Table C14
Impingement Losses for Pool 14 (cont.)

Species	Total Number Impinged (August)						
	7/31-8/1	8/6-8/7	8/13-8/14	8/20-8/21	8/27-8/28	Total Number	Projected Number
Gizzard Shad	8	2	38	49	19	116	719
Golden Shiner					1	1	6
Largemouth Bass			1			1	6
Longnose Gar	5	4	1	1		11	68
Mooneye	1	1	14	6	3	25	155
Orangespotted Sunfish	2			1		3	19
River Shiner					1	1	6
Shorthead Redhorse			1			1	6
Silver Chub			1	3	2	6	37
Spottail Shiner			1			1	6
White Bass	6	6	5	4	1	22	136
White Crappie	1	2	2			5	31

Species	Total Number Impinged (September)					
	9/5-9/6	9/10-9/11	9/16-9/17	9/24-9/25	Total Number	Projected Number
Black Crappie		5	4	7	16	120
Bluegill	5	4	11	213	233	1,748
Carp				1	1	8
Carpsucker Species	1				1	8

Table C14
Impingement Losses for Pool 14 (cont.)

Species	Total Number Impinged (September)					
	9/5-9/6	9/10-9/11	9/16-9/17	9/24-9/25	Total Number	Projected Number
Channel Catfish	32	29	90	80	231	1,733
Emerald Shiner	8	39	26	45	118	885
Fathead Minnow				1	1	8
Flathead Catfish				1	1	8
Freshwater Drum	1	3	9	7	20	150
Gizzard Shad	36	56	68	188	348	2,610
Largemouth Bass				4	4	30
Logperch	1				1	8
Longnose Gar			1	1	2	15
Mooneye	5	4		2	11	83
Northern Pike	1				1	8
Orangespotted Sunfish			1	1	2	15
Pumpkinseed			1	1	2	15
River Carpsucker			14		14	105
River Shiner				3	3	23
Sauger			1		1	8
Silver Chub	2	3	2	1	8	60

Table C14
Impingement Losses for Pool 14 (cont.)

Species	Total Number Impinged (September)					
	9/5-9/6	9/10-9/11	9/16-9/17	9/24-9/25	Total Number	Projected Number
Silvery Minnow			1	26	27	203
Smallmouth Buffalo			1	2	3	23
Spottail Shiner		1	1	1	3	23
Spotted Sucker			1		1	8
Stonecat				1	1	8
Walleye	1				1	8
White Bass	7	5	19	17	48	360
White Crappie		1		1	2	15

Species	Total Number Impinged (October)						
	10/2-10/3	10/8-10/9	10/15-10/16	10/22-10/23	10/29-10/30	Total Number	Projected Number
Black Crappie	6	1	2		6	15	93
Bluegill	280	89	272	208	180	1,029	6,380
Carp	1					1	6
Carpsucker Species					3	3	19
Channel Catfish	34	29	12	8	12	95	589
Emerald Shiner	55		11	25	12	103	639
Fathead Minnow					3	3	19
Freshwater Drum	24	44	49	305	1,167	1,589	9,852

Table C14
Impingement Losses for Pool 14 (cont.)

Species	Total Number Impinged (October)						
	10/2-10/3	10/8-10/9	10/15-10/16	10/22-10/23	10/29-10/30	Total Number	Projected Number
Gizzard Shad	288	473	119	672	15,753	17,305	107,291
Golden Shiner		1		2		3	19
Green Sunfish					3	3	19
Largemouth Bass	5	5	1	25	9	45	279
Logperch					3	3	19
Longnose Gar	3	2	4	3	6	18	112
Mooneye	7	4	5	9	18	43	267
Orangespotted Sunfish			2	5	6	13	81
Pumpkinseed	2	10	9	3	12	36	
River Carpsucker		1		2		3	19
River Shiner				1		1	6
Rock Bass					3	3	19
Shorthead Redhorse		1		1		2	12
Shortnose Gar				3	6	9	56
Silver Chub	1	1		6	42	50	310
Silvery Minnow	12	17	1	10		40	248
Smallmouth Buffalo	2	1		2		5	31

Table C14
Impingement Losses for Pool 14 (cont.)

Species	Total Number Impinged (October)						
	10/2-10/3	10/8-10/9	10/15-10/16	10/22-10/23	10/29-10/30	Total Number	Projected Number
Spottail Shiner	5			7	6	18	112
Walleye					3	3	19
White Bass	32	13	8	26	36	115	713
White Crappie					3	3	19
Yellow Bass					3	3	19

Species	Total Number Impinged (November)					
	11/5-11/6	11/12-11/13	11/20-11/21	11/25	Total Number	Projected Number
Black Bullhead			1		1	9
Black Crappie	2	21		3	26	237
Bluegill	14	7	3		24	219
Buffalo Species	4				4	36
Carp	2				2	18
Carpsucker Species	8		1	2	11	100
Channel Catfish	2		1	11	14	128
Emerald Shiner	2	1		2	5	46
Flathead Catfish		2			2	18
Freshwater Drum	318	302	323	830	1,773	16,152
Gizzard Shad	15,800	1,659	2,009	1,901	21,369	194,672

Table C14
Impingement Losses for Pool 14 (cont.)

Species	Total Number Impinged (November)					
	11/5-11/6	11/12-11/13	11/20-11/21	11/25	Total Number	Projected Number
Golden Shiner			1		1	9
Hybrid Striped Bass				1	1	9
Largemouth Bass	18	5	5		28	255
Longnose Gar	2	2	1	3	8	73
Mooneye		8	6	2	16	146
Northern Pike				1	1	9
Orangespotted Sunfish		6		1	7	64
Pumpkinseed				1	1	9
River Carpsucker		3			3	27
River Shiner				1	1	9
Shortnose Gar	14		1		15	137
Silver Chub		2			2	18
Smallmouth Buffalo	2	1	2	1	6	55
Spottail Shiner		2			2	18
Walleye			1		1	9
White Bass	58	33	22	9	122	1,111

Table C14
Impingement Losses for Pool 14 (cont.)

Species	Total Number Impinged (December)						
	12/2-12/3	12/10-12/11	12/17-12/18	12/26-12/27	12/30-12/31	Total Number	Projected Number
Black Bullhead				1		1	6
Black Crappie	3	3	1	7	5	19	121
Bluegill	1	3	2		2	8	51
Buffalo Species				1	1	2	13
Carpsucker Species	3	3	1	1		8	51
Channel Catfish	5	16	5	7	5	38	242
Emerald Shiner	1					1	6
Flathead Catfish					1	1	6
Freshwater Drum	175	237	144	135	203	894	5,686
Gizzard Shad	7,345	3,751	691	269	205	12,261	77,980
Largemouth Bass			1	1	1	3	19
Longnose Gar		2	1			3	19
Mooneye		4	2	2	4	12	76
Orangespotted Sunfish			1			1	6
Pumpkinseed		1		1		2	13
Sauger			1			1	6
Shortnose Gar	1	1	2			4	25

Table C14
Impingement Losses for Pool 14 (cont.)

Species	Total Number Impinged (December)						
	12/2-12/3	12/10-12/11	12/17-12/18	12/26-12/27	12/30-12/31	Total Number	Projected Number
Silver Chub	3		1	1		5	32
Smallmouth Buffalo	1					1	6
White Bass	13	15	17	13	11	69	439
White Crappie	1					1	6

Quad Cities Station, 1996 (LMSE 1997a)

Species	Estimated Number Impinged											
	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Bigmouth Buffalo				1								
Black Bullhead		5	35	20	11	6		1			1	1
Black Crappie	11	8	8	5	3	4	3	4	16	15	26	19
Bluegill	34	7	195	84	32	20	2	12	233	1,029	24	8
Buffalo Species								1			4	2
Carp	3		1				1	3	1	1	2	
Carpsucker Species	5	13	40	20	5			2	1	3	11	8
Central Mudminnow		1	2	1								
Channel Catfish	31	50	67	111	28	38	12	175	231	95	14	38
Emerald Shiner		9	4	2	2	3		7	118	103	5	1

Table C14
Impingement Losses for Pool 14 (cont.)

Species	Estimated Number Impinged											
	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Fathead Minnow				1					1	3		
Flathead Catfish	8	29	25	19	3	1			1		2	1
Freshwater Drum	2,481	6,655	6,340	10,316	1,767	241	19	34	20	1,589	1,773	894
Gizzard Shad	73,384	8,392	153	150	9	1	6	116	348	17,305	21,369	12,261
Golden Redhorse	2	1										
Golden Shiner		2	2	5				1		3	1	
Grass Pickerel			1									
Green Sunfish			1							3		
Highfin Carpsucker						1						
Hybrid Striped Bass										1		
Johnny Darter				1								
Largemouth Bass	2	2	8	3		2	2	1	4	45	28	3
Logperch			1	21	2				1	3		
Longnose Gar				4			3	11	2	18	8	3
Mooneye	29	23	40	59	15	6	1	25	11	43	16	12
Northern Pike							2		1		1	
Orangespotted Sunfish			6	1	4	1	1	3	2	13	7	1

Table C14
Impingement Losses for Pool 14 (cont.)

Species	Estimated Number Impinged											
	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Pumpkinseed			108	34	4		1		2	36	1	2
Quillback	2	1				1						
Redhorse Species					4	1						
River Carpsucker	2	1	1		2	2			14	3	3	
River Darter					1							
River Shiner	3	2	22	8		1	3	1	1			
Rock Bass										3		
Sauger						1			1			1
Shorthead Redhorse	2	2	2	3	4	9		1		2		
Shortnose Gar			6	4			2			9	15	4
Silver Chub	4	3	2			1		6	8	50	2	5
Silver Lamprey		2										
Silvery Minnow			1	1					27	40		
Slenderhead Darter				1								
Smallmouth Buffalo	4	21	20	41	34	20			3	5	6	1
Spotfin Shiner							1					
Spottail Shiner			2	4	1	1	1	1	3	18	2	

Table C14
Impingement Losses for Pool 14 (cont.)

Species	Estimated Number Impinged											
	Jan	**Feb**	**March**	**April**	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
Spotted Sucker									1			
Stonecat		1	3	3		1			1			
Tadpole Madtom		1	1									
Walleye	2	2	10	1	1				1	3	1	
White Bass	55	89	146	307	37	5	36	22	48	115	122	69
White Crappie			3	1	2			5	2	3		1
White Sucker		1			1	3						
Yellow Bass		1	1	15						3		
Yellow Bullhead			1	1								
Yellow Perch			4	5								

Quad Cities Station, 1996 (LMSE 1997b)

Species	Estimated Number Impinged											
	Jan	**Feb**	**March**	**April**	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
Freshwater Drum	12,479	24,890	24,346	35,693	13,694	1,846	159	211	150	9,852	16,152	5,686

Table C14
Impingement Losses for Pool 14 (cont.)

Quad Cities Station, 1996 (LMSE 1997a)

Species	Estimated Number Impinged
Bigmouth Buffalo	3
Black Bullhead	375
Black Crappie	808
Bluegill	10,126
Buffalo Species	55
Carp	78
Carpsucker Species	525
Central Mudminnow	15
Channel Catfish	5,368
Emerald Shiner	1,713
Fathead Minnow	30
Flathead Catfish	373
Freshwater Drum	145,158
Gizzard Shad	785,013
Golden Redhorse	14
Golden Shiner	66
Grass Pickerel	4

Table C14
Impingement Losses for Pool 14 (cont.)

Species	Estimated Number Impinged
Green Sunfish	22
Highfin Carpsucker	8
Hybrid Striped Bass	9
Johnny Darter	3
Largemouth Bass	680
Logperch	118
Longnose Gar	326
Mooneye	1,486
Northern Pike	33
Orangespotted Sunfish	258
Pumpkinseed	832
Quillback	21
Redhorse Species	39
River Carpsucker	199
River Darter	8
River Shiner	294
Rock Bass	19
Sauger	22

Table C14
Impingement Losses for Pool 14 (cont.)

Species	Estimated Number Impinged
Shorthead Redhorse	154
Shortnose Gar	271
Silver Chub	504
Silver Lamprey	7
Silvery Minnow	458
Slenderhead Darter	3
Smallmouth Buffalo	849
Spotfin Shiner	8
Spottail Shiner	204
Spotted Sucker	8
Stonecat	41
Tadpole Madtom	8
Walleye	102
White Bass	5,618
White Crappie	101
White Sucker	34
Yellow Bass	78
Yellow Bullhead	7

Table C14
Impingement Losses for Pool 14 (cont.)

Species	Estimated Number Impinged
Yellow Perch	33

Table C15
Impingement Losses for Pool 15

Riverside Generating Station (Old Screen House), 1974-1975 (MidAmerican Energy Company 1976)

Species	Total Number Impinged from 7/22/74 to 5/9/75											
	July 22-26	August 26-30	Sept 16-20	Oct 14-18	Nov 18-22	Dec 16-20	Jan 20-24	Feb 18-21	March 10-14	April 7-11	May 5-9	Total
Black Bullhead										1	8	9
Black Crappie	1											1
Bluegill	9									1		10
Carp	5											5
Channel Catfish	25	2	8	1		1	4	2	12	55	1	111
Emerald Shiner			1							4		5
Fathead Minnow										6		6
Flathead Catfish	1		4	1					1		11	18
Freshwater Drum	11	3	5			11	134	136	84	144	2	530
Ghost Shiner	7											7
Gizzard Shad	2		8	10		1,379	63	13	40	27	10	1,552
Golden Shiner											1	1
Mooneye	1											1
Northern River Carpsucker										1		1
Orangespotted Sunfish										1		1

Table C15
Impingement Losses for Pool 15 (cont.)

Species	Total Number Impinged from 7/22/74 to 5/9/75											
	July 22-26	**August 26-30**	**Sept 16-20**	**Oct 14-18**	**Nov 18-22**	**Dec 16-20**	**Jan 20-24**	**Feb 18-21**	**March 10-14**	**April 7-11**	**May 5-9**	**Total**
Quillback		2										2
Silver Lamprey										1		1
Smallmouth Bass	1											1
Smallmouth Buffalo										1		1
Spottail Shiner										1		1
White Bass		2				1	3		2	14	1	23
White Crappie										1		1
Yellow Bullhead										4	1	5

Riverside Generating Station (New Screen House), 1974-1975 (MidAmerican Energy Company 1976)

Species	Total Number Impinged from 7/22/74 to 5/9/75											
	July 22-26	**August 26-30**	**Sept 16-20**	**Oct 14-18**	**Nov 18-22**	**Dec 16-20**	**Jan 20-24**	**Feb 18-21**	**March 10-14**	**April 7-11**	**May 5-9**	**Total**
Black Bullhead							3		2	13		18
Black Crappie				2		1	1	1		4		9
Bluegill	11	8	2	8	1	3		2	3	7		45
Carp	3	1	1		2	4		1	3	1		16
Channel Catfish	23	87	14	2	6	67	110	60	32	100		501

Table C15
Impingement Losses for Pool 15 (cont.)

Species	Total Number Impinged from 7/22/74 to 5/9/75											
	July 22-26	August 26-30	Sept 16-20	Oct 14-18	Nov 18-22	Dec 16-20	Jan 20-24	Feb 18-21	March 10-14	April 7-11	May 5-9	Total
Emerald Shiner	1	4				2	3	1	1	55		67
Fathead Minnow							6		3	14		23
Flathead Catfish	7	3	2	10	1	5	1	2	5	11		47
Freshwater Drum	15	54	6	32	155	122	430	410	79	132		1,435
Ghost Shiner	4											4
Gizzard Shad	31	7	1	23	734	9,914	1,902	462	404	46		13,524
Golden Shiner					1				1	8		10
Grass Pickerel										2		2
Largemouth Bass	2	1										3
Longnose Gar	1			1								2
Mooneye	3	3								10		16
Northern Pike										2		2
Northern Redhorse										2		2
Northern River Carpsucker										2		2
Notropis sp.							1			26		27
Orangespotted Sunfish										3		3

Table C15
Impingement Losses for Pool 15 (cont.)

Species	Total Number Impinged from 7/22/74 to 5/9/75											
	July 22-26	August 26-30	Sept 16-20	Oct 14-18	Nov 18-22	Dec 16-20	Jan 20-24	Feb 18-21	March 10-14	April 7-11	May 5-9	Total
Quillback				2								2
River Chub										7		7
River Shiner	1											1
Shortnose Gar						1			1			2
Shovelnose Sturgeon	1											1
Silver Lamprey						1		1		1		3
White Bass	1	6	1	1	14	58	21	5	11	8		126
White Crappie						2			1	3		6
Yellow Bullhead		1			1					14		16
Yellow Perch										2		2

Table C16
Impingement Losses for Pool 17

Muscatine Power Station, 1976 (Wapora, Inc. 1976b)

Species	**Total Number Impinged** (Sum of Units 5, 6, 7, and 8)									
	1/12/76	**1/20/76**	**1/28/76**	**2/5/76**	**2/9/76**	**2/20/76**	**2/24/76**	**3/3/76**	**3/11/76**	**3/23/76**
Brown Bullhead										1
Channel Catfish		1	2							
Freshwater Drum		1				1	1			3
Gizzard Shad	2	5	2	2	1	3	1			
Mooneye									1	1
River Carpsucker								1		
White Bass										1

Table C17
Impingement Losses for Pool 19

Burlington Generating Station, July 1975 (Prill 1977)

Species	Total Number Impinged				
	<100 mm	100-124 mm	125-149 mm	≥150 mm	Total
Black Crappie	1			1	2
Bluntnose Minnow		2			2
Carp	3				3
Carpsucker				1	1
Channel Catfish	7		1	8	16
Freshwater Drum	4				4
Gizzard Shad	1				1
Largemouth Bass	2				2
Mooneye	3		1	1	5
Notropis sp.	2				2
White Bass	1				1
White Crappie	1	1			2
Yellow Bullhead	2				2

Table C17
Impingement Losses for Pool 19 (cont.)

Burlington Generating Station, August 1975 (Prill 1977)

Species	**Total Number Impinged**				
	<100 mm	**100-124 mm**	**125-149 mm**	**≥150 mm**	**Total**
Black Crappie	2			1	3
Bluegill	11			1	12
Bluntnose Minnow	1				1
Buffalo				1	1
Channel Catfish	69			20	89
Flathead Catfish	8			5	13
Freshwater Drum	104			4	108
Gizzard Shad	10	1			11
Hybopsis sp.	1				1
Mooneye	2			2	4
Notropis sp.	2				2
Stonecat	3				3
Sucker			1		1
White Bass	2				2
White Crappie	6		1	1	8

Table C17
Impingement Losses for Pool 19 (cont.)

Burlington Generating Station, September 1975 (Prill 1977)

Species	Total Number Impinged				
	<100 mm	100-124 mm	125-149 mm	≥150 mm	Total
Black Crappie	1				1
Bluegill	6				6
Bluntnose Minnow	1				1
Channel Catfish	31			3	34
Flathead Catfish	1	1			2
Freshwater Drum	18				18
Gizzard Shad	2				2
Minnow	1				1
Mooneye			2		2
White Bass	1	1			2
White Crappie	1				1

Burlington Generating Station, October 1975 (Prill 1977)

Species	Total Number Impinged				
	<100 mm	100-124 mm	125-149 mm	≥150 mm	Total
Bluegill	3				3
Bluntnose Minnow	1				1

Table C17
Impingement Losses for Pool 19 (cont.)

Species	Total Number Impinged				
	<100 mm	100-124 mm	125-149 mm	≥150 mm	Total
Channel Catfish	3	1			4
Freshwater Drum	1				1
Gizzard Shad	1			1	2
Mooneye		1	4		5
White Bass			1		1
Burlington Generating Station, November 1975 (Prill 1977)					
Species	**Total Number Impinged**				
	<100 mm	**100-124 mm**	**125-149 mm**	**≥150 mm**	**Total**
Bluegill	6	1			7
Carp				1	1
Flathead Catfish		1			1
Freshwater Drum	23	3	2	3	31
Gizzard Shad	1	1		3	5
Mooneye			2	1	3
Notropis sp.	1				1
Smallmouth Bass	1	1			2
Stonecat	1				1

Table C17
Impingement Losses for Pool 19 (cont.)

Species	Total Number Impinged				
	<100 mm	**100-124 mm**	**125-149 mm**	**≥150 mm**	**Total**
Walleye				1	1
White Bass		2			2
White Crappie	1				1
Burlington Generating Station, December 1975 (Prill 1977)					
Species	**Total Number Impinged**				
	<100 mm	**100-124 mm**	**125-149 mm**	**≥150 mm**	**Total**
Black Crappie				1	1
Bluegill	10	1			11
Bluntnose Minnow	1				1
Buffalo	2				2
Channel Catfish	8	1	1	1	11
Flathead Catfish	2	2			4
Freshwater Drum	46	3		3	52
Gizzard Shad	208	8	3	8	227
Mooneye			2		2
Notropis sp.	2				2
Smallmouth Bass	1		1		2

Table C17
Impingement Losses for Pool 19 (cont.)

Species	Total Number Impinged				
	<100 mm	100-124 mm	125-149 mm	≥150 mm	Total
White Bass		12	5	2	19
Yellow Perch	1				1
Burlington Generating Station, January 1976 (Prill 1977)					
Species	**Total Number Impinged**				
	<100 mm	**100-124 mm**	**125-149 mm**	**≥150 mm**	**Total**
Black Bullhead	1				1
Buffalo				1	1
Carp				1	1
Channel Catfish	5				5
Flathead Catfish	5	5			10
Freshwater Drum	9	2	1	1	13
Gizzard Shad	36	22	16	37	111
Stonecat	1		1		2
White Bass	3	11	9	1	24

Table C17
Impingement Losses for Pool 19 (cont.)

Burlington Generating Station, February 1976 (Prill 1977)

Species	**Total Number Impinged**				
	<100 mm	**100-124 mm**	**125-149 mm**	**≥150 mm**	**Total**
Black Bullhead	2	1			3
Bluegill	1				1
Channel Catfish	23	4			27
Flathead Catfish	21	4			25
Freshwater Drum	44	15	15	11	85
Gizzard Shad	3	11	22	68	104
Hybopsis sp.		2			2
Northern Pike				1	1
Notropis sp.	1				1
Stonecat	2	2			4
Walleye				1	1
White Bass		2	5		7

Table C17
Impingement Losses for Pool 19 (cont.)

Burlington Generating Station, March 1976 (Prill 1977)

Species	**Total Number Impinged**				
	<100 mm	**100-124 mm**	**125-149 mm**	**≥150 mm**	**Total**
Black Bullhead	5	1			6
Black Crappie	3				3
Bluegill	14	1			15
Carpsucker	1	2	1	1	5
Channel Catfish	38	4		4	46
Flathead Catfish	2		1		3
Freshwater Drum	59	17	43	36	155
Gizzard Shad	7	10	10	8	35
Golden Shiner	1				1
Hybopsis sp.		11	1		12
Johnny Darter	1				1
Mooneye		2			2
Notropis sp.	5				5
White Bass		7	1		8
White Crappie	1				1
Yellow Perch	1				1

Table C17
Impingement Losses for Pool 19 (cont.)

Burlington Generating Station, April 1976 (Prill 1977)

Species	**Total Number Impinged**				
	<100 mm	**100-124 mm**	**125-149 mm**	**≥150 mm**	**Total**
Black Bullhead	2				2
Bluegill	1				1
Channel Catfish	46	63			109
Freshwater Drum	3	7	9	8	27
Gizzard Shad	3	94	95	10	202
Mooneye			1		1
Notropis sp.	1				1
Smallmouth Bass	1				1
Stonecat	1				1
White Bass		1		1	2
White Crappie				3	3
Yellow Perch	1				1

Table C17
Impingement Losses for Pool 19 (cont.)

Burlington Generating Station, May 1976 (Prill 1977)

Species	Total Number Impinged				
	<100 mm	100-124 mm	125-149 mm	≥150 mm	Total
Bluegill	3			1	4
Bluntnose Minnow	1				1
Carpsucker				1	1
Channel Catfish	10			1	11
Flathead Catfish	1				1
Freshwater Drum	1		2	3	6
Gizzard Shad		1	1	3	5
Mooneye				1	1
Notropis sp.	3				3
Smallmouth Bass		1			1
Stonecat	1				1

Burlington Generating Station, June 1976 (Prill 1977)

Species	Total Number Impinged				
	<100 mm	100-124 mm	125-149 mm	≥150 mm	Total
Bluegill			1		1
Buffalo				1	1

Table C17
Impingement Losses for Pool 19 (cont.)

Species	**Total Number Impinged**				
	<100 mm	**100-124 mm**	**125-149 mm**	**≥150 mm**	**Total**
Channel Catfish	11	10	2	1	24
Flathead Catfish	1			1	2
Gizzard Shad	1			1	2
Mooneye				1	1
Notropis sp.	1				1
Stonecat			1		1

Burlington Generating Station, July 1975-June 1976 (Prill 1977)

Species	**Total Number Impinged**	**Estimated Total Number Impinged**
Black Bullhead	12	84
Black Crappie	10	70
Bluegill	61	427
Bluntnose Minnow	7	49
Buffalo	5	35
Carp	4	28
Carpsucker	8	56
Channel Catfish	376	2,632
Flathead Catfish	61	427

Table C17
Impingement Losses for Pool 19 (cont.)

Species	Total Number Impinged	Estimated Total Number Impinged
Freshwater Drum	500	3,500
Gizzard Shad	707	4,949
Golden Shiner	1	7
Hybopsis sp.	15	105
Johnny Darter	1	7
Largemouth Bass	2	14
Mooneye	26	182
Northern Pike	1	7
Notropis sp.	18	126
Pimephales sp.	1	7
Smallmouth Bass	6	42
Stonecat	13	91
Sucker	1	7
Walleye	2	14
White Bass	68	476
White Crappie	16	112
Yellow Bullhead	2	14
Yellow Perch	3	21

Table C18
Impingement Losses for Pool 26

Sioux Power Plant, 1974 (EEH 1976)

Species	Estimated Number Impinged Per Month					
	July 16-31	August	September	October	November	December
Freshwater Drum	563.0	377.0	166.7	699.5	3,983.3	252.5
Gizzard Shad	236.6	455.5	708.5	892.9	157,095.8	300,653.2
Other Species	1,264.9	439.8	208.4	238.1	255.9	118.8
Total for All Species	2,064.5	1,272.3	1,083.6	1,830.5	161,335.0	301,024.5

Sioux Power Plant, 1975 (EEH 1976)

Species	Estimated Number Impinged Per Month						
	January	February	March	April	May	June	July 1-15
Freshwater Drum	257.0	239.2	9,177.5	31,622.7	38,346.5	1,081.7	357.9
Gizzard Shad	144,887.5	55,074.2	245,136.8	179,991.2	52,708.5	4,273.5	8,948.3
Other Species	408.2	223.2	2,169.1	4,775.0	4,811.1	1,015.1	602.4
Total for All Species	145,552.7	55,536.6	256,483.4	216,388.9	95,866.1	6,370.3	9,908.6

Table C19
Impingement Losses for Open River

Wood River Generating Plant, 1974-1975 (Wapora, Inc. 1975c)

Species	Total Number Impinged											
	Dec	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov
Bigmouth Buffalo									1			
Black Bullhead			6		1							
Black Crappie				1				1	5	1	3	
Blue Catfish										2		
Bluegill	22	1	4	8	1	44	11	3	1	2	3	
Carp						1	2	3		1		
Channel Catfish		3	5	1	3	3	1	4	1	4	1	
Chestnut Lamprey			1	1								
Crappie Species								4				
Flathead Catfish	1			1	1		26					
Freshwater Drum	19	18	134	125	94	296	76	34	33	29	6	
Gizzard Shad	304	148	3,587	1,035	63	1,427	804	87	58	307	27	10
Goldeye			5	2				1				
Grass Pickerel				1	1							
Largemouth Bass		1				2	2	1	2		5	
Longnose Gar				2								

Table C19
Impingement Losses for Open River (cont.)

Species	Total Number Impinged											
	Dec	**Jan**	**Feb**	**March**	**April**	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**	**Nov**
Mooneye				2	1							
Notropis sp.						40						
Paddlefish			1		1	1		1				
River Carpsucker	1			1								
Sauger			4	1		2	1				1	
Shortnose Gar	1				1		1	1	1			
Shovelnose Sturgeon								1				
Skipjack Herring			1						1	1	2	
Smallmouth Buffalo		1	2			3						
Suckermouth Minnow						1						
Warmouth			1			2	2	1				
White Bass			2	2	2	3	4		1	2	2	
White Crappie			1	1		6	3			1		

Table C19
Impingement Losses for Open River (cont.)

Wood River Generating Plant, 1974-1975 (Wapora, Inc. 1975c)

Species	Projected Annual Total Number Impinged
Freshwater Drum	3,733
Gizzard Shad	34,084
Other Species	1,412

New Madrid Power Plant, 1975 (Burns & McDonnell 1977)

Species	Total Impinged During One 8-hr Interval for Sample Dates Between 11/28/75 and 12/29/75		
	11/28	12/12	12/29
Blue Catfish	34		
Channel Catfish		1	
Flathead Catfish	2		1
Freshwater Drum	32	2	
Gizzard Shad	160	87	4
Pirate Perch	1		
Sauger		1	
Skipjack	9		

Table C19
Impingement Losses for Open River (cont.)

New Madrid Power Plant, 1976 (Burns & McDonnell 1977)

Species	Total Impinged During One 8-hr Interval for Sample Dates Between 1/10/76 and 8/13/76													
	1/10	1/24	2/7	2/20	3/5	3/18	4/2	4/9	4/17	4/25	7/24	7/30	8/6	8/13
Blue Catfish		3		3		0.33	1	1	8		2	1		
Buffalo					0.33									
Channel Catfish				0.33		0.66						1	7	13
European Carp					0.33									
Flathead Catfish				0.33		0.66		1	1				1	4
Freshwater Drum		3		1.33	0.33			1	30	7			5	12
Gizzard Shad	3	22	7	27	2	3.66	4	4	22		2	1		4
Green Sunfish									1					
Largemouth Buffalo									1					
Sauger				0.33					1					
Skipjack	1	1	1											
Smallmouth Buffalo				0.66		0.66			1					
White Bass									1					

New Madrid Power Plant, 1976 (Burns & McDonnell 1977)

Species	Total Impinged During One 8-hr Interval for Sample Dates Between 8/22/76 and 11/26/76													
	8/22	8/27	9/3	9/11	9/18	9/25	10/8	10/15	10/24	10/31	11/5	11/14	11/19	11/26
Blue Catfish		1		30		21	8		4					4

Table C19
Impingement Losses for Open River (cont.)

Species	Total Impinged During One 8-hr Interval for Sample Dates Between 8/22/76 and 11/26/76													
	8/22	8/27	9/3	9/11	9/18	9/25	10/8	10/15	10/24	10/31	11/5	11/14	11/19	11/26
Bluegill				1	2									
Channel Catfish	26	45	13	7	18	3			12	6	9	2	1	1
Flathead Catfish	1	8		3		2		1	1		2		1	1
Freshwater Drum		5	3	11	3	4	7	43	28	28	22	15	7	12
Gizzard Shad	15	3	1	3	1		4	5	6	26	57	46	12	12
Longnose Gar		1												
Paddlefish				1										
Quillback												2		
Shortnose Gar				1	1									
Skipjack		1		2		6				1	2		1	2
Smallmouth Buffalo													2	2
Speckled Chub												1		
Striped Bass						1								
White Bass												1	1	1

New Madrid Power Plant, November 28, 1975 - November 26, 1976 (Burns & McDonnell 1977)

Species	Total Number Impinged	Estimated Annual Number Impinged
Blue Catfish	167.3	5,551.3

Table C19
Impingement Losses for Open River (cont.)

Species	Total Number Impinged	Estimated Annual Number Impinged
Bluegill	3	99.5
Channel Catfish	168	5,574.5
European Carp	0.3	10
Flathead Catfish	31	1,028.6
Freshwater Drum	281.6	9,344
Gizzard Shad	543.6	18,037.6
Green Sunfish	1	33.2
Largemouth Buffalo	1	33.2
Longnose Gar	1	33.2
Paddlefish	1	33.2
Pirate Perch	1	33.2
Quillback	2	66.4
Sauger	2.3	76.3
Shortnose Gar	2	66.4
Skipjack	27	895.9
Smallmouth Buffalo	6.6	219
Speckled Chub	1	33.2
Striped Bass	1	33.2

Table C19
Impingement Losses for Open River (cont.)

Species	Total Number Impinged	Estimated Annual Number Impinged
White Bass	3	99.5
New Madrid Power Plant, February 10, 1978-January 26, 1979 (Associated Electric Cooperative 1980)		
Species	**Total Number Impinged**	**Estimated Annual Number Impinged**
Alabama Shad	1	6.2
Alligator Gar	1	6.2
American Eel	1	6.2
American Smelt	12	74.2
Blue Catfish	215	871
Bluegill	9	55.7
Carp	49	303.1
Central Mudminnow	2	12.4
Channel Catfish	581	2,541
Flathead Catfish	101	689
Freshwater Drum	632	3,909.8
Gizzard Shad	1,472	9,106.4
Notropis sp.	1	6.2
Paddlefish	8	49.5
Quillback	2	12.4

Table C19
Impingement Losses for Open River (cont.)

Species	Total Number Impinged	Estimated Annual Number Impinged
River Shiner	8	49.5
Shortnose Gar	3	18.6
Shovelnose Sturgeon	1	6.2
Silverband Shiner	2	12.4
Skipjack Herring	113	699.1
Smallmouth Buffalo	26	160.8
Striped Bass	4	24.7
Threadfin Shad	62	383.6
Unidentifiable	4	24.7
Walleye	5	30.9
White Bass	9	55.7
White Crappie	4	24.7

Table C20
Impingement Losses for Alton Pool

Meredosia Power Station, 1973 (Patulski & Everhart 1981)

Species	**Total Number Impinged**
Alewife	2
Black Bullhead	11
Black Crappie	256
Bluegill	216
Bowfin	21
Carp	42
Channel Catfish	47
Emerald Shiner	53
Flathead Catfish	8
Freshwater Drum	225
Gizzard Shad	10,597
Goldeye	2
Green Sunfish	8
Largemouth Bass	10
Logperch	5
Longnose Gar	9
Quillback	2

Table C20
Impingement Losses for Alton Pool (cont.)

Species	**Total Number Impinged**					
River Carpsucker	11					
Rock Bass	6					
Shorthead Redhorse	4					
Shortnose Gar	12					
Silver Chub	5					
Skipjack Herring	20					
Smallmouth Bass	16					
Unidentified	2					
White Bass	17					
White Crappie	280					
Meredosia Power Station, 1980 (Patulski & Everhart 1981)						
Species	**Total Number Impinged for Sample Dates Between 3/3/80 and 4/7/80**					
	3/3/80	**3/15/80**	**3/17/80**	**3/26/80**	**4/3/80**	**4/7/80**
Bigmouth Buffalo						
Black Buffalo						
Black Bullhead		1				
Black Crappie	1	1				1
Bluegill		2	1	2	1	

Table C20
Impingement Losses for Alton Pool (cont.)

Species	Total Number Impinged for Sample Dates Between 3/3/80 and 4/7/80					
	3/3/80	3/15/80	3/17/80	3/26/80	4/3/80	4/7/80
Bluntnose Minnow						
Bowfin						
Brown Bullhead						
Carp						
Channel Catfish	3	2	2	1	7	1
Crappie Species						
Emerald Shiner						
Flathead Catfish			1	1	1	1
Freshwater Drum	179	31	33	17	50	13
Gizzard Shad	301	421	193	95	194	105
Golden Redhorse				1		
Golden Shiner						
Goldeye						
Goldfish						
Grass Pickerel						
Green Sunfish					1	
Largemouth Bass						

Table C20
Impingement Losses for Alton Pool (cont.)

Species	Total Number Impinged for Sample Dates Between 3/3/80 and 4/7/80					
	3/3/80	3/15/80	3/17/80	3/26/80	4/3/80	4/7/80
Longear Sunfish						
Longnose Gar						
Mooneye						
Paddlefish						
Quillback						
Rainbow Smelt						
Redhorse Species						1
River Carpsucker						
Sauger						
Shiner Species						
Shorthead Redhorse						
Shortnose Gar			1			
Skipjack Herring						
Smallmouth Bass						
Smallmouth Buffalo						
Sucker						1
Unidentified						

Table C20 **Impingement Losses for Alton Pool (cont.)**						
Species	**Total Number Impinged for Sample Dates Between 3/3/80 and 4/7/80**					
	3/3/80	**3/15/80**	**3/17/80**	**3/26/80**	**4/3/80**	**4/7/80**
Walleye	1					
White Bass	2		2	1	1	1
White Crappie					1	
Yellow Bass						1
Yellow Bullhead		1				
Meredosia Power Station, 1980 (Patulski & Everhart 1981)						
Species	**Total Number Impinged for Sample Dates Between 4/15/80 and 5/23/80**					
	4/15/80	**4/25/80**	**5/2/80**	**5/4/80**	**5/21/80**	**5/23/80**
Bigmouth Buffalo						
Black Buffalo						
Black Bullhead	2		2			
Black Crappie	1				1	
Bluegill			2		4	
Bluntnose Minnow						
Bowfin				1		
Brown Bullhead						
Carp						1

Table C20
Impingement Losses for Alton Pool (cont.)

Species	Total Number Impinged for Sample Dates Between 4/15/80 and 5/23/80					
	4/15/80	4/25/80	5/2/80	5/4/80	5/21/80	5/23/80
Channel Catfish	2				1	1
Crappie Species						
Emerald Shiner				1		
Flathead Catfish						2
Freshwater Drum	8	4	19	3	27	18
Gizzard Shad	516	309	698	18	29	3
Golden Redhorse						
Golden Shiner						
Goldeye						
Goldfish						
Grass Pickerel						
Green Sunfish					2	2
Largemouth Bass						
Longear Sunfish						
Longnose Gar						
Mooneye						
Paddlefish			1			

Table C20
Impingement Losses for Alton Pool (cont.)

Species	Total Number Impinged for Sample Dates Between 4/15/80 and 5/23/80					
	4/15/80	4/25/80	5/2/80	5/4/80	5/21/80	5/23/80
Quillback			1		1	1
Rainbow Smelt						
Redhorse Species						
River Carpsucker						
Sauger						
Shiner Species						
Shorthead Redhorse					1	
Shortnose Gar		1	5	2	9	6
Skipjack Herring						
Smallmouth Bass						
Smallmouth Buffalo						
Sucker						
Unidentified						
Walleye						
White Bass	1	2	7	2	1	
White Crappie			1			3
Yellow Bass	5		1		1	1

Table C20
Impingement Losses for Alton Pool (cont.)

Species	Total Number Impinged for Sample Dates Between 4/15/80 and 5/23/80					
	4/15/80	4/25/80	5/2/80	5/4/80	5/21/80	5/23/80
Yellow Bullhead	1					

Meredosia Power Station, 1980 (Patulski & Everhart 1981)

Species	Total Number Impinged for Sample Dates Between 5/27/80 and 7/2/80					
	5/2/80	6/10/80	6/13/80	6/19/80	6/25/80	7/2/80
Bigmouth Buffalo		1	2			
Black Buffalo						
Black Bullhead		1				
Black Crappie	1		2			33
Bluegill	1		1		1	2
Bluntnose Minnow						1
Bowfin						
Brown Bullhead						
Carp		2			1	3
Channel Catfish					2	1
Crappie Species						
Emerald Shiner						1
Flathead Catfish						

Table C20
Impingement Losses for Alton Pool (cont.)

Species	Total Number Impinged for Sample Dates Between 5/27/80 and 7/2/80					
	5/2/80	6/10/80	6/13/80	6/19/80	6/25/80	7/2/80
Freshwater Drum	23	12	11	2	6	26
Gizzard Shad	6	17	7	9	15	243
Golden Redhorse	1					
Golden Shiner						
Goldeye						
Goldfish						
Grass Pickerel						
Green Sunfish	1	1				
Largemouth Bass						
Longear Sunfish						
Longnose Gar						
Mooneye						
Paddlefish						
Quillback	3					
Rainbow Smelt						
Redhorse Species		1				
River Carpsucker						

Table C20
Impingement Losses for Alton Pool (cont.)

Species	Total Number Impinged for Sample Dates Between 5/27/80 and 7/2/80					
	5/2/80	6/10/80	6/13/80	6/19/80	6/25/80	7/2/80
Sauger	1					
Shiner Species				1		
Shorthead Redhorse						
Shortnose Gar	4	1			2	3
Skipjack Herring						
Smallmouth Bass						
Smallmouth Buffalo	1					
Sucker						
Unidentified						
Walleye						
White Bass				1		
White Crappie		1		1	1	
Yellow Bass						
Yellow Bullhead	1					

Table C20
Impingement Losses for Alton Pool (cont.)

Meredosia Power Station, 1980 (Patulski & Everhart 1981)

Species	Total Number Impinged for Sample Dates Between 7/7/80 and 8/13/80					
	7/7/80	7/15/80	7/24/80	7/30/80	8/8/80	8/13/80
Bigmouth Buffalo	2					
Black Buffalo						
Black Bullhead	2					
Black Crappie	65	17	15	5	3	5
Bluegill	75			2	1	
Bluntnose Minnow						
Bowfin		1		1		
Brown Bullhead					1	
Carp	17	4	1	1	2	1
Channel Catfish	4			1		1
Crappie Species	137					4
Emerald Shiner	1		1			1
Flathead Catfish			1	1		
Freshwater Drum	183	280	97	47	158	119
Gizzard Shad	137	28	15	43	48	54
Golden Redhorse						

Table C20
Impingement Losses for Alton Pool (cont.)

Species	Total Number Impinged for Sample Dates Between 7/7/80 and 8/13/80					
	7/7/80	7/15/80	7/24/80	7/30/80	8/8/80	8/13/80
Golden Shiner	2		1			
Goldeye	1					
Goldfish						
Grass Pickerel	1					
Green Sunfish			1			
Largemouth Bass	1					
Longear Sunfish						
Longnose Gar						1
Mooneye						
Paddlefish		1				
Quillback	1					
Rainbow Smelt						
Redhorse Species		1				
River Carpsucker						1
Sauger	2		1			
Shiner Species						
Shorthead Redhorse						

Table C20
Impingement Losses for Alton Pool (cont.)

Species	Total Number Impinged for Sample Dates Between 7/7/80 and 8/13/80					
	7/7/80	**7/15/80**	**7/24/80**	**7/30/80**	**8/8/80**	**8/13/80**
Shortnose Gar	13	18	42	1	3	1
Skipjack Herring		1	1	3	4	1
Smallmouth Bass			1			
Smallmouth Buffalo						
Sucker						
Unidentified						
Walleye						
White Bass	1	1			10	3
White Crappie	1			1		
Yellow Bass					1	
Yellow Bullhead						

Meredosia Power Station, 1980 (Patulski & Everhart 1981)

Species	Total Number Impinged for Sample Dates Between 8/18/80 and 9/27/80					
	8/18/80	**8/26/80**	**8/31/80**	**9/11/80**	**9/14/80**	**9/27/80**
Bigmouth Buffalo	1					2
Black Buffalo						
Black Bullhead						

Table C20
Impingement Losses for Alton Pool (cont.)

Species	Total Number Impinged for Sample Dates Between 8/18/80 and 9/27/80					
	8/18/80	8/26/80	8/31/80	9/11/80	9/14/80	9/27/80
Black Crappie	18	3	2	1	3	1
Bluegill	1	1			1	
Bluntnose Minnow						
Bowfin						
Brown Bullhead						
Carp		3				2
Channel Catfish	1	4		1	3	4
Crappie Species						
Emerald Shiner	1	1				
Flathead Catfish						
Freshwater Drum	121	21	2	26	55	24
Gizzard Shad	444	23	11	809	89	56
Golden Redhorse						
Golden Shiner						
Goldeye						
Goldfish						
Grass Pickerel						1

Table C20
Impingement Losses for Alton Pool (cont.)

Species	Total Number Impinged for Sample Dates Between 8/18/80 and 9/27/80					
	8/18/80	8/26/80	8/31/80	9/11/80	9/14/80	9/27/80
Green Sunfish						
Largemouth Bass						
Longear Sunfish						
Longnose Gar						
Mooneye						
Paddlefish						
Quillback			1			
Rainbow Smelt						
Redhorse Species						
River Carpsucker						
Sauger	1				1	
Shiner Species						
Shorthead Redhorse						
Shortnose Gar		1	2			
Skipjack Herring					2	1
Smallmouth Bass						
Smallmouth Buffalo						

Table C20
Impingement Losses for Alton Pool (cont.)

Species	Total Number Impinged for Sample Dates Between 8/18/80 and 9/27/80					
	8/18/80	**8/26/80**	**8/31/80**	**9/11/80**	**9/14/80**	**9/27/80**
Sucker						
Unidentified						
Walleye						
White Bass	4	2		2	2	2
White Crappie				1		
Yellow Bass						
Yellow Bullhead						
Meredosia Power Station, 1980 (Patulski & Everhart 1981)						
Species	**Total Number Impinged for Sample Dates Between 10/2/80 and 11/5/80**					
	10/2/80	**10/16/80**	**10/17/80**	**10/23/80**	**10/26/80**	**11/5/80**
Bigmouth Buffalo						
Black Buffalo						
Black Bullhead						
Black Crappie	2		2			
Bluegill	2	1				
Bluntnose Minnow						
Bowfin						

Table C20
Impingement Losses for Alton Pool (cont.)

Species	**Total Number Impinged for Sample Dates Between 10/2/80 and 11/5/80**					
	10/2/80	**10/16/80**	**10/17/80**	**10/23/80**	**10/26/80**	**11/5/80**
Brown Bullhead						
Carp		3				2
Channel Catfish	13	1		5	2	
Crappie Species						
Emerald Shiner	1	1				
Flathead Catfish	1					
Freshwater Drum	89	42	57	397	48	12
Gizzard Shad	199	533	131	254	72	186
Golden Redhorse						
Golden Shiner						
Goldeye						
Goldfish						
Grass Pickerel						1
Green Sunfish	2			1		
Largemouth Bass						
Longear Sunfish						
Longnose Gar						

Table C20
Impingement Losses for Alton Pool (cont.)

Species	Total Number Impinged for Sample Dates Between 10/2/80 and 11/5/80					
	10/2/80	10/16/80	10/17/80	10/23/80	10/26/80	11/5/80
Mooneye						
Paddlefish						
Quillback						
Rainbow Smelt						
Redhorse Species						
River Carpsucker			1			
Sauger						
Shiner Species						
Shorthead Redhorse						
Shortnose Gar		270	95			
Skipjack Herring	2	20	1	3		
Smallmouth Bass				1		
Smallmouth Buffalo						
Sucker						
Unidentified						
Walleye						
White Bass	11	71	10	31	5	1

Table C20
Impingement Losses for Alton Pool (cont.)

Species	Total Number Impinged for Sample Dates Between 10/2/80 and 11/5/80					
	10/2/80	10/16/80	10/17/80	10/23/80	10/26/80	11/5/80
White Crappie						
Yellow Bass						
Yellow Bullhead						

Meredosia Power Station, 1980 (Patulski & Everhart 1981)

Species	Total Number Impinged for Sample Dates Between 11/15/80 and 12/30/80					
	11/15/80	11/16/80	11/24/80	12/1/80	12/11/80	12/30/80
Bigmouth Buffalo						
Black Buffalo						
Black Bullhead						
Black Crappie				1		2
Bluegill		1				1
Bluntnose Minnow						
Bowfin	1					
Brown Bullhead						
Carp		1		1		3
Channel Catfish				1		8
Crappie Species						

Table C20
Impingement Losses for Alton Pool (cont.)

Species	Total Number Impinged for Sample Dates Between 11/15/80 and 12/30/80					
	11/15/80	11/16/80	11/24/80	12/1/80	12/11/80	12/30/80
Emerald Shiner						
Flathead Catfish						
Freshwater Drum	34	8	11	10		270
Gizzard Shad	166	45	11	16	61	356
Golden Redhorse						
Golden Shiner						
Goldeye						
Goldfish	1					
Grass Pickerel						
Green Sunfish						1
Largemouth Bass						
Longear Sunfish						
Longnose Gar						
Mooneye						
Paddlefish						
Quillback		1				
Rainbow Smelt						

Table C20
Impingement Losses for Alton Pool (cont.)

Species	Total Number Impinged for Sample Dates Between 11/15/80 and 12/30/80					
	11/15/80	11/16/80	11/24/80	12/1/80	12/11/80	12/30/80
Redhorse Species						
River Carpsucker						
Sauger	1					
Shiner Species						
Shorthead Redhorse						
Shortnose Gar				1		
Skipjack Herring						
Smallmouth Bass						
Smallmouth Buffalo						
Sucker						
Unidentified						
Walleye						
White Bass	7	6	2	6		10
White Crappie						1
Yellow Bass						
Yellow Bullhead		1				

Table C20
Impingement Losses for Alton Pool (cont.)

Meredosia Power Station, 1980-1981 (Patulski & Everhart 1981)

Species	Total Number Impinged for Sample Dates Between 12/31/80 and 1/31/81					
	12/31/80	1/2/81	1/8/81	1/17/81	1/19/81	1/31/81
Bigmouth Buffalo			1		2	
Black Buffalo		1		1		1
Black Bullhead						
Black Crappie	2	1				
Bluegill	1		1			
Bluntnose Minnow						
Bowfin						
Brown Bullhead	1					
Carp		1	1		1	
Channel Catfish	1	2		3	7	
Crappie Species						
Emerald Shiner					1	
Flathead Catfish			1			
Freshwater Drum	29	214	54	165	159	163
Gizzard Shad	320	262	166	246	178	312
Golden Redhorse					4	

Table C20
Impingement Losses for Alton Pool (cont.)

Species	Total Number Impinged for Sample Dates Between 12/31/80 and 1/31/81					
	12/31/80	1/2/81	1/8/81	1/17/81	1/19/81	1/31/81
Golden Shiner						
Goldeye		1				
Goldfish						
Grass Pickerel						
Green Sunfish			1			1
Largemouth Bass						
Longear Sunfish						
Longnose Gar		1				
Mooneye						
Paddlefish						
Quillback		1	1	1		1
Rainbow Smelt						
Redhorse Species						
River Carpsucker			2			1
Sauger						
Shiner Species						
Shorthead Redhorse			1			

Table C20
Impingement Losses for Alton Pool (cont.)

Species	Total Number Impinged for Sample Dates Between 12/31/80 and 1/31/81					
	12/31/80	1/2/81	1/8/81	1/17/81	1/19/81	1/31/81
Shortnose Gar						
Skipjack Herring						
Smallmouth Bass			1	1		
Smallmouth Buffalo					8	
Sucker						
Unidentified					3	
Walleye						
White Bass	3	4	3	3	2	3
White Crappie		1				
Yellow Bass						
Yellow Bullhead		1				

Meredosia Power Station, 1981 (Patulski & Everhart 1981)

Species	Total Number Impinged for Sample Dates Between 2/7/81 and 2/25/81			
	2/7/81	2/14/81	2/19/81	2/25/81
Bigmouth Buffalo				
Black Buffalo	1			
Black Bullhead				

Table C20
Impingement Losses for Alton Pool (cont.)

Species	Total Number Impinged for Sample Dates Between 2/7/81 and 2/25/81			
	2/7/81	2/14/81	2/19/81	2/25/81
Black Crappie				3
Bluegill				
Bluntnose Minnow				
Bowfin				
Brown Bullhead				
Carp	1	1		
Channel Catfish	1	3	17	9
Crappie Species				
Emerald Shiner				2
Flathead Catfish				
Freshwater Drum	32	29	187	110
Gizzard Shad	194	17	882	720
Golden Redhorse				1
Golden Shiner				
Goldeye			3	
Goldfish				
Grass Pickerel				

Table C20
Impingement Losses for Alton Pool (cont.)

Species	Total Number Impinged for Sample Dates Between 2/7/81 and 2/25/81			
	2/7/81	2/14/81	2/19/81	2/25/81
Green Sunfish				1
Largemouth Bass				1
Longear Sunfish				1
Longnose Gar				
Mooneye			1	
Paddlefish				
Quillback			3	
Rainbow Smelt				1
Redhorse Species				
River Carpsucker	1	2		
Sauger				1
Shiner Species				
Shorthead Redhorse				
Shortnose Gar				1
Skipjack Herring	1			
Smallmouth Bass				
Smallmouth Buffalo			4	

Table C20
Impingement Losses for Alton Pool (cont.)

Species	Total Number Impinged for Sample Dates Between 2/7/81 and 2/25/81			
	2/7/81	2/14/81	2/19/81	2/25/81
Sucker			1	
Unidentified				
Walleye				
White Bass	5	5	4	3
White Crappie				
Yellow Bass				
Yellow Bullhead				

Meredosia Power Station, 1980-1981 (Patulski & Everhart 1981)

Species	Total Number Impinged											
	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb
Bigmouth Buffalo				3	2	1	2				3	
Black Buffalo											3	1
Black Bullhead	1	2	2	1	2							
Black Crappie	2	2	2	2	135	31	5	4		5	1	3
Bluegill	5	1	7	2	79	3	1	3	1	2	1	
Bluntnose Minnow					1							
Bowfin			1		2			1	1			

Table C20
Impingement Losses for Alton Pool (cont.)

Species	Total Number Impinged											
	March	**April**	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**
Brown Bullhead						1				1		
Carp			1	3	26	6	2	2	2	4	3	2
Channel Catfish	8	10	2	2	6	6	8	16		10	12	30
Crappie Species					137	4						
Emerald Shiner			1		3	3					1	2
Flathead Catfish	2	2	2		2			1			1	
Freshwater Drum	260	75	90	31	633	421	105	633	65	308	755	358
Gizzard Shad	1,010	1,124	754	48	466	580	954	1,189	408	753	1,164	1,813
Golden Redhorse	1		1								4	1
Golden Shiner					3							
Goldeye					1						1	3
Goldfish									1			
Grass Pickerel					1		1					
Green Sunfish		1	5	1	1			3		1	2	1
Largemouth Bass					1							1
Longear Sunfish												1
Longnose Gar						1		2			1	

Table C20
Impingement Losses for Alton Pool (cont.)

Species	Total Number Impinged											
	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb
Mooneye												1
Paddlefish			1		1							
Quillback			6		1	1			1		4	3
Rainbow Smelt												1
Redhorse Species		1		1	1							
River Carpsucker						1		1			3	3
Sauger			1		3	1	1		1			1
Shiner Species					1							
Shorthead Redhorse			1								1	
Shortnose Gar	1	1	26	3	77	7		3		1		1
Skipjack Herring					5	5	3	26				1
Smallmouth Bass					1			1			2	
Smallmouth Buffalo			1								8	4
Sucker		1										1
Unidentified											3	
Walleye	1											
White Bass	5	5	10	1	2	19	6	128	16	19	15	17

Table C20
Impingement Losses for Alton Pool (cont.)

Species	Total Number Impinged											
	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb
White Crappie		1	4	3	2		1			1	1	
Yellow Bass		6	3			1						
Yellow Bullhead	1	1	1						1		1	

Meredosia Power Station, 1980-1981 (Patulski & Everhart 1981)

Species	Total Number Impinged
Bigmouth Buffalo	11
Black Buffalo	4
Black Bullhead	8
Black Crappie	192
Bluegill	105
Bluntnose Minnow	1
Bowfin	5
Brown Bullhead	2
Carp	51
Channel Catfish	110
Crappie Species	141
Emerald Shiner	10

Table C20
Impingement Losses for Alton Pool (cont.)

Species	Total Number Impinged
Flathead Catfish	10
Freshwater Drum	3,734
Gizzard Shad	10,263
Golden Redhorse	7
Golden Shiner	3
Goldeye	5
Goldfish	1
Grass Pickerel	2
Green Sunfish	15
Largemouth Bass	2
Longear Sunfish	1
Longnose Gar	4
Mooneye	1
Paddlefish	2
Quillback	16
Rainbow Smelt	1
Redhorse Species	3
River Carpsucker	8

Table C20
Impingement Losses for Alton Pool (cont.)

Species	Total Number Impinged
Sauger	8
Shiner Species	1
Shorthead Redhorse	2
Shortnose Gar	120
Skipjack Herring	40
Smallmouth Bass	4
Smallmouth Buffalo	13
Sucker	2
Unidentified	3
Walleye	1
White Bass	243
White Crappie	13
Yellow Bass	10
Yellow Bullhead	5

Table C21
Entrainment Losses for La Grange Pool

E.D. Edwards Power Station, June 1978 (Wapora, Inc. 1981)	
Species	**Total Number Entrained**
Basses, *Morone* sp.	<37
Black Basses	<37
Carp	<37
Carp or Goldfish	552
Carpsuckers or Buffaloes	184
Catostomidae	<37
Crappies or Sunfishes	<37
Cyprinidae	65,857
Eggs	625
Emerald Shiner	37
Freshwater Drum	184
Gizzard Shad	147
Rock Bass	<37
Shad or Herrings	24,931
Shiners	2,905
Unidentifiable	<37

Table C21
Entrainment Losses for La Grange Pool (cont.)

E.D. Edwards Power Station, July 1978 (Wapora, Inc. 1981)

Species	Total Number Entrained
Carp	<18
Carp or Goldfish	2,011
Carpsuckers or Buffaloes	<38
Crappies or Sunfishes	<18
Cyprinidae	1,128
Eggs	130
Emerald Shiner	38
Freshwater Drum	168
Ictaluridae	<38
Shad or Herrings	695
Shiners	113
Unidentifiable	<38

E.D. Edwards Power Station, April 1979 (Wapora, Inc. 1981)

Species	Total Number Entrained
Eggs	<44
Emerald Shiner	<44

Table C21
Entrainment Losses for La Grange Pool (cont.)

E.D. Edwards Power Station, May 1979 (Wapora, Inc. 1981)

Species	**Total Number Entrained**
Basses, *Morone* sp.	<55
Carp or Goldfish	1,210
Carpsuckers or Buffaloes	165
Catostomidae	<55
Crappies	<55
Cyprinidae	3,959
Darters	<55
Eggs	110
Freshwater Drum	110
Mooneye	<55
Shad or Herrings	13,748
Shiners	<55
Stizostedion sp.	<55
Unidentifiable Larvae	165

Table C21
Entrainment Losses for La Grange Pool (cont.)

E.D. Edwards Power Station, June 1979 (Wapora, Inc. 1981)

Species	Total Number Entrained
Basses, *Morone* sp.	<52
Carp or Goldfish	258
Cyprinidae	2,735
Eggs	929
Emerald Shiner	<52
Freshwater Drum	206
Gizzard Shad	310
Ictalurus sp.	<52
Shad or Herrings	7,122
Shiners	774
Sunfishes	<52
Unidentifiable Larvae	52

E.D. Edwards Power Station, July 1979 (Wapora, Inc. 1981)

Species	Total Number Entrained
Basses, *Morone* sp.	<72
Carp or Goldfish	<72
Carpsuckers or Buffaloes	<72

Table C21
Entrainment Losses for La Grange Pool (cont.)

Species	Total Number Entrained
Channel Catfish	<72
Cyprinidae	790
Eggs	1,006
Emerald Shiner	144
Freshwater Drum	<72
Gizzard Shad	<72
Shad or Herrings	503
Shiners	216
Spottail Shiner	<72
Sunfishes	<72
Unidentifiable Larvae	<72
Yellow Bass	<72
E.D. Edwards Power Station, August 1979 (Wapora, Inc. 1981)	
Species	**Total Number Entrained**
Basses, *Morone* sp.	<45
Cyprinidae	90
Eggs	135
Emerald Shiner	<45

Table C21
Entrainment Losses for La Grange Pool (cont.)

Species	Total Number Entrained
Freshwater Drum	<45
Shad or Herrings	<45
Shiners	<45
Sunfishes	<45
E.D. Edwards Power Station, April 1980 (Wapora, Inc. 1981)	
Species	**Total Number Entrained**
Carp or Goldfish	<44
Darters	<44
Eggs	<44
Shad or Herrings	<44
Unidentifiable Larvae	<44
E.D. Edwards Power Station, May 1980 (Wapora, Inc. 1981)	
Species	**Total Number Entrained**
Basses, *Morone* sp.	<55
Carp or Goldfish	491
Carpsuckers or Buffaloes	55
Catostomidae	<55
Crappies	<55

Table C21
Entrainment Losses for La Grange Pool (cont.)

Species	Total Number Entrained
Cyprinidae	2,456
Darters	<55
Eggs	764
Emerald Shiner	<55
Freshwater Drum	109
Percina sp.	<55
Shad or Herrings	12,770
Shiners	<55
Stizostedion sp.	<55
Sunfishes	<55
Unidentifiable Larvae	<55
E.D. Edwards Power Station, June 1980 (Wapora, Inc. 1981)	
Species	**Total Number Entrained**
Basses, *Morone* sp.	<51
Carp	<51
Carp or Goldfish	3,534
Carpsuckers or Buffaloes	<51
Channel Catfish	<51

Table C21
Entrainment Losses for La Grange Pool (cont.)

Species	Total Number Entrained
Cyprinidae	4,661
Eggs	102
Emerald Shiner	102
Freshwater Drum	1,178
Gizzard Shad	154
Logperch	<51
Shad or Herrings	49,426
Shiners	307
Unidentifiable Larvae	102
E.D. Edwards Power Station, July 1980 (Wapora, Inc. 1981)	
Species	**Total Number Entrained**
Basses, *Morone* sp.	<53
Carp or Goldfish	<53
Carpsuckers or Buffaloes	<53
Channel Catfish	<53
Cyprinidae	105
Eggs	315
Emerald Shiner	420

Table C21
Entrainment Losses for La Grange Pool (cont.)

Species	Total Number Entrained
Freshwater Drum	158
Gizzard Shad	53
Rock Bass	<53
Shad or Herrings	1,419
Shiners	53
Silver Chub	<53
Skipjack Herring	<53
Sunfishes	<53
Unidentifiable Larvae	<53
White Bass	<53
E.D. Edwards Power Station, August 1980 (Wapora, Inc. 1981)	
Species	**Total Number Entrained**
Basses, *Morone* sp.	<20
Carp or Goldfish	<20
Channel Catfish	<20
Cyprinidae	<20
Eggs	79
Emerald Shiner	20

Table C21
Entrainment Losses for La Grange Pool (cont.)

Species	Total Number Entrained
Freshwater Drum	<20
Gizzard Shad	<20
Shad or Herrings	<20
Shiners	<20

Table C22
Impingement Losses for La Grange Pool

E.D. Edwards Power Station, July 1974 (Wapora, Inc. 1981)		
Species	**Total Number Impinged**	**Estimated Number Impinged**
American Eel	1	7
Bigmouth Buffalo	3	22
Black Bullhead	19	142
Black Crappie	5	37
Bluegill	264	1,969
Bowfin	1	7
Carp	350	2,611
Catfish	3	22
Channel Catfish	42	313
Crappies	1	7
Creek Chub	2	15
Emerald Shiner	693	5,169
Freshwater Drum	1,640	12,232
Gizzard Shad	11,186	83,432
Golden Redhorse	1	7
Goldeye	1	7
Goldfish	21	157

Table C22
Impingement Losses for La Grange Pool (cont.)

Species	Total Number Impinged	Estimated Number Impinged
Green Sunfish	47	351
Largemouth Bass	21	157
Logperch	2	15
Northern Pike	6	45
Orangespotted Sunfish	64	477
Perches	2	15
Quillback	2	15
Red Shiner	2	15
River Carpsucker	1	7
Sauger	12	90
Sauger-Walleye	1	7
Shortnose Gar	6	45
Shovelnose Sturgeon	1	7
Suckermouth Minnow	1	7
Suckers	1	7
Sunfish	657	4,900
Trout Perch	19	142
White Bass	1	7

Table C22 Impingement Losses for La Grange Pool (cont.)		
Species	**Total Number Impinged**	**Estimated Number Impinged**
White Crappie	28	209
Yellow Bullhead	28	209
E.D. Edwards Power Station, August 1974 (Wapora, Inc. 1981)		
Species	**Total Number Impinged**	**Estimated Number Impinged**
Basses, *Morone* sp.	861	5,582
Bigmouth Buffalo	3	19
Black Bullhead	4	26
Black Crappie	145	940
Bluegill	134	869
Bowfin	8	52
Carp	111	720
Carp x Goldfish	3	19
Channel Catfish	562	3,644
Crappies	3	19
Emerald Shiner	4,497	29,157
Flathead Catfish	16	104
Freshwater Drum	27,420	177,782
Gizzard Shad	16,851	109,256

Table C22
Impingement Losses for La Grange Pool (cont.)

Species	Total Number Impinged	Estimated Number Impinged
Golden Shiner	6	39
Goldfish	7	45
Green Sunfish	17	110
Largemouth Bass	1	6
Longnose Gar	2	13
Orangespotted Sunfish	8	52
Paddlefish	6	39
Perches	39	253
River Carpsucker	5	32
Shortnose Gar	20	130
Skipjack Herring	273	1,770
Smallmouth Buffalo	23	149
Spotted Sucker	1	6
Suckers	44	285
Sunfish	5,016	32,522
Walleye	1	6
White Bass	17	110
White Crappie	5	32

Table C22
Impingement Losses for La Grange Pool (cont.)

Species	Total Number Impinged	Estimated Number Impinged
White Sucker	2	13
Yellow Bass	3	19
Yellow Bullhead	7	45
E.D. Edwards Power Station, September 1974 (Wapora, Inc. 1981)		
Species	**Total Number Impinged**	**Estimated Number Impinged**
Basses, *Morone* sp.	143	884
Bigmouth Buffalo	10	62
Black Bullhead	15	93
Black Crappie	80	494
Bluegill	79	488
Bowfin	4	25
Carp	136	841
Carp x Goldfish	4	25
Channel Catfish	72	445
Crappies	1	6
Emerald Shiner	794	4,907
Flathead Catfish	22	136
Freshwater Drum	3,202	19,789

Table C22
Impingement Losses for La Grange Pool (cont.)

Species	Total Number Impinged	Estimated Number Impinged
Gizzard Shad	56,198	347,318
Goldeye	2	12
Green Sunfish	17	105
Largemouth Bass	1	6
Longnose Gar	3	19
Northern Pike	2	12
Orangespotted Sunfish	3	19
Paddlefish	1	6
Quillback	1	6
River Carpsucker	1	6
Sauger	3	19
Shorthead Redhorse	2	12
Shortnose Gar	21	130
Skipjack Herring	167	1,032
Smallmouth Buffalo	3	19
Suckers	39	241
Sunfish	1,458	9,011
Walleye	1	6

Table C22
Impingement Losses for La Grange Pool (cont.)

Species	Total Number Impinged	Estimated Number Impinged
White Bass	6	37
White Crappie	19	117
Yellow Bass	1	6
Yellow Bullhead	16	99
E.D. Edwards Power Station, October 1974 (Wapora, Inc. 1981)		
Species	**Total Number Impinged**	**Estimated Number Impinged**
Basses, *Morone* sp.	18	118
Bigmouth Buffalo	8	53
Black Bullhead	3	20
Black Crappie	13	85
Bluegill	99	650
Bowfin	2	13
Carp	18	118
Carp x Goldfish	8	53
Channel Catfish	8	53
Emerald Shiner	66	434
Flathead Catfish	2	13
Freshwater Drum	513	3,370

Table C22
Impingement Losses for La Grange Pool (cont.)

Species	Total Number Impinged	Estimated Number Impinged
Gizzard Shad	33,682	221,275
Goldeye	1	7
Green Sunfish	1	7
Largemouth Bass	3	20
Longnose Gar	1	7
Orangespotted Sunfish	2	13
Redhorses	1	7
River Carpsucker	1	7
Sauger	2	13
Shortnose Gar	6	39
Skipjack Herring	238	1,564
Smallmouth Buffalo	3	20
Suckers	2	13
Sunfish	96	631
Trout Perch	1	7
White Bass	13	85
White Crappie	9	59
Yellow Bass	25	164

Table C22
Impingement Losses for La Grange Pool (cont.)

Species	Total Number Impinged	Estimated Number Impinged
Yellow Bullhead	2	13
E.D. Edwards Power Station, November 1974 (Wapora, Inc. 1981)		
Species	**Total Number Impinged**	**Estimated Number Impinged**
Basses, *Morone* sp.	12	78
Bigmouth Buffalo	2	13
Black Bullhead	2	13
Black Crappie	7	45
Bluegill	86	558
Bowfin	1	6
Brown Bullhead	2	13
Carp	50	324
Carp x Goldfish	5	32
Channel Catfish	19	123
Crappies	1	6
Emerald Shiner	106	688
Flathead Catfish	1	6
Freshwater Drum	1,569	10,177
Gizzard Shad	5,495	35,643

Table C22
Impingement Losses for La Grange Pool (cont.)

Species	Total Number Impinged	Estimated Number Impinged
Goldeye	1	6
Goldfish	2	13
Green Sunfish	11	71
Largemouth Bass	16	104
Orangespotted Sunfish	9	58
River Carpsucker	6	39
Sauger	3	19
Shiners	1	6
Shortnose Gar	1	6
Skipjack Herring	1	6
Smallmouth Buffalo	1	6
Stonecat	1	6
Suckermouth Minnow	5	32
Suckers	13	84
Sunfish	98	636
Warmouth	1	6
White Bass	68	441
White Crappie	7	45

Table C22 Impingement Losses for La Grange Pool (cont.)		
Species	**Total Number Impinged**	**Estimated Number Impinged**
Yellow Bass	3	19
Yellow Bullhead	1	6
E.D. Edwards Power Station, December 1974 (Wapora, Inc. 1981)		
Species	**Total Number Impinged**	**Estimated Number Impinged**
Basses, *Morone* sp.	47	389
Bigmouth Buffalo	4	33
Black Bullhead	3	25
Black Crappie	39	322
Bluegill	29	240
Brown Bullhead	1	8
Carp	54	446
Carp x Goldfish	1	8
Channel Catfish	10	83
Emerald Shiner	57	471
Flathead Catfish	16	132
Freshwater Drum	2,302	19,030
Gizzard Shad	11,302	93,430
Golden Redhorse	1	8

Table C22
Impingement Losses for La Grange Pool (cont.)

Species	Total Number Impinged	Estimated Number Impinged
Goldeye	4	33
Goldfish	3	25
Green Sunfish	19	157
Largemouth Bass	11	91
Longnose Gar	1	8
Madtom	3	25
Paddlefish	1	8
River Carpsucker	2	17
Shortnose Gar	9	74
Skipjack Herring	2	17
Suckers	56	463
Sunfish	195	1,612
White Bass	31	256
White Crappie	6	50
E.D. Edwards Power Station, December 1, 1974-January 15, 1975 (Wapora, Inc. 1981)		
Species	**Total Number Impinged**	**Estimated Number Impinged**
Basses, *Morone* sp.	47	577
Bigmouth Buffalo	4	49

Table C22
Impingement Losses for La Grange Pool (cont.)

Species	Total Number Impinged	Estimated Number Impinged
Black Bullhead	3	37
Black Crappie	39	478
Bluegill	29	356
Brown Bullhead	1	12
Carp	54	662
Carp x Goldfish	1	12
Channel Catfish	10	123
Emerald Shiner	57	699
Flathead Catfish	16	196
Freshwater Drum	2,302	28,238
Gizzard Shad	11,302	138,638
Golden Redhorse	1	12
Goldeye	4	49
Goldfish	3	37
Green Sunfish	19	233
Largemouth Bass	11	135
Longnose Gar	1	12
Madtom	3	37

Table C22
Impingement Losses for La Grange Pool (cont.)

Species	Total Number Impinged	Estimated Number Impinged
Paddlefish	1	12
River Carpsucker	2	25
Shortnose Gar	9	110
Skipjack Herring	2	25
Suckers	56	687
Sunfish	195	2,392
White Bass	31	380
White Crappie	6	74
E.D. Edwards Power Station, January 16, 1975-February 28, 1975 (Wapora, Inc. 1981)		
Species	**Total Number Impinged**	**Estimated Number Impinged**
Bigmouth Buffalo	3	34
Black Bullhead	1	11
Black Crappie	3	34
Brown Bullhead	1	11
Carp	12	136
Carp x Goldfish	1	11
Channel Catfish	1	11
Emerald Shiner	13	148

Table C22
Impingement Losses for La Grange Pool (cont.)

Species	Total Number Impinged	Estimated Number Impinged
Freshwater Drum	145	1,646
Gizzard Shad	1,172	13,308
Goldeye	1	11
Goldfish	3	34
Green Sunfish	4	45
Madtom	1	11
River Carpsucker	5	57
Shortnose Gar	2	23
Smallmouth Buffalo	1	11
Spottail Shiner	1	11
Suckermouth Minnow	1	11
Suckers	5	57
Walleye	1	11
White Bass	10	114
Yellow Bullhead	1	11

Table C22
Impingement Losses for La Grange Pool (cont.)

E.D. Edwards Power Station, February 1975 (Wapora, Inc. 1981)

Species	Total Number Impinged	Estimated Number Impinged
Bigmouth Buffalo	3	22
Black Bullhead	1	7
Black Crappie	3	22
Brown Bullhead	1	7
Carp	12	87
Carp x Goldfish	1	7
Channel Catfish	1	7
Emerald Shiner	13	94
Freshwater Drum	145	1,048
Gizzard Shad	1,172	8,469
Goldeye	1	7
Goldfish	3	22
Green Sunfish	4	29
Madtom	1	7
River Carpsucker	5	36
Shortnose Gar	2	14
Smallmouth Buffalo	1	7

Table C22
Impingement Losses for La Grange Pool (cont.)

Species	Total Number Impinged	Estimated Number Impinged
Spottail Shiner	1	7
Suckermouth Minnow	1	7
Suckers	5	36
Walleye	1	7
White Bass	10	72
Yellow Bullhead	1	7
E.D. Edwards Power Station, March 1975 (Wapora, Inc. 1981)		
Species	**Total Number Impinged**	**Estimated Number Impinged**
Black Bullhead	5	38
Black Crappie	4	31
Bluegill	6	46
Carp	10	77
Central Stoneroller	2	15
Channel Catfish	21	162
Emerald Shiner	5	38
Freshwater Drum	118	908
Gizzard Shad	595	4,578
Goldfish	4	31

Table C22
Impingement Losses for La Grange Pool (cont.)

Species	Total Number Impinged	Estimated Number Impinged
Green Sunfish	7	54
Logperch	7	54
Quillback	1	8
River Carpsucker	6	46
Shortnose Gar	1	8
Smallmouth Buffalo	3	23
Spottail Shiner	13	100
Trout Perch	12	92
White Bass	4	31
Yellow Bullhead	1	8
E.D. Edwards Power Station, April 1975 (Wapora, Inc. 1981)		
Species	**Total Number Impinged**	**Estimated Number Impinged**
Black Bullhead	5	37
Black Crappie	1	7
Bluegill	23	170
Carp	3	22
Channel Catfish	14	103
Emerald Shiner	42	310

Table C22
Impingement Losses for La Grange Pool (cont.)

Species	Total Number Impinged	Estimated Number Impinged
Freshwater Drum	7	52
Gizzard Shad	273	2,016
Golden Shiner	1	7
Goldeye	1	7
Goldfish	27	199
Green Sunfish	17	126
Largemouth Bass	1	7
Logperch	2	15
River Carpsucker	2	15
Sauger	1	7
Spottail Shiner	21	155
Tadpole Madtom	3	22
Trout Perch	9	66
White Bass	6	44
White Crappie	1	7
Yellow Bullhead	2	15

Table C22
Impingement Losses for La Grange Pool (cont.)

E.D. Edwards Power Station, May 1975 (Wapora, Inc. 1981)

Species	Total Number Impinged	Estimated Number Impinged
Bigmouth Buffalo	1	6
Bluegill	19	114
Carp	6	36
Channel Catfish	2	12
Emerald Shiner	8	48
Freshwater Drum	1	6
Gizzard Shad	54	325
Goldfish	6	36
Green Sunfish	14	84
Largemouth Bass	1	6
Madtom	1	6
Quillback	1	6
Red Shiner	1	6
River Carpsucker	1	6
Stonecat	1	6
Suckers	14	84
Sunfish	2	12

Table C22
Impingement Losses for La Grange Pool (cont.)

Species	Total Number Impinged	Estimated Number Impinged
Trout Perch	2	12
White Bass	1	6
E.D. Edwards Power Station, June 1975 (Wapora, Inc. 1981)		
Species	**Total Number Impinged**	**Estimated Number Impinged**
Black Bullhead	2	4
Bluegill	7	14
Carp	13	92
Channel Catfish	1	2
Creek Chub	11	22
Emerald Shiner	4	39
Freshwater Drum	1	2
Gizzard Shad	15	94
Goldfish	2	4
Green Sunfish	1	9
Northern Pike	1	2
River Carpsucker	3	30
Shortnose Gar	1	2
Skipjack Herring	15	141

Table C22
Impingement Losses for La Grange Pool (cont.)

Species	Total Number Impinged	Estimated Number Impinged
Sunfish	16	40
Trout Perch	1	2
White Bass	2	13
E.D. Edwards Power Station, July 1975 (Wapora, Inc. 1981)		
Species	**Total Number Impinged**	**Estimated Number Impinged**
American Eel	1	3
Basses, *Morone* sp.	14	42
Bigmouth Buffalo	11	35
Black Bullhead	40	123
Black Crappie	115	318
Blue Catfish	1	3
Bluegill	73	227
Bowfin	1	3
Carp	220	678
Channel Catfish	225	698
Crappies	14	44
Emerald Shiner	513	1,635
Flathead Catfish	3	11

Table C22
Impingement Losses for La Grange Pool (cont.)

Species	Total Number Impinged	Estimated Number Impinged
Freshwater Drum	3,579	10,888
Gizzard Shad	23,218	73,550
Goldfish	5	16
Green Sunfish	7	22
Largemouth Bass	9	29
Longear Sunfish	1	3
Longnose Gar	5	15
Orangespotted Sunfish	3	9
River Shiner	6	17
River Carpsucker	3	9
Sauger	5	16
Shortnose Gar	1	3
Silver Chub	4	12
Skipjack Herring	372	1,209
Smallmouth Bass	7	19
Smallmouth Buffalo	4	13
Spottail Shiner	8	24
Suckers	40	117

Table C22
Impingement Losses for La Grange Pool (cont.)

Species	Total Number Impinged	Estimated Number Impinged
Sunfish	705	2,142
Tadpole Madtom	4	12
Trout Perch	2	7
Walleye	1	3
White Bass	10	32
White Crappie	119	329
White Sucker	1	3
Yellow Bullhead	5	15
E.D. Edwards Power Station, August 1975 (Wapora, Inc. 1981)		
Species	**Total Number Impinged**	**Estimated Number Impinged**
Bigmouth Buffalo	3	14
Black Bullhead	2	10
Black Crappie	1,008	4,459
Bluegill	5	27
Carp	61	299
Channel Catfish	410	2,030
Emerald Shiner	1,069	5,038
Freshwater Drum	5,682	27,366

Table C22
Impingement Losses for La Grange Pool (cont.)

Species	Total Number Impinged	Estimated Number Impinged
Gizzard Shad	16,638	75,372
Goldeye	1	4
Goldfish	9	41
Green Sunfish	5	24
Largemouth Bass	11	49
Longnose Gar	3	13
Northern Pike	1	5
Paddlefish	1	4
River Carpsucker	1	4
Shorthead Redhorse	1	5
Shortnose Gar	3	15
Silver Chub	2	9
Skipjack Herring	569	2,878
Smallmouth Buffalo	5	25
Spottail Shiner	2	9
Suckers	5	30
Sunfish	679	3,755
Tadpole Madtom	10	50

Table C22
Impingement Losses for La Grange Pool (cont.)

Species	Total Number Impinged	Estimated Number Impinged
Trout Perch	1	4
White Bass	33	161
White Crappie	3	14
Yellow Bullhead	3	15
E.D. Edwards Power Station, September 1975 (Wapora, Inc. 1981)		
Species	**Total Number Impinged**	**Estimated Number Impinged**
Basses, *Morone* sp.	5	18
Bigmouth Buffalo	2	7
Black Bullhead	1	4
Black Crappie	44	153
Blue Catfish	1	3
Bluegill	16	64
Carp	71	257
Carp x Goldfish	17	57
Channel Catfish	235	835
Crappies	609	2,225
Emerald Shiner	475	1,708
Flathead Catfish	10	36

Table C22
Impingement Losses for La Grange Pool (cont.)

Species	Total Number Impinged	Estimated Number Impinged
Freshwater Drum	2,766	10,057
Gizzard Shad	5,468	19,647
Golden Shiner	1	3
Goldeye	2	7
Goldfish	21	70
Green Sunfish	5	17
Largemouth Bass	5	18
Orangespotted Sunfish	2	7
River Carpsucker	3	10
Shorthead Redhorse	1	4
Shortnose Gar	6	21
Silver Chub	1	4
Skipjack Herring	276	990
Smallmouth Buffalo	1	3
Suckers	1	3
Sunfish	4	14
Trout Perch	1	3
Walleye	1	3

Table C22
Impingement Losses for La Grange Pool (cont.)

Species	Total Number Impinged	Estimated Number Impinged
White Bass	53	190
White Crappie	9	33
E.D. Edwards Power Station, October 1975 (Wapora, Inc. 1981)		
Species	**Total Number Impinged**	**Estimated Number Impinged**
Bigmouth Buffalo	4	13
Black Bullhead	3	11
Black Crappie	14	38
Bluegill	36	120
Carp	17	58
Carp x Goldfish	5	16
Channel Catfish	75	265
Crappies	52	187
Emerald Shiner	41	135
Flathead Catfish	3	10
Freshwater Drum	399	1,250
Gizzard Shad	3,795	13,485
Goldfish	13	44
Green Sunfish	3	10

Table C22
Impingement Losses for La Grange Pool (cont.)

Species	Total Number Impinged	Estimated Number Impinged
Largemouth Bass	3	10
Longnose Gar	2	7
Mooneye	1	4
River Carpsucker	7	25
Sauger	3	11
Shortnose Gar	3	11
Silver Chub	1	4
Skipjack Herring	80	263
Spottail Shiner	5	17
Walleye	1	3
White Bass	128	423
White Crappie	45	150
Yellow Bass	2	7
Yellow Bullhead	5	15
E.D. Edwards Power Station, November 1975 (Wapora, Inc. 1981)		
Species	**Total Number Impinged**	**Estimated Number Impinged**
Bigmouth Buffalo	3	11
Black Crappie	21	80

Table C22
Impingement Losses for La Grange Pool (cont.)

Species	Total Number Impinged	Estimated Number Impinged
Bluegill	21	68
Carp	116	478
Carp x Goldfish	12	54
Catfish	2	9
Channel Catfish	119	467
Crappies	4	13
Emerald Shiner	29	103
Flathead Catfish	8	36
Freshwater Drum	256	953
Gizzard Shad	2,199	7,861
Goldfish	152	613
Largemouth Bass	1	4
Longnose Gar	1	4
Northern Hog Sucker	1	5
Orangespotted Sunfish	3	10
River Carpsucker	6	25
Sauger	4	15
Shorthead Redhorse	2	7

Table C22
Impingement Losses for La Grange Pool (cont.)

Species	Total Number Impinged	Estimated Number Impinged
Shortnose Gar	3	11
Shovelnose Sturgeon	1	3
Silver Chub	18	66
Skipjack Herring	13	48
Smallmouth Bass	1	5
Smallmouth Buffalo	10	33
Spottail Shiner	2	9
Suckers	1	5
White Bass	58	215
White Crappie	18	70
Yellow Bass	1	3
Yellow Bullhead	8	31
E.D. Edwards Power Station, December 1975 (Wapora, Inc. 1981)		
Species	**Total Number Impinged**	**Estimated Number Impinged**
Bigmouth Buffalo	8	28
Black Crappie	15	52
Blue Catfish	1	4
Bluegill	18	67

Table C22
Impingement Losses for La Grange Pool (cont.)

Species	Total Number Impinged	Estimated Number Impinged
Carp	24	90
Carp x Goldfish	9	30
Channel Catfish	72	266
Creek Chub	1	4
Emerald Shiner	43	158
Flathead Catfish	8	29
Freshwater Drum	741	2,553
Gizzard Shad	19,888	62,744
Goldfish	20	73
Green Sunfish	30	106
Largemouth Bass	4	14
Mooneye	5	17
Northern Hog Sucker	1	4
River Carpsucker	16	57
Shortnose Gar	1	4
Silver Chub	3	11
Silver Shiner	1	4
Silvery Minnow	4	16

Table C22
Impingement Losses for La Grange Pool (cont.)

Species	Total Number Impinged	Estimated Number Impinged
Smallmouth Bass	3	11
Smallmouth Buffalo	8	28
Spottail Shiner	6	21
Suckers	2	8
Trout Perch	1	3
Walleye	1	3
White Bass	60	203
White Crappie	43	149
White Sucker	1	4
Yellow Bass	1	4
Yellow Bullhead	2	8
E.D. Edwards Power Station, January 1976 (Wapora, Inc. 1981)		
Species	**Total Number Impinged**	**Estimated Number Impinged**
Bigmouth Buffalo	21	87
Black Bullhead	2	10
Black Crappie	7	29
Blue Catfish	31	125
Bluegill	5	21

Table C22
Impingement Losses for La Grange Pool (cont.)

Species	Total Number Impinged	Estimated Number Impinged
Brown Bullhead	2	10
Carp	42	182
Carp x Goldfish	1	4
Channel Catfish	186	809
Emerald Shiner	10	43
Flathead Catfish	2	8
Freshwater Drum	611	2,594
Gizzard Shad	22,725	94,256
Goldeye	5	22
Goldfish	15	62
Green Sunfish	5	21
Longnose Gar	1	4
River Carpsucker	22	94
Shorthead Redhorse	1	4
Shortnose Gar	1	4
Silver Chub	2	8
Skipjack Herring	1	4
Smallmouth Bass	1	4

Table C22
Impingement Losses for La Grange Pool (cont.)

Species	Total Number Impinged	Estimated Number Impinged
Smallmouth Buffalo	8	33
Spottail Shiner	1	4
Tadpole Madtom	2	8
White Bass	92	400
White Crappie	2	8
Yellow Bullhead	2	8
E.D. Edwards Power Station, February 1976 (Wapora, Inc. 1981)		
Species	**Total Number Impinged**	**Estimated Number Impinged**
Bigmouth Buffalo	2	8
Black Bullhead	1	4
Black Crappie	1	4
Bluegill	4	16
Bluntnose Minnow	2	8
Brindled Madtom	1	4
Brook Silverside	1	4
Brown Bullhead	2	8
Carp	13	51
Carp x Goldfish	1	4

Table C22
Impingement Losses for La Grange Pool (cont.)

Species	Total Number Impinged	Estimated Number Impinged
Channel Catfish	198	771
Emerald Shiner	10	41
Fathead Minnow	1	4
Flathead Catfish	8	31
Freshwater Drum	372	1,485
Gizzard Shad	971	3,797
Goldeye	3	12
Goldfish	78	306
Green Sunfish	7	27
Mooneye	2	8
River Carpsucker	5	21
Sauger	1	4
Shortnose Gar	1	4
Silvery Minnow	5	18
Smallmouth Bass	3	12
Smallmouth Buffalo	3	12
Spottail Shiner	3	11
Tadpole Madtom	1	4

Table C22
Impingement Losses for La Grange Pool (cont.)

Species	Total Number Impinged	Estimated Number Impinged
White Bass	15	59
White Crappie	2	8
Yellow Bullhead	1	4
E.D. Edwards Power Station, March 1976 (Wapora, Inc. 1981)		
Species	**Total Number Impinged**	**Estimated Number Impinged**
Bigmouth Buffalo	2	15
Black Bullhead	5	38
Bluegill	17	134
Carp	2	12
Carp x Goldfish	4	25
Carpsuckers	2	26
Channel Catfish	35	262
Emerald Shiner	2	15
Fathead Minnow	2	26
Flathead Catfish	1	7
Freshwater Drum	15	103
Gizzard Shad	98	897
Goldfish	40	304

Table C22
Impingement Losses for La Grange Pool (cont.)

Species	Total Number Impinged	Estimated Number Impinged
Green Sunfish	18	142
Logperch	1	6
Orangespotted Sunfish	1	8
River Carpsucker	5	33
Spottail Shiner	5	52
Suckermouth Minnow	1	6
White Bass	1	7
E.D. Edwards Power Station, April 1976 (Wapora, Inc. 1981)		
Species	**Total Number Impinged**	**Estimated Number Impinged**
Bigmouth Buffalo	4	18
Black Bullhead	3	14
Black Crappie	2	10
Bluegill	74	326
Brown Bullhead	1	4
Carp	9	42
Carpsuckers	20	93
Catfish	2	8
Channel Catfish	72	320

Table C22
Impingement Losses for La Grange Pool (cont.)

Species	Total Number Impinged	Estimated Number Impinged
Crappies	2	9
Creek Chub	1	5
Emerald Shiner	127	553
Fathead Minnow	1	4
Freshwater Drum	63	270
Gizzard Shad	802	3,669
Goldfish	46	213
Green Sunfish	25	108
Largemouth Bass	1	4
Northern Pike	1	4
Orangespotted Sunfish	1	4
Rainbow Smelt	1	5
River Carpsucker	1	4
Shortnose Gar	1	4
Silver Chub	2	8
Silvery Minnow	5	20
Spottail Shiner	9	40
Steelcolor Shiner	1	5

Table C22
Impingement Losses for La Grange Pool (cont.)

Species	Total Number Impinged	Estimated Number Impinged
Suckers	2	9
Tadpole Madtom	10	45
White Bass	5	22
White Crappie	2	9
White Sucker	1	4
Yellow Bullhead	2	9
E.D. Edwards Power Station, May 1976 (Wapora, Inc. 1981)		
Species	**Total Number Impinged**	**Estimated Number Impinged**
Bigmouth Buffalo	3	11
Black Bullhead	6	24
Bluegill	34	121
Brown Bullhead	3	11
Carp	5	18
Carp x Goldfish	1	4
Carpsuckers	1	4
Channel Catfish	10	36
Creek Chub	1	4
Emerald Shiner	60	233

Table C22
Impingement Losses for La Grange Pool (cont.)

Species	Total Number Impinged	Estimated Number Impinged
Freshwater Drum	35	134
Gizzard Shad	368	1,373
Goldfish	10	37
Green Sunfish	22	79
Largemouth Bass	1	3
Longnose Gar	1	3
Orangespotted Sunfish	3	14
Rainbow Trout	1	4
Skipjack Herring	2	7
Suckers	1	4
Tadpole Madtom	4	14
Warmouth	1	5
White Crappie	1	4
Yellow Bullhead	1	4
E.D. Edwards Power Station, June 1976 (Wapora, Inc. 1981)		
Species	**Total Number Impinged**	**Estimated Number Impinged**
Bigmouth Buffalo	1	6
Black Bullhead	3	16

Table C22
Impingement Losses for La Grange Pool (cont.)

Species	Total Number Impinged	Estimated Number Impinged
Black Crappie	1	5
Bluegill	30	155
Carp	3	17
Channel Catfish	6	32
Creek Chub	1	6
Emerald Shiner	324	1,769
Freshwater Drum	43	222
Gizzard Shad	182	995
Goldfish	2	10
Green Sunfish	9	50
Largemouth Bass	1	6
Northern Pike	1	6
River Carpsucker	3	15
Sauger	1	6
Shortnose Gar	1	6
Silvery Minnow	1	6
Skipjack Herring	3	18
Suckers	1	6

Table C22
Impingement Losses for La Grange Pool (cont.)

Species	Total Number Impinged	Estimated Number Impinged
Tadpole Madtom	1	6
Yellow Bullhead	1	5
E.D. Edwards Power Station, July 1976 (Wapora, Inc. 1981)		
Species	**Total Number Impinged**	**Estimated Number Impinged**
Bigmouth Buffalo	4	15
Black Bullhead	5	20
Black Crappie	6	22
Bluegill	66	260
Bullhead Minnow	1	5
Carp	24	91
Carpsuckers	2	9
Channel Catfish	27	108
Crappies	105	435
Emerald Shiner	208	830
Fathead Minnow	2	8
Freshwater Drum	213	803
Gizzard Shad	5,919	22,817
Golden Shiner	1	4

Table C22
Impingement Losses for La Grange Pool (cont.)

Species	Total Number Impinged	Estimated Number Impinged
Goldfish	3	10
Green Sunfish	8	32
Largemouth Bass	15	60
Mimic Shiner	2	8
Northern Pike	6	21
Pirate Perch	1	5
River Carpsucker	1	5
Shortnose Gar	4	15
Silver Chub	4	16
Skipjack Herring	295	1,260
Speckled Chub	3	13
Spottail Shiner	16	67
Suckers	1	3
Trout Perch	1	4
White Bass	12	48
White Crappie	8	31
White Sucker	4	15
Yellow Bullhead	1	3

Table C22
Impingement Losses for La Grange Pool (cont.)

E.D. Edwards Power Station, August 1976 (Wapora, Inc. 1981)

Species	Total Number Impinged	Estimated Number Impinged
Black Bullhead	4	16
Black Crappie	22	89
Bluegill	31	126
Carp	38	155
Carpsuckers	4	16
Channel Catfish	174	711
Crappies	27	110
Emerald Shiner	624	2,502
Flathead Catfish	5	20
Freshwater Drum	636	2,568
Gizzard Shad	3,588	14,393
Goldeye	1	4
Goldfish	1	4
Green Sunfish	4	16
Largemouth Bass	5	21
Minnows	1	4
Northern Pike	2	8

Table C22
Impingement Losses for La Grange Pool (cont.)

Species	Total Number Impinged	Estimated Number Impinged
Orangespotted Sunfish	2	8
River Carpsucker	3	12
Sauger	3	12
Shortnose Gar	5	20
Silver Chub	7	28
Skipjack Herring	195	782
Smallmouth Buffalo	1	4
Spottail Shiner	9	37
Suckermouth Minnow	1	4
Suckers	2	8
Trout Perch	1	4
White Bass	14	56
White Crappie	22	89
Yellow Bass	1	4

Table C22
Impingement Losses for La Grange Pool (cont.)

E.D. Edwards Power Station, July 1974-June 1975 (Wapora, Inc. 1981)

Species	**Total Number Impinged**	**Estimated Number Impinged**
American Eel	1	7
Basses, *Morone* sp.	1,081	7,239
Bigmouth Buffalo	34	258
Black Bullhead	59	426
Black Crappie	297	2,153
Bluegill	746	5,253
Bowfin	16	104
Brown Bullhead	4	37
Carp	755	5,570
Carp x Goldfish	22	153
Catfish	3	22
Central Stoneroller	2	15
Channel Catfish	752	4,994
Crappies	6	40
Creek Chub	13	66
Emerald Shiner	6,281	41,598
Flathead Catfish	57	456

Table C22
Impingement Losses for La Grange Pool (cont.)

Species	Total Number Impinged	Estimated Number Impinged
Freshwater Drum	36,918	254,205
Gizzard Shad	136,816	955,827
Golden Redhorse	2	20
Golden Shiner	7	46
Goldeye	11	101
Goldfish	75	561
Green Sunfish	154	1,186
Largemouth Bass	55	441
Logperch	11	84
Longnose Gar	7	50
Madtom	5	54
Northern Pike	9	62
Orangespotted Sunfish	86	619
Paddlefish	8	57
Perches	41	268
Quillback	5	35
Redhorses	1	7
Red Shiner	3	21

Table C22
Impingement Losses for La Grange Pool (cont.)

Species	Total Number Impinged	Estimated Number Impinged
River Carpsucker	30	240
Sauger	21	148
Sauger-Walleye	1	7
Shiners	1	6
Shorthead Redhorse	2	12
Shortnose Gar	67	496
Shovelnose Sturgeon	1	7
Skipjack Herring	681	4,397
Smallmouth Buffalo	34	228
Spottail Shiner	35	266
Spotted Sucker	1	6
Stonecat	2	13
Suckermouth Minnow	7	51
Suckers	174	1,459
Sunfish	7,537	50,173
Tadpole Madtom	3	22
Trout Perch	44	324
Walleye	3	24

Table C22
Impingement Losses for La Grange Pool (cont.)

Species	Total Number Impinged	Estimated Number Impinged
Warmouth	1	6
White Bass	158	1,261
White Crappie	75	544
White Sucker	2	13
Yellow Bass	32	209
Yellow Bullhead	58	407
E.D. Edwards Power Station, July 1975-August 1976 (Wapora, Inc. 1981)		
Species	**Total Number Impinged**	**Estimated Number Impinged**
American Eel	1	3
Basses, *Morone* sp.	19	60
Bigmouth Buffalo	68	245
Black Bullhead	75	276
Black Crappie	1,256	5,241
Blue Catfish	34	110
Bluegill	430	1,608
Bluntnose Minnow	2	8
Bowfin	1	3
Brindled Madtom	1	4

Table C22
Impingement Losses for La Grange Pool (cont.)

Species	Total Number Impinged	Estimated Number Impinged
Brook Silverside	1	4
Brown Bullhead	8	29
Bullhead Minnow	1	5
Carp	653	2,391
Carpsuckers	29	134
Carp x Goldfish	50	194
Catfish	4	16
Channel Catfish	1,844	7,316
Crappies	813	3,010
Creek Chub	4	15
Emerald Shiner	3,539	13,751
Fathead Minnow	6	42
Flathead Catfish	48	184
Freshwater Drum	15,411	60,316
Gizzard Shad	105,866	373,468
Golden Shiner	2	7
Goldeye	12	44
Goldfish	415	1,757

Table C22
Impingement Losses for La Grange Pool (cont.)

Species	Total Number Impinged	Estimated Number Impinged
Green Sunfish	149	612
Largemouth Bass	56	212
Logperch	1	6
Longear Sunfish	1	3
Longnose Gar	13	46
Mimic Shiner	2	8
Minnows	1	4
Mooneye	8	29
Northern Hog Sucker	2	9
Northern Pike	11	40
Orangespotted Sunfish	15	57
Paddlefish	1	4
Pirate Perch	1	5
Rainbow Smelt	1	4
Rainbow Trout	1	3
River Carpsucker	79	300
River Shiner	6	17
Sauger	17	60

Table C22
Impingement Losses for La Grange Pool (cont.)

Species	Total Number Impinged	Estimated Number Impinged
Shorthead Redhorse	5	20
Shortnose Gar	30	113
Shovelnose Sturgeon	1	3
Silver Chub	44	161
Silvery Minnow	15	56
Silver Shiner	1	4
Skipjack Herring	1,821	7,416
Smallmouth Bass	15	50
Smallmouth Buffalo	40	143
Speckled Chub	3	13
Spottail Shiner	66	283
Steelcolor Shiner	1	4
Suckermouth Minnow	2	10
Suckers	56	188
Sunfish	1,389	5,914
Tadpole Madtom	32	129
Trout Perch	7	25
Walleye	4	13

Table C22
Impingement Losses for La Grange Pool (cont.)

Species	Total Number Impinged	Estimated Number Impinged
Warmouth	1	4
White Bass	482	1,730
White Crappie	274	882
White Sucker	7	26
Yellow Bass	5	18
Yellow Bullhead	31	113
E.D. Edwards Power Station, July 1974-August 1976 (Wapora, Inc. 1981)		
Species	**Total Number Impinged**	**Estimated Number Impinged**
American Eel	2	11
Basses, *Morone* sp.	1,100	7,299
Bigmouth Buffalo	102	503
Black Bullhead	134	696
Black Crappie	1,553	7,395
Blue Catfish	34	110
Bluegill	1,176	6,842
Bluntnose Minnow	2	8
Bowfin	17	107
Brindled Madtom	1	4

Table C22
Impingement Losses for La Grange Pool (cont.)

Species	Total Number Impinged	Estimated Number Impinged
Brook Silverside	1	4
Brown Bullhead	12	65
Bullhead Minnow	1	5
Carp	1,408	8,001
Carpsuckers	29	134
Carp x Goldfish	72	347
Catfish	7	38
Central Stoneroller	2	15
Channel Catfish	2,596	12,307
Crappies	819	3,049
Creek Chub	17	52
Emerald Shiner	9,820	55,375
Fathead Minnow	6	42
Flathead Catfish	105	639
Freshwater Drum	52,329	314,519
Gizzard Shad	242,682	1,329,325
Golden Redhorse	2	20
Golden Shiner	9	53

Table C22
Impingement Losses for La Grange Pool (cont.)

Species	Total Number Impinged	Estimated Number Impinged
Goldeye	23	145
Goldfish	490	2,313
Green Sunfish	303	1,804
Largemouth Bass	111	653
Logperch	12	90
Longear Sunfish	1	3
Longnose Gar	20	96
Madtom	5	54
Mimic Shiner	2	8
Minnows	1	4
Mooneye	8	29
Northern Hog Sucker	2	8
Northern Pike	20	100
Orangespotted Sunfish	101	676
Paddlefish	9	62
Perches	41	268
Pirate Perch	1	5
Quillback	5	35

Table C22
Impingement Losses for La Grange Pool (cont.)

Species	Total Number Impinged	Estimated Number Impinged
Rainbow Smelt	1	4
Rainbow Trout	1	3
Redhorses	1	7
Red Shiner	3	21
River Carpsucker	109	559
River Shiner	6	17
Sauger	38	208
Sauger-Walleye	1	7
Shiners	1	6
Shorthead Redhorse	7	32
Shortnose Gar	97	606
Shovelnose Sturgeon	2	10
Silver Chub	44	161
Silvery Minnow	15	56
Silver Shiner	1	4
Skipjack Herring	2,502	11,904
Smallmouth Bass	15	50
Smallmouth Buffalo	74	372

Table C22
Impingement Losses for La Grange Pool (cont.)

Species	Total Number Impinged	Estimated Number Impinged
Speckled Chub	3	13
Spottail Shiner	101	549
Spotted Sucker	1	6
Steelcolor Shiner	1	4
Stonecat	2	13
Suckermouth Minnow	9	61
Suckers	230	1,647
Sunfish	8,926	56,054
Tadpole Madtom	35	151
Trout Perch	51	347
Walleye	7	37
Warmouth	2	11
White Bass	640	2,996
White Crappie	349	1,426
White Sucker	9	39
Yellow Bass	37	227
Yellow Bullhead	89	519

Table C22
Impingement Losses for La Grange Pool (cont.)

Havana Power Station, December 1974 (Wapora, Inc. 1975a)

Species	Total Number Impinged		
	12/24	12/27	12/31
Black Crappie	5	1	1
Bluegill Sunfish	3		
Channel Catfish	5	2	
Crappies			2
Emerald Shiner	1		
Flathead Catfish	1		
Freshwater Drum	112	42	76
Gizzard Shad	941	330	358
Goldeye			1
Green Sunfish	1	3	3
White Bass	1	1	
White Crappie	3		
Yellow Bullhead	1		

Table C22
Impingement Losses for La Grange Pool (cont.)

Havana Power Station, January 1975 (Wapora, Inc. 1975a)

Species	Total Number Impinged				
	1/4	1/8	1/16	1/20	1/28
Bigmouth Buffalo			1		
Black Crappie	8	2	2		1
Bluegill Sunfish	6	3	3		1
Carp	2	1	2		1
Channel Catfish	10	3	12	6	7
Emerald Shiner				1	1
Freshwater Drum	233	93	76	46	40
Gizzard Shad	823	1,068	611	1,827	2,247
Green Sunfish	6		1		
Largemouth Bass	2	1			
River Carpsucker				1	
Shorthead Redhorse		1			
Shortnose Gar	1				
Skipjack Herring		4			
Smallmouth Buffalo			2	2	
White Bass		2	1	1	1

Table C22
Impingement Losses for La Grange Pool (cont.)

Species	Total Number Impinged				
	1/4	1/8	1/16	1/20	1/28
White Crappie		2			
Yellow Bass	11				
Yellow Bullhead					2

Havana Power Station, February 1975 (Wapora, Inc. 1975a)

Species	Total Number Impinged						
	2/1	2/5	2/13	2/17	2/21	2/25	2/27
Bigmouth Buffalo				1			
Black Crappie	2		4	6	2		6
Bluegill Sunfish		1	1			5	2
Carp	2		1	1	1	1	3
Channel Catfish	5	3	10	11	8	13	12
Emerald Shiner						1	
Flathead Catfish			1				1
Freshwater Drum	32		67	69	26	36	70
Gizzard Shad	4,376	1,217	1,585	1,383	285	248	652
Goldeye				1			
Green Sunfish				1	1		

Table C22
Impingement Losses for La Grange Pool (cont.)

Species	Total Number Impinged						
	2/1	**2/5**	**2/13**	**2/17**	**2/21**	**2/25**	**2/27**
Largemouth Bass							1
Paddlefish	1						
River Carpsucker	1						1
Silver Chub					1		
Smallmouth Buffalo			1				1
Suckers		1					
White Bass				1			1
White Crappie			1	1	1		1
White Sucker			1				
Yellow Bass							1

Havana Power Station, March 1975 (Wapora, Inc. 1975a)

Species	Total Number Impinged								
	3/1	**3/5**	**3/9**	**3/10**	**3/13**	**3/17**	**3/21**	**3/25**	**3/29**
Bigmouth Buffalo						1			
Black Crappie		1	9	1		1	2	1	1
Bluegill Sunfish		1	7	2		1	5	4	
Carp		1			2	1			

Table C22
Impingement Losses for La Grange Pool (cont.)

Species	Total Number Impinged								
	3/1	3/5	3/9	3/10	3/13	3/17	3/21	3/25	3/29
Channel Catfish		1	9	2	1	3	5	1	
Emerald Shiner			1						
Freshwater Drum	18	5	14	9	9	5	30	6	18
Gizzard Shad	163	378	650	58	124	192	84	54	149
Green Sunfish							1		1
Largemouth Bass	1		1						
Red Shiner								1	
River Carpsucker			2						
Smallmouth Buffalo							1		
Trout Perch								1	
White Bass		1							1
Yellow Bass									1

Havana Power Station, April 1975 (Wapora, Inc. 1975a)

Species	Total Number Impinged						
	4/2	4/6	4/14	4/18	4/22	4/26	4/30
Bigmouth Buffalo	1						
Black Bullhead		1					

Table C22
Impingement Losses for La Grange Pool (cont.)

Species	Total Number Impinged						
	4/2	4/6	4/14	4/18	4/22	4/26	4/30
Black Crappie	1			2	3	1	
Bluegill Sunfish		2	2	7	7	1	2
Carp							3
Channel Catfish	1	5	2	1			1
Emerald Shiner						1	
Freshwater Drum	23	25	2	11	6	1	1
Gizzard Shad	138	175	29	66	77	5	2
Green Sunfish					1		2
Largemouth Bass	2				1		
River Carpsucker					2		1
Spotfin Shiner		1					
Stoneroller		1					
Trout Perch		1	1				
White Crappie				1			

Table C22
Impingement Losses for La Grange Pool (cont.)

Havana Power Station, May 1975 (Wapora, Inc. 1975a)

Species	**Total Number Impinged**					
	5/4	**5/8**	**5/16**	**5/20**	**5/22**	**5/29**
Bigmouth Buffalo	1		1			
Black Crappie				2	1	
Bluegill Sunfish			1	4		
Carp	1				1	1
Channel Catfish						1
Creek Chub				1		
Emerald Shiner	1		1			
Freshwater Drum	1	1	1	16	4	3
Gizzard Shad	5		1	5	4	1
Green Sunfish			1			
Largemouth Bass					1	
Orangespotted Sunfish			1			
River Carpsucker						1
Shiners				1		
Shortnose Gar					1	
Tadpole Madtom	1					

Table C22
Impingement Losses for La Grange Pool (cont.)

Species	Total Number Impinged					
	5/4	5/8	5/16	5/20	5/22	5/29
White Bass				1	2	
White Crappie				1		
Yellow Bass				1		

Havana Power Station, June 1975 (Wapora, Inc. 1975a)

Species	Total Number Impinged							
	6/1	6/5	6/9	6/13	6/17	6/21	6/26	6/29
Black Crappie						1		
Bluegill Sunfish	1	2			5	2	1	1
Carp							3	1
Common Shiner	1							
Emerald Shiner	1							
Freshwater Drum						4	1	1
Gizzard Shad	2		2			7	9	3
Green Sunfish			1	1		1		
Largemouth Bass						1		
Redear Sunfish						1	2	
White Crappie								2

Table C22
Impingement Losses for La Grange Pool (cont.)

Havana Power Station, July 1975 (Wapora, Inc. 1975a)

Species	Total Number Impinged					
	7/3	7/7	7/11	7/15	7/23	7/31
Black Bullhead		1				
Black Crappie	1	1		15		1
Bluegill Sunfish	1	1	1	2	16	1
Carp		2		1		2
Channel Catfish					1	
Crappies		4			36	25
Emerald Shiner					2	3
Freshwater Drum		2	2	15	92	93
Gizzard Shad	6	1		2	8	50
Largemouth Bass			1			
Skipjack Herring		1				
Sunfish	2					
Tadpole Madtom					2	4
Trout Perch					1	
White Crappie				4		

Table C22
Impingement Losses for La Grange Pool (cont.)

Havana Power Station, August 1975 (Wapora, Inc. 1975a)

Species	Total Number Impinged				
	8/4	8/8	8/12	8/16	8/28
Black Bullhead					1
Black Crappie				1	3
Bluegill Sunfish	1	1			
Carp	2		1	1	
Channel Catfish		1			1
Crappies	7		8		15
Emerald Shiner			1	2	5
Flathead Catfish				1	2
Freshwater Drum	7	5	20	47	45
Gizzard Shad	13	3	45	91	2,347
Largemouth Bass			1		
Longnose Gar			1		
Silver Chub					2
Skipjack Herring			4		
Smallmouth Bass				1	
Sunfish				17	

Table C22
Impingement Losses for La Grange Pool (cont.)

Species	Total Number Impinged				
	8/4	8/8	8/12	8/16	8/28
Tadpole Madtom	1	1			
White Bass			3	1	4

Havana Power Station, September 1975 (Wapora, Inc. 1975a)

Species	Total Number Impinged						
	9/5	9/9	9/13	9/17	9/21	9/25	9/29
Black Bullhead						1	
Black Crappie	3			4			
Bluegill Sunfish		1		1			1
Carp	2						
Channel Catfish	1			1	1	2	
Crappies	32		3		1	3	2
Emerald Shiner	2	1					
Flathead Catfish					1	3	
Freshwater Drum	95	5	4	4	16	11	4
Gizzard Shad	249	4	18	37	17	17	4
Green Sunfish		1					1
Pirate Perch	1						

Table C22
Impingement Losses for La Grange Pool (cont.)

Species	Total Number Impinged						
	9/5	9/9	9/13	9/17	9/21	9/25	9/29
River Carpsucker	1						
Skipjack Herring	7				2		
Smallmouth Buffalo			1				
White Bass	1					1	
White Crappie		2					

Havana Power Station, October 1975 (Wapora, Inc. 1975a)

Species	Total Number Impinged							
	10/3	10/7	10/11	10/15	10/19	10/23	10/26	10/31
Black Bullhead								1
Bluegill Sunfish					1		3	1
Carp			1	1				
Channel Catfish								1
Crappies			4					
Emerald Shiner	2							1
Flathead Catfish	1		1		1			
Freshwater Drum	14	6		31	2	6	3	3
Gizzard Shad	8	10	5	153	19	34	21	25

Table C22
Impingement Losses for La Grange Pool (cont.)

Species	**Total Number Impinged**							
	10/3	**10/7**	**10/11**	**10/15**	**10/19**	**10/23**	**10/26**	**10/31**
Green Sunfish								2
Longnose Gar								1
Skipjack Herring		1		8	1			
White Bass	1	2		2		2		1
White Crappie	2	1						2

Havana Power Station, November 1975 (Wapora, Inc. 1975a)

Species	**Total Number Impinged**			
	11/4	**11/8**	**11/11**	**11/16**
Black Crappie	1			
Bluegill Sunfish			2	1
Carp		1		2
Channel Catfish		1		
Freshwater Drum	1		11	5
Gizzard Shad	27	10	60	28
Smallmouth Buffalo			1	
White Bass	2		1	
White Crappie	5		3	1

Table C22
Impingement Losses for La Grange Pool (cont.)

Species	Total Number Impinged			
	11/4	11/8	11/11	11/16
Yellow Bullhead			1	

Havana Power Station, December 24, 1974-March 29, 1975 (Wapora, Inc. 1975a)

Species	Total Number Impinged	Estimated Number Impinged
Bigmouth Buffalo	3	11.6
Black Crappie	56	216.2
Bluegill Sunfish	45	173.7
Carp	19	73.4
Channel Catfish	129	498.1
Crappies	2	7.7
Emerald Shiner	5	19.3
Flathead Catfish	3	11.6
Freshwater Drum	1,154	4,455.5
Gizzard Shad	19,803	76,457.7
Goldeye	2	7.7
Green Sunfish	18	69.5
Largemouth Bass	6	23.2
Paddlefish	1	3.9

Table C22
Impingement Losses for La Grange Pool (cont.)

Species	Total Number Impinged	Estimated Number Impinged
Red Shiner	1	3.9
River Carpsucker	5	19.3
Shorthead Redhorse	1	3.9
Shortnose Gar	1	3.9
Silver Chub	1	3.9
Skipjack Herring	4	15.4
Smallmouth Buffalo	7	27
Suckers	1	3.9
Trout Perch	1	3.9
White Bass	11	42.5
White Crappie	9	34.7
White Sucker	1	3.9
Yellow Bass	13	50.2
Yellow Bullhead	3	11.6
Havana Power Station, April 2, 1975-June 29, 1975 (Wapora, Inc. 1975a)		
Species	**Total Number Impinged**	**Estimated Number Impinged**
Bigmouth Buffalo	3	12.2
Black Bullhead	1	4.1

Table C22
Impingement Losses for La Grange Pool (cont.)

Species	Total Number Impinged	Estimated Number Impinged
Black Crappie	12	48.6
Bluegill Sunfish	38	154
Carp	10	40.5
Channel Catfish	11	44.6
Common Shiner	1	4.1
Creek Chub	1	4.1
Emerald Shiner	4	16.2
Freshwater Drum	101	409.3
Gizzard Shad	531	2,151.8
Green Sunfish	7	28.4
Largemouth Bass	5	20.3
Orangespotted Sunfish	1	4.1
Redear Sunfish	3	12.2
River Carpsucker	5	20.3
Shiners	1	4.1
Shortnose Gar	1	4.1
Spotfin Shiner	1	4.1
Stoneroller	1	4.1

Table C22
Impingement Losses for La Grange Pool (cont.)

Species	Total Number Impinged	Estimated Number Impinged
Tadpole Madtom	1	4.1
Trout Perch	2	8.1
White Bass	3	12.2
White Crappie	4	16.2
Yellow Bass	1	4.1
Havana Power Station, July 3, 1975-September 29, 1975 (Wapora, Inc. 1975a)		
Species	**Total Number Impinged**	**Estimated Number Impinged**
Black Bullhead	3	14.2
Black Crappie	29	137.6
Bluegill Sunfish	27	128.1
Carp	11	52.2
Channel Catfish	8	38
Crappies	136	645.4
Emerald Shiner	16	75.9
Flathead Catfish	7	33.2
Freshwater Drum	467	2,216.2
Gizzard Shad	2,912	13,819.2
Green Sunfish	2	9.5

Table C22
Impingement Losses for La Grange Pool (cont.)

Species	Total Number Impinged	Estimated Number Impinged
Largemouth Bass	2	9.5
Longnose Gar	1	4.7
Pirate Perch	1	4.7
River Carpsucker	1	4.7
Silver Chub	2	9.5
Skipjack Herring	14	66.4
Smallmouth Bass	1	4.7
Smallmouth Buffalo	1	4.7
Sunfish	19	90.2
Tadpole Madtom	8	38
Trout Perch	1	4.7
White Bass	10	47.5
White Crappie	6	28.5
Havana Power Station, October 3, 1975-November 16, 1975 (Wapora, Inc. 1975a)		
Species	**Total Number Impinged**	**Estimated Number Impinged**
Black Bullhead	1	3.4
Black Crappie	1	3.4
Bluegill Sunfish	8	27.3

Table C22
Impingement Losses for La Grange Pool (cont.)

Species	Total Number Impinged	Estimated Number Impinged
Carp	5	17
Channel Catfish	2	6.8
Crappies	4	13.6
Emerald Shiner	3	10.2
Flathead Catfish	3	10.2
Freshwater Drum	82	279.4
Gizzard Shad	400	1,362.9
Green Sunfish	2	6.8
Longnose Gar	1	3.4
Skipjack Herring	10	34.1
Smallmouth Buffalo	1	3.4
White Bass	11	37.5
White Crappie	14	47.7
Yellow Bullhead	1	3.4
Havana Power Station, December 1974-November 1975 (Wapora, Inc. 1975a)		
Species	**Total Number Impinged**	**Estimated Number Impinged**
Bigmouth Buffalo	6	24.3
Black Bullhead	5	20.2

Table C22
Impingement Losses for La Grange Pool (cont.)

Species	Total Number Impinged	Estimated Number Impinged
Black Crappie	98	396.8
Bluegill Sunfish	118	477.8
Carp	45	182.2
Channel Catfish	150	607.3
Common Shiner	1	4
Crappies	142	574.9
Creek Chub	1	4
Emerald Shiner	28	113.4
Flathead Catfish	13	52.6
Freshwater Drum	1,804	7,304
Gizzard Shad	23,646	95,739
Goldeye	2	8.1
Green Sunfish	29	117.4
Largemouth Bass	13	52.6
Longnose Gar	2	8.1
Orangespotted Sunfish	1	4
Paddlefish	1	4
Pirate Perch	1	4

Table C22
Impingement Losses for La Grange Pool (cont.)

Species	Total Number Impinged	Estimated Number Impinged
Redear Sunfish	3	12.1
Red Shiner	1	4
River Carpsucker	11	44.5
Shiners	1	4
Shorthead Redhorse	1	4
Shortnose Gar	2	8.1
Silver Chub	3	12.1
Skipjack Herring	28	113.4
Smallmouth Bass	1	4
Smallmouth Buffalo	9	36.4
Spotfin Shiner	1	4
Stoneroller	1	4
Suckers	1	4
Sunfish	19	76.9
Tadpole Madtom	9	36.4
Trout Perch	4	16.2
White Bass	35	141.7
White Crappie	33	133.6

Table C22
Impingement Losses for La Grange Pool (cont.)

Species	Total Number Impinged (longer than 5 inches, excluding gizzard shad)	Estimated Number Impinged
White Sucker	1	4
Yellow Bass	14	56.7
Yellow Bullhead	4	16.2
Havana Power Station, December 1974-November 1975 (Wapora, Inc. 1975a)		
Species	**Total Number Impinged (longer than 5 inches, excluding gizzard shad)**	**Estimated Number Impinged (longer than 5 inches, excluding gizzard shad)**
Bigmouth Buffalo	6	24
Black Bullhead	2	8
Black Crappie	61	247
Bluegill Sunfish	27	109
Carp	34	138
Channel Catfish	129	522
Creek Chub	1	4
Flathead Catfish	1	4
Freshwater Drum	561	2,271
Goldeye	2	8
Green Sunfish	3	12
Largemouth Bass	8	32

Table C22
Impingement Losses for La Grange Pool (cont.)

Species	Total Number Impinged	Estimated Number Impinged
Longnose Gar	2	8
Paddlefish	1	4
River Carpsucker	6	24
Shorthead Redhorse	1	4
Shortnose Gar	1	4
Skipjack Herring	4	16
Smallmouth Buffalo	7	28
Tadpole Madtom	1	4
White Bass	12	48
White Crappie	10	40
White Sucker	1	4
Yellow Bass	5	20
Yellow Bullhead	2	8

Table C23
Impingement Losses for Peoria Pool

Hennepin Power Station, December 1974 (Wapora, Inc. 1975b)

Species	**Total Number Impinged**		
	12/24	**12/27**	**12/31**
Basses	1		
Black Crappie			23
Bluegill Sunfish		5	
Carp	1	2	1
Channel Catfish	6	22	9
Emerald Shiner	6	17	7
Freshwater Drum	6	15	
Gizzard Shad	519	2,386	1,966
Green Sunfish		1	
Largemouth Bass		1	
Log Perch		1	
Longnose Gar		1	
Shortnose Gar		2	
Skipjack Herring			1
Suckers	2	4	
Trout Perch			1

Table C23
Impingement Losses for Peoria Pool (cont.)

Species	**Total Number Impinged**		
	12/24	**12/27**	**12/31**
White Bass		12	2
Yellow Bass	1	2	2

Hennepin Power Station, January 1975 (Wapora, Inc. 1975b)

Species	**Total Number Impinged**				
	1/4	**1/8**	**1/20**	**1/24**	**1/28**
Basses	3				
Black Bullhead					2
Black Crappie		1			
Bluegill Sunfish	2	1			
Carp	3	3	10	2	5
Channel Catfish	4	14	2		8
Emerald Shiner	14	9	3	1	6
Freshwater Drum	3	8			1
Gizzard Shad	1,046	1,791	146	295	117
Goldfish	2				1
Green Sunfish					4
Largemouth Bass		1		1	

Table C23
Impingement Losses for Peoria Pool (cont.)

Species	Total Number Impinged				
	1/4	**1/8**	**1/20**	**1/24**	**1/28**
River Carpsucker		1	5		
Spottail Shiner					1
Threespine Stickleback			1		
Trout Perch	1			1	2
Warmouth	1				
White Bass		2	3		
Yellow Bass	2			1	

Hennepin Power Station, February 1975 (Wapora, Inc. 1975b)

Species	Total Number Impinged					
	2/1	**2/4**	**2/5**	**2/13**	**2/18**	**2/21**
Basses			1			
Bigmouth Buffalo				1		
Bluegill Sunfish	2					1
Carp	1	1		1		1
Channel Catfish				3	1	2
Emerald Shiner	5	7	2	12	1	6
Flathead Catfish					1	

Table C23
Impingement Losses for Peoria Pool (cont.)

Species	Total Number Impinged					
	2/1	2/4	2/5	2/13	2/18	2/21
Freshwater Drum		4		4	2	1
Gizzard Shad	109	320	86	47	110	266
Goldeye					1	1
Goldfish	1	1	1			1
Green Sunfish				3		2
Largemouth Bass		1				2
Orangespotted Sunfish		2				
River Carpsucker	1					
Smallmouth Bass		1				
Smallmouth Buffalo						1
Spottail Shiner						1
Suckers		1	2			
Sunfish				7		
Tadpole Madtom		2				
Trout Perch	1	2		3	1	1
Warmouth		1				
White Bass				3		

Table C23
Impingement Losses for Peoria Pool (cont.)

Species	Total Number Impinged					
	2/1	2/4	2/5	2/13	2/18	2/21
White Crappie				1	1	
Yellow Bass				1		3
Yellow Bullhead	1					

Hennepin Power Station, March 1975 (Wapora, Inc. 1975b)

Species	Total Number Impinged							
	3/1	3/5	3/9	3/13	3/17	3/21	3/25	3/29
Black Bullhead	1	1	4		1			1
Bluegill Sunfish							3	
Carp	3	1		2		1		1
Carp x Goldfish	1							
Channel Catfish	1	4	7	2	2	4	3	2
Creek Chub							1	
Emerald Shiner	3	2	5	2	1	2	9	7
Freshwater Drum			1			1		
Gizzard Shad	56	52	27	12	2	4	11	9
Goldfish	1	4			1		1	
Green Sunfish				2	4		2	

Table C23
Impingement Losses for Peoria Pool (cont.)

Species	**Total Number Impinged**							
	3/1	**3/5**	**3/9**	**3/13**	**3/17**	**3/21**	**3/25**	**3/29**
Madtoms		1						
Orangespotted Sunfish						1		
Quillback		1						
River Carpsucker			2					
Stonecat						1		
Suckers	12	6						
Sunfish				1				
Trout Perch	2	13	5		1	2	2	
White Bass	2	4						
White Sucker			1					
Yellow Bass		1	1				3	1
Yellow Bullhead					1			
Hennepin Power Station, April 1975 (Wapora, Inc. 1975b)								
Species	**Total Number Impinged**							
	4/2	**4/6**	**4/10**	**4/14**	**4/18**	**4/22**	**4/26**	**4/30**
Black Bullhead			1					1
Black Crappie					1		2	

Table C23
Impingement Losses for Peoria Pool (cont.)

Species	Total Number Impinged							
	4/2	4/6	4/10	4/14	4/18	4/22	4/26	4/30
Bluegill Sunfish				1		5	24	18
Carp			1				1	13
Channel Catfish	3	4	1	3	1	1		1
Common Shiner					5			
Emerald Shiner	2		1	2	3	3	11	22
Freshwater Drum				1				
Gizzard Shad	10	12	4	2	1	22	5	18
Goldfish							4	3
Green Sunfish			1				4	3
Log Perch						1	2	
River Carpsucker		1				1	1	
Rock Bass							1	
Smallmouth Buffalo						1	1	
Spottail Shiner				1		3		4
Suckers								25
Tadpole Madtom					1			
Trout Perch					1	1	3	

Table C23
Impingement Losses for Peoria Pool (cont.)

Species	Total Number Impinged							
	4/2	4/6	4/10	4/14	4/18	4/22	4/26	4/30
Walleye								19
White Bass	1							
White Crappie					1	2		1
Yellow Bass	1				1			
Yellow Bullhead							1	1

Hennepin Power Station, May 1975 (Wapora, Inc. 1975b)

Species	Total Number Impinged						
	5/4	5/8	5/12	5/16	5/20	5/22	5/29
Bigmouth Buffalo							1
Black Crappie							1
Bluegill Sunfish	3	4		8	1	1	4
Brown Bullhead			8				
Carp	1		1			2	
Channel Catfish				1			
Emerald Shiner	7	3	1	1		9	15
Freshwater Drum		2	1			1	
Gizzard Shad	6	5	9	6		3	6

Table C23
Impingement Losses for Peoria Pool (cont.)

Species	Total Number Impinged						
	5/4	5/8	5/12	5/16	5/20	5/22	5/29
Goldfish	11	8	4	3	1		
Green Sunfish	2						
Largemouth Bass						2	
Northern Pike			1			1	
River Carpsucker			1				
Shortnose Gar			2				
Spottail Shiner		1					2
Suckers	1	2					
Sunfish			2				
Tadpole Madtom				1			
Trout Perch		1	5	1	2	1	4
Walleye						1	
White Bass				1		3	
White Crappie						3	

Table C23
Impingement Losses for Peoria Pool (cont.)

Hennepin Power Station, June 1975 (Wapora, Inc. 1975b)

Species	**Total Number Impinged**							
	6/1	**6/5**	**6/9**	**6/13**	**6/17**	**6/21**	**6/25**	**6/29**
Black Bullhead				1			1	
Black Crappie	2					1		
Bluegill Sunfish	3	2	5	1	1	3	1	
Carp		2				1	1	3
Channel Catfish	2							
Emerald Shiner	4		7	15		2	3	9
Freshwater Drum		1						
Gizzard Shad		3	1	3	1	15	7	2
Goldfish				1		1		
Green Sunfish	1					1		
Northern Pike			1	1				1
Orangespotted Sunfish				1		1		
River Carpsucker		2	1	2				
Shortnose Gar	1		1					1
Smallmouth Bass			1					
Spotfin Shiner		2						

Table C23
Impingement Losses for Peoria Pool (cont.)

Species	Total Number Impinged							
	6/1	6/5	6/9	6/13	6/17	6/21	6/25	6/29
Spottail Shiner		1		1				
Suckers		1						
Tadpole Madtom		1						
Trout Perch				1				
White Bass				1				6
White Crappie	1			1				
Yellow Bullhead		1						

Hennepin Power Station, July 1975 (Wapora, Inc. 1975b)

Species	Total Number Impinged							
	7/3	7/7	7/11	7/15	7/19	7/23	7/27	7/31
Bigmouth Buffalo				4		1		
Black Bullhead		1						
Black Crappie			2		2			2
Bluegill Sunfish	1	4	5			1		1
Carp	2	4	2	4		5		3
Crappies		4				1	1	
Emerald Shiner	6	4	9	4	7	16		6

Table C23
Impingement Losses for Peoria Pool (cont.)

Species	Total Number Impinged							
	7/3	7/7	7/11	7/15	7/19	7/23	7/27	7/31
Freshwater Drum						3		
Gizzard Shad	39	346	294	18	37	146	9	46
Goldfish			2					
Green Sunfish		2					1	
Largemouth Bass		1						
Northern Pike	1	3	1	1				
Red Shiner			1			1		
Redfin Shiner		1						
River Carpsucker	1			1				
Shortnose Gar		1		1	1	1		
Silver Chub						3		
Skipjack Herring			1	1	2	6	1	3
Smallmouth Buffalo			1					
Spottail Shiner		1						
Sunfish			3					
Tadpole Madtom		1						
Trout Perch	1		3		1			

Table C23
Impingement Losses for Peoria Pool (cont.)

Species	Total Number Impinged							
	7/3	7/7	7/11	7/15	7/19	7/23	7/27	7/31
White Bass					2		1	2
White Crappie			1		1			
Yellow Bullhead			2					

Hennepin Power Station, August 1975 (Wapora, Inc. 1975b)

Species	Total Number Impinged						
	8/4	8/9	8/12	8/16	8/20	8/24	8/28
Bigmouth Buffalo					1		
Black Bullhead							1
Brown Bullhead						1	
Carp	1	3	2	3	4	1	3
Carp x Goldfish						1	
Channel Catfish	1	3		1		2	2
Emerald Shiner	6	2	4	7	2	7	4
Freshwater Drum	2	2	3	6	2	9	4
Gizzard Shad	234	14	38	438	143	275	90
Goldeye	1						
Goldfish	2				1	1	

Table C23
Impingement Losses for Peoria Pool (cont.)

Species	Total Number Impinged						
	8/4	8/9	8/12	8/16	8/20	8/24	8/28
Green Sunfish	1						
Largemouth Bass				1			
Paddlefish					1		
Quillback					1		
River Carpsucker				2	1		
Sauger		1					
Silver Chub						1	
Silvery Minnow	1						
Skipjack Herring	3	3		1	7		3
Spottail Shiner		1				1	
Suckers				1			
Tadpole Madtom	1						
White Bass			2	2	4	3	1
White Crappie			1	2			
Yellow Bullhead				1			

Table C23
Impingement Losses for Peoria Pool (cont.)

Hennepin Power Station, September 1975 (Wapora, Inc. 1975b)

Species	**Total Number Impinged**							
	9/1	**9/5**	**9/9**	**9/13**	**9/17**	**9/21**	**9/25**	**9/29**
Bigmouth Buffalo				1				
Black Crappie			1	2				
Bluegill Sunfish	3	3	1	1			1	1
Carp	3	6	2	1				
Channel Catfish	2	1	5	2	2	1		
Crappies		6						
Emerald Shiner	8	9	4	5		1		
Flathead Catfish						1		
Freshwater Drum	7	9	2	3	3			
Gizzard Shad	228	199	271	204	48	25	2	
Goldfish			1	1				
Longnose Gar				1				
Quillback	1							
Sauger			1					
Skipjack Herring		4	9	2	2			
Suckers			3	2				

Table C23
Impingement Losses for Peoria Pool (cont.)

Species	Total Number Impinged							
	9/1	9/5	9/9	9/13	9/17	9/21	9/25	9/29
Trout Perch				1				
White Bass	3	11	4	2				
White Crappie				1				
Hennepin Power Station, October 1975 (Wapora, Inc. 1975b)								
Species	**Total Number Impinged**							
	10/3	**10/7**	**10/11**	**10/15**	**10/19**	**10/23**	**10/26**	**10/31**
Black Crappie							1	
Bluegill Sunfish				1			2	2
Carp							1	
Channel Catfish		1			1			2
Emerald Shiner				1		1		
Freshwater Drum			1	1	3	1	16	11
Gizzard Shad	1			3	29	9	52	81
Goldfish							1	1
Green Sunfish							1	
Silver Chub							1	
Skipjack Herring							2	

Table C23
Impingement Losses for Peoria Pool (cont.)

Species	Total Number Impinged							
	10/3	10/7	10/11	10/15	10/19	10/23	10/26	10/31
Spottail Shiner		1					1	1
Trout Perch								1
White Bass								2
White Crappie							2	1
Yellow Bullhead				1				

Hennepin Power Station, November 1975 (Wapora, Inc. 1975b)

Species	Total Number Impinged			
	11/4	11/8	11/11	11/16
Bigmouth Buffalo	1			
Blue Catfish				1
Bluegill Sunfish	2		1	11
Carp	2	2		
Channel Catfish	1		1	
Emerald Shiner		1	3	
Freshwater Drum	6	4	16	
Gizzard Shad	78	35	47	283
River Carpsucker			1	

Table C23
Impingement Losses for Peoria Pool (cont.)

Species	**Total Number Impinged**			
	11/4	**11/8**	**11/11**	**11/16**
Trout Perch	1			
White Bass	2	1		3
White Crappie	1	1	2	1
Yellow Bass		1		1

Hennepin Power Station, December 24, 1974-March 24, 1975 (Wapora, Inc. 1975b)

Species	**Total Number Impinged**	**Estimated Number Impinged**
Basses	5	21.3
Bigmouth Buffalo	1	4.3
Black Bullhead	10	42.6
Black Crappie	24	102.2
Bluegill Sunfish	14	59.6
Carp	39	166.1
Carp x Goldfish	1	4.3
Channel Catfish	96	408.9
Emerald Shiner	127	541
Flathead Catfish	1	4.3
Freshwater Drum	46	195.9

Table C23
Impingement Losses for Peoria Pool (cont.)

Species	Total Number Impinged	Estimated Number Impinged
Gizzard Shad	9,377	39,942
Goldeye	2	8.5
Goldfish	14	59.6
Green Sunfish	18	76.7
Largemouth Bass	6	25.6
Logperch	1	4.3
Longnose Gar	1	4.3
Madtoms	1	4.3
Orangespotted Sunfish	3	12.8
Quillback	1	4.3
River Carpsucker	9	38.3
Shortnose Gar	2	8.5
Skipjack Herring	1	4.3
Smallmouth Bass	1	4.3
Smallmouth Buffalo	1	4.3
Spottail Shiner	4	17
Stonecat	1	4.3
Suckers	25	106.5

Table C23
Impingement Losses for Peoria Pool (cont.)

Species	Total Number Impinged	Estimated Number Impinged
Sunfish	8	34.1
Tadpole Madtom	2	8.5
Threespine Stickleback	1	4.3
Trout Perch	38	161.9
Warmouth	2	8.5
White Bass	28	119.3
White Crappie	2	8.5
White Sucker	1	4.3
Yellow Bass	18	76.7
Yellow Bullhead	2	8.5
Hennepin Power Station, April 2, 1975-June 29, 1975 (Wapora, Inc. 1975b)		
Species	**Total Number Impinged**	**Estimated Number Impinged**
Bigmouth Buffalo	1	3.9
Black Bullhead	4	15.6
Black Crappie	12	46.8
Bluegill Sunfish	103	401.6
Brown Bullhead	8	31.2
Carp	26	101.4

Table C23
Impingement Losses for Peoria Pool (cont.)

Species	Total Number Impinged	Estimated Number Impinged
Channel Catfish	17	66.3
Common Shiner	5	19.5
Emerald Shiner	120	467.9
Freshwater Drum	6	23.4
Gizzard Shad	141	549.8
Goldfish	36	140.4
Green Sunfish	12	46.8
Largemouth Bass	2	7.8
Log Perch	3	11.7
Northern Pike	5	19.5
Orangespotted Sunfish	2	7.8
River Carpsucker	9	35.1
Rock Bass	1	3.9
Shortnose Gar	5	19.5
Smallmouth Bass	1	3.9
Smallmouth Buffalo	2	7.8
Spotfin Shiner	1	3.9
Spottail Shiner	14	54.6

Table C23
Impingement Losses for Peoria Pool (cont.)

Species	Total Number Impinged	Estimated Number Impinged
Suckers	29	113.1
Sunfish	2	7.8
Tadpole Madtom	3	11.7
Trout Perch	20	78
Walleye	20	78
White Bass	12	46.8
White Crappie	9	35.1
Yellow Bass	2	7.8
Yellow Bullhead	3	11.7
Hennepin Power Station, July 3, 1975-September 29, 1975 (Wapora, Inc. 1975b)		
Species	**Total Number Impinged**	**Estimated Number Impinged**
Bigmouth Buffalo	7	26.7
Black Bullhead	2	7.6
Black Crappie	9	34.4
Bluegill Sunfish	22	84
Brown Bullhead	1	3.8
Carp	49	187.1
Carp x Goldfish	1	3.8

Table C23
Impingement Losses for Peoria Pool (cont.)

Species	Total Number Impinged	Estimated Number Impinged
Channel Catfish	22	84
Crappies	12	45.8
Emerald Shiner	111	423.9
Flathead Catfish	1	3.8
Freshwater Drum	55	210
Gizzard Shad	3,144	12,007.1
Goldeye	1	3.8
Goldfish	8	30.6
Green Sunfish	4	15.3
Largemouth Bass	2	7.6
Longnose Gar	1	3.8
Northern Pike	6	22.9
Paddlefish	1	3.8
Quillback	2	7.6
Red Shiner	2	7.6
Redfin Shiner	1	3.8
River Carpsucker	5	19.1
Sauger	2	7.6

Table C23
Impingement Losses for Peoria Pool (cont.)

Species	Total Number Impinged	Estimated Number Impinged
Shortnose Gar	4	15.3
Silver Chub	4	15.3
Silvery Minnow	1	3.8
Skipjack Herring	48	183.3
Smallmouth Buffalo	1	3.8
Spottail Shiner	3	11.5
Suckers	6	22.9
Sunfish	3	11.5
Tadpole Madtom	2	7.6
Trout Perch	6	22.9
White Bass	37	141.3
White Crappie	6	22.9
Yellow Bullhead	3	11.5
Hennepin Power Station, October 3, 1975-November 16, 1975 (Wapora, Inc. 1975b)		
Species	**Total Number Impinged**	**Estimated Number Impinged**
Bigmouth Buffalo	1	3.6
Black Crappie	1	3.6
Blue Catfish	1	3.6

Table C23
Impingement Losses for Peoria Pool (cont.)

Species	Total Number Impinged	Estimated Number Impinged
Bluegill Sunfish	19	68.7
Carp	5	18.1
Channel Catfish	6	21.7
Emerald Shiner	6	21.7
Freshwater Drum	59	213.3
Gizzard Shad	618	2,234.5
Goldfish	2	7.2
Green Sunfish	1	3.6
River Carpsucker	1	3.6
Silver Chub	1	3.6
Skipjack Herring	2	7.2
Spottail Shiner	3	10.8
Trout Perch	2	7.2
White Bass	8	28.9
White Crappie	8	28.9
Yellow Bass	2	7.2
Yellow Bullhead	1	3.6

Table C23
Impingement Losses for Peoria Pool (cont.)

Hennepin Power Station, December 24, 1974-November 16, 1975 (Wapora, Inc. 1975b)		
Species	**Total Number Impinged**	**Estimated Number Impinged**
Basses	5	19.7
Bigmouth Buffalo	10	39.3
Black Bullhead	16	62.9
Black Crappie	46	180.9
Blue Catfish	1	3.9
Bluegill Sunfish	158	621.4
Brown Bullhead	9	35.4
Carp	119	468
Carp x Goldfish	2	7.9
Channel Catfish	141	554.5
Common Shiner	5	19.7
Crappies	12	47.2
Creek Chub	1	3.9
Emerald Shiner	364	1,431.5
Flathead Catfish	2	7.9
Freshwater Drum	166	652.8
Gizzard Shad	13,280	52,227.7

Table C23
Impingement Losses for Peoria Pool (cont.)

Species	Total Number Impinged	Estimated Number Impinged
Goldeye	3	11.8
Goldfish	60	236
Green Sunfish	35	137.6
Largemouth Bass	10	39.3
Log Perch	4	15.7
Longnose Gar	2	7.9
Madtoms	1	3.9
Northern Pike	11	43.3
Orangespotted Sunfish	5	19.7
Paddlefish	1	3.9
Quillback	3	11.8
Redfin Shiner	1	3.9
Red Shiner	2	7.9
River Carpsucker	24	94.4
Rock Bass	1	3.9
Sauger	2	7.9
Shortnose Gar	11	43.3
Silver Chub	5	19.7

Table C23
Impingement Losses for Peoria Pool (cont.)

Species	Total Number Impinged	Estimated Number Impinged
Silvery Minnow	1	3.9
Skipjack Herring	51	200.6
Smallmouth Bass	2	7.9
Smallmouth Buffalo	4	15.7
Spotfin Shiner	1	3.9
Spottail Shiner	24	94.4
Stonecat	1	3.9
Suckers	60	236
Sunfish	13	51.1
Tadpole Madtom	7	27.5
Threespine Stickleback	1	3.9
Trout Perch	66	259.6
Walleye	20	78.7
Warmouth	2	7.9
White Bass	85	334.3
White Crappie	25	98.3
White Sucker	1	3.9
Yellow Bass	22	86.5

Table C23
Impingement Losses for Peoria Pool (cont.)

Species	Total Number Impinged	Estimated Number Impinged
Yellow Bullhead	9	35.4
Hennepin Power Station, December 1974-November 1975 (Wapora, Inc. 1975b)		
Species	**Total Number Impinged (longer than 5 inches, excluding gizzard shad)**	**Estimated Number Impinged (longer than 5 inches, excluding gizzard shad)**
Bigmouth Buffalo	6	24
Black Bullhead	4	16
Black Crappie	39	156
Bluegill Sunfish	39	156
Brown Bullhead	9	36
Carp	59	235
Carp x Goldfish	2	8
Channel Catfish	8	32
Creek Chub	1	4
Emerald Shiner	1	4
Freshwater Drum	21	84
Goldeye	1	4
Goldfish	55	219
Green Sunfish	6	24
Largemouth Bass	3	12

Table C23
Impingement Losses for Peoria Pool (cont.)

Species	Total Number Impinged (longer than 5 inches, excluding gizzard shad)	Estimated Number Impinged (longer than 5 inches, excluding gizzard shad)
Longnose Gar	2	8
Northern Pike	3	52
Paddlefish	1	4
Quillback Carpsucker	3	12
River Carpsucker	9	36
Sauger	2	8
Shortnose Gar	11	44
Silvery Minnow	1	4
Smallmouth Bass	1	4
Trout Perch	1	4
Walleye	3	12
White Bass	26	104
White Crappie	7	28
White Sucker	1	4
Yellow Bass	19	76
Yellow Bullhead	5	20

Appendix D
Fish Commercial Catch Data

References cited in this Appendix are included in the References at the end of the main text.

Table D1

The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Bowfin in the Upper Mississippi River System

Year	Pool 3 lbs	Pool 3 fish	Pool 3 tons	Pool 4 lbs	Pool 4 fish	Pool 4 tons	Pool 4a lbs	Pool 4a fish	Pool 4a tons	Pool 5 lbs	Pool 5 fish
1961											
1962											
1963											
1964											
1965											
1966											
1967											
1968											
1969											
1970											
1978				199	80	0.0902	160	64	0.0726	119	48
1983				137	55	0.0621	533	213	0.2417	86	34
1988	10	4	0.0045	272	109	0.1234	0	0	0.0000	15	6
1994	0	0	0.0000	40	16	0.0181	0	0	0.0000	0	0
1995	0	0	0.0000	70	28	0.0317	10	4	0.0045	0	0

Table D1 (cont.)
The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Bowfin in the Upper Mississippi River System

Pool 5 tons	Pool 5a lbs	Pool 5a fish	Pool 5a tons	Pool 6 lbs	Pool 6 fish	Pool 6 tons	Pool 7 lbs	Pool 7 fish	Pool 7 tons	Pool 8 lbs
0.0540	134	54	0.0608	8	3	0.0036	2,283	913	1.0354	814
0.0390	87	35	0.0395	130	52	0.0590	421	168	0.1909	217
0.0068	82	33	0.0372	204	82	0.0925	188	75	0.0853	215
0.0000	101	40	0.0458	48	19	0.0218	543	217	0.2463	44
0.0000	13	5	0.0059	33	13	0.0150	12	5	0.0054	39

Table D1 (cont.)
The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Bowfin in the Upper Mississippi River System

Pool 8 fish	Pool 8 tons	Pool 9 lbs	Pool 9 fish	Pool 9 tons	Pool 10 lbs	Pool 10 fish	Pool 10 tons	Pool 11 lbs	Pool 11 fish	Pool 11 tons
								287	115	0.1302
								76	30	0.0345
								503	201	0.2281
								1,220	488	0.5533
								388	155	0.1760
								488	195	0.2213
								387	155	0.1755
								612	245	0.2776
								1,202	481	0.5451
								695	278	0.3152
326	0.3692	241	96	0.1093	1,056	422	0.4789	691	276	0.3134
87	0.0984	176	70	0.0798	285	114	0.1293	379	152	0.1719
86	0.0975	38,775	15,510	17.5850	1,253	501	0.5683	318	127	0.1442
18	0.0200	1,445	578	0.6553	18,766	7,506	8.5107	2,120	848	0.9615
16	0.0177	3,486	1,394	1.5810	1,110	444	0.5034	142	57	0.0644

Table D1 (cont.)
The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Bowfin in the Upper Mississippi River System

Pool 12 lbs	Pool 12 fish	Pool 12 tons	Pool 13 lbs	Pool 13 fish	Pool 13 tons	Pool 14 lbs	Pool 14 fish	Pool 14 tons	Pool 15 lbs
			30	12	0.0136				
			15	6	0.0068				
			19	8	0.0086				
51	20	0.0231	59	24	0.0268				
14	6	0.0063	194	78	0.0880	56	22	0.0254	112
			5	2	0.0023				
118	47	0.0535	25	10	0.0113	1,100	440	0.4989	
						500	200	0.2268	
			100	40	0.0454				
25	10	0.0113	85	34	0.0385	85	34	0.0385	
1,640	656	0.7438	1,887	755	0.8558	102	41	0.0463	
0	0	0.0000	350	140	0.1587	90	36	0.0408	0
0	0	0.0000	690	276	0.3129	200	80	0.0907	0
0	0	0.0000	380	152	0.1723	65	26	0.0295	0

Table D1 (cont.)
The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Bowfin in the Upper Mississippi River System

Pool 15 fish	Pool 15 tons	Pool 16 lbs	Pool 16 fish	Pool 16 tons	Pool 17 lbs	Pool 17 fish	Pool 17 tons	Pool 18 lbs	Pool 18 fish
								620	248
		5,950	2,380	2.6984	219	88	0.0993	55	22
								684	274
					47	19	0.0213	300	120
					200	80	0.0907	238	95
45	0.0508				300	120	0.1361	350	140
								67	27
					40	16	0.0181	111	44
		7	3	0.0032	375	150	0.1701	300	120
					40	16	0.0181	12	5
		240	96	0.1088	50	20	0.0227	1,761	704
0	0.0000	0	0	0.0000	291	116	0.1320	700	280
0	0.0000	0	0	0.0000	0	0	0.0000	566	226
0	0.0000	0	0	0.0000	0	0	0.0000	0	0

Table D1 (cont.)
The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Bowfin in the Upper Mississippi River System

Pool 18 tons	Pool 19 lbs	Pool 19 fish	Pool 19 tons	Pool 20 lbs	Pool 20 fish	Pool 20 tons	Pool 21 lbs	Pool 21 fish	Pool 21 tons
0.2812				610	244	0.2766			
0.0249				15	6	0.0068			
0.3102				435	174	0.1973	900	360	0.4082
0.1361									
0.1079	283	113	0.1283						
0.1587	823	329	0.3732	40	16	0.0181			
	70	28	0.0317	25	10	0.0113			
0.0304	458	183	0.2077						
0.0503	704	282	0.3193						
0.1361									
0.0054	150	60	0.0680						
0.7986	575	230	0.2608				23	9	0.0104
0.3175	250	100	0.1134	60	24	0.0272	15	6	0.0068
0.2567	60	24	0.0272	0	0	0.0000	0	0	0.0000
0.0000	0	0	0.0000	0	0	0.0000	20	8	0.0091

Table D1 (cont.)
The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Bowfin in the Upper Mississippi River System

Pool 22 lbs	Pool 22 fish	Pool 22 tons	Pool 24 lbs	Pool 24 fish	Pool 24 tons	Pool 25 lbs	Pool 25 fish	Pool 25 tons	Pool 26 lbs
350	140	0.1587							
15	6	0.0068							
66	26	0.0299							
8	3	0.0036							
			372	149	0.1687	10	4	0.0045	548
8	3	0.0036	142	57	0.0644	86	34	0.0390	1,581
3	1	0.0014	0	0	0.0000	0	0	0.0000	51
5	2	0.0023	0	0	0.0000	6	2	0.0027	0
0	0	0.0000	65	26	0.0295	0	0	0.0000	50

Table D1 (cont.)

The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Bowfin in the Upper Mississippi River System

Pool 26 fish	Pool 26 tons	Open River lbs	Open River fish	Open River tons
219	0.2485			
632	0.7170			
20	0.0231			
0	0.0000	40	16	0.0181
20	0.0227	40	16	0.0181

Table D2
The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Mooneye and Goldeye in the Upper Mississippi River System

Year	Pool 3 lbs	Pool 3 fish	Pool 3 tons	Pool 4 lbs	Pool 4 fish	Pool 4 tons	Pool 4a lbs	Pool 4a fish	Pool 4a tons	Pool 5 lbs	Pool 5 fish
1978	40,000	53,333	18.1406	3	4	0.0014	10	13	0.0045	11	15
1983	9,145	12,193	4.1474	7	9	0.0032	18	24	0.0082	9	12
1988	0	0	0.0000	9	12	0.0041	130	173	0.0590	11	15
1994	0	0	0.0000	0	0	0.0000	3	4	0.0014	0	0
1995	15	20	0.0068	2	3	0.0009	9	12	0.0041	0	0

Table D2 (cont.)

The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Mooneye and Goldeye in the Upper Mississippi River System

Pool 5 tons	Pool 5a lbs	Pool 5a fish	Pool 5a tons	Pool 6 lbs	Pool 6 fish	Pool 6 tons	Pool 7 lbs	Pool 7 fish	Pool 7 tons	Pool 8 lbs
0.0055				12,020	16,027	5.4512	75	100	0.0340	1,004
0.0045	115	153	0.0574	21	28	0.0095	148	197	0.0671	3,103
0.0055	0	0	0.0000	223	297	0.1011	10	13	0.0045	996
0.0000	0	0	0.0000	41	55	0.0186	0	0	0.0000	457
0.0000	0	0	0.0000	46	61	0.0209	2	3	0.0009	0

Table D2 (cont.)

The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Mooneye and Goldeye in the Upper Mississippi River System

Pool 8 fish	Pool 8 tons	Pool 9 lbs	Pool 9 fish	Pool 9 tons	Pool 10 lbs	Pool 10 fish	Pool 10 tons	Pool 11 lbs	Pool 11 fish	Pool 11 tons
1,339	0.4553	42	56	0.0190	133	177	0.0603	8	11	0.0036
4,137	1.4073	11	15	0.0050	75	100	0.0340	26	35	0.0118
1,328	0.4517	6,400	8,533	2.9025	0	0	0.0000	19	25	0.0086
609	0.2073	2	3	0.0009	2	3	0.0009	19	25	0.0086
0	0.0000	107	143	0.0485	5	7	0.0023	0	0	0.0000

Table D2 (cont.)

The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Mooneye and Goldeye in the Upper Mississippi River System

Pool 12 lbs	Pool 12 fish	Pool 12 tons	Pool 13 lbs	Pool 13 fish	Pool 13 tons	Pool 14 lbs	Pool 14 fish	Pool 14 tons	Pool 15 lbs	Pool 15 fish
110	147	0.0499	173	231	0.0785				50	67
0	0	0.0000	0	0	0.0000	70	93	0.0317	0	0
0	0	0.0000	0	0	0.0000	10,400	13,867	4.7166	0	0
0	0	0.0000	0	0	0.0000	60	80	0.0272	0	0

Table D2 (cont.)
The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Mooneye and Goldeye in the Upper Mississippi River System

Pool 15 tons	Pool 16 lbs	Pool 16 fish	Pool 16 tons	Pool 17 lbs	Pool 17 fish	Pool 17 tons	Pool 18 lbs	Pool 18 fish	Pool 18 tons	Pool 19 lbs
0.0227	1,660	2,213	0.7528				3,125	4,167	1.4172	1,079
0.0000	0	0	0.0000	0	0	0.0000	15	20	0.0068	10,215
0.0000	0	0	0.0000	500	667	0.2268	120,400	160,533	54.6032	0
0.0000	0	0	0.0000	0	0	0.0000	0	0	0.0000	0

Table D2 (cont.)

The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Mooneye and Goldeye in the Upper Mississippi River System

Pool 19 fish	Pool 19 tons	Pool 20 lbs	Pool 20 fish	Pool 20 tons	Pool 21 lbs	Pool 21 fish	Pool 21 tons	Pool 22 lbs	Pool 22 fish
1,439	0.4893	2	3	0.0009					
13,620	4.6327	500	667	0.2268	0	0	0.0000	1,000	1,333
0	0.0000	0	0	0.0000	0	0	0.0000	500	667
0	0.0000	0	0	0.0000	0	0	0.0000	500	667

Table D2 (cont.)

The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Mooneye and Goldeye in the Upper Mississippi River System

Pool 22 tons	Pool 24 lbs	Pool 24 fish	Pool 24 tons	Pool 25 lbs	Pool 25 fish	Pool 25 tons	Pool 26 lbs	Pool 26 fish	Pool 26 tons
							24	32	0.0109
				403	537	0.1828	130	173	0.0590
0.4535	0	0	0.0000	0	0	0.0000	0	0	0.0000
0.2268	0	0	0.0000	0	0	0.0000	0	0	0.0000
0.2268	0	0	0.0000	50	67	0.0227	0	0	0.0000

Table D3
The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Common Carp in the Upper Mississippi River System

Year	Pool 3 lbs	Pool 3 fish	Pool 3 tons	Pool 4 lbs	Pool 4 fish	Pool 4 tons	Pool 4a lbs	Pool 4a fish	Pool 4a tons	Pool 5 lbs	Pool 5 fish
1953	112,644	59,443	51.0857	82,450	43,509	37.3923	217,310	114,675	98.5533	42,138	22,236
1954	43,968	23,202	19.9401	182,253	96,176	82.6544	473,532	249,885	214.7537	51,321	27,082
1955	63,002	33,246	28.5723	305,266	161,090	138.4426	1,867,312	985,389	846.8535	67,622	35,684
1956	182,130	96,111	82.5986	177,064	93,437	80.3011	900,326	475,106	408.3111	76,937	40,600
1957	121,728	64,236	55.2054	62,567	33,017	28.3751	529,687	279,518	240.2209	63,151	33,325
1958	15,678	8,273	7.1102	494,858	261,139	224.4254	541,523	285,764	245.5887	41,752	22,033
1959	11,168	5,893	5.0649	378,236	199,597	171.5356	1,407,486	742,737	638.3156	81,436	42,974
1960	103,325	54,525	46.8594	394,042	207,938	178.7039	1,073,617	566,553	486.9011	106,215	56,050
1961	98,399	51,926	44.6254	317,813	167,711	144.1329	1,295,328	683,550	587.4503	166,494	87,860
1962	36,807	19,423	16.6925	390,438	206,036	177.0694	1,282,434	676,746	581.6027	135,475	71,491
1963	36,132	19,067	16.3864	115,618	61,012	52.4345	1,958,527	1,033,523	888.2209	120,326	63,497
1964	84,650	44,670	38.3900	379,067	200,035	171.9125	2,080,421	1,097,847	943.5016	133,364	70,377
1965	189	100	0.0857	100,885	53,237	45.7528	1,245,529	657,271	564.8658	82,755	43,670
1966	12,560	6,628	5.6961	82,378	43,471	37.3596	2,140,093	1,129,337	970.5637	34,423	18,165
1967	23,986	12,658	10.8780	98,294	51,870	44.5778	1,786,382	942,682	810.1506	35,199	18,575
1968	293,479	154,870	133.0971	67,724	35,738	30.7138	1,359,723	717,532	616.6544	29,613	15,627
1969	100,403	52,983	45.5342	24,875	13,127	11.2812	1,353,275	714,129	613.7302	58,658	30,954
1970	187,880	99,145	85.2063	109,104	57,575	49.4803	1,500,784	791,970	680.6277	55,329	29,197
1971	13,418	7,081	6.0853	197,484	104,213	89.5619	2,026,879	1,069,593	919.2195	69,072	36,450
1972	195,820	103,335	88.8073	51,333	27,089	23.2803	969,236	511,470	439.5628	35,892	18,940
1973	5,903	3,115	2.6771	337,517	178,109	153.0689	1,355,627	715,370	614.7968	36,089	19,044
1974	231,093	121,949	104.8041	56,371	29,747	25.5651	987,367	521,038	447.7855	47,803	25,226
1975	99,842	52,687	45.2798	25,957	13,698	11.7719	443,852	234,223	201.2934	123,665	65,259
1976	231,415	122,119	104.9501	22,028	11,624	9.9900	971,941	512,898	440.7896	177,199	93,509
1977	84,713	44,703	38.4186	56,196	29,655	25.4857	391,051	206,359	177.3474	204,928	108,141
1978	46,769	24,680	21.2104	23,249	12,269	10.5438	123,218	65,023	55.8812	133,897	70,658
1979	5,290	2,792	2.3991	656	346	0.2975	98,544	52,002	44.6912	15,100	7,968
1980	5,300	2,797	2.4036	89	47	0.0404	130,509	68,870	59.1878	37,456	19,766
1981	60,303	31,822	27.3483	9,107	4,806	4.1302	81,425	42,968	36.9274	115,059	60,717
1982	8,555	4,515	3.8798	1,460	770	0.6621	109,054	57,548	49.4576	43,067	22,727
1983	127,496	67,280	57.8213	54,974	29,010	24.9315	202,207	106,706	91.7039	285,270	150,538
1988	53,233	28,091	24.1420	4,986	2,631	2.2612	67,271	35,499	30.5084	168,857	89,107
1994	15,665	8,266	7.1043	178,770	94,338	81.0748	261,103	137,785	118.4141	89,751	47,362
1995	21,225	11,201	9.6259	2,513	1,326	1.1397	299,324	157,955	135.7478	99,626	52,573

Table D3 (cont.)
The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Common Carp in the Upper Mississippi River System

Pool 5 tons	Pool 5a lbs	Pool 5a fish	Pool 5a tons	Pool 6 lbs	Pool 6 fish	Pool 6 tons	Pool 7 lbs	Pool 7 fish	Pool 7 tons	Pool 8 lbs	Pool 8 fish
19.1102	21,072	11,120	9.5565	28,982	15,294	13.1438	68,842	36,328	31.2209	227,188	119,888
23.2748	20,698	10,922	9.3868	21,283	11,231	9.6522	103,384	54,556	46.8862	247,959	130,849
30.6676	34,498	18,205	15.6454	19,805	10,451	8.9819	125,150	66,042	56.7574	290,393	153,242
34.8921	52,614	27,765	23.8612	31,538	16,643	14.3029	102,977	54,341	46.7016	258,337	136,326
28.6399	50,173	26,477	22.7542	14,086	7,433	6.3882	133,670	70,538	60.6213	243,963	128,740
18.9351	28,030	14,792	12.7120	31,109	16,416	14.1084	122,876	64,842	55.7261	311,699	164,485
36.9324	167,589	88,437	76.0041	65,062	34,334	29.5066	112,368	59,297	50.9605	320,443	169,099
48.1701	102,584	54,134	46.5234	53,517	28,241	24.2707	119,150	62,876	54.0363	474,571	250,433
75.5075	37,457	19,766	16.9873	75,366	39,771	34.1796	198,515	104,757	90.0295	519,325	274,050
61.4399	59,786	31,549	27.1138	47,764	25,205	21.6617	396,446	209,206	179.7941	429,866	226,842
54.5696	52,300	27,599	23.7188	83,193	43,901	37.7293	229,915	121,327	104.2698	342,722	180,856
60.4825	85,921	45,341	38.9664	98,823	52,149	44.8177	196,690	103,794	89.2018	685,125	361,544
37.5306	74,623	39,379	33.8426	55,801	29,446	25.3066	133,634	70,519	60.6050	543,405	286,757
15.6113	49,113	25,917	22.2735	39,542	20,866	17.9329	117,947	62,241	53.4907	453,264	239,189
15.9633	78,309	41,324	35.5143	29,022	15,315	13.1619	262,049	138,284	118.8431	437,551	230,898
13.4299	171,605	90,557	77.8254	45,399	23,957	20.5891	194,461	102,618	88.1909	319,745	168,731
26.6023	190,493	100,524	86.3914	12,608	6,653	5.7179	97,365	51,380	44.1565	313,122	165,236
25.0925	147,688	77,936	66.9787	16,446	8,679	7.4585	390,935	206,298	177.2948	351,891	185,694
31.3252	171,804	90,662	77.9156	66,868	35,287	30.3256	288,639	152,316	130.9020	627,681	331,230
16.2776	235,631	124,344	106.8621	91,156	48,103	41.3406	271,646	143,349	123.1955	658,034	347,247
16.3669	85,698	45,223	38.8653	66,426	35,053	30.1252	187,969	99,192	85.2467	439,628	231,994
21.6794	79,441	41,921	36.0277	21,715	11,459	9.8481	202,505	106,863	91.8390	413,778	218,353
56.0839	139,466	73,597	63.2499	22,181	11,705	10.0594	140,815	74,309	63.8617	407,200	214,881
80.3624	182,884	96,509	82.9406	38,590	20,364	17.5011	309,936	163,555	140.5605	622,898	328,706
92.9379	102,141	53,900	46.3224	13,617	7,186	6.1755	268,379	141,625	121.7138	578,643	305,353
60.7243	144,957	76,494	65.7401	55,429	29,250	25.1379	202,672	106,951	91.9147	650,918	343,492
6.8481	63,622	33,574	28.8535	71,306	37,628	32.3383	193,386	102,051	87.7034	406,548	214,537
16.9868	91,865	48,478	41.6621	68,125	35,950	30.8957	124,791	65,853	56.5946	611,121	322,491
52.1810	79,912	42,170	36.2413	26,846	14,167	12.1751	195,144	102,978	88.5007	485,071	255,974
19.5315	87,178	46,004	39.5365	61,094	32,240	27.7070	123,190	65,008	55.8685	445,569	235,129
129.3741	75,875	40,040	34.4104	32,983	17,405	14.9583	114,619	60,485	51.9814	392,708	207,234
76.5791	48,511	25,599	22.0005	43,654	23,036	19.7977	109,701	57,890	49.7510	321,285	169,544
40.7034	114,537	60,442	51.9442	45,290	23,900	20.5397	305,477	161,202	138.5383	289,430	152,734
45.1819	51,105	26,968	23.1769	74,114	39,110	33.6118	100,237	52,896	45.4590	304,785	160,836

Table D3 (cont.)

The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Common Carp in the Upper Mississippi River System

Pool 8 tons	Pool 9 lbs	Pool 9 fish	Pool 9 tons	Pool 10 lbs	Pool 10 fish	Pool 10 tons	Pool 11 lbs	Pool 11 fish	Pool 11 tons	Pool 12 lbs
103.0331	317,118	167,345	143.8177	43,907	23,170	19.9125	85,589	45,166	38.8159	62,366
112.4531	536,744	283,242	243.4213	69,947	36,911	31.7220	83,072	43,837	37.6744	110,818
131.6975	564,684	297,986	256.0925	77,452	40,872	35.1256	98,397	51,925	44.6245	122,765
117.1596	396,625	209,301	179.8753	84,481	44,581	38.3134	73,988	39,044	33.5546	82,278
110.6408	447,648	236,226	203.0150	51,023	26,925	23.1397	43,813	23,120	19.8698	55,017
141.3601	533,025	281,280	241.7347	104,144	54,957	47.2308	95,714	50,509	43.4077	95,552
145.3256	612,317	323,122	277.6948	91,593	48,334	41.5388	53,637	28,304	24.3252	50,854
215.2249	596,085	314,557	270.3333	96,834	51,100	43.9156	89,525	47,243	40.6009	63,190
235.5215	611,509	322,696	277.3283	202,918	107,081	92.0263	104,069	54,918	47.1968	138,904
194.9506	843,391	445,061	382.4902	93,032	49,093	42.1914	157,362	83,041	71.3660	99,251
155.4295	744,292	392,766	337.5474	155,836	82,235	70.6739	155,011	81,800	70.2998	49,043
310.7143	1,089,376	574,869	494.0481	176,099	92,928	79.8635	124,085	65,480	56.2744	57,897
246.4422	923,293	487,226	418.7270	143,216	75,576	64.9506	109,913	58,002	49.8472	70,559
205.5619	1,320,389	696,775	598.8159	182,748	96,437	82.8789	152,504	80,477	69.1628	65,495
198.4358	964,312	508,872	437.3297	189,070	99,773	85.7460	129,270	68,216	58.6259	95,712
145.0091	981,785	518,092	445.2540	210,648	111,160	95.5320	109,676	57,877	49.7397	77,803
142.0054	1,004,998	530,342	455.7814	202,503	106,862	91.8381	123,668	65,260	56.0853	96,149
159.5878	1,247,463	658,292	565.7429	269,527	142,231	122.2345	135,088	71,287	61.2644	101,216
284.6626	998,261	526,787	452.7261	237,600	125,383	107.7551	207,315	109,401	94.0204	62,426
298.4281	909,200	479,789	412.3356	187,823	99,115	85.1805	171,801	90,660	77.9143	116,285
199.3778	1,185,838	625,772	537.7950	151,878	80,147	68.8789	80,080	42,259	36.3175	125,357
187.6544	1,403,997	740,896	636.7333	218,730	115,425	99.1973	92,444	48,783	41.9247	74,704
184.6712	969,285	511,496	439.5850	156,111	82,380	70.7986	124,351	65,621	56.3950	100,551
282.4934	889,794	469,548	403.5347	176,185	92,974	79.9025	86,224	45,501	39.1039	148,803
262.4231	634,544	334,852	287.7751	189,785	100,150	86.0703	105,004	55,411	47.6209	91,797
295.2009	578,587	305,323	262.3977	186,517	98,426	84.5882	109,861	57,974	49.8236	39,471
184.3755	444,560	234,596	201.6145	116,211	61,325	52.7034				
277.1524	145,396	76,726	65.9392	105,148	55,487	47.6862				
219.9868	275,749	145,514	125.0562	176,720	93,256	80.1451				
202.0721	281,223	148,403	127.5388	131,887	69,597	59.8127				
178.0989	468,306	247,127	212.3837	232,592	122,740	105.4839	181,447	95,750	82.2889	71,049
145.7075	343,569	181,303	155.8136	199,502	105,278	90.4771	145,817	76,948	66.1302	25,958
131.2608	639,001	337,204	289.7964	155,694	82,160	70.6095	113,658	59,978	51.5456	41,037
138.2245	699,819	369,298	317.3782	169,443	89,416	76.8449	137,696	72,663	62.4472	113,443

Table D3 (cont.)
The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Common Carp in the Upper Mississippi River System

Pool 12 fish	Pool 12 tons	Pool 13 lbs	Pool 13 fish	Pool 13 tons	Pool 14 lbs	Pool 14 fish	Pool 14 tons	Pool 15 lbs	Pool 15 fish	Pool 15 tons
32,911	28.2839	51,694	27,279	23.4440	24,974	13,179	11.3261	11,100	5,858	5.0340
58,479	50.2576	99,592	52,555	45.1664	88,179	46,532	39.9905	11,144	5,881	5.0540
64,784	55.6757	149,254	78,762	67.6889	105,871	55,869	48.0141	12,205	6,441	5.5351
43,418	37.3143	188,481	99,462	85.4789	90,616	47,818	41.0957	30,687	16,194	13.9170
29,033	24.9510	114,728	60,542	52.0308	80,409	42,432	36.4667	14,203	7,495	6.4413
50,423	43.3342	154,726	81,650	70.1705	166,196	87,702	75.3723	11,216	5,919	5.0866
26,836	23.0630	241,351	127,362	109.4562	109,222	57,637	49.5338	30,649	16,174	13.8998
33,346	28.6576	346,360	182,776	157.0794	124,931	65,927	56.6580	32,031	16,903	14.5265
73,300	62.9950	263,063	138,820	119.3029	107,233	56,587	48.6317	10,693	5,643	4.8494
52,375	45.0118	165,191	87,172	74.9166	89,095	47,016	40.4059	17,219	9,087	7.8091
25,880	22.2417	173,273	91,437	78.5819	87,067	45,946	39.4862	12,741	6,723	5.7782
30,553	26.2571	142,887	75,402	64.8014	118,166	62,357	53.5900	20,653	10,899	9.3664
37,234	31.9995	177,694	93,770	80.5868	51,178	27,007	23.2100	37,293	19,680	16.9129
34,562	29.7029	209,756	110,689	95.1274	74,444	39,284	33.7615	51,964	27,422	23.5664
50,508	43.4068	219,848	116,015	99.7043	117,151	61,821	53.1297	36,605	19,317	16.6009
41,057	35.2848	216,529	114,263	98.1991	79,886	42,156	36.2295	17,293	9,126	7.8426
50,738	43.6050	128,772	67,954	58.4000	103,149	54,432	46.7796	24,682	13,025	11.1937
53,412	45.9029	207,572	109,537	94.1370	90,599	47,809	41.0880	6,786	3,581	3.0776
32,942	28.3111	214,065	112,963	97.0816	95,711	50,507	43.4063	40,822	21,542	18.5134
61,364	52.7370	308,256	162,668	139.7986	89,627	47,297	40.6472	53,457	28,209	24.2435
66,151	56.8512	201,779	106,480	91.5098	85,859	45,308	38.9383	51,380	27,113	23.3016
39,422	33.8794	280,658	148,104	127.2825	119,257	62,932	54.0848	21,300	11,240	9.6599
53,061	45.6014	228,964	120,825	103.8385	156,845	82,768	71.1315	79,316	41,855	35.9710
78,524	67.4844	179,936	94,953	81.6036	89,773	47,374	40.7134	13,904	7,337	6.3057
48,442	41.6313	323,117	170,510	146.5383	41,605	21,955	18.8685	38,836	20,494	17.6127
20,829	17.9007	255,079	134,606	115.6821	95,525	50,409	43.3220	24,429	12,891	11.0789
37,493	32.2218	394,373	208,112	178.8540	121,295	64,008	55.0091	19,287	10,178	8.7469
13,698	11.7723	219,583	115,875	99.5841	46,176	24,367	20.9415	19,708	10,400	8.9379
21,655	18.6109	321,180	169,488	145.6599	99,941	52,739	45.3247	22,351	11,795	10.1365
59,864	51.4481	363,239	191,683	164.7342	77,448	40,870	35.1238	32,175	16,979	14.5918

Table D3 (cont.)

The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Common Carp in the Upper Mississippi River System

Pool 16 lbs	Pool 16 fish	Pool 16 tons	Pool 17 lbs	Pool 17 fish	Pool 17 tons	Pool 18 lbs	Pool 18 fish	Pool 18 tons	Pool 19 lbs	Pool 19 fish
45,944	24,245	20.8363	57,671	30,433	26.1546	164,227	86,663	74.4794	179,878	94,922
55,699	29,393	25.2603	70,808	37,366	32.1125	300,404	158,525	136.2376	274,355	144,778
48,282	25,479	21.8966	60,909	32,142	27.6231	358,401	189,130	162.5401	530,983	280,202
52,064	27,474	23.6118	75,277	39,724	34.1392	343,682	181,363	155.8649	384,538	202,922
25,475	13,443	11.5533	42,019	22,174	19.0562	263,190	138,887	119.3605	339,859	179,345
39,777	20,991	18.0395	36,401	19,209	16.5084	191,755	101,190	86.9637	544,919	287,556
47,908	25,281	21.7270	113,060	59,662	51.2744	359,037	189,465	162.8286	334,761	176,655
165,434	87,300	75.0268	65,404	34,514	29.6617	205,923	108,666	93.3891	287,211	151,563
83,088	43,846	37.6816	70,193	37,041	31.8336	167,390	88,332	75.9138	300,139	158,385
112,458	59,345	51.0014	52,895	27,913	23.9887	167,662	88,476	76.0372	309,222	163,178
37,897	19,998	17.1868	35,474	18,720	16.0880	203,614	107,448	92.3420	281,680	148,644
59,962	31,642	27.1937	40,465	21,354	18.3515	235,395	124,219	106.7551	364,121	192,148
78,833	41,601	35.7519	145,441	76,750	65.9596	221,443	116,856	100.4277	277,861	146,628
55,308	29,186	25.0830	235,141	124,085	106.6399	177,949	93,904	80.7025	391,129	206,401
66,691	35,193	30.2454	134,496	70,974	60.9959	149,257	78,764	67.6902	179,820	94,892
53,240	28,095	24.1451	111,744	58,968	50.6776	145,560	76,813	66.0136	381,994	201,580
54,158	28,579	24.5615	98,266	51,855	44.5651	167,394	88,335	75.9156	284,851	150,317
146,796	77,465	66.5741	65,012	34,307	29.4839	262,980	138,776	119.2653	229,549	121,134
86,467	45,629	39.2141	158,996	83,903	72.1070	338,721	178,745	153.6150	571,360	301,509
145,365	76,710	65.9252	132,000	69,657	59.8639	499,745	263,718	226.6417	512,645	270,525
87,930	46,401	39.8776	128,188	67,645	58.1351	323,345	170,631	146.6417	490,330	258,749
87,082	45,954	39.4930	35,354	18,656	16.0336	170,407	89,925	77.2821	444,826	234,737
56,315	29,718	25.5397	51,512	27,183	23.3615	285,463	150,640	129.4617	376,193	198,519
44,140	23,293	20.0181	74,745	39,443	33.8980	228,816	120,747	103.7714	345,168	182,147
18,954	10,002	8.5959	99,105	52,298	44.9456	310,469	163,836	140.8023	150,774	79,564
66,791	35,246	30.2907	88,529	46,717	40.1492	182,338	96,221	82.6930	296,005	156,203
45,063	23,780	20.4367	28,591	15,088	12.9664	182,444	96,277	82.7410	106,291	56,090
32,048	16,912	14.5342	71,309	37,630	32.3397	191,880	101,256	87.0204	428,391	226,064
46,903	24,751	21.2712	40,237	21,233	18.2481	231,568	122,199	105.0195	248,853	131,321
33,152	17,494	15.0349	122,666	64,731	55.6308	116,831	61,652	52.9846	263,545	139,074

Table D3 (cont.)
The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Common Carp in the Upper Mississippi River System

Pool 19 tons	Pool 20 lbs	Pool 20 fish	Pool 20 tons	Pool 21 lbs	Pool 21 fish	Pool 21 tons	Pool 22 lbs	Pool 22 fish	Pool 22 tons	Pool 24 lbs
81.5773	26,326	13,892	11.9392	42,434	22,393	19.2444	35,365	18,662	16.0385	45,918
124.4240	14,384	7,591	6.5234	32,732	17,273	14.8444	12,868	6,791	5.8358	68,428
240.8086	44,580	23,525	20.2177	30,296	15,987	13.7397	21,317	11,249	9.6676	102,951
174.3937	24,029	12,680	10.8975	38,717	20,431	17.5587	27,256	14,383	12.3610	70,597
154.1311	28,737	15,165	13.0327	55,243	29,152	25.0535	20,072	10,592	9.1029	70,890
247.1288	28,421	14,998	12.8893	42,164	22,250	19.1220	12,936	6,826	5.8667	57,166
151.8190	88,239	46,564	40.0177	22,273	11,754	10.1011	31,391	16,565	14.2363	88,612
130.2544	179,408	94,674	81.3642	23,651	12,481	10.7261	12,111	6,391	5.4925	70,053
136.1175	131,567	69,428	59.6676	53,933	28,461	24.4594	18,459	9,741	8.3714	89,839
140.2367	79,009	41,693	35.8317	32,015	16,894	14.5193	22,129	11,678	10.0358	121,788
127.7460	82,044	43,295	37.2082	27,732	14,634	12.5769	44,888	23,688	20.3574	345,990
165.1342	48,537	25,613	22.0122	30,435	16,061	13.8027	34,549	18,232	15.6685	149,712
126.0141	109,583	57,827	49.6975	24,687	13,027	11.1959	26,795	14,140	12.1519	218,881
177.3828	74,687	39,413	33.8717	21,574	11,385	9.7841	8,097	4,273	3.6721	92,241
81.5510	64,250	33,905	29.1383	22,864	12,065	10.3692	21,359	11,271	9.6866	134,082
173.2399	24,179	12,759	10.9655	34,052	17,969	15.4431	17,338	9,149	7.8630	43,745
129.1841	59,749	31,530	27.0971	46,223	24,392	20.9628	16,071	8,481	7.2884	108,417
104.1039	116,074	61,253	52.6413	25,024	13,205	11.3488	31,058	16,389	14.0853	65,061
259.1202	71,101	37,520	32.2454	39,308	20,743	17.8268	21,635	11,417	9.8118	37,213
232.4921	31,741	16,750	14.3950	46,973	24,788	21.3029	72,218	38,110	32.7519	89,155
222.3719	101,693	53,664	46.1193	79,451	41,927	36.0322	96,954	51,163	43.9701	82,817
201.7351	166,401	87,811	75.4653	109,095	57,570	49.4762	84,102	44,381	38.1415	293,282
170.6091	75,708	39,951	34.3347	94,424	49,828	42.8227	134,548	71,002	61.0195	118,898
156.5388	86,018	45,392	39.0104	21,184	11,179	9.6073	82,424	43,496	37.3805	61,859
68.3782	88,174	46,530	39.9882	13,095	6,910	5.9388	197,186	104,056	89.4268	27,249
134.2426	151,406	79,898	68.6649	37,233	19,648	16.8857	119,252	62,930	54.0825	47,271
48.2045	81,553	43,036	36.9855	14,663	7,738	6.6499	28,657	15,122	12.9964	28,305
194.2816	96,719	51,039	43.8635	37,529	19,804	17.0200	45,433	23,975	20.6045	21,596
112.8585	15,760	8,317	7.1474	38,197	20,157	17.3229	5,865	3,095	2.6599	23,383
119.5215	129,921	68,560	58.9211	49,301	26,016	22.3587	8,775	4,631	3.9796	33,588

Table D3 (cont.)

The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Common Carp in the Upper Mississippi River System

Pool 24 fish	Pool 24 tons	Pool 25 lbs	Pool 25 fish	Pool 25 tons	Pool 26 lbs	Pool 26 fish	Pool 26 tons	Open River lbs	Open River fish
24,231	20.8245	100,774	53,179	45.7025	74,871	39,510	33.9551		
36,110	31.0331	67,811	35,784	30.7533	136,647	72,109	61.9714		
54,328	46.6898	154,203	81,374	69.9333	218,021	115,051	98.8757		
37,254	32.0168	121,635	64,187	55.1633	80,452	42,455	36.4862		
37,409	32.1497	96,631	50,993	43.8236	69,226	36,531	31.3950		
30,167	25.9256	105,209	55,519	47.7138	151,494	79,944	68.7048		
46,761	40.1868	94,085	49,649	42.6689	226,189	119,361	102.5800		
36,967	31.7701	117,304	61,902	53.1991	336,906	177,787	152.7918		
47,408	40.7433	117,567	62,041	53.3184	70,116	37,001	31.7986		
64,268	55.2327	98,894	52,187	44.8499	51,160	26,997	23.2018		
182,580	156.9116	130,089	68,649	58.9973	85,303	45,015	38.6862		
79,004	67.8966	172,443	90,999	78.2054	188,543	99,495	85.5070		
115,504	99.2658	173,966	91,803	78.8961	237,519	125,340	107.7184		
48,676	41.8327	168,485	88,910	76.4104	57,454	30,319	26.0562		
70,756	60.8082	170,988	90,231	77.5456	76,490	40,364	34.6893		
23,084	19.8390	153,205	80,847	69.4807	133,565	70,483	60.5737		
57,212	49.1687	157,060	82,881	71.2290	99,731	52,628	45.2295		
34,333	29.5061	171,102	90,291	77.5973	167,450	88,364	75.9410		
19,637	16.8766	138,398	73,033	62.7655	51,065	26,947	23.1587		
47,047	40.4331	145,037	76,537	65.7764	183,975	97,084	83.4354		
43,703	37.5587	215,535	113,739	97.7483	42,673	22,519	19.3528		
154,766	133.0077	174,212	91,932	79.0077	107,063	56,498	48.5546		
62,743	53.9220	202,323	106,767	91.7565	400,859	211,535	181.7955		
32,643	28.0540	215,834	113,897	97.8839	175,807	92,774	79.7311		
14,379	12.3578	140,425	74,103	63.6848	113,083	59,674	51.2848		
24,945	21.4381	166,543	87,885	75.5297	131,809	69,556	59.7773		
14,937	12.8367	119,122	62,861	54.0236	45,077	23,787	20.4431		
11,396	9.7941	86,083	45,426	39.0399	75,105	39,633	34.0612		
12,339	10.6045	16,057	8,473	7.2821	35,608	18,791	16.1488	40,950	21,609
17,725	15.2327	16,050	8,470	7.2789	51,921	27,399	23.5469	23,560	12,433

Table D3 (cont.)
The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Common Carp in the Upper Mississippi River System

Open River tons
18.5714
10.6848

Table D4

The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Buffalo in the Upper Mississippi River System

Year	Pool 3 lbs	Pool 3 fish	Pool 3 tons	Pool 4 lbs	Pool 4 fish	Pool 4 tons	Pool 4a lbs	Pool 4a fish	Pool 4a tons	Pool 5 lbs	Pool 5 fish
1953	8,425	1,404	3.8209	36,798	6,133	16.6884	20,175	3,363	9.1497	13,403	2,234
1954	1,324	221	0.6005	30,926	5,154	14.0254	22,836	3,806	10.3565	16,126	2,688
1955	1,863	311	0.8449	15,382	2,564	6.9760	35,956	5,993	16.3066	11,809	1,968
1956	13,627	2,271	6.1800	3,650	608	1.6553	36,888	6,148	16.7293	5,036	839
1957	19,803	3,301	8.9810	1,886	314	0.8553	25,968	4,328	11.7769	3,574	596
1958	358	60	0.1624	25,734	4,289	11.6707	32,155	5,359	14.5828	7,429	1,238
1959	2,447	408	1.1098	10,637	1,773	4.8240	34,273	5,712	15.5433	5,058	843
1960	7,392	1,232	3.3524	24,030	4,005	10.8980	23,251	3,875	10.5447	7,930	1,322
1961	650	108	0.2948	6,845	1,141	3.1043	24,141	4,024	10.9483	12,409	2,068
1962	2,995	499	1.3583	15,074	2,512	6.8363	44,702	7,450	20.2730	9,899	1,650
1963	4	1	0.0018	4,788	798	2.1714	37,462	6,244	16.9896	5,833	972
1964	2,170	362	0.9841	12,769	2,128	5.7909	39,147	6,525	17.7537	11,106	1,851
1965	6	1	0.0027	8,272	1,379	3.7515	32,807	5,468	14.8785	14,600	2,433
1966	6,358	1,060	2.8834	2,225	371	1.0091	35,765	5,961	16.2200	6,504	1,084
1967	18,688	3,115	8.4753	14,769	2,462	6.6980	56,571	9,429	25.6558	4,640	773
1968	63,656	10,609	28.8689	2,410	402	1.0930	72,555	12,093	32.9048	3,750	625
1969	24,054	4,009	10.9088	278	46	0.1261	38,053	6,342	17.2576	8,025	1,338
1970	83,234	13,872	37.7478	7,405	1,234	3.3583	56,364	9,394	25.5619	13,614	2,269
1971	23,749	3,958	10.7705	7,033	1,172	3.1896	51,518	8,586	23.3642	11,256	1,876
1972	39,141	6,524	17.7510	5,350	892	2.4263	65,936	10,989	29.9029	3,395	566
1973	17,602	2,934	7.9828	35,783	5,964	16.2281	31,970	5,328	14.4989	7,502	1,250
1974	13,285	2,214	6.0249	4,387	731	1.9896	80,279	13,380	36.4077	8,836	1,473
1975	3,486	581	1.5810	7,340	1,223	3.3288	64,538	10,756	29.2689	20,345	3,391
1976	14,344	2,391	6.5052	8,148	1,358	3.6952	59,067	9,845	26.7878	28,238	4,706
1977	4,802	800	2.1778	7,928	1,321	3.5955	34,400	5,733	15.6009	110,155	18,359
1978	2,837	473	1.2866	2,374	396	1.0766	25,213	4,202	11.4345	10,957	1,826
1983	106,240	17,707	48.1814	27,569	4,595	12.5029	44,301	7,384	20.0912	67,522	11,254
1988	31,415	5,236	14.2472	12,106	2,018	5.4902	33,127	5,521	15.0236	46,185	7,698
1994	1,866	311	0.8463	60,970	10,162	27.6508	107,018	17,836	48.5342	35,814	5,969
1995	83,810	13,968	38.0091	4,722	787	2.1415	183,083	30,514	83.0308	60,719	10,120

Table D4 (cont.)
The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Buffalo in the Upper Mississippi River System

Pool 5 tons	Pool 5a lbs	Pool 5a fish	Pool 5a tons	Pool 6 lbs	Pool 6 fish	Pool 6 tons	Pool 7 lbs	Pool 7 fish	Pool 7 tons	Pool 8 lbs
6.0785	19,239	3,207	8.7252	27,955	4,659	12.6780	77,871	12,979	35.3156	101,063
7.3134	11,776	1,963	5.3406	16,936	2,823	7.6807	93,257	15,543	42.2934	100,725
5.3556	15,216	2,536	6.9007	10,186	1,698	4.6195	85,454	14,242	38.7546	67,570
2.2839	11,515	1,919	5.2222	7,655	1,276	3.4717	55,557	9,260	25.1959	92,920
1.6209	6,171	1,029	2.7986	2,292	382	1.0395	47,880	7,980	21.7143	74,887
3.3692	3,498	583	1.5864	6,513	1,086	2.9537	56,515	9,419	25.6304	73,464
2.2939	17,475	2,913	7.9252	7,874	1,312	3.5710	63,237	10,540	28.6789	70,538
3.5964	24,034	4,006	10.8998	16,057	2,676	7.2821	48,606	8,101	22.0435	88,097
5.6277	15,399	2,567	6.9837	23,497	3,916	10.6562	78,229	13,038	35.4780	139,287
4.4893	8,872	1,479	4.0236	19,131	3,189	8.6762	154,383	25,731	70.0150	404,145
2.6454	36,900	6,150	16.7347	24,516	4,086	11.1184	152,803	25,467	69.2984	78,627
5.0367	8,826	1,471	4.0027	16,324	2,721	7.4032	105,721	17,620	47.9460	125,519
6.6213	27,373	4,562	12.4141	13,695	2,283	6.2109	140,277	23,380	63.6177	115,448
2.9497	31,783	5,297	14.4141	19,903	3,317	9.0263	45,340	7,557	20.5624	106,017
2.1043	18,408	3,068	8.3483	11,289	1,882	5.1197	80,770	13,462	36.6304	79,933
1.7007	61,867	10,311	28.0576	24,894	4,149	11.2898	53,769	8,962	24.3850	101,650
3.6395	23,343	3,891	10.5864	18,763	3,127	8.5093	28,020	4,670	12.7075	76,587
6.1741	26,337	4,390	11.9442	10,756	1,793	4.8780	105,641	17,607	47.9098	172,316
5.1048	17,229	2,872	7.8136	18,861	3,144	8.5537	45,791	7,632	20.7669	82,842
1.5397	54,668	9,111	24.7927	29,961	4,994	13.5878	28,487	4,748	12.9193	86,899
3.4023	48,440	8,073	21.9683	29,130	4,855	13.2109	43,246	7,208	19.6127	71,831
4.0073	48,076	8,013	21.8032	24,855	4,143	11.2721	59,345	9,891	26.9138	44,866
9.2268	34,836	5,806	15.7986	46,694	7,782	21.1764	35,735	5,956	16.2063	45,455
12.8063	23,514	3,919	10.6639	16,513	2,752	7.4889	68,513	11,419	31.0717	93,942
49.9569	14,666	2,444	6.6512	4,508	751	2.0444	47,778	7,963	21.6680	114,764
4.9692	86,594	14,432	39.2717	98,362	16,394	44.6086	59,899	9,983	27.1651	69,828
30.6222	11,621	1,937	5.2703	48,990	8,165	22.2177	51,351	8,559	23.2884	156,447
20.9456	23,005	3,834	10.4331	66,594	11,099	30.2014	46,130	7,688	20.9206	144,602
16.2422	6,112	1,019	2.7719	37,654	6,276	17.0766	84,073	14,012	38.1283	247,177
27.5370	15,717	2,620	7.1279	23,954	3,992	10.8635	30,312	5,052	13.7469	142,135

Table D4 (cont.)

The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Buffalo in the Upper Mississippi River System

Pool 8 fish	Pool 8 tons	Pool 9 lbs	Pool 9 fish	Pool 9 tons	Pool 10 lbs	Pool 10 fish	Pool 10 tons	Pool 11 lbs	Pool 11 fish	Pool 11 tons
16,844	45.8336	106,864	17,811	48.4644	41,486	6,914	18.8145	99,959	16,660	45.3329
16,788	45.6803	267,739	44,623	121.4236	73,416	12,236	33.2952	81,124	13,521	36.7909
11,262	30.6440	247,343	41,224	112.1737	87,687	14,615	39.7673	111,318	18,553	50.4844
15,487	42.1406	194,313	32,386	88.1238	93,958	15,660	42.6113	110,427	18,405	50.0803
12,481	33.9624	191,511	31,919	86.8531	72,953	12,159	33.0853	62,639	10,440	28.4077
12,244	33.3170	202,838	33,806	91.9900	88,559	14,760	40.1628	114,640	19,107	51.9909
11,756	31.9900	213,052	35,509	96.6222	575,826	95,971	261.1456	60,997	10,166	27.6630
14,683	39.9533	268,586	44,764	121.8077	117,805	19,634	53.4263	140,094	23,349	63.5347
23,215	63.1687	196,372	32,729	89.0576	173,039	28,840	78.4757	173,805	28,968	78.8231
67,358	183.2857	227,745	37,958	103.2857	117,482	19,580	53.2798	210,157	35,026	95.3093
13,105	35.6585	248,300	41,383	112.6077	125,475	20,913	56.9048	196,692	32,782	89.2027
20,920	56.9247	248,210	41,368	112.5669	217,821	36,304	98.7850	238,606	39,768	108.2113
19,241	52.3574	239,203	39,867	108.4821	177,577	29,596	80.5338	187,840	31,307	85.1882
17,670	48.0803	223,112	37,185	101.1846	221,012	36,835	100.2322	244,908	40,818	111.0694
13,322	36.2508	280,345	46,724	127.1406	209,687	34,948	95.0961	207,068	34,511	93.9084
16,942	46.0998	254,599	42,433	115.4644	260,259	43,377	118.0313	156,557	26,093	71.0009
12,765	34.7333	263,450	43,908	119.4785	286,187	47,698	129.7900	208,238	34,706	94.4390
28,719	78.1478	318,760	53,127	144.5624	307,050	51,175	139.2517	169,109	28,185	76.6934
13,807	37.5701	245,563	40,927	111.3664	237,864	39,644	107.8748	286,026	47,671	129.7170
14,483	39.4100	345,346	57,558	156.6195	255,358	42,560	115.8086	175,057	29,176	79.3909
11,972	32.5764	264,099	44,017	119.7728	300,412	50,069	136.2413	86,291	14,382	39.1342
7,478	20.3474	483,245	80,541	219.1587	241,380	40,230	109.4694	141,996	23,666	64.3973
7,576	20.6145	213,736	35,623	96.9324	184,803	30,801	83.8109	195,743	32,624	88.7723
15,657	42.6041	254,610	42,435	115.4694	309,559	51,593	140.3896	121,136	20,189	54.9370
19,127	52.0472	173,029	28,838	78.4712	270,118	45,020	122.5025	151,211	25,202	68.5764
11,638	31.6680	156,278	26,046	70.8744	207,300	34,550	94.0136	142,843	23,807	64.7814
26,075	70.9510	142,260	23,710	64.5170	258,491	43,082	117.2295	135,968	22,661	61.6635
24,100	65.5791	138,207	23,035	62.6789	252,788	42,131	114.6431	336,052	56,009	152.4045
41,196	112.0984	256,744	42,791	116.4372	225,030	37,505	102.0544	119,671	19,945	54.2726
23,689	64.4603	326,259	54,377	147.9633	253,081	42,180	114.7760	133,164	22,194	60.3918

Table D4 (cont.)
The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Buffalo in the Upper Mississippi River System

Pool 12 lbs	Pool 12 fish	Pool 12 tons	Pool 13 lbs	Pool 13 fish	Pool 13 tons	Pool 14 lbs	Pool 14 fish	Pool 14 tons	Pool 15 lbs
97,974	16,329	44.4327	47,550	7,925	21.5646	20,160	3,360	9.1429	20,500
69,976	11,663	31.7351	126,075	21,013	57.1769	76,460	12,743	34.6757	16,570
105,930	17,655	48.0408	189,858	31,643	86.1034	95,134	15,856	43.1447	12,919
102,149	17,025	46.3261	325,974	54,329	147.8340	132,308	22,051	60.0036	38,107
96,011	16,002	43.5424	229,705	38,284	104.1746	154,821	25,804	70.2136	27,333
130,813	21,802	59.3256	281,081	46,847	127.4744	164,878	27,480	74.7746	19,052
57,319	9,553	25.9950	676,016	112,669	306.5832	250,244	41,707	113.4893	55,887
100,496	16,749	45.5764	844,598	140,766	383.0376	171,127	28,521	77.6086	146,983
213,936	35,656	97.0231	450,734	75,122	204.4145	129,035	21,506	58.5193	13,025
107,481	17,914	48.7442	343,071	57,179	155.5878	94,452	15,742	42.8354	18,907
105,033	17,506	47.6340	206,951	34,492	93.8553	81,154	13,526	36.8045	23,736
129,494	21,582	58.7274	205,397	34,233	93.1506	159,956	26,659	72.5424	16,557
63,879	10,647	28.9701	274,898	45,816	124.6703	104,753	17,459	47.5070	38,561
128,340	21,390	58.2041	309,119	51,520	140.1900	158,768	26,461	72.0036	63,655
144,293	24,049	65.4390	473,835	78,973	214.8912	208,097	34,683	94.3751	38,282
157,102	26,184	71.2481	199,748	33,291	90.5887	129,390	21,565	58.6803	18,683
143,907	23,985	65.2639	214,759	35,793	97.3964	109,291	18,215	49.5651	22,073
156,792	26,132	71.1075	327,635	54,606	148.5873	118,301	19,717	53.6512	25,825
173,424	28,904	78.6503	253,739	42,290	115.0744	139,506	23,251	63.2680	36,996
205,375	34,229	93.1406	354,992	59,165	160.9941	162,271	27,045	73.5923	61,033
114,868	19,145	52.0943	417,930	69,655	189.5374	66,240	11,040	30.0408	38,325
82,777	13,796	37.5406	263,460	43,910	119.4830	105,929	17,655	48.0404	10,861
116,686	19,448	52.9188	182,515	30,419	82.7732	75,593	12,599	34.2825	42,028
166,526	27,754	75.5220	222,889	37,148	101.0834	96,693	16,116	43.8517	10,933
162,279	27,047	73.5959	205,759	34,293	93.3147	81,233	13,539	36.8404	26,003
117,606	19,601	53.3361	358,320	59,720	162.5034	89,631	14,939	40.6490	33,371
76,139	12,690	34.5302	293,947	48,991	133.3093	77,926	12,988	35.3406	20,570
50,919	8,487	23.0925	293,696	48,949	133.1955	59,374	9,896	26.9270	55,021
48,513	8,086	22.0014	240,504	40,084	109.0721	72,862	12,144	33.0440	48,878
60,962	10,160	27.6472	406,204	67,701	184.2195	88,528	14,755	40.1488	52,921

Table D4 (cont.)
The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Buffalo in the Upper Mississippi River System

Pool 15 fish	Pool 15 tons	Pool 16 lbs	Pool 16 fish	Pool 16 tons	Pool 17 lbs	Pool 17 fish	Pool 17 tons	Pool 18 lbs	Pool 18 fish
3,417	9.2971	38,724	6,454	17.5619	66,341	11,057	30.0866	103,054	17,176
2,762	7.5147	38,193	6,366	17.3211	51,143	8,524	23.1941	211,469	35,245
2,153	5.8590	21,259	3,543	9.6413	46,094	7,682	20.9043	215,199	35,867
6,351	17.2821	48,871	8,145	22.1637	57,127	9,521	25.9079	237,219	39,537
4,556	12.3959	51,440	8,573	23.3288	35,193	5,866	15.9605	236,104	39,351
3,175	8.6404	63,270	10,545	28.6939	46,824	7,804	21.2354	162,993	27,166
9,315	25.3456	89,814	14,969	40.7320	157,638	26,273	71.4912	285,979	47,663
24,497	66.6590	209,355	34,893	94.9456	88,283	14,714	40.0376	164,839	27,473
2,171	5.9070	103,118	17,186	46.7655	33,781	5,630	15.3202	93,123	15,521
3,151	8.5746	119,476	19,913	54.1841	22,501	3,750	10.2045	57,524	9,587
3,956	10.7646	32,049	5,342	14.5347	19,288	3,215	8.7474	109,230	18,205
2,760	7.5088	72,009	12,002	32.6571	40,753	6,792	18.4821	104,770	17,462
6,427	17.4880	123,876	20,646	56.1796	149,874	24,979	67.9701	121,331	20,222
10,609	28.8685	49,503	8,251	22.4503	194,532	32,422	88.2231	145,370	24,228
6,380	17.3615	57,020	9,503	25.8594	140,715	23,453	63.8163	179,900	29,983
3,114	8.4730	93,358	15,560	42.3392	92,187	15,365	41.8082	99,607	16,601
3,679	10.0104	128,757	21,460	58.3932	108,045	18,008	49.0000	192,375	32,063
4,304	11.7120	149,187	24,865	67.6585	97,724	16,287	44.3193	324,297	54,050
6,166	16.7782	112,490	18,748	51.0159	126,795	21,133	57.5034	218,547	36,425
10,172	27.6794	159,488	26,581	72.3302	197,481	32,914	89.5605	224,275	37,379
6,388	17.3810	74,871	12,479	33.9551	158,382	26,397	71.8286	239,283	39,881
1,810	4.9256	89,625	14,938	40.6463	37,322	6,220	16.9261	144,435	24,073
7,005	19.0603	44,765	7,461	20.3016	80,603	13,434	36.5546	136,236	22,706
1,822	4.9583	67,735	11,289	30.7188	116,699	19,450	52.9247	219,109	36,518
4,334	11.7927	19,638	3,273	8.9061	129,991	21,665	58.9528	276,655	46,109
5,562	15.1342	124,050	20,675	56.2585	157,979	26,330	71.6458	148,791	24,799
3,428	9.3288	40,595	6,766	18.4104	44,628	7,438	20.2395	108,026	18,004
9,170	24.9528	104,580	17,430	47.4286	105,987	17,665	48.0667	182,674	30,446
8,146	22.1669	33,692	5,615	15.2798	79,816	13,303	36.1977	158,736	26,456
8,820	24.0005	18,715	3,119	8.4875	74,505	12,418	33.7891	189,781	31,630

Table D4 (cont.)
The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Buffalo in the Upper Mississippi River System

Pool 18 tons	Pool 19 lbs	Pool 19 fish	Pool 19 tons	Pool 20 lbs	Pool 20 fish	Pool 20 tons	Pool 21 lbs	Pool 21 fish	Pool 21 tons
46.7365	131,985	21,998	59.8571	19,311	3,219	8.7578	36,234	6,039	16.4327
95.9043	173,762	28,960	78.8036	16,339	2,723	7.4100	30,935	5,156	14.0295
97.5959	240,113	40,019	108.8948	27,991	4,665	12.6943	23,573	3,929	10.6907
107.5823	185,965	30,994	84.3379	30,191	5,032	13.6921	36,969	6,162	16.7660
107.0766	130,113	21,686	59.0082	20,012	3,335	9.0757	43,678	7,280	19.8086
73.9197	265,486	44,248	120.4018	11,721	1,954	5.3156	27,498	4,583	12.4707
129.6957	198,252	33,042	89.9102	87,682	14,614	39.7651	23,703	3,951	10.7497
74.7569	78,970	13,162	35.8141	43,231	7,205	19.6059	23,518	3,920	10.6658
42.2327	112,170	18,695	50.8707	31,738	5,290	14.3937	47,349	7,892	21.4735
26.0880	84,116	14,019	38.1478	60,630	10,105	27.4966	31,458	5,243	14.2667
49.5374	337,184	56,197	152.9179	26,860	4,477	12.1814	19,524	3,254	8.8544
47.5147	197,343	32,891	89.4980	47,354	7,892	21.4757	25,187	4,198	11.4227
55.0254	128,013	21,336	58.0558	102,612	17,102	46.5361	21,346	3,558	9.6807
65.9274	140,691	23,449	63.8054	104,945	17,491	47.5941	33,602	5,600	15.2390
81.5873	64,686	10,781	29.3361	77,882	12,980	35.3206	26,614	4,436	12.0698
45.1732	197,191	32,865	89.4290	34,509	5,752	15.6503	28,037	4,673	12.7152
87.2449	133,815	22,303	60.6871	58,692	9,782	26.6177	75,526	12,588	34.2522
147.0735	145,030	24,172	65.7732	79,327	13,221	35.9760	47,654	7,942	21.6118
99.1143	153,667	25,611	69.6902	45,478	7,580	20.6249	58,317	9,720	26.4476
101.7120	151,936	25,323	68.9052	19,407	3,235	8.8014	39,003	6,501	17.6884
108.5184	125,052	20,842	56.7129	31,466	5,244	14.2703	77,817	12,970	35.2912
65.5034	156,729	26,122	71.0789	27,335	4,556	12.3968	27,037	4,506	12.2617
61.7850	110,680	18,447	50.1950	24,569	4,095	11.1424	11,317	1,886	5.1324
99.3692	137,118	22,853	62.1850	13,700	2,283	6.2132	5,660	943	2.5669
125.4671	116,176	19,363	52.6875	24,346	4,058	11.0413	12,595	2,099	5.7120
67.4789	190,270	31,712	86.2902	60,666	10,111	27.5129	4,274	712	1.9383
48.9914	149,224	24,871	67.6753	38,471	6,412	17.4472	5,982	997	2.7129
82.8454	351,728	58,621	159.5138	39,467	6,578	17.8989	48,598	8,100	22.0399
71.9891	261,051	43,509	118.3905	16,400	2,733	7.4376	51,656	8,609	23.4268
86.0685	259,051	43,175	117.4834	33,156	5,526	15.0367	71,550	11,925	32.4490

Table D4 (cont.)
The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Buffalo in the Upper Mississippi River System

Pool 22 lbs	Pool 22 fish	Pool 22 tons	Pool 24 lbs	Pool 24 fish	Pool 24 tons	Pool 25 lbs	Pool 25 fish	Pool 25 tons	Pool 26 lbs
19,288	3,215	8.7474	39,224	6,537	17.7887	53,985	8,998	24.4830	62,095
4,473	746	2.0286	59,374	9,896	26.9270	40,788	6,798	18.4980	174,092
20,336	3,389	9.2227	89,026	14,838	40.3746	114,116	19,019	51.7533	167,008
7,257	1,210	3.2912	79,896	13,316	36.2340	81,351	13,559	36.8939	60,849
3,135	523	1.4218	93,457	15,576	42.3841	76,543	12,757	34.7134	95,506
13,149	2,192	5.9633	39,148	6,525	17.7542	89,391	14,899	40.5401	101,118
25,684	4,281	11.6481	51,303	8,551	23.2667	75,425	12,571	34.2063	100,570
4,195	699	1.9025	48,080	8,013	21.8050	133,189	22,198	60.4032	66,076
6,999	1,167	3.1741	42,518	7,086	19.2825	86,465	14,411	39.2132	56,892
10,280	1,713	4.6621	52,338	8,723	23.7361	60,783	10,131	27.5660	54,759
23,465	3,911	10.6417	61,957	10,326	28.0984	59,718	9,953	27.0830	68,970
22,681	3,780	10.2862	60,100	10,017	27.2562	116,983	19,497	53.0535	154,894
14,980	2,497	6.7937	68,664	11,444	31.1401	82,471	13,745	37.4018	123,489
8,560	1,427	3.8821	27,542	4,590	12.4907	117,791	19,632	53.4200	74,447
18,938	3,156	8.5887	34,787	5,798	15.7764	99,644	16,607	45.1900	82,303
14,767	2,461	6.6971	42,652	7,109	19.3433	78,386	13,064	35.5492	67,628
42,896	7,149	19.4540	94,507	15,751	42.8603	137,024	22,837	62.1424	107,729
5,986	998	2.7147	34,609	5,768	15.6957	117,966	19,661	53.4993	128,343
9,421	1,570	4.2726	40,564	6,761	18.3964	110,364	18,394	50.0517	88,210
9,666	1,611	4.3837	40,084	6,681	18.1787	109,839	18,307	49.8136	78,676
7,258	1,210	3.2916	39,560	6,593	17.9410	92,010	15,335	41.7279	41,868
11,879	1,980	5.3873	53,372	8,895	24.2050	118,458	19,743	53.7224	104,208
33,472	5,579	15.1800	26,833	4,472	12.1692	138,927	23,155	63.0054	232,501
42,465	7,078	19.2585	27,727	4,621	12.5746	104,306	17,384	47.3043	144,034
63,123	10,521	28.6272	8,291	1,382	3.7601	92,227	15,371	41.8263	79,516
67,402	11,234	30.5678	108,573	18,096	49.2395	123,938	20,656	56.2077	136,135
7,536	1,256	3.4177	17,298	2,883	7.8449	168,745	28,124	76.5283	105,916
62,224	10,371	28.2195	66,993	11,166	30.3823	155,753	25,959	70.6363	267,891
14,435	2,406	6.5465	91,012	15,169	41.2753	41,126	6,854	18.6512	250,690
34,635	5,773	15.7075	93,732	15,622	42.5088	57,377	9,563	26.0213	288,778

Table D4 (cont.)
The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Buffalo in the Upper Mississippi River System

Pool 26 fish	Pool 26 tons	Open River lbs	Open River fish	Open River tons
10,349	28.1610			
29,015	78.9533			
27,835	75.7406			
10,142	27.5959			
15,918	43.3134			
16,853	45.8585			
16,762	45.6100			
11,013	29.9664			
9,482	25.8014			
9,127	24.8340			
11,495	31.2789			
25,816	70.2467			
20,582	56.0041			
12,408	33.7628			
13,717	37.3256			
11,271	30.6703			
17,955	48.8567			
21,391	58.2054			
14,702	40.0045			
13,113	35.6807			
6,978	18.9878			
17,368	47.2599			
38,750	105.4426			
24,006	65.3215			
13,253	36.0617			
22,689	61.7392			
17,653	48.0345			
44,649	121.4925			
41,782	113.6916	190,874	31,812	86.5642
48,130	130.9651	249,970	41,662	113.3651

Table D5

The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Redhorse and Suckers in the Upper Mississippi River System

Year	Pool 3 lbs	Pool 3 fish	Pool 3 tons	Pool 4 lbs	Pool 4 fish	Pool 4 tons	Pool 4a lbs	Pool 4a fish	Pool 4a tons	Pool 5 lbs	Pool 5 fish
1961											
1962											
1963											
1964											
1965											
1966											
1967											
1968											
1969											
1970											
1978				154	308	0.0698	824	1,648	0.3737	4,179	8,358
1983	15	30	0.0068	125	250	0.0567	2,624	5,248	1.1900	1,225	2,450
1988	241	482	0.1093	1,021	2,042	0.4630	192	384	0.0871	1,916	3,832
1994	0	0	0.0000	16	32	0.0073	80	160	0.0363	2,425	4,850
1995	0	0	0.0000	68	136	0.0308	4,842	9,684	2.1959	1,449	2,898

Table D5 (cont.)

The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Redhorse and Suckers in the Upper Mississippi River System

Pool 5 tons	Pool 5a lbs	Pool 5a fish	Pool 5a tons	Pool 6 lbs	Pool 6 fish	Pool 6 tons	Pool 7 lbs	Pool 7 fish	Pool 7 tons	Pool 8 lbs
1.8952	1,479	2,958	0.6707	69	138	0.0313	1,488	2,976	0.6748	4,576
0.5556	73	146	0.0331	16	32	0.0073	251	502	0.1138	3,658
0.8689	102	204	0.0463	2,089	4,178	0.9474	1,940	3,880	0.8798	8,252
1.0998	2,094	4,188	0.9497	1,002	2,004	0.4544	6,908	13,816	3.1329	2,960
0.6571	1,828	3,656	0.8290	715	1,430	0.3243	13,281	26,562	6.0231	4,260

Table D5 (cont.)

The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Redhorse and Suckers in the Upper Mississippi River System

Pool 8 fish	Pool 8 tons	Pool 9 lbs	Pool 9 fish	Pool 9 tons	Pool 10 lbs	Pool 10 fish	Pool 10 tons	Pool 11 lbs	Pool 11 fish	Pool 11 tons
								1,739	3,478	0.7887
								3,975	7,950	1.8027
								1,277	2,554	0.5791
								3,228	6,456	1.4639
								3,198	6,396	1.4503
								5,145	10,290	2.3333
								4,588	9,176	2.0807
								12,550	25,100	5.6916
								8,599	17,198	3.8998
								10,765	21,530	4.8821
9,152	2.0753	35,401	70,802	16.0549	16,142	32,284	7.3206	11,531	23,062	5.2295
7,316	1.6590	23,507	47,014	10.6608	43,527	87,054	19.7401	7,894	15,788	3.5800
16,504	3.7424	27,673	55,346	12.5501	22,673	45,346	10.2825	11,044	22,088	5.0086
5,920	1.3424	50,228	100,456	22.7791	33,467	66,934	15.1778	2,940	5,880	1.3333
8,520	1.9320	53,386	106,772	24.2113	25,870	51,740	11.7324	7,509	15,018	3.4054

Table D5 (cont.)
The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Redhorse and Suckers in the Upper Mississippi River System

Pool 12 lbs	Pool 12 fish	Pool 12 tons	Pool 13 lbs	Pool 13 fish	Pool 13 tons	Pool 14 lbs	Pool 14 fish	Pool 14 tons	Pool 15 lbs
984	1,968	0.4463	1,414	2,828	0.6413	1,057	2,114	0.479	50
439	878	0.1991	633	1,266	0.2871	775	1,550	0.351	117
2,165	4,330	0.9819	625	1,250	0.2834	432	864	0.196	
1,730	3,460	0.7846	390	780	0.1769	344	688	0.156	20
1,493	2,986	0.6771	2,781	5,562	1.2612	405	810	0.184	
1,144	2,288	0.5188	3,177	6,354	1.4408	160	320	0.073	
1,140	2,280	0.5170	3,027	6,054	1.3728	247	494	0.112	
5,930	11,860	2.6893	4,230	8,460	1.9184	87	174	0.039	293
1,617	3,234	0.7333	3,710	7,420	1.6825	307	614	0.139	
875	1,750	0.3968	5,985	11,970	2.7143	122	244	0.055	
3,190	6,380	1.4467	3,074	6,148	1.3941	3,044	6,088	1.380	702
10,932	21,864	4.9578	850	1,700	0.3855	226	452	0.102	650
7,407	14,814	3.3592	1,480	2,960	0.6712	350	700	0.159	5,006
0	0	0.0000	7,670	15,340	3.4785	1,496	2,992	0.678	316
173	346	0.0785	9,777	19,554	4.4340	1,325	2,650	0.601	2,482

Table D5 (cont.)

The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Redhorse and Suckers in the Upper Mississippi River System

Pool 15 fish	Pool 15 tons	Pool 16 lbs	Pool 16 fish	Pool 16 tons	Pool 17 lbs	Pool 17 fish	Pool 17 tons	Pool 18 lbs	Pool 18 fish
100	0.0227	6	12	0.0027	480	960	0.2177	160	320
234	0.0531				152	304	0.0689	1,127	2,254
		8,000	16,000	3.6281				1,124	2,248
40	0.0091	4,049	8,098	1.8363				500	1,000
		1,042	2,084	0.4726	55	110	0.0249	6,000	12,000
		3,056	6,112	1.3859	2,261	4,522	1.0254		
		17	34	0.0077	2,017	4,034	0.9147		
586	0.1329	12	24	0.0054	3,523	7,046	1.5977		
		1,029	2,058	0.4667	799	1,598	0.3624		
		376	752	0.1705	1,979	3,958	0.8975	769	1,538
1,404	0.3184	2,773	5,546	1.2576	5,458	10,916	2.4753	102	204
1,300	0.2948	3,474	6,948	1.5755	2,415	4,830	1.0952	1,103	2,206
10,012	2.2703	0	0	0.0000	24	48	0.0109	300	600
632	0.1433	50	100	0.0227	178	356	0.0807	644	1,288
4,964	1.1256	200	400	0.0907	0	0	0.0000	0	0

Table D5 (cont.)
The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Redhorse and Suckers in the Upper Mississippi River System

Pool 18 tons	Pool 19 lbs	Pool 19 fish	Pool 19 tons	Pool 20 lbs	Pool 20 fish	Pool 20 tons	Pool 21 lbs	Pool 21 fish	Pool 21 tons	Pool 22 lbs
0.0726	187	374	0.0848	1,560	3,120	0.7075	32	64	0.0145	
0.5111	11	22	0.0050	730	1,460	0.3311	135	270	0.0612	
0.5098	3	6	0.0014	3,120	6,240	1.4150	255	510	0.1156	
0.2268	81,500	163,000	36.9615	1,010	2,020	0.4580	33	66	0.0150	
2.7211	24	48	0.0109	680	1,360	0.3084				
	1,153	2,306	0.5229	860	1,720	0.3900				
	50	100	0.0227	925	1,850	0.4195				
	3,740	7,480	1.6961	1,146	2,292	0.5197	470	940	0.2132	155
				2,617	5,234	1.1868	700	1,400	0.3175	98
0.3488	490	980	0.2222	85	170	0.0385				518
0.0463	28	56	0.0127							
0.5002	4,701	9,402	2.1320	4,945	9,890	2.2426	249	498	0.1129	17
0.1361	1,161	2,322	0.5265	3,125	6,250	1.4172	257	514	0.1166	33
0.2921	0	0	0.0000	6,250	12,500	2.8345	0	0	0.0000	0
0.0000	64	128	0.0290	1,475	2,950	0.6689	120	240	0.0544	122

Table D5 (cont.)
The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Redhorse and Suckers in the Upper Mississippi River System

Pool 22 fish	Pool 22 tons	Pool 24 lbs	Pool 24 fish	Pool 24 tons	Pool 25 lbs	Pool 25 fish	Pool 25 tons	Pool 26 lbs	Pool 26 fish	Pool 26 tons
310	0.0703									
196	0.0444									
1,036	0.2349									
		416	832	0.1887	211	422	0.0957	2,229	4,458	1.0109
34	0.0077	459	918	0.2082	150	300	0.0680	574	1,148	0.2603
66	0.0150	500	1,000	0.2268	428	856	0.1941	85	170	0.0385
0	0.0000	411	822	0.1864	160	320	0.0726	64	128	0.0290
244	0.0553	302	604	0.1370	220	440	0.0998	4	8	0.0018

Table D5 (cont.)

The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Redhorse and Suckers in the Upper Mississippi River System

Open River lbs	Open River fish	Open River tons
112	224	0.0508
410	820	0.1859

Table D6
The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Carpsucker in the Upper Mississippi River System

Year	Pool 3 lbs	Pool 3 fish	Pool 3 tons	Pool 4 lbs	Pool 4 fish	Pool 4 tons	Pool 4a lbs	Pool 4a fish	Pool 4a tons	Pool 5 lbs	Pool 5 fish
1961											
1962											
1963											
1964											
1965											
1966											
1967											
1968											
1969											
1970											
1978	38	48	0.0172	128	160	0.0580	464	580	0.2104	2,972	3,715
1983	5,921	7,401	2.6853	892	1,115	0.4045	8,308	10,385	3.7678	9,577	11,971
1988	1,560	1,950	0.7075	3,707	4,634	1.6812	3,180	3,975	1.4422	14,343	17,929
1994	739	924	0.3351	13,595	16,994	6.1655	24,248	30,310	10.9968	13,166	16,458
1995	3,792	4,740	1.7197	149	186	0.0676	39,828	49,785	18.0626	7,699	9,624

Table D6 (cont.)
The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Carpsucker in the Upper Mississippi River System

Pool 5 tons	Pool 5a lbs	Pool 5a fish	Pool 5a tons	Pool 6 lbs	Pool 6 fish	Pool 6 tons	Pool 7 lbs	Pool 7 fish	Pool 7 tons	Pool 8 lbs
1.3478	437	546	0.1982	2,514	3,143	1.1401	703	879	0.3188	1,000
4.3433	108	135	0.0490	116	145	0.0526				4,715
6.5048	9,500	11,875	4.3084	24,714	30,893	11.2082	3,694	4,618	1.6753	13,386
5.9710	4,090	5,113	1.8549	2,953	3,691	1.3392	51,334	64,168	23.2807	15,654
3.4916	4,802	6,003	2.1778	2,597	3,246	1.1778	29,542	36,928	13.3977	8,670

Table D6 (cont.)
The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Carpsucker in the Upper Mississippi River System

Pool 8 fish	Pool 8 tons	Pool 9 lbs	Pool 9 fish	Pool 9 tons	Pool 10 lbs	Pool 10 fish	Pool 10 tons	Pool 11 lbs	Pool 11 fish	Pool 11 tons
								1,353	1,691	0.6136
								545	681	0.2472
								4,644	5,805	2.1061
								4,576	5,720	2.0753
								4,173	5,216	1.8925
								5,630	7,038	2.5533
								3,136	3,920	1.4222
								2,306	2,883	1.0458
								6,600	8,250	2.9932
								3,861	4,826	1.7510
1,250	0.4535	1,936	2,420	0.8780	7,581	9,476	3.4381	3,291	4,114	1.4925
5,894	2.1383	1,629	2,036	0.7388	2,257	2,821	1.0236	3,311	4,139	1.5016
16,733	6.0707	11,006	13,758	4.9914	16,590	20,738	7.5238	10,561	13,201	4.7896
19,568	7.0993	5,128	6,410	2.3256	24,790	30,988	11.2426	5,420	6,775	2.4580
10,838	3.9320	6,929	8,661	3.1424	23,725	29,656	10.7596	7,700	9,625	3.4921

Table D6 (cont.)
The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Carpsucker in the Upper Mississippi River System

Pool 12 lbs	Pool 12 fish	Pool 12 tons	Pool 13 lbs	Pool 13 fish	Pool 13 tons	Pool 14 lbs	Pool 14 fish	Pool 14 tons	Pool 15 lbs
160	200	0.0726	1,730	2,163	0.7846	1,000	1,250	0.4535	
100	125	0.0454	50	63	0.0227	1,749	2,186	0.7932	
350	438	0.1587	100	125	0.0454				
			66	83	0.0299	1,409	1,761	0.6390	
937	1,171	0.4249							
						5,147	6,434	2.3342	
260	325	0.1179	10	13	0.0045				
447	559	0.2027	1,500	1,875	0.6803	1,258	1,573	0.5705	780
			84	105	0.0381				
			600	750	0.2721				
			3,210	4,013	1.4558	9,665	12,081	4.3832	750
15	19	0.0068	13,339	16,674	6.0494	4,300	5,375	1.9501	800
1,020	1,275	0.4626	9,966	12,458	4.5197	3,530	4,413	1.6009	13,310
1,957	2,446	0.8875	16,097	20,121	7.3002	5,923	7,404	2.6862	9,561
3,279	4,099	1.4871	21,349	26,686	9.6821	5,648	7,060	2.5615	850

Table D6 (cont.)
The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Carpsucker in the Upper Mississippi River System

Pool 15 fish	Pool 15 tons	Pool 16 lbs	Pool 16 fish	Pool 16 tons	Pool 17 lbs	Pool 17 fish	Pool 17 tons	Pool 18 lbs	Pool 18 fish
								3,922	4,903
		2,300	2,875	1.0431				255	319
								600	750
		1,119	1,399	0.5075	1,700	2,125	0.7710	700	875
					10,749	13,436	4.8748		
					6,499	8,124	2.9474		
975	0.3537				5,769	7,211	2.6163		
		650	813	0.2948	713	891	0.3234	2,500	3,125
		4,703	5,879	2.1329	5,423	6,779	2.4594	5,300	6,625
938	0.3401	7,492	9,365	3.3977	5,000	6,250	2.2676		
1,000	0.3628	2,800	3,500	1.2698				9,020	11,275
16,638	6.0363	5,805	7,256	2.6327	6,649	8,311	3.0154	7,083	8,854
11,951	4.3361	1,060	1,325	0.4807	4,750	5,938	2.1542	18,253	22,816
1,063	0.3855	160	200	0.0726	3,280	4,100	1.4875	1,350	1,688

Table D6 (cont.)
The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Carpsucker in the Upper Mississippi River System

Pool 18 tons	Pool 19 lbs	Pool 19 fish	Pool 19 tons	Pool 20 lbs	Pool 20 fish	Pool 20 tons	Pool 21 lbs	Pool 21 fish	Pool 21 tons
1.7787				9,335	11,669	4.2336	2,952	3,690	1.3388
0.1156				6,990	8,738	3.1701	1,050	1,313	0.4762
				9,636	12,045	4.3701	875	1,094	0.3968
0.2721				3,337	4,171	1.5134			
0.3175				2,458	3,073	1.1147			
	600	750	0.2721	75,988	94,985	34.4617			
	1,000	1,250	0.4535	13,606	17,008	6.1705	225	281	0.1020
	174	218	0.0789	8,391	10,489	3.8054	2,425	3,031	1.0998
1.1338	500	625	0.2268	7,518	9,398	3.4095	696	870	0.3156
2.4036	2,022	2,528	0.9170	5,409	6,761	2.4531	135	169	0.0612
	60	75	0.0272	27,590	34,488	12.5125	2,310	2,888	1.0476
4.0907	2,854	3,568	1.2943	60,883	76,104	27.6113	2,082	2,603	0.9442
3.2122	41,186	51,483	18.6785	14,545	18,181	6.5964	3,782	4,728	1.7152
8.2780	3,401	4,251	1.5424	18,300	22,875	8.2993	0	0	0.0000
0.6122	10,674	13,343	4.8408	9,610	12,013	4.3583	300	375	0.1361

Table D6 (cont.)
The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Carpsucker in the Upper Mississippi River System

Pool 22 lbs	Pool 22 fish	Pool 22 tons	Pool 24 lbs	Pool 24 fish	Pool 24 tons	Pool 25 lbs	Pool 25 fish	Pool 25 tons	Pool 26 lbs
2,273	2,841	1.0308							
350	438	0.1587							
500	625	0.2268							
1,078	1,348	0.4889							
5,183	6,479	2.3506							
2,500	3,125	1.1338							
5,377	6,721	2.4385							
5,146	6,433	2.3338							
9,944	12,430	4.5098							
241	301	0.1093	1,862	2,328	0.8444	3,600	4,500	1.6327	21,916
937	1,171	0.4249	1,174	1,468	0.5324	985	1,231	0.4467	22,136
5,211	6,514	2.3633	2,137	2,671	0.9692	1,825	2,281	0.8277	10,835
3,130	3,913	1.4195	2,848	3,560	1.2916	1,545	1,931	0.7007	94
342	428	0.1551	3,648	4,560	1.6544	1,360	1,700	0.6168	6,128

Table D6 (cont.)

The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Carpsucker in the Upper Mississippi River System

Pool 26 fish	Pool 26 tons	Open River lbs	Open River fish	Open River tons
27,395	9.9392			
27,670	10.0390			
13,544	4.9138			
118	0.0426	16,207	20,259	7.3501
7,660	2.7791	10,146	12,683	4.6014

Table D7

The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Catfish in the Upper Mississippi River System

Year	Pool 3 lbs	Pool 3 fish	Pool 3 tons	Pool 4 lbs	Pool 4 fish	Pool 4 tons	Pool 4a lbs	Pool 4a fish	Pool 4a tons	Pool 5 lbs	Pool 5 fish
1953	2,217	2,067	1.0054	7,506	6,997	3.4041	30,731	28,646	13.9370	10,016	9,336
1954	3,759	3,504	1.7048	26,312	24,526	11.9329	27,331	25,476	12.3950	22,623	21,088
1955	5,484	5,112	2.4871	26,130	24,357	11.8503	27,502	25,636	12.4726	15,641	14,580
1956	2,669	2,488	1.2104	7,236	6,745	3.2816	18,333	17,089	8.3143	14,883	13,873
1957	268	250	0.1215	4,743	4,421	2.1510	15,287	14,250	6.9329	9,531	8,884
1958	378	352	0.1714	11,116	10,362	5.0413	23,629	22,026	10.7161	12,387	11,546
1959	874	815	0.3964	5,336	4,974	2.4200	29,563	27,557	13.4073	13,387	12,479
1960	1,387	1,293	0.6290	9,741	9,080	4.4177	23,793	22,178	10.7905	22,398	20,878
1961	2,133	1,988	0.9673	14,403	13,426	6.5320	15,432	14,385	6.9986	18,120	16,890
1962	3,305	3,081	1.4989	9,848	9,180	4.4662	43,789	40,817	19.8590	13,759	12,825
1963	1,307	1,218	0.5927	10,117	9,430	4.5882	10,473	9,762	4.7497	13,202	12,306
1964	369	344	0.1673	5,515	5,141	2.5011	18,211	16,975	8.2590	10,057	9,375
1965	658	613	0.2984	7,369	6,869	3.3420	22,173	20,668	10.0558	17,483	16,297
1966	675	629	0.3061	12,578	11,724	5.7043	32,336	30,142	14.6649	16,620	15,492
1967	1,457	1,358	0.6608	19,975	18,620	9.0590	29,555	27,549	13.4036	19,318	18,007
1968	2,160	2,013	0.9796	17,230	16,061	7.8141	32,633	30,419	14.7995	13,463	12,549
1969	1,320	1,230	0.5986	24,942	23,249	11.3116	30,919	28,821	14.0222	12,572	11,719
1970	759	707	0.3442	19,223	17,919	8.7179	27,181	25,337	12.3270	17,393	16,213
1971	202	188	0.0916	14,556	13,568	6.6014	23,193	21,619	10.5184	20,781	19,371
1972	652	608	0.2957	17,712	16,510	8.0327	12,935	12,057	5.8662	13,102	12,213
1973	85	79	0.0385	9,791	9,127	4.4404	19,792	18,449	8.9760	14,902	13,891
1974	64	60	0.0290	19,854	18,507	9.0041	17,902	16,687	8.1188	8,972	8,363
1975	86	80	0.0390	13,583	12,661	6.1601	21,415	19,962	9.7120	12,935	12,057
1976	18	17	0.0082	18,930	17,645	8.5850	15,074	14,051	6.8363	23,022	21,460
1977	96	89	0.0435	18,949	17,663	8.5937	11,466	10,688	5.2000	25,963	24,201
1978	273	254	0.1238	10,067	9,384	4.5655	9,807	9,141	4.4476	13,486	12,571
1983	2,436	2,271	1.1048	7,646	7,127	3.4676	8,942	8,335	4.0553	7,811	7,281
1988	1,041	970	0.4721	9,512	8,867	4.3138	8,422	7,850	3.8195	24,978	23,283

Table D7 (cont.)

The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Catfish in the Upper Mississippi River System

Pool 5 tons	Pool 5a lbs	Pool 5a fish	Pool 5a tons	Pool 6 lbs	Pool 6 fish	Pool 6 tons	Pool 7 lbs	Pool 7 fish	Pool 7 tons	Pool 8 lbs
4.5424	5,710	5,323	2.5896	2,315	2,158	1.0499	40,912	38,136	18.5542	111,303
10.2599	4,001	3,729	1.8145	8,990	8,380	4.0771	50,468	47,043	22.8880	121,556
7.0934	8,188	7,632	3.7134	9,711	9,052	4.4041	55,055	51,319	24.9683	112,758
6.7497	13,181	12,287	5.9778	19,856	18,509	9.0050	45,674	42,575	20.7138	60,968
4.3224	7,215	6,725	3.2721	9,652	8,997	4.3773	33,724	31,435	15.2943	44,300
5.6177	7,330	6,833	3.3243	11,313	10,545	5.1306	62,368	58,136	28.2848	66,804
6.0712	8,311	7,747	3.7692	8,589	8,006	3.8952	49,247	45,905	22.3342	135,045
10.1578	7,005	6,530	3.1769	16,982	15,830	7.7016	74,015	68,992	33.5669	144,930
8.2177	10,162	9,472	4.6086	11,358	10,587	5.1510	83,764	78,080	37.9882	142,869
6.2399	10,783	10,051	4.8902	12,339	11,502	5.5959	60,422	56,322	27.4023	158,806
5.9873	11,970	11,158	5.4286	8,968	8,359	4.0671	71,401	66,556	32.3814	87,803
4.5610	13,086	12,198	5.9347	6,657	6,205	3.0190	68,190	63,563	30.9252	85,201
7.9288	6,983	6,509	3.1669	3,451	3,217	1.5651	63,365	59,065	28.7370	72,596
7.5374	8,352	7,785	3.7878	8,987	8,377	4.0757	53,333	49,714	24.1873	81,160
8.7610	8,766	8,171	3.9755	8,361	7,794	3.7918	59,461	55,426	26.9664	107,094
6.1057	8,857	8,256	4.0168	6,031	5,622	2.7351	69,595	64,872	31.5624	111,948
5.7016	8,873	8,271	4.0240	4,788	4,463	2.1714	63,604	59,288	28.8454	108,384
7.8880	9,029	8,416	4.0948	4,804	4,478	2.1787	89,338	83,276	40.5161	137,465
9.4245	8,281	7,719	3.7556	2,835	2,643	1.2857	88,406	82,407	40.0934	158,260
5.9420	5,387	5,021	2.4431	4,153	3,871	1.8834	85,692	79,877	38.8626	102,353
6.7583	7,086	6,605	3.2136	7,440	6,935	3.3741	39,457	36,779	17.8943	119,990
4.0689	7,794	7,265	3.5347	2,162	2,015	0.9805	64,269	59,908	29.1469	131,880
5.8662	6,621	6,172	3.0027	2,948	2,748	1.3370	86,376	80,515	39.1728	154,051
10.4408	14,477	13,495	6.5655	4,801	4,475	2.1773	64,436	60,063	29.2227	187,267
11.7746	7,890	7,355	3.5782	7,619	7,102	3.4553	35,840	33,408	16.2540	95,635
6.1161	6,726	6,270	3.0503	19,136	17,837	8.6785	32,838	30,610	14.8925	91,737
3.5424	2,946	2,746	1.3361	5,337	4,975	2.4204	27,470	25,606	12.4580	55,112
11.3279	21,592	20,127	9.7923	23,827	22,210	10.8059	46,667	43,500	21.1642	148,584

Table D7 (cont.)
The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Catfish in the Upper Mississippi River System

Pool 8 fish	Pool 8 tons	Pool 9 lbs	Pool 9 fish	Pool 9 tons	Pool 10 lbs	Pool 10 fish	Pool 10 tons	Pool 11 lbs	Pool 11 fish	Pool 11 tons
103,750	50.4776	214,583	200,021	97.3166	27,431	25,570	12.4404	69,557	64,837	31.5451
113,307	55.1274	282,888	263,691	128.2939	88,866	82,836	40.3020	124,606	116,150	56.5107
105,106	51.1374	304,661	283,987	138.1683	108,588	101,219	49.2463	72,602	67,675	32.9261
56,831	27.6499	204,540	190,660	92.7619	61,906	57,705	28.0753	89,696	83,609	40.6785
41,294	20.0907	265,325	247,320	120.3288	58,707	54,723	26.6245	106,470	99,245	48.2857
62,271	30.2966	284,972	265,634	129.2390	88,006	82,034	39.9120	161,787	150,808	73.3728
125,881	61.2449	338,584	315,608	153.5528	84,251	78,534	38.2091	174,700	162,845	79.2290
135,095	65.7279	291,559	271,774	132.2263	97,845	91,205	44.3741	142,685	133,002	64.7098
133,174	64.7932	152,554	142,202	69.1855	94,557	88,140	42.8830	121,776	113,512	55.2272
148,029	72.0209	151,856	141,551	68.8689	57,614	53,704	26.1288	120,727	112,534	54.7515
81,845	39.8200	191,565	178,565	86.8776	45,925	42,809	20.8277	168,512	157,077	76.4227
79,419	38.6399	301,802	281,322	136.8717	77,616	72,349	35.2000	332,561	309,993	150.8213
67,670	32.9234	225,042	209,771	102.0599	82,321	76,735	37.3338	225,766	210,446	102.3882
75,652	36.8073	188,147	175,379	85.3274	68,705	64,043	31.1587	120,201	112,044	54.5129
99,827	48.5687	250,174	233,197	113.4576	79,749	74,337	36.1673	181,568	169,247	82.3438
104,351	50.7701	229,210	213,656	103.9501	86,670	80,789	39.3061	189,178	176,340	85.7950
101,029	49.1537	135,599	126,397	61.4961	67,173	62,615	30.4639	131,392	122,476	59.5882
128,137	62.3424	196,192	182,878	88.9760	93,166	86,844	42.2522	127,234	118,600	57.7025
147,521	71.7732	137,565	128,230	62.3878	67,818	63,216	30.7565	96,288	89,754	43.6680
95,407	46.4186	114,653	106,873	51.9968	81,774	76,225	37.0857	119,324	111,227	54.1152
111,848	54.4172	148,815	138,716	67.4898	74,556	69,497	33.8122	112,623	104,980	51.0762
122,931	59.8095	183,346	170,904	83.1501	85,499	79,697	38.7751	130,476	121,622	59.1728
143,597	69.8644	173,780	161,987	78.8118	99,613	92,853	45.1760	124,556	116,104	56.4880
174,559	84.9283	113,700	105,984	51.5646	60,199	56,114	27.3011	94,642	88,220	42.9215
89,145	43.3719	126,378	117,802	57.3143	69,833	65,094	31.6703	101,821	94,911	46.1773
85,512	41.6041	118,553	110,508	53.7655	77,106	71,874	34.9687	127,161	118,532	57.6694
51,372	24.9941	70,061	65,307	31.7737	58,660	54,679	26.6032	64,320	59,955	29.1701
138,501	67.3850	106,857	99,606	48.4612	90,730	84,573	41.1474	125,545	117,026	56.9365

Table D7 (cont.)

The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Catfish in the Upper Mississippi River System

Pool 12 lbs	Pool 12 fish	Pool 12 tons	Pool 13 lbs	Pool 13 fish	Pool 13 tons	Pool 14 lbs	Pool 14 fish	Pool 14 tons	Pool 15 lbs
10,864	10,127	4.9270	18,399	17,150	8.3442	8,075	7,527	3.6621	1,100
17,599	16,405	7.9814	37,593	35,042	17.0490	21,581	20,117	9.7873	6,229
20,662	19,260	9.3705	69,836	65,097	31.6717	37,166	34,644	16.8553	3,744
34,474	32,135	15.6345	77,501	72,242	35.1478	40,984	38,203	18.5868	9,826
37,294	34,763	16.9134	63,993	59,650	29.0218	55,986	52,187	25.3905	13,783
62,083	57,870	28.1556	77,690	72,418	35.2336	74,537	69,479	33.8036	15,527
47,403	44,186	21.4980	82,151	76,576	37.2567	80,482	75,021	36.4998	15,307
38,772	36,141	17.5837	83,681	78,002	37.9506	60,138	56,057	27.2735	17,438
46,466	43,313	21.0730	143,275	133,552	64.9773	34,492	32,151	15.6426	1,769
52,439	48,880	23.7819	57,556	53,650	26.1025	38,679	36,054	17.5415	10,584
67,024	62,476	30.3964	76,552	71,357	34.7175	43,271	40,335	19.6240	6,404
71,551	66,696	32.4494	77,442	72,187	35.1211	75,652	70,518	34.3093	9,695
50,185	46,779	22.7596	108,579	101,211	49.2422	45,292	42,218	20.5406	15,314
32,789	30,564	14.8703	78,136	72,834	35.4358	56,722	52,873	25.7243	7,457
44,208	41,208	20.0490	103,004	96,014	46.7138	78,110	72,809	35.4240	4,652
56,407	52,579	25.5814	143,277	133,554	64.9782	78,258	72,947	35.4912	11,325
42,644	39,750	19.3397	83,466	77,802	37.8531	86,840	80,947	39.3832	7,591
40,607	37,851	18.4159	152,270	141,937	69.0567	65,402	60,964	29.6608	2,435
23,581	21,981	10.6943	109,367	101,945	49.5995	63,172	58,885	28.6494	9,132
38,159	35,570	17.3057	110,792	103,274	50.2458	87,320	81,394	39.6009	10,905
48,521	45,228	22.0050	121,685	113,427	55.1859	62,083	57,870	28.1556	9,193
61,275	57,117	27.7891	177,557	165,508	80.5247	69,369	64,662	31.4599	11,862
88,331	82,337	40.0594	148,347	138,280	67.2776	56,519	52,684	25.6322	15,477
53,241	49,628	24.1456	112,911	105,249	51.2068	39,305	36,638	17.8254	9,437
99,819	93,045	45.2694	149,791	139,626	67.9324	41,344	38,538	18.7501	23,503
71,307	66,468	32.3388	178,896	166,756	81.1320	55,210	51,463	25.0385	18,581
36,942	34,435	16.7537	123,976	115,563	56.2249	35,621	33,204	16.1546	11,963
45,615	42,520	20.6871	180,684	168,423	81.9429	83,492	77,826	37.8649	28,309

Table D7 (cont.)

The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Catfish in the Upper Mississippi River System

Pool 15 fish	Pool 15 tons	Pool 16 lbs	Pool 16 fish	Pool 16 tons	Pool 17 lbs	Pool 17 fish	Pool 17 tons	Pool 18 lbs	Pool 18 fish
1,025	0.4989	7,923	7,385	3.5932	44,578	41,553	20.2168	78,793	73,446
5,806	2.8249	15,815	14,742	7.1723	39,955	37,244	18.1202	202,770	189,010
3,490	1.6980	12,042	11,225	5.4612	34,736	32,379	15.7533	216,435	201,748
9,159	4.4562	16,686	15,554	7.5673	32,787	30,562	14.8694	267,921	249,740
12,848	6.2508	27,682	25,804	12.5542	37,890	35,319	17.1837	324,671	302,639
14,473	7.0417	29,711	27,695	13.4744	42,347	39,473	19.2050	378,952	353,236
14,268	6.9420	30,151	28,105	13.6739	79,170	73,798	35.9048	299,348	279,034
16,255	7.9084	49,756	46,380	22.5651	94,479	88,068	42.8476	215,694	201,057
1,649	0.8023	33,179	30,927	15.0472	41,705	38,875	18.9138	113,183	105,502
9,866	4.8000	33,818	31,523	15.3370	38,084	35,500	17.2717	108,591	101,222
5,969	2.9043	24,193	22,551	10.9719	35,848	33,415	16.2576	154,044	143,591
9,037	4.3968	65,503	61,058	29.7066	53,433	49,807	24.2327	216,732	202,025
14,275	6.9451	47,053	43,860	21.3392	52,097	48,562	23.6268	134,362	125,244
6,951	3.3819	12,940	12,062	5.8685	79,372	73,986	35.9964	101,610	94,715
4,336	2.1098	21,877	20,392	9.9215	50,127	46,725	22.7333	108,932	101,540
10,556	5.1361	39,886	37,179	18.0889	35,482	33,074	16.0916	135,353	126,168
7,076	3.4426	27,740	25,858	12.5805	68,032	63,415	30.8535	130,397	121,548
2,270	1.1043	38,389	35,784	17.4100	37,069	34,554	16.8113	125,910	117,366
8,512	4.1415	16,864	15,720	7.6481	18,708	17,438	8.4844	119,856	111,723
10,165	4.9456	34,816	32,453	15.7896	18,783	17,508	8.5184	104,179	97,109
8,569	4.1692	41,140	38,348	18.6576	72,579	67,654	32.9156	110,584	103,080
11,057	5.3796	37,213	34,688	16.8766	29,546	27,541	13.3995	127,687	119,022
14,427	7.0190	29,414	27,418	13.3397	30,462	28,395	13.8150	140,505	130,970
8,797	4.2798	24,555	22,889	11.1361	35,036	32,658	15.8893	122,227	113,933
21,908	10.6590	33,134	30,886	15.0268	95,923	89,414	43.5025	213,928	199,411
17,320	8.4268	67,452	62,875	30.5905	65,946	61,471	29.9075	191,709	178,700
11,151	5.4254	19,038	17,746	8.6340	35,467	33,060	16.0848	125,866	117,325
26,388	12.8385	60,098	56,020	27.2553	76,761	71,552	34.8122	182,437	170,057

Table D7 (cont.)

The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Catfish in the Upper Mississippi River System

Pool 18 tons	Pool 19 lbs	Pool 19 fish	Pool 19 tons	Pool 20 lbs	Pool 20 fish	Pool 20 tons	Pool 21 lbs	Pool 21 fish	Pool 21 tons	Pool 22 lbs
35.7338	238,187	222,024	108.0213	19,289	17,980	8.7478	24,038	22,407	10.9016	11,967
91.9592	358,493	334,166	162.5819	14,885	13,875	6.7506	20,151	18,784	9.1388	6,735
98.1565	366,107	341,263	166.0349	17,713	16,511	8.0331	17,246	16,076	7.8213	7,481
121.5061	369,398	344,331	167.5274	36,388	33,919	16.5025	12,641	11,783	5.7329	5,170
147.2431	436,210	406,609	197.8277	44,615	41,587	20.2336	30,140	28,095	13.6689	12,556
171.8603	657,616	612,990	298.2385	31,522	29,383	14.2957	22,763	21,218	10.3234	5,420
135.7587	434,598	405,106	197.0966	48,413	45,128	21.9560	16,870	15,725	7.6508	14,682
97.8204	132,967	123,944	60.3025	48,518	45,226	22.0036	12,434	11,590	5.6390	7,391
51.3302	148,125	138,073	67.1769	31,427	29,294	14.2526	14,827	13,821	6.7243	2,236
49.2476	217,758	202,981	98.7565	36,040	33,594	16.3447	11,338	10,569	5.1420	6,282
69.8612	234,959	219,015	106.5574	21,506	20,047	9.7533	10,776	10,045	4.8871	12,875
98.2912	326,525	304,367	148.0839	40,783	38,015	18.4957	19,449	18,129	8.8204	16,988
60.9351	133,232	124,191	60.4227	31,061	28,953	14.0866	10,041	9,360	4.5537	7,278
46.0816	263,921	246,011	119.6921	20,024	18,665	9.0812	15,783	14,712	7.1578	8,944
49.4023	140,721	131,172	63.8190	17,254	16,083	7.8249	24,264	22,617	11.0041	10,968
61.3846	148,899	138,795	67.5279	16,009	14,923	7.2603	17,282	16,109	7.8376	11,171
59.1370	110,204	102,726	49.9791	18,535	17,277	8.4059	25,755	24,007	11.6803	13,913
57.1020	67,379	62,807	30.5574	18,432	17,181	8.3592	15,630	14,569	7.0884	7,413
54.3565	89,215	83,161	40.4603	15,453	14,404	7.0082	15,426	14,379	6.9959	8,076
47.2467	128,373	119,662	58.2190	8,761	8,166	3.9732	18,316	17,073	8.3066	7,066
50.1515	149,782	139,618	67.9283	18,675	17,408	8.4694	12,439	11,595	5.6413	6,769
57.9079	173,536	161,760	78.7011	10,069	9,386	4.5664	15,738	14,670	7.1374	8,237
63.7211	114,121	106,377	51.7556	9,493	8,849	4.3052	14,079	13,124	6.3850	6,477
55.4317	109,838	102,384	49.8132	10,079	9,395	4.5710	2,717	2,533	1.2322	11,359
97.0195	159,329	148,517	72.2580	17,129	15,967	7.7683	4,154	3,872	1.8839	20,453
86.9429	244,772	228,162	111.0077	27,855	25,965	12.6327	4,854	4,525	2.2014	30,859
57.0821	224,959	209,693	102.0222	37,217	34,691	16.8785	12,074	11,255	5.4757	16,402
82.7379	379,046	353,324	171.9029	32,965	30,728	14.9501	15,770	14,700	7.1519	18,505

Table D7 (cont.)
The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Catfish in the Upper Mississippi River System

Pool 22 fish	Pool 22 tons	Pool 24 lbs	Pool 24 fish	Pool 24 tons	Pool 25 lbs	Pool 25 fish	Pool 25 tons	Pool 26 lbs	Pool 26 fish
11,155	5.4272	20,009	18,651	9.0744	43,421	40,474	19.6921	27,460	25,597
6,278	3.0544	50,196	46,790	22.7646	56,478	52,645	25.6136	56,224	52,409
6,973	3.3927	38,015	35,435	17.2404	85,578	79,771	38.8109	70,638	65,845
4,819	2.3447	43,472	40,522	19.7152	57,447	53,549	26.0531	46,099	42,971
11,704	5.6943	57,729	53,812	26.1810	99,726	92,959	45.2272	116,021	108,148
5,052	2.4580	48,821	45,508	22.1410	118,316	110,287	53.6580	99,452	92,703
13,686	6.6585	50,864	47,412	23.0676	47,910	44,659	21.7279	82,391	76,800
6,889	3.3519	41,384	38,576	18.7683	67,267	62,702	30.5066	75,501	70,378
2,084	1.0141	45,970	42,850	20.8481	58,855	54,861	26.6916	70,024	65,272
5,856	2.8490	35,780	33,352	16.2268	60,652	56,536	27.5066	74,119	69,089
12,001	5.8390	66,474	61,963	30.1469	74,998	69,909	34.0127	59,669	55,620
15,835	7.7043	95,780	89,280	43.4376	92,451	86,177	41.9279	117,109	109,162
6,784	3.3007	79,951	74,526	36.2590	69,619	64,895	31.5732	77,783	72,505
8,337	4.0562	72,415	67,501	32.8413	60,724	56,603	27.5392	73,380	68,400
10,224	4.9741	60,357	56,261	27.3728	80,608	75,138	36.5569	67,662	63,070
10,413	5.0662	30,117	28,073	13.6585	62,639	58,388	28.4077	103,647	96,614
12,969	6.3098	28,366	26,441	12.8644	63,628	59,310	28.8562	97,260	90,660
6,910	3.3619	13,415	12,505	6.0839	52,592	49,023	23.8512	90,970	84,797
7,528	3.6626	17,957	16,738	8.1438	36,185	33,729	16.4104	33,411	31,144
6,587	3.2045	21,880	20,395	9.9229	33,806	31,512	15.3315	29,312	27,323
6,310	3.0698	18,760	17,487	8.5079	42,684	39,787	19.3578	22,727	21,185
7,678	3.7356	34,408	32,073	15.6045	32,406	30,207	14.6966	59,043	55,036
6,037	2.9374	18,651	17,385	8.4585	30,338	28,279	13.7587	55,506	51,739
10,588	5.1515	8,483	7,907	3.8472	45,003	41,949	20.4095	75,233	70,128
19,065	9.2757	7,911	7,374	3.5878	24,586	22,918	11.1501	45,446	42,362
28,765	13.9950	22,167	20,663	10.0531	24,311	22,661	11.0254	82,742	77,127
15,289	7.4385	9,942	9,267	4.5088	29,650	27,638	13.4467	67,045	62,495
17,249	8.3923	37,728	35,168	17.1102	29,656	27,644	13.4494	133,346	124,297

Table D7 (cont.)

The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Catfish in the Upper Mississippi River System

Pool 26 tons
12.4535
25.4984
32.0354
20.9066
52.6172
45.1029
37.3655
34.2408
31.7569
33.6141
27.0608
53.1107
35.2757
33.2789
30.6857
47.0054
44.1088
41.2562
15.1524
13.2934
10.3070
26.7769
25.1728
34.1193
20.6104
37.5247
30.4059
60.4744

Table D8

The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Channel Catfish in the Upper Mississippi River System

Year	Pool 3 lbs	Pool 3 fish	Pool 3 tons	Pool 4 lbs	Pool 4 fish	Pool 4 tons	Pool 4a lbs	Pool 4a fish	Pool 4a tons	Pool 5 lbs	Pool 5 fish
1973	545	508	0.2472	5,645	5262	2.5601	17,752	16547	8.0508	11,008	10261
1974				13,053	12167	5.9197	15,250	14215	6.9161	4,363	4067
1975				9,223	8597	4.1828	18,673	17406	8.4685	9,143	8523
1976				9,668	9012	4.3846	12,112	11290	5.4930	19,114	17817
1977				10,100	9415	4.5805	9,828	9161	4.4571	16,250	15147
1978	47	44	0.0213	5,771	5379	2.6172	9,323	8690	4.2281	8,630	8044
1979	34	32	0.0154	2,717	2533	1.2322	8,505	7928	3.8571	7,419	6916
1980	166	155	0.0753	5,508	5134	2.4980	13,220	12323	5.9955	6,301	5873
1981	246	229	0.1116	10,334	9633	4.6866	17,621	16425	7.9914	13,334	12429
1982	332	309	0.1506	7,494	6985	3.3986	13,173	12279	5.9741	4,342	4047
1994	43	40	0.0195	8,075	7527	3.6621	2,362	2202	1.0712	1,578	1471
1995	367	342	0.1664	5,734	5345	2.6005	4,081	3804	1.8508	1,741	1623

Table D8 (cont.)

The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Channel Catfish in the Upper Mississippi River System

Pool 5 tons	Pool 5a lbs	Pool 5a fish	Pool 5a tons	Pool 6 lbs	Pool 6 fish	Pool 6 tons	Pool 7 lbs	Pool 7 fish	Pool 7 tons	Pool 8 lbs
4.9923	2,695	2512	1.2222	5,101	4755	2.3134	37,601	35049	17.0526	115,699
1.9787	4,547	4238	2.0621	823	767	0.3732	60,749	56627	27.5506	130,112
4.1465	2,814	2623	1.2762	940	876	0.4263	83,015	77382	37.6485	149,455
8.6685	2,912	2714	1.3206	1,283	1196	0.5819	56,212	52397	25.4930	182,479
7.3696	2,629	2451	1.1923	6,102	5688	2.7673	32,421	30221	14.7034	92,171
3.9138	4,328	4034	1.9628	17,363	16185	7.8744	31,013	28908	14.0649	90,442
3.3646	842	785	0.3819	8,029	7484	3.6413	39,227	36565	17.7900	64,038
2.8576	3,871	3608	1.7556	7,583	7068	3.4390	48,455	45167	21.9751	83,429
6.0472	2,573	2398	1.1669	10,466	9756	4.7465	44,436	41421	20.1524	66,845
1.9692	2,998	2795	1.3596	14,138	13179	6.4118	22,261	20750	10.0957	53,723
0.7156	3,247	3027	1.4726	6,734	6277	3.0540	59,001	54997	26.7578	59,084
0.7896	1,698	1583	0.7701	9,683	9026	4.3914	43,882	40904	19.9011	35,658

Table D8 (cont.)

The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Channel Catfish in the Upper Mississippi River System

Pool 8 fish	Pool 8 tons	Pool 9 lbs	Pool 9 fish	Pool 9 tons	Pool 10 lbs	Pool 10 fish	Pool 10 tons	Pool 11 lbs	Pool 11 fish	Pool 11 tons
107848	52.4712	94,903	88463	43.0399	48,323	45044	21.9152			
121283	59.0077	98,102	91445	44.4907	56,280	52461	25.5238			
139313	67.7800	84,377	78651	38.2662	60,368	56271	27.3778			
170096	82.7569	48,593	45295	22.0376	30,043	28004	13.6249			
85916	41.8009	48,133	44867	21.8290	33,283	31024	15.0943			
84305	41.0168	49,304	45958	22.3601	44,739	41703	20.2898			
59692	29.0422	21,086	19655	9.5628	34,499	32158	15.6458			
77768	37.8363	23,776	22163	10.7828	27,856	25966	12.6331			
62309	30.3152	20,077	18715	9.1052	29,799	27777	13.5143			
50077	24.3642	16,538	15416	7.5002	21,074	19644	9.5574			
55075	26.7955	254,539	237266	115.4372	133,978	124886	60.7610	89,872	83773	40.7583
33238	16.1714	272,952	254430	123.7878	114,295	106539	51.8345	104,872	97755	47.5610

Table D8 (cont.)

The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Channel Catfish in the Upper Mississippi River System

Pool 12 lbs	Pool 12 fish	Pool 12 tons	Pool 13 lbs	Pool 13 fish	Pool 13 tons	Pool 14 lbs	Pool 14 fish	Pool 14 tons	Pool 15 lbs	Pool 15 fish
61,030	56889	27.6780	231,370	215669	104.9297	124,139	115715	56.2989	43,159	40230
94,397	87991	42.8104	257,398	239931	116.7338	101,453	94568	46.0104	25,281	23565

Table D8 (cont.)

The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Channel Catfish in the Upper Mississippi River System

Pool 15 tons	Pool 16 lbs	Pool 16 fish	Pool 16 tons	Pool 17 lbs	Pool 17 fish	Pool 17 tons	Pool 18 lbs	Pool 18 fish	Pool 18 tons	Pool 19 lbs
19.5732	31,408	29277	14.2440	60,758	56635	27.5546	117,574	109595	53.3215	188,624
11.4653	22,808	21260	10.3438	57,643	53731	26.1420	123,820	115418	56.1542	158,084

Table D8 (cont.)
The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Channel Catfish in the Upper Mississippi River System

Pool 19 fish	Pool 19 tons	Pool 20 lbs	Pool 20 fish	Pool 20 tons	Pool 21 lbs	Pool 21 fish	Pool 21 tons	Pool 22 lbs	Pool 22 fish	Pool 22 tons
175824	85.5438	4,660	4344	2.1134	17,191	16024	7.7964	21,885	20400	9.9252
147356	71.6934	8,300	7737	3.7642	12,936	12058	5.8667	12,379	11539	5.6141

Table D8 (cont.)

The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Channel Catfish in the Upper Mississippi River System

Pool 24 lbs	Pool 24 fish	Pool 24 tons	Pool 25 lbs	Pool 25 fish	Pool 25 tons	Pool 26 lbs	Pool 26 fish	Pool 26 tons	Open River lbs
43,282	40345	19.6290	20,528	19135	9.3098	86,586	80710	39.2680	72,149
37,056	34541	16.8054	11,318	10550	5.1329	68,010	63395	30.8435	80,291

Table D8 (cont.)

The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Channel Catfish in the Upper Mississippi River System

Open River fish	Open River tons
67253	32.7206
74842	36.4132

Table D9
The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Flathead Catfish in the Upper Mississippi River System

Year	Pool 3 lbs	Pool 3 fish	Pool 3 tons	Pool 4 lbs	Pool 4 fish	Pool 4 tons	Pool 4a lbs	Pool 4a fish	Pool 4a tons	Pool 5 lbs	Pool 5 fish
1994	0	0	0.0000	3,119	2,431	1.4145	5,942	4,631	2.6948	2,853	2,224
1995	35	27	0.0159	1,215	947	0.5510	5,085	3,963	2.3061	2,568	2,002

Table D9 (cont.)
The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Flathead Catfish in the Upper Mississippi River System

Pool 5 tons	Pool 5a lbs	Pool 5a fish	Pool 5a tons	Pool 6 lbs	Pool 6 fish	Pool 6 tons	Pool 7 lbs	Pool 7 fish	Pool 7 tons	Pool 8 lbs
1.2939	3,329	2,595	1.5098	3,510	2,736	1.5918	4,709	3,670	2.1356	9,362
1.1646	2,486	1,938	1.1274	1,994	1,554	0.9043	1,566	1,221	0.7102	5,155

Table D9 (cont.)
The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Flathead Catfish in the Upper Mississippi River System

Pool 8 fish	Pool 8 tons	Pool 9 lbs	Pool 9 fish	Pool 9 tons	Pool 10 lbs	Pool 10 fish	Pool 10 tons	Pool 11 lbs	Pool 11 fish	Pool 11 tons
7,297	4.2458	13,608	10,606	6.1714	37,808	29,468	17.1465	9,966	7,768	4.5197
4,018	2.3379	17,226	13,426	7.8122	30,367	23,669	13.7719	17,855	13,917	8.0975

Table D9 (cont.)

The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Flathead Catfish in the Upper Mississippi River System

Pool 12 lbs	Pool 12 fish	Pool 12 tons	Pool 13 lbs	Pool 13 fish	Pool 13 tons	Pool 14 lbs	Pool 14 fish	Pool 14 tons	Pool 15 lbs
1,006	784	0.4562	21,584	16,823	9.7887	19,073	14,866	8.6499	6,470
4,078	3,178	1.8494	43,490	33,897	19.7234	17,705	13,800	8.0295	4,486

Table D9 (cont.)

The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Flathead Catfish in the Upper Mississippi River System

Pool 15 fish	Pool 15 tons	Pool 16 lbs	Pool 16 fish	Pool 16 tons	Pool 17 lbs	Pool 17 fish	Pool 17 tons	Pool 18 lbs	Pool 18 fish
5,043	2.9342	5,452	4,249	2.4726	18,942	14,764	8.5905	38,079	29,680
3,496	2.0345	5,379	4,193	2.4395	13,397	10,442	6.0757	22,755	17,736

Table D9 (cont.)
The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Flathead Catfish in the Upper Mississippi River System

Pool 18 tons	Pool 19 lbs	Pool 19 fish	Pool 19 tons	Pool 20 lbs	Pool 20 fish	Pool 20 tons	Pool 21 lbs	Pool 21 fish	Pool 21 tons
17.2694	25,876	20,168	11.7351	6,885	5,366	3.1224	8,645	6,738	3.9206
10.3197	35,536	27,698	16.1161	9,164	7,143	4.1560	6,726	5,242	3.0503

Table D9 (cont.)

The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Flathead Catfish in the Upper Mississippi River System

Pool 22 lbs	Pool 22 fish	Pool 22 tons	Pool 24 lbs	Pool 24 fish	Pool 24 tons	Pool 25 lbs	Pool 25 fish	Pool 25 tons	Pool 26 lbs
14,366	11,197	6.5152	14,347	11,182	6.5066	9,467	7,379	4.2934	23,482
3,689	2,875	1.6730	25,750	20,070	11.6780	8,343	6,503	3.7837	30,405

Table D9 (cont.)
The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Flathead Catfish in the Upper Mississippi River System

Pool 26 fish	Pool 26 tons	Open River lbs	Open River fish	Open River tons
18,302	10.6494	40,663	31,694	18.4413
23,698	13.7891	76,578	59,687	34.7293

Table D10
The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Blue Catfish in the Upper Mississippi River System

Year	Pool 3 lbs	Pool 3 fish	Pool 3 tons	Pool 4 lbs	Pool 4 fish	Pool 4 tons	Pool 4a lbs	Pool 4a fish	Pool 4a tons	Pool 5 lbs	Pool 5 fish
1994	0	0	0.0000	0	0	0.0000	0	0	0.0000	0	0
1995	0	0	0.0000	0	0	0.0000	0	0	0.0000	0	0

Table D10 (cont.)
The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Blue Catfish in the Upper Mississippi River System

Pool 5 tons	Pool 5a lbs	Pool 5a fish	Pool 5a tons	Pool 6 lbs	Pool 6 fish	Pool 6 tons	Pool 7 lbs	Pool 7 fish	Pool 7 tons	Pool 8 lbs
0.0000	0	0	0.0000	0	0	0.0000	0	0	0.0000	0
0.0000	0	0	0.0000	0	0	0.0000	0	0	0.0000	0

Table D10 (cont.)
The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Blue Catfish in the Upper Mississippi River System

Pool 8 fish	Pool 8 tons	Pool 9 lbs	Pool 9 fish	Pool 9 tons	Pool 10 lbs	Pool 10 fish	Pool 10 tons	Pool 11 lbs	Pool 11 fish	Pool 11 tons
0	0.0000	0	0	0.0000	0	0	0.0000	0	0	0.0000
0	0.0000	0	0	0.0000	0	0	0.0000	0	0	0.0000

Table D10 (cont.)
The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Blue Catfish in the Upper Mississippi River System

Pool 12 lbs	Pool 12 fish	Pool 12 tons	Pool 13 lbs	Pool 13 fish	Pool 13 tons	Pool 14 lbs	Pool 14 fish	Pool 14 tons	Pool 15 lbs
160	156	0.0726	1,624	1,580	0.7365	720	701	0.3265	100
200	195	0.0907	4,150	4,038	1.8821	120	117	0.0544	750

Table D10 (cont.)
The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Blue Catfish in the Upper Mississippi River System

Pool 15 fish	Pool 15 tons	Pool 16 lbs	Pool 16 fish	Pool 16 tons	Pool 17 lbs	Pool 17 fish	Pool 17 tons	Pool 18 lbs	Pool 18 fish	Pool 18 tons
97	0.0454	1,187	1,155	0.5383	150	146	0.0680	0	0	0.0000
730	0.3401	1,000	973	0.4535	1,200	1,168	0.5442	0	0	0.0000

Table D10 (cont.)
The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Blue Catfish in the Upper Mississippi River System

Pool 19 lbs	Pool 19 fish	Pool 19 tons	Pool 20 lbs	Pool 20 fish	Pool 20 tons	Pool 21 lbs	Pool 21 fish	Pool 21 tons	Pool 22 lbs	Pool 22 fish
0	0	0.0000	320	311	0.1451	500	486	0.2268	200	195
0	0	0.0000	1,205	1,172	0.5465	2,544	2,475	1.1537	789	768

Table D10 (cont.)
The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Blue Catfish in the Upper Mississippi River System

Pool 22 tons	Pool 24 lbs	Pool 24 fish	Pool 24 tons	Pool 25 lbs	Pool 25 fish	Pool 25 tons	Pool 26 lbs	Pool 26 fish	Pool 26 tons
0.0907	3,355	3,264	1.5215	697	678	0.3161	4,980	4,845	2.2585
0.3578	5,912	5,752	2.6812	1,601	1,558	0.7261	17,673	17,195	8.0150

Table D10 (cont.)
The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Blue Catfish in the Upper Mississippi River System

Open River lbs	Open River fish	Open River tons
107,487	104,580	48.7469
103,911	101,100	47.1252

Table D11
The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Crappie in the Upper Mississippi River System

Year	Pool 3 lbs	Pool 3 fish	Pool 3 tons	Pool 4 lbs	Pool 4 fish	Pool 4 tons	Pool 7 lbs	Pool 7 fish	Pool 7 tons	Pool 8 lbs	Pool 8 fish
1961	240	2,400	0.1088	2,100	21,000	0.9524	400	4,000	0.1814		
1962							4,200	42,000	1.9048	892	8,920
1963											
1967										168	1,680

Table D11 (cont.)
The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Crappie in the Upper Mississippi River System

Pool 8 tons	Pool 9 lbs	Pool 9 fish	Pool 9 tons	Pool 10 lbs	Pool 10 fish	Pool 10 tons	Pool 11 lbs	Pool 11 fish	Pool 11 tons	Pool 12 lbs
	780	7,800	0.3537	7,189	71,890	3.2603	100	1,000	0.0454	17
0.4045	464	4,640	0.2104	8,907	89,070	4.0395	45	450	0.0204	
	842	8,420	0.3819	1,034	10,340	0.4689				
0.0762										

Table D11 (cont.)
The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Crappie in the Upper Mississippi River System

Pool 12 fish	Pool 12 tons	Pool 13 lbs	Pool 13 fish	Pool 13 tons
170	0.0077	50	500	0.0227
		675	6,750	0.3061

Table D12

The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Freshwater Drum in the Upper Mississippi River System

Year	Pool 3 lbs	Pool 3 fish	Pool 3 tons	Pool 4 lbs	Pool 4 fish	Pool 4 tons	Pool 4a lbs	Pool 4a fish	Pool 4a tons	Pool 5 lbs	Pool 5 fish
1953	5,422	2,711	2.4590	32,042	16,021	14.5315	88,218	44,109	40.0082	10,025	5,013
1954	3,689	1,845	1.6730	71,172	35,586	32.2776	116,530	58,265	52.8481	27,560	13,780
1955	3,542	1,771	1.6063	62,266	31,133	28.2385	100,703	50,352	45.6703	12,858	6,429
1956	29,937	14,969	13.5769	33,695	16,848	15.2812	84,254	42,127	38.2104	6,427	3,214
1957	1,154	577	0.5234	9,643	4,822	4.3732	71,957	35,979	32.6336	31,256	15,628
1958	186	93	0.0844	14,484	7,242	6.5687	120,165	60,083	54.4966	27,633	13,817
1959	1,061	531	0.4812	19,341	9,671	8.7714	53,050	26,525	24.0590	13,735	6,868
1960	6,240	3,120	2.8299	18,246	9,123	8.2748	46,560	23,280	21.1156	20,922	10,461
1961	2,887	1,444	1.3093	15,011	7,506	6.8077	35,157	17,579	15.9442	14,490	7,245
1962	2,607	1,304	1.1823	14,888	7,444	6.7519	26,455	13,228	11.9977	10,840	5,420
1963	1,283	642	0.5819	2,386	1,193	1.0821	37,061	18,531	16.8077	3,113	1,557
1964	1,732	866	0.7855	3,433	1,717	1.5569	47,807	23,904	21.6812	7,396	3,698
1965	327	164	0.1483	2,858	1,429	1.2961	38,522	19,261	17.4703	8,210	4,105
1966	540	270	0.2449	2,948	1,474	1.3370	67,235	33,618	30.4921	1,777	889
1967	1,492	746	0.6766	2,312	1,156	1.0485	224,332	112,166	101.7379	940	470
1968	2,558	1,279	1.1601	13,213	6,607	5.9923	302,959	151,480	137.3964	599	300
1969	2,951	1,476	1.3383	2,603	1,302	1.1805	18,155	9,078	8.2336	9,986	4,993
1970	5,492	2,746	2.4907	3,919	1,960	1.7773	186,029	93,015	84.3669	6,953	3,477
1971	594	297	0.2694	2,617	1,309	1.1868	187,865	93,933	85.1995	3,129	1,565
1972	1,449	725	0.6571	2,092	1,046	0.9488	101,128	50,564	45.8630	29,180	14,590
1973	137	69	0.0621	3,280	1,640	1.4875	60,836	30,418	27.5900	10,605	5,303
1974	913	457	0.4141	4,771	2,386	2.1637	55,587	27,794	25.2095	12,500	6,250
1975	25	13	0.0113	2,871	1,436	1.3020	113,522	56,761	51.4839	5,983	2,992
1976	1,570	785	0.7120	2,133	1,067	0.9673	22,566	11,283	10.2340	28,172	14,086
1977	155	78	0.0703	13,371	6,686	6.0639	5,002	2,501	2.2685	3,610	1,805
1978	876	438	0.3973	7,459	3,730	3.3828	50,423	25,212	22.8676	25,211	12,606
1979							3,199	1,600	1.4508	4,827	2,414
1980							5,902	2,951	2.6766	10,242	5,121
1981	435	218	0.1973	806	403	0.3655	54,356	27,178	24.6512	2,776	1,388
1982				18,276	9,138	8.2884	9,385	4,693	4.2562	62,329	31,165
1983	1,900	950	0.8617	917	459	0.4159	92,373	46,187	41.8925	122,206	61,103
1988	3,054	1,527	1.3850	762	381	0.3456	22,728	11,364	10.3075	13,089	6,545
1994				7,153	3,577	3.2440	11,868	5,934	5.3823	79,651	39,826
1995	935	468	0.4240	78	39	0.0354	26,541	13,271	12.0367	13,003	6,502

Table D12 (cont.)
The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Freshwater Drum in the Upper Mississippi River System

Pool 5 tons	Pool 5a lbs	Pool 5a fish	Pool 5a tons	Pool 6 lbs	Pool 6 fish	Pool 6 tons	Pool 7 lbs	Pool 7 fish	Pool 7 tons	Pool 8 lbs	Pool 8 fish
4.5465	13,572	6,786	6.1551	4,549	2,275	2.0630	8,387	4,194	3.8036	27,807	13,904
12.4989	17,929	8,965	8.1311	4,166	2,083	1.8893	11,822	5,911	5.3615	16,168	8,084
5.8313	5,045	2,523	2.2880	4,129	2,065	1.8726	10,757	5,379	4.8785	32,633	16,317
2.9147	9,550	4,775	4.3311	10,130	5,065	4.5941	14,549	7,275	6.5982	62,357	31,179
14.1751	8,432	4,216	3.8240	7,101	3,551	3.2204	24,970	12,485	11.3243	102,501	51,251
12.5320	2,092	1,046	0.9488	4,753	2,377	2.1556	16,145	8,073	7.3220	65,038	32,519
6.2290	4,417	2,209	2.0032	4,521	2,261	2.0503	15,448	7,724	7.0059	99,311	49,656
9.4884	4,767	2,384	2.1619	4,631	2,316	2.1002	23,044	11,522	10.4508	92,925	46,463
6.5714	5,391	2,696	2.4449	8,630	4,315	3.9138	27,807	13,904	12.6109	129,146	64,573
4.9161	37,663	18,832	17.0807	5,722	2,861	2.5950	80,097	40,049	36.3252	137,251	68,626
1.4118	10,922	5,461	4.9533	6,382	3,191	2.8943	51,953	25,977	23.5615	131,655	65,828
3.3542	1,907	954	0.8649	8,898	4,449	4.0354	60,678	30,339	27.5184	194,395	97,198
3.7234	15,793	7,897	7.1624	10,161	5,081	4.6082	116,012	58,006	52.6132	139,283	69,642
0.8059	13,751	6,876	6.2363	8,313	4,157	3.7701	33,019	16,510	14.9746	161,195	80,598
0.4263	5,550	2,775	2.5170	9,228	4,614	4.1850	102,135	51,068	46.3197	286,062	143,031
0.2717	32,158	16,079	14.5841	19,026	9,513	8.6286	184,043	92,022	83.4662	165,443	82,722
4.5288	15,328	7,664	6.9515	2,439	1,220	1.1061	34,238	17,119	15.5274	100,124	50,062
3.1533	27,768	13,884	12.5932	3,617	1,809	1.6404	233,438	116,719	105.8676	132,199	66,100
1.4190	23,363	11,682	10.5955	19,606	9,803	8.8916	72,161	36,081	32.7261	164,229	82,115
13.2336	23,074	11,537	10.4644	4,989	2,495	2.2626	27,653	13,827	12.5410	231,461	115,731
4.8095	28,554	14,277	12.9497	16,073	8,037	7.2893	56,854	28,427	25.7841	182,548	91,274
5.6689	32,323	16,162	14.6590	2,037	1,019	0.9238	82,790	41,395	37.5465	70,871	35,436
2.7134	15,298	7,649	6.9379	18,838	9,419	8.5433	70,038	35,019	31.7633	81,408	40,704
12.7764	14,181	7,091	6.4313	7,168	3,584	3.2508	34,172	17,086	15.4975	165,484	82,742
1.6372	14,880	7,440	6.7483	1,220	610	0.5533	24,165	12,083	10.9592	397,505	198,753
11.4336	9,572	4,786	4.3410	7,786	3,893	3.5311	84,063	42,032	38.1238	256,375	128,188
2.1891	1,643	822	0.7451	2,264	1,132	1.0268	28,058	14,029	12.7247	105,019	52,510
4.6449	2,192	1,096	0.9941	3,047	1,524	1.3819	24,468	12,234	11.0966	298,802	149,401
1.2590	7,510	3,755	3.4059	2,111	1,056	0.9574	37,786	18,893	17.1365	408,014	204,007
28.2671	4,856	2,428	2.2023	2,622	1,311	1.1891	21,948	10,974	9.9537	167,462	83,731
55.4222	13,389	6,695	6.0721	3,148	1,574	1.4277	11,842	5,921	5.3705	243,235	121,618
5.9361	33,978	16,989	15.4095	97,734	48,867	44.3238	11,401	5,701	5.1705	205,742	102,871
36.1229	6,454	3,227	2.9270	37,032	18,516	16.7946	127,703	63,852	57.9152	322,221	161,111
5.8971	45,076	22,538	20.4426	39,388	19,694	17.8630	114,008	57,004	51.7043	208,572	104,286

Table D12 (cont.)

The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Freshwater Drum in the Upper Mississippi River System

Pool 8 tons	Pool 9 lbs	Pool 9 fish	Pool 9 tons	Pool 10 lbs	Pool 10 fish	Pool 10 tons	Pool 11 lbs	Pool 11 fish	Pool 11 tons	Pool 12 lbs
12.6109	71,783	35,892	32.5546	3,837	1,919	1.7401	9,438	4,719	4.2803	66,602
7.3324	127,828	63,914	57.9719	25,204	12,602	11.4304	33,254	16,627	15.0812	30,984
14.7995	201,579	100,790	91.4190	22,692	11,346	10.2912	44,070	22,035	19.9864	28,774
28.2798	160,721	80,361	72.8893	29,169	14,585	13.2286	103,299	51,650	46.8476	26,341
46.4857	234,970	117,485	106.5624	30,587	15,294	13.8717	43,518	21,759	19.7361	18,292
29.4957	142,449	71,225	64.6027	47,152	23,576	21.3841	111,852	55,926	50.7265	28,839
45.0390	141,594	70,797	64.2150	48,160	24,080	21.8413	39,052	19,526	17.7107	15,098
42.1429	184,888	92,444	83.8494	78,693	39,347	35.6884	21,031	10,516	9.5379	13,116
58.5696	199,134	99,567	90.3102	132,346	66,173	60.0209	45,224	22,612	20.5098	34,377
62.2454	151,354	75,677	68.6413	18,385	9,193	8.3379	29,800	14,900	13.5147	35,665
59.7075	263,448	131,724	119.4776	57,604	28,802	26.1243	74,942	37,471	33.9873	15,094
88.1610	272,446	136,223	123.5583	29,284	14,642	13.2807	57,823	28,912	26.2236	13,516
63.1669	300,239	150,120	136.1628	23,786	11,893	10.7873	38,282	19,141	17.3615	12,489
73.1043	308,338	154,169	139.8358	64,986	32,493	29.4721	76,788	38,394	34.8245	26,950
129.7333	294,694	147,347	133.6481	76,322	38,161	34.6132	123,470	61,735	55.9955	30,602
75.0308	273,910	136,955	124.2222	56,478	28,239	25.6136	51,563	25,782	23.3846	34,203
45.4077	497,947	248,974	225.8263	76,692	38,346	34.7810	59,566	29,783	27.0141	18,982
59.9542	527,123	263,562	239.0580	55,027	27,514	24.9556	60,400	30,200	27.3923	12,121
74.4803	585,985	292,993	265.7528	81,672	40,836	37.0395	53,090	26,545	24.0771	16,724
104.9710	526,446	263,223	238.7510	118,594	59,297	53.7841	46,037	23,019	20.8785	28,898
82.7882	588,936	294,468	267.0912	76,935	38,468	34.8912	43,306	21,653	19.6399	19,614
32.1410	481,208	240,604	218.2349	112,052	56,026	50.8172	94,450	47,225	42.8345	24,968
36.9197	341,542	170,771	154.8943	79,392	39,696	36.0054	106,957	53,479	48.5066	15,674
75.0494	317,064	158,532	143.7932	138,560	69,280	62.8390	73,335	36,668	33.2585	36,639
180.2744	192,832	96,416	87.4522	76,313	38,157	34.6091	64,817	32,409	29.3955	12,952
116.2698	300,206	150,103	136.1478	60,649	30,325	27.5052	40,268	20,134	18.2621	10,255
47.6277	241,972	120,986	109.7379	27,492	13,746	12.4680				
135.5111	51,451	25,726	23.3338	17,798	8,899	8.0717				
185.0404	123,816	61,908	56.1524	42,012	21,006	19.0531				
75.9465	114,848	57,424	52.0853	10,845	5,423	4.9184				
110.3107	248,573	124,287	112.7315	67,037	33,519	30.4023	30,862	15,431	13.9964	32,436
93.3070	290,274	145,137	131.6435	117,029	58,515	53.0744	62,666	31,333	28.4200	23,643
146.1320	490,663	245,332	222.5229	81,977	40,989	37.1778	70,281	35,141	31.8735	12,902
94.5905	766,409	383,205	347.5778	166,961	83,481	75.7193	48,388	24,194	21.9447	21,872

Table D12 (cont.)

The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Freshwater Drum in the Upper Mississippi River System

Pool 12 fish	Pool 12 tons	Pool 13 lbs	Pool 13 fish	Pool 13 tons	Pool 14 lbs	Pool 14 fish	Pool 14 tons	Pool 15 lbs	Pool 15 fish	Pool 15 tons
33,301	30.2050	11,217	5,609	5.0871	9,786	4,893	4.4381	2,700	1,350	1.2245
15,492	14.0517	18,928	9,464	8.5841	22,968	11,484	10.4163	3,903	1,952	1.7701
14,387	13.0494	46,423	23,212	21.0535	27,357	13,679	12.4068	4,243	2,122	1.9243
13,171	11.9460	47,411	23,706	21.5016	17,134	8,567	7.7705	4,499	2,250	2.0404
9,146	8.2957	39,872	19,936	18.0825	30,046	15,023	13.6263	5,385	2,693	2.4422
14,420	13.0789	90,661	45,331	41.1161	27,836	13,918	12.6240	5,897	2,949	2.6744
7,549	6.8472	50,756	25,378	23.0186	39,128	19,564	17.7451	9,541	4,771	4.3270
6,558	5.9483	74,381	37,191	33.7329	41,509	20,755	18.8249	49,930	24,965	22.6440
17,189	15.5905	53,199	26,600	24.1265	37,225	18,613	16.8821	7,569	3,785	3.4327
17,833	16.1746	51,045	25,523	23.1497	21,959	10,980	9.9587	7,966	3,983	3.6127
7,547	6.8454	33,163	16,582	15.0399	12,870	6,435	5.8367	3,202	1,601	1.4522
6,758	6.1297	49,818	24,909	22.5932	34,036	17,018	15.4358	7,226	3,613	3.2771
6,245	5.6639	52,491	26,246	23.8054	14,740	7,370	6.6848	22,097	11,049	10.0213
13,475	12.2222	27,209	13,605	12.3397	42,827	21,414	19.4227	7,519	3,760	3.4100
15,301	13.8785	64,719	32,360	29.3510	45,943	22,972	20.8358	8,130	4,065	3.6871
17,102	15.5116	34,437	17,219	15.6177	34,105	17,053	15.4671	8,951	4,476	4.0594
9,491	8.6086	29,606	14,803	13.4268	22,119	11,060	10.0313	10,511	5,256	4.7669
6,061	5.4971	77,060	38,530	34.9478	23,724	11,862	10.7592	1,014	507	0.4599
8,362	7.5846	66,186	33,093	30.0163	26,460	13,230	12.0000	5,622	2,811	2.5497
14,449	13.1057	82,502	41,251	37.4159	46,563	23,282	21.1170	17,421	8,711	7.9007
9,807	8.8952	85,843	42,922	38.9311	17,669	8,835	8.0132	9,635	4,818	4.3696
12,484	11.3234	97,786	48,893	44.3474	48,902	24,451	22.1778	19,817	9,909	8.9873
7,837	7.1084	68,408	34,204	31.0240	22,426	11,213	10.1705	21,589	10,795	9.7909
18,320	16.6163	73,314	36,657	33.2490	20,174	10,087	9.1492	6,424	3,212	2.9134
6,476	5.8739	87,080	43,540	39.4921	8,135	4,068	3.6893	6,782	3,391	3.0757
5,128	4.6508	98,830	49,415	44.8209	18,799	9,400	8.5256	4,231	2,116	1.9188
16,218	14.7102	96,623	48,312	43.8200	36,950	18,475	16.7574	15,303	7,652	6.9401
11,822	10.7224	160,831	80,416	72.9392	47,146	23,573	21.3814	38,032	19,016	17.2481
6,451	5.8512	72,649	36,325	32.9474	71,140	35,570	32.2630	82,962	41,481	37.6245
10,936	9.9193	114,176	57,088	51.7805	50,700	25,350	22.9932	98,531	49,266	44.6853

Table D12 (cont.)
The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Freshwater Drum in the Upper Mississippi River System

Pool 16 lbs	Pool 16 fish	Pool 16 tons	Pool 17 lbs	Pool 17 fish	Pool 17 tons	Pool 18 lbs	Pool 18 fish	Pool 18 tons	Pool 19 lbs	Pool 19 fish
4,650	2,325	2.1088	29,190	14,595	13.2381	24,520	12,260	11.1202	72,345	36,173
14,476	7,238	6.5651	22,565	11,283	10.2336	60,122	30,061	27.2662	77,327	38,664
4,638	2,319	2.1034	20,788	10,394	9.4277	197,006	98,503	89.3451	193,296	96,648
2,610	1,305	1.1837	42,038	21,019	19.0649	140,265	70,133	63.6122	137,512	68,756
9,286	4,643	4.2113	17,575	8,788	7.9705	145,384	72,692	65.9338	109,135	54,568
9,674	4,837	4.3873	33,613	16,807	15.2440	84,673	42,337	38.4005	239,267	119,634
14,163	7,082	6.4231	90,630	45,315	41.1020	270,355	135,178	122.6100	257,303	128,652
19,421	9,711	8.8077	95,773	47,887	43.4345	181,290	90,645	82.2177	96,936	48,468
15,636	7,818	7.0912	30,754	15,377	13.9474	76,930	38,465	34.8889	93,011	46,506
35,647	17,824	16.1664	9,638	4,819	4.3710	57,320	28,660	25.9955	90,557	45,279
3,333	1,667	1.5116	7,491	3,746	3.3973	58,393	29,197	26.4821	186,647	93,324
16,205	8,103	7.3492	19,670	9,835	8.9206	124,404	62,202	56.4190	202,644	101,322
39,854	19,927	18.0744	58,429	29,215	26.4984	51,494	25,747	23.3533	75,550	37,775
11,485	5,743	5.2086	124,949	62,475	56.6662	72,991	36,496	33.1025	142,763	71,382
43,536	21,768	19.7442	70,814	35,407	32.1152	36,247	18,124	16.4385	68,172	34,086
8,228	4,114	3.7315	59,924	29,962	27.1764	63,472	31,736	28.7855	120,066	60,033
28,531	14,266	12.9392	77,691	38,846	35.2340	116,057	58,029	52.6336	76,205	38,103
39,191	19,596	17.7737	31,957	15,979	14.4930	152,761	76,381	69.2794	127,360	63,680
33,499	16,750	15.1923	28,027	14,014	12.7107	90,789	45,395	41.1741	86,345	43,173
66,797	33,399	30.2934	76,245	38,123	34.5782	86,272	43,136	39.1256	97,800	48,900
34,369	17,185	15.5868	107,213	53,607	48.6227	105,628	52,814	47.9039	102,907	51,454
65,610	32,805	29.7551	23,695	11,848	10.7460	142,678	71,339	64.7066	120,222	60,111
24,238	12,119	10.9923	42,801	21,401	19.4109	134,165	67,083	60.8458	83,094	41,547
14,702	7,351	6.6676	64,361	32,181	29.1887	77,491	38,746	35.1433	40,901	20,451
5,978	2,989	2.7111	106,317	53,159	48.2163	106,675	53,338	48.3787	23,577	11,789
32,707	16,354	14.8331	59,545	29,773	27.0045	131,991	65,996	59.8599	56,053	28,027
34,186	17,093	15.5039	16,993	8,497	7.7066	79,775	39,888	36.1791	46,816	23,408
42,173	21,087	19.1261	68,036	34,018	30.8553	106,179	53,090	48.1537	343,292	171,646
13,793	6,897	6.2553	25,141	12,571	11.4018	43,398	21,699	19.6816	104,534	52,267
15,239	7,620	6.9111	33,516	16,758	15.2000	56,098	28,049	25.4413	72,165	36,083

Table D12 (cont.)
The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Freshwater Drum in the Upper Mississippi River System

Pool 19 tons	Pool 20 lbs	Pool 20 fish	Pool 20 tons	Pool 21 lbs	Pool 21 fish	Pool 21 tons	Pool 22 lbs	Pool 22 fish	Pool 22 tons	Pool 24 lbs
32.8095	11,667	5,834	5.2912	23,983	11,992	10.8766	16,262	8,131	7.3751	16,845
35.0689	8,860	4,430	4.0181	21,185	10,593	9.6077	9,139	4,570	4.1447	53,253
87.6626	14,441	7,221	6.5492	7,656	3,828	3.4721	10,959	5,480	4.9701	63,785
62.3637	22,111	11,056	10.0277	12,551	6,276	5.6921	21,807	10,904	9.8898	51,112
49.4943	8,199	4,100	3.7184	22,106	11,053	10.0254	8,003	4,002	3.6295	50,003
108.5111	8,205	4,103	3.7211	97,193	48,597	44.0785	16,188	8,094	7.3415	26,037
116.6907	33,687	16,844	15.2776	13,610	6,805	6.1723	23,092	11,546	10.4726	40,521
43.9619	43,310	21,655	19.6417	10,143	5,072	4.6000	5,222	2,611	2.3683	17,419
42.1819	28,175	14,088	12.7778	11,857	5,929	5.3773	2,403	1,202	1.0898	39,067
41.0689	46,321	23,161	21.0073	5,801	2,901	2.6308	7,610	3,805	3.4512	26,672
84.6472	19,547	9,774	8.8649	35,438	17,719	16.0717	21,121	10,561	9.5787	69,291
91.9020	27,329	13,665	12.3941	27,548	13,774	12.4934	88,965	44,483	40.3469	50,933
34.2630	55,067	27,534	24.9737	9,421	4,711	4.2726	17,319	8,660	7.8544	66,461
64.7451	46,241	23,121	20.9710	14,698	7,349	6.6658	5,942	2,971	2.6948	64,727
30.9170	21,029	10,515	9.5370	12,970	6,485	5.8821	28,597	14,299	12.9692	49,329
54.4517	10,745	5,373	4.8730	21,774	10,887	9.8748	15,442	7,721	7.0032	16,275
34.5601	31,151	15,576	14.1274	19,280	9,640	8.7438	29,553	14,777	13.4027	69,173
57.7596	36,004	18,002	16.3283	27,184	13,592	12.3283	24,326	12,163	11.0322	40,943
39.1587	30,881	15,441	14.0050	34,485	17,243	15.6395	14,976	7,488	6.7918	29,080
44.3537	9,020	4,510	4.0907	21,673	10,837	9.8290	17,665	8,833	8.0113	43,031
46.6698	35,765	17,883	16.2200	15,410	7,705	6.9887	12,085	6,043	5.4807	74,793
54.5224	10,877	5,439	4.9329	16,000	8,000	7.2562	10,487	5,244	4.7560	58,469
37.6844	5,825	2,913	2.6417	19,153	9,577	8.6862	5,552	2,776	2.5179	16,028
18.5492	7,551	3,776	3.4245	2,397	1,199	1.0871	26,143	13,072	11.8562	5,130
10.6925	6,331	3,166	2.8712	1,980	990	0.8980	5,955	2,978	2.7007	2,900
25.4209	12,329	6,165	5.5914	1,336	668	0.6059	3,296	1,648	1.4948	8,242
21.2317	18,719	9,360	8.4893	1,442	721	0.6540	6,333	3,167	2.8721	6,882
155.6880	37,412	18,706	16.9669	8,978	4,489	4.0717	22,298	11,149	10.1125	18,085
47.4077	9,700	4,850	4.3991	2,324	1,162	1.0540	2,310	1,155	1.0476	9,530
32.7279	6,787	3,394	3.0780	3,000	1,500	1.3605	3,756	1,878	1.7034	9,327

Table D12 (cont.)

The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Freshwater Drum in the Upper Mississippi River System

Pool 24 fish	Pool 24 tons	Pool 25 lbs	Pool 25 fish	Pool 25 tons	Pool 26 lbs	Pool 26 fish	Pool 26 tons	Open River lbs	Open River fish
8,423	7.6395	87,444	43,722	39.6571	26,903	13,452	12.2009		
26,627	24.1510	59,983	29,992	27.2032	73,735	36,868	33.4399		
31,893	28.9274	54,145	27,073	24.5556	78,670	39,335	35.6780		
25,556	23.1800	51,576	25,788	23.3905	39,460	19,730	17.8957		
25,002	22.6771	77,669	38,835	35.2240	61,663	30,832	27.9651		
13,019	11.8082	104,037	52,019	47.1823	46,411	23,206	21.0481		
20,261	18.3769	64,102	32,051	29.0712	86,178	43,089	39.0830		
8,710	7.8998	85,012	42,506	38.5542	49,134	24,567	22.2830		
19,534	17.7175	75,065	37,533	34.0431	23,996	11,998	10.8825		
13,336	12.0961	57,265	28,633	25.9705	15,627	7,814	7.0871		
34,646	31.4245	56,229	28,115	25.5007	24,040	12,020	10.9025		
25,467	23.0989	97,014	48,507	43.9973	23,125	11,563	10.4875		
33,231	30.1410	72,472	36,236	32.8671	13,645	6,823	6.1882		
32,364	29.3546	94,325	47,163	42.7778	18,898	9,449	8.5705		
24,665	22.3714	117,099	58,550	53.1061	15,038	7,519	6.8200		
8,138	7.3810	41,723	20,862	18.9220	18,933	9,467	8.5864		
34,587	31.3710	38,347	19,174	17.3909	17,197	8,599	7.7991		
20,472	18.5683	78,649	39,325	35.6685	16,484	8,242	7.4757		
14,540	13.1882	52,072	26,036	23.6154	7,330	3,665	3.3243		
21,516	19.5152	37,095	18,548	16.8231	45,062	22,531	20.4363		
37,397	33.9197	52,559	26,280	23.8363	3,780	1,890	1.7143		
29,235	26.5166	37,806	18,903	17.1456	10,007	5,004	4.5383		
8,014	7.2689	42,190	21,095	19.1338	28,185	14,093	12.7823		
2,565	2.3265	21,517	10,759	9.7583	27,015	13,508	12.2517		
1,450	1.3152	15,223	7,612	6.9039	7,632	3,816	3.4612		
4,121	3.7379	10,282	5,141	4.6630	24,199	12,100	10.9746		
3,441	3.1211	14,790	7,395	6.7075	11,633	5,817	5.2757		
9,043	8.2018	13,074	6,537	5.9293	23,359	11,680	10.5937		
4,765	4.3220	6,467	3,234	2.9329	7,643	3,822	3.4662	25,569	12,785
4,664	4.2299	3,170	1,585	1.4376	16,749	8,375	7.5959	23,926	11,963

Table D12 (cont.)
The Annual Commercial Catch (Pounds, Fish, and Metric Tons) of Freshwater Drum in the Upper Mississippi River System

Open River tons
11.5959
10.8508

Appendix E
Fish Entrainment Models: Instructions, Model Code, Data Sets, and Results (on CD)[1]

UMR-IWW System Navigation Study Larval Fish Entrainment Mortality Model Instructions

The larval fish entrainment model was developed using Digital's Visual FORTRAN 5.0 Developer Studio. Access to and familiarity with this software greatly facilitate the use of the model. The CD includes the files necessary to execute the larval fish entrainment model used to produce the results presented in this report. All files needed to run the model are located in the directory named Models. To run the model, several directories must first be created on c:\ drive:

1) Create the directory: c:\nav_study\fish_models

   Copy the following files into the above directory from the CD:

gofish.exe	the fish model executable file,
P_cntrl.dat	a control file that you edit to set up a simulation,
river.dat	pool volumes for low, medium, and high stages,
fsh_bas.out	results file for 1992 baseline impacts,
fsh_scn.out	results file for % increase scenarios,
fsh_scn.dlt	results file of incremental impacts,
nav_fish.dbg	general dubugging information file.

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[1] References cited in this Appendix are included in the References at the end of the main text.

2) Create the directory: c:\nav_study\fish_data

Copy all the fish data files into this directory from the CD.
These files contain the data described for each fish species in Appendix A.

3) Create the directory: c:\nav_study\traffic

Copy the following files into the above directory from the CD:

tr_scen.dat	the tows/day files for the 1992 baseline and % increase traffic scenarios for each pool,
um_tchar.out	mean and sd values of entrainment rate and vessel speeds per pool and month,
mo_pdis.dat	probability of different stage heights for UMR-IWW System pool.

4) Create the directory: c:\nav_study\results

This directory is used to store the results for each species after each model simulation.

5) Once the directories have been properly established and the files copied, the user should be able to execute the model from within the c:\nav_study\fish_model directory by entering:

gofish followed by a carriage return, <CR>, i.e., the "Enter" key

6) To run the model for a particular species, the P_cntrl.dat file must be edited. For each species, change the name of the data set file on line 5 (see below) and save the file.

7) After each model run, rename the fsh_bas.out, fsh_scn.out, and fsh_scn.dlt for the species that was run. For example, rename the fsh_bas.out to whitecrappie_bas.out. These files must be renamed after each model run since the results of the most recent simulation are placed into these files, replacing previous results. Move all the results files to the Results directory (easiest done in Windows Explorer or File Manager).

The following lists the P_cntrl.dat file that is used to set up the simulation. For purposes of this report, the user would only have the opportunity to select the fish species to be modeled or the number of pools. This example points to the fish data file for the white crappie; consult the c:\nav_study\fish_data\ directory to learn the file names for the other species.

```
Control file for Nav_Fish computations
Number of pools: 31 (Range:1-37)
Debug flag:   0  (0=no debug, 1=print debug file)
File designating the fish species to be modeled
c:\nav_study\fish_data\whitecrappie.dat
```

File designating traffic input data
c:\nav_study\traffic\tr_scen.dat
File designating fleet characteristics (Q_p, V_a)
c:\nav_study\traffic\um_tchar.out
File designating pool information
c:\nav_study\fish_models\river.dat
File designating monthly discharge probabilities
c:\nav_study\traffic\mo_pdis.dat
Number of standard deviations assigned to Q_p and V_a
SD's:1.0

Note that Pool 1 identifies Upper St. Anthony's Falls, not Pool 1. Pool 37 identifies the T. J. O'Brien Pool on the Illinois Waterway. The current assessment addresses mainly UMR Pools 4-27 and the IWW La Grange Pool.

For questions or technical support concerning this code, contact:

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sbartell@cadmusgroup.com

Instructions for Reading Model Results

The CD contains the results of the model simulations for all 30 species in a directory called Results. All of the files are in ASCII format. They are best read using MS-DOS; however, they can be opened using any type of software that can open files in ASCII format. In all of the tabulated results, the mean result refers to impacts estimated using the mean entrainment rates determined from the exposure assessment; the HQLS corresponds to the higher larval mortality rates produced by vessels with high entrainment rates traveling at slower speeds; and the LQHS identifies results obtained using the combination of lower entrainment rate and higher vessel speeds. For all of the results: Dlrv = the number of larvae entrained; Percent = the percent of total available larvae entrained; Rs*T = monthly survivorship; CEM = condition entrainment mortality for the spawning season/year; EAL = equivalent adult fish lost; Rec_Frgn = recruitment forgone, number of fish; and Prd_Frgn = production forgone in tons per year.

There are three files for each species: _bas.out, _scn.out, and _scn.dlt. The _bas.out file contains the results for the baseline traffic scenario (1992) for each month for each pool in which the species occurs, with the CEM summed over the spawning season. The _scn.out file contains the results for the 25, 50, 75, and 100 percent increase in traffic scenarios for each month for each pool in which the species occurs, with the CEM summed over the spawning season. The _scn.dlt file contains the incremental (scenario minus baseline) results for the 25, 50, 75, and 100 percent increase in traffic scenarios for each month for each pool in which the species occurs. All results are summed for the spawning season. In addition, EAL, RF, and PF are summed for each scenario for the UMR, the IWW, and the UMR-IWW System.