IEPA ATTACHMENT NO. LL

THE UPPER ILLINOIS WATERWAY STUDY
INTERIM REPORT

1994 ICHTHYOPLANKTON INVESTIGATION
RM 276.2-321.7

Prepared for:

Commonwealth Edison Company
Environmental Services
One First National Plaza
Chicago, Illinois 60690

Prepared by:

EA Engineering, Science, and Technology
444 Lake Cook Road, Suite 18
Deerfield, IL 60015

April 1995

THE UPPER ILLINOIS WATERWAY STUDY INTERIM REPORT

1994 ICHTHYOPLANKTON INVESTIGATION RM 276.2-321.7

Prepared for:

Commonwealth Edison Company
Environmental Services
One First National Plaza
Chicago, Illinois 60690

Prepared by:

EA Engineering, Science, and Technology
444 Lake Cook Road, Suite 18
Deerfield, IL 60015

Joe Vondruska 24 April 1995
Joe Vondruska — Date
Project Manager

Greg Seegert 24 April 1995
Greg Seegert — Date
Project Director

April 1995

60799.01

TABLE OF CONTENTS

TABLE OF CONTENTS (cont.)

LIST OF FIGURES

LIST OF TABLES

EXECUTIVE SUMMARY

This study of the Upper Illinois Waterway (UIW) for early life stages of fishes was conducted during the spring and summer of 1994. The purpose was to determine what portion of the Illinois River drainage fish community is currently using this physically limited and impacted subunit of the system as a spawning or nursery area as well as when and where those uses occur.

Prior to starting the field study, a cursory literature review was conducted on selected fish species known to occur in the UIW. Information collected during this literature review was used to select appropriate habitats and gears for the field study and determine sampling frequency. Based on the results of this literature review and the availability of various habitat types within the UIW, 22 locations in the UIW were selected for sampling; eight in Lockport Pool (RM 292.5 to RM 321.7), two in Brandon Pool (RM 286.3 and 292.8 [upper Des Plaines River]), and 12 in upper Dresden Pool (RM 276.2 [Bear Island slough] to RM 285.8 [Brandon Dam tailwater]). Habitat types that were sampled were: main channel border (seven locations), main channel (five), backwaters (five), tributary mouth (two), and tailwater (three). Sampling was conducted during the first and last weeks in April, weekly in May and June, and biweekly in July and August. The following gear types were used: pump, grid (pumping within a defined area), dip net, towed net, stationary net, light trap, seine, and physical examination of vegetation. Except for light traps, all gears were fished during the day. All gears were not used at all stations. Gear selection at each station was based on habitat constraints and the larval assemblage expected. Up to 99 gear efforts were expended weekly during the study and 1235 samples were collected. A voucher series was compiled and verified by an outside expert. As part of a comprehensive review, EA compiled and summarized life history accounts of 69 selected species in terms of: spawning date and duration; spawning temperature; preferred spawning substrate and habitat; egg type; dispersal of fry; and reproductive guild.

This report identified 73 potential spawning species. These 73 species were assigned to 14 spawning guilds (Balon 1975) on the basis of the life history information as a means of refining our expectations for habitat use by individual species.

Approximately one-half of the 29,407 fish eggs collected could be identified of which the great majority were carp. Smaller numbers of carp/goldfish and freshwater drum eggs were also taken. A total of 21,789 larval and young-of-the-year (YOY) fish was collected representing at least 48 species and all 14 of the expected reproductive guilds. Because some larvae could be identified only to the genus or family level, it is possible that as many as 62 species were collected. The catch was dominated by *Lepomis* (26.0 percent), clupeidae (primarily gizzard shad) (25.0 percent), carp and goldfish (primarily carp) (18.8 percent), and *Pimephales* (primarily bluntnose minnow) (18.5 percent). These taxa were also the most abundant taxa during the 1994 adult fish study.

Spawning and nursery conditions in upper Dresden Pool are clearly superior to those in Lockport and Brandon Pools. Species richness in upper Dresden Pool (37 species) was double the values in Lockport or Brandon Pools (17 and 15 species, respectively). Larvae and YOYs were much more abundant in upper Dresden Pool (16,448 larvae/YOYs) than in Lockport or Brandon Pools (2634 and 2707 larvae/YOYs, respectively). The reduced diversity and abundance and seen in the larval fish community upstream of Brandon Road Lock and Dam is consistent with the pattern seen for the adult fish community.

Distributions of larvae and YOYs among mesohabitats within pools were complex. While the more common species or taxa were taken in most mesohabitat types, certain species or taxa were sufficiently more common in certain mesohabitats to suggest a preference. The timing of spawning for individual species or taxa also varied among pools. Virtually all species or taxa considered spawned within the time period expected indicating that thermal input from Commonwealth Edison power plants did not disrupt normal spawning patterns. However, there was a clear tendency for spawning to occur earlier in the warmer upper Dresden Pool than in the upper two pools.

1. INTRODUCTION

1.1 OBJECTIVES

This study of the Upper Illinois Waterway (UIW) for early life stages of fishes was conducted during the spring and summer of 1994. The purpose is to determine what portion of the Illinois River drainage fish community are currently using this physically limited and impacted subunit of the system as a spawning or nursery area as well as when and where those uses occur. The study is NOT intended to quantify the extent or success of spawning activity or make quantitative comparisons with reproductive performance in other systems. To design a sampling program that will define the occurrence of spawning and nursery utilization, we have identified what appear to be the most important spatial and temporal constraints on spawning. We also reviewed the literature on critical biological characteristics of prospective spawning species that might help us locate the spawn. These spatial, temporal, and biological features have been integrated to design a collection program that would collect all but the rarest of spawn and that will enable us to correlate reproductive performance by species with temporal and physical conditions by pool and habitat type.

1.2 THE PHYSICAL ENVIRONMENT

The UIW is a series of reservoirs extending from the historic discharge point of the Chicago River to Lake Michigan (Chicago Lock & Dam) downstream to Dresden Lock & Dam, a distance of 53 miles (Figure 1). The system is patchwork of flow-regulated natural and artificial channels operated to facilitate barge transport between Chicago and the Mississippi River and provide a conduit for domestic and industrial wastes away from the Chicago metropolitan area. UIW incorporates components of the Mississippi River and Lake Michigan drainages and is directly accessible to both fisheries.

The UIW is divided into three pools - Lockport Pool, Brandon Pool, and Dresden Pool. There are two major tributaries - the (upper) Des Plaines River which enters the Brandon Pool and the Kankakee River which enters the Dresden Pool. Both major tributaries have a more diverse resident fish assemblage than the respective pools they enter into. These two tributaries may flush early life stages into the UIW. A third, unconventional "tributary" to the system is the discharge from the Metropolitan Water Reclamation District. This contribution enters the system in the Lockport Pool. While sufficient in volume to be considered a "major tributary", this component is totally lacking in fish. There are also a number of minor tributaries, the most important of which are the Du Page River, Jackson Creek, Grant Creek, and the I&M Canal. Each provides living space for a local fish assemblage with unobstructed access to the larger UIW.

Primary fish habitats in the system include the dredged main channel; main channel border; side channel, backwaters, and off-channel embayments; areas of rooted vegetation; two tailwater areas (one of which contains tailrace/riffle habitats and the other of which is essentially a turbulent main channel); a tributary delta; and areas around the intakes and discharges of power stations where flows and local water temperatures may be enhanced. These habitat types are unevenly distributed among the pools with the Lockport and Brandon

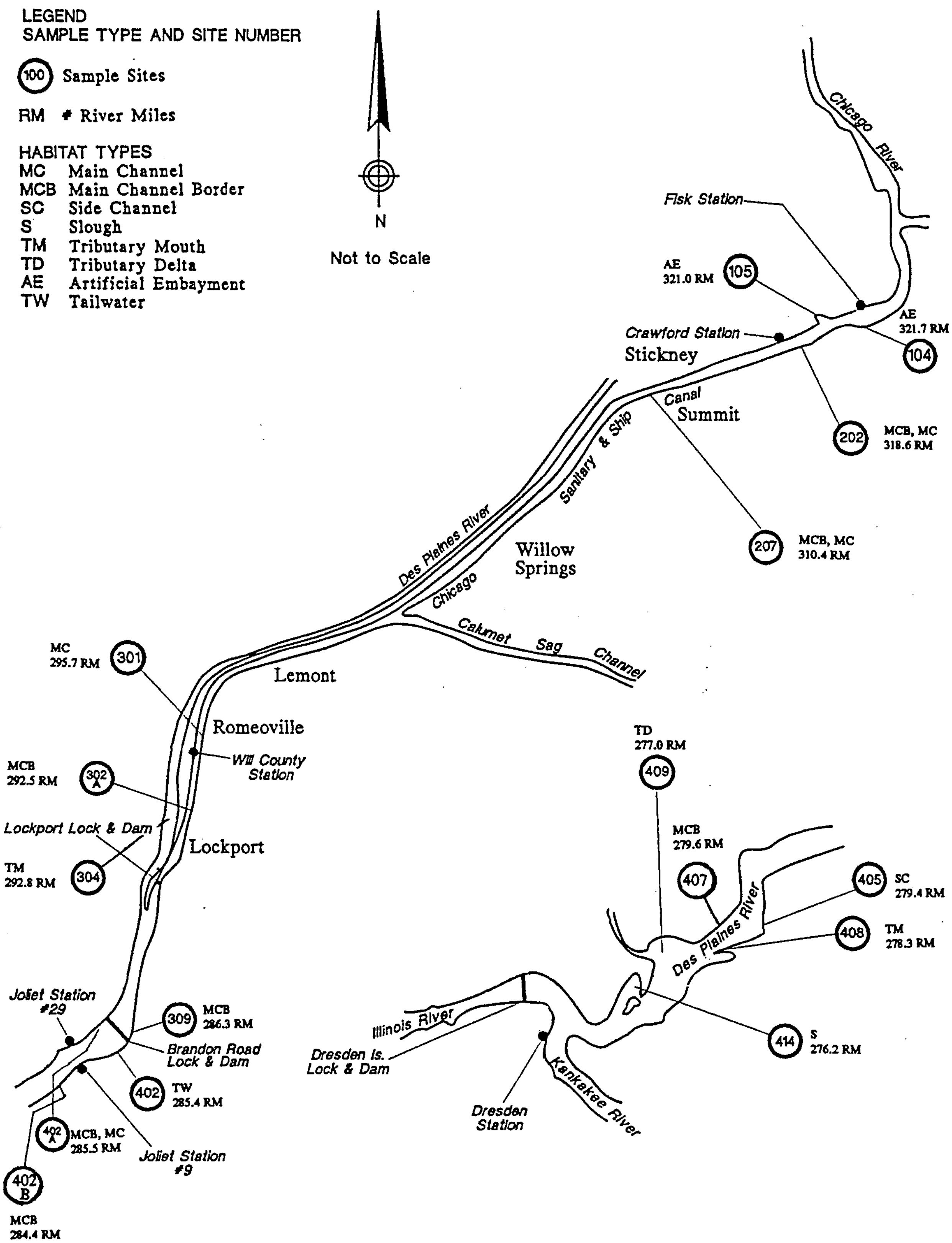


Figure 1. Ichthyoplankton sampling locations in the Upper Illinois Waterway, River Miles 276.2-321.7.

Pools providing primarily main channel habitat with vertical banks and there are few areas of rooted vegetation or off-channel embayments. The Dresden Pool provides a substantially greater diversity of habitats including the only side channel, slough, tributary delta, and tailrace/riffle (i.e., Brandon Dam tailwater) habitats in the system. An analogous area (i.e., natural riffle/run) to the Brandon Dam tailwater exists in the upper Des Plaines River (a tributary to Brandon Pool).

The UIW is considered "highly impacted" from a fisheries management perspective. In addition to obstructions to fish movement posed by the two locks and dams, skewed habitat distribution, and general lack of physical diversity in the upper reaches, the system is subject to more-or-less continuous disturbance by the barge traffic. Water levels in the pools vary substantially with operation of the locks and off-channel habitats suffer sediment resuspension and surge effects. Long-term chemical contamination from a wide variety of domestic and industrial sources is pervasive. Oxygen and ammonia concentrations in the water and surface sediments are a concern and the burden of toxicants entrapped in the sediments is thought to be substantial. Part of the flow is entrained through power plant condenser cooling system with the associated physical stress and thermal enhancement. The relative importance of these limitations in controlling the composition and species-abundance of the fishery and the gains that might be achieved by specific changes in use-patterns are issues of debate.

1.3 THE LOCAL FISH COMMUNITY

While the UIW links two major North American drainages, its general physical characteristics are such that species native to the Mississippi River drainage would be expected to inhabit the system while many of the native Lake Michigan species would not. True cold-water Lake Michigan residents such as the trout, salmon, and whitefish species are especially unsuited to the UIW. Commonwealth Edison Company has been monitoring the fishery of the UIW since 1971. Fish species collected in the course of those programs are listed in Table 1. While the fishery is only slightly less diverse than inhabits the parent drainages in terms of species composition, many species abundant in the larger Illinois River system are rare or infrequent captures in the UIW and many species have been collected only as adults. This implies that the species able to successfully spawn in the UIW or that spawn in tributaries and can utilize the UIW as a nursery area are relatively few.

We determined the species viewed as "likely spawners" and separated them into reproductive guilds (Balon 1975, 1981) according to the type of spawning habitat (especially substrate) preferred (Table 2). We also reviewed the technical literature to establish characteristics of the adults or spawn (Appendix A). Life history characteristics summarized in the review include: spawning season, spawning temperature range, spawning location characteristics (Table 2), spawning activities, parental care, egg type (i.e., adhesive, buoyant, etc.), dispersal of fry, and selection of nursery areas.

This study used a variety of sampling gear types deployed in all major physical habitat types and across the season of potential occurrence to fully identify fish species using the UIW as spawning or nursery grounds.

Table 1. Composite List of Fish Species Collected in the Upper Illinois Waterway During Commonwealth Edison Sponsored Studies, 1971 to present.

Common Name	Scientific Name	Native[a] Drainage	Collected As: Adult	YOY[b]	Relative Abundance[c]
Longnose gar	*Lepisosteus osseus*	LM, M	X	X[d]	U
Shortnose gar	*Lepisosteus platostomus*	M	X	-	R
Bowfin	*Amia calva*	LM, M	X	-	R
American eel	*Anguilla rostrata*	LM(?), M	X	-	H
Skipjack herring	*Alosa chrysochloris*	M	X	X	U
Alewife	*Alosa pseudoharengus*	Exotic	X	X	X
Gizzard shad	*Dorosoma cepedianum*	M	X	X	A
Threadfin shad	*Dorosoma petenense*	Exotic	X	X[d]	X
Goldeye	*Hiodon alosoides*	M	X	-	O
Mooneye	*Hiodon tergisus*	LM, M	X	-	R
Coho salmon	*Oncorhynchus kisutch*	Exotic	X	-	X
Chinook salmon	*Oncorhynchus tsawytscha*	Exotic	X	-	X
Rainbow trout	*Oncorhynchus mykiss*	Exotic	X	-	X
Brown trout	*Salmo trutta*	Exotic	X	-	X
Brook trout	*Salvelinus fontinalis*	LM	X	-	X
Rainbow smelt	*Osmerus mordax*	Exotic	X	X[d]	X
Central mudminnow	*Umbra limi*	LM, M	X	-	X
Grass Pickerel	*Esox americanus*	LM, M	X	X[d]	R
Northern pike	*Esox lucius*	LM, M	X	-	R
Muskellunge	*Esox masquinongy*	LM	X	-	H,X
Central stoneroller	*Campostoma anomalum*	LM, M	X	X	X
Goldfish	*Carassius auratus*	Exotic	X	X	O
Red shiner	*Cyprinella lutrensis*	M	X	-	U
Spotfin shiner	*Cyprinella spiloptera*	LM, M	X	X	O
Common carp	*Cyprinus carpio*	Exotic	X	X	A
Striped shiner	*Luxilus chrysocephalus*	LM, M	X	X	X
Common shiner	*Luxilus cornutus*	LM, M	X	-	H,X
Redfin shiner	*Lythurus umbratilis*	LM, M	X	X	X
Speckled chub	*Macrhybopsis aestivalis*	M	-	X	R
Silver chub	*Macrhybopsis storeriana*	M	X	-	R
Hornyhead chub	*Nocomis biguttatus*	LM, M	X	-	R
Golden shiner	*Notemigonus crysoleucas*	LM, M	X	X[d]	U
Pallid shiner	*Notropis amnis*	M	X	-	H,X
Emerald shiner	*Notropis atherinoides*	LM, M	X	X	A
Silverjaw minnow	*Notropis buccata*	LM, M	X	-	R

Table 1. (continued)

Common Name	Scientific Name	Native[a] Drainage	Collected As: Adult	YOY[b]	Relative Abundance[c]
Ghost shiner	*Notropis buchanani*	M	X	X	O
Bigmouth shiner	*Notropis dorsalis*	LM, M	X	-	H,X
Spottail shiner	*Notropis hudsonius*	LM, M	X	X	C
Rosyface shiner	*Notropis rubellus*	LM, M	X	-	H,X
Sand shiner	*Notropis stramineus*	LM, M	X	X	U
Mimic shiner	*Notropis volucellus*	LM, M	X	-	U
Suckermouth minnow	*Phenacobius mirabilis*	M	X	X[d]	R
Bluntnose minnow	*Pimephales notatus*	LM, M	X	X	A
Fathead minnow	*Pimephales promelas*	M	X	X	O
Bullhead minnow	*Pimephales vigilax*	M	X	X	O
Rudd	*Scardinius erythrophthalmus*	Exotic	X	-	H,X
Creek chub	*Semotilus atromaculatus*	LM, M	X	-	X
River carpsucker	*Carpiodes carpio*	M	X	?[e]	O
Quillback	*Carpiodes cyprinus*	LM, M	X	?	O
Highfin carpsucker	*Carpiodes velifer*	LM, M	X	?	R
White sucker	*Catostomus commersoni*	LM, M	X	X	O
Blue sucker	*Cycleptus elongatus*	M	X	-	R
Northern hog sucker	*Hypentilium nigricans*	LM, M	X	-	R
Smallmouth buffalo	*Ictiobus bubalus*	LM, M	X	X	U
Bigmouth buffalo	*Ictiobus cyprinellus*	LM, M	X	?	R
Black buffalo	*Ictiobus niger*	LM, M	X	?	R
Spotted sucker	*Minytrema melanops*	LM, M	X	-	R
Silver redhorse	*Moxostoma anisurum*	LM, M	X	X	U
River redhorse	*Moxostoma carinatum*	LM, M	X	?	R
Black redhorse	*Moxostoma duquesnei*	LM, M	X	?	R
Golden redhorse	*Moxostoma erythrurum*	LM, M	X	X	O
Shorthead redhorse	*Moxostoma macrolepidotum*	LM, M	X	X	O
Greater redhorse	*Moxostoma valenciennesi*	LM, M	X	?	R
Oriental weatherfish	*Misgurnus anguillicaudatus*	Exotic	X	-	R
Black bullhead	*Ameiurus melas*	LM, M	X	-	R
Yellow bullhead	*Ameiurus natalis*	LM, M	X	X[d]	U
Brown bullhead	*Ameiurus nebulosus*	LM, M	X	-	R
Channel catfish	*Ictalurus punctatus*	LM, M	X	X	O
Stonecat	*Noturus flavus*	LM, M	X	-	H
Tadpole madtom	*Noturus gyrinus*	LM, M	X	X	R
Flathead catfish	*Pylodictis olivaris*	LM, M	X	-	R
Trout-Perch	*Percopsis omiscomaycus*	LM, M	X	X	U

Table 1. (continued)

Common Name	Scientific Name	Native[a] Drainage	Collected As: Adult	YOY[b]	Relative Abundance[c]
Blackstripe topminnow	*Fundulus notatus*	LM, M	X	X	U
Mosquitofish	*Gambusia affinis*	Exotic	X	X	O
Brook silverside	*Labidesthes sicculus*	LM, M	X	X	O
Brook stickleback	*Culaea inconstans*	LM, M	X	-	X
Threespine stickleback	*Gasterosteus aculeatus*	Exotic	X	-	X
White perch	*Morone americana*	Exotic	X	X	R
White bass	*Morone chrysops*	LM, M	X	X	U
Yellow bass	*Morone mississippiensis*	M	X	X	U
Striped bass	*Morone saxatilis*	Exotic	X	-	X
Rock bass	*Ambloplites rupestris*	LM, M	X	X[d]	R
Green sunfish	*Lepomis cyanellus*	LM, M	X	X	A
Pumpkinseed	*Lepomis gibbosus*	LM, M	X	-	U
Warmouth	*Lepomis gulosus*	LM, M	X	-	R
Orangespotted sunfish	*Lepomis humilis*	M	X	X	O
Bluegill	*Lepomis macrochirus*	LM, M	X	X	C
Longear sunfish	*Lepomis megalotis*	LM, M	X	X	U
Smallmouth bass	*Micropterus dolomieu*	LM, M	X	X	O
Largemouth bass	*Micropterus salmoides*	LM, M	X	X	O
White crappie	*Pomoxis annularis*	LM, M	X	X	R
Black crappie	*Pomoxis nigromaculatus*	LM, M	X	X	R
Johnny darter	*Etheostoma nigrum*	LM, M	X	X	R
Orangethroat darter	*Etheostoma spectabile*	M	X	-	H,X
Banded darter	*Etheostoma zonale*	LM, M	-	X	R
Yellow perch	*Perca flavescens*	LM, M	X	X[d]	R
Logperch	*Percina caprodes*	LM, M	X	X	U
Blackside darter	*Percina maculata*	LM, M	X	X	R
Slenderhead darter	*Percina phoxocephala*	LM, M	X	X	R
Walleye	*Stizostedion vitreum*	LM, M	X	-	R
Freshwater drum	*Aplodinotus grunniens*	LM, M	X	X	O

(a) LM=Lake Michigan M=Mississippi R.; Source: Burr and Page 1986, Becker 1976

(b) YOY (young-of-the-year) collections based on 1993 and 1994 adult fish data (EA 1994 and 1995), unless noted otherwise.

(c) A=Abundantly taken in most surveys. C=Commonly taken in some sample collections; can make up a large portion of some samples. O=Occasionally collected, not generally distributed, but local concentrations may occur. U=Uncommon, does not usually appear in sample collections. R=Considered to be rare. H=Records of occurrence are available, but no collections have been documented in the past five years (1990-1994). X=Probably occurs only as a stray from a tributary, Lake Michigan, or inland stocking.

(d) Collected as a YOY in surveys prior to 1993.

(e) May have been represented as a YOY in genus or subfamily identifications.

Table 2. Reproductive Guilds Represented by Upper Illinois Waterway Fishes.

NONGUARDERS	
Open Substrate Spawners	
Pelagic spawners (Pelagophils):	emerald shiner, freshwater drum
Rock and gravel spawners with pelagic larvae (Litho-pelagophils):	gizzard shad, *Hiodon spp.*, walleye
Rock and gravel spawners with benthic larvae (Lithophils):	*Alosa spp.*, rainbow smelt, speckled chub, bigmouth shiner, rosyface shiner, suckermouth minnow, (highfin carpsucker), white sucker, blue sucker, northern hog sucker, spotted sucker, *Moxostoma spp.*, trout-perch
Nonobligatory plant spawners (Phyto-lithophils):	threadfin shad, red shiner, spotfin shiner, redfin shiner, silver chub, (ghost shiner), mimic shiner, river carpsucker, smallmouth buffalo, blackstripe topminnow, brook silverside, white perch, white bass, yellow bass, yellow perch
Obligatory plant spawners (Phytophils):	*Lepisosteus spp.*, central mudminnow, *Esox spp.*, goldfish, common carp, golden shiner, bigmouth buffalo, black buffalo
Sand spawners (Psammophils):	silverjaw minnow, spottail shiner, sand shiner, quillback, logperch
Brood Hiders	
Rock and gravel spawners (Lithophils):	*Oncorhynchus spp.*, brown trout, brook trout, hornyhead chub, creek chub, blackside darter, slenderhead darter
GUARDERS	
Substrate Choosers	
Plant spawners (Phytophils):	white crappie
Nest Spawners	
Rock and gravel nesters (Lithophils):	central stoneroller, common shiner, black bullhead, rock bass, green sunfish, warmouth, orangespotted sunfish, bluegill, longear sunfish, smallmouth bass

<u>GUARDERS (cont.)</u>	
Nest Spawners (cont.)	
Plant material nesters (Phytophils):	bowfin, largemouth bass, black crappie, (banded darter)
Hole nesters (Speleophils): (holes & crevices; undersides of rocks)	striped shiner, *Pimephales spp.*, yellow bullhead, brown bullhead, channel catfish, stonecat, tadpole madtom, flathead catfish, johnny darter, orangethroat darter
Miscellaneous substrate and material nesters (Polyphils):	pumpkinseed
Gluemaking nesters (Ariadnophils)(misc. substrates):	brook stickleback, threespine stickleback
<u>BEARERS</u>	
Internal Bearers	Mosquitofish
<u>UNASSIGNED</u>	Pallid shiner

Source: Balon 1975, 1981; Pearson and Krumholz 1984; Smith 1979; Page 1983; Kwak 1991
Note: Parentheses denote species which have been provisionally assigned.

2. MATERIALS AND METHODS

2.1 LIFE HISTORY REVIEW OF UPPER ILLINOIS WATERWAY FISHES

EA reviewed and summarized life history accounts of 69 selected species known to occur in the Upper Illinois Waterway to determine the spawning requirements and characteristics of each species (Appendix A). This review included 63 of the 73 potential spawning species and the omissions were Lake Michigan species or species that are sufficiently rare that we did not expect to catch them. A matrix table was developed that includes the following categories for each species: breeding guilds based on Ohio EPA (1989), spawning season, spawning temperature range, spawning location characteristics (Table 2), spawning activities, parental care, type of egg (i.e., adhesive, buoyant, etc.), dispersal of fry, and selection of nursery areas. Information used in the life history review was obtained from numerous references including current field and laboratory guidebooks, reprints, scientific journals, abstracts, conference proceedings, various theses and dissertations, published and unpublished bibliographies and manuscripts, and computer library searches in Dialog (Zoological Records Online, SciSearch, and Aquatic Sciences and Fisheries Abstracts), and ABSEARCH-1994 (which contains all abstracts for the Transactions of the American Fisheries Society). The majority of the life history information was retrieved from major fish literature works for individual states including Illinois, Wisconsin, Ohio, Missouri, Arkansas, Kansas, Tennessee, and Canada. Other important references included Reproductive Biology and Early Life History of Fishes in the Ohio River Drainage, Vol. I, by Wallus, et al., K.D. Carlander's Handbook of Freshwater Fisheries Biology Vols. I and II, N. Auer's Identification of Larval Fishes of the Great Lakes Basin with Emphasis on the Lake Michigan Drainage, R. D. Hoyt's Bibliography of the Early Life History of Fishes, A Guide to Larval Fishes of the Upper Mississippi River by Holland-Bartels, et al. Additionally, early life history experts including Drs. Darrel Snyder of Colorado State University and Robert Wallus of Tennessee Valley Authority were contacted to fill data gaps in the early life history accounts of several species (primarily cyprinids). The review includes 464 cited references (Appendix A).

2.2 FIELD

2.2.1 Selection of Sampling Locations

The Upper Illinois Waterway (UIW) was segmented into 40 reaches (Table 3) and the mesohabitat types (Table 4) available in each reach were identified on Corps of Engineers navigation charts (EA 1993c). Thirteen of these reaches were selected for this study (Table 5). The study area encompassed ~46 river miles of the UIW. It began at River Mile 321.7 in the South Fork of the South Branch and ended in the Bear Island slough at River Mile 276.2 (Figure 1). This portion of the UIW is separated into three pools or reservoirs (i.e., Lockport, Brandon, and Dresden Pools) by the Lockport Lock and Dam (RM 291.1) and the Brandon Lock and Dam (RM 286.0). Presumably, these dams represent obstacles to fish movement within the system although the significance of these obstacles to spawning movements and the extent to which pool fisheries should be considered independent is uncertain. The study area included Lockport Pool, Brandon Pool, and upper Dresden Pool (that portion of Dresden Pool

Table 3. Study Reaches for the Upper Illinois Waterway.

REACH NO.	UPSTREAM RM	DOWNSTREAM RM	DISTANCE (Miles)	DESCRIPTION (Up to Downstream)
1	324.3	323.2	1.1	Roosevelt Rd. bridge to Cermak Rd. bridge
2	323.2	321.8	1.4	Cermak Rd. bridge (0.8 miles upstream of Fisk Station discharge) to just upstream of South Fork of South Branch (0.6 miles downstream of Fisk Station discharge)
3	321.8	320.9	0.9	South Fork of South Branch to narrowing of canal
4	320.9	319.5	1.4	Narrowing of canal to S. Kedzie Ave. bridge
5	319.5	317.3	2.2	S. Kedzie Ave. bridge (1.0 mile upstream of Crawford Station discharge) to Cicero Ave. (Rt. 50) bridge (1.2 miles downstream of Crawford Station discharge)
6	317.3	314.8	2.5	Cicero Ave. bridge (1.5 miles upstream of MWRD's Stickney WRP's outfall) to Railroad bridge (1.0 mile downstream of MWRD's Stickney WRP's outfall)
7	314.8	313.0	1.8	Railroad bridge to Archer Ave. (Rt. 171) bridge
8	313.0	310.3	2.7	Archer Ave. bridge to I & M diversion canal

Table 3 (cont.)

REACH NO.	UPSTREAM RM	DOWNSTREAM RM	DISTANCE (Miles)	DESCRIPTION (Up to Downstream)
9	310.3	307.9	2.4	I & M diversion canal to Willow Springs Rd. bridge (narrowing of canal)
10	307.9	303.5	4.4	Willow Springs Rd. bridge to just upstream of Cal-Sag Channel
11	303.5	301.5	2.0	Cal-Sag Channel (including the lower 0.1 miles of the Cal-Sag Channel) to upstream end of furthest upstream barge slip of three.
12	301.5	300.5	1.0	Upstream barge slip to Stephen St. bridge
13	300.5	299.1	1.4	Stephen St. bridge to downstream end of Twin City Barge Line and Acme Welding's Slip No. 1
14	299.1	296.2	2.9	Slip No. 1 (1.6 miles upstream of UNO-VEN refinery's discharge) to Romeoville Rd. Bridge (1.3 miles downstream of the discharge)
15	296.2	294.6	1.6	Romeoville Rd. bridge (0.8 miles upstream of Will County Station's discharge) to 0.8 miles downstream of the discharge
16	294.6	293.5	1.1	0.8 miles downstream of Will County Station discharge to widening of canal just upstream of sluice gates
17	293.5	292.1	1.4	Just upstream of sluice gates to remnants of 16 St. bridge (narrowing of canal)

Table 3 (cont.)

REACH NO.	UPSTREAM RM	DOWNSTREAM RM	DISTANCE (Miles)	DESCRIPTION (Up to Downstream)
18	292.1	291.1	1.0	16 St. bridge to Lockport Dam
19	291.1	290.6	0.5	Lockport Dam tail waters (including mouth of Deep Run)
20	290.6	290.0	0.6	End of Lockport Dam tail waters to confluence of Chicago Sanitary and Ship Canal and Des Plaines River
21	290.0	288.9	1.1	Confluence to mouth of I & M Canal
22	288.9	287.3	1.6	I & M Canal to McDonough St. (widening of canal)
23	287.3	286.0	1.3	McDonough St. to Brandon Rd. Dam
24	286.0	285.5	0.5	Brandon Rd. Dam tail waters (including mouth of Hickory Creek)
25	285.5	283.7	1.8	End of Brandon Rd. Dam tail waters (0.7 miles upstream of Joliet Station's Unit 6 discharge) to Joliet Army Ammunition discharge (0.6 miles downstream of Joliet Station's Units 7 & 8 discharge)
26	283.7	282.8	0.9	Waste Management discharge to Santa Fe Light and Daymark
27	282.8	281.3	1.5	Santa Fe Light and Daymark to Hunting Lodge Bend Light (including mouth of Rock Run)

Table 3 (cont.)

REACH NO.	UPSTREAM RM	DOWNSTREAM RM	DISTANCE (Miles)	DESCRIPTION (Up to Downstream)
28	281.3	280.2	1.1	Hunting Lodge Bend Light to Treats Island
29	280.2	279.1	1.1	Treats Island (including mouth of Jackson Creek Diversion)
30	279.1	278.3	0.8	Treats Island to just upstream of mouth of Jackson Creek
31	278.3	277.7	0.6	Mouth of Jackson Creek to DuPage River Delta
32	277.7	276.6	1.1	DuPage River Delta
33	276.6	275.9	0.7	DuPage River Delta (DuPage River Light and Daymark) to downstream end of Bear Island
34	275.9	275.0	0.9	Downstream end of Bear Island to Campbell Daymark (narrowing of river and just upstream of mouth of Grant Creek)
35	275.0	273.6	1.4	Campbell Daymark (including mouth of Grant Creek) to Bayhill Marina (narrowing of river)
36	273.6	273.0	0.6	Bayhill Marina to mouth (just upstream of confluence with Kankakee River)
37	273.0	272.2	0.8	Mouth to Dresden Station discharge (including the confluence of the Des Plaines and Kankakee Rivers and the lower 0.4 miles of the Kankakee River)
38	272.2	271.5	0.7	Dresden Station discharge to Dresden Island Dam

Table 3 (cont.)

REACH NO.	UPSTREAM RM	DOWNSTREAM RM	DISTANCE (Miles)	DESCRIPTION (Up to Downstream)
39	271.5	271.0	0.5	Dresden Island Dam tail waters
40	271.0	270.0	1.0	End of Dresden Island Dam tail waters to end of study area

Table 4. Definitions and Anticipated Spawners of Each Mesohabitat of the Upper Illinois Waterway.

Main Channel - This includes only that portion of the river through which large commercial craft can operate. It is defined by combinations of river regulating structures (wing dikes), river banks, islands, buoys, and other markers (Rasmussen 1979). In the upper Illinois waterway, the low water channel below Lockport Dam is generally 300 feet wide and 9 feet deep. From Lockport to Chicago Harbor, about 36 miles, the channel is generally 160 feet wide and a minimum of 17 feet deep (USACE 1973). Expect eggs and/or larvae of pelagic spawners (e.g., freshwater drum) and rock and gravel spawners with pelagic larvae (e.g., gizzard shad).

Main Channel Border (Rasmussen 1979) - This is the zone between the nine foot navigation channel and the main river bank, islands, or submerged definitions of the old main river channel. Buoys often mark the outer edge of this zone. Where the main channel is defined only by the bank, a narrow border still occurs, and often the banks have rip-rap. Most fishes in the nonobligatory and obligatory plant spawner (e.g., spotfin shiner, carp, etc.), and hole nester (e.g., *Pimephales spp.*) guilds probably spawn in this mesohabitat. Where gravel deposits occur, some members of the rock and gravel nester guild may spawn here (e.g., green sunfish).

Tailwaters (Rasmussen 1979) - These include the main channel, main channel border, and areas immediately below the navigation dams where turbulence is caused by passage of water through the gates of the dams and out of the locks. Since these areas change in size according to water stage, an arbitrary lower boundary for fishery purposes has been set at one-half mile below each dam. May be important spawning areas for rock and gravel spawners (e.g, *Moxostoma spp.*), sand spawners (e.g., spottail shiner), and hole nesters (e.g., some darters), particularly those which require hard substrates in conjunction with moderate to fast current velocities.

Side Channels (Rasmussen 1979) - These include all departures from the main channel and main channel border in which there is current during normal river stage. Probably important spawning areas for hole nesters (e.g., yellow bullhead), some nonobligatory and obligatory plant spawners (e.g., spotfin shiner and carp), rock and gravel nesters (e.g., bluegill), and plant material nesters (e.g, largemouth bass).

Sloughs (Rasmussen 1979) - Sloughs are narrow branches or offshoots of the main water body and are characterized by no current at normal water stage and may be former side channels that have been cut off. Probably represents an important spawning areas for rock and gravel nesters (e.g., bluegill), plant material nesters (e.g, largemouth bass), plant spawners (e.g, white crappie), miscellaneous substrate and material nesters (e.g., pumpkinseed), and obligatory plant spawners (e.g., carp).

Table 4 (cont.)

Artificial Embayments - Man-made diversions from the main channel or side channel that are open only on one end. For those embayments that lack littoral areas (e.g., active slips), expect eggs and/or larvae of pelagic spawners (e.g., freshwater drum) and the rock and gravel spawners with pelagic larvae (e.g., gizzard shad). For those embayments that have littoral areas, they probably represent a locally important spawning area for rock and gravel nesters (e.g., green sunfish), plant material nesters (e.g, largemouth bass), miscellaneous substrate and material nesters (e.g., pumpkinseed), and obligatory plant spawners (e.g., carp).

Tributary Mouth - The portion of the tributary defined by one of the following definitions: 1) for minor tributaries, from the mouth upstream for 0.25 miles (e.g. Deep Run and Hickory Creek); 2) from the mouth upstream to a point of obvious narrowing (e.g., Jackson Creek Diversion), 3) from the mouth upstream to a dam (e.g., Jackson Creek) or significant narrowing due to a bridge (e.g., Grant Creek), or 4) for the Kankakee River, from the mouth upstream for 0.4 miles. Look for larvae and eggs spawned in tributaries drifting into the UIW. May also represent spawning areas for rock and gravel nesters (e.g., bluegill), plant material nesters (e.g, largemouth bass), sand spawners (e.g., spottail shiner), and some nonobligatory and obligatory plant spawners (e.g., spotfin shiner and carp).

Tributary Deltas - The depositional areas between tributary mouths and the main channel of the river/canal. Look for larvae and eggs spawned in tributaries drifting into the UIW. May also represent spawning areas for rock and gravel nesters (e.g., bluegill) and plant material nesters (e.g, largemouth bass). Probably also important spawning areas for hole nesters (e.g., yellow bullhead) and some nonobligatory and obligatory plant spawners (e.g., spotfin shiner and carp).

Table 5. Ichthyoplankton Sampling Locations for the Upper Illinois Waterway, 1994.

Location	Description	Habitat Types	Collection Methods
104	Reach 3, RM 321.7-South Fork of the South Branch Chicago River.	Artificial Embayment. Primarily fine sediments with a narrow border of rock, sparse macrophyte beds.	Pump and grid; light traps: non-vegetation and vegetation; physical vegetation.
105	Reach 3, RM 321.0- Triangular shaped artificial embayment.	Artificial Embayment. Primarily fine sediments, with some rock and gravel, macrophyte beds.	Pump and grid; light traps: non-vegetation and vegetation; larval seine; physical vegetation.
202	Reach 5, RM 318.6-Upstream of Crawford Station Intake, mid-channel and left bank. Intake flow field.	Main channel and main channel border. Rock and gravel, fine sediments, sparse macrophyte beds.	Pump and grid; light traps: non-vegetation and vegetation; larval seine; physical vegetation; towed nets.
207	Reaches 8 and 9, RM 310.4-near I&M Diversion Channel, mid-channel and both banks.	Main channel and main channel border. Rock and gravel, sparse macrophyte beds.	Pump and grid; light traps: non-vegetation and vegetation; physical vegetation; towed nets.
301	Reach 15, RM 295.7-Upstream of Will County Station Intake, mid-channel and left bank. Intake flow field.	Main Channel and vertical rock wall with and without eroded areas.	Pump; dip net; towed nets.
302A	Reach 17, RM 292.5-west bank, shallow area out of main channel near Cargill.	Main Channel Border. Primarily fine sediments with some rock, dense macrophyte beds.	Pump and grid; light traps: non-vegetation and vegetation; physical vegetation.
304	Upper Des Plaines River beneath Southwest Highway (9th Street) bridge	Tributary. Riffle-run with rock and gravel, small patches of fine sediments, sparse macrophyte beds. Slow to fast current.	Pump and grid or dipnet; stationary net; larval seine; physical vegetation.
309	Reach 23, RM 286.3-East (left) bank above Brandon Road Dam on treatment plant side.	Main Channel Border. Fine sediments, woody debris, dense macrophyte beds.	Light traps: non-vegetation and vegetation; physical vegetation.
402-1	Reach 24, RM 285.4-East (left) bank of tailwater below Brandon Road Dam.	Tailwater. Shallow clay with some gravel, slow to moderate current, dense macrophyte beds.	Pump and grid; light traps: non-vegetation and vegetation; larval seine; dip net; physical vegetation.

Table 5 (continued)

Location	Description	Habitat Types	Collection Methods
402-2	Reach 24, RM 285.4-West (right) bank of tailwater below Brandon Road Dam.	Tailwater. Shallow to deep rock and gravel with some clay, moderate to fast current.	Pump and grid; light traps: non-vegetation; dip net.
402-3	Reach 24, RM 285.8-East (left) bank of tailwater directly upstream of Brandon Road bridge.	Tailwater. Shallow cobble and gravel, slow to fast current.	Pump and grid; larval seine; physical vegetation.
402A	Reaches 24 and 25, RM 285.5-channel between Brandon Road Lock Chamber and the mouth of the tailwater area, mid-channel and right bank. Intake flow field.	Main Channel and Main Channel Border. Rock and gravel.	Pump and grid; larval seine; towed nets.
402B	Reach 25, RM 284.4-east (left) bank main channel border. Below Joliet #9, across from Joliet #29 discharge canal. Discharge far field.	Main Channel Border. Primarily fine sediments with some rock, dense macrophyte beds.	Pump and grid; light traps: non-vegetation and vegetation; larval seine; physical vegetation.
405	Reach 29, RM 279.4-side channel inside Treats Island.	Side Channel. Primarily fine sediments with some rock and gravel, woody debris, locally dense macrophyte beds.	Pump and grid; light traps: non-vegetation and vegetation; larval seine; physical vegetation.
407	Reach 29, RM 279.6-mid-point of Treats Island, mid-channel and left bank.	Main Channel and Main Channel Border. Rock and gravel.	Pump and grid; light traps: non-vegetation; towed nets.
408	Reach 31, RM 278.3-mouth of Jackson Creek.	Tributary Mouth. Rock, gravel, fine sediments, macrophyte beds.	Pump and grid; light traps: non-vegetation and vegetation; larval seine; physical vegetation.
409	Reach 32, RM 277.0-Du Page River delta.	Tributary Delta. Fine sediments with some rock, dense macrophyte beds.	Light traps: non-vegetation and vegetation; larval seine; physical vegetation.
414	Reach 33, RM 276.2-west (right) bank behind Bear Island in slough.	Slough. Fine sediments with some rock, macrophyte beds.	Light traps: non-vegetation and vegetation; larval seine; physical vegetation.

between the Brandon Lock and Dam and the Kankakee River). The areas within each pool can be further divided into mesohabitats based on their relationship to the primary sources of impact in the system. Mesohabitat types available to fishes within the study area include main channel, main channel border, side channel, artificial embayment, slough, tailwater, tributary mouth, and tributary delta (Table 5). Discharges of domestic wastewater and industrial process wastes as well as power plant thermal effluents are to the main channel mesohabitat. This is also the primary conduit for barge traffic and is presumably the most disturbed mesohabitat type. These disruptions to the main channel carry over to the main channel border mesohabitat which is also strongly affected by the fluctuations in water level associated with operations of the locks and dams and serves as a repository for sediments contaminated by discharges to the main channel. Subunits of the main channel mesohabitat that have unique importance as a spawning and nursery area are the tailwater areas below the dams. In this system, discrete tailwater mesohabitats are present in Brandon Pool (Lockport Dam tailwater) and upper Dresden Pool (Brandon Dam tailwater); however, their physical habitats are quite different. The Lockport Dam tailwater is a high velocity, turbulent, main channel mesohabitat, whereas the Brandon Dam tailwater is more diverse and contains a variety of riffle/run habitats. An analogous area (i.e., natural riffle/run) to the Brandon Dam tailwater exists in the upper Des Plaines River (a tributary to Brandon Pool). Mesohabitats in which conditions are a mix of main channel influences and/or influences from subdrainages include the side channel, tributary mouths, the (Du Page River) tributary delta, and artificial embayments (primarily active barge slips or turning basins). These mesohabitats also serve as repositories for sediments contaminated by discharges to the main channel. The last mesohabitat category is slough; areas where exchange of water and sediment with the main channel are limited or infrequent and water quality and sediment characteristics are locally determined.

Individual mesohabitats may contain one or more discrete types of spawning habitats (Tables 2 and 5). Table 4 summarizes the various mesohabitat characteristics and lists the reproductive guilds most likely to use each of them.

Main channel, main channel border, artificial embayment, and tributary mouth are the only mesohabitats found in all three pools (i.e., Lockport, Brandon, and upper Dresden Pools); however, their areal extents (based on percent of total surface area) vary among pools (Table 6). For example, main channel composes approximately 79 percent of the surface area in both the Lockport and Brandon Pools, but only 36 percent of the upper Dresden Pool. Conversely, main channel border composes a larger percentage in the upper Dresden Pool (29 percent) than in either of the upper two pools (10 and 13 percent). Main channel and main channel border are the most prevalent mesohabitats throughout the entire waterway (Table 6). Artificial embayments are well distributed throughout the system (16 of 40 reaches), but are most prevalent in Lockport Pool where they compose 10 percent of the total surface area compared to only one or two percent in Brandon and upper Dresden Pools. Most artificial embayments are active barge slips and cannot be sampled safely and effectively due to constant traffic. The tributary mouth mesohabitat composes only one or two percent of the total surface area within each of the three pools. The remaining four mesohabitats are limited in the UIW both in terms of areal extent and distribution within the waterway. The side channel, slough, and tributary

TABLE 6. PERCENT COMPOSITION OF MESOHABITAT TYPES PRESENT WITHIN EACH REACH OF THE UPPER ILLINOIS WATERWAY, RM 270.0 - RM 324.3.

WATER BODY	REACH	MAIN CHANNEL	MAIN CHANNEL BORDER	TAIL WATER	SIDE CHANNEL	SLOUGH	ARTIFICIAL EMBAYMENT	TRIB. MOUTH	TRIB. DELTA	INTAKE/ DISCHARGE	PERCENT OF ENTIRE STUDY AREA
SBCR	1	100.0									0.7
SBCR	2	79.3					20.7			5.9	1.1
CSSC	3	54.9	5.2				39.9				1.2
CSSC	4	88.1	4.4				7.5				1.2
CSSC	5	70.7	29.3							1.9	2.4
CSSC	6	84.2	15.8								2.4
CSSC	7	77.5	22.5								1.8
CSSC	8	81.6	18.4								2.9
CSSC	9	81.2	18.8								2.4
CSSC	10	100.0									2.2
CSSC	11	75.3						24.7			1.3
CSSC	12	51.6					48.4				1.0
CSSC	13	39.5					60.5				2.0
CSSC	14	100.0									1.5
CSSC	15	85.7					14.3			0.8	1.2
CSSC	16	100.0									0.6
CSSC	17	74.4	19.0				6.6				1.6
CSSC	18	100.0									0.9
Lockport Pool		79.1	10.1				9.6	1.2		0.4	28.6
CSSC	19	22.8	12.0	44.5			5.3	15.4			0.7
CSSC	20	79.7	20.3								0.5
LDPR	21	55.1	42.1					2.8			1.6
LDPR	22	88.5	7.1				4.4				1.2
LDPR	23	99.3	0.7								3.4
Brandon Pool		79.7	13.2	3.9			1.2	2.0			7.4
LDPR	24			96.3		0.6		3.1			2.7
LDPR	25	68.3	31.2				0.5			26.3	3.3
LDPR	26	37.7	62.1			0.2					2.7
LDPR	27	33.8	64.4			0.8	1.0				5.3
LDPR	28	49.5	50.5								3.0
LDPR	29	29.0	13.5		48.4	7.6		1.4			3.4
LDPR	30	65.6	32.1				2.3				1.7
LDPR	31	43.3	27.1			4.2	10.4	14.9		0.4	2.1
LDPR	32	13.8	5.7			8.0		0.9	71.7		9.9
LDPR	33	46.3	29.9			23.8					4.5
LDPR	34	45.3	25.9		26.4	2.4					4.4
LDPR	35	51.8	30.1			2.7	3.0	12.3			4.2
Up. Dres. Pl.		36.4	28.7	5.5	6.0	5.3	1.0	2.2	15.0	1.9	47.0
LDPR	36	32.8	63.8			2.6	0.8				3.1
UIR	37	26.9	29.7			23.1		20.3			7.4
UIR	38	81.3	14.6			2.5	1.6			0.5	2.9
Lw. Dres. Pl.		40.2	34.2			13.9	0.5	11.2		0.1	13.4
UIR	39			100.0							1.8
UIR	40	58.8	41.2								1.8
Below Dres. Dam		29.4	20.6	50.0							3.6
	TOTAL	52.1	22.7	4.7	2.8	4.3	3.3	3.0	7.1	1.0	

delta mesohabitats are confined to upper Dresden Pool. The tailwater mesohabitat is present in Brandon and upper Dresden Pools; however, their physical habitats are quite different (as discussed previously).

Discrete sampling locations (and reaches) were selected that: 1) provided good longitudinal coverage; 2) included all mesohabitat types; 3) provided a mixture of microhabitats (e.g., macrophyte beds, hard substrates); and 4) included all mesohabitats or other areas (e.g., Brandon Dam tailwater) that had a high likelihood of serving as potential spawning or nursery areas. Other factors considered included proximity to power plants and accessibility. Based on these criteria, 16 sampling locations were selected (Figure 1). Sampling at four of these locations was conducted both in the main channel and along the main channel border, and the Brandon Dam tailwater (Location 402) was sampled in three separate areas. Therefore, sampling was conducted in 22 discrete areas with respect to mesohabitat type. The number of sampling areas by pool with respect to mesohabitat type and segment are presented in Table 7. As presented in this table, all mesohabitats present in the waterway were sampled; all mesohabitat types present in Lockport Pool and upper Dresden Pool were sampled; and all mesohabitat types except main channel were sampled in the Brandon Pool. Table 5 and Appendix B have detailed descriptions of each sampling location.

2.2.2 Selection of Sampling Frequency

Sampling must be sufficiently frequent that those species that might potentially spawn have a high probability of being caught. The expected distribution of spawning activity through the year was compiled as part of the life history review (Appendix A). This information is summarized in Figure 2. Based on Appendix A and Figure 2, it is clear that the spawning period in the UIW encompasses the period from March through August, with the bulk of the activity being concentrated in May and June. Based on this temporal distribution, sampling was conducted during the first and last weeks in April, weekly in May and June, and biweekly in July and August.

2.2.3 Selection of Gear Types

The previous two sections provided the seasons in which spawning by the composite assemblage should occur in the system and the locations and physical conditions (i.e., mesohabitat) where sampling was to be conducted. For sampling of these areas to be effective, the appropriate gears need to be deployed.

Exploratory ichthyoplankton sampling was done in 1993 using only towed nets (LMS 1993a). Based on the 1993 data and discussions with Upper Illinois Waterway Task Force members, it was decided to use a variety of gears or techniques in the 1994 sampling program: pump, grid, dip net, towed net, stationary net, light trap, seine, and physical examination of vegetation. The collection methods typically used at each sampling location are presented in Table 5. Detailed descriptions of gear deployment and utilization are presented in Appendix B.

Table 7. Number of Discrete Sampling Areas by Segment and Mesohabitat.

Mesohabitat	Lockport Pool	Brandon Pool	Upper Dresden Pool
Main Channel Border	3	1	3
Main Channel	3	0	2
Backwater			
Artificial Embayment	2	0	0
Side Channel	0	0	1
Tributary Delta	0	0	1
Slough	0	0	1
Tributary Mouth	0	1	1
Tailwater	0	0	3
Total Sampling Areas	8	2	12

FIGURE 2. SPAWNING PERIODS FOR FISHES OF THE UPPER ILLINOIS WATERWAY

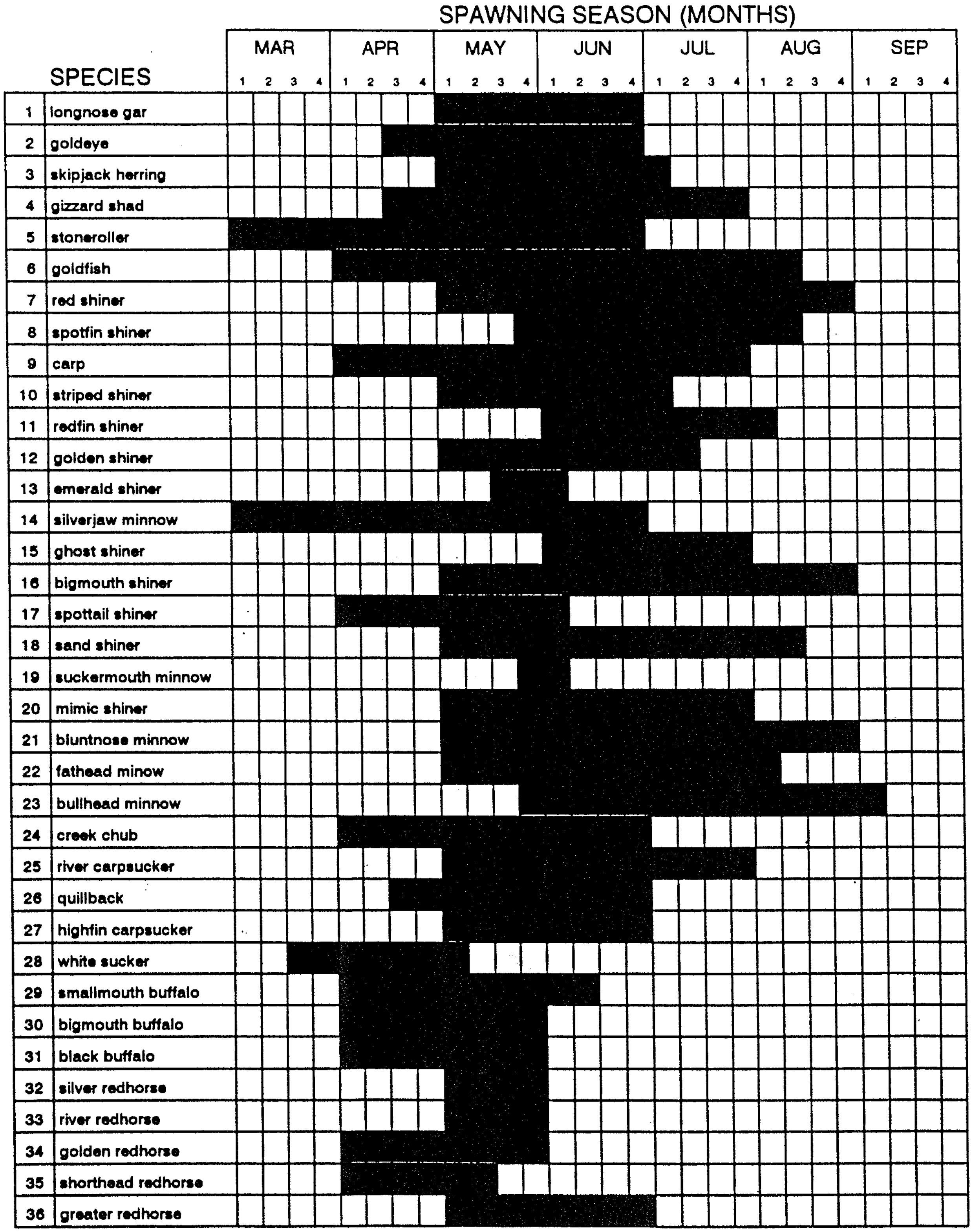
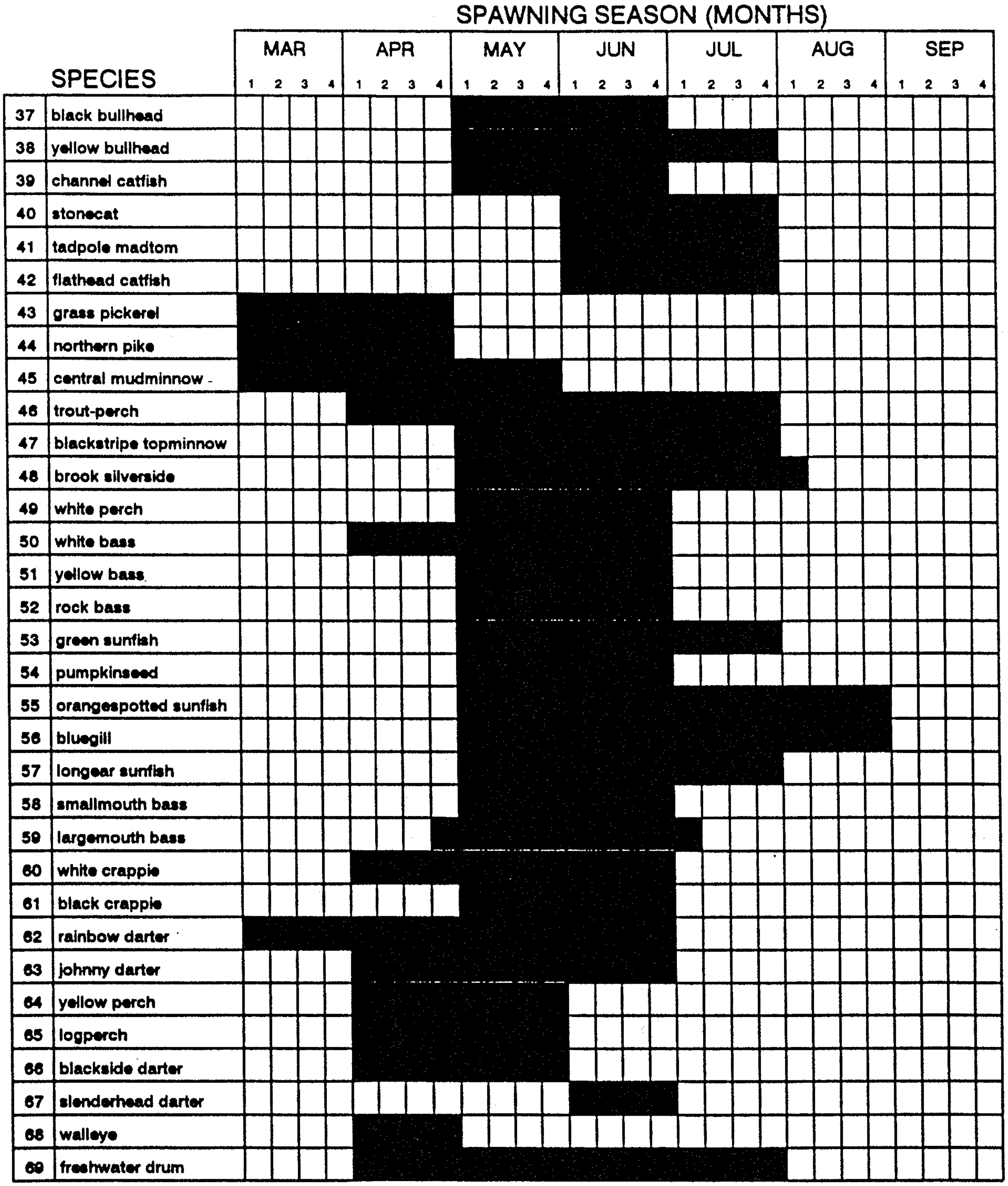


FIGURE 2. (continued)



Gears typically used within each mesohabitat type were: Main Channel - towed nets in mid-channel, pump and dip net along a vertical channel wall; Main Channel Border, Artificial Embayment, and Side Channel - pump, grid, seine, light traps, and physical examination of vegetation; Tributary Delta and Slough- seine, light traps, and physical examination of vegetation; Tributary Mouth - pump, grid, seine, light traps or stationary net, and physical examination of vegetation; and Tailwater - pump, grid, seine, dip net, light traps, and physical examination of vegetation. Given this deployment of gears among mesohabitat types at 22 sampling areas, up to 99 gear efforts were expended weekly during the study. Thus, the level of effort expended during this study was sufficient so that if ichthyoplankton were present in anything above negligible quantities they would be collected. The following subsections present detailed description of each gear type.

2.2.3.1 Pump and Grid Sampling

Pump and grid sampling, directed primarily at collecting fish eggs, was conducted at 13 of the 16 locations. These locations contained bottom substrates that are relatively firm consisting of rock, cobble, gravel, and\or sand. Samples were collected using a gasoline driven pump with a 1.5 inch ID intake hose. The pumping rate was approximately 50 gallons per minute and the samples passed through the pump chamber. The intake end of the hose was attached to a length of 1.5 inch PVC tubing which enabled the operator to keep the intake in close contact with the substrate or to probe around large objects. The intake was equipped with a strainer nozzle to prevent large material from clogging or damaging the pump. Each pump sample consisted of pumping bottom material as the pump intake was moved around by the wading operator. In conjunction with each pump sample, a grid sample was also collected. The grid sample consisted of carefully pumping the substrate within two one-meter diameter rings. Please note that grid sampling was not implemented until the second sampling trip. The grid samples were kept separate from the pump samples. Approximately 30 man minutes were spent on this effort. Discharge from the pump first entered a large tub, which acted as a trap for larger, heavy material. The trap tub was equipped with an overflow pipe so that water exiting the tub could be filtered through a No. 0 mesh (505 micron square mesh) Nitex net. After pump or grid sampling within a given location was completed, the contents in the trap tub and the net were condensed and transferred into labeled jars. Pumping did not appear to cause a significant amount of damage to eggs or larvae. Very few eggs collected were damaged and only six unidentified (damaged) larvae (0.5 percent of the total pump and grid catch) and seven damaged clupeids (3.7 percent of the total clupeid catch) were collected (Appendix C).

Grid samples were collected in anticipation that large numbers of eggs might be found in these microhabitat types. A fair number of eggs were collected (2666), but they were composed primarily of carp (71 percent) and unidentified specimens (29 percent) (Appendix C). Based on these data, or lack thereof, it was decided not to proceed with quantitative analyses of the grid data.

2.2.3.2 Seining

Seining for larval fish was conducted at 10 of the 16 locations. Seining was conducted where bottom substrates were relatively firm. The larval seine was two meters wide by one meter deep and had a bag that consisted of a 0.5 meter diameter plankton net sewed in the middle of it. The entire seine consisted of No. 0 mesh Nitex. Each larval seine sample typically consisted of one ~40-foot seine haul. For locations that covered a large area (e.g., the Du Page River Delta [Location 409]), seining was conducted typically at two to three separate areas in order to provide good areal coverage. All material collected at each location was condensed into a single sample.

2.2.3.3 Dipnetting

Dipnetting was conducted at two of the 16 locations using long-handled, standard D-frame dip nets with No. 0 Nitex mesh bags. The bags were 18 inches in diameter and 12 inches deep. Dip net samples were collected by making numerous sweeping passes in and around objects, structures, or macrophytes that could have provided cover for larval and juvenile fish. At Location 301, located just upstream of the Will County Station, dipnetting was conducted along the vertical channel wall. Sampling at this location was conducted by making numerous vertical sweeps from the surface to a depth of ~10-feet, carefully keeping the net in close contact with the wall. Approximately 30 man minutes were spent dipnetting at each location.

2.2.3.4 Towed Nets

Mid-channel tow samples were collected at five locations. Each collection consisted of one subsurface and one near-bottom sample at each location. Tow samples were collected using 0.5 meter diameter conical plankton nets constructed of No. 0 mesh Nitex. Each net was equipped with a calibrated flowmeter to determine the volume sampled. Approximately 50 cubic meters of water was filtered by each net tow. The purpose of the flow meter was to evaluate whether or not clogging was a problem. Clogging was not observed during the study. Due to access constraints placed on us by Material Service Corporation, the samples at Location 301 near the Will County Station were collected midday. At other locations, samples were collected in the evening, typically just before sunset.

2.2.3.5 Stationary Net

Mid-channel stationary net sampling was conducted only in the upper Des Plaines River (Location 304), and was conducted in lieu of light trapping which was not possible because of high current velocities and insufficient depth. Because of the shallow nature of the upper Des Plaines River ($\leq$ 0.4 m), the net filtered the entire water column. Samples were collected using a 0.5 meter diameter conical plankton net constructed of No. 0 mesh Nitex that was attached to a 40 cm square frame. The net was equipped with a calibrated flowmeter to determine the volume sampled. The purpose of the flow meter was to evaluate whether or not clogging was a problem. Clogging was not observed during the study. However, during the week of 15 May the bridle of the net was fouled with periphyton causing an erroneous flow meter reading. The net was set at sunset and left in place for 30-40 minutes. Greater than 50 cubic meters of water was filtered during each net set.

2.2.3.6 Light Trapping

Light trapping was conducted at 16 of the 18 locations. Where appropriate, each location consisted of one vegetation sample (a composite of up to three samplers set in macrophyte beds) and one non-vegetation sample (a composite of up to three samplers set in non-vegetated areas). Where appropriate, light traps were distributed throughout a location to provide good areal coverage and to sample either different macrophyte beds in case of the vegetation samplers, or different microhabitats in case of the non-vegetation samplers (Appendix B). Light trapping was conducted from sunset to approximately three hours after sunset. Each light trap was deployed for a minimum of 30 minutes. The quatrefoil light traps were patterned after those described by Secor et al. 1992, with the light source modified as per Floyd et al. 1984a. This modification consisted of replacing a chemical stick with a "mini mag light" and a spirally grooved rod that distributes the light evenly all around. The slit widths of the quatrefoil traps ranged from two to five mm. Upon retrieval of each light trap, a dip net was placed underneath the sampler in order to collect fish that may have escaped through the slits as the trap was lifted out of the water. Since light traps were a last minute addition to the program and were not readily available, light trapping did not commence until the first week in May. The light traps were built by Southern Illinois University.

2.2.3.7 Physical Examination of Vegetation

This technique was designed to collect fish eggs. Sampling consisted of collecting representative numbers of randomly selected plant stems and leaves from various portions of the vegetated area. One crew member would carefully visually examine plant material for presence of ichthyoplankton, while the other crew member vigorously rinsed plant material in a benthos sieve to remove ichthyoplankton. If no fish eggs or larvae were observed during this procedure, plant material was discarded. However, when ichthyoplankton were encountered, the plant material and the ichthyoplankton were placed in a labeled container. Physical examination of vegetation was conducted for approximately 20 man minutes at each location.

All samples collected were preserved with 10 percent formalin containing rose bengal.

2.2.4 Physicochemical Measurements

Water temperature and dissolved oxygen were measured each time a sample was collected. These measurements were taken in close proximity to the depth and location where the sample was collected. Instruments used to measure temperature are factory calibrated every six months, and were checked against a calibrated thermometer before each sampling trip. Instruments used to measure dissolved oxygen were calibrated in the field immediately before each sampling day using the Winkler method as specified in "Standard Methods for the Examination of Water and Wastewater" (current edition).

2.3 LABORATORY

Upon arrival in the laboratory, all ichthyoplankton samples were logged on a sample control sheet. Before being sorted, ichthyoplankton samples were rinsed on a No. 30 U.S. Standard sieve to remove excess detritus and formalin. All fish eggs and larvae were then handpicked from the debris with the aid of an illuminated magnifier. Five percent of the samples were resorted for quality assurance purposes. Subsampling was conducted on only four samples, three due to large numbers of larvae and one due to large numbers of eggs. These samples were split with a Folsom Plankton Splitter. The larval samples were split until approximately 500 specimens remained. The egg sample was split until approximately 1,000 eggs remained. Ichthyoplankton identifications were made with the aid of a dissecting scope equipped with polarizing lenses. Ichthyoplankton identifications were made to the lowest practical taxonomic level using current references and taxonomic keys. Depending on the taxa, this could mean species, genera, or a species group. To improve accuracy and ensure consistency during the identification process, we used two larval fish taxonomists who worked side by side during most of the identification process. This enabled them to pass specimens back and forth, providing a good level of confidence for the level of identifications presented here. Furthermore, a larval fish voucher series, which contained specimens of each taxa identified, was compiled and sent to Dr. Robert Wallus of the Tennessee Valley Authority for verification.

Fish larvae were categorized as yolk-sac, post yolk-sac, or juvenile (Auer 1982):

Yolk-sac larvae	Phase of development from the moment of hatching to complete absorption of yolk.
Post yolk-sac	Phase of development from complete absorption of yolk to the development of the full complement of adult fin rays and absorption of finfold. (The post yolk-sac phase, as defined here, does not occur for the Ictaluridae family).
Juvenile	Complete fin ray development and finfold absorption.

Total counts by taxa and life stages were recorded for each sample.

2.4 DATA HANDLING

Field and laboratory data were entered on forms compatible for computer entry following serialization, diga-coding, and QA/QC checks. Data were managed in a SAS format (SAS 1988a, 1988b) to provide flexibility in reporting study results.

3. RESULTS AND DISCUSSION

3.1 OBSERVATIONS OF THE SYSTEM

3.1.1 Availability of Mesohabitat Types

Mesohabitat types available to fishes within the study area include main channel, main channel border, side channel, artificial embayment, slough, tailwater, tributary mouth, and tributary delta (Table 5). Main channel, main channel border, artificial embayment, and tributary mouth are the only mesohabitats found in all three pools (i.e., Lockport, Brandon, and upper Dresden Pools) (Table 6). However, their areal extents (based on percent of total surface area) vary among pools.

Main channel composes approximately 79 percent of the surface area in both the Lockport and Brandon Pools, but only 36 percent of the upper Dresden Pool. Conversely, main channel border composes a larger percentage in the upper Dresden Pool (29 percent) than in either of the upper two pools (10 and 13 percent). Main channel and main channel border are the most prevalent mesohabitats throughout the entire waterway (Table 6). Seven main channel border locations were sampled during the study; three locations in Lockport Pool, one location in Brandon Pool, and three locations in upper Dresden Pool (Figure 1 and Table 7). Five main channel locations were sampled during the study; three locations in Lockport Pool and two locations in upper Dresden Pool (Figure 1 and Table 7).

Artificial embayments are well distributed throughout the system (16 of 40 reaches). They are most prevalent in Lockport Pool where they compose 10 percent of the total surface area compared to only one or two percent in Brandon and upper Dresden Pools. However, most artificial embayments are active barge slips and cannot be sampled safely and effectively due to constant traffic. Two artificial embayments were sampled during the study and both are in Lockport Pool (Figure 1 and Table 7). These two artificial embayments represent the only artificial embayments in the study area that are not active barge slips; however, Location 104 is used by tow boats as a turning basin.

The tributary mouth mesohabitat composes only one or two percent of the total surface area within each of the three pools. Two tributary mouth locations were sampled during the study: the upper Des Plaines River in Brandon Pool and the mouth of Jackson Creek in upper Dresden Pool (Figure 1 and Table 7). Since the physical habitats of these two tributary mouths are distinctly different, their results are presented separately. The physical habitat in the upper Des Plaines River is primarily riffle/run and consists primarily of hard substrates; very different from the mouth of Jackson Creek. The habitat features in the upper Des Plaines River are most similar to that observed within the Brandon tailwater. These two areas are the only areas of the UIW (besides possibly some tributaries to upper Dresden Pool) that contain riffle/run habitats. It should be noted that the lower approximately two miles of the upper Des Plaines River becomes inundated with water from the Chicago Sanitary and Ship Canal (containing markedly lower dissolved oxygen) when the Metropolitan Water Reclamation District of Greater Chicago lowers the level of Lockport Pool in preparation of a storm event.

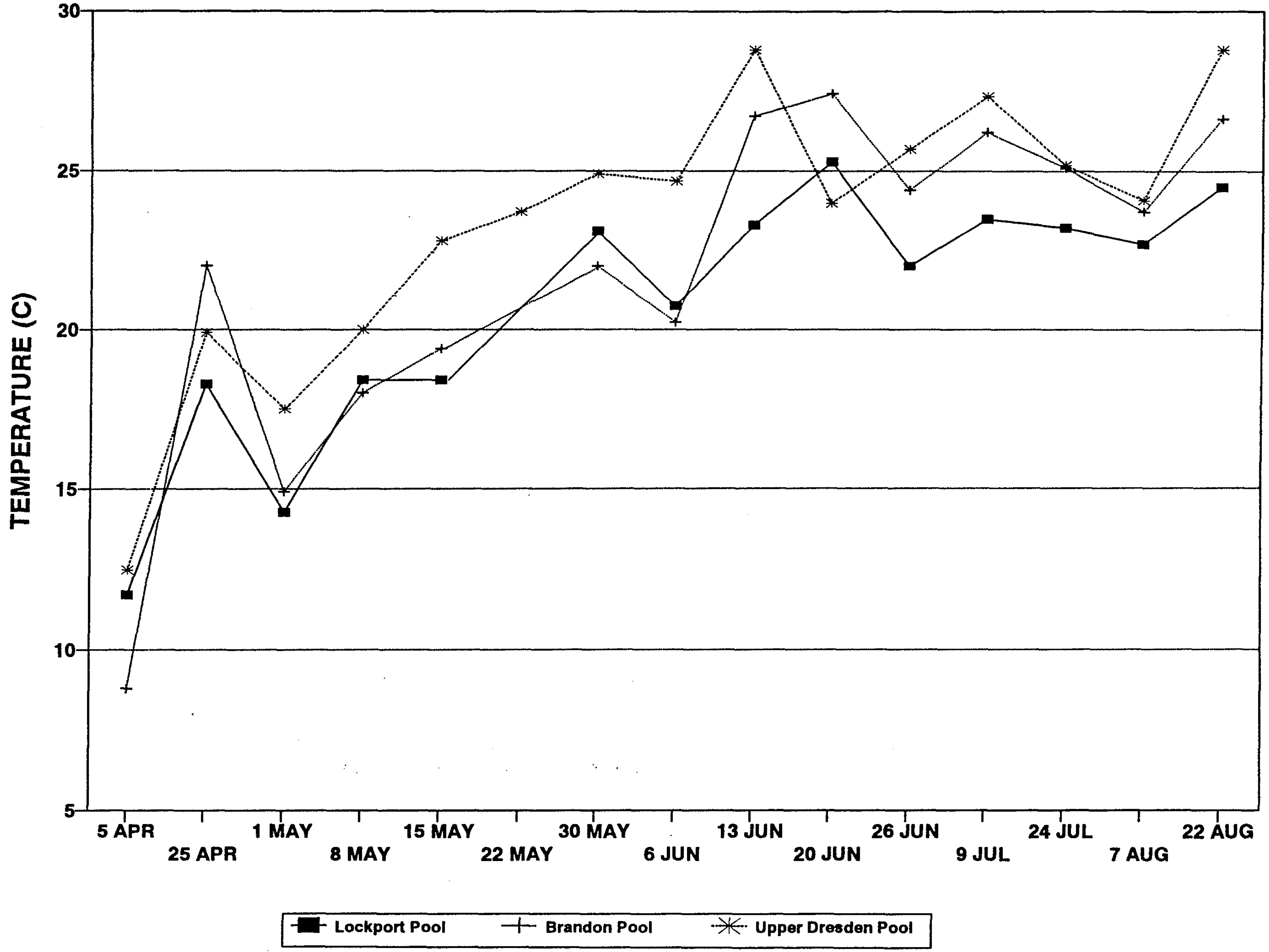
Water from the Ship Canal is discharged through the sluice gates at RM 293.1 into the upper Des Plaines River. When this occurs, water levels within the upper Des Plaines River can rise approximately six feet in a matter of minutes (Heiderscheidt 1994, personal communication). The mouth of Jackson Creek is functionally a quiet, backwater area. Compared to other backwaters in upper Dresden Pool (i.e., side channel, slough, and tributary delta), this location is smaller and deeper, better protected from wind and wave action, and contains more boulder/slab and "clean" gravel substrates, particularly in deep, nearshore areas.

The remaining four mesohabitats are limited in the UIW both in terms of areal extent and distribution within the waterway. The side channel, slough, and tributary delta mesohabitats are confined to upper Dresden Pool and each of these mesohabitats were sampled during the study. For comparative purposes, these three mesohabitats as well as artificial embayment were combined under the broader habitat category of backwater. The tailwater mesohabitat is present in Brandon Pool (Lockport Dam tailwater) and upper Dresden Pool (Brandon Dam tailwater); however, their physical habitats are quite different. The Lockport Dam tailwater is a high velocity, turbulent, main channel mesohabitat, whereas the Brandon Dam tailwater is more diverse and contains a variety of riffle/run habitats. The Brandon tailwater was sampled during this study. It should be noted that the water level in the Brandon tailwater can fluctuate noticeably several times a day. During the study, we observed the water level rise and fall approximately one foot over a 15-minute period. These water level fluctuations could cause eggs and larvae to become displaced into areas that become dry after the water recedes or into isolated pools that may eventually become anoxic.

3.1.2 Seasonal Temperatures

A comparison of mean water temperatures among the three pools is presented in Figure 3. Mean, minimum, and maximum water temperatures for each sampling location and trip are provided in Appendix D. No temperature data are available from Lockport and Brandon Pools during the week of 22 May, as the data was lost in the field. Mean temperatures fluctuated markedly during the first three weeks of the study. From the week of 5 April to the week of 25 April temperatures increased by 6.6 to 13.2 C in each of the three pools. The largest increase (13.2 C) was observed in Brandon Pool and was due to temperatures in the upper Des Plaines River being the coolest during the week of 5 April and the warmest during the week of 25 April. From the week of 25 April to the week of 1 May temperatures decreased by 2.4 to 7.1 C in each of the three pools. The largest decrease (7.1 C) was observed in Brandon Pool and was again due to temperatures in the upper Des Plaines River. From the week of 1 May through the week of 13 June temperatures consistently increased (except during the week of 6 June) in all pools and were consistently highest in upper Dresden Pool and lower, but typically similar between Lockport and Brandon Pools. During the week of 20 June temperatures continued to increase in Lockport and Brandon Pools, but decreased in upper Dresden Pool. This decrease was due to a storm event that occurred midweek during sampling in upper Dresden Pool, but after sampling had been completed in the upper two pools. During the week of 26 June temperatures decreased in Lockport and Brandon Pools due to the storm event the previous week, but increased in upper Dresden Pool. Beginning the week of 26 June and

FIGURE 3. TEMPORAL COMPARISON OF MEAN WATER TEMPERATURES AMONG SEGMENTS.



extending through the end of the study, temperatures were similar between Brandon and upper Dresden Pools, and consistently cooler in Lockport Pool.

3.1.3 Seasonal Dissolved Oxygen

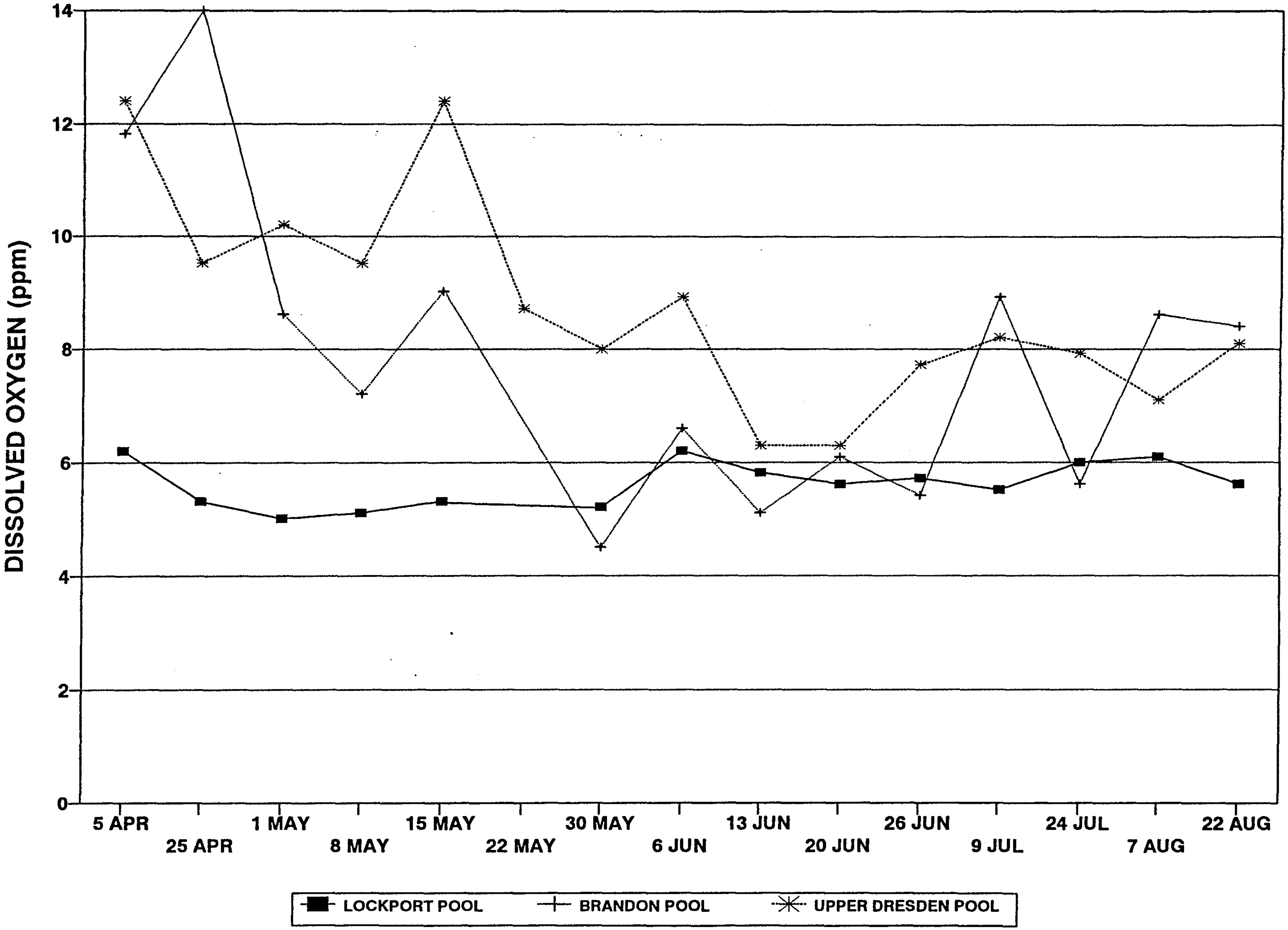
A comparison of mean dissolved oxygen values (DOs) among the three pools is presented in Figure 4. Mean, minimum, and maximum DO values for each sampling location and trip are provided in Appendix D. No DO data are available from Lockport and Brandon Pools during the week of 22 May, as the data was lost in the field. Thus, data are available from these two pools for 14 of the 15 sampling events.

Mean DOs in Lockport Pool were similar throughout the study period, ranging from 5.0 to 6.2 ppm. They were consistently lower than mean values in upper Dresden Pool. Minimum DO values in Lockport Pool were below the State standard of 4.0 ppm for Secondary Contact Waters during nine of the 14 sampling events (2.3-3.8 ppm) (Appendix D).

Mean DOs in Figure 4 for Brandon Pool represent means of values collected from the upper Des Plaines River (tributary mouth) and main channel border Location 309 in Brandon Pool proper. Mean DOs during each sampling event in the upper Des Plaines River were consistently at least 1.5 times higher than in Brandon Pool proper, except during the week of 24 July when mean DOs were similar between these two locations (5.5 and 5.6 ppm) (Appendix D). Throughout the study period, mean DOs in Brandon Pool proper were similar to or lower than mean values observed in Lockport Pool and were consistently lower than mean values in upper Dresden Pool (Figure 4 and Appendix D). Minimum DO values in Brandon Pool were below the State standard of 4.0 ppm for Secondary Contact waters during three of the 14 trips (2.8-3.8 ppm) (Appendix D). Conversely, DOs in the upper Des Plaines River were consistently above 4.0 ppm (Appendix D). Mean DOs at this location were typically (nine of 14 sampling events) above 10 ppm. In addition, mean DOs of greater than 13 ppm were observed during six of the 14 sampling events and these high values (except for the week of 5 April) were likely due to photosynthetic activities by periphyton. The high DO value (17.3 ppm) during the week of 5 April was attributable, at least in part, to the cold water temperature (6.4 C) (Appendix D).

Mean DOs in upper Dresden Pool exhibited a general decline throughout the study period (Figure 4). Mean DOs were higher during the first five sampling events (9.5-12.4 ppm) than during the subsequent 10 sampling events (6.3-8.9 ppm). Mean DOs at each sampling location during the first five sampling events were typically higher than their respective mean values during the subsequent 10 trips (Appendix D). In addition, atypically high DOs (12.8-30.2 ppm) were frequently observed during this period at backwater Locations 405 (Treats Island side channel) and 414 (Bear Island slough), as well as tributary mouth Location 405 (mouth of Jackson Creek). The exceptionally high DO value of 30.2 ppm was measured (by the Winkler method) at Location 414 (Bear Island slough) during the week of 1 May and some cyprinid mortality was observed. During the subsequent 10 sampling events, atypically high DO values were observed less frequently, but when they occurred they were typically measured at backwater locations and/or the tributary mouth location (Appendix D).

FIGURE 4. TEMPORAL COMPARISON OF MEAN DISSOLVED OXYGEN VALUES AMONG SEGMENTS.



These atypically high DO values were likely attributable to photosynthetic activities of macrophytes, phytoplankton, and/or periphyton. Throughout the study period, mean DOs were typically higher in the backwater and tributary mouth locations than at either the main channel, main channel border, or tailwater locations (Appendix D). Mean DOs were lowest during the weeks of 13 and 20 June which coincided with a high flow event. These lower mean DOs were likely due to larger than normal volumes of water with lower DO being dumped from Brandon Pool into upper Dresden Pool. No DO values less than 4.0 ppm were measured in the Secondary Contact waters between I-55 and the Brandon Dam. DOs in the General Use waters downstream of I-55 were consistently above the State standard of 5.0 ppm.

3.2 TAXONOMIC COMPOSITION

3.2.1 Overview

The primary objective of the study was to identify which of a predefined list of fish species, having access (as adults) to the UIW, were actually spawning in the system, where and when. Consequently, our ability to identify individual eggs and larvae to the species level was critical. Those readers not familiar with larval fishes should understand that the taxonomy of larval fishes in not nearly as advanced as that for adult fishes. Many larval fishes, particularly cyprinids and percids, either remain to be described or are not adequately described for all life stages (Hoyt 1988; Fuiman et al. 1983; Holland-Bartels 1990). Furthermore, many of the characters (e.g., pigmentation patterns) used to describe larval fish are qualitative, rather subjective, and change as the larvae develop. Even quantitative characters (e.g., myomere counts) show considerable overlap among species and can vary geographically and temporally for a given species (Bosley and Conner 1984). Thus, even common taxa (e.g., *Lepomis*) often cannot be assigned to the species level (Conner 1979; Lathrop 1982; Holland-Bartels 1990). In this study, we made every effort to provide species level identifications; however, the state-of-the-art is such that many cyprinid, *Moxostoma*, and *Lepomis* larvae cannot be identified to species. We resolved some dichotomies based on where larvae were collected. Similarly, in some cases, the relative abundance of adult fishes offers insight into what species are likely represented among the higher taxonomic groupings. For example, we were able to positively identify only one green sunfish juvenile; however, it is a reasonable assumption that many of the *Lepomis* larvae we could not identify to the species level represent this species. Similarly, it is safe to say that many of the unidentified *Pimephales* we identified were bluntnose minnows, by far the most common *Pimephales* in the study area (EA 1995). The problem is that there is no way to determine the exact breakdown of species within these higher level groupings.

As is common in larval fish studies, we typically could sort specimens into different "species", but could not determine which species the sorted specimens represented. In such cases, we followed normal convention and assigned letter codes (i.e., A, B, C, etc.) to these "species" (e.g., Floyd et al. 1984b). Thus, in Table 8, *Lepomis* is differentiated into *Lepomis* A, *Lepomis* B, *Lepomis* C, *Lepomis* D, in addition to unidentified *Lepomis*. Similarly, many cyprinids were separated into Cyprinid A, Cyprinid C, etc. (Appendix E), but they were grouped into unidentified cyprinids in Table 8. In those cases when we identified specimens by a "letter", we feel confident that each "lettered" group represents a different species, but taxonomic keys are not available that allow us to give these "lettered" groups a species name. As new and better taxonomic information becomes available, it might be possible to go back and assign species names to these "lettered" groups.

We referred to three cyprinids as "types": emerald shiner type, spottail shiner type, and striped shiner type. In these instances, the use of the word "type" indicated that the specimens in question agree well with the species to which it was assigned, but we could not be 100 percent certain that it in fact was that species. For example, in all likelihood specimens listed as emerald shiner type are probably emerald shiners. However, there is a small probability that they are not emerald shiners, but are rather a closely related species that shares many of the same larval characteristics with emerald shiner. Our approach to the identification of ichthyoplankton during this study was appropriate as evidenced by the conservative approach Dr. Robert Wallus, a noted larval fish expert, took when he verified the voucher specimens.

3.2.2 Potential Spawners

Of the 101 species of fishes reported from the UIW since 1971 (Table 1) which could represent potential spawners, a number of them can be eliminated from further consideration. We eliminated American eel and the salmonids (five species) from consideration as potential spawners because they do not spawn in the UIW. American eel spawns in the ocean and the salmonids do not spawn in the UIW due to lack of appropriate spawning habitat. We also eliminated three stocked species (threadfin shad, muskellunge, and striped bass), two exotic aquarium or bait fishes (oriental weatherfish and rudd), and 17 species (shortnose gar, bowfin, mooneye, silverjaw minnow, common shiner, speckled chub, silver chub, rosyface shiner, creek chub, highfin carpsucker, blue sucker, spotted sucker, brown bullhead, stonecat, brook stickleback, warmouth, and blackside darter) that are extremely rare in the UIW; some of these 17 species have not been collected for five or more years (e.g., bowfin), while others are collected primarily from the mouth of the Kankakee River (e.g., blackside darter) or downstream of Dresden Lock and Dam (e.g., speckled chub). In fact, all of the 28 species listed above have been represented typically by five or fewer specimens from up to 24 years of CECo-sponsored monitoring (EA 1993a, 1993b, 1994, 1995; LMS 1993b). Thus, our list of potential spawners includes 73 species (including three state-listed species) (Table 8).

Three state-listed species have been collected from the UIW: pallid shiner (endangered), river redhorse (threatened), and greater redhorse (endangered) (EA 1993a, 1993b, 1994, 1995). These species are rare in the UIW, particularly in upper Dresden Pool, but have been included in Table 8 because they warrant special consideration since they are listed. Only one specimen of pallid shiner has been reported from the UIW. It was collected downstream of Dresden Lock and Dam in 1987 (EA 1988). This specimen probably came from the population known to inhabit the Kankakee River. Pallid shiner could not be assigned to a guild since nothing is known about its spawning habits (Kwak 1991). River redhorse has been collected from the UIW in five of the past six years, primarily in lower Dresden Pool. However, four specimens have been reported in upper Dresden Pool (two in 1991 and two in 1994), primarily from the Brandon tailwater (EA 1995). These specimens probably were from the Kankakee River

TABLE 8. NUMBER AND RELATIVE ABUNDANCE OF LARVAL AND JUVENILE FISHES COLLECTED DURING THE ICHTHYOPLANKTON STUDY, 1994.

	NUMBER CAUGHT #	%
NONGUARDERS		
Open Substrate Spawners		
Pelagophils (pelagic spawners)		
EMERALD SHINER	201	0.92
EMERALD SHINER type	420	1.93
FRESHWATER DRUM	3	0.01
Litho-pelagophils (rock & gravel spawners with pelagic larvae)		
GIZZARD SHAD	4975	22.83
UNID DOROSOMA	27	0.12
GOLDEYE	0	--
WALLEYE	0	--
Lithophils (rock & gravel spawners with benthic larvae)		
SKIPJACK HERRING	P[a]	
ALEWIFE	P[a]	
UNID ALOSA	179	0.82
RAINBOW SMELT	1	<0.005
BIGMOUTH SHINER	5	0.02
SUCKERMOUTH MINNOW	?[b]	
WHITE SUCKER	236	1.08
WHITE SUCKER/N. HOG SUCKER	271	1.24
NORTHERN HOG SUCKER	5	0.02
SILVER REDHORSE	P[c]	
RIVER REDHORSE	?	
BLACK REDHORSE	?	
GOLDEN REDHORSE	P[d]	
SHORTHEAD REDHORSE	P[c]	
GREATER REDHORSE	0	--
UNID MOXOSTOMA	312	1.43
UNID CATOSTOMINAE	96	0.44
TROUT-PERCH	0	--
Phyto-lithophils (nonobligatory plant spawners)		
RED SHINER	?	
SPOTFIN SHINER	6	0.03
REDFIN SHINER	?	
(GHOST SHINER)[e]	?	
MIMIC SHINER	?	
RIVER CARPSUCKER	P[f]	
(UNID CARPIODES)	7	0.03
SMALLMOUTH BUFFALO	P[g]	
(UNID ICTIOBINAE)	29	0.13
BLACKSTRIPE TOPMINNOW	6	0.03
BROOK SILVERSIDE	1	<0.005
WHITE PERCH	P[h]	
WHITE BASS	?	
YELLOW BASS	P[c]	
UNID MORONE	6	0.03
YELLOW PERCH	2	0.01
Phytophils (obligatory plant spawners)		
LONGNOSE GAR	2	0.01
CENTRAL MUDMINNOW	0	--
GRASS PICKEREL	0	--
NORTHERN PIKE	0	--
GOLDFISH	81	0.37
COMMON CARP	3757	17.24
CARP/GOLDFISH	248	1.14
GOLDEN SHINER	31	0.14
BIGMOUTH BUFFALO	?	
BLACK BUFFALO	?	

TABLE 8 (cont.)

	NUMBER CAUGHT #	%
NONGUARDERS (cont.)		
Open Substrate Spawners (cont.)		
Psammophils (sand spawners)		
SPOTTAIL SHINER	176	0.81
SPOTTAIL SHINER type	272	1.25
SAND SHINER	34	0.16
QUILLBACK	?	
LOGPERCH	1	<0.005
(UNID PERCINA)	2	0.01
Brood Hiders		
Lithophils (rock and gravel spawners)		
HORNYHEAD CHUB	0	--
SLENDERHEAD DARTER	?	
GUARDERS		
Substrate Choosers		
Phytophils (plant spawners)		
WHITE CRAPPIE	P[c]	
Nest Spawners		
Lithophils (rock and gravel nesters)		
CENTRAL STONEROLLER	3	0.01
BLACK BULLHEAD	0	--
ROCK BASS	1	<0.005
GREEN SUNFISH	1	<0.005
ORANGESPOTTED SUNFISH	P[f]	
BLUEGILL	17	0.08
LONGEAR SUNFISH	?	
LEPOMIS A	137	0.63
LEPOMIS C	16	0.07
LEPOMIS D	4	0.02
(UNID LEPOMIS)	5486	25.18
SMALLMOUTH BASS	1	<0.005
Phytophils (plant material nesters)		
LARGEMOUTH BASS	8	0.04
UNID MICROPTERUS	4	0.02
BLACK CRAPPIE	1	<0.005
(BANDED DARTER)	?	
Speleophils (nest in holes & crevices; undersides of rocks)		
STRIPED SHINER	25	0.11
STRIPED SHINER type	1	<0.005
BLUNTNOSE MINNOW	2923	13.42
FATHEAD MINNOW	89	0.41
BULLHEAD MINNOW	P[c]	
UNID PIMEPHALES	1022	4.69
YELLOW BULLHEAD	1	<0.005
CHANNEL CATFISH	11	0.05
TADPOLE MADTOM	2	0.01
FLATHEAD CATFISH	0	
JOHNNY DARTER	6	0.03
ORANGETHROAT DARTER	P[j]	
RAINBOW/ORANGETHROAT DARTER	2	0.01

TABLE 8 (cont.)

		NUMBER CAUGHT #	%
GUARDERS (cont.)			
Nest Spawners (cont.)			
Polyphils (misc. substrate and material nesters)			
	PUMPKINSEED	P[k]	
	(LEPOMIS B)	7	0.03
Ariadnophils (gluemaking nesters; misc. substates)			
	THREESPINE STICKLEBACK	1	<0.005
BEARERS			
Internal Bearers			
	MOSQUITOFISH	12	0.06
UNASSIGNED			
	UNID CLUPEIDAE	266	1.22
	PALLID SHINER	0	--
	UNID CYPRINID	324	1.49
	UNID POMOXIS	4	0.02
	UNID CENTRARCHID	1	<0.005
	UNID ETHEOSTOMA	2	0.01
	UNID PERCID	2	0.01
	UNIDENTIFIED	17	0.08
	TOTAL FISH	21789	100.00

(a) Skipjack herring and alewife both likely represented by unidentified Alosa.
(b) Question mark (?) indicates that this species may be represented among specimens identified to a higher taxonomy (e.g., genus, family).
(c) Collected as young-of-the-year during the 1994 adult fish study (EA 1995).
(d) Golden redhorse likely represented by unidentified Moxostoma.
(e) Taxa in parentheses are provisionally assigned to a guild.
(f) River carpsucker likely represented by unidentified Carpiodes and/or Ictiobinae.
(g) Smallmouth buffalo likely represented by unidentified Ictiobinae.
(h) White perch likely represented by unidentified Morone.
(i) Orangespotted sunfish likely represented by unidentified Lepomis.
(j) Orangethroat darter likely represented by Rainbow/Orangethroat darter.
(k) Pumpkinseed likely represented by Lepomis B.

population, which is the best in the state (Smith 1979). From 1989-1994, five greater redhorse have been collected from the UIW and all except one of these specimens were collected downstream of Dresden Lock and Dam. In 1993, one greater redhorse was collected from lower Dresden Pool, which represents the only record of the species upstream of Dresden Lock and Dam (EA 1994, 1995). It is unclear whether the specimens collected from the Illinois River are part of a population that resides in the Illinois River itself or are strays from recently discovered populations in the Fox and Vermillion Rivers (Seegert 1991). No YOY specimens have been collected in the UIW for these three listed species and river redhorse is probably the only one of these three species that has any likelihood of spawning in the UIW.

Balon proposed 33 reproductive guilds divided into three major sections, each with two subsections: 1) nonguarders, which ignore eggs and larvae after spawning and either spawn on open substrates or hide their broods, 2) guarders, which protect and/or aerate eggs and larvae after spawning and either choose the substrate on which the brood is reared, or construct a nest to receive the brood, and 3) bearers, which carry their eggs either on or in the parent's body. Sixty-four percent of the potential spawners in the UIW (47 species) were assigned to the "nonguarders" section, 33 percent were assigned to the "guarders" section (24 species), one species (mosquitofish) was assigned to the "bearers" section, and one species (pallid shiner) was unassigned. Fourteen of Balon's 33 guilds were represented by potential spawners.

3.2.3 Larval and Juvenile Fishes

During the 1994 ichthyoplankton study, a total of 21,789 larval and juvenile (=young-of-the-year [YOY]) fish was collected representing conservatively 48 of the 73 potential spawning species (66 percent) and all 14 reproductive guilds represented by the potential spawners (Table 8). These 48 species include five species (bullhead minnow, silver redhorse, shorthead redhorse, yellow bass, and white crappie) that were collected as YOY during the 1994 adult fish study (EA 1995), but were not collected (or at least could not be identified to the species level) during this study. Also included are nine species (skipjack herring, alewife, river carpsucker, smallmouth buffalo, white perch, pumpkinseed, orangespotted sunfish, and orangethroat darter) because they are likely represented among the specimens that were identified to a higher taxonomic level (e.g., genus, family, etc.) based on either their abundance in the adult fish collections or where a particular taxon was collected within the UIW (e.g., Lockport Pool vs. upper Dresden Pool). Conversely, there were 11 species that were definitely not represented by larvae or YOYs in 1994. An additional 14 species may have been represented among specimens identified to a higher taxonomy (Table 8). The distribution of larval and YOY species collected in 1994 can be summarized as follows:

Definitely collected as larvae or YOYs-	39 species
Probably collected as larvae or YOYs-	9 species
Possibly collected as larvae or YOYs-	14 species
Definitely not collected as larvae or YOYs-	11 species
	73 species

The larval/juvenile catch was dominated by *Lepomis* (26.0 percent), clupeidae (25.0 percent; primarily gizzard shad), carp and goldfish (18.8 percent; primarily carp), and *Pimephales* (18.5 percent; primarily bluntnose minnow) (Table 8). These same taxa were also the most abundant taxa collected electrofishing, within the same study area, during the 1994 adult fish collections: clupeidae (29.8 percent; primarily gizzard shad), carp and goldfish (23.0 percent; primarily carp), *Pimephales* (20.0 percent; primarily bluntnose minnow), and *Lepomis* (10.0 percent; primarily green sunfish) (EA 1995). Emerald shiner (2.9 percent), white sucker/n. hog sucker (2.3 percent), spottail shiner (2.1 percent), and *Moxostoma* (1.4 percent) were common in the larval/juvenile catch. These taxa were also common in the 1994 adult fish collections: emerald shiner (2.5 percent), white sucker (2.3 percent), spottail shiner (1.2 percent), and *Moxostoma* (1.1 percent). Conversely, Ictiobinae (carpsuckers/buffalos), channel catfish, largemouth bass, and freshwater drum were common during the adult fish collections (1.5-2.6 percent), but were rare or uncommon (0.01-0.16 percent) in the larval/juvenile collections. All other taxa (excluding unidentified cyprinidae and catostominae) were rare in the larval/juvenile and adult fish collections.

3.2.4 Fish Eggs

During the 1994 ichthyoplankton study, a total of 29,407 fish eggs was collected representing only three identifiable taxa:

Taxa	Number	Percent
Carp	13,136	44.7
Carp/goldfish	250	0.9
Freshwater drum	757	2.6
Unidentified	15,264	51.9
Total	29,407	

As presented above, nearly 45 percent of the fish eggs collected were carp eggs. These eggs were identified to species when two conditions were met: 1) carp were observed spawning during sample collection, and 2) the eggs collected from such areas were consistent with carp eggs as described in the literature. The carp/goldfish eggs were identified as such by observing the characteristic carp or goldfish pigmentation pattern on late embryos through the chorion. Freshwater drum was the only species for which eggs could be positively identified. Of the unidentified eggs, approximately 99 percent of them were demersal, adhesive, of relatively similar size and shape, lacked oil globules, and appeared to be consistent with cyprinid eggs particularly with respect to carp and possibly *Pimephales*. Furthermore, 47 percent of the unidentified eggs were collected during physical examination of vegetation (Appendix C) and carp eggs would be expected to be collected in association with vegetation (Appendix A). Within the remaining approximately one percent, eggs may have been observed for clupeidae, emerald shiner, other cyprinidae (besides carp, *Pimephales*, and emerald shiner), ictaluridae, centrarchidae, *Etheostoma*, and *Percina*; however, eggs of these taxa were extremely rare. Eggs were not observed for goldeye, walleye, white sucker, northern hog sucker, *Moxostoma*, blackstripe topminnow, brook silverside, yellow perch, longnose gar, grass pickerel, northern pike, and mosquitofish (live bearers) based on either the distinct nature of their eggs (e.g., large diameter, filamentous attachments, gelatinous mass, etc.), or that no eggs resembling eggs for these taxa were collected during the periods for which they would have been expected to spawn, or that sampling was not conducted early enough to collect their eggs (i.e., northern pike and grass pickerel).

3.3 SPATIAL AND TEMPORAL DISTRIBUTION

3.3.1 Nonguarders

3.3.1.1 Pelagophils

Both representatives of this guild (emerald shiner and freshwater drum) were collected (Table 8). Selected key features of early ontogeny for this guild include numerous buoyant eggs, none or poorly developed embryonic respiratory organs, little pigment, and no photophobia (Balon 1981).

Emerald shiner

Emerald shiner spawns in nearshore areas of large lakes and large rivers in depths of two to six meters (Appendix A). It spawns over hard sand or mud that is free of detritus, gravel shoals, boulders, and coarse rubble. Eggs are demersal and non-adhesive and are deposited on the substrate. Yolk-sac larvae remain on the substrate for approximately four days; post yolk-sac larvae and juveniles are pelagic. Larval emerald shiners were particularly common in main channel drift samples from the Ohio and upper Mississippi Rivers (Holland-Bartels et al. 1990 and ESE 1992).

Emerald shiner was among the four most abundant species collected within the study area during adult fish collections the past two years (EA 1994, 1995). During this study, it was also an abundant component of the catch (Table 8), and was collected as yolk-sac larvae, post yolk-sac larvae, and juveniles (Appendix C). It probably was also represented by eggs and additional yolk-sac larvae are probably represented in the unidentified cyprinids. Although it was collected in all three pools (i.e., Lockport Pool, Brandon Pool, and upper Dresden Pool), it was abundant in upper Dresden Pool, occasionally collected in Lockport Pool, and rare in Brandon Pool (Table 9). During the 1994 adult fish study, adults were abundant in upper Dresden Pool, uncommon in Brandon Pool, and were rare in Lockport Pool, similar to the spatial pattern exhibited by the early life stages. YOYs of this species were collected in Brandon and upper Dresden Pools during the 1994 adult fish study; none were collected in Lockport Pool (EA 1995).

It was first observed in upper Dresden Pool (week of 22 May) followed four weeks later (week of 20 June) in Lockport and Brandon Pools (Figure 5). Mean water temperatures at initial occurrence were 23.7, 25.3, and 27.4 C, respectively (Figure 3). In upper Dresden Pool, spawning may have been slightly earlier than expected, whereas spawning in Lockport and

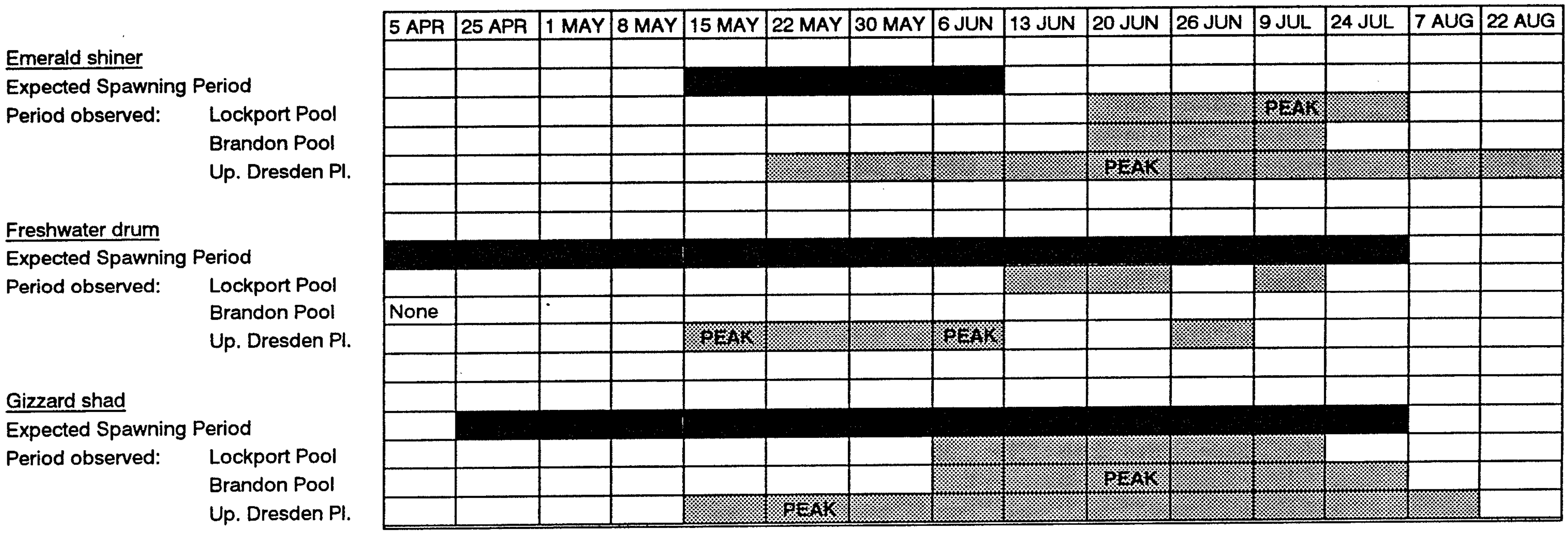
TABLE 9. NUMBER AND RELATIVE ABUNDANCE OF LARVAL AND JUVENILE FISHES COLLECTED WITHIN EACH STUDY SEGMENT.

	LOCKPORT POOL		BRANDON POOL		UPPER DRESDEN POOL		COMBINED	
	#	%	#	%	#	%	#	%
NONGUARDERS								
Open Substrate Spawners								
Pelagophils								
EMERALD SHINER[a]	58	2.20	5	0.19	558	3.39	621	2.85
FRESHWATER DRUM	2	0.08	--	--	1	0.01	3	0.01
Litho-pelagophils								
GIZZARD SHAD[b]	66	2.51	110	4.06	4826	29.34	5002	22.95
Lithophils								
UNID ALOSA	174	6.61	1	0.04	4	0.02	179	0.82
RAINBOW SMELT	1	0.04	--	--	--	--	1	<0.005
BIGMOUTH SHINER	--	--	--	--	5	0.03	5	0.02
WHITE SUCKER	--	--	212	7.83	24	0.15	236	1.08
WHITE SUCKER/N. HOG SUCKER	--	--	--	--	271	1.65	271	1.24
NORTHERN HOG SUCKER	--	--	--	--	5	0.03	5	0.02
SILVER REDHORSE	--	--	P[c]	--	P	--	P	--
SHORTHEAD REDHORSE	--	--	--	--	P	--	P	--
UNID MOXOSTOMA	--	--	57	2.11	255	1.55	312	1.43
UNID CATOSTOMINAE	--	--	22	0.81	74	0.45	96	0.44
Phyto-lithophils								
SPOTFIN SHINER	--	--	5	0.18	1	0.01	6	0.03
(UNID CARPIODES)[d]	--	--	--	--	7	0.04	7	0.03
(UNID ICTIOBINAE)	--	--	--	--	29	0.18	29	0.13
BLACKSTRIPE TOPMINNOW	--	--	3	0.11	3	0.02	6	0.03
BROOK SILVERSIDE	--	--	--	--	1	0.01	1	<0.005
YELLOW BASS	--	--	--	--	P	--	P	--
UNID MORONE	3	0.11	2	0.07	1	0.01	6	0.03
YELLOW PERCH	2	0.08	--	--	--	--	2	0.01
Phytophils								
LONGNOSE GAR	--	--	--	--	2	0.01	2	0.01
GOLDFISH	61	2.32	6	0.22	14	0.09	81	0.37
COMMON CARP	1593	60.48	832	30.74	1332	8.10	3757	17.24
CARP/GOLDFISH	146	5.54	66	2.44	36	0.22	248	1.14
GOLDEN SHINER	12	0.46	2	0.07	17	0.10	31	0.14
Psammophils								
SPOTTAIL SHINER[a]	12	0.46	--	--	436	2.65	448	2.06
SAND SHINER	--	--	--	--	34	0.21	34	0.16
LOGPERCH	--	--	--	--	1	0.01	1	<0.005
(UNID PERCINA)	--	--	--	--	2	0.01	2	0.01
GUARDERS								
Substrate Choosers								
Phytophils								
White crappie	--	--	--	--	P	--	P	--

	LOCKPORT POOL		BRANDON POOL		UPPER DRESDEN POOL		COMBINED	
	#	%	#	%	#	%	#	%
GUARDERS (cont.)								
Nest Spawners								
Lithophils								
CENTRAL STONEROLLER	--	--	--	--	3	0.02	3	0.01
ROCK BASS	--	--	--	--	1	0.01	1	<0.005
GREEN SUNFISH	--	--	--	--	1	0.01	1	<0.005
BLUEGILL	1	0.04	7	0.26	9	0.05	17	0.08
UNID LEPOMIS[e]	41	1.56	1	0.04	5601	34.05	5643	25.90
SMALLMOUTH BASS	--	--	--	--	1	0.01	1	<0.005
Phytophils								
LARGEMOUTH BASS[f]	--	--	--	--	12	0.07	12	0.06
BLACK CRAPPIE	--	--	--	--	1	0.01	1	<0.005
Speleophils								
STRIPED SHINER[a]	--	--	--	--	26	0.16	26	0.12
BLUNTNOSE MINNOW	3	0.11	967	35.72	1953	11.87	2923	13.42
FATHEAD MINNOW	84	3.19	--	--	5	0.03	89	0.41
BULLHEAD MINNOW	--	--	--	--	P	--	P	--
UNID PIMEPHALES	197	7.48	275	10.16	550	3.34	1022	4.69
YELLOW BULLHEAD	--	--	--	--	1	0.01	1	<0.005
CHANNEL CATFISH	--	--	1	0.04	10	0.06	11	0.05
TADPOLE MADTOM	--	--	--	--	2	0.01	2	0.01
JOHNNY DARTER	--	--	--	--	6	0.04	6	0.03
RAINBOW/ORANGETHROAT DARTER	--	--	--	--	2	0.01	2	0.01
Polyphils								
PUMPKINSEED	--	--	--	--	--	--	--	--
LEPOMIS B	7	0.27	--	--	--	--	7	0.03
Ariadnophils								
THREESPINE STICKLEBACK	1	0.04	--	--	--	--	1	<0.005
BEARERS								
Internal Bearers								
MOSQUITOFISH	10	0.38	2	0.07	--	--	12	0.06
UNASSIGNED								
UNID CLUPEIDAE	118	4.48	1	0.04	147	0.89	266	1.22
UNID CYPRINID	39	1.48	128	4.73	157	0.95	324	1.49
UNID POMOXIS	--	--	--	--	4	0.02	4	0.02
UNID CENTRARCHID	1	0.04	--	--	--	--	1	<0.005
UNID ETHEOSTOMA	--	--	--	--	2	0.01	2	0.01
UNID PERCID	--	--	--	--	2	0.01	2	0.01
UNIDENTIFIED	2	0.08	2	0.07	13	0.08	17	0.08
TOTAL FISH	2634	100.00	2707	100.00	16448	100.00	21789	100.00

(a) Includes specimens identified to "type".
(b) Includes unidentified Dorosoma.
c) Collected as young-of-the-year within this study area during the 1994 adult fish study (EA 1995).
d) Taxa in parentheses are provisionally assigned to a guild.
.e) Includes Lepomis specimens identified by a "letter".
(f) Includes unidentified Micropterus.

FIGURE 5. COMPARISONS OF THE PERIOD OF OCCURRENCE FOR EMERALD SHINER, FRESHWATER DRUM, AND GIZZARD SHAD.



Brandon Pools probably occurred when expected (Figure 5). Emerald shiners were most abundant in upper Dresden Pool during the week of 20 June, whereas the peak in Lockport Pool occurred three weeks later (week of 9 July).

Emerald shiners were collected in all mesohabitats, except in the upper Des Plaines River (Table 10). They were most commonly collected from the mouth of Jackson Creek (44.3 percent) in upper Dresden Pool and the backwaters of upper Dresden Pool (27.4 percent) (Table 10 and Appendix C). In Lockport Pool, they were almost exclusively collected in the main channel at Location 301 near Will County Station from the small eroded coves of the vertical rock wall (Appendix C). Adult emerald shiners can be locally abundant near Will County Station (EA 1993a). It appears that emerald shiners in the UIW prefer backwaters and coves for nursery areas. Emerald shiners were collected most frequently by seining and light trapping (Appendix C).

Freshwater drum

Freshwater drum spawns in open water at or near the surface (Appendix A). Eggs are broadcast singly and are demersal or semi-buoyant and pelagic. Yolk-sac larvae are pelagic and can be much more abundant in surface waters upstream of locks and dams than in other areas of a pool in the upper Mississippi River (Holland-Bartels et al. 1990). In the lower Mississippi River, yolk-sac larvae were found to be most abundant during the day, whereas older larvae were most abundant at night (Gallagher and Conner 1983). Post yolk-sac larvae are also pelagic and are found in main channel bottom waters and tend to migrate to the surface at night. Juveniles are benthic and tend to school (Appendix A).

During this study, 757 eggs and only three larvae were collected (Section 3.2.4 and Table 8). All but four of the eggs were collected from upper Dresden Pool, primarily from mid-channel tows at Location 407 (adjacent to Treats Island) (Appendix E). However, this number of eggs is small since one drum can produce between 34,000 and 850,000 eggs (Auer 1982). The remaining four eggs were collected in Lockport Pool; none were collected in Brandon Pool. One yolk-sac larva was collected in upper Dresden Pool, two post yolk-sac larvae were collected in Lockport Pool, and no larvae were collected in Brandon Pool (Table 10). YOY drum were collected from upper Dresden and Brandon Pools during the 1994 adult fish study, but none were collected from Lockport Pool (EA 1995). It is uncertain why few freshwater drum eggs and even fewer larvae were collected in upper Dresden Pool; freshwater drum have been fairly common in this pool during the adult fish studies of the past two years (EA 1994, 1995). It is possible that the drum eggs were flushed downstream and developed outside of the study area as most drum eggs (89 percent) were collected in mid-channel tows at Location 407, the furthest downstream tow location. It is also possible that freshwater drum did not spawn successfully within upper Dresden Pool during 1994. The possibility that the 1994 year class was poor is supported by the fact that only nine YOY drum were collected within upper Dresden Pool in 1994 during the adult fish study (EA 1995), compared to 29 in 1993 (EA 1994). However, the absence or near absence of freshwater drum eggs and larvae in Lockport and Brandon Pools is not surprising as no freshwater drum were collected from Lockport Pool during the adult fish surveys the past two years and it was extremely rare in

TABLE 10. NUMBER AND RELATIVE ABUNDANCE OF LARVAL AND JUVENILE FISHES COLLECTED WITHIN EACH MESOHABITAT TYPE.

	MAIN CHANNEL BORDER		MAIN CHANNEL		BACKWATER		UPPER DES PLAINES		JACKSON CREEK		BRANDON TAILWATER		COMBINED	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%
NONGUARDERS														
Open Substrate Spawners														
Pelagophils														
EMERALD SHINER[a]	85	13.69	56	9.02	170	27.38	--	--	275	44.28	35	5.64	621	2.85
FRESHWATER DRUM	1	33.33	1	33.33	1	33.33	--	--	--	--	--	--	3	0.01
Litho-pelagophils														
GIZZARD SHAD[b]	221	4.42	56	1.12	275	5.50	--	--	4273	85.43	177	3.54	5002	22.95
Lithophils														
UNID ALOSA	14	7.82	142	79.33	23	12.85	--	--	--	--	--	--	179	0.82
RAINBOW SMELT	--	--	1	100.0	--	--	--	--	--	--	--	--	1	<0.005
BIGMOUTH SHINER	--	--	--	--	--	--	--	--	--	--	5	100.0	5	0.02
WHITE SUCKER	21	8.90	--	--	2	0.85	212	89.83	--	--	1	0.42	236	1.08
WHITE SUCKER/N. HOG SUCKER	148	53.82	--	--	3	1.09	--	--	1	0.36	119	43.27	271	1.24
NORTHERN HOG SUCKER	--	--	--	--	1	20.00	--	--	4	80.00	--	--	5	0.02
SILVER REDHORSE	P[c]	--	--	--	--	--	--	--	--	--	--	--	P	--
SHORTHEAD REDHORSE	P	--	--	--	--	--	--	--	--	--	--	--	P	--
UNID MOXOSTOMA	75	24.04	--	--	22	7.05	57	18.27	1	0.32	157	50.32	312	1.43
UNID CATOSTOMINAE	24	25.00	--	--	6	6.25	22	22.92	--	--	44	45.83	96	0.44
Phyto-lithophils														
SPOTFIN SHINER	--	--	--	--	1	16.67	5	83.33	--	--	--	--	6	0.03
(UNID CARPIODES)[d]	--	--	--	--	6	85.71	--	--	--	--	1	14.29	7	0.03
(UNID ICTIOBINAE)	--	--	5	17.24	22	75.86	--	--	2	6.90	--	--	29	0.13
BLACKSTRIPE TOPMINNOW	1	16.67	--	--	3	50.00	2	33.33	--	--	--	--	6	0.03
BROOK SILVERSIDE	--	--	--	--	--	--	--	--	1	100.0	--	--	1	<0.005
YELLOW BASS[e]	--	--	--	--	--	--	--	--	--	--	--	--	P	--
UNID MORONE	2	33.33	4	66.67	--	--	--	--	--	--	--	--	6	0.03
YELLOW PERCH	--	--	2	100.0	--	--	--	--	--	--	--	--	2	0.01
Phytophils														
LONGNOSE GAR	--	--	--	--	1	50.00	--	--	--	--	1	50.00	2	0.01
GOLDFISH	38	46.91	16	19.75	25	30.86	--	--	2	2.47	--	--	81	0.37
COMMON CARP	1800	47.91	399	10.62	648	17.25	473	12.59	270	7.19	167	4.45	3757	17.24
CARP/GOLDFISH	74	29.84	23	9.27	60	24.19	65	26.21	21	8.47	5	2.02	248	1.14
GOLDEN SHINER	6	19.35	3	9.68	10	32.26	2	6.45	9	29.03	1	3.23	31	0.14
Psammophils														
SPOTTAIL SHINER[a]	96	21.43	6	1.34	117	26.12	--	--	199	44.42	30	6.70	448	2.06
SAND SHINER	30	88.24	1	2.94	1	2.94	--	--	--	--	2	5.88	34	0.16
LOGPERCH	--	--	--	--	--	--	--	--	1	100.0	--	--	1	<0.005
(UNID PERCINA)	--	--	--	--	1	50.00	--	--	1	50.00	--	--	2	0.01
GUARDERS														
Substrate Choosers														
Phytophils														
WHITE CRAPPIE[f]	--	--	--	--	--	--	--	--	--	--	--	--	P	--
Nest Spawners														
Lithophils														
CENTRAL STONEROLLER	--	--	--	--	1	33.33	--	--	--	--	2	66.67	3	0.01
ROCK BASS	--	--	--	--	1	100.0	--	--	--	--	--	--	1	<0.005
GREEN SUNFISH	--	--	--	--	--	--	--	--	--	--	1	100.0	1	<0.005
BLUEGILL	--	--	1	5.88	6	35.29	7	41.18	2	11.76	1	5.88	17	0.08
UNID LEPOMIS[g]	39	0.69	--	--	346	6.13	1	0.02	5256	93.14	1	0.02	5643	25.90
SMALLMOUTH BASS	--	--	--	--	--	--	--	--	--	--	1	100.0	1	<0.005

TABLE 10 (cont.)

	MAIN CHANNEL BORDER		MAIN CHANNEL		BACKWATER		UPPER DES PLAINES		JACKSON CREEK		BRANDON TAILWATER		COMBINED	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%
GUARDERS (cont.)														
Nest Spawners (cont.)														
Phytophils														
LARGEMOUTH BASS[h]	2	16.67	--	--	--	--	--	--	6	50.00	4	33.33	12	0.06
BLACK CRAPPIE	--	--	--	--	1	100.0	--	--	--	--	--	--	1	<0.005
Speleophils														
STRIPED SHINER[a]	3	11.54	--	--	13	50.00	--	--	2	7.69	8	30.77	26	0.12
BLUNTNOSE MINNOW	929	31.78	3	0.10	216	7.39	962	32.91	156	5.34	657	22.48	2923	13.42
FATHEAD MINNOW	79	88.76	5	5.62	2	2.25	--	--	1	1.12	2	2.25	89	0.41
BULLHEAD MINNOW[i]	--	--	--	--	P	--	--	--	--	--	--	--	P	--
UNID PIMEPHALES	208	20.35	77	7.53	58	5.68	254	24.85	67	6.56	358	35.03	1022	4.69
YELLOW BULLHEAD	--	--	--	--	--	--	--	--	--	--	1	100.0	1	<0.005
CHANNEL CATFISH	--	--	9	81.82	1	9.09	1	9.09	--	--	--	--	11	0.05
TADPOLE MADTOM	--	--	--	--	--	--	--	--	1	50.00	1	50.00	2	0.01
JOHNNY DARTER	--	--	--	--	6	100.0	--	--	--	--	--	--	6	0.03
RAINBOW/ORANGETHROAT DARTER	--	--	--	--	--	--	--	--	--	--	2	100.0	2	0.01
Polyphils														
PUMPKINSEED	--	--	--	--	--	--	--	--	--	--	--	--	--	--
LEPOMIS B	3	42.86	--	--	4	57.14	--	--	--	--	--	--	7	0.03
Ariadnophils														
THREESPINE STICKLEBACK	--	--	1	100.0	--	--	--	--	--	--	--	--	1	<0.005
BEARERS														
Internal Bearers														
MOSQUITOFISH	1	8.33	9	75.00	--	--	2	16.67	--	--	--	--	12	0.06
UNASSIGNED														
UNID CLUPEIDAE	16	6.02	106	39.85	15	5.64	--	--	124	46.62	5	1.88	266	1.22
UNID CYPRINID	44	13.58	34	10.49	40	12.35	127	39.20	53	16.36	26	8.02	324	1.49
UNID POMOXIS	--	--	--	--	--	--	--	--	4	100.0	--	--	4	0.02
UNID CENTRARCHID	--	--	1	100.0	--	--	--	--	--	--	--	--	1	<0.005
UNID ETHEOSTOMA	--	--	--	--	2	100.0	--	--	--	--	--	--	2	0.01
UNID PERCID	--	--	--	--	1	50.00	--	--	--	--	1	50.00	2	0.01
UNIDENTIFIED	1	5.88	--	--	5	29.41	2	11.76	8	47.06	1	5.88	17	0.08
TOTAL FISH	3961	18.18	961	4.41	2116	9.71	2194	10.07	10740	49.29	1817	8.34	21789	100.0

a) Includes specimens identified to "type".
b) Includes unidentified *Dorosoma*.
(c) Collected as young-of-the-year within this study area during the 1994 adult fish study (EA 1995). Silver redhorse was also collected in the mouth of Grant Creek in upper Dresden Pool.
d) Taxa in parentheses are provisionally assigned to a guild.
e) One YOY yellow bass was collected from the mouth Grant Creek in upper Dresden Pool.
(f) All YOY white crappie were collected from the mouth Grant Creek in upper Dresden Pool.
(g) Includes *Lepomis* specimens identified by a "letter".
h) Includes unidentified *Micropterus*.
i) Bullhead minnow were also collected from the mouth of Grant Creek.

Brandon Pool during this period (EA 1994, 1995). Thus, the eggs and post yolk-sac larvae collected in Lockport Pool represent the only collections of this species for this pool during CECo-sponsored studies the past two years.

Freshwater drum eggs were first observed in upper Dresden Pool (week of 15 May) followed four weeks later (week of 13 June) in Lockport Pool (Figure 5). Mean water temperatures at initial occurrence were 22.8 and 23.3 C, respectively (Figure 3). In both pools, spawning occurred when expected (Figure 5). Freshwater drum eggs were most abundant in upper Dresden Pool during the weeks of 15 May and 6 June. It is interesting to note that no drum eggs were collected in upper Dresden Pool during the weeks of 13 and 20 June, during a period of high flow. The yolk-sac larva in upper Dresden Pool was collected during the week of 22 May, whereas the post yolk-sac larvae in Lockport Pool were collected during the weeks of 20 June and 9 July.

3.3.1.2 Litho-pelagophils

This guild is represented by three potential spawners: gizzard shad, goldeye, and walleye (Table 8). Selected key features of early ontogeny for the guild include adhesive chorion at first, some eggs soon buoyant, after hatching the larvae are pelagic by positive buoyancy or active movement, no photophobia, and limited embryonic respiratory structures. Gizzard shad was the only species of the three that was collected during the study. The absence of eggs, larvae, and juveniles for goldeye and walleye is not surprising since these two species were not collected in Lockport and Brandon Pools during the adult fish collections the past two years and they were extremely rare in upper Dresden Pool during the same period (EA 1994, 1995). Therefore, discussion of this guild will be limited to gizzard shad.

Gizzard shad

Gizzard shad spawns in a variety of habitats over a variety of substrates (Appendix A). Eggs are broadcast singly, demersal, and adhesive; drift with the current slowly sinking to the bottom and adhere to anything they come in contact with. For the first two to four days, yolk-sac larvae repeatedly passively sink and actively swim-up, which concentrates them away from the substrate and toward the surface making them susceptible to currents, wave action, and wind. Post yolk-sac larvae are reported in greatest abundance in areas with little or no current and little or no water fluctuation (i.e., floodplains, backwaters, bays, etc.). Juveniles occur over mud bottoms close inshore, in beds of vegetation, and usually in shallow water. In late summer, large schools are frequently observed near the surface of reservoirs. They exhibit this open water schooling behavior until fall.

Gizzard shad was the second most abundant species collected within the study area during adult fish collections the past two years (EA 1994, 1995). During this study, it was also the second most abundant taxa collected (Table 8), and was collected as yolk-sac larvae, post yolk-sac larvae, and juveniles (Appendix C). It probably was also represented by a few eggs; additional post yolk-sac larvae are probably represented among the unidentified clupeids (all damaged larvae). Although it was collected in all three pools, it was abundant in upper

Dresden Pool, common in Brandon Pool, and occasional in Lockport Pool (Table 9). The distribution of the larval/juvenile catch among the three pools was: upper Dresden Pool = 96 percent, Brandon Pool = 2 percent, and Lockport Pool = 1 percent (Table 9). This is similar to the distribution of the YOYs collected during the 1994 adult fish study: upper Dresden Pool = 86 percent, Brandon Pool = 12 percent, and Lockport Pool = 2 percent (EA 1995). During the 1994 adult fish study, adult gizzard shad were common in upper Dresden Pool, occasionally collected in Lockport Pool, and were uncommon in Brandon Pool, fairly similar to the spatial pattern exhibited by the early life stages and YOYs.

Gizzard shad larvae were first observed in upper Dresden Pool (week of 15 May) followed three weeks later (week of 6 June) in Lockport and Brandon Pools (Figure 5). Mean water temperatures at initial occurrence were 22.8, 20.7, and 20.2 C, respectively (Figure 3). In all three pools, spawning occurred when expected (Figure 5). Gizzard shad were most abundant in upper Dresden Pool during the week of 22 May, whereas the peak in Brandon Pool occurred four weeks later (week of 20 June).

Gizzard shad were collected in all mesohabitats, except for the upper Des Plaines River (Table 10). They were markedly more abundant in the mouth of Jackson Creek (85 percent) in upper Dresden Pool than in any other mesohabitat (one to six percent) (Table 10 and Appendix C). It is uncertain why there was such a large concentration of gizzard shad at this location, particularly compared to other backwater locations in upper Dresden Pool. The mouth of Jackson Creek is functionally a quiet, backwater area. Compared to other backwaters in upper Dresden Pool, this location is smaller and deeper, better protected from wind and wave action, and contains more boulder/slab and "clean" gravel substrates, particularly in deep, nearshore areas. These physical characteristics may make this location a preferred spawning/nursery area for gizzard shad. In upper Dresden Pool, this species was collected primarily by light trapping and seining. In Brandon Pool, all gizzard shad were collected at main channel border Location 309 (directly upstream of the Brandon Road Dam) by light trapping. In Lockport Pool, nearly all gizzard shad were collected in mid-channel tows near Will County Station (Location 301) (Appendix C).

3.3.1.3 Lithophils

This guild is represented by 14 potential spawning species: skipjack herring, alewife, rainbow smelt, bigmouth shiner, suckermouth minnow, white sucker, northern hog sucker, silver redhorse, river redhorse, black redhorse, golden redhorse, shorthead redhorse, greater redhorse, and trout-perch (Table 8). Selected key features of early ontogeny for this guild include deposition of eggs over clean gravel-rock substrates and photophobic larvae that are adapted for living in well-oxygenated interstitial waters. The embryonic respiratory system is only moderately developed in these fishes (Balon 1975, 1981). Nine of the 14 species were represented by larval and/or YOY specimens during this study and/or the 1994 adult fish study (Table 8). We include both skipjack herring and alewife among the nine species. Unidentified *Alosa* was collected in all three pools; based on the adult fish data (EA 1994, 1995), alewife is the likely choice for Lockport Pool and skipjack herring is the likely choice for upper Dresden Pool. Golden redhorse was also included in the nine species as it was likely represented by unidentified *Moxostoma* since it was the second most commonly collected *Moxostoma* in the study area during adult fish studies the past two years (EA 1994, 1995). Among the remaining five species not clearly represented by eggs or larvae, suckermouth minnow, black redhorse, and river redhorse may have been represented by larval/juvenile specimens in the higher taxonomic groupings; greater redhorse (see Section 3.2.2) and trout-perch were not collected (Table 8). These five species are rare in the study area and since no YOY specimens have been collected from the study area during recent adult fish collections (EA 1993a, 1994, 1995), they are excluded from further discussion. Rainbow smelt and bigmouth shiner were rare in the larval/juvenile collections (Table 8) and were not collected during adult fish studies the past two years (EA 1994, 1995). Thus, they will not be discussed further. However, it should be noted that this collection of bigmouth shiner YOYs represents the first record of this species from upper Dresden Pool during CECo-sponsored monitoring (EA 1993a, 1994, 1995). All previous records of this species in the UIW have been from lower Dresden Pool or downstream of Dresden Lock and Dam (EA 1993b). All bigmouth shiners collected during this study came from the Brandon tailwater (Appendix C).

***Alosa* spp.**

Anadromous alewife populations spawn in headwaters of brooks, large rivers, small streams, ponds, and flooded swamplands. Landlocked populations such as those in Lake Michigan retain anadromous habits, moving to headwaters of lakes and in tributaries, shallow bays, and nearshore areas of lakes to spawn. Spawning substrate is quite variable. Eggs are broadcast at random and are demersal, semidemersal, or pelagic. Nearshore waters are important nursery areas. Alewife remain on or near spawning grounds until the late larval stage and move slowly into protected areas on their way to deep water. Larvae are positively phototrophic and pelagic. Juveniles are essentially pelagic until age two (Wallus et al. 1990).

Little is known about the early life history of skipjack herring (Appendix A). Adults migrate upstream in spring and congregate in swift waters below dams. Ripe or ripe and running adults have been collected in a headwater tributary, tailwaters of a dam, and near a shoal area of the Tennessee River (Wallus et al. 1990). Spawning probably occurs in main channel over coarse sand and gravel. No species-specific information is available for eggs and yolk-sac larvae. Post yolk-sac larvae have been collected in main channel drift nets and main channel border larval seines in the Ohio River (ESE 1992). Juveniles are more often collected in pelagic open waters than are larvae (Appendix A).

Alewife and skipjack herring were rare in adult fish collections the past two years (EA 1994, 1995). During 1993 and 1994, alewife was collected from only Lockport Pool. Skipjack herring was collected in all three pools during 1993 and 1994; however, it typically is more common in lower Dresden Pool and downstream of Dresden Lock and Dam. During this study, unidentified *Alosa* was a common component of the catch (Table 8), but was collected only as post yolk-sac larvae (Appendix C). It may have been represented by a few eggs; additional post yolk-sac larvae are probably represented in the unidentified clupeids. No juvenile (YOY) skipjack herring or alewife were collected during this study and none were collected during the 1994 adult fish study (EA 1995). Although unidentified *Alosa* were collected in all three pools, it was common in Lockport Pool and rare in Brandon and upper Dresden Pools (Table 9).

This taxa was first observed in Lockport Pool (week of 20 June) followed by upper Dresden Pool (week of 26 June) and Brandon Pool (week of 9 July) (Figure 6). Mean water temperatures at initial occurrence were 25.3, 25.7, and 26.2 C, respectively (Figure 3). Spawning for this taxa (whether alewife or skipjack herring) occurred when expected (Figure 6). *Alosa* larvae were most abundant in Lockport Pool during the week of 26 June. Although this taxa is likely represented by both alewife and skipjack herring, the specimens collected in Brandon and upper Dresden Pools may represent drift from Lockport Pool (Figure 6).

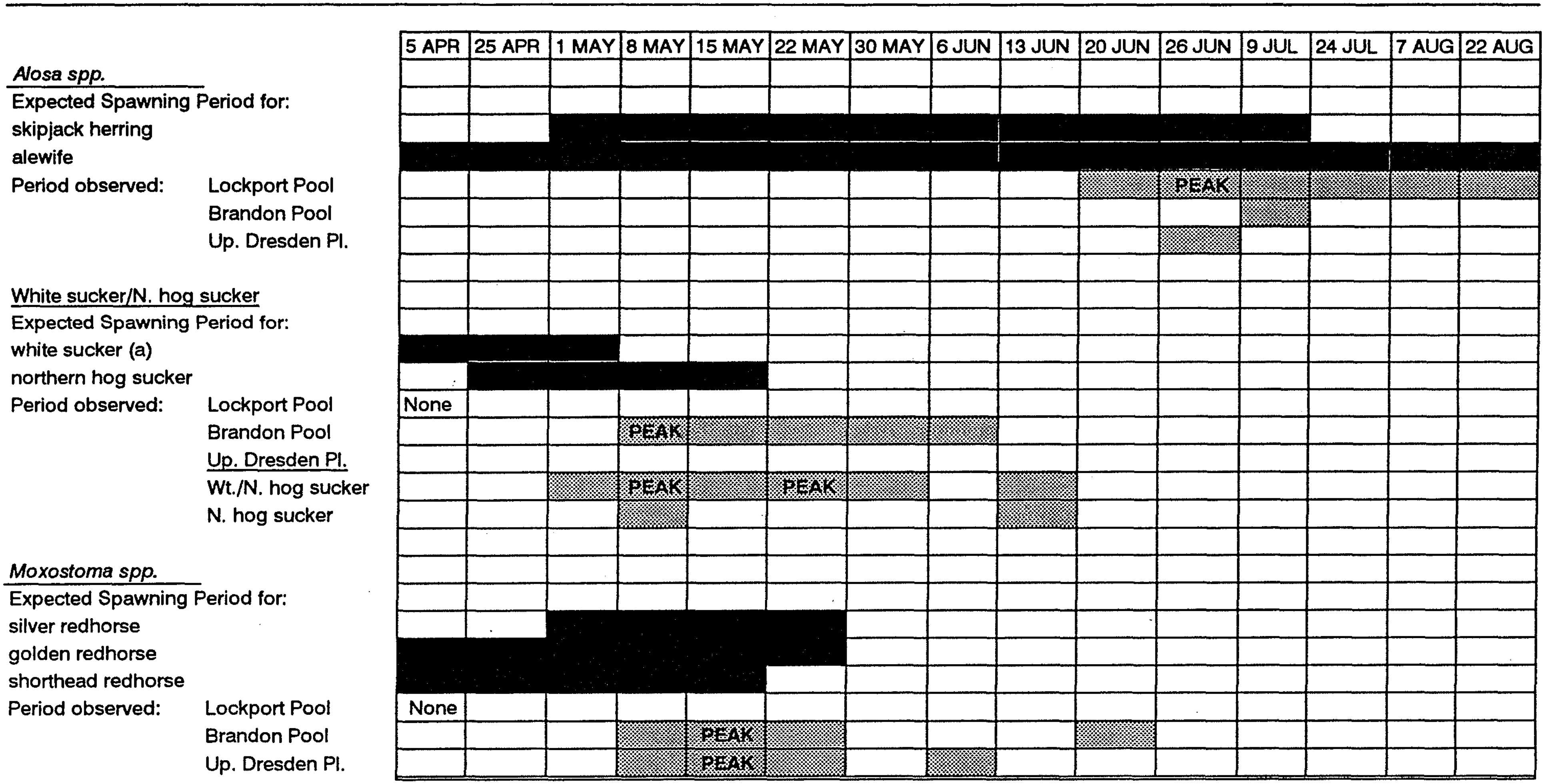
White sucker/Northern hog sucker

We were not able to separate larval white suckers from larval northern hog suckers, but could differentiate late metalarvae and juveniles of these two species. Thus, the yolk-sac larvae, mesolarvae, and early metalarvae specimens collected in upper Dresden Pool were called white sucker/northern hog suckers. However, these same life stages collected from the upper Des Plaines River in Brandon Pool were characterized as white suckers based on the fact that the Metropolitan Water Reclamation District of Greater Chicago (MWRD) has not collected northern hog sucker from the upper Des Plaines River since the late 1970s (Dennison 1994, personal communication).

Northern hog sucker spawns in riffles or in the downstream ends of pools (Becker 1983). Eggs are deposited over loose gravel, and are demersal and nonadhesive (Auer 1982). Northern hog sucker had not been previously collected from the study area in up to 17 years of CECo-sponsored monitoring (EA 1993a, 1994, 1995). The only previous collections of this species within the UIW during CECo-sponsored monitoring had been from either lower Dresden Pool or downstream of Dresden Lock and Dam. In that portion of the waterway, it has been collected in only five of the past 24 years (EA 1993b, 1994, 1995). During this study, only five post yolk-sac larvae were positively identified (Table 8 and Appendix C). All were collected from upper Dresden Pool (Table 9). Four were collected by seining in the mouth of Jackson Creek (Location 408) on 13 May. The other specimen was collected seining in Treats Island side channel (Location 405) near the mouth of the Jackson Creek Diversion Channel on 17 June (Appendix C and Figure 6). These specimens likely drifted into the study area from Jackson Creek. It appears that northern hog sucker spawned when expected (Figure 6), but spawning probably did not take place directly within the UIW. Additional yolk-sac and/or post yolk-sac larvae may have been represented within the white sucker/northern hog sucker and/or unidentified catostominae.

White sucker spawns in tributaries of lakes, streams, backwaters, riffles, and pools over sand or gravel bottoms (Appendix A). Eggs are broadcast in small lots over a considerable area and are demersal, adhesive, and nonadhesive after water hardening. Yolk-sac larvae remain in sand or gravel one to two weeks after hatching. Post yolk-sac larvae school in very shallow water near shore, sometimes in association with aquatic vegetation.

FIGURE 6. COMPARISONS OF THE PERIOD OF OCCURRENCE FOR SELECTED NONGUARDING LITHOPHILS.



(a) Expected spawning period for white sucker begins mid-March.

Juveniles are found in shallow water over muddy bottoms with little vegetation, usually along the shoreline; they may form schools.

Adult white suckers were rare within all three pools during adult fish collections the past two years (EA 1994, 1995). In 1994, YOYs were rare in Lockport and upper Dresden Pools and common in Brandon Pool. During this study, larval and juvenile white suckers and white sucker/northern hog suckers were common in Brandon and upper Dresden Pools; none were collected in Lockport Pool (Table 9). Collectively, white suckers and white sucker/northern hog suckers were represented by yolk-sac larvae, post yolk-sac larvae, and juveniles; eggs were probably not collected. Additional yolk-sac and/or post yolk-sac larvae are likely included within the unidentified catostominae.

Larvae were first observed in upper Dresden Pool (week of 1 May) followed one week later in Brandon Pool (week of 8 May) (Figure 6). Mean water temperatures at initial occurrence were 17.5 and 18.0 C, respectively (Figure 3). Spawning for this taxa (whether white sucker and/or northern hog sucker) appears to have occurred when expected (Figure 6). This taxa was abundant in both pools during the week of 8 May and a second peak occurred in upper Dresden Pool during the week of 22 May.

Collectively, white sucker and white sucker/northern hog sucker larvae were collected in all mesohabitats, except main channel (Table 10). They were rare in backwaters and the mouth of Jackson Creek. They were most commonly collected in the upper Des Plaines River (41.8 percent), main channel border (33.3 percent), and the Brandon tailwater (23.7 percent). Ninety-seven percent of the main channel border catch occurred at Location 402B in upper Dresden Pool (Appendix C), approximately one mile downstream of the Brandon tailwater (Figure 1). These specimens were likely spawned in the Brandon tailwater and settled out of the drift at this location. Thus, it is possible that nearly all of the specimens collected for this taxa were spawned in the upper Des Plaines River and the Brandon tailwater, the only two areas of the UIW (besides possibly some tributaries to upper Dresden Pool) that contain riffle/run habitats. Larval/juvenile white suckers and white sucker/northern hog suckers were collected almost exclusively by dipnetting and seining (Appendix C).

***Moxostoma* spp.**

Silver, golden, and shorthead redhorse typically spawn in riffles with rock, gravel, or boulder substrates (Appendix A). In the upper Mississippi River, *Moxostoma* larvae were usually associated with vegetation in backwater areas (Holland-Bartels et al. 1990). In the Ohio River, larval catostominae were common in main channel tow samples, but rarely abundant (ESE 1992). In a small Kentucky stream, larval *Moxostoma* were primarily associated with a vegetated shoreline and along a bedrock outcrop with algal growth; they were common in seine samples, occasional in light trap samples, but rare in drift net samples; however, no yolk-sac larvae were collected (Floyd et al. 1984b). Juvenile silver and golden redhorse are typically found in slow moving water in areas with soft bottoms. Conversely, juvenile shorthead redhorse are usually found in fast water in streams and rivers.

During the 1993 and 1994 adult fish studies, all *Moxostoma* except one YOY silver redhorse were collected in upper Dresden Pool (EA 1994, 1995). This YOY silver redhorse was collected from Brandon Pool in 1994; no *Moxostoma* were collected in Lockport Pool during this period. During the ichthyoplankton study, no *Moxostoma* were collected in Lockport Pool, but it was occasional in Brandon Pool and common in upper Dresden Pool (Table 9). This taxa was represented by post yolk-sac larvae and juveniles; eggs were not collected. Additional yolk-sac and/or post yolk-sac larvae are likely represented among the unidentified catostominae.

Moxostoma larvae were initially collected in Brandon and upper Dresden Pools during the week of 8 May (Figure 6). Mean water temperatures at initial occurrence were 18.0 and 20.0 C, respectively (Figure 3). Spawning for this taxa probably occurred when expected (Figure 6). This taxa was most abundant in both pools during the week of 15 May.

Moxostoma larvae were collected in all mesohabitats, except main channel (Table 10). They were most commonly collected from the Brandon tailwater (50.3 percent), main channel border (24.0 percent), and the upper Des Plaines River (18.3 percent). They were rare in the mouth of Jackson Creek. Ninety-six percent of the main channel border catch occurred at Location 402B in upper Dresden Pool (Appendix C), approximately one mile downstream of the Brandon tailwater (Figure 1). These specimens were likely spawned in the Brandon tailwater and settled out of the drift at this location. Thus, it is possible that most of the specimens collected for this taxa were spawned in the upper Des Plaines River and the Brandon tailwater, the only two areas of the UIW (besides possibly some tributaries to upper Dresden Pool) that contain riffle/run habitats. *Moxostoma* larvae were collected primarily by dipnetting (Appendix C).

3.3.1.4 Phyto-lithophils

This guild is represented by 13 potential spawning species: red shiner, spotfin shiner, redfin shiner, ghost shiner, mimic shiner, river carpsucker, smallmouth buffalo, blackstripe topminnow, brook silverside, white perch, white bass, yellow bass, and yellow perch (Table 8). This guild represents an intermediary group midway between the reproductive modes of the nonguarding lithophils and the nonguarding phytophils. Selected key features of early ontogeny for the guild include deposition of adhesive eggs in relatively clearwater habitats on submerged vegetation or logs, gravel, and rocks. Larvae are photophobic; have cement glands on the head to attach themselves off the soft bottom and moderately developed respiratory structures (Balon 1975, 1981). Eight of the 13 species were represented by larval and/or YOY specimens during this study and/or the 1994 adult fish study (Table 8). Included among these eight species are river carpsucker, smallmouth buffalo, and white perch. River carpsucker and smallmouth buffalo were included because they were the two most commonly collected Ictiobinae during adult fish studies the past two years (EA 1994, 1995) so they are likely represented among the unidentified *Carpiodes* and/or the unidentified Ictiobinae. Similarly, unidentified *Carpiodes* and Ictiobinae are provisionally assigned to this guild since river carpsucker and smallmouth buffalo were the two most commonly collected Ictiobinae during adult fish studies the past two years. White perch was also among the eight species because unidentified larval *Morone* were collected in Lockport Pool (Table 9) and no other adult or YOY *Morone* spp. have been collected within this pool during adult fish studies the past two years (EA 1994, 1995). Additionally, larval specimens of red shiner, redfin shiner, ghost shiner, mimic shiner, and white bass may be represented among higher taxonomic identifications. Furthermore, eggs may have been collected for all 13 members of this guild, except yellow perch.

All members of this guild, except for spotfin shiner, river carpsucker, and smallmouth buffalo, were extremely rare in the study area during adult fish studies the past two years (EA 1994, 1995). Therefore, the following discussion will be limited to these three species.

Spotfin shiner

Spotfin shiner spawns in crevices, undersides of submerged objects, and on exposed tree roots near riffles and in shallow areas of lakes and large rivers (Appendix A). Eggs are deposited into crevices or onto the substrate and are demersal and adhesive. No information is available for the dispersal of the fry. Although spotfin shiner was collected in all three pools during adult fish studies the past two years, it was rare in Lockport and Brandon Pools and relatively common in upper Dresden Pool (EA 1994, 1995). During this study, only six juveniles were positively identified (Table 8 and Appendix C). Five were collected in Brandon Pool from the upper Des Plaines River and one was collected in upper Dresden Pool from Bear Island slough (Location 414) (Tables 9 and 10; Appendix C). All were collected by seining. Eggs may have been collected, and yolk-sac and/or post yolk-sac larvae may have been represented within the unidentified cyprinids.

Ictiobinae

River carpsucker spawns in the bottoms of rivers and tributaries, and in flooded meadows and marshes over a variety of substrates (Appendix A). Eggs are scattered and are demersal or semi-buoyant and adhesive. No species-specific information is available for the dispersal of yolk-sac and post yolk-sac larvae. Larval Ictiobinae were common in backwater habitats of the upper Mississippi River and were consistently collected in main channel drift (Holland-Bartels et al. 1990). They were common and occasionally abundant in Ohio River main channel ichthyoplankton tow samples (ESE 1992). Juveniles are found in shallows, quiet pools, and backwaters (Appendix A).

Smallmouth buffalo spawns in shallow areas of quiet pools and backwaters of medium and large rivers over a variety of substrates (Appendix A). Eggs are scattered, demersal, and adhesive. Yolk-sac larvae are found in shallow vegetated backwaters, marshes, and pools. No species-specific information is available for the dispersal of post yolk-sac larvae. Larval Ictiobinae were common in backwater habitats of the upper Mississippi River and were consistently collected in main channel drift (Holland-Bartels et al. 1990). They were common and occasionally abundant in Ohio River main channel ichthyoplankton tow samples (ESE 1992). Juveniles are found in shallow vegetated areas and not in the main channel.

During adult fish studies the past two years, river carpsucker and smallmouth buffalo were uncommon to occasional in upper Dresden Pool; none were collected in Lockport or Brandon Pools (EA 1994, 1995). In addition, one YOY specimen was collected in upper Dresden Pool during the 1994 adult fish study; no YOYs were collected in Lockport or Brandon Pools (EA 1995). Similarly, during this study larval Ictiobinae (including unidentified *Carpiodes*) were collected only in upper Dresden Pool where they were uncommon (Tables 8 and 9). This taxa was represented by yolk-sac larvae and post yolk-sac larvae (Appendix C). Eggs could not be distinguished from those of many other species and probably occurred in the unidentified component of the catch. Ictiobinae larvae were initially collected in upper Dresden Pool during the week of 25 April (Figure 7). Mean water temperatures at initial occurrence were 19.9 C (Figure 3). Spawning for this taxa (whether river carpsucker or smallmouth buffalo) probably occurred when expected (Figure 7). Seventy-eight percent of the Ictiobinae (including unidentified *Carpiodes*) were collected in the backwater locations, particularly in the Du Page River delta (Location 409) (Table 10 and Appendix C). Ictiobinae larvae were collected primarily by seining (Appendix C).

3.3.1.5 Phytophils

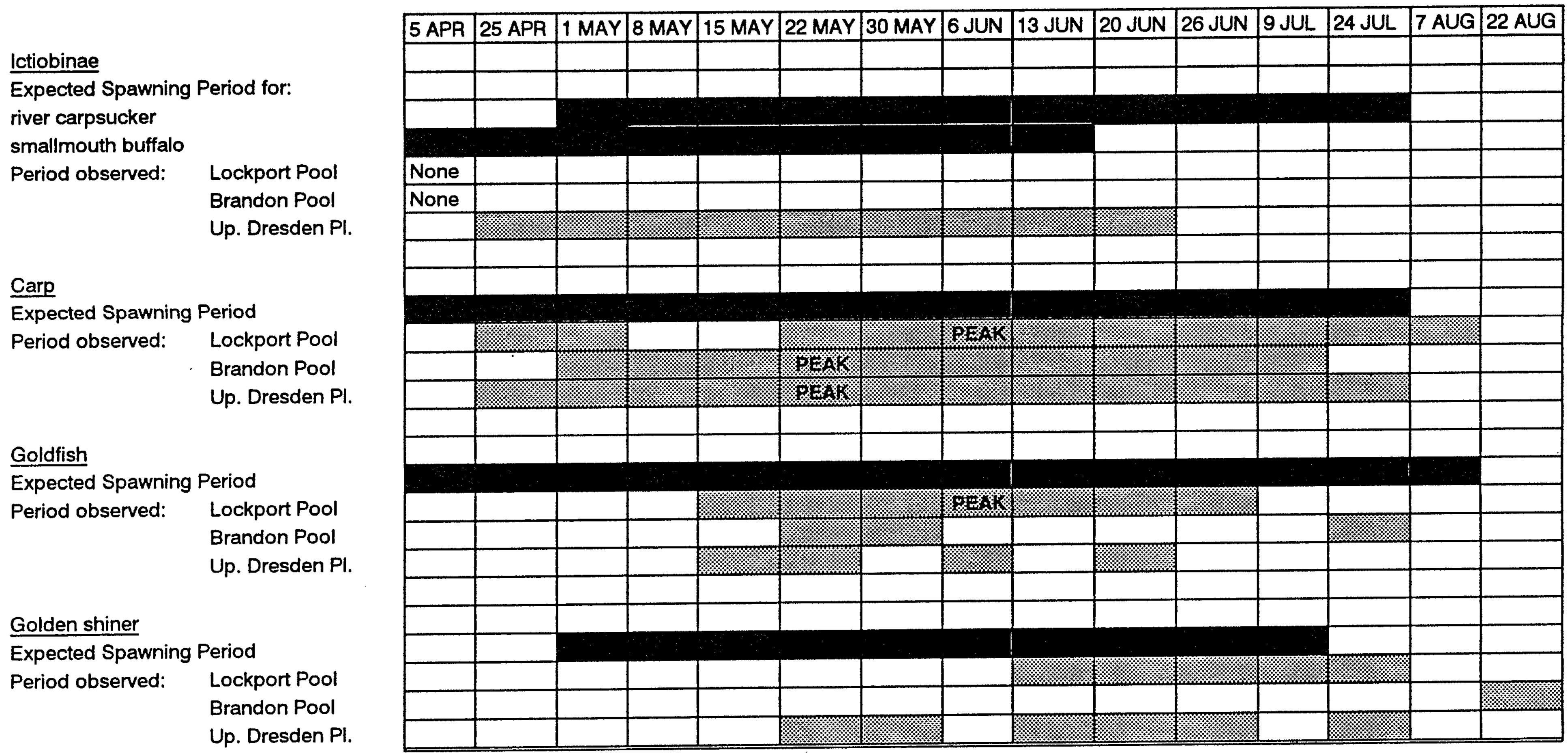
This guild is represented by nine potential spawning species: longnose gar, central mudminnow, grass pickerel, northern pike, goldfish, carp, golden shiner, bigmouth buffalo, and black buffalo (Table 8). Selected key features of early ontogeny for this guild include deposition of adhesive eggs over either live or dead vegetation, flooded plants, and vegetative debris. The larvae typically are not photophobic, have cement glands on the head to attach themselves to vegetation off the soft bottom, and have highly developed embryonic respiratory structures which adapt them for survival in poorly-oxygenated waters (Balon 1975, 1981). Four of the nine species were represented by larval and/or juvenile specimens during this study: longnose gar, carp, goldfish, and golden shiner (Table 8). Larval or YOY specimens were not collected for central mudminnow, grass pickerel, or northern pike during either this study or the 1994 adult fish study (Table 8). Black buffalo and bigmouth buffalo may have been represented by unidentified Ictiobinae (see Section 3.3.1.4) during either this study or the 1994 adult fish study. Furthermore, eggs may have been collected for all nine members of this guild, except longnose gar, grass pickerel, and northern pike.

All members of this guild, except for longnose gar, carp, goldfish, and golden shiner, have been extremely rare in the study area during adult fish studies the past two years (EA 1994, 1995). Therefore, the following discussion will be limited to longnose gar, carp, goldfish, and golden shiner.

Longnose gar

Longnose gar typically spawns in quiet backwaters over vegetation (Appendix A). Yolk-sac larvae tend to remain near the spawning bed in locally dense populations attached to submerged vegetation or debris. Post yolk-sac and juveniles are habitat generalists. Larval longnose gar were uncommon in main channel drift collections of the upper Mississippi River

FIGURE 7. COMPARISONS OF THE PERIOD OF OCCURRENCE FOR SELECTED NONGUARDING PHYTO-LITHOPHILS AND PHYTOPHILS.



(Holland-Bartels et al. 1990). In the lower Ohio River, larval *Lepisosteus* spp. were common in main channel drift samples (ESE 1992).

During adult fish studies the past two years, longnose gar were rare or uncommon in upper Dresden Pool; none were collected in Lockport and Brandon Pools (EA 1994, 1995). During this study, only two post yolk-sac larvae were collected, both in upper Dresden Pool (Tables 8 and 9; Appendix C). One specimen was collected by dipnetting in the Brandon tailwater during the week of 30 May and the other specimen was collected by light trapping in backwater Location 405 (Treats Island side channel) during the week of 6 June (Table 10 and Appendix C).

Carp

Carp spawns in sheltered, vegetated areas of streams, or over logs, rocks, and other submerged objects (Appendix A). Eggs are deposited in clusters in small areas and are extremely adhesive and demersal. Yolk-sac larvae are initially found near the bottom attached to vegetation or parts of the substrate. Post yolk-sac larvae and juveniles are typically found among vegetation but have been collected from a wide variety of habitats. In the upper Mississippi River, larval carp are most abundant in backwaters but they also occur in the main channel drift (Holland-Bartels et al. 1990).

Carp was the third most abundant species collected within the study area during adult fish collections the past two years and was abundant in all three pools (EA 1994, 1995). Similarly, during this study, it was also the third most abundant taxa collected and was abundant in all three pools (Tables 8 and 9). Carp were collected as eggs, yolk-sac larvae, post yolk-sac larvae, and juveniles (Appendix C). Additional yolk-sac and post yolk-sac larvae are likely represented within the carp/goldfish taxon that could not be identified to the species level due to damage.

Carp larvae were first observed in Lockport and upper Dresden Pools (week of 25 April) followed one week later (week of 1 May) in Brandon Pool (Figure 7). Mean water temperatures at initial occurrence were 18.3, 19.9, and 14.9 C, respectively (Figure 3). However, the temperature in Brandon Pool during the week prior to initial collection was 22.0 C (Figure 3). In all three pools, spawning occurred when expected (Figure 7). Carp were most abundant in Lockport and upper Dresden Pools during the week of 22 May, whereas the peak in Lockport Pool occurred two weeks later (week of 6 June).

Carp were collected in all mesohabitats (Table 10). They were most abundant in main channel border (47.9 percent) and least abundant (4.5 percent) in the Brandon tailwater. Carp were collected primarily (56 percent) by light trapping, particularly within the vegetative light traps (Appendix C).

Goldfish

Goldfish spawns in areas with debris and vegetation over predominantly mud bottoms (Appendix A). Eggs are demersal and adhesive until water hardened, enabling them to drift in river currents. Yolk-sac larvae attach to plants or remain on the bottom and their swimming movements are limited. Post yolk-sac larvae are free swimming after one to two days. Juveniles are presumed to use the same habitat as adults (i.e., shallow water with dense vegetation [Becker 1983]).

Although goldfish was collected in all three pools during adult fish studies the past two years, it was common in Lockport Pool but rare to uncommon in Brandon and upper Dresden Pools (EA 1994, 1995). During this study, it was occasional in Lockport Pool and rare to uncommon in Brandon and upper Dresden Pools (Table 9). It was collected as yolk-sac larvae, post yolk-sac larvae, and juveniles (Appendix C). Eggs were likely collected, particularly in Lockport Pool where adults are common. Additional yolk-sac and post yolk-sac larvae are likely represented within the carp/goldfish; these specimens could not be identified to the species level due to damage.

Goldfish larvae were first observed in Lockport and upper Dresden Pools (week of 15 May) followed one week later (week of 22 May) in Brandon Pool (Figure 7). Mean water temperatures at initial occurrence were 18.4 C in Lockport Pool and 22.8 C in upper Dresden Pool (Figure 3). No temperature is available for Brandon Pool during the week of 22 May as the data were lost in the field. In all three pools, spawning occurred when expected (Figure 7). Goldfish were most abundant in Lockport Pool during the week of 6 June.

It was collected in all mesohabitats except for the upper Des Plaines River and the Brandon tailwater (Table 10). They were most commonly encountered in the main channel border (46.9 percent) and backwater mesohabitats (30.9 percent). They were collected primarily by pumping, mid-channel tows, and vegetative light traps (Appendix C).

Golden shiner

Golden shiner spawns in bays and quiet water over submerged vegetation or debris and in nests of largemouth bass (Appendix A). Eggs are broadcast and are demersal and adhesive. Yolk-sac larvae are found in surface layers of shallow water. Post yolk-sac larvae exhibit schooling behavior and inhabit shallow waters. Juveniles are found among aquatic vegetation over various substrates. Larval golden shiners are occasionally collected in the upper Mississippi River in ichthyoplankton drift samples (Holland-Bartels et al. 1990).

Golden shiner was rare to uncommon in each of the three pools during adult fish studies the past two years (EA 1994, 1995). During this study, it was also rare to uncommon in each of the three pools (Table 9). It was collected as post yolk-sac larvae and juveniles (Appendix C). Eggs could not be distinguished for those of many other species and probably occurred in the unidentified component of the catch.

Golden shiner larvae were first observed in upper Dresden Pool (week of 22 May) followed four weeks later (week of 13 June) in Lockport Pool (Figure 7). Mean water temperatures at initial occurrence were 23.7 and 23.3 C, respectively (Figure 3). In all three pools, spawning occurred when expected (Figure 7). Golden shiners were collected in all mesohabitats, primarily by seining (Table 10 and Appendix C).

3.3.1.6 Psammophils

This guild is represented by four potential spawning species: spottail shiner, sand shiner, quillback, and logperch (Table 8). Selected key features of early ontogeny for the guild include deposition of eggs directly on the sand or near roots overhanging a sandy bottom. They hatch on the surface of the sand and are adapted to swift water. Eggs have adhesive membranes and are frequently small. Larvae are phototropic. Pectoral fins develop early and when spread hold the larvae to the substrate (Balon 1975, 1981). Three of the four species (spottail shiner, sand shiner, and logperch) were represented by larval and/or juvenile specimens during this study (Table 8). Quillback may have also been collected since it may have been represented by unidentified *Carpiodes* and/or Ictiobinae. However, it was conservatively not counted since we included the unidentified *Carpiodes* and Ictiobinae in the phyto-lithophil guild (see Section 3.3.1.4) because river carpsucker and smallmouth buffalo are the more commonly collected Ictiobinae within the UIW (EA 1994, 1995). Eggs may have been collected for all four members of this guild. Logperch were extremely rare during this study and during the adult fish studies the past two years; therefore, it is excluded from further discussion.

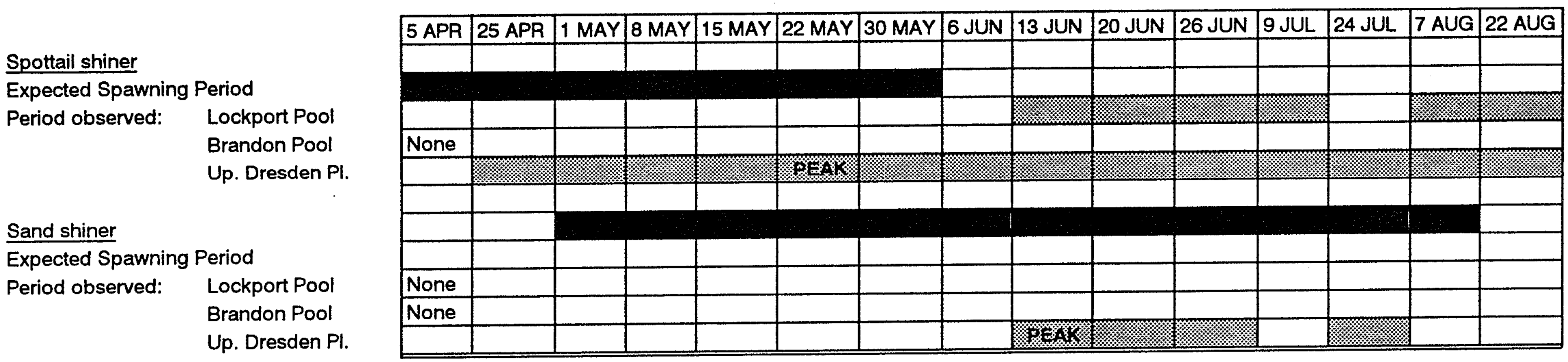
Spottail shiner

Spottail shiner spawns in shallow nearshore areas with sandy shoals, in beds of *Cladophera*, and in mouths and riffles of small tributaries (Appendix A). It avoids strong currents, silt bottoms, and turbid water. Eggs are scattered over clean sand or gravel, and are demersal and adhesive until water hardened. Eggs can be common in drift samples. No information is available for the dispersal of yolk-sac and post yolk-sac larvae (Appendix A). Juveniles frequently school in shallow water with abundant vegetation.

Adult spottail shiners were rare in Lockport and Brandon Pools but common in upper Dresden Pool during adult fish collections the past two years (EA 1994, 1995). During the 1994 adult fish study, YOYs were rare in Lockport Pool, not collected in Brandon Pool, and occasional in upper Dresden Pool (EA 1995). During this study, larval/juveniles were uncommon in Lockport Pool, not collected in Brandon Pool, and very common in upper Dresden Pool (Table 9); similar to the spatial pattern observed for YOYs and adults. Spottail shiner was represented by yolk-sac larvae, post yolk sac larvae, and juveniles (Appendix C). Eggs may have been collected and additional yolk-sac larvae may be represented by unidentified cyprinids.

Spottail shiner larvae were first observed in upper Dresden Pool (week of 25 April) followed seven weeks later (week of 13 June) in Lockport Pool (Figure 8). Mean water temperatures at

FIGURE 8. COMPARISONS OF THE PERIOD OF OCCURRENCE FOR SELECTED NONGUARDING PSAMMOPHILS.



initial occurrence were 19.9 and 23.3 C, respectively (Figure 3). Spawning in upper Dresden Pool was probably slightly earlier than expected, whereas spawning in Lockport Pool was probably slightly later than expected. Spottail shiners were most abundant in upper Dresden Pool during the week of 22 May. Peak numbers occurred well within the expected spawning period (Figure 8).

Spottail shiners were collected in all mesohabitats except for the upper Des Plaines River (Table 10). They were most commonly encountered in the mouth of Jackson Creek (44.4 percent), followed by backwaters (26.1 percent) and main channel border (21.4 percent). Eighty-two percent of the main channel border catch occurred at Location 402B in upper Dresden Pool (Appendix C), approximately one mile downstream of the Brandon tailwater (Figure 1). These specimens may have spawned in the Brandon tailwater and settled out of the drift at this location. Spottail shiners were collected primarily by seining and nonvegetative light traps (Appendix C).

Sand shiner

Sand shiner spawns in shallow areas of lakes and large rivers, often in sparse vegetation, or at creek mouths over clean sand or gravel (Appendix A). Eggs are scattered over the bottom, and are demersal and adhesive. Yolk-sac larvae are found along the shoreline and in the mouths of tributaries. Larval sand shiners are collected in main channel drift and main channel border seine samples in the Ohio River (ESE 1992). No information is available for the dispersal of juveniles (Appendix A).

Adult sand shiners were rare in Lockport and Brandon Pools and uncommon in upper Dresden Pool during adult fish collections the past two years (EA 1994, 1995). During this study, juveniles were not collected in Lockport and Brandon Pools and were uncommon in upper Dresden Pool (Table 9). Only juvenile sand shiners could be positively identified to the species level; therefore, it is likely that yolk-sac larvae and post yolk sac larvae were represented among the unidentified cyprinids in upper Dresden Pool. Eggs could not be distinguished from those of many other species and probably occurred in the unidentified component of the catch. Since only juveniles could be positively identified, no discussion regarding initial occurrence is possible. In upper Dresden Pool, juvenile sand shiners were most abundant during the week of 13 June (Figure 8). Eighty-eight percent of all juvenile sand shiners were collected at main channel border Location 402B (Appendix C), approximately one mile downstream of the Brandon tailwater (Figure 1). These specimens may have spawned in the Brandon tailwater and settled out of the drift at this location. Juvenile sand shiners were collected primarily by seining (Appendix C).

Quillback

Quillback spawns in quiet waters of streams, in overflow areas, lower ends of deep riffles, and in large rivers over sand, mud, gravel, or organic matter (Appendix A). Eggs are randomly deposited and are semi-demersal or demersal and adhesive. Eggs are carried easily by the current. Ictiobinae larvae were common and occasionally abundant in Ohio River main channel ichthyoplankton tow samples (ESE 1992). They were also common in backwater habitats of the upper Mississippi River and were consistently collected in the main channel drift (Holland-Bartels et al. 1990). Juveniles are found in broad, shallow flats with silt substrates (Appendix A). During adult fish studies the past two years, quillback were uncommon in upper Dresden Pool; none were collected in Lockport and Brandon Pools (EA 1994, 1995). Quillback may have been represented by unidentified *Carpiodes* and/or Ictiobinae. These two taxa were discussed in the phyto-lithophil guild (see Section 3.3.1.4) because river carpsucker and smallmouth buffalo are the more commonly collected Ictiobinae within the UIW (EA 1994, 1995).

3.3.2 Guarders: Nest Spawners

Members of the guarder guilds remain near their spawn and are able to offer protection against predators and provide artificial aeration by cleaning and fanning the eggs. With this strategy, fishes are able to reproduce in situations where fine sediments and low oxygen concentrations would otherwise be prohibitive. The nest spawners construct a cleaned depression on the substrate or clean a naturally-occurring cavity or crevice, where the eggs are deposited.

3.3.2.1 Lithophils

This guild is represented by eight potential spawning species: central stoneroller, black bullhead, rock bass, green sunfish, orangespotted sunfish, bluegill, longear sunfish, and smallmouth bass (Table 8). Selected key features of early ontogeny for this guild include deposition of eggs in a single-layer or multi-layer clutches on cleaned areas of rocks or in pits in gravel. The larvae of most fishes in this guild hide in the gravel at the bottom, are photophobic, may have cement glands, and their embryonic respiratory organs are moderately- to well-developed (Balon 1975, 1981). Many of the species in the guild prefer to spawn in relatively still backwaters which are virtually absent in Lockport and Brandon Pools, but common in upper Dresden Pool.

Six of the eight species were represented by larval and/or juvenile specimens during this study (Table 8). These six species include orangespotted sunfish even though it was not identified (to a species level) as being collected (Table 8). It was included among the six species because it was occasional to common in upper Dresden Pool during adult fish studies the past two years (EA 1994, 1995), and therefore it is likely represented among the unidentified *Lepomis*. Conversely, because longear sunfish was extremely rare during adult fish studies the past two years (EA 1994, 1995), it was conservatively not counted even though it may also be represented among the unidentified *Lepomis*. Larval or YOY specimens were not collected for black bullhead during either this study or the 1994 adult fish study (Table 8). Eggs may have been collected for all eight members of this guild.

All members of this guild, except for green sunfish, orangespotted sunfish, and bluegill, were extremely rare in the study area during adult fish studies the past two years (EA 1994, 1995). Therefore, the following discussion will be limited to green sunfish, orangespotted sunfish, and bluegill.

Green sunfish

Green sunfish build nests in shallow waters of lakes, sloughs, and ponds (Appendix A). These nests are constructed in the shelter of logs, rocks, or vegetation on a variety of substrates including sand, mud, and roots. Eggs are laid in a mass and are demersal and adhesive. Yolk-sac larvae are free-swimming two days after hatching. Larval *Lepomis* were abundant in backwaters and occurred regularly in drift samples in the upper Mississippi River (Holland-Bartels et al. 1990). Larval *Lepomis* were also common in drift samples from the Ohio River (ESE 1992). Juveniles are found in low velocity areas and pool areas of streams (Appendix A).

Green sunfish was among the 10 most abundant species collected during adult fish studies the past two years and was collected from all three pools (EA 1994, 1995). Although it was collected in all three pools during this period, it was uncommon in Lockport Pool, occasional to common in Brandon Pool, and common in upper Dresden Pool. During this study and the 1994 adult fish study, only one and two YOY green sunfish were identified to the species level, respectively; however, additional larval and/or juvenile specimens were likely represented among the unidentified *Lepomis* during both of these studies (Table 8; EA 1995).

Orangespotted sunfish

Orangespotted sunfish spawns in shallow areas of lakes and impoundments over fine gravel, sand, silt, and mud (Appendix A). Eggs are demersal and adhesive. No species-specific information is available for the dispersal of the fry (Appendix A). Larval *Lepomis* were abundant in backwaters and occurred regularly in drift samples in the upper Mississippi River (Holland-Bartels et al. 1990). Larval *Lepomis* were also common in drift samples from the Ohio River (ESE 1992). Juveniles are found in low velocity areas and pool areas of streams (Appendix A).

During adult fish studies the past two years, orangespotted sunfish was occasional to common in upper Dresden Pool; none were collected in Lockport and Brandon Pools (EA 1994, 1995). Although no larval or YOY specimens were identified as this species during either this study or the 1994 adult fish study, it was likely represented among the unidentified *Lepomis* particularly in upper Dresden Pool where adults were fairly common (Table 8; EA 1995).

Bluegill

Bluegill build nests in shallows of lentic habitats near shore, typically in sand or gravel where vegetation is not abundant (Appendix A). Eggs are demersal and adhesive. Yolk-sac larvae hatch in the nest and are free-swimming three days after hatching. They are closely associated with the bottom of the nest until after yolk absorption. Post yolk-sac larvae are found in littoral vegetation, limnetic zones, and nearshore areas. Larval *Lepomis* were abundant in backwaters and occurred regularly in drift samples in the upper Mississippi River (Holland-Bartels et al. 1990). Larval *Lepomis* were also common in drift samples from the Ohio River

(ESE 1992). Juveniles are associated with submergent vegetation in backwaters and nearshore areas (Appendix A).

During adult fish studies the past two years, bluegill was uncommon in Lockport Pool, rare in Brandon Pool, and occasional in upper Dresden Pool (EA 1994, 1995). Identifiable YOY specimens were rare but were collected in all three pools during both this study and the 1994 adult fish study (Table 8; EA 1995). Additional larval or juvenile specimens were likely represented among the unidentified *Lepomis*, particularly in upper Dresden Pool where adults were fairly common.

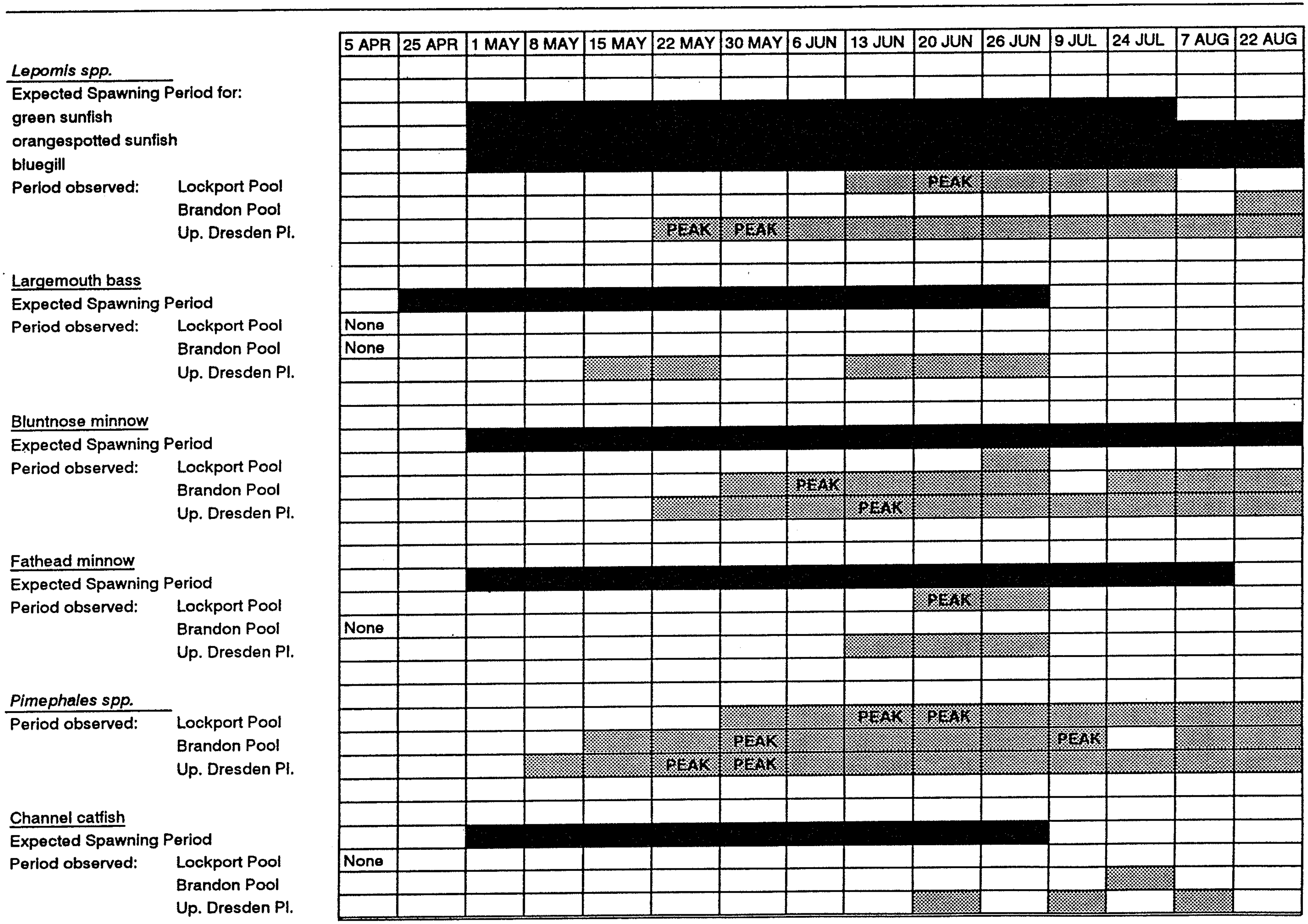
***Lepomis* spp.**

The unidentified *Lepomis* groups (excluding *Lepomis* B) were provisionally assigned to this guild because green sunfish, orangespotted sunfish, and bluegill are the three most commonly collected *Lepomis* spp. in the study area. Unidentified *Lepomis* (including the "lettered" specimens except for *Lepomis* B) was the most abundant taxon collected during this study, composing 25.9 percent of the catch (Table 9). Although *Lepomis* larvae/juveniles were collected from all three pools, they were markedly more abundant in upper Dresden Pool (99 percent of the total *Lepomis* catch) than in Lockport and Brandon Pools (Table 9). Similarly, during the 1994 adult fish study, 97 percent of all YOY *Lepomis* spp. collected from the study area occurred in upper Dresden Pool (EA 1995). The disparity in the *Lepomis* catches among the three pools is likely attributable to habitat since quiet backwaters, the preferred spawning/nursery habitat for *Lepomis*, are prevalent in upper Dresden Pool, but virtually absent in Lockport and Brandon Pools. *Lepomis* were represented by yolk-sac larvae, post yolk-sac larvae, and juveniles (Appendix C), and were probably represented by eggs.

Lepomis larvae were initially collected in upper Dresden Pool during the week of 22 May followed three weeks later (week of 13 June) in Lockport Pool (Figure 9). Mean water temperatures at initial occurrence were 23.7 and 23.3 C, respectively (Figure 3). Spawning for this taxa (whether green sunfish, orangespotted sunfish, and/or bluegill) occurred when expected (Figure 9). This taxa was most abundant in upper Dresden Pool during the weeks of 22 May and 30 May, whereas the peak in Lockport Pool occurred three weeks later (week of 20 June). Seventy-eight percent (4,356/5,611) of all *Lepomis* larvae collected from upper Dresden Pool occurred during this two-week period (Appendix C).

Lepomis spp. were collected in all mesohabitats (Table 10). However, 93 percent (5,258/5,661) of the total *Lepomis* catch was collected within the mouth of Jackson Creek in upper Dresden Pool (Table 10). This taxa was rare or uncommon in all other mesohabitats except for backwaters where it was common. It is uncertain why there was such a large concentration of *Lepomis* larvae in the mouth of Jackson Creek, particularly compared to other backwater locations in upper Dresden Pool. The mouth of Jackson Creek is functionally a quiet, backwater area. Compared to other backwaters in upper Dresden Pool, this location is smaller and deeper, better protected from wind and wave action, and contains more boulder/slab and "clean" gravel substrates, particularly in deep, nearshore areas. These physical characteristics may make this location a preferred spawning/nursery area for *Lepomis*.

FIGURE 9. COMPARISONS OF THE PERIOD OF OCCURRENCE FOR SELECTED GUARDING NEST SPAWNERS.



99

3.3.2.2 Phytophils

Members of this guild are adapted to nesting above or on a soft muddy bottom. Some members attach their eggs to vegetation and have larvae with cement glands that attach to the vegetation. Embryonic respiratory organs are well developed and are assisted by fanning actions of the parents (Balon 1975, 1981). This guild is represented by three potential spawning species: largemouth bass, black crappie, and banded darter (provisionally assigned to this guild) (Table 8). Largemouth bass and black crappie prefer to spawn in relatively still backwaters which are virtually absent in Lockport and Brandon Pools, but common in upper Dresden Pool. These two species were represented by larval and/or juvenile specimens during this study (Table 8), and all of which were collected in upper Dresden Pool (Table 9). Banded darter may have been represented by unidentified *Etheostoma*; however, since it has not been collected within the study area in up to 17 years of CECo-sponsored adult fish monitoring (EA 1993b, 1994, 1995), its collection during this study is unlikely. Black crappie was extremely rare in adult fish collections the past two years and was also extremely rare during this study. Since banded darter has not been previously collected from the study area and black crappie was extremely rare during both this study and the adult fish studies, they will not be discussed further.

Largemouth bass

Largemouth bass build nests in shallow sheltered areas usually with aquatic vegetation, in substrates of gravel, sand, or soft mud (Appendix A). The importance of sheltered areas for successful spawning of this species is demonstrated by the fact that wave action generated by storms has been shown to cause nesting failure in largemouth bass populations (Kramer and Smith 1962; Summerfelt 1975). Thus, this species may not nest successfully in shallow areas that are constantly disturbed by tow boat wakes (e.g., artificial embayments in Lockport Pool). Eggs are laid in a mass either in or near the nest and are demersal and adhesive. Yolk-sac larvae remain in the bottom of the nest until yolk is absorbed. In the upper Mississippi River, larvae and juveniles are specifically associated with dense submerged vegetation (Holland-Bartels et al. 1990). In the Ohio River, larval *Micropterus* are sporadically encountered and seldom abundant in main channel tow and main channel border seine samples (ESE 1992). In a small Kentucky stream, larval *Micropterus* were primarily associated with a vegetated shoreline and were abundant in light trap samples, common in seine samples, and rare in drift net samples; however, no yolk-sac larvae were collected (Floyd et al. 1984b). This indicates that yolk-sac larvae are probably difficult to collect. Post yolk-sac larvae and juveniles exhibit schooling behavior and appear to remain near the nesting area (Appendix A).

During the 1994 adult fish study, adult and YOY largemouth bass were uncommon to occasional in Lockport and upper Dresden Pools, but rare in Brandon Pool (EA 1995). However, during this study, only six larvae (including unidentified *Micropterus*) and six juveniles were collected, all from upper Dresden Pool (Table 9 and Appendix C). It is unclear why so few larval largemouth bass were collected during this study since adults and YOYs were fairly common in portions of the study area during the adult fish studies. It is possible that they are difficult to collect with conventional sampling equipment. As presented above,

Channel catfish

Channel catfish spawns in secluded and darkened areas near shore (Appendix A). A nest is built under rock ledges, undercut banks, under rocks, in logs, in manmade containers, or on a mud substrate. Eggs are deposited in a gelatinous mass and are demersal and adhesive. Yolk-sac larvae are guarded by the male in the nest for two to five days after hatching. In the upper Mississippi River, yolk-sac larvae were rarely collected in main channel drift samples; however, alevins were abundant in main channel trawl catches and were most commonly collected at night (Holland-Bartels et al. 1990). In the Ohio River, larval channel catfish were commonly encountered in main channel tow samples, but were rarely abundant (ESE 1992). Alevins seek quiet, shallow water over sandbars, drift piles, and among rocks. They exhibit a strong schooling tendency at four to ten months (Appendix A). In a small Kentucky stream, channel catfish alevins were collected almost exclusively by drift nets; none were collected in light trap samples and they were extremely rare in seine samples; no yolk-sac larvae were collected (Floyd et al. 1984b). During 24-hour drift sampling on the Illinois River in Arkansas, all channel catfish alevins were collected at night (Armstrong and Brown 1983).

During the adult fish studies the past two years, adult channel catfish were rare in Lockport Pool, rare to uncommon in Brandon Pool, and occasional to common in upper Dresden Pool (EA 1994, 1995). During this study, only 11 specimens were collected; four yolk-sac larvae and seven alevins (Table 8 and Appendix C). Ten of the specimens were collected from lower Dresden Pool and the other specimen was collected from the upper Des Plaines River in Brandon Pool (Tables 9 and 10). Although it is not certain why so few larvae and alevins were collected during this study since adults were fairly common in portions of the study area during the adult fish studies, it is possible that they are difficult to collect with conventional sampling gear. As presented above, several studies have shown that channel catfish alevins can be common in main channel tow and drift net samples, particularly at night; however, yolk-sac larvae are rarely collected. During this study, ten of the eleven channel catfish were taken in main channel tow and stationary net samples that were collected either during the day or near dusk (Appendix C). Since we could not tow at night due to safety considerations, we may have missed the bulk of the drifting channel catfish. Furthermore, main channel towing and stationary net sampling was conducted at only six locations, which may have not been adequate to sufficiently sample for this species. In addition, the schooling behavior exhibited by larvae and alevins would make them "patchy" in their distribution and difficult to collect. Moreover, since channel catfish alevins hide in drift piles and among rocks (Appendix A), they would have been difficult to collect utilizing the ichthyoplankton gears. Alternatively, it is also possible that channel catfish are either not reproducing successfully within the study area or that the larvae are not successfully developing. For example, only one YOY channel catfish was collected within upper Dresden Pool during the 1994 adult fish study and none were collected in Lockport and Brandon Pools (EA 1995).

Channel catfish yolk-sac larvae were initially collected in upper Dresden Pool during the week of 20 June (Figure 9). The mean water temperature at initial occurrence was 24.0 C (Figure 3). Spawning for this species occurred when expected (Figure 9).

4. REFERENCES

Armstrong, M.L. and A.V. Brown. 1983. Diel drift and feeding of channel catfish alevins in the Illinois River, Arkansas. Trans. Amer. Fish. Soc. 112:302-307.

Auer, N.A. (editor). 1982. Identification of larval fishes of the Great Lakes basin with emphasis on the Lake Michigan drainage. Great Lakes Fish. Comm. Spec. Publ. 82-3, Ann Arbor, Michigan. 744 pp.

Balon, E.K. 1975. Reproductive guilds of fishes: a proposal and definition. J. Fish. Res. Bd. Can. 32:821-864.

Balon, E.K. 1981. Additions and amendments to the classifications of reproductive styles in fishes. Environmental Biology of Fishes 6:377-389.

Becker, G.C. 1976. Inland fishes of the Lake Michigan drainage basin. Argonne Natl. Lab. ANL/ES-40. Vol. 17. 237 pp.

Becker, G.C. 1983. Fishes of Wisconsin. The University of Wisconsin Press, Madison, WI. 1,052 pp.

Bosley, T.R. and J.V. Conner. 1984. Geographic and temporal variation in numbers of myomeres in fish larvae from the lower Mississippi River. Trans. Amer. Fish. Soc. 113:238-242.

Burr, B.M. and L.M. Page. 1986. Zoogeography of fishes of the lower Ohio-upper Mississippi basin. Offprints from the Zoogeography of North American Freshwater Fishes. C.H. Hocutt and E.O. Wiley eds.

Conner, J.V. 1978. Identification of larval sunfishes (Centrarchidae, Elassomatidae) from southeastern Louisiana, pp. 17-52. In: Hoyt, R.D. (ed.), Proc. of the third symposium on larval fishes. Western Kentucky University, Bowling Green, Kentucky.

EA Science and Technology. 1988. Dresden Station Aquatic Monitoring 1987. Report by EA to Commonwealth Edison Company, Chicago, Ill. 190 pp. plus Appendices.

EA Engineering, Science, and Technology. 1993a. Lower Des Plaines River aquatic monitoring final report 1992. Report by EA to Commonwealth Edison Company, Chicago, IL.

____________. 1993b. Dresden aquatic monitoring final report 1992. Report by EA to Commonwealth Edison Company, Chicago, IL.

____________. 1993c. Mesohabitat survey of the Upper Illinois Waterway RM 270.0 to 324.3. Report by EA to Commonwealth Edison Company, Chicago, IL.

____________. 1994. The Upper Illinois Waterway study: Interim Report: 1993 fisheries investigation RM 270.2-323.2. Report by EA to Commonwealth Edison Company, Chicago, IL.

____________. 1995. The Upper Illinois Waterway study: Interim Report: 1994 fisheries investigation RM 270.2-323.2. Report by EA to Commonwealth Edison Company, Chicago, IL.

Environmental Science & Engineering, Inc. (ESE). 1992. Ohio Ecological Research Program. Analysis of long-term larval fish data. Final Report. St. Louis, Missouri. 272 pp.

Floyd K.B., W.H. Courtney, and R.D. Hoyt. 1984a. A new larval fish light trap: the quatrefoil trap. Progressive Fish-Culturist 46:216-219.

Floyd, K.B., R.D. Hoyt, and S. Timbrook. 1984b. Chronology of appearance and habitat partitioning by stream larval fishes. Trans. Amer. Fish. Soc. 113:217-223.

Fuiman, L.A., J.V. Conner, B.F. Lathrop, G.L. Buynak, D.E. Snyder and J.J. Loss. 1983. State of the art of identification for cyprinid fish larvae from eastern North America. Trans. Amer. Fish. Soc. 112: 319-332.

Gallagher, R.P. and J.V. Conner. 1983. Comparison of two ichthyoplankton sampling gears with notes on microdistribution of fish larvae in a large river. Trans. Amer. Fish. Soc. 112:280-285.

Holland-Bartels, L.E., S.K. Littlejohn, and M.L. Huston. 1990. A guide to larval fishes of the upper Mississippi River. U.S. Fish Wildl. Serv. Natl. Fish Res. Ctr. LaCrosse, Wisconsin. 107 pp.

Hoyt, R.D. 1988. A bibliography of the early life history of fishes; Volume I: List of Titles and Volume II: Index. Dept. of Biology, Western Kentucky University, Bowling Green, Kentucky.

Kramer, R.H. and L.L. Smith. 1962. Formation of year classes in largemouth bass. Trans. Amer. Fish. Soc. 91(1):29-41.

Kwak, T.J. 1991. Ecological characteristics of a northern population of the pallid shiner. Trans. Amer. Fish. Soc. 120:106-115.

Lathrop, B.F. 1982. Keys to the larval and juvenile fishes from the lower Susquehanna River near Middletown, Pennsylvania. Ichthyological Associates, Inc., Etters, Pennsylvania.

Lawler, Matusky & Skelly Engineers (LMS). 1993a. Spring spawning survey in the upper Illinois waterway. Report by LMS to Commonwealth Edison Company, Chicago, IL. 40 pp. plus Appendices.

_____________. 1993b. Winter fisheries studies in the upper Illinois waterway. Report by LMS to Commonwealth Edison Company, Chicago, IL. 97 pp. plus Appendices.

Ohio Environmental Protection Agency. 1989. Addendum to Biological criteria for the protection of Aquatic Life: Vol. II. Users Manual for Biological Field assessment of Ohio Surface Waters. Ohio Env. Prot. Agency. Columbus, Ohio.

Page, L.M. 1983. Handbook of darters. TFH Publications, Inc. Ltd. Neptune City, New Jersey. 271 pp.

Pearson, W.D. and L.A. Krumholz. 1984. Distribution and status of Ohio River fishes. Oak Ridge Nat. Lab.. Pub. No. ORNL/Sub/79-7831/1. 401 pp.

Rasmussen, J.L. ed. 1979. A compendium of fishery information on the Upper Mississippi River. A contribution of the Upper Mississippi River Conservation Committee, 2nd edition.

SAS Institute, Inc. 1988a. SAS Language Guide for Personal Computers. Release 6.03 SAS Institute, Cary, North Carolina.

_____________. 1988b. SAS Procedure Guide. Release 6.03. SAS Institute, Cary, North Carolina.

Secor, D.H., J.M. Dean, and J. Hansbarger. 1992. Modification of the quatrefoil light trap for use in hatchery ponds. Progressive Fish-Culturist 54:202-205.

Seegert, G. 1991. A Survey of the Greater Redhorse in the Vermillion River. Prepared for the Illinois Department of Conservation, Springfield, IL. 5 pp.

Smith, P. 1979. The Fishes of Illinois. Univ. of Illinois Press, Urbana, Illinois.

Summerfelt, R.C. 1975. Relationship between weather and year-class strength of largemouth bass, pp. 167-171. In: H. Clepper (ed.), Black Bass Biology and Management. Sport Fishery Institute, Washington, D.C.

U.S. Army Corps of Engineers. 1973. Charts of the Illinois Waterway. U.S. Lake Survey-Illinois Waterway 481-8002-0802-2740. Chicago, IL.

Wallus, R., B.L. Yeager, and T.P. Simon. 1990. Reproductive biology and early life history of fishes in the Ohio River drainage, Volume 1: Acipenseridae through Esocidae. Tennessee Valley Authority, Chattanooga, Tennessee. 273 pp.

APPENDIX A

LIFE HISTORY REVIEW

TABLE OF CONTENTS

TABLE OF CONTENTS (cont.)

Species	Breeding Guild[25,26]	Spawning Season	Spawning Temperature	Spawning Location
Emerald shiner	Simple lithophil.	April to mid-August in the Great Lakes[16]; Late May and early July in TN[134]; Peak during June and July in WI; Mid-May to early June in IL[135]; Late June to mid-August in Lake Erie[7].	24 C[169]; 22.2 C[16]; 20.1 to 23.2 C in southern Canada[170]; 22 C[16,121]	Nearshore areas of large lakes, depths avg. 3 m[16]; 2-6 m[134]; over hard sand[3,134], mud that is free of detritus[16]; normally gravelly schools[138]; rounded boulders and coarse rubble[170].

Spawning Activities	Parental Care	Dispersal of Fry	Selection of Nursery Areas
Adults gather in enormous schools offshore at night[3], smaller males pursue the larger females for a few seconds at a time. As the pairs swim in a 10 to 20 ft circle, the male overtakes the female and presses closely on either side while interlocking their pectoral fins. The pair will arch and roll over together. Eggs and milt are released while rolling. The act may be repeated several times[3].	Nonguarded[19].	**Eggs:** demersal[3,4,28,121]; non-adhesive[3,4,28]; deposited on to substrate[121] and hatch 24-32 hrs[3]. **Yolk-sac larvae:** Remain on substrate for 4 days[4]. **Post yolk-sac larvae:** Free swimming[3]; congregate in schools at surface[4]; common in main channel drift[171] in open water[3].	Pelagic[3]; mid-water or near the surface[62].

Species	Breeding Guild[25,26]	Spawning Season	Spawning Temperature	Spawning Location
Walleye	Simple lithophil	April in IL[62]; April to May in WI[3] and in upper Mississippi Valley[121]; Spring or early summer in Canada[49]. April through May[94].	3.3 to 14.4 C with peak activity from 7.7 to 10 C[94]; 7.8 to 8.9 C[381]; 5.6 to 7.8 C[382]; peak at 5.6 to 10 C[3]; 5.6 to 11.1 C[49].	Rocky areas in white water below falls or boulder to coarse gravel shoals of lakes[49]; marshes[49]; with flowing water[3,94]; flooded fields[62,121], in lakes over vegetation, debris, or gravel[62]; main channel outer bends[121]; clean substrates and shorelines of lakes and streams[382,383,384] over coarse gravel to boulder, rock substrates or sand and fine gravel at night[49,382,383,389,390,391,392].

Spawning Activities	Parental Care	Dispersal of Fry	Selection of Nursery Areas
Males precede females to spawning grounds. Spawning occurs at night in groups of one female and one to smaller males or two females and up to six males. No territoriality and no nest building. Prior to spawning, there is much pursuit, pushing, circular swimming, and fin display. The group finally rushes into shallow water, stops, the females roll onto their sides and eggs and sperm are released[3,49].	Nonguarding lithophil[19]; no parental care[3,49,220,391].	**Eggs:** Semi-bouyant[389], demersal and adhesive until water hardened[3,49,94,121,220,391]; broadcast over substrates, fall into cracks and crevices[3,49,220,391]; highest survival occurs on clean gravel and rubble[391]; hatch in 12 to 18 days, can be dislodged by current and become part of main channel drift[49,391]. **Yolk-sac larvae:** Phototrophic at hatching and swim toward surface, sink back to bottom immediately; free-swimming by second day[389]; probably swept out of rubble by currents in riverine habitats[3]; drift with currents until yolk is absorbed[389]. **Post yolk-sac:** Dispersed in upper levels of open water, remain pelagic for 4 to 5 weeks[389]; avoids strong wind currents by sinking below 2 m deep, otherwise remain ~0.3 to 3.6 m deep.	Strongly phototrophic to around 37.5 mm length. Remain pelagic from 25 to 30 mm[389]; fingerlings either return to shore or remain in open water; sometimes form loose schools along shore, usually near rooted aquatic vegetation, over bottoms of sand, gravel, silt, rubble, or boulders. Young-of-the-year usually become demersal[3,389], and move into deeper water; definite schooling behavior[389].

Species	Breeding Guild[25,26]	Spawning Season	Spawning Temperature	Spawning Location
Skipjack herring	Simple, misc.	Early May to early July in IA[6,27]; Early March to late April in FL[28,29].	Yolk-sac larval Alosa sp. were collected at 21.3 C in AL[6,30]; Near ripe adults were collected at 9 and 13.5 C, and adults with flowing gametes were collected at 16 C in TN[6].	Migrate upstream in spring[6,27], congregate in swift waters below dams[4,31]. Ripe or ripe and running adults collected in headwater tributary, tailwaters of dam, and near a shoal area of the Tennessee River[6]. Spawning probably occurs in main channel over coarse sand and gravel[28].

Spawning Activities	Parental Care	Dispersal of Fry	Selection of Nursery Areas
Apparently do not spawn in large aggregations[3,27].	None[19]	**Eggs:** No species-specific information[6]. **Yolk-sac larvae:** No information[6]. **Post yolk-sac larvae:** Collected in main channel drift nets and main channel border larval seines from May through July in the Ohio River[32]; collected mainstream from Cumberland and Tennessee River reservoirs with most coming from surface waters in littoral habitats at night[6,33].	Little reported information[6]. In Tennessee River, juveniles nearly evenly distributed horizontally and vertically, more often collected in pelagic open waters than were larvae, more abundant in larval samples than in cove populations[6,33].

Species	Breeding Guild[25,26]	Spawning Season	Spawning Temperature	Spawning Location
Bigmouth shiner	Simple, misc.	May, June, and July in IL[62,94,121]; July through September in OH[220]; Late May into August in WI[3].		Creeks and small rivers, occasionally large rivers[62]. Probably spawns over sand and gravel[444]; sand bottoms that are free of silt[221]; broad expanses of shallow water in streams with slight current[4]; mid-stream[220].

Spawning Activities	Parental Care	Dispersal of Fry	Selection of Nursery Areas
		Eggs: Carried with stream currents[3,220]. **Yolk-sac larvae:** **Post yolk sac larvae:**	

Species	Breeding Guild[25,26]	Spawning Season	Spawning Temperature	Spawning Location
Suckermouth minnow	Simple lithophil.	In KS, spawning occurs two or more times from April to August[129]; Late May to early June in IL[1]; May to mid-July in IA[158]; March in OK[159]; Early July to end of August in WI[3].	14 to 25 C[159]; 22.4 to 25 C in OK[28].	Suspected to spawn on gravelly riffles[43]; adults prefer riffles in warm streams with moderate or low gradients[3]; occurs in large rivers[134], large creeks and small rivers[62].

Spawning Activities	Parental Care	Dispersal of Fry	Selection of Nursery Areas
Eggs probably deposited over gravel[4,28,62].	Nonguarder[206].	**Eggs:** **Yolk-sac larvae:** **Post yolk-sac larvae:**	Usually in backwaters[193].

Species	Breeding Guild[25,26]	Spawning Season	Spawning Temperature	Spawning Location
Highfin carpsucker	Simple, misc.	Mid-May to July in WI[3]; May in IA[144]; Late July in MO[4]; June through September in OH[213,220].	19-28 C[121,213,220], 20-23 C in AR[28].	Shallow areas and the overflow ponds of streams[144,164], or in deep gravelly riffles[4], sand or mud bottoms[49].

Spawning Activities	Parental Care	Dispersal of Fry	Selection of Nursery Areas
Adults aggregate in large numbers into shallows[221], and broadcast eggs and milt[121].	None, nonguarders[206,220].	**Eggs:** Semi-demersal[220], demersal and adhesive[94,222], drift with current[220]. **Yolk-sac larvae:** **Post yolk-sac larvae:** Ictiobinae larvae were common and occasionally abundant in Ohio River main channel tows[462]. Larval Ictiobinae were common in backwater habitats of the upper Mississippi River and consistently collected in main channel drift[121].	

Species	Breeding Guild[25,26]	Spawning Season	Spawning Temperature	Spawning Location
White sucker	Simple lithophil.	Late March to May in IL[55,62]; April to early May in WI[3]; Possibly June[223,224], in MI[225]; Mid-May in Canada[226].	6 to 23 C[221], 7.2 to 10 C[3,72,227], 10 to 23.3 C[220].	Tributaries of lakes[220,228], shoreline[220], streams[49,220,221], backwaters[220,229], riffles[94,106], pools[62,106], homing to parent stream[220], sometimes rapids[49], over sand or gravel bottoms[62,71,229,230,231], loose gravel[94].

Spawning Activities	Parental Care	Dispersal of Fry	Selection of Nursery Areas
Adults congregate[4,225], usually occurs between one female and two males with one male on each side of her. Males spread their pectoral fins underneath the female and press her caudal fins. The males arch their backs, and the trio vibrates rapidly while depositing eggs and milt onto the substrate[3,62,49,225]. The act stirs up the gravel, releasing a cloud of sand[225].	None, female usually moves upstream[3]; nonguarder[19].	**Eggs:** Demersal[229,3], and adhesive[3], non-adhesive after hardening[106,121]; broadcast in small lots over a considerable area. **Yolk-sac larvae:** Remain in sand or gravel one to two weeks after emerging[3,227,232]. **Post yolk-sac larvae:** School in very shallow water near shore[3,106], near surface associated with aquatic vegetation[228].	Shallow water over muddy bottom with little vegetation[100], gregarious, may form schools, usually along shores[3].

Species	Breeding Guild[25,26]	Spawning Season	Spawning Temperature	Spawning Location
Silver redhorse	Simple lithophil.	May in IL[62]; April and May in WI[3]; Early May in IA[232].	Begins at 13.3 C in IA[233], 13 C[234], 14 C[121,235].	Deep, clear riffles in main channels[62,232], in shallow riffles[4,235], among rocks, gravel, and rubble[121,232,235]; 1 to 3 ft deep[3].

Spawning Activities	Parental Care	Dispersal of Fry	Selection of Nursery Areas
Adults gather in large schools over spawning grounds[3,4], apparently defend territories[3]; males outnumber females[3]; sometimes migrate upstream[24].	Nonguarder[19].	**Eggs:** Scattered[220], deposited among rocks, gravel, and rubble[121,232,235]. **Yolk-sac larvae:** **Post yolk-sac larvae:** Larval *Moxostoma* associated with vegetation in backwater areas[121].	Slow moving waters[49,232], with overhanging banks[49], smaller streams[164], stream mouths[24,220], over soft bottom areas[232].

Species	Breeding Guild[25,26]	Spawning Season	Spawning Temperature	Spawning Location
River redhorse	Simple lithophil.	April in AL[236]; June in Quebec[233]; May in WI[3].	22 to 24 C[233,236]. 20 to 23.3 C[3].	In large tributaries[49,220], 2 to 4 ft deep[3], shoals[236], excavate redds in gravel[236]; gravel bottom riffles and shallows[233]; enters smaller streams to breed[134].

Spawning Activities	Parental Care	Dispersal of Fry	Selection of Nursery Areas
Male constructs a large redd with sweeping of the caudal fin, head, and mouth. A female approaches the male over his nest. The resident male darts back and forth and is soon joined by another male. The female takes position between the males and vibratory spawning occurs over the redd[233,236].	Nonguarder[19].	**Eggs:** Demersal and non-adhesive[236]; buried in gravel[236]. **Yolk-sac larvae:** **Post yolk-sac larvae:**	Juveniles: Small to moderate size streams[120].

Species	Breeding Guild[25,26]	Spawning Season	Spawning Temperature	Spawning Location
Golden redhorse	Simple lithophil.	April and May in IL[62]; May in WI[3]; MI[94]; April to August in OH[220].	18 to 24 C with 21 C optimum[220]; 17 to 22 C[121,172,233]; 15.5 C in IA[55].	In lower ends of pools[3,94], in rivers and moderate size streams[94], riffles in mainstream[3,62,121,220], over loose gravel[121], shallows[238].

Spawning Activities	Parental Care	Dispersal of Fry	Selection of Nursery Areas
Males aggressively defend territories and are joined by females from adjacent pool areas[3,134]. Spawning occurs in groups of three to five adults[134]; no nest construction[3]. During the act two males are present for each female, one on each side[3].	Unguarded[19,220].	**Eggs:** Demersal[94,121,220,222], scattered over gravel-rubble bottom[94,220]; non-adhesive[94,121,222]. **Yolk-sac larvae:** **Post yolk-sac larvae:** Larval *Moxostoma* associated with vegetation in backwater areas[121]; a vegetated shoreline and bedrock outcrop with algal growth[461].	Slow moving waters over soft bottomed areas[232].

Species	Breeding Guild[25,26]	Spawning Season	Spawning Temperature	Spawning Location
Shorthead redhorse	Simple lithophil.	April to May in OH[220], WI[3], KS[129], IL[239]; Mid-May in IL[62].	8.3 to 16 C[3]; 16 C[240]; above 11 C[220]; 14 C in AL[134]; 11 to 16 C[232,233,241]; 11.1 to 21.7[106].	In shallow riffles of large streams[225,240], ascends tributaries of lakes or large rivers[220], over sand and gravel[62,240]; gravel bottom in swift flowing water[220], gravel[4], stones or rubble[240].

Spawning Activities	Parental Care	Dispersal of Fry	Selection of Nursery Areas
Males congregate and females move to the males. Two males station directly above a female that has a male on either side over the spawning site[134]. The group violently rolls and undulates until depressions are formed in the substrate[240]. The males closely press their caudal and anal fins against those of the female. Eggs and milt are scattered onto the substrate[225]	Nonguarders[19,220].	**Eggs:** Demersal[121,220] and non-adhesive[121], scattered on substrate[225,240], buried in the bottom[106] in small lots[235]. **Yolk-sac larvae:** **Post yolk-sac larvae:** Larval *Moxostoma* associated with vegetation in backwater areas[121], larval shorthead redhorse observed in tributary mouths[220].	Fast water in streams and rivers[106].

Species	Breeding Guild[25,26]	Spawning Season	Spawning Temperature	Spawning Location
Greater redhorse	Simple lithophil.	May to early July in Canada[49]; April in NY; June in MI[3]; May to June in OH[220]; June to early July in St. Lawrence River[94].	16 to 19 C[220,233,242].	Moderately rapid water[3,220,242], over gravel, sand, and small rubble[3,242].

Spawning Activities	Parental Care	Dispersal of Fry	Selection of Nursery Areas
Males defend territory and are periodically visited by females. Spawning act occurs with two males and one female[3], similar to other *Moxostoma sp*[220].	Nonguarders[19].	**Eggs:** Not described[62,94,220]. **Yolk-sac larvae:** **Post yolk-sac larvae:**	

Species	Breeding Guild[25,26]	Spawning Season	Spawning Temperature	Spawning Location
Trout-perch	Simple, misc.	May to August or earlier in IL[62], MN[165], and Lake Erie[220]; April to June in WI[3]; June to late September in Lake Michigan[89].	16 to 20 C[255]; 19 to 21.4 C[256]; 16 to 21.4 C[220]; 15.6 to 20 C[70]; 15.0 C[257].	Along beaches[165] and in streams (slow moving[220]) in water 2 m deep[165] or less; over gravel[49,55,62,257]; riffles in streams[220,257]; over sandy bottom[49,55,94,220]; or muck on lake bottoms[62]; silt and boulder bottoms[55].

Spawning Activities	Parental Care	Dispersal of Fry	Selection of Nursery Areas
Adults aggregate in shallows. Two or more males gather around a single female and press her sides. Eggs are fertilized as they are released and scattered randomly[165].	Nonguarder[19]; adults subject to high post-spawn mortality[3,49].	**Eggs:** Demersal, adhesive[62,165]; bouyant with oil globule[220]; randomly scattered[70,165,220]; drift with current until attached[24,165]. **Yolk-sac larvae:** Captured in drift[24]. Subject to wind and wave action[165]. **Post yolk-sac larvae:** Observed inshore in less than 20 m in Lake Erie[220], usually near shore[24].	Bottom habitats at first (10 to 20 m) then gradually move offshore[165].

Species	Breeding Guild[25,26]	Spawning Season	Spawning Temperature	Spawning Location
Red Shiner	Breeding guild not established, close to complex with parental care.	May into August in IL[135]. May through October in KS[439] May to early September in MO[4] April to September in OK[28].	23 C[3,440]; 15.6 to 29.4 C[129]; 25 C[441].	Shallow water on clean, gravel riffles, or on submerged objects, often around the margins of sunfish nests[4,28,121,443]; flooded weed beds[4,28,216], lakes and streams[216]; gravel in pools[442]; crevices formed by rubble, branches, and logs[4,51].

Spawning Activities	Parental Care	Dispersal of Fry	Selection of Nursery Areas
Spawning has been reported over sunfish nests[3,4,28]. One or more males follow a female with rapid movements at the surface. Females produce sounds which may signal the males[3]. The male may display his fins at the side or in front of the female before resuming the chase of the female. He may swim around the female in a spiral fashion. The male will nudge the female on the caudal ?peduncle and in the anal region eventually placing his genital pore about a head length below and behind that of the female. Eggs and sperm are emitted as the pair moves forward[443]. Males exhibit territoriality[3,4,28]. The spawning act may occur near the bottom edges of a sunfish nest[3].	Males may guard the spawning area in a small territory around the nest[4,28,121].	**Eggs:** Dermersal and adhesive[28,121]; eggs are broadcast[4]. **Yolk-sac larvae:** **Post yolk-sac larvae:**	

Species	Breeding Guild[25,26]	Spawning Season	Spawning Temperature	Spawning Location
Spotfin shiner	Simple, misc.	Early June until mid-August with a peak in June and early July in IL[175]; Late May to early September in WI[3]; June to early September[134], July to August in IA[158].	21.1 to 23.9 C in WI[3]; 18 C or more[152]; 21-24 C in upper Mississippi River[121].	Crevices, on undersides of submerged objects[28,62,94,121,134,152,175] and exposed tree roots near riffles[62]; shallow areas of lakes[138].

Spawning Activities	Parental Care	Dispersal of Fry	Selection of Nursery Areas
Male will actively entice a female by display passes near a potential spawning crevice[3,28]. The male aggressively defends the female against other males. Once in the crevice, the male will press the female against the crevice object and both will vibrate rapidly, repeating the act two or three more times. Males may eat unfertilized and exposed eggs[175]. Breeding individuals produce sounds during courtship[176].	Eggs are defended briefly by males[134].	**Eggs:** Deposited into spawning crevice[28,94,175]; demersal, adhesive[94,177,220]. **Yolk-sac larvae:** **Post yolk-sac larvae:**	

Species	Breeding Guild[25,26]	Spawning Season	Spawning Temperature	Spawning Location
Smallmouth buffalo	Simple, misc.	Late spring in IL[62]; Late May to early June in SD[55,94]; April to early June in upper MS[121] and WI[3]; May in IA[94].	16 and 18 C[94], extending to 21 C[94]; 15.6 to 18.3 C in WI[3]; 22 to 22.6 C in NM; about 17 C[55].	Quiet pools and backwaters[28,62] of medium and large rivers and lakes[62], shallow areas[3,70]; sometimes ascend small streams[27], flooded lands[28], random substrates[3,28,144,191,192] in shoal areas[3,191], or over vegetation[28,144,192]; submerged or floating vegetation[121].

Spawning Activities	Parental Care	Dispersal of Fry	Selection of Nursery Areas
Ripe males concentrate and precede females to spawning areas. Females join concentration as they ripen. Spawning occurs in large numbers. Eggs are broadcast at random[3].	None[19].	**Eggs:** Demersal[220] and adhesive[3,28,94,121]; randomly scattered[3,121], adhere to any surface[3]. **Yolk-sac larvae:** Shallow, vegetated backwaters, marshes, and pools[277]. **Post yolk-sac larvae:** Ictiobinae larvae were common and occasionally abundant in Ohio River main channel tows[462]. Larval Ictiobinae were common in backwater habitats of the upper Mississippi River and consistently collected in main channel drift[121].	Shallow, vegetated areas not in the main current[277]; remain sedentary for 2 years, then move upstream[220].

Species	Breeding Guild[25,26]	Spawning Season	Spawning Temperature	Spawning Location
Blackstripe topminnow	Simple, misc.	Late spring into summer[62], and late May in IL[160]; June and July in WI[3]; May to August in MI[258], with multiple spawns; May to June in OH[220].		Among submerged vegetation[4,220,258]; possibly migration to spawning areas[134]; slack water habitats preferred[134,220]; streams and small, clear tributaries or pothole lakes[220].

Spawning Activities	Parental Care	Dispersal of Fry	Selection of Nursery Areas
Males defend territories near vegetation. Females are courted by following beneath and beside them and engaging in head-dipping behavior. Females press against substrate, eggs are laid and fertilized by males[134]. In spawning position, dorsal and anal fins of the male are folded over the female. Both adults vibrate rapidly for one or two seconds. Throats are expanded. Female releases an egg during the vibrations, about 20-30 per event[258].	Nonguarders[206].	**Eggs:** Demersal and probably adhesive[220,258]; attached to submerged aquatic vegetation[205,220,258]; adhesive filaments[258]. **Yolk-sac larvae:** **Post yolk-sac larvae:**	

Species	Breeding Guild[25,26]	Spawning Season	Spawning Temperature	Spawning Location
Brook silverside	Simple, misc.	Throughout summer in IL[62]; May to early August in WI[3,121,261]; May and July in MI[262]; June to August in IN[263].	20 to 23.2 C[261,262]. 20 to 22.7 C[3,121].	Shallow areas over gravel shoals or in beds of submerged vegetation[49], of rivers and lakes[261,262]; gravel, sand[261,262], aquatic vegetation[49,125,261,263].

Spawning Activities	Parental Care	Dispersal of Fry	Selection of Nursery Areas
Males follow the females with much rapid darting. One male and female pair together. The pair descends to the bottom at an angle while contacting the edges of their abdomens with repeated momentary contact. Eggs and milt are released from the pair during the descent. The act is repeated many times[3,261].	Nonguarder[19].	**Eggs:** Demersal, chorion non-adhesive with one to three long, adhesive filaments[49,94,261]; egg and bouyant filament may drift for some distance before adhering to vegetation or sediments[3]. **Yolk-sac larvae:** Wriggle up to surface and assemble in schools of 30 to 200. Prefer upper 3 cm below surface[3]. **Post yolk-sac larvae:** School and swim to pelagic habitats over deep water[3] (3 to 20 m).	Pelagic, near surface[3,49]; make nocturnal migrations to shallows, return to pelagic habitats by day[3].

Species	Breeding Guild[25,26]	Spawning Season	Spawning Temperature	Spawning Location
White perch	Simple, misc.	May through June in OH[220]; Mid-May to late June in Lake Ontario[448]; Late May to late July in ME[449].	11 to 15 C[220,448,449].	In shallow water over all types of bottoms including those with vegetation, rocks, and other objects[49], less than 1 to 3.7 m deep[49,97]; in quiet ponds[205]; lakes and rivers over gravel or shoals[72,270].

Spawning Activities	Parental Care	Dispersal of Fry	Selection of Nursery Areas
Males precede females to spawning grounds[97]. Large numbers of adults congregate in shallows[389]. Males always more numerous than females[97]. Individual females are usually attended by numerous males[97]. Eggs and sperm are randomly released[49].	Eggs are unguarded[220].	**Eggs:** Demersal and adhesive[49,94,97,220,389]; randomly scattered and attached to vegetation, rocks, or other objects[49]; sand, gravel, tree roots, leaves, other eggs[97,389]; some are carried downstream by currents and remain semi-pelagic during incubation[97]. **Yolk-sac larvae:** Settle to bottom, may lie on their sides and occasionally swim to the surface[389]. Remain in spawning area as a nursery[389]; capable of limited but vertical darting movements, sometimes carried away from spawning grounds by currents to downstream areas in surface and bottom waters[97]. **Post yolk-sac larvae:** Exhibit preference for subsurface waters[97]. Remain in spawning area for nursery[389].	Creeks[97] and shoreline areas[97,389] in shallow, sluggish water[389], sometimes among plants, in channels[389]; in large schools[450,451,452,453,454]; may hide among vegetation[455].

Species	Breeding Guild[25,26]	Spawning Season	Spawning Temperature	Spawning Location
White bass	Simple, misc.	April or May in IL[62]; April to June in WI[3], and Great Lakes[24,70]; February to May in TN[134].	12 to 16 C[49,70,264]; up to 24 C[94]; 12.5 to 26.1 C[3]; 16.9 to 22.6[265].	Shallows of lakes, creek mouths and in streams near the surface or in mid-water. Selects moving water[3,94,134]. Spawns over rocks, algae, logs, sand and gravel[3,62,94,266,267].

Spawning Activities	Parental Care	Dispersal of Fry	Selection of Nursery Areas
Adults migrate to spawning grounds with males arriving first[134,264]. Several males surround a female and the group swims rapidly and erratically while scattering and fertilizing the eggs[266,268].	Nonguarder[3,19,49].	**Eggs:** Demersal, adhesive[134,266,269,270,271,272]; scattered[3,94,134,266]. **Yolk-sac larvae:** Free swimming[273]; exhibit repeated vertical swimming to the surface and head first sinking[273]; shallows[3]. **Post yolk-sac larvae:** Shallows[3], near shore[198], and eventually migrate to deeper waters[3]; low velocity refugia[134].	Avoids dense vegetation and shallow areas with organic bottoms; prefer shallow water over sandy beaches[274].

Species	Breeding Guild[25,26]	Spawning Season	Spawning Temperature	Spawning Location
Yellow bass		May or June in WI[3]; April or May in MO[4,134,278].	16 to 20 C[279]; from 15[280] up to 20 to 22 C[278,281].	Shallow waters 0.7 to 1.0 m deep[3,28,278,280], in open water over gravel bottoms[3,4,282], tributaries[4,121,134].

Spawning Activities	Parental Care	Dispersal of Fry	Selection of Nursery Areas
Male and female pair off during the spawning act, releasing eggs and sperm as they swim[4], side by side[278]; the act may continue for an hour or more[278].	Unguarded eggs and young[3].	**Eggs:** Demersal[4,279], adhesive[279]; broadcast over substrate[4,28,121,278]; semi-bouyant[3]. **Yolk-sac larvae:** Swim-up after 4 days[278]; at surface about 0.6 m deep[3]. **Post yolk-sac larvae:** Swarm in the shallows[3].	Frequent shallows during night, prefer lake bottoms during daylight[3]; seinable habitats[3].

Species	Breeding Guild[25,26]	Spawning Season	Spawning Temperature	Spawning Location
Yellow perch	Simple, misc.	April and May in IL[62,406], WI[3], and NY[72,125]; Mid-May to late June in Lake Michigan[404,405]; May in MN[125].	5.0 to 12.8 C[338,407]; 8.9 to 12.2 C[49]; peak at 8.5 to 11.0 C[408]; 7.2 and 11.1 C[409,410,411]; 5.6 to 18.5 C in Great Lakes basin[94].	Slow moving or static waters[419]; shallow bays, shoreline and/or littoral areas[49,70,72,125,412,413] in water 0.6 to 10.0 m deep[94]; never deeper than 15 m[404] in rocky trenches with hard clay shoals[94]; over bottoms of rock[404], sand[413], gravel[414], or rubble[410]; sometimes over aquatic vegetation[62,415]; in association with brush, weeds, roots, and fallen trees[49,407,416]; or in areas of emergent aquatic weeds[49,62,70,412,417,418].

Spawning Activities	Parental Care	Dispersal of Fry	Selection of Nursery Areas
Exhibit pre-spawning inshore or upstream migrations[407,420]. Males arrive on spawning grounds before the females and stay longer[408,413,421]. Usually spawn at night[205,389]. Nests are not constructed[3,49]. A female is followed by a long queue of males. The closest males press the female's abdomen with their snouts. The entire queue moves and maneuvers through the spawning area simultaneously[422]. The males swim beneath the female's vent. The female beats her tail with increased frequency until the eggs are extruded. The males release milt onto the egg mass[423,7].	Nonguarding phyto-lithophil[19]; eggs not protected[3,49,220,423].	**Eggs:** Contained in a long, flat demersal[389], semi-demersal[94], semi-bouyant, transparent, gelatinous, accordion-like strand[3,49,94,220], which may adhere to the substrate, vegetation, or drift with current[49,220]. Many are washed onto beaches by wave action[220]; tangled in debris and fallen branches in shallow water[389,424]. **Yolk-sac larvae:** Swim up to surface, remain in upper 0.9 to 1.2 m of water[3]; abundant in weedy littoral backwaters[121]; drift with current[220]. **Post yolk-sac larvae:** Open water, near surface, gradually swim to bottom around 25 mm length[224]; limnetic, pelagic, photopositive, and schools in shallow water[389]; subject to dispersal by wind induced currents[425].	Move in large schools, initially pelagic, becoming demersal around 25 mm length, young found inshore from deeper water around 25 to 50 mm length, common in shoals, associated with aquatic vegetation[389].

Species	Breeding Guild[25,26]	Spawning Season	Spawning Temperature	Spawning Location
Longnose gar	Simple, misc.	May to mid or late June in IL[1,2], WI[3], MO[4], Ohio and Tennessee Rivers[5,6]; Peak mid-May in TN[6,134]; May to early June in KS[8]; Until July in NY[6,9]; March through August in FL with peak activity in April[2,6,10,11].	Two ranges of temperatures peaking at 19.5 C and 21 C in WI[3]; 19-21 C in NY[6,12]; 20-30 C in OK[13].	In shallow water[6,14], beneath overhangs over gravel-rubble[6,15], in aquatic vegetation and over stone piles[1,6], over algae and along windswept shorelines and rocky points[13], quiet backwaters over vegetation[121], over naked granite[6,17], on a shallow gravel bar where water was 0.3-0.9 m deep with bulrushes present and in 2 m of water over boulder substrate[3,18], over gravelly stretches of shallow riffles[4].

Spawning Activities	Parental Care	Dispersal of Fry	Selection of Nursery Areas
Adults gather in large numbers near a spawning bed, males far outnumber females, group swims across several times before spawning[3,4,6,17,18]; no nest is prepared[4]; during spawning the group males nudge the female with their snouts[3,18], the group frequently surfaces and gulps, lashes and splashes, with convulsive or rapidly vibrating movements during release of eggs and sperm[3,4,6,17,18].	None by species[19]; however, known to spawn in smallmouth bass nests with the male bass providing brood care for eggs and larvae of both species[20].	**Eggs:** Adhesive[3,5,6,14,17] to various material/structure near spawning bed (see Spawning Location). **Yolk-sac larvae:** Tend to remain near spawning bed in locally dense populations[6,21], attach at submerged vegetation or debris[4,13,21]; in aquaria attach to surface film of water, sides of tank, and on aquatic vegetation[6,13,17,22,23]. **Post yolk-sac larvae:** Free swimming[3,6,17,23], fry disperse and do not show tendency to school[3,13] in nearshore areas[6,53]; in contrast, found in greater abundance in limnetic habitats[34], or no difference in abundances between nearshore and offshore sites[41,45].	Juveniles prefer shallow waters[6,21]; found close to shore among weed beds[24]; often along windswept shorelines, but most often in open areas in Lake Texoma[13].

Species	Breeding Guild[25,26]	Spawning Season	Spawning Temperature	Spawning Location
Central mudminnow	Complex with parental care.	March and April in WI[3]; Late March through May in OH[3]; April in NY and IN[445].	12.8 to 15.6 C[3]; 13 to 15.6 C[226]; 18 to 25 C[445]; begins at 13 C[134].	Shallow waters[134]; flood vegetation[55]; overflow areas with plant matter[3]; shore areas of small streams, over organic detritus and aquatic vegetation[220].

Spawning Activities	Parental Care	Dispersal of Fry	Selection of Nursery Areas
Adults congregate in shallow areas, where the eggs are deposited on vegetation[3]. No nest is built[184].	Females guard nests[184,445]; unguarded young[184,220].	**Eggs:** Demersal and adhesive[3,134,220]; attached to plants[3,446,447]; detritus[220]; scattered over aquatic vegetation[220]. **Yolk-sac larvae:** **Post yolk-sac larvae:**	Young move from breeding areas back to main stream at about 30 mm length[3,184].

Species	Breeding Guild[25,26]	Spawning Season	Spawning Temperature	Spawning Location
Grass pickerel	Simple, misc.	April and May in PA and Canada[6,49,66]; March and April in IL[62]; Usually spawn in April in WI[55,67]; some evidence of additional spawning in late fall[4,6,55].	7.8-12.2 C[68]; 4.4 11.7 C[67]; 4-12 C[49,70].	Aquatic vegetation, moss, leaves, and twiggs in sloughs, temporary flood plains, marshes and shallow vegetated[5] pools of tributary streams[6,49,67,68], and grassy banks less than 0.3 m deep[68]. Prefers clear water but tolerates turbid conditions[62].

Spawning Activities	Parental Care	Dispersal of Fry	Selection of Nursery Areas
Single females usually accompanied by several males; eggs and milt ejected at intervals by sudden lashing of caudal fin[72]; eggs are broadcast randomly over vegetation[3,67,68]; no nest building[49].	None[3,4,6,31,69,71]	**Eggs:** Demersal[6], adhesive[67,68], or non-adhesive[72], and presumably scattered among aquatic vegetation. **Yolk-sac larvae:** Attach to vegetation[49], found among leaf litter in the winter[69]. **Post yolk-sac larvae:** Found in very shallow water in roadside ditches[6]; overflow pools of moderate to large rivers[73], among dead leaf litter[69].	Young prefer shallow stream borders among aquatic vegetation[6], weed choked sloughs[67], near exposed roots, twigs, leaves, and grass in 7.6 to 10.2 cm of water, mostly from swamp drainages[68].

Species	Breeding Guild[25,26]	Spawning Season	Spawning Temperature	Spawning Location
Northern Pike	Simple, misc.	Spring spawners[6,49]; spawning coincides with spring peak runoff in WI[72]; During March and April in OH[22]; In March in IL[62], late March to early April[3].	Spawns from 4.4 to 11.1 C[70,72,74,75,76,77], mostly between 5- 9 C[72,74,78,79]. Most spawning is completed when water temperature exceeds 13 C[80]. Preferred temperature range of 2.2-2.8 C in a MN slough. 5 to 11 C[32].	Heavily vegetated floodplains of rivers, marshes, and bays of larger lakes[6,49]; shallow inlets with weedy bottoms and shores overgrown with reeds and rushes in water 0.9 to 3.0 m deep[44]; uses submerged aquatic plants[78,81], short emergent vegetation[75], sedges and marsh grasses[82,83]. Spawns over detritus and silt covered substrate[84]. Spawns at depths ranging from 5 to 53 cm[76,77] less than 1 m where current velocity is less than 0.1 m/s[84]. Maximum egg deposition between 17.5 to 25.4 cm in WI[75].

Spawning Activities	Parental Care	Dispersal of Fry	Selection of Nursery Areas
Spawning occurs during daylight[76,77]. Two large females accompanied by one or two smaller males swim through vegetation often no more than 17.8 cm deep[6]. A male and female roll, approximate vents, and extrude eggs and milt simultaneously while bodies rapidly vibrate. A thrust of the tails scatters the eggs as they settle[3,85]. Spawning is repeated many times over 2 to 5 days[49,86]. No nest building[3,81,87].	None[3,81,87,91]. Susceptible to heavy predation[3,6].	**Eggs:** Demersal[32,72,76,87,88]; adhesive[72,76,88] to vegetation[3,6] and mud[6]. Siltation increases embryonic mortality[22]. Hatch in 12 to 14 days[3]. **Yolk-sac larvae:** Remain in spawning area[6,49], attach to vegetation[3,78], and remain inactive for 4-10 days[49,78]. **Post yolk-sac larvae:** Typically reclusive in or near aquatic vegetation[90]; remain in shallow, vegetated spawning areas for several weeks after hatching[49,75], or they begin migration from sloughs when 15 to 23 mm[82,91,92,93], or 10 to 24 days after hatching[6].	Juveniles prefer areas with submerged vegetation[6]. In rivers, young favor areas with heavy detritus deposition and fairly turbid conditions, an abundance of filamentous green algae, and a heavy growth of vascular plants[84]. Young occupy the lower half of the water column in still and moving waters[84]. Young emigrate from spawning areas into lakes or rivers[3].

Species	Breeding Guild[25,26]	Spawning Season	Spawning Temperature	Spawning Location
Goldfish	Simple, misc.	Prolonged season in the late spring and summer in IL[62]; April to August in WI[3]; March to late June in MO[4].	Spawning begins at 15.6 C and continued throughout summer if the temperature remains above 15.6 C (WI)[3]; 16 C[94,95,96]; 16.0 to 25.0 C (DE)[97].	Areas with debris and vegetation on the bottom[62,94]; submerged aquatic plants or willow roots at depths of 15 cm[3,94]; aquatic vegetation on predominantly mud bottom[97]; warm, weedy shallows[49], and over floating aquatic plants[94,98], in channels of large rivers[4].

Spawning Activities	Parental Care	Dispersal of Fry	Selection of Nursery Areas
Spawning occurs from day break to mid-afternoon[3,98]; a female may be accompanied[3] or chased[100] by two or more males[49], eggs are fertilized after they are released[49,99]; over aquatic plants[3,49], or debris and vegetation[62]; male fertilizes eggs immediately as they attach to aquatic plants or other fixed objects[3].	None[3,49,62,97,98,206].	**Eggs:** Demersal[62,94], and adhesive[3,49,97]; adhesive until water hardened[94,98]; able to drift in river currents[4]. **Yolk-sac larvae:** Cling to plants or remain on the bottom[3]; swimming movements are limited[98]. **Post yolk-sac larvae:** Free swimming after 1-2 days[3,106]; yolk-sac absorbed after 20 hrs[94].	Generally, goldfish are most successful in small bodies of water with good growth of aquatic plants[3,28,49]. Presumed to use same habitat as adults[106].

Species	Breeding Guild[25,26]	Spawning Season	Spawning Temperature	Spawning Location
Carp	Simple, misc.	Throughout spring and summer in IL[55,62] and WI[3].	Peak activity at 18.3 to 23.9 C in WI[3]; 19-23 C in Ontario[3]; Peak at 18.5 C in SD[55]; From 14 to 17 C with peak at 18.5 to 20 C in UT[55]; 15 to 25 C[94] with optimum between 18 and 23 C[97,101], 17 to 26 C[49].	Shallow, vegetated lake waters[51,97,102]; randomly selected substrates of logs, rocks, or other submerged objects[4]; debris and vegetation[62], mud[97]; grassy shallows in Canada[49]; in ponds and vegetated areas of streams[94,103]; temporary floodplains and marshes at depths of 8 cm to 183 cm[3].

Spawning Activities	Parental Care	Dispersal of Fry	Selection of Nursery Areas
Typically segregate into pairs or small groups of one female and two to four males or six to seven males[3,101]; and one to three females and two or three to 15 males[49]; no nest is prepared for spawning[5]; frequently large spawning exhibit carp splashing, excited swimming, and thrashing activity[49,97]; spawning is intermittent, lasting several days to several weeks[104,105].	None[3,4,19,106].	**Eggs:** Deposited in clusters in a small 1.8-2.0 m^3 area[106], extremely adhesive[106], and demersal[94], when first deposited[106,107]. Eggs adhere to debris or plants or sink to the substrate[3,49,97,108]; adhere singly or in clusters[97]. **Yolk-sac larvae:** Initially at bottom, attach to aquatic vegetation or other parts of the substrate[109,110], frequently in water 25-100 mm deep[111]. **Post yolk-sac larvae:** At bottom among aquatic vegetation[109]; some congregation and schooling behavior is evident, but is not very significant[112].	Eventually, juveniles seek slightly deeper water[111]. Young less than 1 year old, non-schooling and found in vegetation in shallow water over sand, clay, or silt substrates[111].

Species	Breeding Guild[25,26]	Spawning Season	Spawning Temperature	Spawning Location
Golden shiner	Simple, misc.	Late March[136] to August[137]; May to August in Michigan[119]; Early May to mid-July in IL[62,135]; sometimes 4 or 5 distinct spawning peaks per season[138].	20 to 21 C[138,139]; 20 to 27 C[3,106]; Spawning ceases after water temperature exceeds 27 C[3,94,106].	Beds of submerged vegetation[3]; debris[3,62]; nests of largemouth bass[3,94,106]; in ponds[125,136,140], lakes[125,140], bays, and quiet water among plants[4,106].

Spawning Activities	Parental Care	Dispersal of Fry	Selection of Nursery Areas
One or two males pursue a female, nosing her cheeks, opercles, and sides of her abdomen. Eggs are dropped[3], broadcast[62], as she swims. Act is repeated back and forth over beds of vegetation with rapid circling movements[3,100,122].	Nonguarder[19].	**Eggs:** Adhesive[3,62,106,119,135,138,140], and demersal[62,119,135,140] cling to fibrous organic debris[3], vegetation[3,62,106], and bare sand[3]. **Yolk-sac larvae:** Surface layers of shallow waters[97]. **Post yolk-sac larvae:** Form into schools and inhabit shallow waters[97].	Among aquatic vegetation over various substrates[106]; near periphery of ponds or in open water of shallows not far from vegetation[100,141]. In lakes with rock shores, young remain deeper near vegetation[100].

Species	Breeding Guild[25,26]	Spawning Season	Spawning Temperature	Spawning Location
Bigmouth buffalo	Simple, misc.	April to May in WI[3]; April to June[70,194]; March until May in OH[120].	14.4 to 18.3[3,55], 16 to 18 C[70,195,196,197] extremes of 14[195] to 27 C[196].	Small streams on rip-rap in quiet back waters[4,121]; shallow waters[4] over sand gravel bottoms[3,198]; marshes or flooded river bottoms[3]; aquatic vegetation[195,196].

Spawning Activities	Parental Care	Dispersal of Fry	Selection of Nursery Areas
No nest site prepared[3,28]. A female and two to four males engage in a series of rushes which create large wakes and splashing turns. The female will sink to the bottom to deposit eggs and the males crowd around and under her to fertilize the eggs. The act may last a few hours[3,27,28].	None[3,19,220].	**Eggs:** Demersal and adhesive[3,121,220], adhere to aquatic vegetation[220]. Remain unattended until the hatch[3]; randomly scattered eggs[276]. **Yolk-sac larvae:** **Post yolk-sac larvae:** Ictiobinae larvae were common and occasionally abundant in Ohio River main channel tows[462]. Larval Ictiobinae were common in backwater habitats of the upper Mississippi River and consistently collected in main channel drift[121].	Shallow bays[3], backwaters and marshes[275].

Species	Breeding Guild[25,26]	Spawning Season	Spawning Temperature	Spawning Location
Black buffalo	Simple, misc.	April in MS[203]; April and May in WI[3], possibly mid-June in WI[3].		Sloughs, silty backwaters, and impoundments[3]; flooded lands or swamps[203]; brackish ponds[204]; over submerged terrestrial and probably aquatic vegetation[203].

Spawning Activities	Parental Care	Dispersal of Fry	Selection of Nursery Areas
Adults aggregate and excitedly break the water's surface. Pairs separate from the group for mating[205]. Eggs are broadcast randomly[3,4].	None; nonguarders[206,220].	**Eggs:** Demersal, adhesive[203]; deposited in masses[220]. **Yolk-sac larvae:** Free swimming[207]. **Post yolk-sac larvae:** Ictiobinae larvae were common and occasionally abundant in Ohio River main channel tows[462]. Larval Ictiobinae were common in backwater habitats of the upper Mississippi River and consistently collected in main channel drift[121].	Habits and life history are not well known[3,4,28,134].

Species	Breeding Guild[25,26]	Spawning Season	Spawning Temperature	Spawning Location
Silverjaw minnow	Simple, misc.	In IL, March through June[62]; Late April[55,130], and May in eastern IL[154]; Two spawning peaks - in IN[154], TN[134], one in early May and another in late June or early July[154].	Less than 13.3[156].	Shifting sand bottom[154,155]; fine gravel[4,156]; sand[120,130,134]; riffles and raceways[62]; brooks and streams of moderate gradient[55]; and large rivers[134].

Spawning Activities	Parental Care	Dispersal of Fry	Selection of Nursery Areas
Spawning behavior has not been reported[134].	None indicated[25]; unguarded[220].	**Eggs:** Demersal and buried in sand[220]. **Yolk-sac larvae:** **Post yolk-sac larvae:**Gravel areas in quiet water near the shore[156].	

Species	Breeding Guild[25,26]	Spawning Season	Spawning Temperature	Spawning Location
Spottail shiner	Simple, misc.	April[113] to late August or early September[114] in MI; Late April to early June in WI[3]; Late May and early June and possibly August in IA[116].	18.3 C[73]; 11.5[118] to 18.3 C[117]; 15 to 20 C[97].	Shallow inshore lake waters[3,94] with sandy shoals[3,106,119] and/or beds of *Cladophera*[114]; or mouths[3] and riffles[3,113] of small tributaries[94]. Avoids strong currents, silt bottoms, and turbid water[120].

Spawning Activities	Parental Care	Dispersal of Fry	Selection of Nursery Areas
Closely packed groups[3] or mass aggregations[3,121] gather over suitable areas or migrate up tributary streams[3,121]. No evidence of nest building. Details of actual spawning behavior not clear[122] but females have been observed depositing eggs in clusters on sand and patches of *Cladophora*[3].	Nonguarder[19].	**Eggs:** Demersal[14,94,106,121] and adhesive until water hardened[94,97,121]. Scattered over clean sand or gravel[3,125] not attached to substrate[119,122,124] common in river drift samples[94]. **Yolk-sac larvae:** **Post yolk-sac larvae:**	Juveniles frequently school in shallow water with abundant vegetation[73,125].

Species	Breeding Guild[25,26]	Spawning Season	Spawning Temperature	Spawning Location
Sand shiner	Simple, misc.	August to September in IA[158]; May to mid-August in WI[3]; late July and August in KS[178]; Spring throughout summer in OK[28]; June through July in Lake Erie[24].	21-37 C in KS[178]; 21-27[94,121]; Ohio River initial appearance of larvae 11.1 to 30 C[57].	Clean gravel and sand[55,179]; sand[4,119,125] in streams of all sizes[4]; in shallows[49,94], and creek mouths[152], often in sparse vegetation[49].

Spawning Activities	Parental Care	Dispersal of Fry	Selection of Nursery Areas
		Eggs: Demersal, adhesive[220], scattered over bottom[220]. **Yolk-sac larvae:** Shoreline and mouths of tributaries[220]. **Post yolk-sac larvae:** Collected in tow and seine samples on the Ohio River[57].	

Species	Breeding Guild[25,26]	Spawning Season	Spawning Temperature	Spawning Location
Quillback	Simple, misc.	Mid-April to June in IL[62]; Late June through September in OH[3]; May through July in IA[214,215]; April to late May in MO[28].	19 to 28 C[3,213,???]; 20 to 23 C[28].	Quiet waters[4,94], overflow areas[144], large rivers[217], and migrates upstream[218] over sand, gravel[49,219,220], mud[49,121], or organic matter[108]; lower ends of deep riffles[4], and bayous[124].

Spawning Activities	Parental Care	Dispersal of Fry	Selection of Nursery Areas
Broadcast eggs in quiet waters of streams[3,62]; random egg deposits[164].	None[3,206,220].	**Eggs:** Semi-demersal[220]; demersal and adhesive[212,217]; randomly deposited[106], carried easily by current[220]. **Yolk-sac larvae:** Drifting June through mid-July in OH[220]. **Post yolk-sac larvae:** Ictiobinae larvae were common and occasionally abundant in Ohio River main channel tows[462]. Larval Ictiobinae were common in backwater habitats of the upper Mississippi River and consistently collected in main channel drift[121].	Quiet broad flats with silt substrates; shallows[3].

Species	Breeding Guild[25,26]	Spawning Season	Spawning Temperature	Spawning Location
Logperch	Simple lithophil	April in IL[62]; May to June in OH[220]; April to July in WI[3]; April to June in southern MI[393]; Begins in June in Canada[49]; April through May in upper Mississippi River[121].	10 to 15 C[389]; 14 to 22 C[28]; ripe females at 9 to 23 C[389].	In streams[24], in quiet and fast moving water and typically in riffles[3,4,134,220]; also in lakes and reservoirs[394,395,396]. Spawns at depths of 10.1 cm to 2 m[389,400], over substrates of sand[4,121,125,397,398], gravel, and boulders[220,394,395,396,399].

Spawning Activities	Parental Care	Dispersal of Fry	Selection of Nursery Areas
Males gather in large schools[389], on clean gravelly or sandy riffles. Females, gathered nearby in deeper water, enter the aggregations of males. The female is often pursued by several males, only one normally participates in the act[4]. A male mounts the female by straddling her dorsum with pelvic fins and bending caudal region beneath hers. Both individuals vibrate vigorously as eggs and milt are extruded and partially buried in the substrate[393,394,395].	Nonguarder[19]; eggs and young receive no parental care[220,393,394].	**Eggs:** Demersal and adhesive[3,49,134,220,389,399] and deposited in sand or gravel[220,393,394,395] also scattered over sand[121]. Non-spawning males may eat the eggs[49,220]. 10 to 20 eggs deposited with each spawning act[49,394]. **Yolk-sac larvae:** Embryos develop in the sand[3], 2 days after hatching, usually rest on bottom[402]; abundant in backwater pools and occasionally occur in ichthyoplankton drift of the main channel[121], free-swimming for over 30 days[396]; more restricted to shallow water than larvae, more abundant in open water, not on bottom[51]; best survival limits at 22 to 26 C[389]. **Post yolk-sac larvae:** Observed inshore and to 13 m deep in Lake Erie after drifting from tributaries[220]; make diurnal vertical migrations, bottom by day, surface at night[51]; usually swim in mid-water or near the surface[402].	Associated with dense beds of vegetation in shallow water[3]; shallows[389]; demersal habits at all hours[51,402].

Species	Breeding Guild[25,26]	Spawning Season	Spawning Temperature	Spawning Location
Creek chub	Complex, no parental care.	April and May in IL[63,130]; May to July in WI[3]; Mid-April to June in MI[150,234], or July[55].	12.8 to 17 C[3]; 13 to 18 C[49,151,152,234].	Usually in streams at the lower end of a pool[150,152], with gravel substrates[94]; coarse gravel runs in currents of 0.3 to 0.7 m/sec or over littoral areas of gravel in lakes[3], sand or gravel[62,157].

Spawning Activities	Parental Care	Dispersal of Fry	Selection of Nursery Areas
Males excavate a pit-type nest by moving gravel with its mouth to the upstream edge of the nest[49]. The male defends the pit against other males. The spawning act is initiated when a female enters the pit. The male clasps her between pectoral fin and body, followed by egg release and fertilization into the pit[3,62,132,134,150].	The male covers the eggs with gravel to protect them from predation before he deserts the spawning site[3,62].	**Eggs:** Hatch within the nest[3]; demersal; non-adhesive[94,133]. **Yolk-sac larvae:** Protected in the interstitial spaces of the nest[3,28]. **Post yolk-sac larvae:** Larvae swim out through chinks in the gravel; drift downstream[3].	Schools in shallow runs, edges of pools and deeper runs[153].

Species	Breeding Guild[25,26]	Spawning Season	Spawning Temperature	Spawning Location
Rainbow darter	Simple lithophils.	April to late May in the Lake Michigan drainage[3,365]; Late March through April in IL[62]; April to June in WI[3].	15 C or greater[3,365].	In swift riffles about 0.3 m deep over fine gravel, large gravel, rubble, or a mixture of gravel and rubble[3,94]; coarse gravel[49].

Spawning Activities	Parental Care	Dispersal of Fry	Selection of Nursery Areas
Males defend territories. When a female enters the spawning area, a male swims up behind her and, while parallel to her, prods her side with his snout by rapidly vibrating his head. The female buries her head in the gravel and raises her caudal region at a 45° angle to nearly vertical. With a few caudal fin strokes, she pushes herself downward and forward so that her ventral side is buried in the gravel. This posture stimulates the male to mount her. The male uses his pelvic fins and caudal fin to place himself atop and beside her. The pair vibrate rapidly and release eggs and sperm simultaneously. The pair leave the eggs buried.[3,49].	Eggs receive no care from either parent[3]; brood hider[206]; unguarded[220].	**Eggs:** Demersal and adhesive to gravel[457,458]; buried in sand[220], gravel[3,49]. **Yolk-sac larvae:** **Post yolk-sac larvae:**	Congregated with females in raceways and pools[3].

Species	Breeding Guild[25,26]	Spawning Season	Spawning Temperature	Spawning Location
Blackside darter	Simple lithophil	May in IL[62] and OH[220]; April to June in WI[3]; May to mid-June in MI and throughout Great Lakes region[94]; May or June in Canada[49].	Includes 16.5 C[3,49,395,401].	Raceways[3]; gravel runs with moderate current[134]; not in riffles[395]; gravel-bottomed pools[49,394]; in water 30 to 60 cm deep[395], 60 cm or more[49]; over sand and gravel depressions[3,394,401]; undersides of rocks in streams[394].

Spawning Activities	Parental Care	Dispersal of Fry	Selection of Nursery Areas
No nest is prepared[3]. Female swims to suitable depression in the gravel where she is followed by males. Upon resting, she is mounted by one of the males who straddles her nape with his pelvic fins and drops his caudal peduncle down to the substrate so that the genital openings are in proximity. Both individuals vibrate vigorously as eggs and milt are emitted, kicking up a cloud of sand and creating a depression for the eggs[401].	Unguarded eggs[3,401].	**Eggs:** Demersal and adhesive[3,401]; deposited into shallow depression in sand or gravel[395,401]. Hatch in about 6 days[3]. **Yolk-sac larvae:** Live in water column, possibly subjected to drift currents[134]. **Post yolk-sac larvae:** Surface strata; drop to bottom after 3 weeks[401].	Stands of aquatic vegetation in backwaters[221], among detritus and debris[4].

Species	Breeding Guild[25,26]	Spawning Season	Spawning Temperature	Spawning Location
Slenderhead darter	Simple lithophil	First half of June in IL[62,403]; June in WI[3]; May in TN[134]; May to June in OH[220]; April to May in MO[4].	21.1 C[129].	Swift water 15 to 60 cm deep[403], in riffles over gravel and rubble[3,4,134].

Spawning Activities	Parental Care	Dispersal of Fry	Selection of Nursery Areas
Males precede females into spawning areas. Possibly territorial. Males outnumber females approximately 11 to 2. Eggs and milt are extruded over the substrate in swift riffles[403].	Nonguarder[206]; adults return to deeper water[3].	**Eggs:** Demersal[220] and adhesive[3,220], deposited among gravel[403]. **Yolk-sac larvae:** Hatch in about 2 weeks[134]. **Post yolk-sac larvae:**	Remain on gravel riffles in shallow waters[403].

Species	Breeding Guild[25,26]	Spawning Season	Spawning Temperature	Spawning Location
White crappie	Complex with parental care	April, May, and June in IL[55,62] and IA[365]; Late March to July in OH[366]; May and June in MS[121] and WI[3].	14 to 23 C with peak at 16 to 20 C[3,49,367,369,374]; begins at 13.3 C[4,28]; at 15.6 C[368].	River pools, bays, coves, and littoral areas of lakes and reservoirs near vegetation or other cover[4,49,369,370,371]. Nests at average depths of 10 to 420 cm[370,372] in substrates of clay, dirt, or gravel[370,372], usually near inundated vegetation[372], or filamentous algae[370,373].

Spawning Activities	Parental Care	Dispersal of Fry	Selection of Nursery Areas
Male and female may participate in nest building. A circular nest is created by sweeping the substrate with fin and body movements. Nesting territory is vigorously defended. The female is eventually accepted by the male following several chases. The male and female position beside each other, facing each other in the nest after the female circles the nest several times. Their bodies touch and quiver while slowly moving forward and upward. The female slides under the male, pushing him up and to the side, causing the pair to move in a curve as eggs and milt are emitted. The male exerts a steady pressure on the female's abdomen. Each act lasts from 2 to 5 seconds. The act is repeated many times[369].	Guarder[19]; male aggressively guards the eggs and fans them with pectoral fins[28,49,205].	**Eggs:** Demersal and adhesive[3,49,94,121,216]; may cling to vegetation[94,216]. **Yolk-sac larvae:** Hatch in the nest in about 4 days[49]; limited mobility[3]. **Post yolk-sac larvae:** Littoral zones near coves, boat basins, backwaters; significant drift into main channels at dusk[121].	Prefer open water[3,216]; forage in open water[374]; pelagic zone[375]; large numbers taken in bottom trawls in less than 6 m deep[376].

Species	Breeding Guild[25,26]	Spawning Season	Spawning Temperature	Spawning Location
Central stoneroller	Complex, no parental care.	May and June in WI[3]; Mid-April to early June in southern Lake Ontario[126,127]; March and May in IL[62].	14.4 to 23.9 C[3,127], between 13 and 27 C, usually from 16 to 21 C[126,128,129,130,131].	Shallow portions of streams[94,127], near deep pools[3,94], typically gravel[3,126,130] substrates in slow water or riffles[3,127].

Spawning Activities	Parental Care	Dispersal of Fry	Selection of Nursery Areas
A nest is prepared by the males first by digging. The nest is deepened by the males picking up stones in their mouths and ejecting them at the edge of the nest. The males uses his head and body to define a pit[94,126,127,132], and remove small particles. Males vigorously defend the pits against intruders. Females generally school in deeper water nearby but will move over and dip into a pit. All nearby males dart in beside her and attempt to press her body while releasing milt. When a male presses her side, the female deposits some eggs and darts away. The spawning act is extremely brief and the flurry of activity that follows includes digging which covers the eggs with sand and fine gravel[132]. Spawning may continue for several weeks[127]. Either spawn over gravel beds, build their own nest or use nests of other minnows[133]. ?Rewrite: Males excavate pits in gravel substrates, and females periodically move into the pits to spawn with resident male or males. Males aggressively defend their pit, but may change pits or use pits of other species for spawning[134].	Guarding lithophil[206].	**Eggs:** Demersal[128]; non-adhesive[131]; adhesive once fertilized[128]. Eggs usually covered with sand or fine gravel[132]. **Yolk-sac larvae:** **Post yolk-sac larvae:**	??

Species	Breeding Guild[25,26]	Spawning Season	Spawning Temperature	Spawning Location
Black bullhead	Complex with parental care.	May and June in IL[62]; April through June in WI[3,121], and MN[238]; June to August in IA; May through July in TN[134].	21 C[3,49].	Shallows of ponds or streams[144,244], pools[220], weedy or muddy water[94]; beneath vegetation[3,179,244], over gravel, silt, debris, mud, or sand[94,220], overhanging banks or in muskrat burrows[3].

Spawning Activities	Parental Care	Dispersal of Fry	Selection of Nursery Areas
Female constructs the nest[3,49,121,220,245]; male and female orientate in opposite directions over the nest, they embrace each others heads with the caudal fins; the male gapes his mouth open and arches his back while the female quivers before depositing eggs[134,245].	Female guards the nest initially[49,121,220,245]; both parents guard after eggs are deposited[28,245]; free-swimming larvae are guarded by parents for first 2 weeks[3].	**Eggs:** Demersal and adhesive[49,220]; laid in a single mass[3,129] in the nest[220]. **Yolk-sac larvae:** Develop in the nest[3].	Free-swimming, schooling behavior, swirling slowly near the surface in deep water[3]. Move into shallower water after 25 mm length, very gregarious[3]; marshy edges of lakes[460].

Species	Breeding Guild[25,26]	Spawning Season	Spawning Temperature	Spawning Location
Rock bass	Complex with parental care.	Late May to early June in WI[3], IA[216], and MN[238]; April to June in MO[4], and NY[216]; May to July in MI[289]; June in IL[135]; May to June in IL[216], and OH[220].	20.5 to 26 C[290]; 15.6 to 21.1 C[49,121,291]; 12.8 to 15.6 C[28].	Shallow water[3,121], along shorelines[1], near aquatic vegetation[4,292], over bottoms of coarse sand, gravel[3,4,28,94,220], or marl[94,121], in slight current[28,134].

Spawning Activities	Parental Care	Dispersal of Fry	Selection of Nursery Areas
Male fans out a nest[134,220], a female enters the nest area[28]. The two engage in a rocking motion in a head-to-tail position. A few eggs are distributed at any given moment and the male fertilizes them during the act[205,221,293].	Guarders[19]; male guards eggs[3,28,220], until fry are dispersed[4,134].	**Eggs:** Demersal and adhesive[3,49,220,294]; guarded and cleaned by the male[3,125,220]. **Yolk-sac larvae:** Develop in nest, rise out[3]. **Post yolk-sac larvae:**	Inhabit backwaters with emergent vegetation[24,295], in areas protected from wave[216]; tributary mouth[220].

Species	Breeding Guild[25,26]	Spawning Season	Spawning Temperature	Spawning Location
Green sunfish	Complex with parental care.	May to August[3,62,134,216,220,296]; June to August in IL[130].	22-26 C[216]; 15.6 to 28 C[3,49,296,297].	Shallow areas of lakes and ponds[94], usually in locations sheltered by rocks, logs, or clumps of vegetation[49,163] over sand, gravel[296,297], mud, or marl bottoms[187,238,296]; possibly aquatic vegetation[187]; clay[130].

Spawning Activities	Parental Care	Dispersal of Fry	Selection of Nursery Areas
Single or groups of males construct nests in sunny areas near cover, if possible. Depressions are hollowed out with vigorous caudal fin action. Males may move pebbles with their mouths[300]. Territories are defended. Receptive females enter the nests and spawn with several males. Males produce grunting sounds while courting a female[296,299]. Males occasionally spawn with two females simultaneously. Female reclines on her side and vibrates to release eggs while the male fertilizes the eggs from an upright position. After spawning, the female is driven from the nest by the male[296].	Male guards nest about 1 week while eggs are developing[134]; guarders[19,216,220].	**Eggs:** Demersal and adhesive[3,94,220,298], hatch in the nest[3], laid in a mass[3,163]. **Yolk-sac larvae:** Free-swimming 2 days after hatching[216,301]; occur regularly in drift[121]. **Post yolk-sac larvae:** Backwaters[121]; avoid areas with velocities exceeding 8 cm/s[275,302].	Low velocity areas and pool areas of streams[303].

Species	Breeding Guild[25,26]	Spawning Season	Spawning Temperature	Spawning Location
Orangespotted sunfish	Complex with parental care.	May through July in IL[135,160] May through August in IA[205,308], MO[4], WI[3], and OH[220].	18.3 to 31.7 C[3]; 18.4 to 31.6 C[129,308]; above 18 C[220]	Shallows of lakes and impoundments[299,308], in water 0.05 to 0.6 m deep[129,160], over fine gravel, sand, and mud bottom[129,308]; silted bottom[220].

Spawning Activities	Parental Care	Dispersal of Fry	Selection of Nursery Areas
Male constructs a circular nest with his tail and head. Males produce courtship sounds[299]. A male and female maneuver and splash before attaining body position so that their abdomens touch. The eggs and sperm are deposited into the nest at that point[308].	Male guards the nest[19,220] until eggs hatch[4,308].	**Eggs:** Adhesive[3,94] and demersal[3]. **Yolk-sac larvae:** Backwaters and main channel drift[121]. **Post yolk-sac larvae:** Backwaters[121]	

Species	Breeding Guild[25,26]	Spawning Season	Spawning Temperature	Spawning Location
Bluegill	Complex with parental care.	May to September in IL[309]; May to August in WI[3,305,312], IL[310], and OH[220]; June to September in MI[311]; April to August in AR[28].	16 to 32 C[220]; 18 to 25 C[97], with 23.9 to 27.8 optimum[220]; 17 to 31 C[293,313,314,315]; 22 to 32 C[216]; 19.4 to 26.7[3]	Littoral areas[216]; shallows of lentic habitats[3,125,216,220], where vegetation is not abundant[293]; near shore on sand or gravel[3,94,97,121], fine gravel[4,317], variety of substrates[216]; clay or mud bottom[94,220]; shoals[316]. Depths usually of 0.15 to 1.2 m[216], in sunny areas[318], and in shade[216,304].

Spawning Activities	Parental Care	Dispersal of Fry	Selection of Nursery Areas
Male constructs a nest[4,28,220], with tail sweeps[28,49,319], and vigorously defends the nest[3,49]. Male makes lateral displays with maximum fin erection and caudal fin elevation while on the nest. Males may repeatedly circle the rim of the nest while displaying fins[319]. Circling may.serve to attract females to the nest[3,49]. Males produce courtship calls as a series of grunts[216,299]. Once in the nest, the male and female swim circular patterns eventually stopping with the male upright and the female at an angle with their abdomens touching. A few eggs and milt are released and repeated. Females may deposit eggs in more than one nest[4,28,49,319].	Male guards[28,97,216,220], cleans, and aerates eggs[3,49], but does not guard free-swimming fry[4,28,134]; probably guards newly hatched young for a short period[49,220].	**Eggs:** Demersal and adhesive[3,49,97,125,220,293,314,313]. **Yolk-sac larvae:** Hatch in nest and are free swimming three days after hatching[301]. Larvae closely associated with nest bottom until after yolk absorption[121]. Backwater habitats and ichthyoplankton drift[121]; form small schools[97]. **Post yolk-sac larvae:** Littoral vegetation[216], limnetic zones[224], taken in plankton samples[216], shorezones[97].	Closely associated with submergent vegetation in backwaters[121], shorezone[97], gregarious and frequent weed beds or other areas of heavy cover[134].

Species	Breeding Guild[25,26]	Spawning Season	Spawning Temperature	Spawning Location
Longear sunfish	Complex with parental care.	May to August in IL[130] and MO[4]. April to August in OH[220]; June to August in WI[3] and MI[187,320]; July in NY[321].	23.3 to 25 C[320]; up to 30 C[3]; 24 to 30 C[129]; 21.6 to 28.9[216]; to 31 C[322]; 20 to 25 C[220].	Shallows[4,130,187,322,323], streams with pool-riffle development, small lakes, backwaters[222], reservoirs[94]; over gravel, pebbles, sand or hard mud[3,49,125,220,322,323]; brush-free areas[216].

Spawning Activities	Parental Care	Dispersal of Fry	Selection of Nursery Areas
Male constructs nest with sweeping tail action[319] and defends nest[3,216]. Males produce grunting, courtship sounds[299]. Female enters nest and is circled by the male which remains in upright position. The female occasionally and repeatedly rolls on her side and is met by the male so their abdomens are close together. Both fish shudder and release eggs and milt into the nest[324]. Female darts away from the nest immediately, possibly into other nests to spawn again[3].	Male guards and fans the eggs[3,134,220,324].	**Eggs:** Demersal and adhesive[3,125,187,220,293,325]. **Yolk-sac larvae:** Hatch in 3 to 5 days[3,220] and swim up[3]; guarded by male[3,28]; on bottom, swim up at night[389]. **Post yolk-sac larvae:** Most abundant at bottom. May disperse at night[389].	On bottom in shallow water[389].

Species	Breeding Guild[25,26]	Spawning Season	Spawning Temperature	Spawning Location
Smallmouth bass	Complex with parental care.	May or June in IL[62]; NY, MI[328], IA[329,330,331], and Lake Erie[220]; Mid-April to May in OH[220,326]; May to July in WI[3,327].	11.7 to 23.9 C[3]; 12.8 to 21 C[347]; 19 C[332]; 15 to 23.9[220]; 12.8 to 18.3 and up to 23.9 C[49,163,220,328,333,334].	Rivers, river shallows, backwaters, sloughs[144,330,341,342,343,344,345]; impoundments, all size streams and rivers with pool-riffle development, rip-rap shores[220]; over rock, gravel, coarse sand[3,220,336,337,338]; near submerged objects[49,220]; bedrock with overlying gravel[340]; prefer depths 0.4 to 1.5 m deep[3], 2.4 to 3.7 m[339], 0.3 to 6.0 m[49,328,333,336,344]; very slow current[346].

Spawning Activities	Parental Care	Dispersal of Fry	Selection of Nursery Areas
Male constructs the nest after several false starts[339,342]. He may use his mouth to remove large objects[3]. When a female approaches the nest, the male may drive her into the nest. As she enters the nest, the male will display his dorsal spines towards her. The female's color will change to dark mottling. The two fish lie side by side on the bottom. The females roll to a 45° angle while the male remains upright with his head just back of the female's pectoral fin. The female displays fin movements. Eggs are emitted at repeated brief intervals[205]. A female may spawn in more than one nest[3].	Male guards the nest[3] and cleans the eggs[220].	**Eggs:** Demersal[49] and adhesive[3,220,328,336,348]; laid in a mass[3,49]. **Yolk-sac larvae:** Associated with nest[349] and are guarded by the male for a few days[3,121,220]; near submerged cover in shallows or backwaters of streams[345]; remain on bottom 12 days then rise to surface and drift[220]. **Post yolk-sac larvae:** Calm, shallow, marginal areas with rocks and vegetation[328,345]; move away from nest[339].	Young seek shelter behind submerged objects and avoids thick weedbeds in shallow water[3]; use quiet water near or under a dark shelter such as brush or rocks[345], and prefer low velocity water near a current[345].

Species	Breeding Guild[25,26]	Spawning Season	Spawning Temperature	Spawning Location
Largemouth bass	Complex with parental care	Late April to May or May or June in IL[62,310,350]; May to mid-June[351], late April to early June[305], and late April to early July in WI[352]; April to June in MN[216], and MI[353]; May in NY[354]; April to early July in MS[121].	16.7 to 18.3 C[3,49]; 15.6 to 18.3 C[216]; 11.5 to 29 C[354]; 12.8 to 21.1 C[216]; 11.7 to 13.9 C[355]; 16 to 23.9 C[94].	Shallow sheltered areas[3,28,49,62,238,305,359], usually with aquatic vegetation[49,62,187,216,356,357], over gravel, sand, or soft mud[3,4,28,187,216,289,305,356,357,358], or marl[359]; roots[216], near boulders or pilings[360]; silt-free substrates[4,361].

Spawning Activities	Parental Care	Dispersal of Fry	Selection of Nursery Areas
Male constructs nest by using fins to sweep out a large circular basin[3,28,31,134]. Male guards nest[28,200]. Male and female may nudge or nip at each other and swim parallel or vertically[49]. Female is induced to spawn by repeated physical contact. Female approaches a male in the nest and turns on her side with her head obliquely pointed downward appearing to float or hover. The male takes a similar position beside the female. Eggs and sperm are emitted while the pair lay and partly roll side by side. The act may be repeated and last for 30 minutes per event. The male receives more than one female in his nest[358].	Guarders[19]; male guards and fans the eggs[3,28,31,49], and may remain with young for some time after they leave the nest[3,4,28,362].	**Eggs:** Demersal and adhesive[24,49,97,293,359,363,364], deposited in center, along the rim, or even outside the nest[3]. **Yolk-sac larvae:** Remain in bottom of nest until yolk is absorbed (6 or 7 days)[3,97]. **Post yolk-sac larvae:** Rise from the nest, school and begin feeding[49,356], guarded by the male parent up to 31 days[3,49]; dense submerged vegetation[121].	Schooling behavior[3,4,49,97], within several square meters of the nesting area[3]; associated with beds of dense submerged vegetation[121]; shore zone[97].

Species	Breeding Guild[25,26]	Spawning Season	Spawning Temperature	Spawning Location
Black crappie	Complex with parental care	May or June and possibly July in WI[3] and MN[377]; March to June in OH[366]; March to May in TX[216].	4.4 to 15.6 C[366]; 17.8 to 20 C[3,28,378]; 17.4 to 20 C[94]; 16 to 20 C[49].	Quiet[28], shallow areas of lakes and ponds[3,49,125,160,379], usually in water 25 to 610 cm deep; near aquatic vegetation[3,49,94,216], or undercut banks[49]; over clay or muddy bottom[3,94,366]; sand and fine gravel is preferred[3,49,205,216].

Spawning Activities	Parental Care	Dispersal of Fry	Selection of Nursery Areas
Male moves to shallows[216], builds a nest using fins and guards the nest area[3]. Male usually builds nests after females are attracted to the spawning area[216], or male may clear just the silt away from the substrate[97]. Habits are similar to white crappie[4,28,49,121]. A female may spawn with several males and may produce eggs several times during the spawning period[3].	Guarder[19]; males guard nest[97,216,220] and protects young[3,97].	**Eggs:** Demersal and adhesive[3,49,97,160,205,220]. **Yolk-sac larvae:** Hatch in nest in 48 to 68 hrs[363] and are guarded by the male until they disperse[224]. **Post yolk-sac larvae:** Most abundant in backwater areas but tend to drift into main channels[121]; common in ichthyoplankton samples[121]; fry go to limnetic zone where they are not subject to predation by young bass[216].	School in shallow, quiet, or protected waters[3,380].

Species	Breeding Guild[25,26]	Spawning Season	Spawning Temperature	Spawning Location
Striped shiner	Simple lithophil.	May and June in IL[62] and MI[119]; June to mid-July in Lake Erie[94]; Late April to mid-June in MO[3,4].	15 to 18 C in IL[62]; 18 C in MI[172]; 15.6 C in TN[134]. 13 C in TN[174].	Gravel[4,28,62,120,134] in riffles[62,220]; boulders, bedrock, and sand[120] in brooks[120] where gradient is moderate or high[120,134] and water is clear[28,120].

Spawning Activities	Parental Care	Dispersal of Fry	Selection of Nursery Areas
Male builds craterlike nest in the gravel and defends it. Male embraces female with his body, holding her on her side with the venter facing upstream and fertilizes eggs as they are deposited[62,173]; male may spawn with a group of females[3]; pectoral fin tubercles of the male apparently aid maintaining contact during spawning[134].	Male may guard eggs[220].	**Eggs:** Laid in the nest[3,62,120,220]; demersal and adhesive[174,220]. **Yolk-sac larvae:** Tributary creek[3]. **Post yolk-sac larvae:**	May move to deeper waters of lower gradients after the spawning season[120].

Species	Breeding Guild[25,26]	Spawning Season	Spawning Temperature	Spawning Location
Bluntnose minnow	Complex with parental care.	May through August[3,4,24,62,119,130,138]; May to June in OH[120]; May and June in IL[62].	Eggs collected in IL at 21 to 26 C[130]; 21.1 to 26.1 C[3]; 19 to 21 C or higher[119,138].	Rivers, streams, and lakes[119]; undersides of submerged objects[3,119,184]. Excavates nests below objects in sand, gravel[3,4,62,119,120,184,185,186] or occasionally marl shoals[119].

Spawning Activities	Parental Care	Dispersal of Fry	Selection of Nursery Areas
Male excavates and defends[3] a nest[62,119]. A male may spawn with several females and visa versa during a single night.	Male guards and aerates the eggs and larvae until they swim away[3]. Male remains on the nest throughout the incubation period, driving away all other fish except females ready to spawn[4,28].	**Eggs:** Demersal[6,121,184], and adhesive[3,6,121,184]. Laid in oblong patches 8-10 cm or larger, usually one layer thick[121]. **Yolk-sac larvae:** Remain in nest[3,4,28]. **Post yolk-sac larvae:** Free swimming, surface of water[187]. Collected in association with vegetated shoreline, undercut bank near roots, near roots in a pool, in an open pool, gravel, and algae [461].	On or near shallow water breeding grounds of the parents[3].

Species	Breeding Guild[25,26]	Spawning Season	Spawning Temperature	Spawning Location
Fathead minnow	Complex with parental care.	May to late summer in IL[62,70], PA[62,188]; April to July in AK[28]; May to August in MO[4], and WI[3,189].	15.6-18.4[55,121,190]; begins at 15.6 in WI[3], 18.3 C in AK[28]; 14.4 to 18.3 C in NE[191]; 18 C[137,138,192]; 16 C[70].	Slower moving sections of streams and in ponds[94,121,193]; underside of submerged plant and debris objects[3,4,28,55,94,121,192]. Substrates of sand, marl, or gravel[3,189].

Spawning Activities	Parental Care	Dispersal of Fry	Selection of Nursery Areas
Males prepare and defend nests, males may admit or chase females into the nest, after sufficient vibratory stimulation. The male lifts and presses the female upward. The female emits one to several eggs while the male releases milt. The act may be repeated several times[194].	Eggs guarded and aerated by male[3,220].	**Eggs:** Deposited in nests[3] or underside of objects[3,220]. Demersal and adhesive[3,220]. **Yolk-sac larvae:** Remain near nest[3]. **Post yolk-sac larvae:**	

Species	Breeding Guild[25,26]	Spawning Season	Spawning Temperature	Spawning Location
Bullhead minnow	Complex with parental care.	Late May to late July in IL[4,135], into September[189]; June to August in WI[3,70].	$\geq$25.6 C[3], 21 to 26 C[94].	Shallow pools, slowly flowing water of medium to large streams[28,70], beneath stones, tree limbs, or other solid objects on the bottom[3,70,190].

Spawning Activities	Parental Care	Dispersal of Fry	Selection of Nursery Areas
Male constructs and aggressively defends a nest while female may go in or out of the nest, sometimes remaining outside for hours. When coupled, the adults may swim in a circular manner when entering or leaving the nest. The spawning session lasts about 10 minutes[190].	Males guards and cleans eggs[3,4,190,220].	**Eggs:** Demersal and adhesive[120,121,220]; attached under objects[220]. **Yolk-sac larvae:** Hatched in the nest[3]. **Post yolk-sac larvae:** Benthic, feed on bottom-ooze diatoms[190].	

Species	Breeding Guild[25,26]	Spawning Season	Spawning Temperature	Spawning Location
Yellow bullhead	Complex with parental care.	May through July in WI[3]; April and May in TN[134]; May through June in IL[24,160,164,166].	No data available except one record that coincides with larval peak densities in Ohio River. Southern PA was 23 to 28.3 C[57].	Shallow areas, 0.5 to 1.2 m deep[162], 0.45 to 1.22 m[164], in lakes and rivers[163]. Overhanging stream banks[3], burrows[3,49], or near stones or stumps[3,49,71].

Spawning Activities	Parental Care	Dispersal of Fry	Selection of Nursery Areas
Nest or burrow may be constructed by both sexes[3,134].	Male guards eggs and young[164,167] until they reach a length of about 50 mm[3,73,164,168].	**Eggs:** Adhesive[3,73,106], demersal[94], deposited in clusters[3,106] in nest; sometimes attached to roots in nest[3,106]. **Yolk-sac larvae:** Remain in the nest[220].	School by the hundreds in quiet water[3]. Seek logs and stones in shallow water to hide from predators[161]. Swim to surface to feed[220].

Species	Breeding Guild[25,26]	Spawning Season	Spawning Temperature	Spawning Location
Channel catfish	Complex with parental care.	May to July in IL[62], WI[3], MO[4], Great Lakes[49].	21.5 to 29.5 C[49,121,142,143], 23.9 to 26.7 C[3], 23.9 and 21 to 27 C[55], 22 to 30 C[134].	Secluded, darkened[49,143,144], semi-darkened[3,106], areas near shore[24]. Frequent use rock ledges[3,144], undercut banks[3], under rocks[94], logs[4,49,143,144], man-made containers[3,145,146], or muddy substrate[147].

Spawning Activities	Parental Care	Dispersal of Fry	Selection of Nursery Areas
Male cleans a nest site with his fins and body. A single female will initiate spawning at the nest with any sign of biting. The male may respond by nudging the female near the vent. Male and female will wrap around each other with their tail fins. Female will release eggs into a small area by a series of abdominal contractions and short lunges. The male releases milt onto the eggs following each release. Spawning act may last up to 6 hrs[3,142]. The female will soon be forced from the nest by the male which guards the eggs[97,142].	Eggs, larvae, and small young are cared for by the male parent. The parent will aerate and clean the eggs. The male will guard the nest until most or all fry swim away (up to 10 days after hatching)[97].	**Eggs:** Demersal[3,94,97,106], adhesive[3,94,97,106], and deposited in gelatinous mass[4,97,145,149]. **Yolk-sac larvae:** Guarded by male in the nest 2 to 5 days after hatching[97]. Rarely collected in drift samples[121,461]. Larvae common in main channel tows, but rarely abundant[462].	Alevins swim up to surface to feed. Travel in schools for several days or weeks[97]. Seek quite, shallow[73,97] water over sandbars, drift piles, and among rocks. Strong schooling tendency at 4-10 months[3,73]. Alevins abundant in main channel trawl catches, most commonly collected at night[121]. Collected exclusively at night during 24-hour drift sampling[464].

Species	Breeding Guild[25,26]	Spawning Season	Spawning Temperature	Spawning Location
Stonecat	Complex with parental care.	June or July in WI[3], IL and MO[252]; June in Lake Erie[244]; July in NY[251]; April or May in MO[4]; Late June in IN[135]; June to late August in OH[55].	Begins at 27.8 C[3,49,220,251].	In streams or shallow, rocky areas of lakes[49,55,70,244], under rock or logs[70,205,251], under large rocks in pools and riffles of moderate current[28,220], and slightly turbid water[28], beneath flat stones[4,251].

Spawning Activities	Parental Care	Dispersal of Fry	Selection of Nursery Areas
	Male guards eggs[19,28,134,220].	**Eggs:** Demersal, adhesive[24,49,70,220]. **Yolk-sac larvae:**	

Species	Breeding Guild[25,26]	Spawning Season	Spawning Temperature	Spawning Location
Tadpole madtom	Complex with parental care.	Late June and July in Canada[49], WI[3], IA[116], IN[254], and MO[4]; May to July in OH[220,253]; Peak in June in TN[134], May into September[259].	20 C and higher[97].	Large rivers and tributaries in shallow water[49,73], low gradient portions of streams, oxbows, lakes or artificial impoundments over substrates of muck, mud, or organic debris[73,253], with or without aquatic vegetation[253].

Spawning Activities	Parental Care	Dispersal of Fry	Selection of Nursery Areas
	Eggs guarded by one parent fish[125]; by both parents[97]; guarded by male[123]; no evidence that parents care for broods after hatching[3].	**Eggs:** Demersal and adhesive[49,73,97,220,260], in clusters beneath boards or logs, in holes, under roots, in debris[73,94,106,134]; clutch deposited in beer and soda cans[260]. **Yolk-sac larvae:**	

Species	Breeding Guild[25,26]	Spawning Season	Spawning Temperature	Spawning Location
Flathead catfish	Complex with parental care.	June and July in WI[3], MI[70], MN[238], KS[246], and AR[28].	23.9 to 25 C[246]; 22.2 to 23.9 C[3]; 20.0 to 30.0 C[220]	Quiet pools or backwaters of large rivers[129,220,247], or impoundments[129,220], in 2 to 5 m of water[220], in secluded shelters and dark places[3,216]. Nests constructed under cut banks[3,129,220], brush piles, large boulders, logs, or crevices[4,220,238].

Spawning Activities	Parental Care	Dispersal of Fry	Selection of Nursery Areas
A nest or depression is excavated in a natural cavity or near a large submerged object by one or both parent fish[4,28]. The male and female encircle each other's head with their caudal fins. The male repeatedly quivers strongly and the female deposits eggs into the nest. Males fertilize eggs after they are deposited in masses of 30 to 50[248].	Males guard the eggs[19,220,248,249], beyond hatching[3,4].	**Eggs:** Demersal, adhesive[129,205,220]; deposited in nest[3,4,220]; agitated by parent[4,28,248]. **Yolk-sac larvae:** Remain near the nest in compact school, but later become solitary[3,121].	Alevins: Free-swimming, schooling[28]. Found among rocks and riffle areas[3,4], shallow riffles, beneath stones or other cover[129,247].

Species	Breeding Guild[25,26]	Spawning Season	Spawning Temperature	Spawning Location
Johnny darter	Complex with parental care.	May in IL[62] and southern Canada[49]; June through early August in Lake Erie[220]; April through June in OH[220]; April to June in Lake Michigan drainage[94]; in WI[3].	11.7 to 21.1 C[3,24,94].	Protected shallow areas on the undersides of rocks[4,49,62,94,220]; submerged objects[3,4,134]; quiet waters of lakes, pools and raceways[394,395].

Spawning Activities	Parental Care	Dispersal of Fry	Selection of Nursery Areas
Spawning migrations occur with males moving to spawning areas prior to females and establishing territories near breeding sites[394,395,456]. The male builds a nest by clearing debris away from an area under a submerged object with his fins[134]. Males may attract females into their nests by darting towards them and returning to the nest and assuming an inverted position[3]. The female may enter the nest in an inverted position and invites the male to prod her sides while the two fish maintain parallel head positions. The activity stimulates the female to move continuously over the surface of the object and to lay eggs. The male and female move jerkily over the eggs and the male, while inverted, fertilizes the eggs[3,49].	Guarded and cleaned by the male[3,49,134]; guarded[19,220].	**Eggs:** Demersal and adhesive[94,220,395,456]; adhesive[49,134]. Laid in oblong patch in a single layer[3]. Male guards and cleans the eggs[3,49,134,220]. **Yolk-sac larvae:** **Post yolk-sac larvae:** Common in backwater habitats[121]; observed inshore at 7 to 25 mm[220].	

Species	Breeding Guild[25,26]	Spawning Season	Spawning Temperature	Spawning Location
Pumpkinseed	Complex with parental care.	May and August in WI[3,163,220,304]; May to July in MI[94,216]; May to June in IL[135], and MN[238].	20 to 27.8 C[49]; 13 to 17 C or 15 to 18 C[216]; 20 to 29 C[216,220]; 17.5 to 29 C[49,97,305]	Shallow quiet waters of lakes, ponds, and creeks[125,293], usually in water less than 0.7 m deep[49,216,289,293], over sand or gravel[3,94,216], rock, clay, or muck bottom with roots of aquatic plants, woody debris[97,187,202,216,289,305].

Spawning Activities	Parental Care	Dispersal of Fry	Selection of Nursery Areas
Male constructs nest by fanning the bottom with caudal fin[3], and may clear debris with mouth[161]. Males defend territories around their nests[304]. Females and males swim side by side in a circle, while touching abdomens. During a rotation, the female rolls slightly and emits eggs. The male fertilizes the deposited eggs. The act may last an hour[293]. A male may spawn over two nests intermittently[205].	Male guards nest, eggs[3,220], and newly hatched fry[19,134,216,293].	**Eggs:** Demersal and adhesive[94,97,220,306]; laid in the nest[3,216,293]; attach to roots, sticks, sand, gravel[220]. **Yolk-sac larvae:** Backwaters and current drift[121]; male guards them for 11 days[220,293]. **Post yolk-sac larvae:** Backwaters, on or near the shallow breeding areas[3].	Juveniles: Shallow waters in abundant and loose schools near the surface in areas of emergent aquatic plants[307].

REFERENCES

1. Forbes, S.A. and R.E. Richardson. 1920. The fishes of Illinois. Illinois Natural History Survey Division, Springfield, Illinois.

2. Netsch, N.F. and A.W. Witt, Jr. 1962. Contributions to the life history of the longnose gar (*Lepisosteus osseus*) in Missouri. Trans. Am. Fish. Soc. 91:251-262.

3. Becker, G.C. 1983. Fishes of Wisconsin. The University of Wisconsin Press, Madison, WI. 1,052 pp.

4. Pflieger, W.L. 1975. The fishes of Missouri. Missouri Dep. Cons., Jefferson City, MO. 343 pp.

5. Simon, T.P. and R. Wallus. 1989. Contributions to the early life histories of gar (Actinopterygii: Lepisosteidae) in the Ohio and Tennessee River basins with emphasis on larval development. Trans. Kent. Acad. Sci. 50:59-74.

6. Wallus, R., B.L. Yeager, and T.P. Simon. 1990. Reproductive biology and early life history of fishes in the Ohio River drainage. Vol. 1: Acipenseridae through Esocidae. Tennessee Valley Authority, Chattanooga, TN.

7. Etnier, D.A. and W.C. Starnes. 1994. The fishes of Tennessee (unpublished manuscript). University of Tennessee Press, Knoxville, Tennessee.

8. Deacon, J.E. 1961. Fish populations following a drought in the Neosho and Marais des Cygnes Rivers of Kansas. Univ. Kans. Publ. Mus. Nat. Hist., 13(9): 359-427.

9. Beard, J. 1889. On the early development of *Lepisosteus osseus*. Proc. Royal Soc. of London 46:108-118.

10. Moody, H.L. 1957. A fishery study of Lake Panasoffkee, Florida. Quarterly J. Fl. Acad. Sc. 20:21-88.

11. Holloway, A.D. 1954. Notes on the life history and management of the shortnose and longnose gars in Florida waters. J. of Wildl. Mgmt. 18:438-448.

12. Dean, B. 1895. The early development of gar-pike and sturgeon. J. Morph. 11:1-62.

13. Echelle, A.A. and C.D. Riggs. 1972. Aspects of the early life history of gars (*Lepisosteus*) in Lake Texoma. Trans. Am. Fish. Soc. 101:106-112.

14. Lippson, A.J. and R.L. Moran. 1974. Manual for identification of early developmental stages of fishes of the Potomac River Estuary. Prepared for the Power Plant Siting Program of the Maryland Department of Natural Resources, PPSP-MP-13, Baltimore, MD.

15. Yeager, B.L. and R.T. Bryant. 1983. Larvae of the longnose gar *Lepisosteus osseus* from the Little River in Tennessee. J. Tenn. Acad. Sc. 58:20-22.

16. Flittner, G.A. 1964. Morphometry and life history of the emerald shiner, *Notropis atherinoides* Rafinesque. PhD. Diss. Univ. Mich, Ann Arbor, MI. 213 pp.

17. Agassiz, A. 1879. The development of *Lepisosteus*. Proc. Am. Acad. Arts and Sc. 14:65-76.

18. Haase, B.L. 1969. An ecological life history of the longnose gar *Lepisosteus osseus* (Linnaeus), in Lake Mendota and several other lakes of southern Wisconsin. PhD. Diss. Univ. Wisc., Madison, WI.

19. Balon, E.K. 1975. Reproductive guilds of fishes: a proposal and definition. J. Fish. Res. Bd Can. 32:821-864.

20. Goff, G.P. 1984. Brood care of longnose gar (*Lepisosteus osseus*) by smallmouth bass (*Micropterus dolomieui*). Copeia 1984:149-152.

21. Echelle, A.A. 1967. The food habits of young-of-year gars (*Lepisosteus*) in Lake Texoma, with notes on spawning and development. MS Thesis. Univ. Okla., Norman, OK.

22. Hassler, T.J. 1970. Environmental influences on early development and year-class strength of northern pike in Lakes Oahe and Sharpe, South Dakota. Trans. Am. Fish. Soc. 102:89-100.

23. Mark, E.L. 1890. Studies on *Lepisosteus*. Part I. Bulletin of the Harvard Mus. Comp. Zoo. 19:1-128.

24. Fish, M.P. 1932. Contributions to the early life histories of sixty-two species of fishes from Lake Erie and its tributary waters. U.S. Bur. Fish. Bull. 47:293-398.

25. OEPA. 1987. Biological Criteria for the Protection of Aquatic Life: Volume II. Users Manual for Biological Field Assessment of Ohio Surface Waters. Doc. 0046e/0013e - Ohio Env. Prot. Agency, Div. Wat. Qual. Monit. and Assess. Columbus, Ohio.

26. OEPA. 1989. Addendum to Biological criteria for the protection of Aquatic Life: Vol. II. Users Manual for Biological Field assessment of Ohio Surface Waters. Ohio Env. Prot. Agency. Columbus, Ohio.

27. Coker, R.E. 1930. Studies of common fishes of the Mississippi River at Keokuk. U.S. Bur. Fish. Bull. 45:141-225.

28. Robinson, H.W. and T.M. Buchanan. 1988. Fishes of Arkansas. Univ. Ark. Press, Fayetteville, Arkansas.

29. Wolfe, J.C. 1969. Biological studies of the skipjack herring, *Alosa chrysochloris*, in the Apalachicola River, Florida. MS Thesis. Florida State Univ., Tallahassee, Florida.

30. Pestrak, J.M. 1977. Fish eggs and larvae collected from the lower Coosa River, Alabama. MS Thesis. Auburn Univ., Auburn, Alabama.

31. Clay, W.M. 1975. The fishes of Kentucky. Kentucky Dep. Fish Wildl. Res., Frankfort, Kentucky.

32. Embody, G.C. 1910. The ecology, habits and growth of the pike, *Esox lucius*. PhD Diss., Cornell University, Ithaca, New York. 88 pp.

33. Wallus, R. and L. K. Kay. 1989. Descriptions of young skipjack herring, with notes on early life ecology. J. Ala. Acad. Sc. 60:39-47.

34. Storck, T.W., D.W. Dufford, and K.T. Clement. 1978. The distribution of limnetic fish larvae in a flood control reservoir in central Illinois. Trans. Am. Fish. Soc. 107:419-424.

35. Miller, R.R. 1960. Systematics and biology of the gizzard shad (*Dorosoma cepedianum*) and related fishes. U.S. Fish Wildl. Serv. Fish. Bull. 60:371-392.

36. Jester, D.B. and B.L. Jensen. 1972. Life history and ecology of the gizzard shad, *Dorosoma cepedianum* (LeSueur) with reference to Elephant Butte Lake. New Mexico State Univ. Agr. Exp. Stat. Res. Rep. 218. Las Cruces, New Mexico.

37. Shelton W.L. 1972. Comparative reproductive biology of the gizzard shad, *Dorosoma cepedianum* (LeSueur), and the threadfin shad, *Dorosoma petenense* (Gunther), in Lake Texoma, Oklahoma. Doctoral Diss. The University of Oklahoma, Norman, Oklahoma.

38. Bodola, A. 1966. Life history of the gizzard shad, *Dorosoma cepedianum* (LeSueur), in western Lake Erie. U.S. Fish Wildl. Serv. Fish. Bull. 65:391-425, Washington, D.C.

39. Dendy, J.S. 1946. Food of several species of fish, Norris Reservoir, Tennessee. J. Tenn. Acad. of Sci. 21:105-127.

40. Eschmeyer, R.W., R.,H. Stroud, and A.M. Jones. 1944. Studies of the fish population on the shoal area of a TVA main-stream reservoir. J. Tenn. Acad. Sci. 19:70-122.

41. Sager, D.R. 1987. Distribution of larval gizzard shad in the upper Cape Fear River, North Carolina. Am. Fish. Soc. Symp. 2:174-178.

42. Warner, E.N. 1940. Studies on the embryology and early life history of the gizzard shad, *Dorosoma cepedianum* LeSueur. Doctoral Dissertation. The Ohio State Univ., Columbus, Ohio.

43. Tisa, M.S., J.J. Ney, and D.K. Whitehurst. 1985. Spatial and temporal distribution of larval alewives and gizzard shad in a Virginia reservoir. Proc. Annu. Conf. S.E. Assc. Fish Wildl. Agencies 39:65-73.

44. Kendall, W.C. 1919. The pikes: their geographical distribution, habits, culture, and commercial importance. U.S. Bur. Fish. Doc. 853. Rep. of the U.S. Comm. Fish. (1917). Appendix 5.

45. Downey, P. and D. Toetz. 1983. Distribution of larval gizzard shad (*Dorosoma cepedianum*) in Lake Carl Blackwell, Oklahoma. Am. Midl. Nat. 109:23-33.

46. Baglin, R.E., Jr. and R.V. Kilambi. 1968. Maturity and spawning periodicity of the gizzard shad, *Dorosoma cepedianum* (LeSueur), in Beaver Reservoir. Proc. Ark. Acad. Sci. 22:38-43.

47. Willis, D.W. 1987. Reproduction and recruitment of gizzard shad in Kansas reservoirs. N. Am. J. Fish. Mgmt. 7:71-80.

48. Holland, L.E. 1986. Distribution of early life stages of fishes in selected pools of the upper Mississippi River. Hydrobiologia 136:121-130.

49. Scott, W.B. and E.J. Crossman. 1973. Freshwater fishes of Canada. Fish. Res. Bd. Can. Bull. 184, Ottawa, Ontario, Canada.

50. Williamson, K.L. and P.C. Nelson. 1985. Habitat suitability index models and instream flow suitability curves: gizzard shad. U.S. Fish Wildl. Serv. Biol. Rep. 82(10.112), Washington, D.C.

51. Taber, C.A. 1969. The distribution and identification of larval fishes in the Buncombe Creek arm of Lake Texoma with observations on spawning habits and relative abundance. Doctoral Dissertation, University of Oklahoma, Tulsa, Oklahoma.

52. Netsch, N.F., G. M. Kersh, Jr., A. Houser, and R.V. Kilambi. 1971. Distribution of young gizzard and threadfin shad in Beaver Reservoir. Pages 95-105 *in* G.E. Hall, editor. Reservoir Fisheries and Limnology. Am. Fish. Soc. Spec. Publ. No. 8, Washington, D.C.

53. Leslie, J.K. and J.E. Moore. 1985. Ecology of young-of-year fish in Muscote Bay (Bay of Quinte), Ontario. Can. Tech. Rep. Fish. Aqua. Sci. No. 1377. Burlington, Ontario, Canada.

54. Peters, B.A. (editor). 1983. Aquatic baseline studies of the Green River, Martin Creek, and Richland Slough. Report Prepared for United States Department of Energy by the Academy of Natural Sciences, Philadelphia, Pennsylvania. DOE/OR/03054-75 (Volumes 1-2) available from National Technical Information Service, U.S. Dep. Comm., Springfield, Virginia.

55. Carlander, K.D. 1969. Handbook of freshwater fishery biology, Volume I. Iowa State University Press, Ames, Iowa.

56. Nelson, W.R. 1980. Ecology of larval fishes in Lake Oahe, South Dakota. U.S. Fish Wildl. Serv. Tech. Paper 10, Washington, D.C.

57. Environmental Science and Engineering, Inc. 1987. Ohio River ecological research program. 1986 Final Report Submitted to American Electric Power Service Corporation, Ohio Edison Company, and Ohio Valley Electric Corporation. ESE Number 86-815. Environmental Science and Engineering, Inc., St. Louis, Missouri.

58. Holland, L.E. and M.L. Huston. 1983. A compilation of literature on the larvae of fishes common in the upper Missouri River. U.S. Fish Wildl. Serv. Natl. Fish. Res. Lab., LaCrosse, WI.

59. Balon, E.K. 1981. Additions and amendments to the classifications of reproductive styles in fishes. Environmental Biology of Fishes 6:377-389.

60. Battle, H.L. and W.M. Sprules. 1960. A description of the semi-bouyant eggs and early development stages of the goldeye, *Hiodon alosoides* (Rafinesque). J. Fish. Res. Bd. Can. 17:245-266.

61. Kennedy, W.A. and W.M. Sprules. 1967. Goldeye in Canada. Fish. Res. Bd. Can. Bull. 161, Ottawa, Ontario, Canada.

62. Smith, P.W. 1979. The fishes of Illinois. University of Illinois Press, Urbana, Illinois.

63. McPhail, J.D. and C.C. Lindsey. 1970. Freshwater fishes of Northwestern Canada and Alaska. Fish. Res. Bd. Can. Bull. 173, Ottawa, Ontario, Canada.

64. Fuiman, L.A. 1984. Ostariophysi: development and relationships. Pages 126-137 *in* H.G. Moser, W.J. Richards, D.M. Cohen, M.P. Fahay, A.W. Kendall, Jr. and S. Richardson, editors. Ontogeny and systematics of fishes. Am. Soc. Ichthyol. Herp., Spec. Publ. No. 1.

65. Northcote, T.G. 1978. Migrating strategies and production in freshwater fishes. Pages 326-359 *in* S.D. Gerking, editor. Ecology of Freshwater Fish Populations. John Wiley & Sons, New York, New York.

66. Malloy, R. and F.D. Martin. 1982. Comparative development of redfin pickerel (*Esox americanus americanus*) and the eastern mudminnow (*Umbra pygmaea*). Pages 70-72 *in* E.F. Bryan, J.V. Conner, and F.M. Truesdale, editors. Proc. Fifth Ann. Larv. Fish Conf., Louisiana State Univ., Baton Rouge, Louisiana.

67. Kleinert, S.J. and D. Mraz. 1966. Life history of the grass pickerel (*Esox americanus vermiculatus*) in southeastern Wisconsin. Wisc. Dep. Conserv. Tech. Bull. No. 37, Madison, Wisconsin.

68. Crossman, E.J. 1962a. The grass pickerel *Esox americanus vermiculatus* LeSueur in Canada. Life Science Division, Royal Ontario Museum, University of Toronto Contribution No. 55.

69. Ming, A.D. 1968. Life history of the grass pickerel, *Esox americanus vermiculatus*, in Oklahoma. Okla. Fish. Res. Lab. Bull. No. 8, Contrib. No. 171, Norman, Oklahoma.

70. Becker, G.C. 1976. Environmental status of the Lake Michigan region. Volume 17, Inland fishes of the Lake Michigan drainage basin. Prepared for United States Energy Research and Development Administration by Argonne National Laboratory, ANL/ES-40. Available from Natl. Tech. Info. Serv,, U.S. Dep. Comm,, Springfield, Virginia.

71. Scott, W.B. 1954. Freshwater fishes of eastern Canada. University of Toronto Press, Toronto, Ontario, Canada.

72. Raney, E.C. 1959. Some young freshwater fishes of New York. New York Conservationist 14:22-28.

73. Mansueti, A.J. and J.D. Hardy, Jr. 1967. Development of fishes of the Chesapeake Bay region; an atlas of egg, larval, and juvenile stages. Natural Resources Institute, University of Maryland, Baltimore, Maryland.

74. Johnson, L.D. 1959. Story of a thousand stomachs. Wisc. Conserv. Bull. 24:7-9.

75. Threinen, C.W., C. Wistrom, B. Apelgren, and H. Snow. 1978. The northern pike: its life history, ecology and management. Wisc. Dep. Natl. Res. Publ. 23-3600, Madison, Wisconsin.

76. McNamara, F. 1937. Breeding and food habits of the pikes, *Esox lucius* and *Esox vermiculatus*. Trans. Am. Fish. Soc. 66:372-373.

77. Clark, C.F. 1950. Observations on the spawning habits of the northern pike, *Esox lucius*, in northwestern Ohio. Copeia 1950:285-288.

78. Frost, W.E. and C. Kipling. 1967. A study of reproduction, early life weight-length relationship and growth of pike, *Esox lucius L.* in Windermere. J. Animal Ecol. 36:651-693.

79. Fortin, R., P. Dumont, H. Fournier, C. Cadieux, and D. Villeneuve. 1982. Reproduction et force de classas d' age du Grand Brochet (*Esox lucius L.*) dans le Haut-Richelieu et la baie Missisquoi. Can. J. Zool. 60:227-240.

80. Schryer, F., V. Elbert, and L. Dowlin. 1971. Statewide fisheries surveys. Determination of conditions under which northern pike spawn naturally in Kansas reservoirs. Dingell-Johnson Project F-15-R-6, Job C-3. Final Res. Rep. Kansas Forestry, Fish and Game Comm., Topeka, Kansas.

81. McCarraher, D.B. and R.E. Thomas. 1972. Ecological significance of vegetation to northern pike *Esox lucius* spawning. Trans. Am. Fish. Soc. 101:560-563.

82. Franklin, D.R. and L.L. Smith, Jr. 1963. Early life history of the northern pike, *Esox lucius L.*, with special reference to the factors influencing numerical strength of year-classes. Trans. Am. Fish. Soc. 92:91-110.

83. Johnson, F.H. and J.B. Moyle. 1969. Management of a large shallow winter-kill lake in Minnesota for the production of pike (*Esox lucius*). Trans. Am. Fish. Soc. 98:691-697.

84. Osterberg, D.M. 1985. Habitat partitioning by muskellunge and northern pike in the international portion of the St. Lawrence River. N.Y. Fish and Game Journal 32:158-166.

85. Svardson G. 1949. Notes on spawning habits of *Leuciscus erythropthalmus (L.)*, *Abramis brama (L.)* and *Esox lucius (L.)*. Drottningholm, Sweden Fishery Board. Statens Undersoknings (Institute for Freshwater Research)-och Forsoksanstalt for sotvattenfisket 29:102-107.

86. Embody, G.C. 1918. Artificial hybrids between pike and pickerel. J. Heredity 9:253-256.

87. Kennedy, M. 1969. I. Irish pike investigations: 1. Spawning and early life history. Irish Fishery Investigations Serial A (Freshwater) 5:4-33.

88. Hiner, L.E. 1961. Propagation of northern pike. Trans. Am. Fish. Soc. 90:298-302.

89. House, R. and L. Wells. 1973. Age, growth, spawning season, and fecundity of the trout-perch *(Percopsis omiscomaycus)* in southeastern Lake Michigan. J. Fish. Res. Bd. Can. 30:1221-1225.

90. Leslie, J.R. and J.F. Gorrie. 1985. Distingushing features for separating protolarvae of three species of esocids. Pages 1-9 *in* A.W. Kendall and J.B. Marliave, editors. Descriptions of early life history stages of selected fishes: 3rd International Symposium on the early life history of fishes and 8th Annual Larval Fish Conference, May 1984. Univ. of Brit. Columb., Vancouver, Canada.

91. Carbine, W.F. 1942. Observations on the life history of the northern pike, *Esox lucius*, L. in Houghton Lake, Michigan. Trans. Am. Fish. Soc. 71:149-164.

92. Forney, J.L. 1968. Production of young northern pike in a regulated marsh. N.Y. Fish and Game Journal 15:143-154.

93. Hunt, B.P. and W.F. Carbine. 1951. Food of young pike, *Esox lucius L.*, and associated fishes in Peterson's ditches, Houghton Lake, Michigan. Trans. Am. Fish. Soc. 80:67-83.

94. Auer, N.A. (editor). 1982. Identification of larval fishes of the Great Lakes basin with emphasis on the Lake Michigan drainage. Great Lakes Fish. Comm. Spec. Publ. 82-3, Ann Arbor, Michigan.

95. Quast, T. 1929. Goldfish industry. U.S. Bur. Fish., Econ. Circ. 68. 14 pp.

97. Wang, J.C.S. and R.J. Kernehan. 1979. Fishes of the Delaware estuaries, a guide to the early life histories. Ecological Analysts, Inc., Towson, Maryland.

98. Battle, H.I. 1940. The embryology and larval development of the goldfish *(Carrasius auratus* 1.) from Lake Erie, Dep. 200., Univ. W. Ontario. Ontario, Canada.

99. Moyle, P.B. 1976. Inland fishes of California. Univ. Calif. Press, Berkley. 405 pp.

100. Webster, D.A. 1942. The life histories of some Connecticut fishes. Pages 122-127 *in* A fishery survey of important Connecticut lakes. Bull. Conn. State Geol. Nat. Hist. Survey 63.

101. Swee, U.B. and H.R. McCrimmon. 1966. Reproductive biology of the carp, *Cyprinus carpio L.* in Lake St. Lawrence, Ontario. Trans. Am. Fish. Soc. 95(4):372-380.

102. Smallwood, W.M. and M.L. Smallwood. 1931. The development of the carp, *Cyprinus carpio*. Zool. Lab. Lib. Art. Coll., Syracuse Univ., New York.

103. Heufelder and Fuiman. 1982. Family Cyprinidae, minnows. *In* Identification of larval fishes of the Great Lakes Basin with emphasis on the Lake Michigan drainage, ed. N.A. Auer, 173-344. Great Lake Fish. Comm. Spec. Publ. 82-3. 744 pp.

104. Bean, T.H. 1892. The fishes of Pennsylvania, with descriptions of the species and notes on their common names, distribution, habits, reproduction, rate of growth and mode of capture. E.K. Meyers Printing House, Harrisburg, Penn. viii + 149 pp.; 35 pls.

105. Moroz, V.N. 1968. Description of the spawning stock, spawning and fertility of carp from the Kiliya Delta of the Danube. Probl. Ichthyol. 8(3):414-421; 11 tables.

106. Jones, P.W., F.D. Martin, and J.D. Hardy, Jr. 1978. Development of fishes of the mid-Atlantic bight, an atlas of egg, larval, and juvenile states. Volume 1. Acipenseridae through Ictaluridae. U.S. Fish Wildl. Serv., Biol. Serv. Prog., FWS/OBS-78/12, Washington, D.C.

107. Edwards, L.A. 1964. The origin of pharyngeal teeth of the carp (*Cyprinus carpio* Linnaeus). PhD Thesis. Ohio State Univ. 85 pp. 7 pls.

108. Loos, J.J., L.A. Fuiman, N.R. Foster, and E.K. Jankowski. 1979. Notes on early life histories of cyprinid fishes of the upper Potomac River. Acad. Nat. Sci. of Philadelphia, Div. of Limnol. and Ecol. Philadelphia, Pennsylvania.

109. Richardson, R.E. 1913. Observations on the breeding of the European carp in the vicinity or Havana, IL. Ill. State Lab. Nat. Hist. Bull. 9:387-404.

110. McCrimmon, H.R. and U.B. Swee. 1967. Scale formation as related to growth and development of young carp, *Cyprinus carpio L.* J. Fish. Res. Bd. Can. 24(1):47-51.

111. Sigler, W.F. 1955. An ecological approach to understanding Utah's carp populations. Proc. Utah Acad. Sci. 32:95-104.

112. Hoda, S.M. and H. Tsukahari. 1971. Studies on the development and relative growth in the carp, *Cyprinus carpio (Linne')*. J. Fac. Agric. Kyushu Univ. 16(4):387-509.

113. Wright, A.H. and A.A. Allen. 1913. Field notebook of fishes, amphibians, reptiles, and mammals. Ithaca, New York. 88 pp.

114. Wells, LaRue and R. House. 1974. Life history of the spottail shiner *(Notropis hudsonius)* in southeastern Lake Michigan. U.S. Fish Wildl. Res. Rep. 78. 10 pp.

115. Keeton, D. 1963. Growth of fishes in the Des Moines River, with particular reference to water levels. Diss. Abstr. 24(10):3916.

116. Griswald, B.L. 1963. Food and growth of spottail shiners and other forage fishes of Clear Lake, Iowa. Proc. Iowa Acad. Sci. 70:215-223.

117. Greeley, J.R. 1930. Fishes of the Lake Champlain watershed. Pages 44-87; *in* A Biological Survey of New York. Suppl. 18th Annu. Rep., NY Conserv. Dep.

118. Smith. B.A. 1971. The fishes of four low salinity tidal tributaries of the Delaware River Estuaries. MS Thesis. Cornell Univ. 304 pp.

119. Hubbs, C.L. and G.P. Cooper. 1936. Minnows of Michigan. Cranbrook Inst. Sci., Bloomfield Hills, Mich. Bull. No. 8. 95 pp.

120. Trautman, M.B. 1981. The fishes of Ohio. Ohio State University Press, Columbus, Ohio.

121. Holland-Bartels, L.E., S.K. Littlejohn, and M.L. Huston. 1990. A guide to larval fishes of the upper Mississippi River. U.S. Fish Wildl. Serv. Natl. Fish Res. Ctr. LaCrosse, Wisconsin. 107 pp.

122. Greeley, J.R. and C.W. Greene. 1931. Fishes of the Area with annotated list. Pages 44-94 *in* A biological survey of the St. Lawrence watershed. Suppl. 20th Annu. Rep. NY Conserv. Dep.

123. Taylor, W.R. 1969. A revision of the catfish genus *Noturus* Rafinesque with an analysis of higher groups of the Ictaluridae. Smithsonian Inst., U.S. Natl. Mus. Bull. 282. 315 pp.

124. Slastenenko, E.P. 1958. The Freshwater Fishes of Canada. Kiev Printers, Toronto, Canada. 388 pp.

125. Adams, C.C. and T.L. Hankinson. 1928. The ecology and economics of Oneida Lake fishes. Roosevelt Wildlife Annals 1:235-548.

126. Miller, R.J. 1962. Reproductive behavior of the stoneroller minnow *Campostoma anomalum pullum*. Copeia 1962(2):407-417.

127. Miller, R.J. 1962. Behavior and ecology of some North American cyprinid fishes. Dep. Zool., Okla. State Univ., Stillwater, Oklahoma.

128. Reed, R.J. 1958. The early life history of two cyprinids. *Notropis rubellus* and *Campostoma anomalum pullum*. Copeia 1958(4):325-327.

129. Cross, F.B. 1967. Handbook of fishes of Kansas. Mus. Nat. Hist., Misc. Publ. No. 45, Univ. Kansas. Lawrence, Kansas. 357 pp.

130. Hankinson, T.L. 1919. Notes of life histories of Illinois fish. Ill. Acad. Sci. 12:132-150.

131. Schmulbach, J.C. 1957. The life history of the central stoneroller, *Campostoma anomalum pullum* (Agassiz). MS Thesis, So. Illinois Univ.

132. Miller, R.J. 1964. Behavior and ecology of some North American cyprinid fishes. Am. Midl. Nat. 69(1):1-33.

133. Buynak, G.L. and H.W. Mohr, Jr. 1980. Larval development of stoneroller, cutlips minnow, and river chub with diagnostic keys, including four additional cyprinids. Prog. Fish-Cult. 42(3):127-135.

134. Etnier, D.A. and W.C. Starnes. 1994. The fishes of Tennessee. Univ. Tennessee Press, Knoxville, Tennessee.

135. Forbes, S.A. and R.E. Richardson. 1909. The fishes of Illinois. Ill. State Labo. Nat. His. 357 pp.

136. Swingle, H.S. 1946. Experiments with combinations of largemouth black bass, bluegills, and minnows in ponds. Trans. Am. Fish. Soc. 76:46-62.

137. Dobie, J., O.L. Meehean, and G.N. Washburn. 1948. Propagation of minnows and other bait species. U.S. Fish Wildl. Serv. Circ. 12. 113 pp.

138. Dobie, J.R., O.L. Meehean, S.F. Snieszko, and G.N. Washburn. 1956. Raising bait fishes. U.S. Fish Wildl. Serv. Circ. 35. 124 pp.

139. Cooper, G.P. 1935. Some results of forage fish investigations in Michigan. Trans. Am. Fish. Soc. 65:132-142.

140. Schwartz, F.J. 1963. The freshwater minnows of Maryland. Md. Conserv. 40(2):19-29.

141. Lewis, W.M. 1961. Mortality of fingerling shiners resulting from being entangled in the algae, hydrodictyon. Ecology 42(4):835-836.

142. Clemens, H.P. and K. Sneed. 1957. Spawning behavior of the channel catfish, *Ictalurus punctatus*. U.S. Fish Wildl. Serv., Spec. Sci. Rep. Fish. No. 219. 11 pp.

143. Davis, J. 1959. Management of channel catfish in Kansas. State Biol. Surv. For., Fish Game Comm., Mus. Nat. Hist., Misc, Publ. No. 21, Univ. Kansas., Lawrence, Kans. 56 pp.

173. Raney, E.C. 1940. The breeding behavior of the common shiner, *Notropis cornutus* (Mitchill). Zoologica 25(1):1-14.

174. Yeager. B. 1979. Larval and early fry development of the striped shiner, *Notropis chrysocephalus* (Rafinesque) *in* Pages 61-92. R. Wallus and C.W. Voightlander, eds. *in* Proc. of a workshop on Freshwater Larval Fishes. Tennessee Valley Auth., Div. Forest. Fish. and Wildl. Dev., Norris, Tennessee.

175. Pflieger, W.L. 1965. Reproductive behavior of the minnows *Notropis spilopterus* and *Notropis whipplii*. Copeia 1965(1): 1-8.

176. Winn, H.E. and J.F. Stout. 1960. Sound production by the satinfin shiner, *Notropis analotanus*, and related fishes. Sciences 132:222-223.

177. Gale, W.F. and C.A. Gale. 1977. Spawning habits of spotfin shiner (*Notropis spilopterus*) — a fractional, crevice spawner. Trans. Am. Fish. Soc. 106:170-177.

178. Summerfelt, R.C. and C.O. Minckley. 1969. Aspects of the life history of the sand shiner, *Notropis stramineous* (Cope), in the Smokey Hill River, Kansas. Trans. Am. Fish. Soc. 98(3):444-453.

179. Miller, R.J. and H.W. Robinson. 1973. The fishes of Oklahoma. Okla. St. Univ. Mus. Nat. Cult. Hist. Series No. 1. 246 pp.

180. Hunter, J.R. and A.D. Hassler. 1965. Spawning association of the redfin shiner, *Notropis umbratilis*, and the green sunfish, *Lepomis cyanellus*. Copeia 1965 (3):265-285.

181. Black, J.D. 1945. Natural history of the northern mimic shiner, *Notropis volucellus volucellus* (Cope). Invest. Ind. Lakes Streams 2(18):449-69.

182. Moyle, P.B. 1969. Ecology of the fishes of a Minnesota Lake with special reference to the Cyprinidae. Univ. Minn., Minneapolis. PhD Thesis. 169 pp.

183. Potter, W.A. and J.M. Potter. 1981. Description of a protolarva mimic shiner (*Notropis volucellus*). Ohio Acad. Sci. 81(3):135.

184. Westman, J.R. 1936. Studies on the reproduction and growth of the bluntnosed minnow, *Hyborhynchus notatus* (Rafinesque). Copeia 1938(2):56-61.

185. Van Cleave, H.J. and H.C. Markus. 1929. Studies on the life history of the blunt nosed minnow. Am. Nat. 63(689):530-539.

186. Hankinson, T.L. 1920. Report on investigations of the fish of the Galein River, Berrien Co., Mich. Occ. Pap. Mus. Zool. Univ. Mich. 89:1-14.

187. Hankinson, T.L. 1908. A biological survey of Walnut Lake, Michigan. Rep. State Biol. (Geol.) Surv. Mich. 1907:198-251.

188. Hubbs, C.L. and K.F. Lagler. 1958. Fishes of the Great Lakes Region. Univ. Mich. Press, Ann Arbor, Mich. 213 pp.

189. Thomsen, H.P. and A.D. Hassler. 1944. The minnow problem in Wisconsin. Wisc. Conserv. Bull. 9(12):6-8.

190. Swingle, H.S. 1952. Pounds of fish per acre in central Alabama rivers. Temperatures of surface water of ponds at Auburn, AL, when the first young fish hatch in the spring. Tables for Handbook of Biological Data.

191. McCarraher, D.B. and R. Thomas. 1968. Some ecological observations of the fathead minnow, *Pimephales promelas*, in the alkaline waters of Nebraska. Trans. Am. Fish. Soc. 97(1):52-55.

192. Markus, H.C. 1934. Life history of the blackhead minnow (*Pimephales promelas*). Copeia 1934(3):116-122.

193. Andrews, A.K. and S.A. Flickinger. 1974. Spawning requirements and characteristics of the fathead minnow. Proc. S.E. Assoc. Game Fish Comm. 27:759-766.

194. McMillan, V. 1972. Mating of the fathead. Nat. Hist. 81(5)73-78.

198. Walburg, C.H. 1976. Changes in the fish populations of Lewis and Clark Lake, 1956-74, and their relation to water management and the environment. U.S. Fish Wildl. Serv., Res. Rep. 79. 34 pp.

199. Gerking, S.D. 1945. Distribution of the fishes of Indiana. Investigations of Indiana Lakes and Streams 3:1-137.

200. Eddy, S. and T. Surber. 1947. Northern fishes with special reference to the upper Mississippi Valley. The University of Minnesota Press, Minneapolis, Minnesota.

201. Hubbs, C.L. and K.F. Lagler. 1949. Fishes of the Great Lakes region. Cranbrook Institute of Science Bulletin 26, Bloomfield Hills, Michigan.

202. Moore, G.A. 1957. Fishes. Pages 31-210 *in* Invertebrates of the United States; W.F. Blair et al eds. McGraw-Hill Book Co. Inc..

203. Yeager, L.E. 1936. An observation on spawning buffalofish in Mississippi. Copeia 1936 (4):238-239.

204. Perry, W.G. 1976. Black and bigmouth buffalo spawn in brackish water ponds. Prog. Fish-Cult. 38(2):81.

205. Breder, C.M., Jr., and D.E. Rosen. 1966. Modes of reproduction in fishes. Am. Mus. Nat. Hist. New York. 941 pp.

206. Pearson, W.D. and L.A. Krumholz. 1984. Distribution and status of Ohio fishes. Oak Ridge National Laboratory Report ORNL/Sub/79-7831/1, Oak Ridge, Tennessee.

207. Guidice, J.J. 1964. The production and comparative growth of three buffalo hybrids. Proc. 18th Annu. S.E. Assoc. Game Fish Comm. pp. 512-517.

208. Behmer, D.J. 1965. Spawning periodicity of the river carpsucker, *Carpiodes carpio*. Iowa Acad. Sci., 72:253-262.

209. Walburg, C.H. and W.R. Nelson. 1966. Carp, river carpsucker, smallmouth buffalo, and bigmouth buffalo in Lewis and Clark Lake, Missouri River. U.S. Fish Wildl. Serv., Res. Rep. 69. 30 pp.

210. Deacon, J.E. 1961. Fish populations, following a drought, in the Neosho and Marais des Cynges Rivers of Kansas. Univ. Kans. Publ. Mus. Nat. Hist., 13(9):359-427.

211. Jester, D.B. 1972. Life history, ecology, and management of the river carpsucker, *Carpiodes carpio* (Rafinesque), with reference to Elephant Butte Lake. New Mexico State Univ., Agric. Exp. Sta. Res. Rep. 243. Los Cruces, New Mexico. 120 pp.

212. Yeager, B.L. 1980. Early development of the genus *Carpiodes* (Osteichthyes: Catostomidae). MS Thesis, Univ. Tenn., Knoxville, Tenn. 79 pp.

213. Woodward, R.L. and T.E. Wissing. 1976. Age, growth, and fecundity of the quillback *(Carpiodes cyprinus)* and highfin carpsuckers *(C. velifer)* in an Ohio stream. Trans. Am. Fish. Soc. 105(3):411-415.

214. Buchholz, M. 1957. Age and growth of river carpsucker in Des Moines River, Iowa. Proc. Iowa Acad. Sci. 64:589-600.

215. Vanicek, D. 1961. Life history of the quillback and highfin carpsuckers in the Des Moines River, Iowa. Proc. Iowa Acad. Sci. 68:238-246.

216. Carlander, K.D. 1977. Handbook of freshwater fishery biology, Vol. 2, Life history data on centrarchid fishes of the United States and Canada. Iowa State Univ. Press, Ames, Iowa.

217. Gale, W.F. and H.W. Mohr, Jr. 1976. Fish spawning in a large Pennsylvania river receiving mine effuents. Proc. Pa. Acad. Sci. 50:160-162.

218. Madsen, M.L. 1971. The presence of nuptial tubercles on female quillback (*Carpiodes cyprinus*). Trans. Am. Fish. Soc. 100(1):132-134.

219. Gerlach, J.M. 1973. Early development of the quillback carpsucker, *Carpiodes cyprinus*. MS Thesis. Millersville, State Coll., Pennsylvania. 60 pp.

220. Ohio EPA. 1977. Methods and rationale used for establishing seasonal average and daily maximum temperature limitations as proposed in QAC 3745-1. Ohio EPA. Columbus, Ohio.

221. Trautman, M.B. 1957. The fishes of Ohio. Ohio St. Univ. Press, Columbus, 683 pp.

222. Fuiman, L.A. 1982. Family Catostomidae, suckers. Pages 345-435. *in* N.A. Auer, ed. Identification of larval fishes of the Great Lakes basin with emphasis on the Lake Michigan drainage; Great Lakes Fish. Comm. Spec. Publ. 82-3. 744 pp.

223. Spoor, W.A. 1935. On the sexual dimorphism of *Catostomus commersoni* (Lacepede). Copeia 1935 (4):167-171.

224. Faber, D.J. 1967. Limnetic larval fish in northern Wisconsin lakes. J. Fish. Res. Bd. Can. 24(5) 927-937.

225. Reighard, J.E. 1920. Breeding behavior of suckers and minnows. I. Suckers. Biol. Bull., Woods Hole, Massachusetts. 38:1-3.

226. Campbell, R.S. 1935. A study of the common sucker, *Catostomus commersoni* (Lacepede) of Waskesiu Lake. M.A. Thesis, Univ. of Sask. 48 pp.

227. Green, G.H., T.G. Northcote, G.F. Hartman and C.C. Lindsey. 1966. Life histories of two species of catostomid fishes in Sixteenmile Lake, British Columbia, with particular reference to inlet stream spawning. J. Fish Res. Bd. Can. 23(11):1761-1788.

228. Stewart, N.H. 1926. Development, growth, and food habits of the white sucker, *Catostomus commersoni* Lesueur. U.S. Fish Wildl. Serv., Bur. Fish. Bull. 42:147-184.

229. Raney, E.C. 1943. Unusual spawning habitat for the common white sucker. *Catostomus c. commersonii* Copeia. 1943 (4):256.

230. Raney, E.C. and D.A. Webster. 1942. The spring migration of the common white sucker, *Catostomus c. commersonii* (Lacepede), in Shaneateles Lake Inlet, New York. Copeia 1942(3) 139-148.

231. Dence, W.A. 1940. Part III. Progress report on a study of the dwarf sucker *(Catostomus commersonii utawana)*. Roosevelt Wildl. Bull. 7(3):221-233.

232. Meyer, W.H. 1962. Life history of three species of redhorse (*Moxostoma*) in the Des Moines River, Iowa. Trans. Am. Fish. Soc. 91(4):412-419.

233. Jenkins, R.E. 1970. Systematic studies of the catostomid fish tribe Moxostomatini. Univ. Mich., Ann Arbor. PhD Thesis. 799 pp.

234. Washburn, G.N. 1948. Propagation of the creek chub in ponds with artificial raceways. Trans. Am. Fish. Soc. 75:336-350.

235. Hackney, P.A., G.R. Hooper and J.F. Webb. 1971. Spawning behavior, age and growth, and sport fishery for the silver redhorse, *Moxostoma anisurum* (Rafinesque), in the Flint River, Alabama. Proc. S.E. Assoc. Game Fish Comm. 24:569-576.

236. Hackney, P.A., W.M. Tatum, and S.L. Spencer. 1968. Life history study of the river redhorse, *Moxostoma carinatum* (Cope), in the Cahaba River, Alabama, with notes on the management of the species as a sport fish. Proc. S.E. Assoc. Game Fish Comm. 21:324-332.

237. Kwak, T.J. and T.M. Skelley. 1988. Spawning habitat and behavior, and isolating mechanisms of the golden redhorse *(Moxostoma erythrurum)* and the black redhorse *(M. duquesnei)*, two synoptic fishes. 68th Annu. Mtg. Am. Soc. Ichthy. & Herp., p. 125 (abstract).

238. Eddy, S. and J.C. Underhill. 1974. Northern fishes with special reference to the upper Mississippi Valley. The Univ. of Minn. Press, Minneapolis, Minnesota.

239. Sule, M.J. and T.M. Skelley. 1985. The life history of the shorthead redhorse, *Moxostoma macrolepidotum*, in the Kankakee River drainage, Illinois. Ill. Nat. His. Sur. Biol. Notes No. 123:1-15.

240. Burr, B.M. and M.A. Morris. 1977. Spawning behavior of the shorthead redhorse, *Moxostoma macrolepidotum*, in Big Rock Creek, IL. Trans. Am. Fish. Soc. 106(1):80-92.

241. Hawley, M.G. 1967. A study of the northern redhorse *(Moxostoma macrolepidotum)* in the Plover River and Peshtigo River, Wisconsin. Univ. Wisc. Stevens Point, Dep. Biol. 30 pp.

242. Jenkins, R.E. and D.J. Jenkins. 1980. Reproductive behavior of the greater redhorse, *Moxostoma valenciennesi*, in the Thousand Islands region. Can. Field-Nat. 94(4):426-430.

243. Forney, J.L. 1955. Life history of the black bullhead, *Ameiurus melas* (Rafinesque), of Clear Lake, Iowa. Iowa State Coll. J. Sci. 30(1):145-162.

244. Langlois, T.H. 1954. The western end of Lake Erie and its ecology. J.W. Edwards Publ. Inc., Ann Arbor, Mich. 479 pp.

245. Wallace, C.R. 1967. Observations on the reproductive behavior of the black bullhead *(Ictalurus melas)*. Copeia 1967(4):852-853.

246. Snow, J.R. 1959. Notes on the propagation of the flathead catfish, *Pylodictis olivarcis* (Rafinesque). Progress. Fish-Cult. 21(1):75-80.

247. Minckley, W.L. and J.E. Deacon. 1959. Biology of the flathead catfish in Kansas. Trans. Am. Fish. Soc. 88(4):344-355.

248. Fontaine, P.A. 1944. Notes on the spawning of the shovelhead catfish, *Pylodictis olivaris* (Rafinesque). Copeia 1944(1):50-51.

249. Henderson, H. 1965. Observation on the propagation of flathead catfish in the San Marcos State Fish Hatchery, Texas. *Proc. S.E. Assoc. Game Fish Comm.* 17:173-177.

251. Greeley, J.R. 1929. Fishes of the Erie-Niagara watershed. Paper 150-179 *in* A biological survey of Erie-Niagara system. Suppl. 18th Annu. Rep. NY State Conserv. Dep.

252. Walsh, S.J. and B.M. Burr. 1985. Biology of the stonecat, *Noturus flavus* (Siluriformes: Ictaluridae), in central Illinois and Missouri streams, and comparisons with Great Lakes populations and congeners. Ohio J. Sci. 85(3):85-86.

253. Trautman, M.B. 1948. A natural hybrid catfish, *Schilbeodes miurus* x *Shilbeodes mollis*. Copeia 1948(3):166-174.

254. Evermann, B.W. and H.W. Clark. 1920. Lake Maxinkuckee, a physical and biological survey. Ind. Dept. Cons. Publ., 1:1-660.

255. Priegel, G.R. 1962. Plentiful but unknown. Wisc. Conserv. Bull. 27(3):13.

256. Kinney, E.C. 1957. Trout-perch, *Percopsis omiscomaycus* (Walbaum). Data for Handbook of Biological Data. 3 pp.

257. Muth, S.E. and D.C. Tarter. 1975. Reproductive biology of the trout-perch, *Percopsis omiscomaycus* (Walbaum), in Beech Fork of Twelvepole Creek, Wayne Co., Virginia. Am. Midl. Nat. Res. Spec. Publ. 4.

258. Carranza, J. and H.E. Winn. 1954. Reproductive behavior of the blackstripe topminnow, *Fundulus notatus*. Copeia 1954(4):273-278.

259. Lindquist, D.G., P.W. Shute, and J.R. Shute. 1982. Spawning and nest site selection by the broadtail and tadpole madtoms: utilization of experimental spawning cover in Lake Waccamaw, North Carolina. AISH Program and Abstracts, 62nd Annu. Mtg., Northern Ill. Univ., DeKalb.

260. Whiteside, L.A. and B.M. Burr. 1986. Aspects of the life history of the tadpole madtom, *Noturus gyrinus* (Siluriformes: Ictaluridae), in southern Illinois. Ohio J. Sci. 86(4):153-160.

261. Cahn, A.R. 1927. An ecological study of the southern Wisconsin fishes. The brook silverside *(Labidesthes sicculus)* and the cisco (*Leucichthyes artedi*) in their relations to the region. III Biolog. Monogr. 11(1):1-151.

262. Hubbs, C.L. 1921. An ecological study of the life history of the freshwater atherine fish, *Labisdesthes sicculus*. Ecology 2(4):262-276.

263. Nelson, J.S. 1968. Life history of the brook silverside, *Labisdesthes sicculus*, in Crooked Lake, Indiana. Trans. Am. Fish. Soc. 97(3):293-296.

264. Webb, J.F. and D.D. Moss. 1967. Spawning behavior and age and growth of white bass in Center Hill Reservoir, Tennessee. Proc. 21st Conf. S.E. Assoc. Game Fish Comm. pp. 343-357.

265. Horrall, R.M. 1962. A comparative study of two spawning populations of the white bass, *Roccus chrysops* (Rafinesque), in Lake Mendota, Wisconsin, with special reference to homing behavior. Univ. Wisconsin., Madison. PhD Thesis. 181 pp.

266. Riggs, C.D. 1955. Reproduction of the white bass, *Morone chrysops*. Indiana Dep. Conserv. and Indiana Dep. Zool., Invest. Indiana Lakes and Streams. 4(3):87-110.

267. Chadwick, H.K., C.E. von Geldern, Jr. and M.L. Johnson. 1966. White bass. Pages 412-422 *in* A. Calhoun ed., Inland Fisheries Mgmt. Calif. Dep. Fish Game, Sacramento.

268. Baglin, R.E., Jr. and L.G. Hill. 1977. Fecundity of white bass, *Morone chrysops* (Rafinesque), in Lake Texoma; Am. Midl. Nat. 98:223-238.

269. Yellayi, R.T. and R.V. Kilambi. 1969. Observations on early development of white bass, *Roccus chrysops* (Rafinesque). Proc. 23rd Annu. Conf. S.E. Assoc. Game Fish Comm. 23:261-265.

270. Riggs, C.D. 1952. Studies of the life history of the white bass, *Lepibema chrysops* (Rafinesque), with special reference to Shafer Lake, IN. PhD Diss., Univ. Mich., Ann Arbor, Mich.

271. Dorsa, W.J. and R.A. Fritzsche. 1979. Characters of newly hatched larvae of *Morone chrysops* (Pisces). Proc. Miss. Acad. Sci. 24:37-41.

272. Vincent, F. 1969. Spawning ecology of white bass, *Roccus chrysops* (Rafinesque), in Utah Lake, Utah. Great Basin Natur. 28:63-69.

273. Siefert, R.E., A.R. Carlson, and L.J. Herman. 1974. Effects of reduced oxygen concentrations on the early life stages of mountain whitefish, smallmouth bass, and white bass. Prog. Fish-Cult. 36(4):186-191.

274. Wissing, T.E. and A.D. Hassler. 1971. Effects of swimming ability and food intake on respiration of young-of-the-year white bass, *Morone chrysops*. Trans. Am. Fish. Soc. 100(3):537-543.

275. Kallemeyn, L.W. and J.F. Novotny. 1977. Fish and food organisms in various habitats of the Missouri River in South Dakota, Nebraska, and Iowa. U.S. Fish Wildl. Serv., Office Biol. Serv., Columbia, Missouri. FWS/OBS-77/25. 100 pp.

276. Johnson, R.P. 1963. Studies on the life history and ecology of the bigmouth buffalo, *Ictiobus cyprinellus* (Valenciennes). J. Fish. Res. Bd. Can. 20(b):1397-1429.

277. Edwards, E.A. and K. Twoney. 1982. Habitat suitability index models: smallmouth buffalo. U.S. Fish Wildl. Publ. FWS/OBS/82/10.13.

278. Burnam, C.W. 1909. Notes on the yellow bass. Trans. Am. Fish. Soc. 39:103-108.

279. Atchinson, G.J. 1967. Contribution to the life history of the yellow bass, *Roccus mississippiensis* (Jordan and Eigenmann), in Clear Lake, Iowa. MS Thesis Iowa State Univ., Ames. 72 pp.

280. Buckley, R.V. 1970. Changes in yellow bass reproduction associated with environmental conditions. Iowa State J. Sci. 45(2):137-180.

281. Shields, J.T. 1965. Yellow bass *Roccus mississippiensis*. Pages 1023-1024 *in* A.J. McClane, ed. McClane's standard fishing encyclopedia; Holt, Rinehart & Winston, N.Y.

282. Phillips, G.L., W.D. Schmid, and J.C. Underhill. 1982. Fishes of the Minnesota Region. Univ. Minn. Press, Minneapolis. 248 pp.

289. Carbine, W.F. 1939. Observations on the spawning habits of centrarchid fishes in Deep Lake, Oakland Co., Mich. Trans.

290. Raney, E.C. 1965. Some pan fishes of New York--rock bass, crappies and other sunfishes. NY St. Conserv. Dep. Info. Leaflet D-47, pp. 10-16.

291. Powles, P.M., D.R. Vandeloo, and B. Clancy. 1980. Some features of larval rock bass, *Ambloplites rupestris* (Rafinesque), development in central Ontario. Pages 36-44 *in* L.A. Fuiman, ed., Proc. Fourth Annu. Larval Fish Conf. U.S. Fish and Wildl. Serv., Natl. Power Plant Team, Ann Arbor, Mich., FWS/OBS-80/43.

292. Howland, J.W. 1929. Growth changes in the rock bass. MS Thesis, Ohio State Univ. 22 pp.

293. Breder, C.M., Jr. 1936. The reproductive habits of the North American sunfishes (Family Centrarchidae). Zoologica 21(1):1-48.

294. Buynak, G.L. and H.W. Mohr, Jr. 1979. Larval development of rock bass from the Susquehanna River. Prog. Fish-Cult. 41:39-42.

295. Holland, L.E. and M.L. Huston. 1985. Distributions and food habits of young-of-the-year fishes in a backwater lake of the upper Mississippi River. J. Freshwater Ecology. 3:81-91.

296. Hunter, J.R. 1963. The reproductive behavior of the green sunfish, *Lepomis cyanellus*, Zoologica 48(1):13-24.

297. McKechnie, R.J. and R.L. Tharatt. 1966. Green sunfish. Pages 399-401 *in* A. Calhoun ed., Inland Fisheries Mgmt. Calif. Dep. Fish Game.

298. Taubert, B.D. 1977. Early morphological development of the green sunfish, *Lepomis cyanellus*, and its separation from other larval Lepomis species. Trans. Am. Fish Soc. 106:445-448.

300. Carson, J.B. 1968. The green sunfish. Underwat. Nat. 5(1):29.

301. Meyer, F.A. 1970. Development of some larval centrarchids. Prog. Fish-Cult. 32(3):130-136.

302. Hardin, T. and K. Bovee. 1978. The green sunfish. U.S. Dep. Int. Fish Wildl. Serv., Instream Flow Group, Ft. Collins, CO. Unpublished data.

303. Stuber, R.J., G. Gebhart, and O.E. Maughan. 1982. Habitat suitability index Models: green sunfish. U.S. Fish and Wildl. Serv., Publ. No. FWS/OBS-82/10.15.

304. Clark, F.W. and F.H.A. Keenleyside. 1967. Reproductive isolation between the sunfish, *Lepomis gibbosus* and *L. macrochirus*. J. Fish Res. Bd. Can. 24(3):495-514.

305. Johnson, C.E. 1971. Factors affecting fish spawning. Wisc. Conserv. Bull. 36(4):16-17.

306. Gill, T. 1906. Parental care among fresh-water fishes. Annu. Rep. Smithson. Inst. 1905:403-531.

307. Emery, A.R. 1973. Preliminary comparisons of day and night habits of freshwater fish in Ontario Lakes. J. Fish. Res. Bd. Can. 30(6):761-774.

308. Barney, R.L. and B.J. Anson. 1923. Life history and ecology of the orangespotted sunfish *(Lepomis humilis)*. Rep. U.S. Fish. Comm. App. 15, 1-16 pp.

309. Bennett, G.W. 1948. The bass-bluegill combination in a small artificial lake. Ill. Nat. Hist. Surv. Bull. 24(3):377-412.

310. James, M.F. 1946. Histology of gonadal changes in the bluegill, *Lepomis macrochirus* Rafinesque, and the largemouth bass, *Huro salmoides* (Lacepede). J. Morphol. 79:63-92.

311. Schloemer, C.L. 1957. Tabular outline of the life history and ecology of the common bluegill, *Lepomis macrochirus* Rafinesque. Data for Handbook Biol. Data. 27 pp.

312. Snow, H. 1960. Bluegill at Murphy Flowage. Wisc. Conserv. Bull. 25(3):11-14.

313. Snow, H., A. Ensign and J. Klingbiel. 1970. The bluegill, its life history, ecology and management. Wisc. Dep. Nat. Res. Publ. 230-270. 14 pp.

314. Morgan, G.D. 1951. The life history of the bluegill sunfish, *Lepomis macrochirus,* of Buckeye Lake, Ohio. Ohio J. Sci. 42(4):21-59.

315. Stevenson, F., W.T. Monet and F.J. Svoboda, III. 1969. Nesting success of the bluegill, *Lepomis macrochirus,* (Rafinesque) in a small Ohio pond. Ohio J. Sci. 69(6):347-355.

316. Bruns, P.M. 1958. Seasonal changes in growth rates of bluegill, *Lepomis macrochirus,* in Felt Lake, California. MA Thesis, Stanford Univ. 83 pp.

317. Swingle, H.S. and E.V. Smith. 1943. Factors affecting the reproduction of bluegill bream and largemouth black bass in ponds. Ala. Polytech. Inst. Agr. Exp. Sta. Circ. 87:8 pp.

318. Childers, W.F. 1967. Hybridization of four species of sunfishes (Centrarchidae). Ill. Nat. Hist. Surv. Bull. 29(3):159-214.

319. Miller, H.C. 1963. The behavior of the pumpkinseed sunfish, *Lepomis gibbosus* (Linnaeus), with notes on the behavior of other species of Lepomis and pigmy sunfish, *Elassoma everglades*. Behavior 22(1/2):88-151.

320. Hubbs, C.L. and G.P. Cooper. 1935. Age and growth of the long-eared and green sunfishes in Michigan. Pap. Mich. Acad. Sci., Arts Lett. 1934(20):669-696.

321. Raney, E.C. 1965. Some pan fishes of New York--rock bass, crappies and other sunfishes, N.Y. Conserv. 19(6)21-24, 28-29, 35.

322. Huck, L.L. and G.E. Gunning. 1967. Behavior of the longear sunfish, *Lepomis megalotis* (Rafinesque). Tulane Stud. Zool. 14(3):121-131.

323. Boyer, R.L. and L.E. Vogele. 1971. Longear sunfish behavior in two Ozark reservoirs. Res. Fish. Limno., Am. Fish. Soc. Publ. No. 8:13-25.

324. Witt, A., Jr. and R.C. Marzolf. 1954. Spawning and behavior of the longear sunfish, *Lepomis megalotis*. Copeia 1954(3):188-190.

325. Anjard, C.A. 1974. Centrarchidae-sunfishes. Pages 178-195 *in* A.J. Lippson and R.L. Moran, eds. Manual for identification of early developmental stages of fishes of the Potomac River Estuary. Martin Marietta Corp., Spec. Publ. ppsp-mp-13. Baltimore, Maryland.

326. Brown, E.H., Jr. 1960. Little Miami River headwater-stream investigations. Ohio Dep. Nat. Res. Div. Wildl. 1-4.

327. Schneberger, E. 1972. Smallmouth bass. Life history, ecology and management. Wisc. Dep. Nat. Res. Publ. 242. 16 pp.

328. Hubbs, C.L. and R.M. Bailey. 1938. The small-mouthed bass. Cranbrook Inst. Sci. Bull. 1089 pp.

329. Lowry, E.M. 1958. The life history and ecology of the smallmouth bass. Data for Handbook Biol. Data. 29 pp.

330. Harrison, H.M. 1954. Smallmouth bass studies, Des Moines River. Iowa Conserv. Comm. Q. Biol. Rep. 5:6-11.

331. Reynolds, J.B. 1965. Life history of smallmouth bass, *Micropterus dolomieui* Lacepede in the Des Moines River, Boone Co., Iowa. Iowa State J. Sci. 39(4):417-436.

332. Marinac, P. 1976. The smallmouth bass population and fishery in a northern Wisconsin lake, Clear Lake, Oneida County, Univ. Wisc., Stevens Point. MS Thesis. 60 pp.

333. Pflieger, W.L. 1966. Reproduction of the smallmouth bass (*Micropterus dolomieui*) in small Ozark streams. Am. Midl. Nat. 76(2):410-418.

334. Latta, W.C. 1963. The life history of the smallmouth bass, *Micropterus dolomieui*, at Waugoshance Point, Lake Michigan; Mich. Dep. Conserv. Inst. Fish Res. Bull. No. 5. 56 pp.

335. Tester, A.L. 1930. Spawning habits of small-mouthed black bass in Ontario waters. Trans. Am. Fish. Soc. 60:53-61.

336. Beeman, H.W. 1924. Habits and propagation of the small-mouthed black bass. Trans. Am. Fish. Soc. 54(1924):92-107.

337. Surber, E.W. 1935. Production of bass fry. Prog. Fish-Cult. 8:1-7.

338. Curtis, B. 1949. The warm-water gamefishes of California. Calif. Fish Game. 35(4):255-274.

339. Mraz, D. 1964. Observations on large and smallmouth bass nesting and early life history. Wisc. Conserv. Dep. Fish. Res. Rep. No. 11. 13 pp.

340. Wiegert, L.W. 1966. A four-year study of the smallmouth bass in the outlying waters of Door County, Wisconsin. Wisc. Conserv. Dep. Div. Fish. Mgmt. Rep. No. 1. 11 pp.

341. Webster, D.A. 1954. Smallmouth bass, *Micropterus dolomieui*, in Cayuga Lake, Part I. Life history and environment. Cornell Univ. Agric. Exp. Sta. Mem. 327. 39 pp.

342. Cleary, R. 1956. Observations and factors affecting smallmouth bass production in Iowa. J. Wildl. Mgmt. 20:353-359.

343. Sanderson, A.E., Jr. 1958. Smallmouth bass management in the Potomac River basin. Trans. N. Am. Wildl. Conf. 23:248-262.

344. Coble, D.W. 1975. Smallmouth bass. Pages 21-22 *in* H. Clepper, ed. Black bass biology and management.

345. Edwards, E.A. and G. Gebhart. 1983. Habitat suitability information: smallmouth bass. U.S. Fish. Wildl. Serv. Publ. No. FWS/OBS-82/10.36. 47 pp.

346. Robbins, W.H. and H.R. MacCrimmon. 1974. The black basses in America and overseas. Biomanagement and Research Enterprises, Sault Ste. Marie, Ontario. 196 pp.

347. Turner, G.E. and H.R. MacCrimmon. 1970. Reproduction and growth of smallmouth bass, *Micropterus dolomieui*, in a Precambrian Lake. J. Fish. Res. Bd. Can. 27:395-400.

348. James, M.L. 1930. Spawning reactions of smallmouthed bass. Trans. Am. Fish. Soc. 60:62-63.

349. Farabee, G.B. 1979. Life histories of important sport and commercial fishes of the upper Mississippi River. Pages 41-67. A compendium of fishery information on the upper Mississippi River *in* J.L. Rassmussen, ed. Upper Miss. River Conserv. Comm.

350. Bennett, G.W. 1954. Largemouth bass in Ridge Lake, Coles Co., Illinois. Ill. Nat. Hist. Surv. Bull. 26(2).

351. Mraz, D. 1957. Largemouth bass. Data for Handbook Biol. Data. 4 pp.

352. Mraz, D., S. Kmiotek, and L. Frankenberger. 1961. The largemouth bass: its life history, ecology, and management. Wisc. Conserv. Dep. Publ. 232. 13 pp.

353. Durham, L. 1957. Green sunfish, bluegill, largemouth bass. Summaries for Handbook Biol. Data. 20 pp.

354. Badenhuizen, T.R. 1969. Effect of incubation temperature on mortality of embryos of the largemouth bass, *Micropterus salmoides* (Lacepede). M.S. Thesis, Cornell Univ. 88 pp.

355. Miller, K.D. and R.H. Kramer. 1971. Spawning and early life history of largemouth bass, *Micropterus salmoides* (Lacepede) in Lake Powell. Am. Fish. Soc. Spec. Publ. 8:73-83.

356. Kramer, R.H. and L.L. Smith, Jr. 1962. Formation of year classes in largemouth bass. Trans. Am. Fish. Soc. 91(1):29-41.

357. Mraz, D. and E.L. Cooper. 1957. Reproduction of carp, largemouth bass, bluegills, and black crappies in small rearing ponds. J. Wildl. Mgmt. 21(2):127-133.

358. Reighard, J. 1906. The breeding habits, development and propagation of the black bass (*Micropterus dolomieu* Lacepede and *Micropterus salmoides* Lacepede). Bull. Mich. Fish. Comm. No. 7:1-73.

359. Mraz, D., S. Kmiotek, and L. Frankenberger. 1978. The largemouth bass: its life history, ecology and management. Wisc. Dep. Nat. Res., Madison, Wisconsin. Publ. 18-3600(78). 13 pp.

360. Hunsaker II, D. and R.W. Crawford. 1964. Preferential spawning behavior of the largemouth bass, *Micropterus salmoides*. Copeia 1964(1):240-241.

361. Robinson, D.W. 1961. Utilization of spawning box by bass. Prog. Fish-Cult. 23(3):119.

362. Heidinger, R.L. 1975. Life history of the largemouth bass. Pages 11-20 *in* R.H. Stroud and H. Clepper, eds. Black bass biology and management. Sport Fisheries Inst., Washington, D.C.

363. Merriner, J.V. 1971. Egg size as a factor in intergeneric hybrid success of centrarchids. Trans. Am. Fish. Soc 100(1):29-32.

364. Carr, M.H. 1942. The breeding habits, embryology, and larval development of the largemouthed black bass in Florida. Proc. New England Zool. Club. 20:43-77.

365. Mayhew, J. 1974. O-age fish production at Lake Rathburn. Iowa Conserv. Comm. Fish. Sec. Fed. Aid Proj. F-88-R-1, Study 701-3. 1 July 1973-30 June 1974. 83 pp. mimeo.

366. Morgan, G.D. 1951. A comparative study of the spawning periods of the bluegill, *Lepomis macrochirus*, the black crappie, *Pomoxis nigromaculatus*, and the white crappie, *Pomoxis annularis*, of Buckeye Lake, Ohio. J. Sci. Lab. Dennison Univ. 42:112-118.

367. Nelson, R., E. Siefert, and D.V. Swedberg. 1967. Studies of the early life history of reservoir fishes. Pages 374-385 *in* Reservoir Fishery Resources Symposium, Reserv. Comm. Southern. Div. Am. Fish. Soc.

368. Hansen, D.F. 1957. Ecological life history table of the white crappie as observed in Illinois. Material for Handbook Biol. data. 1 p.

369. Siefert, R.E. 1968. Reproductive behavior, incubation, and mortality of eggs, and post-larval food selection in the white crappie. Trans. Am. Fish. Soc. 97(3):252-259.

370. Hansen, D.F. 1965. Further observations on nesting of the white crappie, *Pomoxis annulavis*. Trans. Am. Fish. Soc. 94:182-184.

371. Goodson, L.F. 1966. Crappie. Pages 312-332 *in* A. Calhoun, ed., Inland Fisheries Mgmt. Calif. Fish Game.

372. Vasey, F.W. 1972. The early life history of white crappies in Table Rock Reservoir. Study I-7, Job No. 1, Job Compl. Repts., DJ Project F-1-R-24, Missouri Dep. Conserv. 10 pp.

373. Wydoski, R.S. and R.R. Whitney. 1979. Inland Fishes of Washington. Univ. Wash. Press, Seattle. 220 pp.

374. Edwards, E.A., D.A. Krieger, and G. Gebhart. 1982. Habitat Suitability Index Models: white crappie. U.S. Fish Wildl. Publ. No. FWS/OBS-82/10.7, Washington, D.C.

375. Siefert, R.E. 1969. Biology of the white crappie in Lewis and Clark Lake. U.S. Bur. Sport. Fish Wildl. Tech. Pap. No. 22. 16 pp.

376. Gasaway, C.R. 1970. Changes in the fish population in Lake Francis case in South Dakota in the first 16 years of impoundment. U.S. Bur. Sport Fish. Wildl. Tech. Pap. 56. 30 pp.

377. Burrows, C. and J. Moyle. 1967. Special fishing edition. Conserv. Volunteer. 30(172):64.

378. Schneberger, E. 1972. The black crappie. Its life history, ecology, and management. Wisc. Dep. Nat. Res. Publ. 243-72. 16 pp.

379. Jude, D.J., B.A. Bachen, G.R. Heufelder, H.T. Tin, M.H. Winnell, F.J. Tesar, and J.A. Dorr, III. 1978. Adult and juvenile fish, ichthyoplankton and benthos populations in the vicinity of the J.H. Campbell Power Plant, eastern Lake Michigan, 1977. Spec. Rep. No. 65. Great Lakes Res. Div., Univ. Mich., Ann Arbor. 607 pp.

380. Keast, A. 1965. Resource subdivision amongst cohabiting fish species in a bay, Lake Opinicon, Ontario. Univ. Mich. Great Lakes Res. Div. Publ. No. 13:106-132.

381. Priegel, G.R. 1967. Identification of young walleyes and saugers in Lake Winnebago, Wisconsin. Prog. Fish.-Cult. 29(2):108-109.

382. Priegel, G.R. 1970. Reproduction and early life history of the walleye in the Lake Winnebago Region. Wisc. Dep. Nat. Res. Tech. Bull. No. 45. 105 pp.

383. Eschmeyer, P.H. 1950. The life history of the walleye, *Stizostedion vitreum vitreum* (Mitchill), in Michigan. Mich. Dep. Conserv. Inst. Fish. Res. Bull. 3. 99 pp.

384. Niemuth, W., W. Churchill and T. Wirth. 1959. The walleye life history, ecology, and management. Wisc. Conserv. Dep., Publ. No. 227. 14 pp.

389. Hardy, J.D., Jr. 1978. Development of fishes of the mid-Atlantic bight. An atlas of egg, larval and juvenile stages. U.S. Fish. Wildl. Serv., FWS/OBS-78/12. 394 pp.

390. McElman, J.F. and E.K. Balon. 1979. Early ontogeny of walleye, *Stizostedion vitreum*, with steps of saltatory development. Environ. Biol. Fish. 4(4):309-348.

391. McMahon, T.E., J.W. Terrell, and P.C. Nelson. 1984. Habitat suitability information: walleye. U.S. Fish Wildl. Serv. FWS/OBS-82/10.56. Ft. Collins, Colorado.

392. Ryder, R.A. 1977. Effects of ambient light variations on behavior of yearling, subadult, and adult walleyes (*Stizostedian vitreum vitreum*). J. Fish. Res. Bd. Canada. 34(10):1481-1491.

393. Reighard, J. 1913. The breeding habits of the log-perch *(Percina caprodes)*. Rep. Mich. Acad. Sci. 15:104-105.

394. Winn, H.E. 1958. Comparative reproductive behavior and ecology of fourteen species of darters (Pisces-Percidae). Ecol. Monogr. 28:155-191.

395. Winn, H.E. 1958. Observations on the reproductive habits of darters (Pisces-Percidae). Am. Midl. Nat. 59(1):190-212.

396. Hubbs, C. and K. Strawn. 1957. Relative variability of hybrids between the darters, *Etheostoma spectabile* and *Percina caprodes*. Evolution 11(1):1-10.

397. Reighard, J.E. 1915. An ecological reconnaissance of the fishes of Douglas Lake, Cheboygan County, Michigan, in mid-summer. U.S. Bur. Fish. Bull. 33(1913):215-249.

398. Collette, B.B. 1965. Systematic significance of breeding tubercles in fishes of the family Percidae. Proc. U.S. Natl. Mus. 117(3518):567-617.

399. Cooper, J.E. 1978. Eggs and larvae of the log-perch, *Percina caprodes* (Rafinesque). Am. Midl. Nat. 99:257-269.

400. Lutterbie, G.W. 1976. The darters (Pisces: Percidae: Etheostomatinae) of Wisconsin. MAT Thesis. Univ. Wisc., Stevens Point. 307 pp.

401. Petravicz, W.P. 1938. The breeding habits of the black-sided darter, *Hadropterus maculatus* Girard. Copeia 1938(1):40-44.

402. Grizzle, J.M. and M.R. Curd. 1978. Posthatching histological development of the digestive system and swim bladder of logperch, *Percina caprodes*. Am. Soc. Ichthy. Herp. Copeia 1978(3):448-455.

403. Page, L.M. and P.W. Smith. 1971. The life history of the slenderhead darter, *Percina phoxocephala*, in the Embarras River, Illinois. Ill. Nat. Hist. Surv., Biol. Notes No. 74. 14 pp.

404. Wells, L. 1968. Seasonal depth distribution of fish in southeastern Lake Michigan. U.S. Fish Wildl. Serv., Fish. Bull. 67(1):1-15.

405. Brazo, D.C., P.I. Tack and C.R. Liston. 1975. Age, growth, and fecundity of yellow perch, *Perca flavescens*, in Lake Michigan near Ludington, Michigan. Trans. Am. Fish. Soc. 104(4):726-730.

406. Buck, D.H. and C.F. Thoits, III. 1970. Dynamics of one species populations of fishes in ponds subjected to cropping and additional stocking. Ill. Nat. Hist. Surv. Bull. 30(2):69-165.

407. Hammer, R.C. 1946. Maryland commercial fish hatchery operations. Md. Bd. Nat. Res., Chesapeake Biol. Lab. Publ. 60. 16 pp.

408. Tsai, Chu-Fa and G.R. Gibson, Jr. 1971. Fecundity of the yellow perch, *Perca flavescens*, Mitchill, in the Patuxent River, Maryland. Chesapeake Sci. 12(4):270-284.

409. Van Meter, H.D. 1960. The yellow perch of Lake Erie. Ohio Conserv. Bull. pp. 22-23.

410. Herman, E.F., W. Wisby, L. Wiegert, and M. Burdick. 1959. The yellow perch, its life history, ecology, and management. Wisc. Conserv. Dep., Publ. No. 228-68. 14 pp.

411. Clady, M.D. 1976. Influence of temperature and wind on the survival of early stages of yellow perch, *Perca flavescens*. J. Fish. Res. Bd. Can. 33(9):1887-1893.

412. Nelson, W.R. 1977. Life history of the yellow perch, *Perca flavescens* (Mitchill). M.S. Thesis, Univ. Wash., Seattle. 83 pp.

413. LaRivers, Ira. 1962. Fishes and fisheries of Nevada. Nev. State Fish Game Comm. 782 pp.

414. Sheri, A.N. and G. Power. 1969. Fecundity of the yellow perch, *Perca flavescens* Mitchill, in the Bay of Quinte, Lake Ontario, Canada. J. Zool. 47(1):55-58.

415. Hergenrader, G.L. and A.D. Hasler. 1968. Influence of changing seasons in schooling behavior of yellow perch. J. Fish. Res. Bd. Can. 25(4):711-716.

416. Shields, J.T. 1965. Yellow perch, *Perca flavescens*. Pages 1028-1029 *in* A.J. McClane, ed., McClane's standard fishing encyclopedia and international angling guide. Holt Rinehart and Winston, NY.

417. Embody, G.C. 1915. The farm fishpond. Cornell Reading Courses, County Life Ser. 3:213-252.

418. Embody, G.C. 1922. A study of the fish producing waters of Tompkins County, New York. N.Y. St. Conserv. Comm. 1922:1-41.

419. Collette, B.B., M.A. Ali, K.E.F. Hokanson, M. Nagiec, S.A. Smirnov, J.E. Thorpe, A.H. Weatherley, and J. Willemsem. 1977. Biology of the percids. J. Fish. Res. Bd. Can. 34(10):1891-1897.

420. Muncy, R.J. 1962. Life history of the yellow perch, *Perca flavescens*, in estuarine waters of the Severn River, a tributary of Chesapeake Bay. Chesapeake Sci. 1962(3):143-159.

421. Pearse, A.S. and H. Auchtenberg. 1921. Habits of yellow perch in Wisconsin Lakes. U.S. Bur. Fish. Bull. 36(1917-1918):293-366.

422. Harrington, R.W., Jr. 1947. Observations on the breeding habits of the yellow perch, *Perca flavescens* (Mitchell). Copeia 1947(3):199-200.

423. Hergenrader, G.L. 1969. Spawning behavior of *Perca flavescens* in aquaria. Copeia 1969(4):839-841.

424. Mansueti, A.J. 1964. Early development of the yellow perch, *Perca flavescens*. Chesapeake Sci. 5(1-2):46-66.

425. Houde, E.D. 1969. Distribution of larval walleyes and yellow perch in a bay of Oneida Lake and it relation to water currents and zooplankton. N.Y. Fish Game J. 16(2):184-205.

426. Daiber, F.C. 1953. Notes on the spawning population of the freshwater drum *(Aplodinotus guinniens* Rafinesque) in western Lake Erie. Am. Midl. Nat. 50(1):159-171.

427. Barker, H.W. 1940. Sheepshead-drum fish. Wisc. Conserv. Bull. 5(3):58-59.

428. Wirth, T.L. 1958. Lake Winnebago freshwater drum. Wisc. Conserv. Bull. 23(5):30-32.

429. McLeod, L. 1953. Wisconsin's fresh water sheepshead. Wisc. Conserv. Bull. 18(2):27-29.

430. WDNR. Unknown. Wisconsin Game Fish Life History: Freshwater drum. Wisc. Dep. Nat. Res. Leaflet. 1 p.

431. Fremling, C.R. 1978. Biology and functional anatomy of the freshwater drum, *Aplodinotus grunniens* Rafinesque. Laboratory Manual. Winona State Univ. 46 pp.

432. Butler, R.L. 1965. Freshwater drum in the navigational impoundments of the upper Mississippi River. Trans. Am. Fish. Soc. 94(4):339-349.

433. Swedberg, D.V. and C.H. Walburg. 1970. Spawning and early life history of the freshwater drum in Lewis and Clark Lake, Missouri River. Trans. Am. Fish. Soc. 99(3):560-570.

434. Wrenn, W.B. 1968. Life history aspects of smallmouth buffalo and freshwater drum in Wheeler Reservoir, Alabama. Proc. S.E. Assoc. Game Fish Comm. 22:479-495.

435. Priegel, G.R. 1966. Early scale development of freshwater drum, *Aplodinotus grunniens* Rafinesque. Trans. Am. Fish. Soc. 95:434-436.

436. Nord, R.C. 1967. A compendium of fishery information on the upper Mississippi River. Upper Miss. River Conserv. 238 pp.

437. Schneider, H. and A.D. Hassler. 1960. Laute and Lauterzeugung beim Susswassertrommler *Aplodinotus grunniens* Rafinesque (Sciaenidae, Pisces). Z. Vergleich, Physiol. 43(5):499-517.

438. Davis, C.C. 1959. A planktonic egg from freshwater. Limnol. Oceanogr. 4(3): 352-355.

439. Cross, F.B. 1958. Suckermouth minnow, *Phenecobius mirabilis* (Girard); Plains minnow, *Hybognathus placita*; Red shiner, *Notropis lutrensis* (Baird and Girard); Plains killifish, *Fundulus kansae* (Garman). Data for Handbook Biol. Data. 14 pp.

440. Vives, S.P. 1991. Choice of spawning substrate in red shiner with comments on crevice spawning in Cyprinella. Pages 229-232 *in* W.J. Matthews, ed. Shorter Contributions: Ichthyology, Copeia.

441. Saksena, V.P. 1962. The post hatching stages of the red shiner, *Notropis lutrensis*. Copeia 1962:539-544.

442. Minckley, W.L. 1972. Notes on spawning behavior of red shiner, introduced into Burro Creek, Arizona. S.W. Nat. 17:101-103.

443. Minckley, W.L. 1959. Fishes of the Big Blue River basin, Kansas. Univ. Kansas, Lawrence, Publ. Mus. Nat. Hist. 11:401-442.

444. Loos, J.J. and L.A. Fuiman. 1978. Subordinate taxa of the genus *Notropis*: a preliminary comparative survey of their developmental traits. Pages 1-50. *in*: L. Omsted, ed., Proc. First Symposium Freshwater Larval Fish. Duke Power Co., Huntersville, North Carolina.

445. Westman, J.R. 1941. A consideration of population life-history studies in their relation to the problems of fish management research, with special reference to the small-mouthed bass, *Micropterus dolomieu Lacepede*, the lake trout, Cristivomer namaycush (Walbaum), and the mud minnow, Umbra limi (Kirtland). PhD thesis Cornell Univ. 182 pp.

446. Peckham, R.S. 1955. Ecology and life history of the central mudminnow, Umbra limi (Kirtland). PhD thesis Univ. Notre Dame. 71 pp.

447. Peckham, R.S. and C.F. Dineen. 1957. Ecology of the central mudminnow, Umbra limi (Kirtland). Amer. Midl. Nat., 58(1):222-31.

448. Sheri, A.N. and G. Power. 1968. Reproduction of white perch, *Roccus americanus,* in the Bay of Quinte, Lake Ontario. J. Fish. Res. Bd. Can 25(10):2225-2231.

449. Foster, F.J. 1918. White perch notes and method of propogation. Trans. Am. Fish. Soc. 48:160-165.

450. Woolcott, W.S. 1962. Infraspecific variation in white perch, *Roccus americanus* (Gmelin). Chesapeake Sci. 3(2):94-113.

451. Raney, E.C. 1965. Some panfishes of New York - yellow perch, white perch, white bass, freshwater drum. N.Y. State Conserv. 19(5):22-28.

452. Smith, B.A. 1971. The fishes of four low salinity tidal tributaries of the Delaware River Estuary. M.S. Thesis. Cornell Univ. 304 pp.

453. Richards, W.J. 1960. The life history, habits and ecology of the white perch, *Roccus americanus* (Gmelin) in Cross Lake, New York. M.S. Thesis. State Univ. Coll. Forestry, Syracuse, New York. 113 pp.

454. Goode, G.B. 1888. American Fishes. A popular treatise upon game and food fishes of North America with special reference to habits and method of capture. Standard Book Co., New York. 496 pp.

455. Mansueti, R.J. 1964. Eggs, larvae, and young of the white perch, *Roccus americanus*, with comments on its ecology in the estuary. Chesapeake Sci. 5(1-2):3-45.

456. Speare, E.P. 1965. Fecundity and egg survival of the central johnny darter *(Etheostoma nigrum nigrum)* in southern Michigan. Copiea 1965:308-314.

457. Reeves, C.D. 1907. The breeding habits of the rainbow darter *(Etheostoma Coeruleum* Storer): a study in sexual selection. Biol. Bull. 14:35-59.

458. Cooper, J.E. 1979. Description of eggs and larvae of fantail *(Etheostoma flabellare)* and rainbow *(E. caeruleum)* darters from Lake Erie tributaries. Trans. Amer. Fish. Soc. 108(1):46-56.

459. Noltie, D.B. and R.J.F. Smith. 1988. The redfin shiner, *Notropis umbratilis*, in the Middle Thames River, Ontario, and its association with breeding longear sunfish, *Lepomis megalotis*. Dept. Zool., Univ. of Guelph, Ontario. Canadian Field-Naturalist 102(3):533-535.

460. Forbes, L.S. and D.R. Flook. 1985. Notes on the occurrence and ecology of the black bullhead, Ictahurus melas, near Creston, British Columbia. Dept. of Zool. Univ. Manitoba, Winnipeg. Canadian Field-Naturalist 99(1):110-111.

461. Floyd, K.B., R.D. Hoyt, and S. Timbrook. 1984. Chronology of appearance and habitat partitioning by stream larval fishes. Trans. Amer. Fish. Soc. 113:217-223.

462. Environmental Science & Engineering, Inc. (ESE). 1992. Ohio Ecological Research Program. Analysis of long-term larval fish data. Final Report. St. Louis, Missouri. 272 pp.

463. Gallagher, R.P. and J.V. Conner. 1983. Comparison of two ichthyoplankton sampling gears with notes on microdistribution of fish larvae in a large river. Trans. Amer. Fish. Soc. 112:280-285.

464. Armstrong, M.L. and A.V. Brown. 1983. Diel drift and feeding of channel catfish alevins in the Illinois River, Arkansas. Trans. Amer. Fish. Soc. 112:302-307.

APPENDIX B

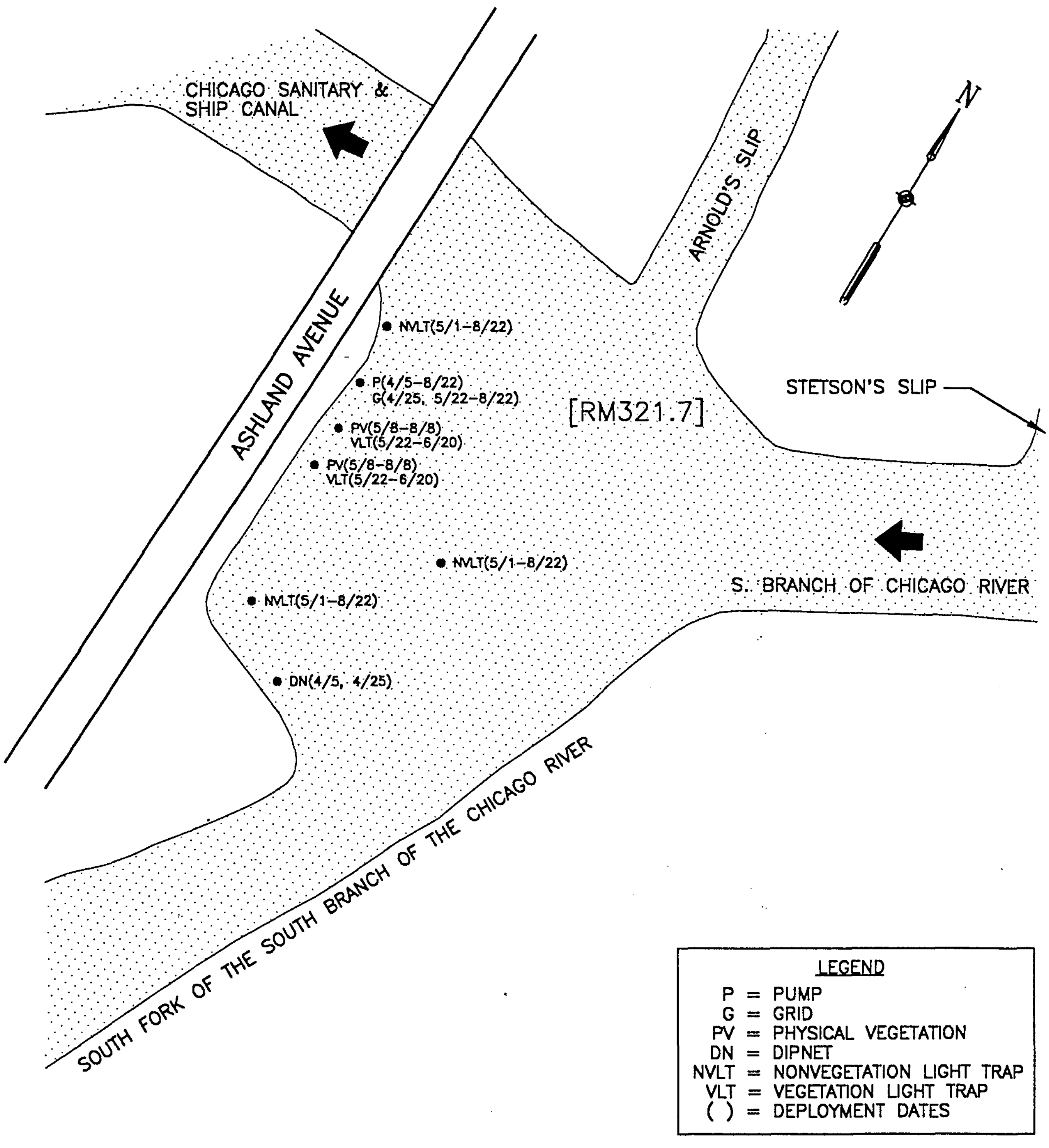
LOCATION DESCRIPTIONS AND GEAR DEPLOYMENT

Upper Illinois Waterway Ichthyoplankton Study -- 1994

Location 104 This location is within the U.S. Turning Basin at the "mouth" of the South Fork of the South Branch of the Chicago River (RM 321.7) (Figure B-1). Substrate consists primarily of muck/silt throughout much of this location; however, a narrow band (~1-2 m wide) of firm substrate (cobble, wood pilings) exists along the shoreline. Ichthyoplankton samples were collected in the small embayment along the west bank of the South Fork of the South Branch of the Chicago River (Figure B-1). Pump samples were collected during all sampling events. Grid samples were collected on all trips from 25 April through 22 August, excluding trips from 1 May through 15 May due to excessive turbidity (Figure B-1). Physical vegetation samples were collected on all trips from 8 May through 8 August. Two vegetative light traps were deployed at this location during each sampling trip between 22 May and 20 June (Table B-1). Three nonvegetative light traps were set during all sampling efforts from 1 May through 22 August (Table B-2). In April, dipnetting was conducted in lieu of light trapping.

Location 105 Location 105 is within an artificial embayment on the right bank (looking downstream) of the Chicago Sanitary and Ship Canal, immediately downstream of the Damen Ave. bridge (RM 321.0). The majority of ichthyoplankton samples were collected along the perimeter of this embayment (Figure B-2). Pump and seine samples were collected during all sampling events. Grid samples were collected on all sampling trips from 25 April through 22 August (Figure B-2). Physical vegetation samples were collected from the 1 May through the 22 August trips. Macrophyte beds were observed from the 22 May through the 26 June trips and remained fairly constant with respect to areal extent during that period. During this period, two to three vegetative light traps were deployed during each trip (Table B-1). Three nonvegetative light traps were deployed each trip from 1 May through 22 August (Table B-2). Substrate consists primarily of muck/silt and detritus; however, a small area of fine gravel exists along the northeast bank where all seine samples and one grid sample (15 May) were collected (Figure B-2). All pump and grid samples (except the 15 May trip) were collected along the southwest bank, where the substrate consists primarily of large concrete slabs and moderate to steep drop-offs.

Location 202 This location is along the left bank of the Chicago Sanitary & Ship Canal across from and slightly upstream of the Crawford Station intake (RM 318.6). Ichthyoplankton samples were collected between the intake and the Illinois Northern Railroad bridge (Figure B-3). Substrate consists of cobble and gravel throughout much of this location with a small area of concrete slabs near the pump location (Figure B-3). Surface and bottom tows were collected in mid-channel beginning at the Crawford Station intake. Pump, seine, and tow samples were collected on all sampling trips (Figure B-3). Grid samples were collected from the 25 April through the 22 August trips. Physical vegetation samples were collected from 15 May to 22 August. Macrophyte beds were sparse and only observed between 30 May and 13



DRAWING NAME: F:\PROJ\6069901\FIGURES\RM3217
DATE:01/27/1995 TIME:09:24

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.	TITLE: CECO-ICHTHYOPLANKTON STUDY LOCATION 104, REACH 3, RM 321.7	FIGURE: B-1	DWN BY: STAFF	SCALE: NO SCALE
			DATE: DEC 94	PJT NO: 60799.01

TABLE B-1. MACROPHYTE DEVELOPEMENT AND NUMBER OF VEGETATIVE LIGHT TRAPS SET DURING EACH SAMPLING EFFORT FOR THE THE UPPER ILLINOIS WATERWAY ICHTHYOPLANKTON STUDY, APRIL-AUGUST 1994.

LOC		Apr 5-8	Apr 25-28	May 1-6	May 8-13	May 15-20	May 22-27	May 30- June 4	June 6-11	June 13-18	June 20-25	June 26- July 1	July 9-14	July 24-29	Aug 7-12	Aug 22-27
104	# of VLTS	0	0	0	0	0	2	2	2	2	2	0	0	0	0	0
	Rel. Abund.	-	-	X	X	X	XXX	XXX	XXX	XX	XX	X	-	-	-	-
105	# of VLTS	0	0	0	0	0	3	2	3	3	3	2	0	0	0	0
	Rel. Abund.	-	X	X	X	XX	XXX	XX	XXX	XXX	XXX	XX	X	X	X	X
202	# of VLTS	0	0	0	0	0	0	1	1	1	0	0	0	0	0	1
	Rel. Abund.	-	-	-	X	X	X	XX	XX	XX	X	X	X	X	X	XX
207	# of VLTS	0	0	0	0	1	2	2	2	2	3	3	3	0	2	0
	Rel. Abund.	-	-	-	X	XX	XX	XX	XX	XX	XXX	XXX	XXX	X	XX	X
301	# of VLTS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Rel. Abund.	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
302A	# of VLTS	0	0	0	3	3	3	3	3	3	3	3	2	1	0	0
	Rel. Abund.	-	-	X	XXX	XXX	XXX	XXX	XXX	XXX	XXXX	XXX	XXX	XX	X	X
304	# of VLTS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Rel. Abund.	-	-	-	-	-	X	X	X	X	X	X	X	X	X	XX
309	# of VLTS	0	0	0	3	3	3	3	3	3	3	3	3	3	3	3
	Rel. Abund.	-	-	X	XX	XXX	XXXX	XXXX	XXXX	XXXX	XXXX	XXX	XXX	XXX	XXX	XX
402A	# of VLTS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Rel. Abund.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE B-1 (cont.)

LOC		Apr 5-8	Apr 25-28	May 1-6	May 8-13	May 15-20	May 22-27	May 30-June 4	June 6-11	June 13-18	June 20-25	June 26-July 1	July 9-14	July 24-29	Aug 7-12	Aug 22-27
402-1	# of VLTS	0	0	0	0	0	0	0	0	1	0(a)	0(a)	0(a)	0(a)	1	1
	Rel. Abund.	–	–	x	x	x	x	x	xx	xx	?(b)	xx	xx	xxx	xxx	xxx
402-2	# of VLTS	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0
	Rel. Abund.	–	–	–	–	–	–	x	x	x	x	xx	xx	xx	x	x
402-3	# of VLTS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Rel. Abund.	–	–	–	x	x	x	x	xx	?(b)	xx	xx	xx	xx	xx	xxx
402B	# of VLTS	0	0	0	0	0	0	3	3	3	1	3	3	3	2	2
	Rel. Abund.	–	–	–	x	x	x	xxx	xxx	xxx	xx	xx	xx	xx	xx	xx
405	# of VLTS	0	0	0	1	2	3	3	3	3	0	3	3	3	3	3
	Rel. Abund.	–	–	–	xx	xx	xxx	xxx	xxx	xxx	?(b)	xxx	xxx	xxx	xxx	xxx
407	# of VLTS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Rel. Abund.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
408	# of VLTS	0	0	0	0	0	0	1	1	1	2	2	3	2	0	0
	Rel. Abund.	–	–	–	x	x	x	xx	xx	xx	xxx	xxx	xxx	xx	x	x
409	# of VLTS	0	0	0	0	0	3	3	3	3	3	3	3	3	0	0
	Rel. Abund.	–	–	–	x	x	xxxx	xxx	xxx	xxx	?(b)	xx	xx	xx	xx	x
414	# of VLTS	0	0	0	0	0	3	3	3	3	3	1	0	0	0	0
	Rel. Abund.	–	–	x	?(b)	x	xx	xx	xx	xx	xx	xx	x	x	x	x

(a)= too shallow for vegetative light traps
(b)= macrophyte assessment difficult due to turbidity and/or high water
VLTS= vegetative light traps
Rel. Abund.= relative abundance of aquatic macrophytes

(-)= macrophytes absent
(x)= isolated stalks
(xx)= sparse beds
(xxx)= moderate beds in a portion of the location
(xxxx)= dense beds throughout much of the location

TABLE B-2. NUMBERS OF VEGETATIVE AND NONVEGETATIVE LIGHT TRAPS SET DURING EACH SAMPLING EFFORT FOR THE THE UPPER ILLINOIS WATERWAY ICHTHYOPLANKTON STUDY, APRIL-AUGUST 1994.

LOC		Apr 5-8	Apr 25-28	May 1-6	May 8-13	May 15-20	May 22-27	May 30- June 4	June 6-11	June 13-18	June 20-25	June 26- July 1	July 9-14	July 24-29	Aug 7-12	Aug 22-27	Total
104	# of VLTS	0	0	0	0	0	2	2	2	2	2	0	0	0	0	0	10
	# of NVLTS	0	0	3	3	3	3	3	3	3	3	3	3	3	3	3	39
105	# of VLTS	0	0	0	0	0	3	2	3	3	3	2	0	0	0	0	16
	# of NVLTS	0	0	3	3	3	3	3	3	3	3	3	3	3	3	3	39
202	# of VLTS	0	0	0	0	0	0	1	1	1	0	0	0	0	0	1	4
	# of NVLTS	0	0	3	3	3	3	3	3	3	3	3	3	3	3	3	39
207	# of VLTS	0	0	0	0	1	2	2	2	2	3	3	3	0	2	0	20
	# of NVLTS	0	0	3	3	3	3	3	3	3	3	3	3	3	3	3	39
301	# of VLTS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	# of NVLTS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
302A	# of VLTS	0	0	0	3	3	3	3	3	3	3	3	2	1	0	0	27
	# of NVLTS	0	0	3	3	3	3	3	3	3	3	3	3	3	3	3	39
304	# of VLTS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	# of NVLTS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
309	# of VLTS	0	0	0	3	3	3	3	3	3	3	3	3	3	3	3	36
	# of NVLTS	0	0	3	3	3	3	3	3	3	3	3	3	3	3	3	39
402A	# of VLTS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	# of NVLTS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

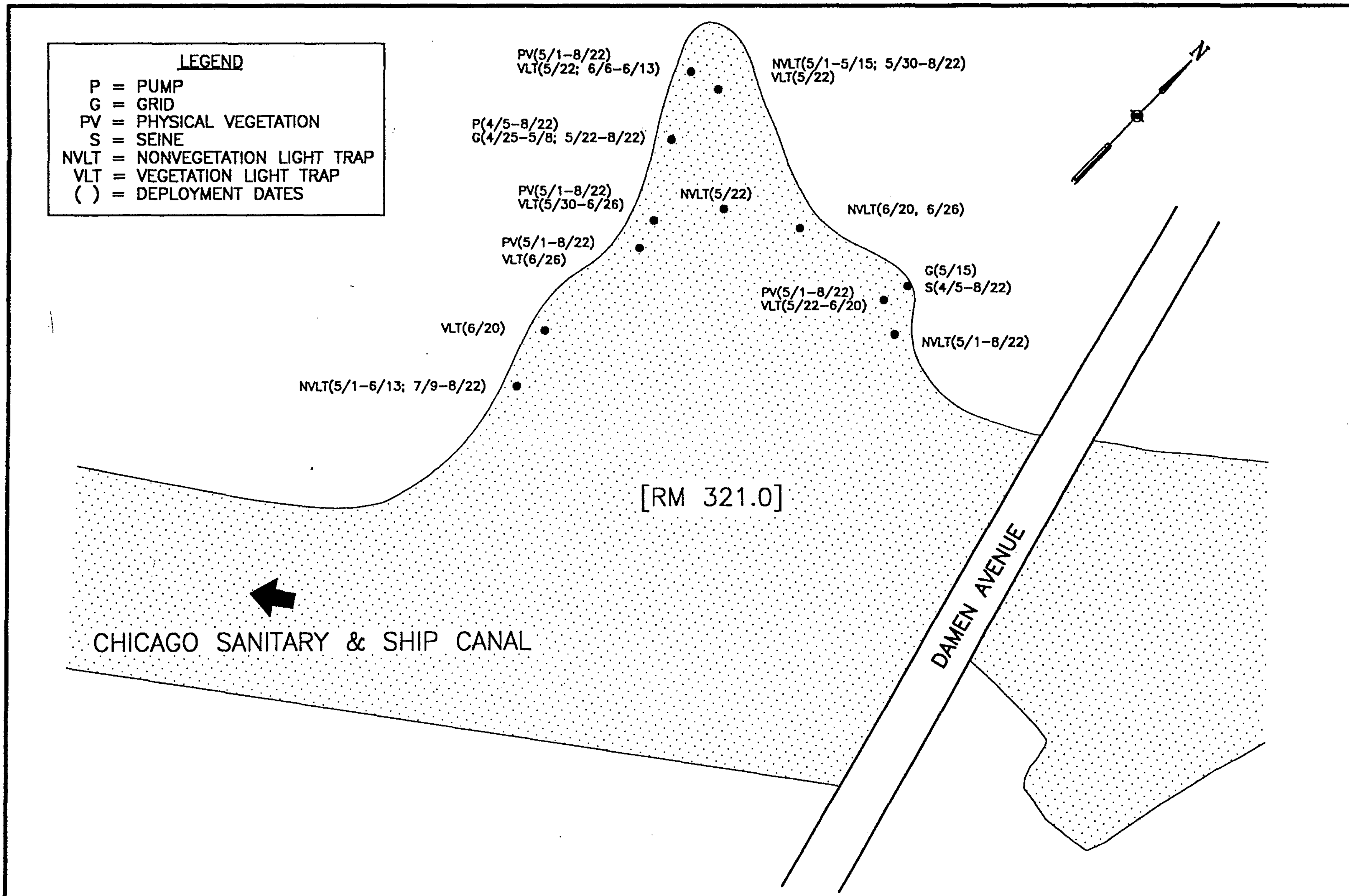
TABLE B-2 (cont.)

LOC		Apr 5-8	Apr 25-28	May 1-6	May 8-13	May 15-20	May 22-27	May 30-June 4	June 6-11	June 13-18	June 20-25	June 26-July 1	July 9-14	July 24-29	Aug 7-12	Aug 22-27	Total
402-1	# of VLTS	0	0	0	0	0	0	0	0	1	0(a)	0(a)	0(a)	0(a)	1	1	3
	# of NVLTS	0	0	3	3	3	3	3	3	3	3	3	3	3	3	3	39
402-2	# of VLTS	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	3
	# of NVLTS	0	0	3	3	3	3	3	3	3	3	2	2	2	3	3	36
402-3	# of VLTS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	# of NVLTS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
402B	# of VLTS	0	0	0	0	0	0	3	3	3	1	3	3	3	2	2	23
	# of NVLTS	0	0	3	3	3	3	3	3	3	3	3	3	3	3	3	39
405	# of VLTS	0	0	0	1	2	3	3	3	3	0	3	3	3	3	3	30
	# of NVLTS	0	0	3	3	3	3	3	3	3	3	3	3	3	3	3	39
407	# of VLTS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	# of NVLTS	0	0	3	3	3	0(a)	3	3	1	3	3	3	3	3	3	34
408	# of VLTS	0	0	0	0	0	0	1	1	1	2	2	3	2	0	0	12
	# of NVLTS	0	0	3	3	3	3	3	3	3	3	3	3	3	3	3	39
409	# of VLTS	0	0	0	0	0	3	3	3	3	3	3	3	3	0	0	24
	# of NVLTS	0	0	3	3	3	3	3	3	3	3	3	3	3	3	3	39
414	# of VLTS	0	0	0	0	0	3	3	3	3	3	1	0	0	0	0	16
	# of NVLTS	0	0	3	3	3	3	3	3	3	3	3	3	3	3	3	39
	Total VLTS	0	0	0	7	9	22	26	27	28	23	24	21	16	11	10	224
	Total NVLTS	0	0	42	42	42	39	42	42	40	42	41	41	41	42	42	538

(a)= current too fast

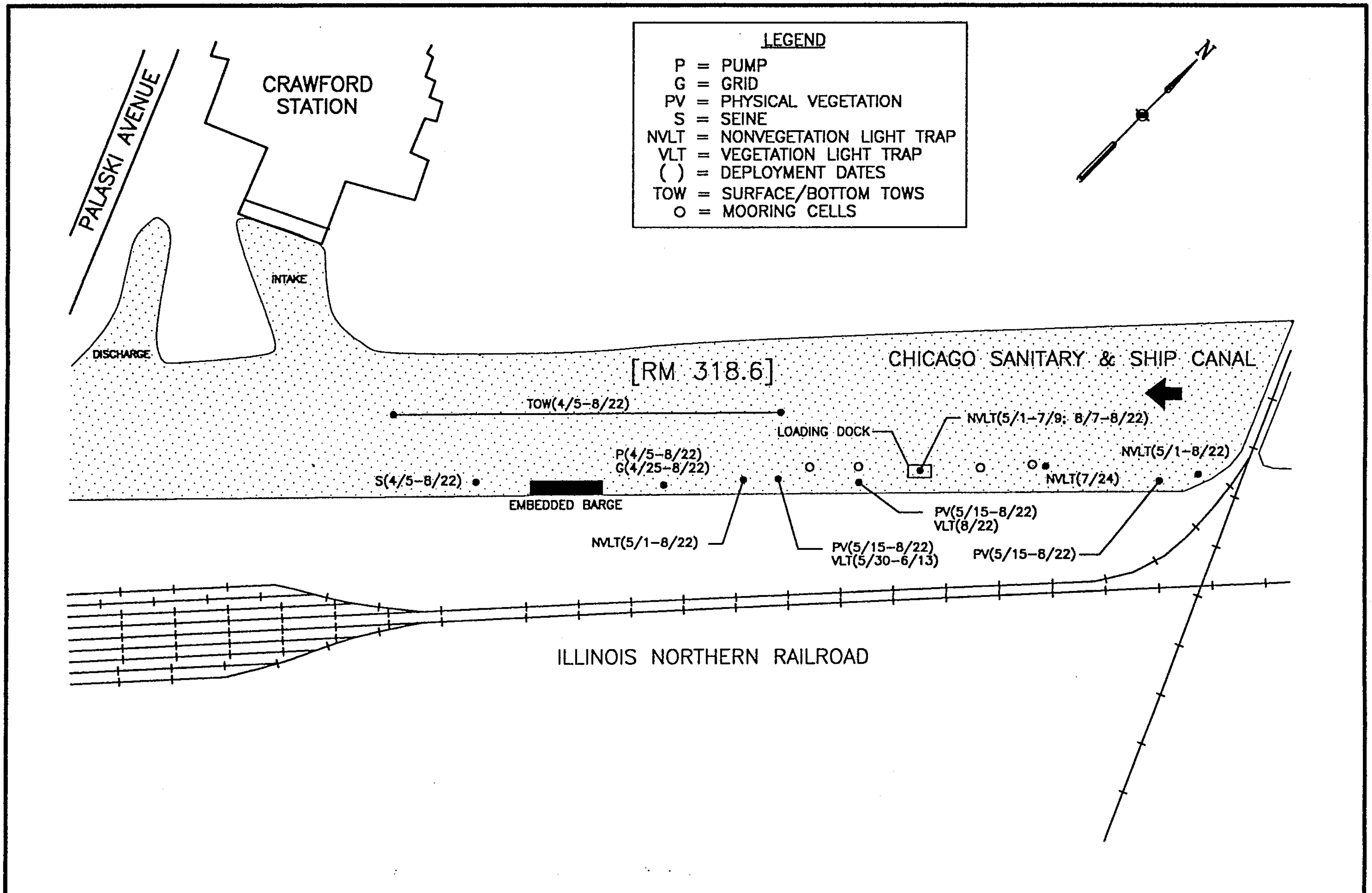
VLTS= vegetative light traps

NVLTS= non-vegetative light traps



EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.	TITLE: CECO-ICHTHYOPLANKTON STUDY LOCATION 105, REACH 3, RM 321.0	FIGURE:	DWN BY:	SCALE	DATE:	PJT NO:
		B-2	STAFF	NO SCALE	DEC 94	60799.01

DRAWING NAME: F:\PPOJ\606990I\FIGURES\RM3210
DATE:01/27/1995 TIME:10:04



EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.	TITLE: CECO-ICHTHYOPLANKTON STUDY LOCATION 202, REACH 5, RM 318.6	FIGURE:	DWN BY:	SCALE	DATE:	PJT NO:
		B-3	STAFF	NO SCALE	DEC 94	60799.01

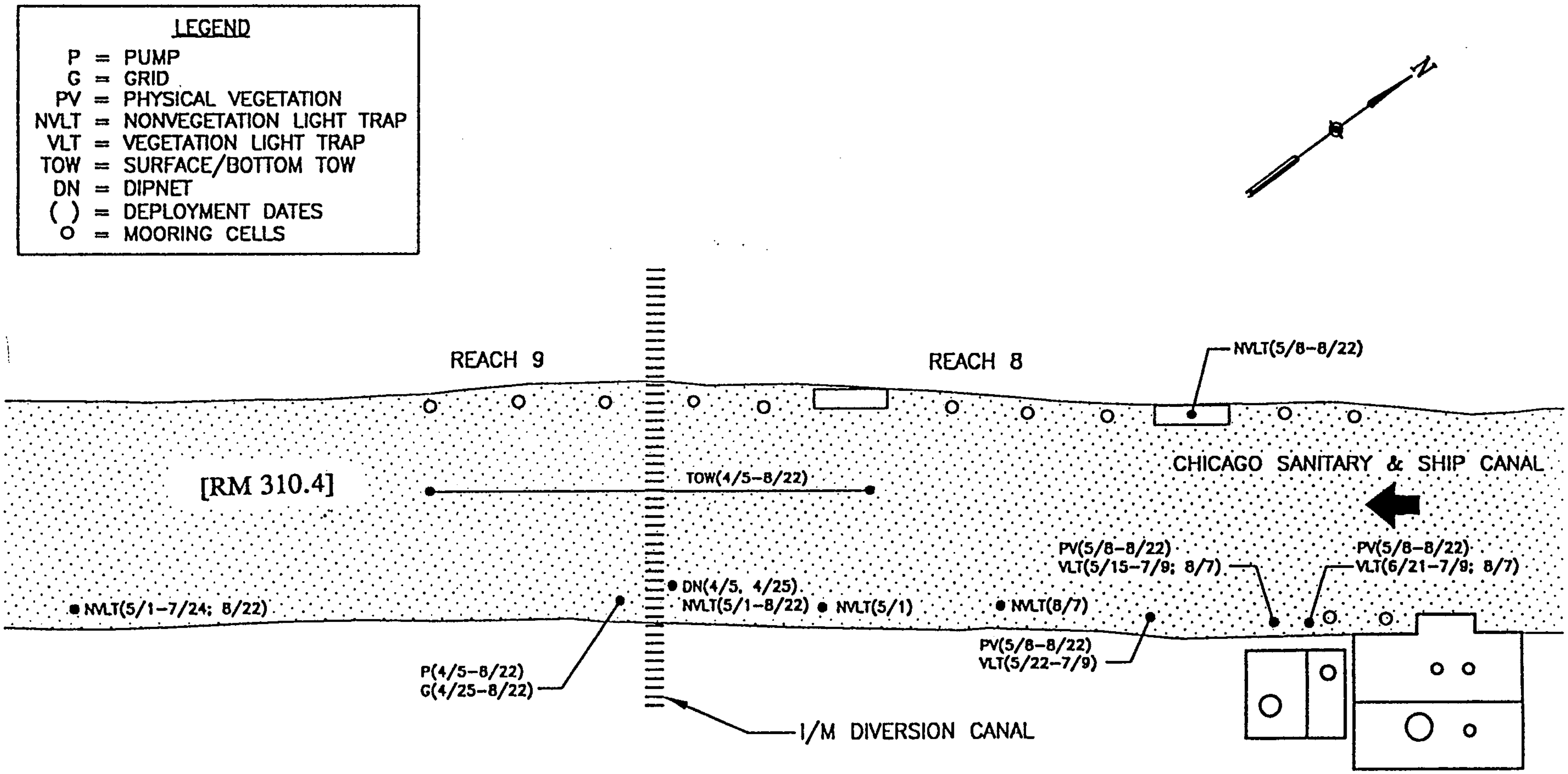
DRAWING NAME: F:\PROJ\6069901\FIGURES\RM3186
DATE:01/27/1995 TIME:10:05

June, and again on 22 August (Table B-1). One vegetative light trap was set at this location for each of those trips when macrophyte beds were observed. Three nonvegetative light traps were deployed during each trip, from 1 May through 22 August (Table B-2).

Location 207 Location 207 is along the left and right banks of the Chicago Sanitary and Ship Canal near the I & M Diversion Canal (RM 310.4). Ichthyoplankton samples were collected from approximately 250 meters upstream of the I & M Diversion Canal to 250 meters downstream of it (Figure B-4). Cobble and gravel are the dominant substrate types, with some boulders present. A moderately sloping bank with a few steep drop-offs is characteristic of this location. Pump and tow samples were collected on all sampling trips (Figure B-4). Grid samples were collected on all trips from 25 April through 22 August. Dipnetting was conducted in April, in lieu of light trapping. Physical vegetation samples were collected from the 8 May trip (isolated stalks) through the 22 August trip. Macrophyte development was sufficient on the 15 May trip to warrant one vegetative light trap. Development increased slightly from the 22 May trip through the 13 June trip (two vegetative light traps), peaked during the period from the 20 June trip through the 9 July trip (three vegetative traps) and decreased from the 24 July trip through the 22 August trip (no vegetative light traps), excluding the 7 August trip (two vegetative light traps) (Table B-1 and Figure B-4). Three nonvegetative traps were deployed each trip, beginning 1 May (Table B-2).

Location 301 This location is along the left bank of the Chicago & Sanitary Ship Canal across from and slightly upstream of the Will County Station intake (RM 295.7) (Figure B-5). This entire location is along a vertical concrete canal wall with a few small coves and crevices. Substrate types are primarily cobble and gravel (ESE 1994). Only pump, dip net, and tow samples were collected at this location. Beginning on the 25 April trip, all pump and dip net samples were collected in two discrete areas - vertical wall and cove, to yield two pump samples (pump-wall, pump-cove) and two dip net samples (dip net-wall, dip net-cove) within this location.

Location 302A This location is located along the right bank immediately downstream of Cargill Grain Inc. (RM 292.5) (Figure B-6). Much of this location is shallow with a substrate consisting of muck upstream of and adjacent to the sunken barges, and gravel, cobble, and boulders near shore, downstream of them. Ichthyoplankton samples were collected from ~100 meters downstream of the sunken barges to ~40 meters upstream of them (Figure B-6). In April, pumping was conducted upstream of the sunken barges; however, from the 1 May trip through the 22 August trip, pumping was conducted downstream of the barges to take advantage of firmer substrates. Pump samples were collected on all sampling trips. Grid samples were collected during all trips except for 15 and 30 May due to high turbidity. Dipnetting was conducted in April in lieu of light trapping. Macrophytes

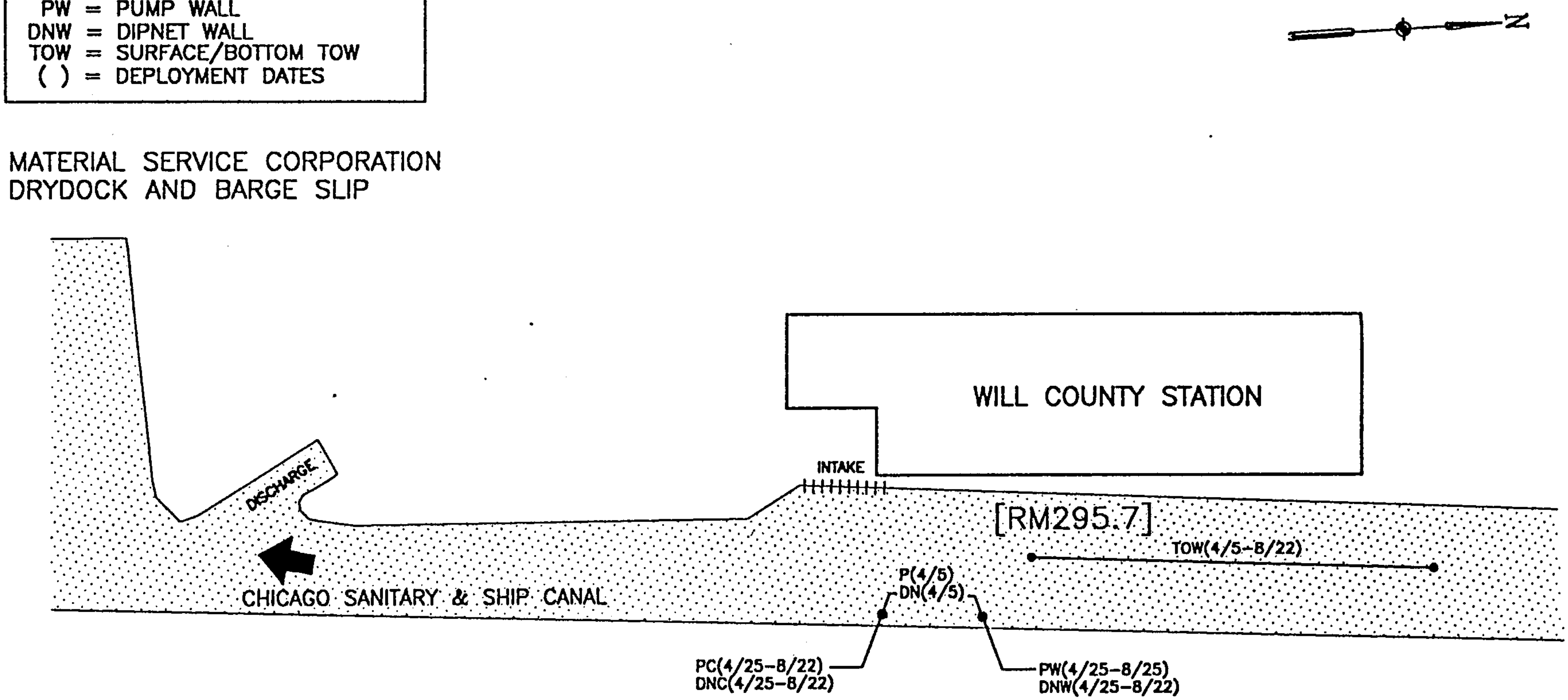


EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.	TITLE: CECO-ICHTHYOPLANKTON STUDY LOCATION 207, REACHES 8/9, RM 310.4	FIGURE: B-4	DWN BY: STAFF	SCALE: NO SCALE	DATE: DEC 94	PJT NO: 60799.01

DRAWING NAME: F:\PROJ\6069901\FIGURES\RM3100
DATE:01/27/1995 TIME:10:03

LEGEND

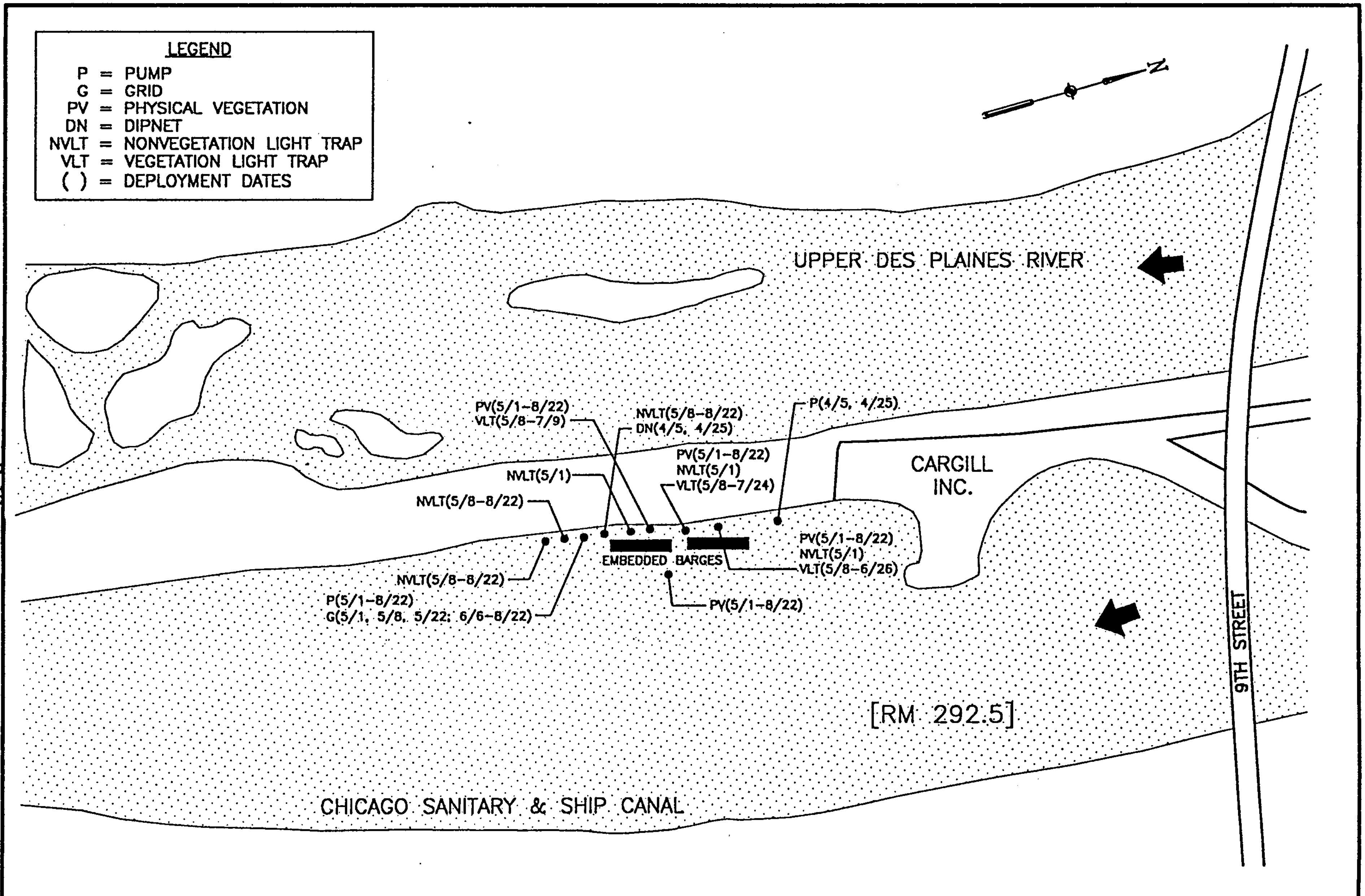
P = PUMP
DN = DIPNET
PC = PUMP COVE
DNC = DIPNET COVE
PW = PUMP WALL
DNW = DIPNET WALL
TOW = SURFACE/BOTTOM TOW
( ) = DEPLOYMENT DATES



B-11

DRAWING NAME: F:\PROJ\60699\01\FIGURES\RM2957
DATE:01/27/1995 TIME:10:02

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.	TITLE: CECO-ICHTHYOPLANKTON STUDY LOCATION 301, REACH 15, RM 295.7	FIGURE:	DWN BY:	SCALE	DATE:	PJT NO:
		B-5	STAFF	NO SCALE	DEC 94	60799.01



EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.	TITLE: CECO-ICHTHYOPLANKTON STUDY LOCATION 302A, REACH 17, RM 292.5	FIGURE: B-6	DWN BY: STAFF	SCALE: NO SCALE	DATE: DEC 94	PJT NO: 60799.01

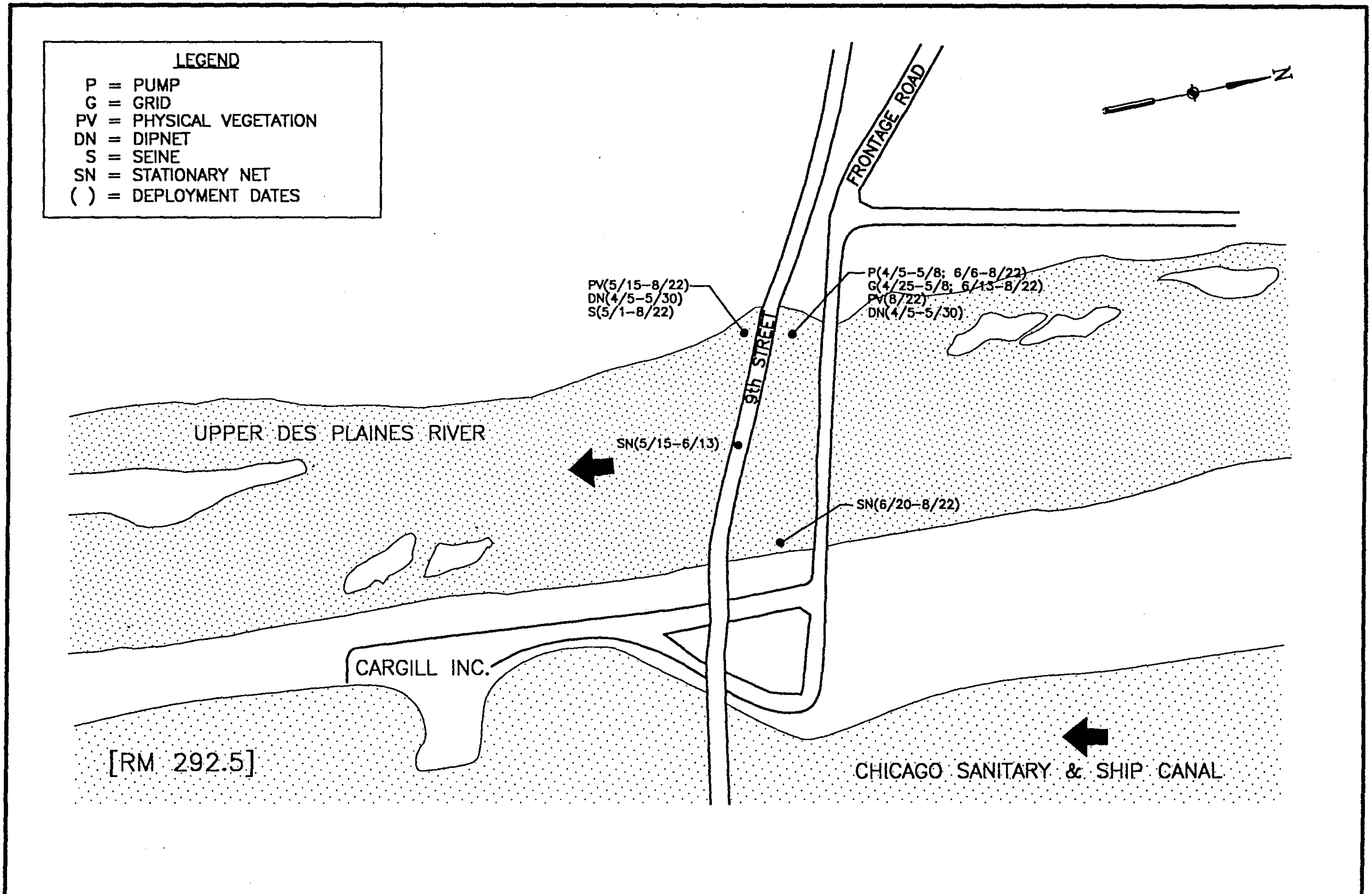
DRAWING NAME: F:\PROJ\6063901\FIGURES\RM2925
DATE:01/27/1995 TIME:10:01

were present in sufficient abundance to warrant three vegetative light traps from the 8 May trip through the 26 June trip. Macrophyte development decreased from the 9 July trip (two vegetative light traps) through the 22 August trip (no vegetative light trips) (Table B-1). Three nonvegetative light traps and physical vegetation samples were collected from the 1 May trip through the 22 August trip at this location (Table B-1 and Figure B-6).

Location 304 — Location 304 is located in the upper Des Plaines River between the 9th Street (Highway 7) bridge and the frontage road bridge. The majority of ichthyoplankton samples were collected along the right bank (Figure B-7). This location is shallow with moderate to swift current throughout much of the sampling area. Substrate is primarily cobble, gravel, and hardpan. Pump samples were collected on all trips excluding 15 May through 30 May due to dense periphyton growth that clogged the pump. Grid samples were collected on all trips beginning 25 April, except during 15 May through 6 June due to dense periphyton growth and/or turbid water. Seining was conducted from the 1 May trip through the 22 August trip. Dip net samples were collected on the 5 April through 30 May trips, typically when pumping could not be conducted. Stationary net sampling, in lieu of light trapping, was conducted at mid-channel from the 15 May trip through the 13 June trip, then moved to the left bank from the 20 June trip to the 22 August trip (Figure B-7). Physical vegetation samples were collected from the 15 May trip through the 22 August trip, primarily near shore under the 9th Street bridge (Figure B-7). No light traps were set at this location due to insufficient depth and swift current.

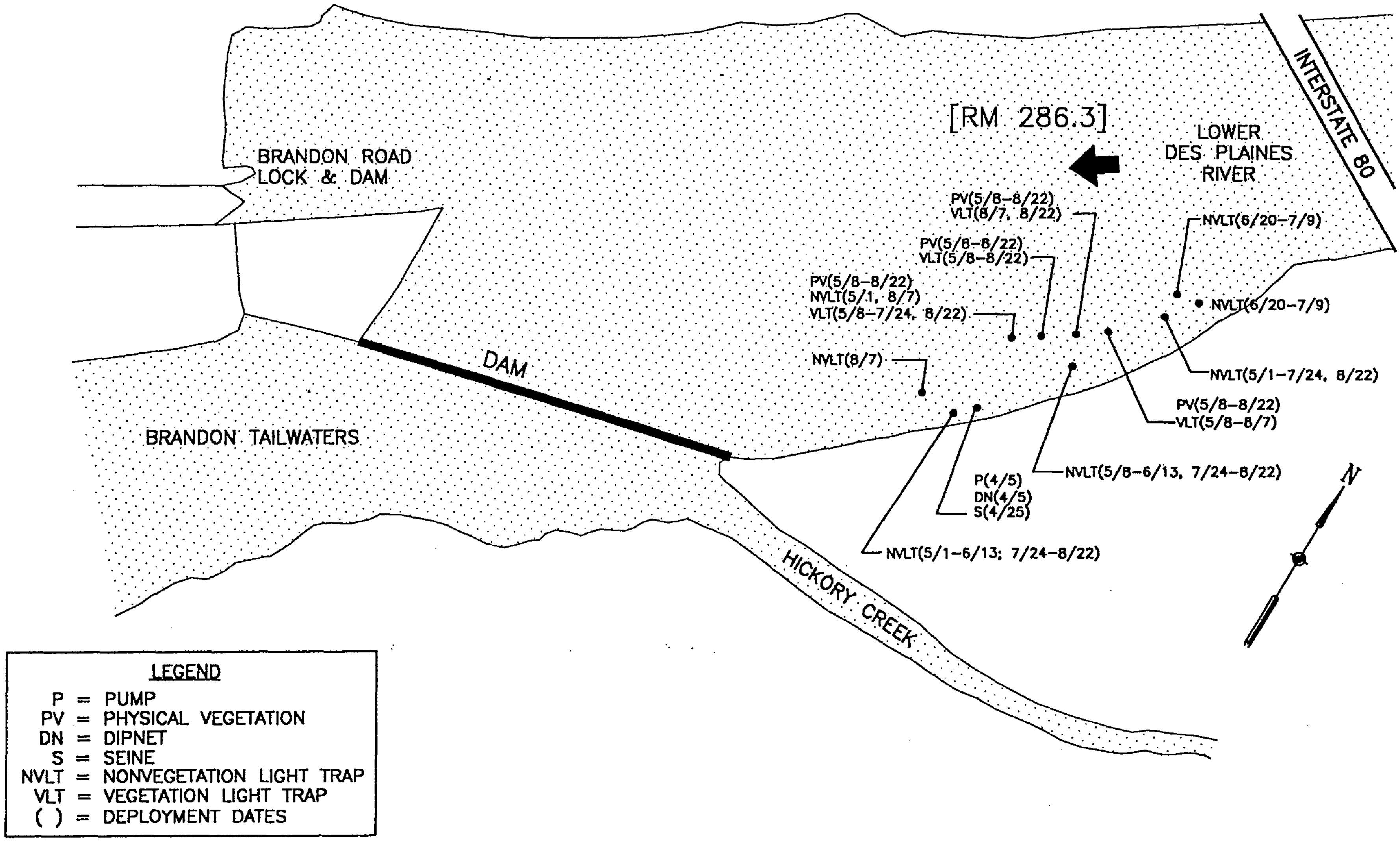
Location 309 — This location is along the left bank of the Chicago & Sanitary Ship Canal immediately upstream of the Brandon Road Lock & Dam and adjacent to the Joliet Wastewater Treatment Plant (RM 286.3) (Figure B-8). Ichthyoplankton samples were collected between the I-80 bridge and the Brandon Road Lock & Dam on a shallow flat consisting primarily of a muck substrate. A single pump (5 April), dip net (5 April), and seine sample (25 April) was collected at this location (Figure B-8). Physical vegetation samples were collected from the 8 May trip through the 22 August trip. Macrophyte beds were present in sufficient abundance to warrant three vegetative light traps from the 8 May trip through the 22 August trip. Dense macrophyte beds were observed from the 22 May trip through the 20 June trip (Table B-1). Three nonvegetative light traps were deployed from the 1 May trip through the 22 August trip (Table B-2).

Location 402A — Location 402A is located along the right bank ~0.5 miles downstream of the Brandon Road Lock (Figure B-9). This location is characterized by moderately sloping cobble and gravel substrate. Pump and tow samples were collected on all sampling trips. Grid samples were collected on all trips beginning 1 May. A single dip net sample was collected on 5 April, in lieu of seining. No macrophytes were observed and no light traps were deployed at this location.



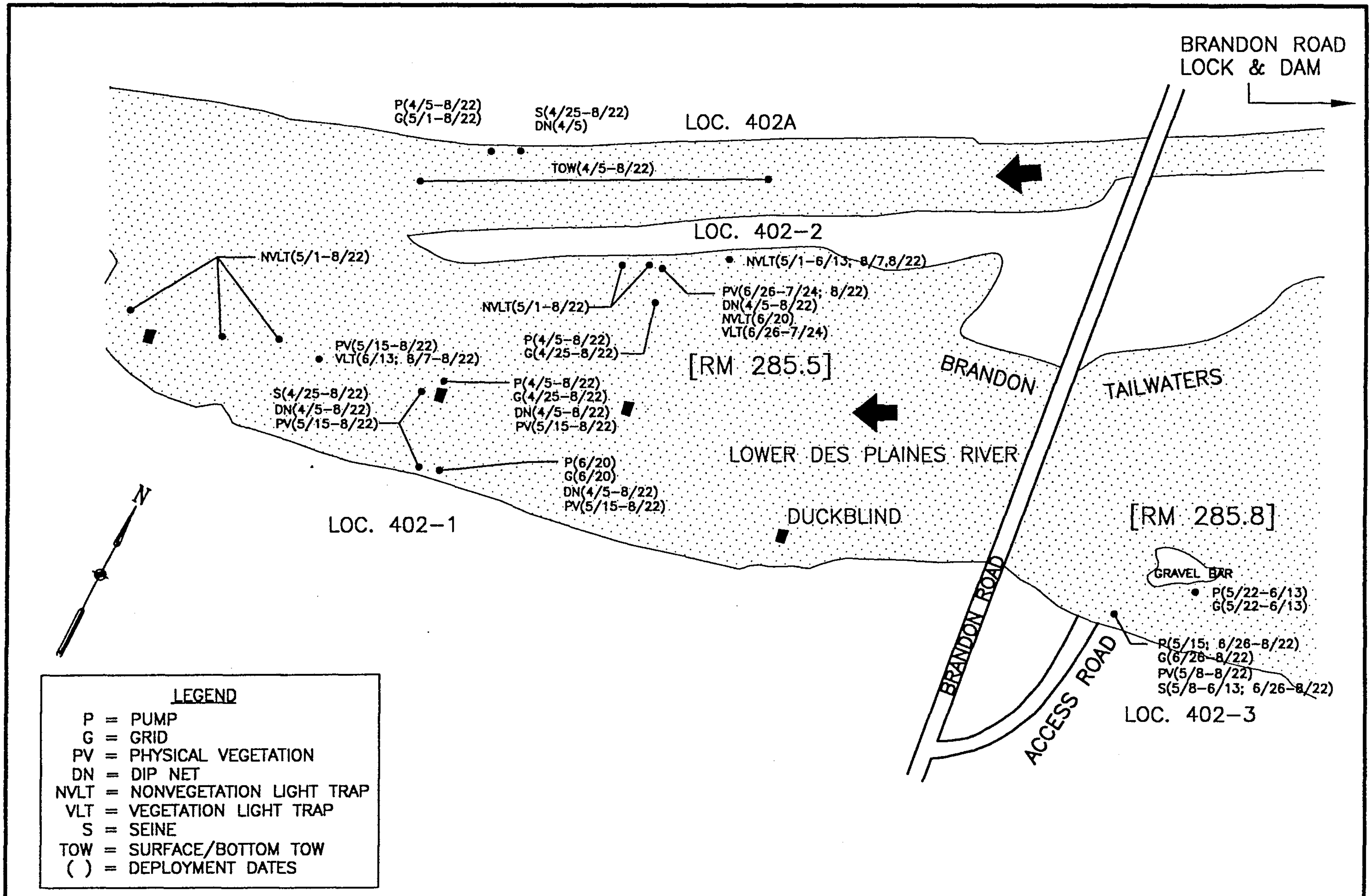
EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.	TITLE: CECO–ICHTHYOPLANKTON STUDY LOCATION 304, UPPPER DES PLAINES RIVER	FIGURE:	DWN BY:	SCALE	DATE:	PJT NO:
		B-7	STAFF	NO SCALE	DEC 94	60799.01

DRAWING NAME: F:\PROJ\6069901\FIGURES\RM2952A
DATE:01/27/1995 TIME:09:59



EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.	TITLE: CECO–ICHTHYOPLANKTON STUDY LOCATION 309, REACH 23, RM 286.3	FIGURE:	DWN BY:	SCALE:	DATE:	PJT NO:
		B-8	STAFF	NO SCALE	DEC 94	60799.01

DRAWING NAME: F:\PROJ\6069901\FIGURES\RM2363
DATE:01/27/1995 TIME:09:58



EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.	TITLE: CECO–ICHTHYOPLANKTON STUDY LOCATION 402–(1–3) REACH 24, RM 285.4–285.8 LOCATION 402A, REACH25, RM 285.5	FIGURE: B-9	DWN BY: STAFF	SCALE NO SCALE	DATE: DEC 94	PJT NO: 60799.01

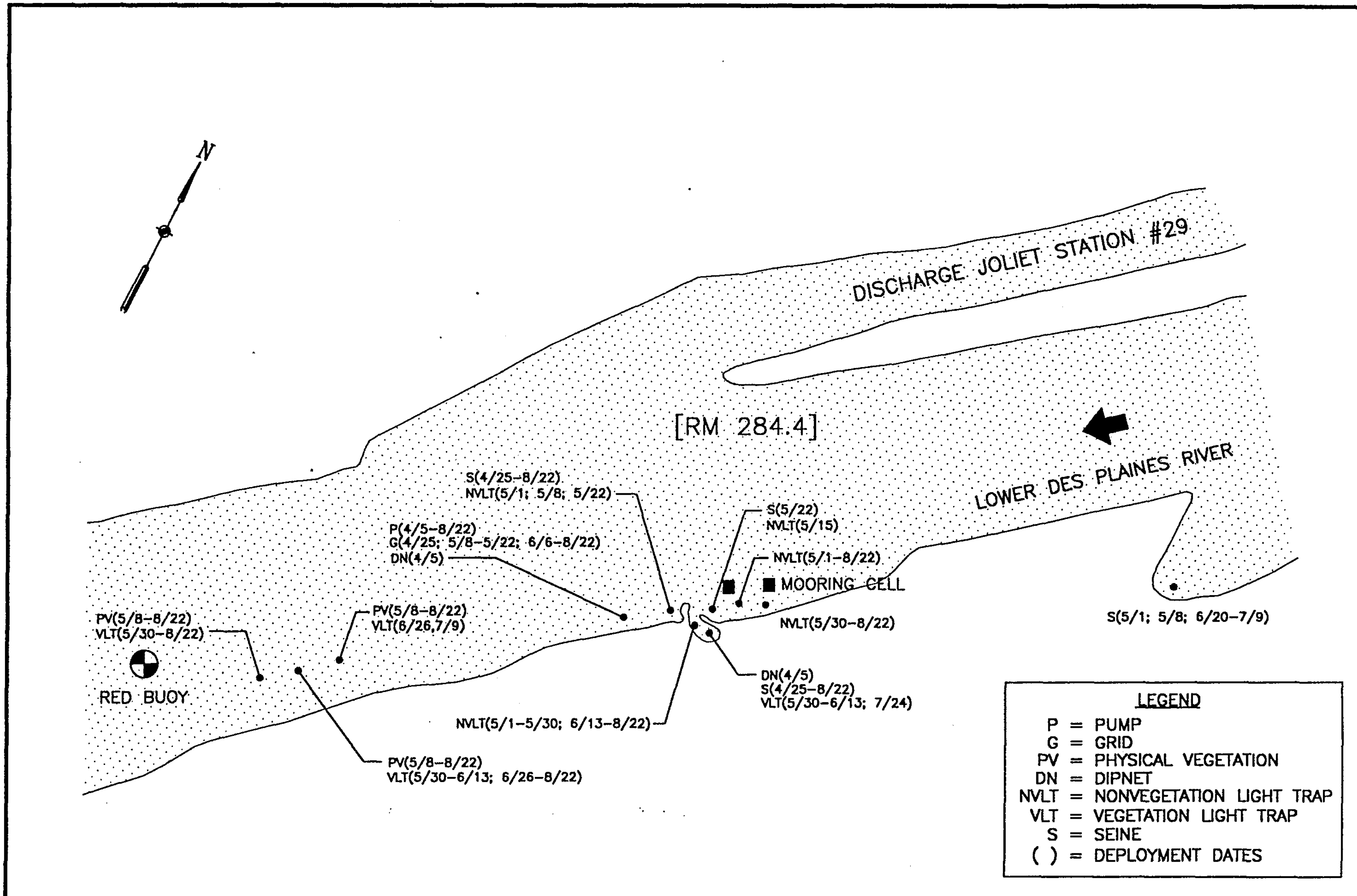
DRAWING NAME: F:\PROJ\6069901\FIGURES\RM2855
DATE:01/27/1995 TIME:09:44

Location 402-1 This location is near the left bank of the Brandon tailwaters ~0.3 miles downstream of Brandon Road Dam (RM 285.5) (Figure B-9). The entire location is fairly shallow (0.3-1.3 m) with slow to fast current and substrates consisting of hardpan, cobble, and gravel. All sampling gears were utilized at this location except for towed nets. Pump and dip net samples were collected on all sampling trips. Grid and seine samples were collected on all trips excluding 5 April. Physical vegetation samples were collected from the 15 May trip through the 22 August trip, primarily from isolated stalks or beds in shallow water (Table B-1 and Figure B-9). Sparse macrophyte beds had developed (off shore) by the 13 June trip and remained until the 22 August trip. A single vegetative light trap was deployed each trip from the 13 June trip through the 22 August trip, excluding 20 June through 24 July due to high flows (Table B-1). Three nonvegetative light traps were deployed each trip from 1 May through 22 August (Table B-2).

Location 402-2 Location 402-2 is located along the right bank of the Brandon Tailwaters ~0.3 miles downstream of Brandon Road, across from Location 402-1 (RM 285.5) (Figure B-9). This tailwater habitat contains slow to fast current with primarily gravel and cobble substrate. Pump and dip net samples were collected on all sampling dates. Grid samples were collected on all trips from 25 April through 22 August. A single vegetative light trap was deployed on all trips from 26 June through 24 July in a small macrophyte bed located immediately downstream of a riffle (Table B-1). Two to three nonvegetative light traps were deployed during each trip from 1 May through 22 August depending on flow conditions (Table B-2). Physical vegetation samples were collected from the 26 June through the 22 August trips, excluding 7 August (Figure B-9).

Location 402-3 This location was added on 13 May and is located along the left bank of the Brandon Tailwaters ~30 meters upstream of Brandon Road (RM 285.8) (Figure B-9). This location is characterized by slow to fast current with primarily cobble and gravel substrate. Only pump, grid, seine, and physical vegetation samples were collected from this location. Seine and vegetation samples were collected on all sampling trips from 8 May through 22 August. Pump samples were collected on all trips from 15 May through 22 August, excluding 20 June due to high water. In addition, grid samples were collected on all trips from 22 May through 22 August, excluding 20 June due to high water (Figure B-9).

Location 402B Location 402B is located along the left bank of the lower Des Plaines River across from the mouth of the Joliet Station #29 discharge canal (RM 284.4). Ichthyoplankton sampling was conducted from a small bay across from the Joliet Station #29 discharge downstream to the first red channel buoy (Figure B-10). Habitats consist of a small cove with muck substrate, and a gently sloping main channel border with primarily silt covered gravel and cobble substrate and slow to moderate current. Pump samples were



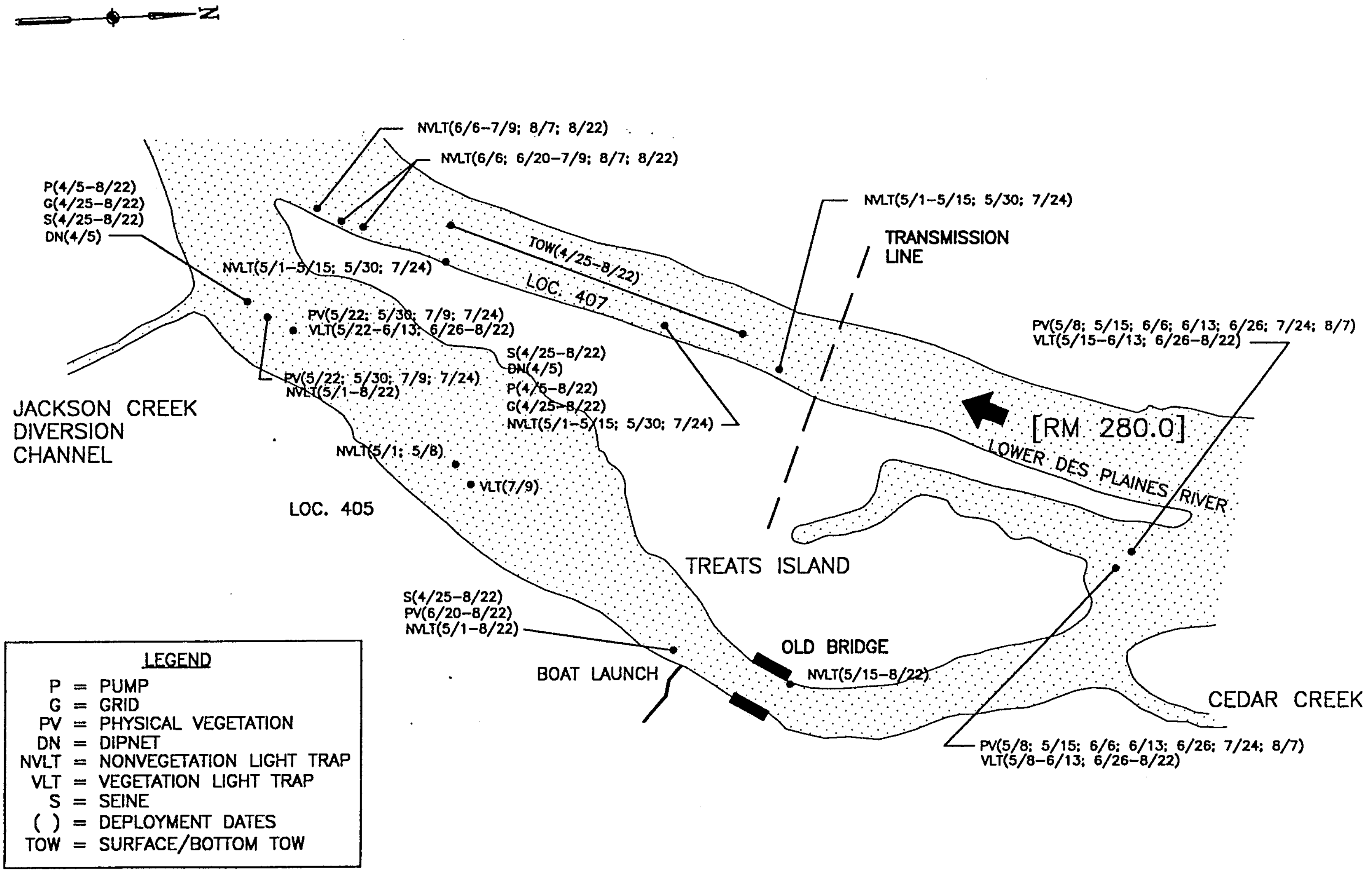
EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.	TITLE: CECO-ICHTHYOPLANKTON STUDY LOCATION 402B, REACH 25, RM 284.4	FIGURE: B-10	DWN BY: STAFF	SCALE NO SCALE	DATE: DEC 94	PJT NO: 60799.01

DRAWING NAME: F:\PROJ\6069901\FIGURES\RM2844
DATE:01/27/1995 TIME:09:52

collected during all sampling trips (Figure B-10). Grid samples were collected on all trips beginning 25 April, except during the 1 May trip and the 30 May trip due to turbidity (Figure B-10). Seining was conducted on all trips beginning 25 April. Dipnetting was conducted in lieu of seining on 5 April. Physical vegetation samples were collected from the 8 May trip through the 22 August trip. Macrophytes were present during the 8 May through the 22 May trips (no vegetative light traps), abundant from the 30 May through the 13 June trips (three vegetative light traps), and intermediate from the 20 June through the 22 August trips (one to three vegetative light traps) (Table B-1). Three nonvegetative light traps were deployed during each trip from 1 May through 22 August (Table B-2).

Location 405 This location is located within the Treats Island side channel (left bank) (RM 279.4). Ichthyoplankton samples were collected from the downstream end to the upstream end of this island (Figure B-11). Current is slow throughout this location. The substrate consists primarily of muck/silt, except near the mouth of the Jackson Creek Diversion Channel where the substrate consists of silt covered gravel and cobble. Pump samples were collected on all sampling trips (Figure B-11). Grid and seine samples were collected on all trips beginning 25 April. Dipnetting was conducted during the 5 April trip in lieu of seining. Physical vegetation samples were collected from the 8 May trip to the 22 August trip in a variety of areas (Figure B-11). Vegetative light traps were deployed each trip at this location from 8 May through 22 August, excluding 20 June (Table B-1). A steady increase in macrophyte development was observed from the 8 May trip through the 22 May trip (one, two, and three vegetative light traps deployed during these three trips, respectively). The size of the macrophyte beds remained fairly consistent for the remainder of the study (three vegetative light traps deployed each trip, excluding 20 June) (Table B-1). Three nonvegetative light traps were deployed each trip from 1 May through 22 August (Table B-2).

Location 407 Location 407 is located along the left bank of the main channel of the lower Des Plaines River (west bank of Treats Island) (RM 279.6). Sampling was conducted between the downstream end of Treats Island and the transmission lines (Figure B-11). This location consists of gently sloping gravel and sand substrate with slow to moderate current. Pump and tow samples were collected during all sampling events (Figure B-11). Grid and seine sampling was conducted from the 25 April trip through the 22 August trip. Dipnetting was conducted during the 5 April trip in lieu of seining. No macrophytes were observed at this location; thus, no physical vegetation or vegetative light trap samples were collected (Table B-1). Three nonvegetative light traps were deployed during each sampling trip from 1 May through 22 August, except during the 22 May trip (no light traps deployed) and the 13 June trip (one light trap deployed) due to fast current (Table B-2).



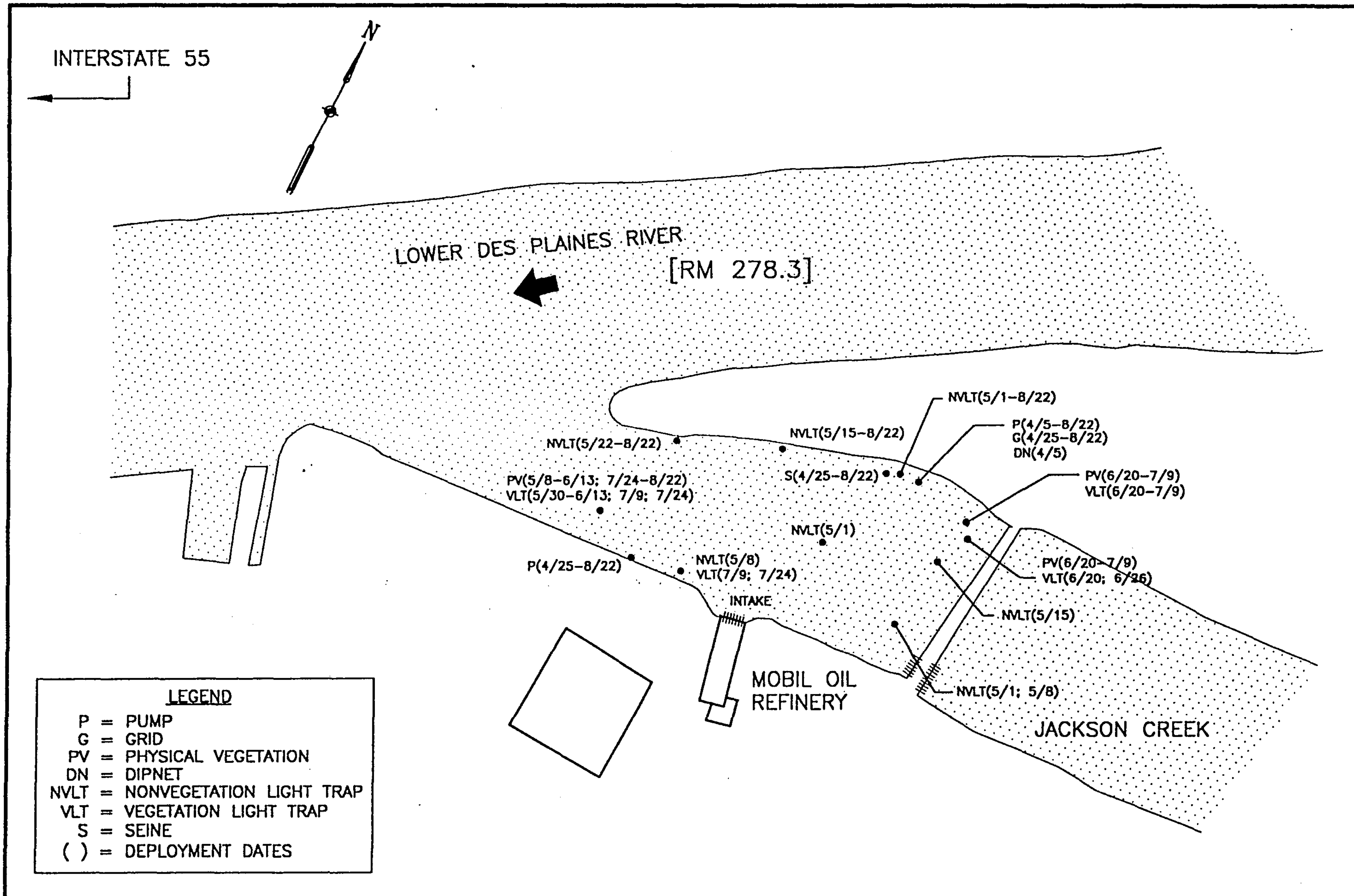
EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.	TITLE: CECO-ICHTHYOPLANKTON STUDY LOCATION 405, REACH 29, RM 279.4 LOCATION 407, REACH 29, RM 279.6	FIGURE:	DWN BY:	SCALE	DATE:	PJT NO:
		B-11	STAFF	NO SCALE	DEC 94	60799.01

DRAWING NAME: F:\PROJ\6069301\FIGURES\RM2800
DATE:01/27/1995 TIME:09:53

Location 408 — This location is in the mouth of Jackson Creek (RM 278.3). Sampling was conducted from the Jackson Creek dam/trash racks to near the mouth of the creek (Figure B-12). Substrate consists primarily of cobble and rip-rap along the south bank (mouth to Mobil Intake), cobble and gravel along the north bank near the pump and grid area, and muck and detritus throughout much of the open water areas. Pump samples were collected on all sampling trips. Excluding the first trip in April, all pump samples were collected from two discrete sampling areas and then composited to yield one sample (Figure B-12). Grid and seine samples were collected on all trips beginning 25 April. Dipnetting was conducted during the 5 April trip in lieu of seining. Physical vegetation samples were collected from the 8 May trip through the 22 August trip. Macrophytes were present in sufficient abundance to warrant vegetative light traps from the 30 May trip through the 24 July trip. During this period one trap was deployed, each trip, during from the 30 May trip through the 13 June trip, two traps were deployed during the 20 June, 26 June and 24 July trips, and three traps were deployed on the 9 July trip (Table B-1). Three nonvegetative light traps were deployed on all trips from 1 May through 22 August (Table B-2).

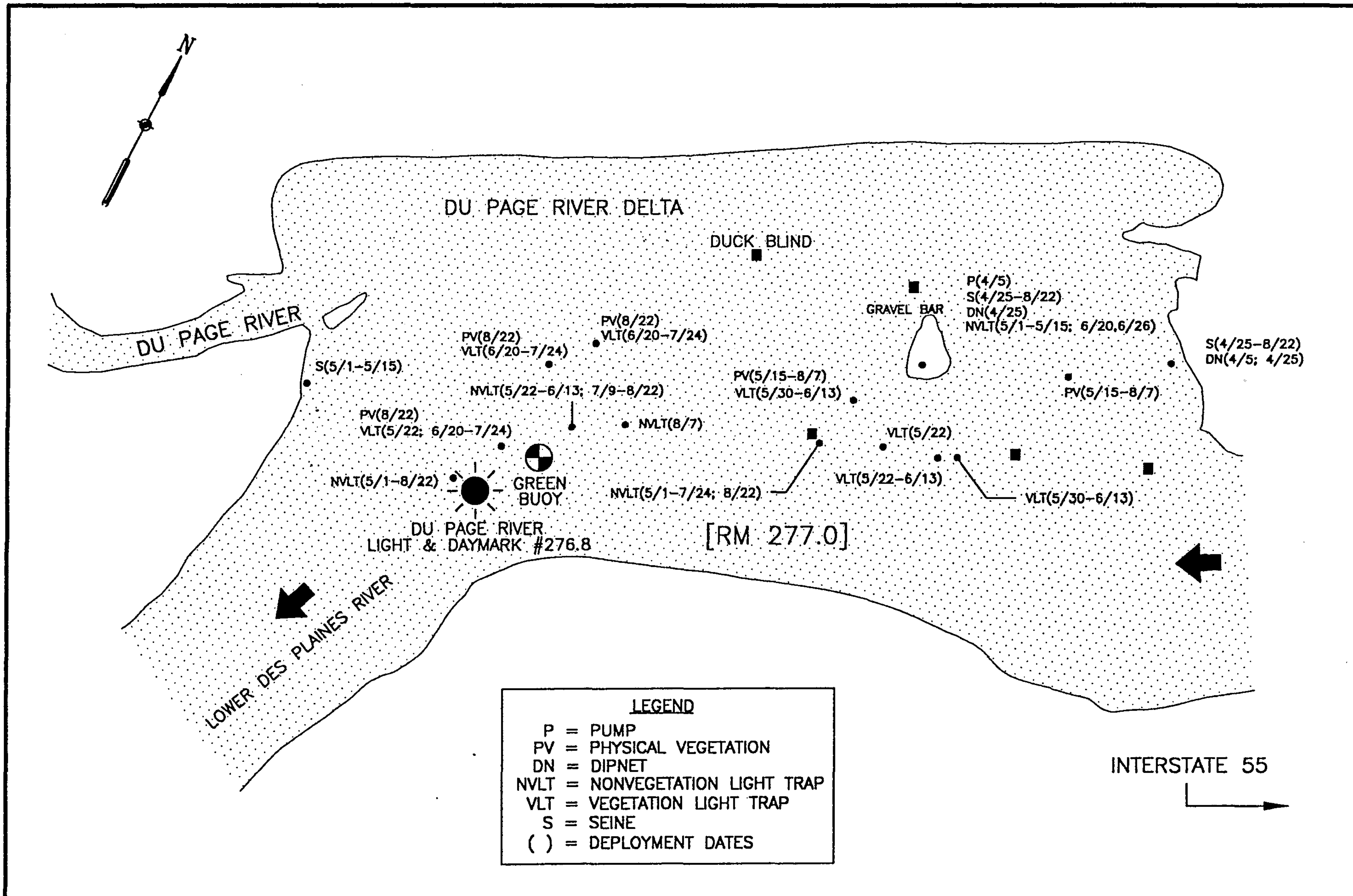
Location 409 — Location 409 is in the Du Page River delta ~0.75 miles downstream of the I-55 bridge (RM 277.0) (Figure B-13). This location is shallow with a substrate consisting primarily of muck/silt; however, a small gravel bar is present in open water where seining was conducted (Figure B-13). Pumping was conducted only during the 5 April trip. Seine samples were collected on all trips beginning 25 April, from up to three localities and composited to yield one sample per trip (Figure B-13). Dipnetting was conducted in April, in lieu of light trapping. Physical vegetation samples were collected from the 15 May trip through the 22 August trip. Three vegetative light traps were deployed each trip from 22 May through 24 July, and three nonvegetative light traps were deployed from the 1 May trip through the 22 August trip (Tables B-1 and B-2).

Location 414 — This location is in the Bear Island slough (RM 276.2) (Figure B-14). This location is uniformly shallow and the substrate consists primarily of muck/silt. Pumping was conducted only during the 5 April trip. Seine samples were collected from the 25 April trip through the 22 August trip (Figure B-14). Dipnetting was conducted in lieu of light trapping during the April trips. Physical vegetation sampling was conducted during all trips from 1 May through 22 August, excluding the 8 May trip. Macrophytes were most abundant from the 22 May trip through the 20 June trip; during this period three vegetative light traps were deployed each trip (Table B-1). A single vegetative light trap was deployed during the 26 June trip (Table B-1). Three nonvegetative light traps were deployed each trip, beginning 1 May (Table B-2).



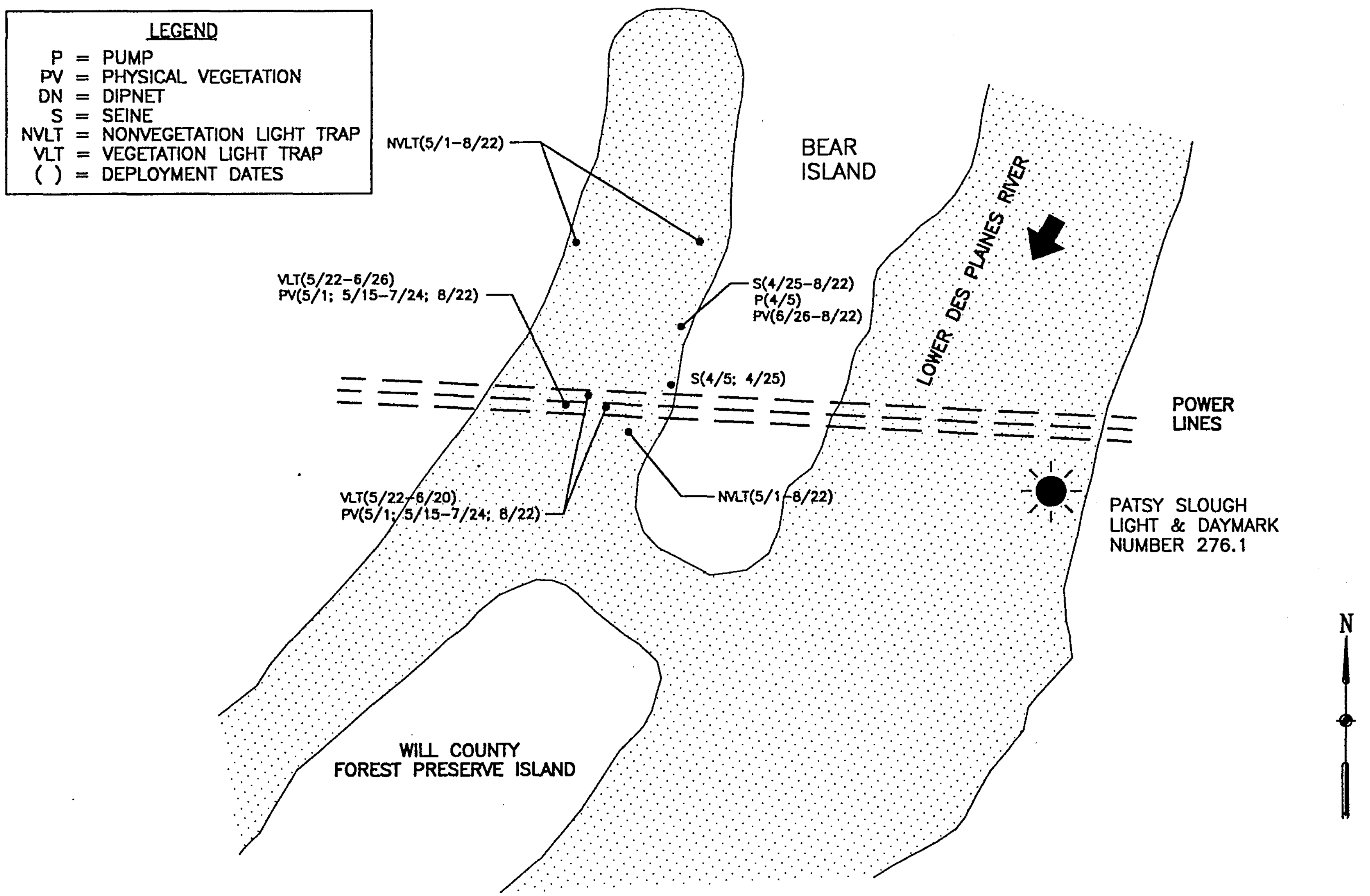
EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.	TITLE: CECO-ICHTHYOPLANKTON STUDY LOCATION 408, REACH 31, RM 278.3	FIGURE: B-12	DWN BY: STAFF	SCALE: NO SCALE	DATE: DEC 94	PJT NO: 60799.01

DRAWING NAME: F:\PROJ\6069901\FIGURES\PM2733
DATE:01/27/1995 TIME:09:55



EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.	TITLE: CECO–ICHTHYOPLANKTON STUDY LOCATION 409, REACH 32, RM 277.0	FIGURE:	DWN BY:	SCALE	DATE:	PJT NO:
		B-13	STAFF	NO SCALE	DEC 94	60799.01

DRAWING NAME: F:\PROJ\6069901\FIGURES\RM2770
DATE:01/27/1995 TIME:03:56



EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.	TITLE: CECO–ICHTHYOPLANKTON STUDY LOCATION 414, REACH 33, RM 276.2	FIGURE: B-14	DWN BY: STAFF	SCALE: NO SCALE	DATE: DEC 94	PJT NO: 60799.01

DRAWING NAME: F:\PROJ\6069901\FIGURES\RM2762
DATE:01/27/1995 TIME:09:57

APPENDIX C

SUMMARIES OF THE NUMBER AND RELATIVE ABUNDANCE OF ICHTHYOPLANKTON

Upper Illinois Waterway Ichthyoplankton Study -- 1994

FISH EGG SUMMARIES

UPPER ILLINOIS WATERWAY - COMMONWEALTH EDISON COMPANY
1994 ICHTHYOPLANKTON STUDY - ANNUAL EGG CATCH BY GEAR

	GEAR:										
	DIPNET	GRID	NOVEGLT	PHYVEG	PUMP	SEINE	STNET	TOW	VEGLT	COMBINED	
	#	#	#	#	#	#	#	#	#	#	%
SPECIES											
COMMON CARP	602	1884	3	537	10108	2	.	.	.	13136	44.67
CARP/GOLDFISH	1	18	1	158	58	14	.	.	.	250	0.85
FRESHWATER DRUM	.	3	.	.	3	23	.	728	.	757	2.57
UNIDENTIFIED	150	761	5	7129	6248	818	4	138	11	15264	51.91
TOTAL EGGS	753	2666	9	7824	16417	857	4	866	11	29407	100.0

NOTE: NOVEGLT=NONVEGETATIVE LIGHT TRAP; PHYVEG=PHYSICAL EXAMINATION OF VEGETATION; STNET=STATIONARY NET; VEGLT=VEGETATIVE LIGHT TRAP.

UPPER ILLINOIS WATERWAY - COMMONWEALTH EDISON COMPANY
1994 ICHTHYOPLANKTON STUDY - ANNUAL EGG CATCH BY SEGMENT AND TRIP

SEGMENT: LOCKPORT POOL

SPECIES	8 MAY #	8 MAY %	15 MAY #	15 MAY %	22 MAY #	22 MAY %	30 MAY #	30 MAY %	6 JUN #	6 JUN %	13 JUN #	13 JUN %	20 JUN #	20 JUN %
COMMON CARP	--	--	113	67.7	--	--	10920	66.4	--	--	--	--	--	--
CARP/GOLDFISH	--	--	34	20.4	6	0.4	--	--	8	1.8	2	0.1	62	7.0
FRESHWATER DRUM	--	--	--	--	--	--	--	--	--	--	3	0.2	1	0.1
UNIDENTIFIED	5	100.0	20	12.0	1565	99.6	5526	33.6	445	98.2	1777	99.7	820	92.9
TOTAL EGGS	5	100.0	167	100.0	1571	100.0	16446	100.0	453	100.0	1782	100.0	883	100.0

SPECIES	26 JUN #	26 JUN %	9 JUL #	9 JUL %	24 JUL #	24 JUL %	7 AUG #	7 AUG %	22 AUG #	22 AUG %
COMMON CARP	--	--	--	--	--	--	--	--	--	--
CARP/GOLDFISH	--	--	--	--	1	0.4	--	--	--	--
FRESHWATER DRUM	--	--	--	--	--	--	--	--	--	--
UNIDENTIFIED	163	100.0	3	100.0	226	99.6	1345	100.0	1	100.0
TOTAL EGGS	163	100.0	3	100.0	227	100.0	1345	100.0	1	100.0

SEGMENT: BRANDON POOL

SPECIES	25 APR #	25 APR %	1 MAY #	1 MAY %	8 MAY #	8 MAY %	15 MAY #	15 MAY %	22 MAY #	22 MAY %	30 MAY #	30 MAY %	6 JUN #	6 JUN %
COMMON CARP	1767	100.0	--	--	--	--	17	100.0	--	--	--	--	--	--
CARP/GOLDFISH	--	--	--	--	--	--	--	--	1	0.6	--	--	3	50.0
UNIDENTIFIED	--	--	65	100.0	9	100.0	--	--	158	99.4	19	100.0	3	50.0
TOTAL EGGS	1767	100.0	65	100.0	9	100.0	17	100.0	159	100.0	19	100.0	6	100.0

SPECIES	13 JUN #	13 JUN %	20 JUN #	20 JUN %	26 JUN #	26 JUN %
COMMON CARP	--	--	--	--	--	--
CARP/GOLDFISH	--	--	19	38.8	--	--
UNIDENTIFIED	47	100.0	30	61.2	7	100.0
TOTAL EGGS	47	100.0	49	100.0	7	100.0

POOL: UPPER DRESDEN POOL

SPECIES	5 APR #	5 APR %	25 APR #	25 APR %	1 MAY #	1 MAY %	8 MAY #	8 MAY %	15 MAY #	15 MAY %	22 MAY #	22 MAY %	30 MAY #	30 MAY %
COMMON CARP	--	--	--	--	--	--	319	62.1	--	--	--	--	--	--
CARP/GOLDFISH	--	--	--	--	--	--	--	--	--	--	47	7.0	4	0.6
FRESHWATER DRUM	--	--	--	--	--	--	--	--	394	29.3	28	4.1	17	2.5
UNIDENTIFIED	1	100.0	38	100.0	13	100.0	195	37.9	952	70.7	601	88.9	652	96.9
TOTAL EGGS	1	100.0	38	100.0	13	100.0	514	100.0	1346	100.0	676	100.0	673	100.0

SPECIES	6 JUN #	6 JUN %	13 JUN #	13 JUN %	20 JUN #	20 JUN %	26 JUN #	26 JUN %	9 JUL #	9 JUL %
COMMON CARP	--	--	--	--	--	--	--	--	--	--
CARP/GOLDFISH	--	--	--	--	60	16.9	3	3.8	--	--
FRESHWATER DRUM	265	88.3	--	--	--	--	49	62.0	--	--
UNIDENTIFIED	35	11.7	210	100.0	295	83.1	27	34.2	11	100.0
TOTAL EGGS	300	100.0	210	100.0	355	100.0	79	100.0	11	100.0

LARVAL/JUVENILE SUMMARIES

UPPER ILLINOIS WATERWAY - COMMONWEALTH EDISON COMPANY
1994 ICHTHYOPLANKTON STUDY - ANNUAL LARVAL/JUVENILE CATCH BY LIFE STAGE

ALL SAMPLING METHODS

LIFE STAGE

	YOLK-SAC LARVAE		POST YOLK-SAC LARVAE		JUVENILE		INDETERMIN.		STAGES COMBINED	
	#	%	#	%	#	%	#	%	#	%
SPECIES										
LONGNOSE GAR	--	--	2	100.0	--	--	--	--	2	0.01
UNID CLUPEIDAE	--	--	266	100.0	--	--	--	--	266	1.22
UNID ALOSA	--	--	179	100.0	--	--	--	--	179	0.82
GIZZARD SHAD	4	0.1	4774	96.0	197	4.0	--	--	4975	22.83
UNID DOROSOMA	--	--	27	100.0	--	--	--	--	27	0.12
RAINBOW SMELT	--	--	1	100.0	--	--	--	--	1	0.00
CENTRAL STONEROLLER	--	--	--	--	3	100.0	--	--	3	0.01
GOLDFISH	71	87.7	6	7.4	2	2.5	2	2.5	81	0.37
COMMON CARP	2460	65.5	1227	32.7	41	1.1	29	0.8	3757	17.24
CARP/GOLDFISH	151	60.9	8	3.2	--	--	89	35.9	248	1.14
GOLDEN SHINER	--	--	23	74.2	8	25.8	--	--	31	0.14
EMERALD SHINER	--	--	16	8.0	185	92.0	--	--	201	0.92
EMERALD SHINER type	6	1.4	414	98.6	--	--	--	--	420	1.93
STRIPED SHINER	--	--	--	--	25	100.0	--	--	25	0.11
STRIPED SHINER type	--	--	1	100.0	--	--	--	--	1	0.00
BIGMOUTH SHINER	--	--	--	--	5	100.0	--	--	5	0.02
SPOTTAIL SHINER	--	--	43	24.4	133	75.6	--	--	176	0.81
SPOTTAIL SHINER type	79	29.0	193	71.0	--	--	--	--	272	1.25
SPOTFIN SHINER	--	--	--	--	6	100.0	--	--	6	0.03
SAND SHINER	--	--	--	--	34	100.0	--	--	34	0.16
BLUNTNOSE MINNOW	--	--	561	19.2	2350	80.4	12	0.4	2923	13.42
FATHEAD MINNOW	--	--	12	13.5	77	86.5	--	--	89	0.41
UNID PIMEPHALES	102	10.0	898	87.9	19	1.9	3	0.3	1022	4.69
UNID CYPRINID	77	23.8	197	60.8	16	4.9	34	10.5	324	1.49
UNID CARPIODES	6	85.7	1	14.3	--	--	--	--	7	0.03
WHITE SUCKER	--	--	203	86.0	33	14.0	--	--	236	1.08
WHITE SUCKER/N. HOG SUCKER	2	0.7	269	97.8	--	--	--	--	271	1.24
NORTHERN HOG SUCKER	--	--	5	100.0	--	--	--	--	5	0.02
UNID MOXOSTOMA	--	--	307	98.4	5	1.6	--	--	312	1.43
UNID CATOSTOMINAE	1	1.0	95	99.0	--	--	--	--	96	0.44
UNID ICTIOBINAE	12	41.4	17	58.6	--	--	--	--	29	0.13
YELLOW BULLHEAD	--	--	--	--	1	100.0	--	--	1	0.00
CHANNEL CATFISH	4	36.4	--	--	7	63.6	--	--	11	0.05
TADPOLE MADTOM	--	--	--	--	2	100.0	--	--	2	0.01
BLACKSTRIPE TOPMINNOW	--	--	2	33.3	4	66.7	--	--	6	0.03
MOSQUITOFISH	--	--	--	--	12	100.0	--	--	12	0.06
BROOK SILVERSIDE	--	--	1	100.0	--	--	--	--	1	0.00
THREESPINE STICKLEBACK	--	--	--	--	1	100.0	--	--	1	0.00
UNID MORONE	--	--	6	100.0	--	--	--	--	6	0.03
ROCK BASS	--	--	1	100.0	--	--	--	--	1	0.00
GREEN SUNFISH	--	--	--	--	1	100.0	--	--	1	0.00
BLUEGILL	--	--	--	--	17	100.0	--	--	17	0.08
LEPOMIS A	--	--	132	96.4	5	3.6	--	--	137	0.63
LEPOMIS B	--	--	7	100.0	--	--	--	--	7	0.03
LEPOMIS C	--	--	16	100.0	--	--	--	--	16	0.07
LEPOMIS D	--	--	4	100.0	--	--	--	--	4	0.02
UNID LEPOMIS	964	17.6	4520	82.4	2	0.0	--	--	5486	25.18
SMALLMOUTH BASS	--	--	--	--	1	100.0	--	--	1	0.00
LARGEMOUTH BASS	2	25.0	--	--	6	75.0	--	--	8	0.04
UNID MICROPTERUS	--	--	--	--	--	--	4	100.0	4	0.02
BLACK CRAPPIE	--	--	--	--	1	100.0	--	--	1	0.00
UNID POMOXIS	4	100.0	--	--	--	--	--	--	4	0.02
UNID CENTRARCHID	--	--	1	100.0	--	--	--	--	1	0.00
JOHNNY DARTER	1	16.7	1	16.7	4	66.7	--	--	6	0.03
RAINBOW/ORANGETHROAT DARTER	--	--	--	--	2	100.0	--	--	2	0.01
UNID ETHEOSTOMA	--	--	2	100.0	--	--	--	--	2	0.01
YELLOW PERCH	1	50.0	1	50.0	--	--	--	--	2	0.01
LOGPERCH	--	--	1	100.0	--	--	--	--	1	0.00
UNID PERCINA	--	--	2	100.0	--	--	--	--	2	0.01
UNID PERCID	--	--	1	50.0	1	50.0	--	--	2	0.01
FRESHWATER DRUM	1	33.3	2	66.7	--	--	--	--	3	0.01
UNIDENTIFIED	1	5.9	1	5.9	--	--	15	88.2	17	0.08
TOTAL FISH	3949	18.1	14446	66.3	3206	14.7	188	0.9	21789	100.00

NOTE: 0.0 DENOTES VALUES <0.05 AND 0.00 DENOTES VALUES <0.005.

UPPER ILLINOIS WATERWAY - COMMONWEALTH EDISON COMPANY
1994 ICHTHYOPLANKTON STUDY - ANNUAL LARVAL/JUVENILE CATCH BY LOCATION

	LOCATION													
	104		105		202		207		301		302A		304	
SPECIES	#	%	#	%	#	%	#	%	#	%	#	%	#	%
LONGNOSE GAR	--	--	--	--	--	--	--	--	--	--	--	--	--	--
UNID CLUPEIDAE	--	--	4	1.4	50	10.1	24	12.8	36	9.3	4	0.4	--	--
UNID ALOSA	--	--	22	7.7	65	13.1	62	33.0	25	6.4	--	--	--	--
GIZZARD SHAD	--	--	6	2.1	3	0.6	--	--	33	8.5	9	0.8	--	--
UNID DOROSOMA	--	--	--	--	--	--	--	--	15	3.9	--	--	--	--
RAINBOW SMELT	--	--	--	--	--	--	--	--	1	0.3	--	--	--	--
CENTRAL STONEROLLER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
GOLDFISH	9	4.7	7	2.4	17	3.4	3	1.6	6	1.5	19	1.8	--	--
COMMON CARP	131	68.6	175	61.2	180	36.3	58	30.9	88	22.6	961	88.7	473	21.6
CARP/GOLDFISH	48	25.1	9	3.1	36	7.3	15	8.0	19	4.9	19	1.8	65	3.0
GOLDEN SHINER	1	0.5	5	1.7	3	0.6	--	--	3	0.8	--	--	2	0.1
EMERALD SHINER	--	--	--	--	--	--	--	--	33	8.5	1	0.1	--	--
EMERALD SHINER type	--	--	--	--	1	0.2	--	--	23	5.9	--	--	--	--
STRIPED SHINER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
STRIPED SHINER type	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BIGMOUTH SHINER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SPOTTAIL SHINER	--	--	--	--	--	--	--	--	--	--	2	0.2	--	--
SPOTTAIL SHINER type	--	--	3	1.0	6	1.2	--	--	1	0.3	--	--	--	--
SPOTFIN SHINER	--	--	--	--	--	--	--	--	--	--	--	--	5	0.2
SAND SHINER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BLUNTNOSE MINNOW	--	--	--	--	--	--	--	--	1	0.3	2	0.2	962	43.8
FATHEAD MINNOW	--	--	--	--	44	8.9	2	1.1	5	1.3	33	3.0	--	--
UNID PIMEPHALES	1	0.5	9	3.1	78	15.7	14	7.4	64	16.5	31	2.9	254	11.6
UNID CYPRINID	--	--	4	1.4	4	0.8	8	4.3	21	5.4	2	0.2	127	5.8
UNID CARPIODES	--	--	--	--	--	--	--	--	--	--	--	--	--	--
WHITE SUCKER	--	--	--	--	--	--	--	--	--	--	--	--	212	9.7
WHITE SUCKER/N. HOG SUCKER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
NORTHERN HOG SUCKER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
UNID MOXOSTOMA	--	--	--	--	--	--	--	--	--	--	--	--	57	2.6
UNID CATOSTOMINAE	--	--	--	--	--	--	--	--	--	--	--	--	22	1.0
UNID ICTIOBINAE	--	--	--	--	--	--	--	--	--	--	--	--	--	--
YELLOW BULLHEAD	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CHANNEL CATFISH	--	--	--	--	--	--	--	--	--	--	--	--	1	0.0
TADPOLE MADTOM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BLACKSTRIPE TOPMINNOW	--	--	--	--	--	--	--	--	--	--	--	--	2	0.1
MOSQUITOFISH	--	--	--	--	--	--	1	0.5	9	2.3	--	--	2	0.1
BROOK SILVERSIDE	--	--	--	--	--	--	--	--	--	--	--	--	--	--
THREESPINE STICKLEBACK	--	--	--	--	--	--	1	0.5	--	--	--	--	--	--
UNID MORONE	--	--	--	--	--	--	--	--	3	0.8	--	--	--	--
ROCK BASS	--	--	--	--	--	--	--	--	--	--	--	--	--	--
GREEN SUNFISH	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BLUEGILL	--	--	--	--	--	--	--	--	1	0.3	--	--	7	0.3
LEPOMIS A	--	--	--	--	--	--	--	--	--	--	--	--	--	--
LEPOMIS B	--	--	4	1.4	3	0.6	--	--	--	--	--	--	--	--
LEPOMIS C	--	--	--	--	--	--	--	--	--	--	--	--	--	--
LEPOMIS D	--	--	--	--	--	--	--	--	--	--	--	--	--	--
UNID LEPOMIS	1	0.5	37	12.9	3	0.6	--	--	--	--	--	--	1	0.0
SMALLMOUTH BASS	--	--	--	--	--	--	--	--	--	--	--	--	--	--
LARGEMOUTH BASS	--	--	--	--	--	--	--	--	--	--	--	--	--	--
UNID MICROPTERUS	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BLACK CRAPPIE	--	--	--	--	--	--	--	--	--	--	--	--	--	--
UNID POMOXIS	--	--	--	--	--	--	--	--	--	--	--	--	--	--
UNID CENTRARCHID	--	--	--	--	--	--	--	--	1	0.3	--	--	--	--
JOHNNY DARTER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
RAINBOW/ORANGETHROAT DARTER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
UNID ETHEOSTOMA	--	--	--	--	--	--	--	--	--	--	--	--	--	--
YELLOW PERCH	--	--	--	--	2	0.4	--	--	--	--	--	--	--	--
LOGPERCH	--	--	--	--	--	--	--	--	--	--	--	--	--	--
UNID PERCINA	--	--	--	--	--	--	--	--	--	--	--	--	--	--
UNID PERCID	--	--	--	--	--	--	--	--	--	--	--	--	--	--
FRESHWATER DRUM	--	--	--	--	1	0.2	--	--	1	0.3	--	--	--	--
UNIDENTIFIED	--	--	1	0.3	--	--	--	--	--	--	1	0.1	2	0.1
TOTAL FISH	191	100.0	286	100.0	496	100.0	188	100.0	389	100.0	1084	100.0	2194	100.0

(CONTINUED)

UPPER ILLINOIS WATERWAY - COMMONWEALTH EDISON COMPANY
1994 ICHTHYOPLANKTON STUDY - ANNUAL LARVAL/JUVENILE CATCH BY LOCATION

	LOCATION													
	309		402		402A		402B		405		407		408	
SPECIES	#	%	#	%	#	%	#	%	#	%	#	%	#	%
LONGNOSE GAR	--	--	1	0.1	--	--	--	--	1	0.2	--	--	--	--
UNID CLUPEIDAE	1	0.2	5	0.3	2	0.9	5	0.3	1	0.2	--	--	124	1.2
UNID ALOSA	1	0.2	--	--	3	1.3	--	--	--	--	--	--	--	--
GIZZARD SHAD	110	21.4	177	9.7	26	11.3	76	4.3	37	7.8	5	2.0	4271	39.8
UNID DOROSOMA	--	--	--	--	--	--	--	--	--	--	--	--	2	0.0
RAINBOW SMELT	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CENTRAL STONEROLLER	--	--	2	0.1	--	--	--	--	1	0.2	--	--	--	--
GOLDFISH	6	1.2	--	--	1	0.4	2	0.1	2	0.4	--	--	2	0.0
COMMON CARP	359	70.0	167	9.2	110	47.8	262	14.7	67	14.1	181	73.9	270	2.5
CARP/GOLDFISH	1	0.2	5	0.3	2	0.9	2	0.1	2	0.4	3	1.2	21	0.2
GOLDEN SHINER	--	--	1	0.1	1	0.4	2	0.1	2	0.4	--	--	9	0.1
EMERALD SHINER	1	0.2	2	0.1	--	--	1	0.1	3	0.6	13	5.3	47	0.4
EMERALD SHINER type	4	0.8	33	1.8	11	4.8	52	2.9	23	4.8	1	0.4	228	2.1
STRIPED SHINER	--	--	8	0.4	--	--	3	0.2	13	2.7	--	--	1	0.0
STRIPED SHINER type	--	--	--	--	--	--	--	--	--	--	--	--	1	0.0
BIGMOUTH SHINER	--	--	5	0.3	--	--	--	--	--	--	--	--	--	--
SPOTTAIL SHINER	--	--	25	1.4	5	2.2	57	3.2	57	12.0	1	0.4	18	0.2
SPOTTAIL SHINER type	--	--	5	0.3	1	0.4	22	1.2	4	0.8	7	2.9	181	1.7
SPOTFIN SHINER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SAND SHINER	--	--	2	0.1	--	--	30	1.7	--	--	1	0.4	--	--
BLUNTNOSE MINNOW	5	1.0	657	36.2	12	5.2	910	51.2	174	36.6	2	0.8	156	1.5
FATHEAD MINNOW	--	--	2	0.1	--	--	--	--	2	0.4	--	--	1	0.0
UNID PIMEPHALES	21	4.1	358	19.7	35	15.2	36	2.0	25	5.3	6	2.4	67	0.6
UNID CYPRINID	1	0.2	26	1.4	2	0.9	24	1.4	28	5.9	16	6.5	53	0.5
UNID CARPIODES	--	--	1	0.1	--	--	--	--	--	--	--	--	--	--
WHITE SUCKER	--	--	1	0.1	--	--	21	1.2	1	0.2	--	--	--	--
WHITE SUCKER/N. HOG SUCKER	--	--	119	6.5	5	2.2	143	8.0	2	0.4	--	--	1	0.0
NORTHERN HOG SUCKER	--	--	--	--	--	--	--	--	1	0.2	--	--	4	0.0
UNID MOXOSTOMA	--	--	157	8.6	3	1.3	72	4.1	1	0.2	--	--	1	0.0
UNID CATOSTOMINAE	--	--	44	2.4	5	2.2	19	1.1	2	0.4	--	--	--	--
UNID ICTIOBINAE	--	--	--	--	--	--	--	--	2	0.4	5	2.0	2	0.0
YELLOW BULLHEAD	--	--	1	0.1	--	--	--	--	--	--	--	--	--	--
CHANNEL CATFISH	--	--	--	--	6	2.6	--	--	1	0.2	3	1.2	--	--
TADPOLE MADTOM	--	--	1	0.1	--	--	--	--	--	--	--	--	1	0.0
BLACKSTRIPE TOPMINNOW	1	0.2	--	--	--	--	--	--	2	0.4	--	--	--	--
MOSQUITOFISH	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BROOK SILVERSIDE	--	--	--	--	--	--	--	--	--	--	--	--	1	0.0
THREESPINE STICKLEBACK	--	--	--	--	--	--	--	--	--	--	--	--	--	--
UNID MORONE	2	0.4	--	--	--	--	--	--	--	--	1	0.4	--	--
ROCK BASS	--	--	--	--	--	--	--	--	--	--	--	--	--	--
GREEN SUNFISH	--	--	1	0.1	--	--	--	--	--	--	--	--	--	--
BLUEGILL	--	--	1	0.1	--	--	--	--	--	--	--	--	2	0.0
LEPOMIS A	--	--	--	--	--	--	--	--	--	--	--	--	123	1.1
LEPOMIS B	--	--	--	--	--	--	--	--	--	--	--	--	--	--
LEPOMIS C	--	--	--	--	--	--	--	--	--	--	--	--	13	0.1
LEPOMIS D	--	--	--	--	--	--	--	--	--	--	--	--	4	0.0
UNID LEPOMIS	--	--	1	0.1	--	--	36	2.0	12	2.5	--	--	5116	47.6
SMALLMOUTH BASS	--	--	1	0.1	--	--	--	--	--	--	--	--	--	--
LARGEMOUTH BASS	--	--	4	0.2	--	--	2	0.1	--	--	--	--	2	0.0
UNID MICROPTERUS	--	--	--	--	--	--	--	--	--	--	--	--	4	0.0
BLACK CRAPPIE	--	--	--	--	--	--	--	--	--	--	--	--	--	--
UNID POMOXIS	--	--	--	--	--	--	--	--	--	--	--	--	4	0.0
UNID CENTRARCHID	--	--	--	--	--	--	--	--	--	--	--	--	--	--
JOHNNY DARTER	--	--	--	--	--	--	--	--	6	1.3	--	--	--	--
RAINBOW/ORANGETHROAT DARTER	--	--	2	0.1	--	--	--	--	--	--	--	--	--	--
UNID ETHEOSTOMA	--	--	--	--	--	--	--	--	1	0.2	--	--	--	--
YELLOW PERCH	--	--	--	--	--	--	--	--	--	--	--	--	--	--
LOGPERCH	--	--	--	--	--	--	--	--	--	--	--	--	1	0.0
UNID PERCINA	--	--	--	--	--	--	--	--	1	0.2	--	--	1	0.0
UNID PERCID	--	--	1	0.1	--	--	--	--	1	0.2	--	--	--	--
FRESHWATER DRUM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
UNIDENTIFIED	--	--	1	0.1	--	--	--	--	1	0.2	--	--	8	0.1
TOTAL FISH	513	100.0	1817	100.0	230	100.0	1777	100.0	476	100.0	245	100.0	10740	100.0

(CONTINUED)

UPPER ILLINOIS WATERWAY - COMMONWEALTH EDISON COMPANY
1994 ICHTHYOPLANKTON STUDY - ANNUAL LARVAL/JUVENILE CATCH BY LOCATION

	LOCATION			
	409		414	
SPECIES	#	%	#	%
LONGNOSE GAR	--	--	--	--
UNID CLUPEIDAE	--	--	10	1.6
UNID ALOSA	--	--	1	0.2
GIZZARD SHAD	66	11.9	156	25.6
UNID DOROSOMA	10	1.8	--	--
RAINBOW SMELT	--	--	--	--
CENTRAL STONEROLLER	--	--	--	--
GOLDFISH	6	1.1	1	0.2
COMMON CARP	235	42.5	40	6.6
CARP/GOLDFISH	--	--	1	0.2
GOLDEN SHINER	1	0.2	1	0.2
EMERALD SHINER	8	1.4	92	15.1
EMERALD SHINER type	22	4.0	22	3.6
STRIPED SHINER	--	--	--	--
STRIPED SHINER type	--	--	--	--
BIGMOUTH SHINER	--	--	--	--
SPOTTAIL SHINER	6	1.1	5	0.8
SPOTTAIL SHINER type	16	2.9	26	4.3
SPOTFIN SHINER	--	--	1	0.2
SAND SHINER	1	0.2	--	--
BLUNTNOSE MINNOW	31	5.6	11	1.8
FATHEAD MINNOW	--	--	--	--
UNID PIMEPHALES	13	2.4	10	1.6
UNID CYPRINID	4	0.7	4	0.7
UNID CARPIODES	6	1.1	--	--
WHITE SUCKER	1	0.2	--	--
WHITE SUCKER/N. HOG SUCKER	1	0.2	--	--
NORTHERN HOG SUCKER	--	--	--	--
UNID MOXOSTOMA	19	3.4	2	0.3
UNID CATOSTOMINAE	3	0.5	1	0.2
UNID ICTIOBINAE	17	3.1	3	0.5
YELLOW BULLHEAD	--	--	--	--
CHANNEL CATFISH	--	--	--	--
TADPOLE MADTOM	--	--	--	--
BLACKSTRIPE TOPMINNOW	--	--	1	0.2
MOSQUITOFISH	--	--	--	--
BROOK SILVERSIDE	--	--	--	--
THREESPINE STICKLEBACK	--	--	--	--
UNID MORONE	--	--	--	--
ROCK BASS	1	0.2	--	--
GREEN SUNFISH	--	--	--	--
BLUEGILL	--	--	6	1.0
LEPOMIS A	1	0.2	13	2.1
LEPOMIS B	--	--	--	--
LEPOMIS C	3	0.5	--	--
LEPOMIS D	--	--	--	--
UNID LEPOMIS	78	14.1	201	33.0
SMALLMOUTH BASS	--	--	--	--
LARGEMOUTH BASS	--	--	--	--
UNID MICROPTERUS	--	--	--	--
BLACK CRAPPIE	--	--	1	0.2
UNID POMOXIS	--	--	--	--
UNID CENTRARCHID	--	--	--	--
JOHNNY DARTER	--	--	--	--
RAINBOW/ORANGETHROAT DARTER	--	--	--	--
UNID ETHEOSTOMA	--	--	1	0.2
YELLOW PERCH	--	--	--	--
LOGPERCH	--	--	--	--
UNID PERCINA	--	--	--	--
UNID PERCID	--	--	--	--
FRESHWATER DRUM	1	0.2	--	--
UNIDENTIFIED	3	0.5	--	--
TOTAL FISH	553	100.0	610	100.0

NOTE: 0.0 DENOTES VALUES <0.05.

UPPER ILLINOIS WATERWAY - COMMONWEALTH EDISON COMPANY
1994 ICHTHYOPLANKTON STUDY - ANNUAL LARVAL/JUVENILE CATCH BY GEAR

	GEAR: DIPNET	GRID	NOVEGLT	PHYVEG	PUMP	SEINE	STNET	TOW	VEGLT	COMBINED	
	#	#	#	#	#	#	#	#	#	#	%
SPECIES											
LONGNOSE GAR	1	.	1	.	.	.	.	.	.	2	0.01
UNID CLUPEIDAE	1	2	73	.	5	35	.	105	45	266	1.22
UNID ALOSA	.	.	1	.	1	36	.	141	.	179	0.82
GIZZARD SHAD	7	7	3156	.	174	1436	.	37	158	4975	22.83
UNID DOROSOMA	.	.	.	.	.	12	.	15	.	27	0.12
RAINBOW SMELT	.	.	.	.	.	.	.	1	.	1	0.00
CENTRAL STONEROLLER	2	.	.	.	.	1	.	.	.	3	0.01
GOLDFISH	.	12	5	1	20	8	.	16	19	81	0.37
COMMON CARP	203	123	872	60	353	350	213	346	1237	3757	17.24
CARP/GOLDFISH	23	21	3	3	122	3	62	4	7	248	1.14
GOLDEN SHINER	4	.	6	.	.	21	.	.	.	31	0.14
EMERALD SHINER	34	.	21	.	1	145	.	.	.	201	0.92
EMERALD SHINER type	20	.	151	.	34	143	.	2	70	420	1.93
STRIPED SHINER	8	.	.	.	.	17	.	.	.	25	0.11
STRIPED SHINER type	.	.	1	.	.	.	.	.	.	1	0.00
BIGMOUTH SHINER	5	.	.	.	.	.	.	.	.	5	0.02
SPOTTAIL SHINER	16	.	22	.	1	125	.	.	12	176	0.81
SPOTTAIL SHINER type	6	19	122	.	8	107	.	5	5	272	1.25
SPOTFIN SHINER	.	.	.	.	.	6	.	.	.	6	0.03
SAND SHINER	2	.	3	.	.	28	.	1	.	34	0.16
BLUNTNOSE MINNOW	305	4	28	1	7	2549	9	2	18	2923	13.42
FATHEAD MINNOW	34	.	4	.	1	47	.	.	3	89	0.41
UNID PIMEPHALES	349	43	79	1	75	355	35	17	68	1022	4.69
UNID CYPRINID	46	19	58	.	24	144	14	13	6	324	1.49
UNID CARPIODES	.	.	.	.	1	6	.	.	.	7	0.03
WHITE SUCKER	194	.	.	.	.	42	.	.	.	236	1.08
WHITE SUCKER/N. HOG SUCKER	115	.	30	.	.	126	.	.	.	271	1.24
NORTHERN HOG SUCKER	.	.	.	.	.	5	.	.	.	5	0.02
UNID MOXOSTOMA	182	.	43	.	1	86	.	.	.	312	1.43
UNID CATOSTOMINAE	61	.	18	.	.	17	.	.	.	96	0.44
UNID ICTIOBINAE	.	.	3	.	.	13	.	5	8	29	0.13
YELLOW BULLHEAD	1	.	.	.	.	.	.	.	.	1	0.00
CHANNEL CATFISH	.	1	.	.	.	.	1	9	.	11	0.05
TADPOLE MADTOM	1	.	.	.	1	.	.	.	.	2	0.01
BLACKSTRIPE TOPMINNOW	.	.	1	.	.	5	.	.	.	6	0.03
MOSQUITOFISH	9	.	1	.	.	2	.	.	.	12	0.06
BROOK SILVERSIDE	.	.	.	.	.	1	.	.	.	1	0.00
THREESPINE STICKLEBACK	.	.	.	.	.	.	.	1	.	1	0.00
UNID MORONE	.	.	1	.	.	.	.	4	1	6	0.03
ROCK BASS	.	.	.	.	.	1	.	.	.	1	0.00
GREEN SUNFISH	1	.	.	.	.	.	.	.	.	1	0.00
BLUEGILL	2	.	.	.	1	13	.	.	1	17	0.08
LEPOMIS A	.	.	8	.	.	122	.	.	7	137	0.63
LEPOMIS B	.	.	.	.	.	7	.	.	.	7	0.03
LEPOMIS C	.	.	2	.	.	12	.	.	2	16	0.07
LEPOMIS D	.	.	.	.	.	4	.	.	.	4	0.02
UNID LEPOMIS	.	12	498	.	26	4931	.	.	19	5486	25.18
SMALLMOUTH BASS	.	.	.	.	.	1	.	.	.	1	0.00
LARGEMOUTH BASS	3	.	.	.	1	4	.	.	.	8	0.04
UNID MICROPTERUS	.	.	.	.	4	.	.	.	.	4	0.02
BLACK CRAPPIE	.	.	.	.	.	1	.	.	.	1	0.00
UNID POMOXIS	.	.	4	.	.	.	.	.	.	4	0.02
UNID CENTRARCHID	1	.	.	.	.	.	.	.	.	1	0.00
JOHNNY DARTER	.	2	.	.	.	4	.	.	.	6	0.03
RAINBOW/ORANGETHROAT DARTER	2	.	.	.	.	.	.	.	.	2	0.01
UNID ETHEOSTOMA	.	1	1	.	.	.	.	.	.	2	0.01
YELLOW PERCH	.	.	.	.	.	.	.	2	.	2	0.01
LOGPERCH	.	.	.	.	.	1	.	.	.	1	0.00
UNID PERCINA	.	.	.	.	.	2	.	.	.	2	0.01
UNID PERCID	.	.	.	.	1	1	.	.	.	2	0.01
FRESHWATER DRUM	.	1	.	.	.	1	.	1	.	3	0.01
UNIDENTIFIED	.	1	1	.	5	8	2	.	.	17	0.08
TOTAL FISH	1638	268	5217	66	867	10984	336	727	1686	21789	100.0

NOTE: NOVEGLT=NONVEGETATIVE LIGHT TRAP; PHYVEG=PHYSICAL EXAMINATION OF VEGETATION; STNET=STATIONARY NET; VEGLT=VEGETATIVE LIGHT TRAP.
0.00 DENOTES VALUES <0.005.

UPPER ILLINOIS WATERWAY - COMMONWEALTH EDISON COMPANY
1994 ICHTHYOPLANKTON STUDY - ANNUAL LARVAL/JUVENILE CATCH BY SEGMENT AND TRIP

SEGMENT: LOCKPORT POOL

SPECIES	25 APR #	25 APR %	1 MAY #	1 MAY %	8 MAY #	8 MAY %	15 MAY #	15 MAY %	22 MAY #	22 MAY %	30 MAY #	30 MAY %	6 JUN #	6 JUN %
UNID CLUPEIDAE	--	--	--	--	--	--	--	--	--	--	1	0.4	12	1.3
UNID ALOSA	--	--	--	--	--	--	--	--	--	--	--	--	--	--
GIZZARD SHAD	--	--	--	--	--	--	--	--	--	--	--	--	20	2.1
UNID DOROSOMA	--	--	--	--	--	--	--	--	--	--	--	--	--	--
RAINBOW SMELT	--	--	--	--	1	100.0	--	--	--	--	--	--	--	--
GOLDFISH	--	--	--	--	--	--	1	100.0	3	0.8	6	2.4	36	3.8
COMMON CARP	1	100.0	1	100.0	--	--	--	--	339	95.0	222	90.2	737	76.9
CARP/GOLDFISH	--	--	--	--	--	--	--	--	15	4.2	1	0.4	112	11.7
GOLDEN SHINER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
EMERALD SHINER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
EMERALD SHINER type	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SPOTTAIL SHINER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SPOTTAIL SHINER type	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BLUNTNOSE MINNOW	--	--	--	--	--	--	--	--	--	--	--	--	--	--
FATHEAD MINNOW	--	--	--	--	--	--	--	--	--	--	--	--	--	--
UNID PIMEPHALES	--	--	--	--	--	--	--	--	--	--	13	5.3	31	3.2
UNID CYPRINID	--	--	--	--	--	--	--	--	--	--	2	0.8	8	0.8
MOSQUITOFISH	--	--	--	--	--	--	--	--	--	--	--	--	--	--
THREESPINE STICKLEBACK	--	--	--	--	--	--	--	--	--	--	--	--	--	--
UNID MORONE	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BLUEGILL	--	--	--	--	--	--	--	--	--	--	--	--	--	--
LEPOMIS B	--	--	--	--	--	--	--	--	--	--	--	--	--	--
UNID LEPOMIS	--	--	--	--	--	--	--	--	--	--	--	--	--	--
UNID CENTRARCHID	--	--	--	--	--	--	--	--	--	--	--	--	--	--
YELLOW PERCH	--	--	--	--	--	--	--	--	--	--	--	--	2	0.2
FRESHWATER DRUM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
UNIDENTIFIED	--	--	--	--	--	--	--	--	--	--	1	0.4	--	--
TOTAL FISH	1	100.0	1	100.0	1	100.0	1	100.0	357	100.0	246	100.0	958	100.0

SPECIES	13 JUN #	13 JUN %	20 JUN #	20 JUN %	26 JUN #	26 JUN %	9 JUL #	9 JUL %	24 JUL #	24 JUL %	7 AUG #	7 AUG %	22 AUG #	22 AUG %
UNID CLUPEIDAE	17	6.9	48	12.5	36	15.2	--	--	--	--	2	9.1	2	8.3
UNID ALOSA	--	--	1	0.3	117	49.4	25	18.7	5	20.8	9	40.9	17	70.8
GIZZARD SHAD	6	2.4	13	3.4	2	0.8	10	7.5	--	--	--	--	--	--
UNID DOROSOMA	--	--	15	3.9	--	--	--	--	--	--	--	--	--	--
RAINBOW SMELT	--	--	--	--	--	--	--	--	--	--	--	--	--	--
GOLDFISH	12	4.9	1	0.3	2	0.8	--	--	--	--	--	--	--	--
COMMON CARP	127	51.8	100	26.1	12	5.1	44	32.8	8	33.3	2	9.1	--	--
CARP/GOLDFISH	--	--	13	3.4	4	1.7	--	--	1	4.2	--	--	--	--
GOLDEN SHINER	1	0.4	4	1.0	4	1.7	2	1.5	1	4.2	--	--	--	--
EMERALD SHINER	--	--	1	0.3	--	--	33	24.6	--	--	--	--	--	--
EMERALD SHINER type	--	--	15	3.9	7	3.0	1	0.7	1	4.2	--	--	--	--
SPOTTAIL SHINER	--	--	--	--	2	0.8	--	--	--	--	--	--	--	--
SPOTTAIL SHINER type	1	0.4	1	0.3	--	--	6	4.5	--	--	1	4.5	1	4.2
BLUNTNOSE MINNOW	--	--	--	--	3	1.3	--	--	--	--	--	--	--	--
FATHEAD MINNOW	--	--	51	13.3	33	13.9	--	--	--	--	--	--	--	--
UNID PIMEPHALES	76	31.0	60	15.7	2	0.8	8	6.0	3	12.5	2	9.1	2	8.3
UNID CYPRINID	1	0.4	14	3.7	10	4.2	1	0.7	1	4.2	1	4.5	1	4.2
MOSQUITOFISH	1	0.4	1	0.3	1	0.4	--	--	2	8.3	4	18.2	1	4.2
THREESPINE STICKLEBACK	--	--	--	--	--	--	--	--	--	--	1	4.5	--	--
UNID MORONE	2	0.8	--	--	--	--	1	0.7	--	--	--	--	--	--
BLUEGILL	--	--	--	--	1	0.4	--	--	--	--	--	--	--	--
LEPOMIS B	--	--	7	1.8	--	--	--	--	--	--	--	--	--	--
UNID LEPOMIS	1	0.4	37	9.7	--	--	2	1.5	1	4.2	--	--	--	--
UNID CENTRARCHID	--	--	--	--	1	0.4	--	--	--	--	--	--	--	--
YELLOW PERCH	--	--	--	--	--	--	--	--	--	--	--	--	--	--
FRESHWATER DRUM	--	--	1	0.3	--	--	1	0.7	--	--	--	--	--	--
UNIDENTIFIED	--	--	--	--	--	--	--	--	1	4.2	--	--	--	--
TOTAL FISH	245	100.0	383	100.0	237	100.0	134	100.0	24	100.0	22	100.0	24	100.0

SEGMENT: BRANDON POOL

	1 MAY		8 MAY		15 MAY		22 MAY		30 MAY		6 JUN		13 JUN	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%
SPECIES														
UNID CLUPEIDAE	--	--	--	--	--	--	--	--	--	--	--	--	--	--
UNID ALOSA	--	--	--	--	--	--	--	--	--	--	--	--	--	--
GIZZARD SHAD	--	--	--	--	--	--	--	--	--	--	1	0.3	3	0.9
GOLDFISH	--	--	--	--	--	--	1	0.2	4	1.6	--	--	--	--
COMMON CARP	1	25.0	23	10.7	144	52.7	294	64.1	156	60.7	79	20.6	105	32.3
CARP/GOLDFISH	3	75.0	--	--	43	15.8	19	4.1	--	--	1	0.3	--	--
GOLDEN SHINER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
EMERALD SHINER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
EMERALD SHINER type	--	--	--	--	--	--	--	--	--	--	--	--	2	0.6
SPOTFIN SHINER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BLUNTNOSE MINNOW	--	--	--	--	--	--	--	--	1	0.4	294	76.6	214	65.8
UNID PIMEPHALES	--	--	--	--	11	4.0	23	5.0	88	34.2	6	1.6	1	0.3
UNID CYPRINID	--	--	--	--	5	1.8	106	23.1	--	--	1	0.3	--	--
WHITE SUCKER	--	--	187	87.0	12	4.4	3	0.7	8	3.1	2	0.5	--	--
UNID MOXOSTOMA	--	--	1	0.5	40	14.7	11	2.4	--	--	--	--	--	--
UNID CATOSTOMINAE	--	--	4	1.9	18	6.6	--	--	--	--	--	--	--	--
CHANNEL CATFISH	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BLACKSTRIPE TOPMINNOW	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MOSQUITOFISH	--	--	--	--	--	--	--	--	--	--	--	--	--	--
UNID MORONE	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BLUEGILL	--	--	--	--	--	--	--	--	--	--	--	--	--	--
UNID LEPOMIS	--	--	--	--	--	--	--	--	--	--	--	--	--	--
UNIDENTIFIED	--	--	--	--	--	--	2	0.4	--	--	--	--	--	--
TOTAL FISH	4	100.0	215	100.0	273	100.0	459	100.0	257	100.0	384	100.0	325	100.0

	20 JUN		26 JUN		9 JUL		24 JUL		7 AUG		22 AUG	
	#	%	#	%	#	%	#	%	#	%	#	%
SPECIES												
UNID CLUPEIDAE	1	0.3	--	--	--	--	--	--	--	--	--	--
UNID ALOSA	--	--	--	--	1	0.7	--	--	--	--	--	--
GIZZARD SHAD	71	24.7	3	2.9	30	21.0	2	2.0	--	--	--	--
GOLDFISH	--	--	--	--	--	--	1	1.0	--	--	--	--
COMMON CARP	10	3.5	10	9.5	10	7.0	--	--	--	--	--	--
CARP/GOLDFISH	--	--	--	--	--	--	--	--	--	--	--	--
GOLDEN SHINER	--	--	--	--	--	--	--	--	--	--	2	8.7
EMERALD SHINER	--	--	--	--	--	--	1	1.0	--	--	--	--
EMERALD SHINER type	1	0.3	1	1.0	--	--	--	--	--	--	--	--
SPOTFIN SHINER	--	--	--	--	--	--	--	--	--	--	5	21.7
BLUNTNOSE MINNOW	172	59.9	80	76.2	--	--	94	93.1	105	80.2	7	30.4
UNID PIMEPHALES	22	7.7	10	9.5	101	70.6	--	--	12	9.2	1	4.3
UNID CYPRINID	4	1.4	--	--	--	--	--	--	12	9.2	--	--
WHITE SUCKER	--	--	--	--	--	--	--	--	--	--	--	--
UNID MOXOSTOMA	5	1.7	--	--	--	--	--	--	--	--	--	--
UNID CATOSTOMINAE	--	--	--	--	--	--	--	--	--	--	--	--
CHANNEL CATFISH	--	--	--	--	--	--	1	1.0	--	--	--	--
BLACKSTRIPE TOPMINNOW	--	--	--	--	1	0.7	2	2.0	--	--	--	--
MOSQUITOFISH	--	--	--	--	--	--	--	--	2	1.5	--	--
UNID MORONE	1	0.3	1	1.0	--	--	--	--	--	--	--	--
BLUEGILL	--	--	--	--	--	--	--	--	--	--	7	30.4
UNID LEPOMIS	--	--	--	--	--	--	--	--	--	--	1	4.3
UNIDENTIFIED	--	--	--	--	--	--	--	--	--	--	--	--
TOTAL FISH	287	100.0	105	100.0	143	100.0	101	100.0	131	100.0	23	100.0

UPPER ILLINOIS WATERWAY - COMMONWEALTH EDISON COMPANY
1994 ICHTHYOPLANKTON STUDY - ANNUAL LARVAL/JUVENILE CATCH BY SEGMENT AND TRIP

SEGMENT: UPPER DRESDEN POOL

	25 APR		1 MAY		8 MAY		15 MAY		22 MAY		30 MAY		6 JUN	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%
SPECIES														
LONGNOSE GAR	--	--	--	--	--	--	--	--	--	--	1	0.0	1	0.1
UNID CLUPEIDAE	--	--	--	--	--	--	--	--	42	0.7	--	--	--	--
UNID ALOSA	--	--	--	--	--	--	--	--	--	--	--	--	--	--
GIZZARD SHAD	--	--	--	--	--	--	13	2.1	3239	52.3	600	14.5	51	4.9
UNID DOROSOMA	--	--	--	--	--	--	--	--	--	--	--	--	10	1.0
CENTRAL STONEROLLER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
GOLDFISH	--	--	--	--	--	--	1	0.2	2	0.0	--	--	7	0.7
COMMON CARP	10	38.5	16	15.1	4	1.6	294	47.9	572	9.2	178	4.3	108	10.4
CARP/GOLDFISH	--	--	--	--	--	--	1	0.2	7	0.1	13	0.3	2	0.2
GOLDEN SHINER	--	--	--	--	--	--	--	--	1	0.0	4	0.1	--	--
EMERALD SHINER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
EMERALD SHINER type	--	--	--	--	--	--	--	--	20	0.3	8	0.2	5	0.5
STRIPED SHINER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
STRIPED SHINER type	--	--	--	--	--	--	1	0.2	--	--	--	--	--	--
BIGMOUTH SHINER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SPOTTAIL SHINER	--	--	--	--	--	--	--	--	27	0.4	44	1.1	4	0.4
SPOTTAIL SHINER type	1	3.8	49	46.2	9	3.6	49	8.0	147	2.4	4	0.1	2	0.2
SPOTFIN SHINER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SAND SHINER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BLUNTNOSE MINNOW	--	--	--	--	--	--	--	--	1	0.0	442	10.7	149	14.3
FATHEAD MINNOW	--	--	--	--	--	--	--	--	--	--	--	--	--	--
UNID PIMEPHALES	--	--	--	--	6	2.4	4	0.7	184	3.0	193	4.7	50	4.8
UNID CYPRINID	7	26.9	18	17.0	56	22.4	11	1.8	18	0.3	7	0.2	2	0.2
UNID CARPIODES	6	23.1	--	--	--	--	--	--	--	--	--	--	--	--
WHITE SUCKER	--	--	--	--	--	--	--	--	20	0.3	1	0.0	--	--
WHITE SUCKER/N. HOG SUCKER	--	--	19	17.9	105	42.0	34	5.5	113	1.8	--	--	--	--
NORTHERN HOG SUCKER	--	--	--	--	4	1.6	--	--	--	--	--	--	--	--
UNID MOXOSTOMA	--	--	--	--	30	12.0	159	25.9	65	1.0	--	--	1	0.1
UNID CATOSTOMINAE	--	--	--	--	33	13.2	38	6.2	3	0.0	--	--	--	--
UNID ICTIOBINAE	--	--	1	0.9	1	0.4	4	0.7	8	0.1	3	0.1	2	0.2
YELLOW BULLHEAD	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CHANNEL CATFISH	--	--	--	--	--	--	--	--	--	--	--	--	--	--
TADPOLE MADTOM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BLACKSTRIPE TOPMINNOW	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BROOK SILVERSIDE	--	--	--	--	--	--	--	--	--	--	--	--	--	--
UNID MORONE	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ROCK BASS	--	--	--	--	--	--	--	--	--	--	--	--	--	--
GREEN SUNFISH	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BLUEGILL	--	--	--	--	--	--	--	--	--	--	--	--	--	--
LEPOMIS A	--	--	--	--	--	--	--	--	--	--	--	--	108	10.4
LEPOMIS C	--	--	--	--	--	--	--	--	--	--	--	--	7	0.7
LEPOMIS D	--	--	--	--	--	--	--	--	--	--	--	--	4	0.4
UNID LEPOMIS	--	--	--	--	--	--	--	--	1712	27.6	2644	63.8	523	50.3
SMALLMOUTH BASS	--	--	--	--	--	--	--	--	--	--	--	--	--	--
LARGEMOUTH BASS	--	--	--	--	--	--	1	0.2	1	0.0	--	--	--	--
UNID MICROPTERUS	--	--	--	--	--	--	4	0.7	--	--	--	--	--	--
BLACK CRAPPIE	--	--	--	--	--	--	--	--	--	--	--	--	--	--
UNID POMOXIS	--	--	--	--	--	--	--	--	4	0.1	--	--	--	--
JOHNNY DARTER	--	--	--	--	--	--	--	--	3	0.0	--	--	--	--
RAINBOW/ORANGETHROAT DARTER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
UNID ETHEOSTOMA	--	--	--	--	1	0.4	--	--	1	0.0	--	--	--	--
LOGPERCH	--	--	--	--	1	0.4	--	--	--	--	--	--	--	--
UNID PERCINA	1	3.8	--	--	--	--	--	--	1	0.0	--	--	--	--
UNID PERCID	--	--	--	--	--	--	--	--	1	0.0	1	0.0	--	--
FRESHWATER DRUM	--	--	--	--	--	--	--	--	1	0.0	--	--	--	--
UNIDENTIFIED	1	3.8	3	2.8	--	--	--	--	1	0.0	3	0.1	3	0.3
TOTAL FISH	26	100.0	106	100.0	250	100.0	614	100.0	6194	100.0	4146	100.0	1039	100.0

UPPER ILLINOIS WATERWAY - COMMONWEALTH EDISON COMPANY
1994 ICHTHYOPLANKTON STUDY - ANNUAL LARVAL/JUVENILE CATCH BY SEGMENT AND TRIP

SEGMENT: UPPER DRESDEN POOL (cont.)

	13 JUN		20 JUN		26 JUN		9 JUL		24 JUL		7 AUG		22 AUG	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%
SPECIES														
LONGNOSE GAR	--	--	--	--	--	--	--	--	--	--	--	--	--	--
UNID CLUPEIDAE	--	--	101	6.6	4	1.2	--	--	--	--	--	--	--	--
UNID ALOSA	--	--	--	--	1	0.3	--	--	--	--	3	5.4	--	--
GIZZARD SHAD	188	11.6	588	38.2	45	13.8	81	23.7	8	5.4	1	1.8	--	--
UNID DOROSOMA	--	--	2	0.1	--	--	--	--	--	--	--	--	--	--
CENTRAL STONEROLLER	--	--	2	0.1	1	0.3	--	--	--	--	--	--	--	--
GOLDFISH	--	--	4	0.3	--	--	--	--	--	--	--	--	--	--
COMMON CARP	17	1.0	118	7.7	6	1.8	7	2.0	2	1.4	--	--	--	--
CARP/GOLDFISH	2	0.1	10	0.7	--	--	--	--	1	0.7	--	--	--	--
GOLDEN SHINER	6	0.4	2	0.1	2	0.6	--	--	2	1.4	--	--	--	--
EMERALD SHINER	1	0.1	26	1.7	4	1.2	89	26.0	44	29.9	1	1.8	1	2.6
EMERALD SHINER type	15	0.9	225	14.6	77	23.5	10	2.9	32	21.8	--	--	--	--
STRIPED SHINER	4	0.2	9	0.6	2	0.6	8	2.3	1	0.7	1	1.8	--	--
STRIPED SHINER type	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BIGMOUTH SHINER	5	0.3	--	--	--	--	--	--	--	--	--	--	--	--
SPOTTAIL SHINER	58	3.6	15	1.0	16	4.9	5	1.5	1	0.7	1	1.8	3	7.7
SPOTTAIL SHINER type	1	0.1	--	--	--	--	--	--	--	--	--	--	--	--
SPOTFIN SHINER	--	--	--	--	--	--	--	--	--	--	--	--	1	2.6
SAND SHINER	26	1.6	1	0.1	4	1.2	--	--	3	2.0	--	--	--	--
BLUNTNOSE MINNOW	1091	67.2	114	7.4	60	18.3	33	9.6	6	4.1	28	50.0	29	74.4
FATHEAD MINNOW	3	0.2	1	0.1	1	0.3	--	--	--	--	--	--	--	--
UNID PIMEPHALES	25	1.5	48	3.1	10	3.1	8	2.3	14	9.5	7	12.5	1	2.6
UNID CYPRINID	12	0.7	14	0.9	9	2.8	1	0.3	2	1.4	--	--	--	--
UNID CARPIODES	--	--	1	0.1	--	--	--	--	--	--	--	--	--	--
WHITE SUCKER	3	0.2	--	--	--	--	--	--	--	--	--	--	--	--
WHITE SUCKER/N. HOG SUCKER	--	--	--	--	--	--	--	--	--	--	--	--	--	--
NORTHERN HOG SUCKER	1	0.1	--	--	--	--	--	--	--	--	--	--	--	--
UNID MOXOSTOMA	--	--	--	--	--	--	--	--	--	--	--	--	--	--
UNID CATOSTOMINAE	--	--	--	--	--	--	--	--	--	--	--	--	--	--
UNID ICTIOBINAE	1	0.1	9	0.6	--	--	--	--	--	--	--	--	--	--
YELLOW BULLHEAD	--	--	--	--	--	--	--	--	--	--	1	1.8	--	--
CHANNEL CATFISH	--	--	7	0.5	--	--	2	0.6	--	--	1	1.8	--	--
TADPOLE MADTOM	--	--	1	0.1	--	--	--	--	--	--	1	1.8	--	--
BLACKSTRIPE TOPMINNOW	--	--	--	--	--	--	1	0.3	--	--	--	--	2	5.1
BROOK SILVERSIDE	1	0.1	--	--	--	--	--	--	--	--	--	--	--	--
UNID MORONE	--	--	--	--	--	--	1	0.3	--	--	--	--	--	--
ROCK BASS	1	0.1	--	--	--	--	--	--	--	--	--	--	--	--
GREEN SUNFISH	1	0.1	--	--	--	--	--	--	--	--	--	--	--	--
BLUEGILL	--	--	2	0.1	2	0.6	--	--	--	--	3	5.4	2	5.1
LEPOMIS A	6	0.4	15	1.0	8	2.4	--	--	--	--	--	--	--	--
LEPOMIS C	--	--	4	0.3	5	1.5	--	--	--	--	--	--	--	--
LEPOMIS D	--	--	--	--	--	--	--	--	--	--	--	--	--	--
UNID LEPOMIS	149	9.2	216	14.0	68	20.8	95	27.8	31	21.1	6	10.7	--	--
SMALLMOUTH BASS	1	0.1	--	--	--	--	--	--	--	--	--	--	--	--
LARGEMOUTH BASS	3	0.2	2	0.1	1	0.3	--	--	--	--	--	--	--	--
UNID MICROPTERUS	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BLACK CRAPPIE	--	--	--	--	--	--	--	--	--	--	1	1.8	--	--
UNID POMOXIS	--	--	--	--	--	--	--	--	--	--	--	--	--	--
JOHNNY DARTER	2	0.1	--	--	--	--	1	0.3	--	--	--	--	--	--
RAINBOW/ORANGETHROAT DARTER	1	0.1	--	--	--	--	--	--	--	--	1	1.8	--	--
UNID ETHEOSTOMA	--	--	--	--	--	--	--	--	--	--	--	--	--	--
LOGPERCH	--	--	--	--	--	--	--	--	--	--	--	--	--	--
UNID PERCINA	--	--	--	--	--	--	--	--	--	--	--	--	--	--
UNID PERCID	--	--	--	--	--	--	--	--	--	--	--	--	--	--
FRESHWATER DRUM	--	--	--	--	--	--	--	--	--	--	--	--	--	--
UNIDENTIFIED	--	--	1	0.1	1	0.3	--	--	--	--	--	--	--	--
TOTAL FISH	1624	100.0	1538	100.0	327	100.0	342	100.0	147	100.0	56	100.0	39	100.0

NOTE: 0.0 DENOTES VALUES <0.05.

APPENDIX D

TEMPERATURE AND DISSOLVED OXYGEN VALUES

Upper Illinois Waterway Ichthyoplankton Study -- 1994

SUMMARY OF TEMPERATURE AND DISSOLVED OXYGEN BY LOCATION AND TRIP

	TRIP																	
	5 APR			25 APR			1 MAY			8 MAY			15 MAY			22 MAY		
	TEMPERATURE (°C)			TEMPERATURE (°C)			TEMPERATURE (°C)			TEMPERATURE (°C)			TEMPERATURE (°C)			TEMPERATURE (°C)		
SAMPLING LOCATION	MEAN	MIN	MAX	MEAN	MIN	MAX	MEAN	MIN	MAX	MEAN	MIN	MAX	MEAN	MIN	MAX	MEAN	MIN	MAX
104	12.8	12.5	13.0	19.5	18.8	19.9	13.9	13.0	14.2	17.5	17.0	18.3	17.7	16.5	19.5	-	-	-
105	12.3	12.2	12.4	19.6	19.4	19.9	13.4	12.8	14.6	17.5	16.2	18.8	17.6	16.0	19.0	-	-	-
202	11.6	11.4	11.8	19.5	16.9	21.1	13.4	13.0	13.7	21.0	17.5	23.5	18.4	16.9	20.5	-	-	-
207	11.2	10.6	11.5	17.4	17.0	18.0	14.8	14.5	15.3	17.9	16.7	20.0	18.1	17.8	18.8	-	-	-
301	11.1	11.0	11.2	16.7	16.5	16.8	14.0	14.0	14.1	16.6	16.2	17.0	18.4	18.2	18.9	-	-	-
302A	12.9	12.8	13.0	18.9	18.5	19.2	16.8	16.4	17.0	18.7	18.4	19.0	19.7	19.2	21.2	-	-	-
304	6.4	6.4	6.4	23.0	23.0	23.0	15.0	15.0	15.0	18.5	18.5	18.5	19.9	19.9	19.9	-	-	-
309	11.2	11.2	11.2	18.9	18.9	18.9	14.8	14.8	14.8	17.9	17.8	18.0	19.1	18.5	21.1	-	-	-
402-1	11.5	11.5	11.5	16.9	16.9	16.9	16.3	15.4	17.0	18.6	17.5	19.5	20.9	19.0	22.0	18.0	18.0	18.0
402-2	11.8	11.8	11.8	19.2	19.2	19.2	16.5	16.0	17.0	18.7	17.5	19.9	20.2	19.4	20.9	20.2	20.2	20.2
402-3	-	-	-	-	-	-	-	-	-	20.0	20.0	20.0	20.9	20.9	20.9	-	-	-
402A	11.8	11.4	12.2	18.1	17.6	18.5	16.7	16.2	17.0	18.9	18.8	19.0	20.4	20.2	20.5	21.1	21.1	21.1
402B	17.6	17.6	17.6	20.2	20.2	20.2	17.0	16.5	18.3	19.9	17.9	21.6	24.7	22.8	26.2	25.8	25.8	25.8
405	11.5	11.5	11.5	22.0	22.0	22.0	17.7	16.6	19.1	21.4	20.3	23.5	25.1	24.0	26.1	24.7	24.0	26.3
407	14.2	14.2	14.2	22.3	20.9	23.2	18.0	17.8	18.3	21.9	21.6	22.2	25.0	24.2	25.7	25.1	24.8	25.2
408	14.8	14.8	14.8	22.8	22.5	22.9	18.6	17.7	19.5	22.1	21.0	23.0	26.0	25.0	26.8	25.2	24.3	26.0
409	12.1	11.3	12.9	19.3	19.3	19.3	18.2	17.7	19.8	18.6	18.5	18.8	21.5	20.1	22.9	-	-	-
414	8.3	8.3	8.3	17.8	17.8	17.8	19.0	18.1	20.5	18.2	18.0	18.7	20.3	19.2	21.9	-	-	-

(CONTINUED)

SUMMARY OF TEMPERATURE AND DISSOLVED OXYGEN BY LOCATION AND TRIP

	TRIP																	
	30 MAY			6 JUN			13 JUN			20 JUN			26 JUN			9 JUL		
	TEMPERATURE (°C)			TEMPERATURE (°C)			TEMPERATURE (°C)			TEMPERATURE (°C)			TEMPERATURE (°C)			TEMPERATURE (°C)		
SAMPLING LOCATION	MEAN	MIN	MAX	MEAN	MIN	MAX	MEAN	MIN	MAX	MEAN	MIN	MAX	MEAN	MIN	MAX	MEAN	MIN	MAX
104	22.2	21.0	24.0	20.8	20.6	20.8	23.4	23.0	24.2	25.3	25.0	25.5	19.8	19.8	19.8	22.6	22.5	22.6
105	22.2	21.0	23.0	20.3	20.0	20.8	23.5	22.5	25.0	24.3	24.0	24.9	20.0	19.9	20.1	23.1	22.6	23.5
202	25.7	20.9	27.7	20.4	19.2	24.9	22.1	21.0	24.0	25.4	24.0	28.0	19.9	19.9	19.9	22.4	22.0	22.6
207	21.3	20.6	22.0	21.0	19.9	21.9	22.2	21.5	22.7	25.0	24.5	25.5	21.5	21.0	21.8	23.1	22.8	23.5
301	24.2	21.4	25.8	21.1	21.0	21.2	23.0	22.9	23.0	25.0	24.9	25.1	21.8	21.7	22.0	23.7	23.7	23.8
302A	23.1	22.0	25.1	20.8	18.0	22.3	25.8	25.5	25.9	26.9	26.5	27.5	24.6	24.0	25.0	26.0	25.7	26.3
304	21.0	21.0	21.0	19.1	17.6	19.8	29.0	28.9	29.1	29.4	27.5	30.0	25.0	24.0	25.4	27.6	27.1	28.1
309	22.5	22.0	22.9	20.7	20.3	21.2	25.0	25.0	25.1	26.3	26.0	26.5	24.1	24.0	24.1	25.2	25.2	25.3
402-1	23.9	22.4	25.0	23.1	22.5	23.5	27.1	26.7	27.5	22.6	22.5	23.3	24.9	24.0	26.5	26.3	25.8	26.6
402-2	23.5	22.9	24.3	22.8	22.0	23.5	27.1	26.9	27.3	22.8	22.5	23.0	24.8	24.2	25.2	26.6	25.6	27.3
402-3	23.5	23.5	23.5	23.8	23.8	23.8	26.2	26.2	26.2	25.0	25.0	25.0	24.1	24.1	24.1	25.7	25.7	25.7
402A	23.6	23.0	24.0	23.1	22.0	23.5	27.0	27.0	27.2	23.0	22.3	23.5	25.0	24.8	25.2	26.5	25.9	26.8
402B	27.3	25.6	29.8	24.8	24.0	26.0	29.1	27.5	39.0	23.4	22.5	27.0	27.6	26.0	31.1	28.0	26.3	30.5
405	25.4	24.6	27.6	25.8	25.0	27.1	28.9	28.0	29.5	22.7	21.2	24.0	27.1	26.0	30.1	27.4	24.7	29.9
407	25.0	24.7	26.0	25.7	25.0	26.5	29.6	29.0	30.0	24.0	23.9	24.3	25.6	25.0	26.1	28.0	27.8	28.3
408	26.1	25.0	27.3	26.6	25.2	28.0	29.9	29.5	30.0	24.1	23.8	24.9	26.8	25.0	29.9	27.7	26.2	29.9
409	24.9	24.3	25.9	24.5	23.0	26.8	29.0	28.6	30.8	27.1	26.2	28.3	24.2	23.1	25.0	27.6	26.8	29.9
414	23.4	22.8	25.5	24.8	24.3	26.3	31.3	31.0	32.0	25.5	24.0	27.0	24.0	23.5	24.8	29.0	28.8	29.3

(CONTINUED)

SUMMARY OF TEMPERATURE AND DISSOLVED OXYGEN BY LOCATION AND TRIP

	TRIP								
	24 JUL			7 AUG			22 AUG		
	TEMPERATURE (°C)			TEMPERATURE (°C)			TEMPERATURE (°C)		
	MEAN	MIN	MAX	MEAN	MIN	MAX	MEAN	MIN	MAX
SAMPLING LOCATION									
104	23.2	22.5	23.8	21.8	20.5	23.2	24.0	23.9	24.0
105	23.0	22.9	23.1	21.9	21.0	22.8	24.3	23.7	24.9
202	22.0	20.9	22.6	22.9	20.9	26.5	23.7	23.1	24.9
207	22.5	22.2	23.1	22.9	22.6	23.5	24.6	24.0	25.0
301	23.5	23.3	23.8	23.2	22.8	24.0	24.1	24.0	24.2
302A	25.5	25.0	26.0	23.5	22.8	24.5	26.6	26.0	27.0
304	26.3	25.8	27.0	24.0	22.9	25.2	27.3	27.0	27.8
309	24.3	24.1	24.5	23.5	23.5	23.6	26.1	26.1	26.1
402-1	24.0	23.9	24.2	22.6	22.3	22.8	27.5	26.9	27.8
402-2	24.4	23.9	24.8	23.0	23.0	23.0	26.3	26.0	27.0
402-3	24.2	24.2	24.2	24.2	24.2	24.2	27.8	27.8	27.8
402A	24.5	24.0	24.9	23.4	23.1	23.5	27.0	27.0	27.0
402B	25.2	24.0	27.8	23.8	23.2	25.0	31.1	29.0	32.8
405	25.5	25.0	26.3	25.1	25.0	25.2	29.6	29.0	30.9
407	25.9	25.1	26.5	25.1	24.6	25.5	29.6	29.0	30.0
408	26.2	25.5	26.8	25.0	24.9	25.1	29.6	29.0	30.1
409	25.7	25.0	26.7	25.4	25.0	26.1	29.6	29.0	30.9
414	25.7	25.3	25.9	23.6	23.0	23.8	28.5	28.0	29.3

SUMMARY OF TEMPERATURE AND DISSOLVED OXYGEN BY LOCATION AND TRIP

	TRIP																	
	5 APR			25 APR			1 MAY			8 MAY			15 MAY			22 MAY		
	DISSOLVED OXYGEN (ppm)			DISSOLVED OXYGEN (ppm)			DISSOLVED OXYGEN (ppm)			DISSOLVED OXYGEN (ppm)			DISSOLVED OXYGEN (ppm)			DISSOLVED OXYGEN (ppm)		
SAMPLING LOCATION	MEAN	MIN	MAX	MEAN	MIN	MAX	MEAN	MIN	MAX	MEAN	MIN	MAX	MEAN	MIN	MAX	MEAN	MIN	MAX
104	6.6	6.2	6.9	5.5	5.2	5.6	4.9	4.7	5.4	4.9	4.4	5.3	5.4	5.3	5.6	-	-	-
105	5.8	5.8	5.9	7.1	6.9	7.2	4.5	4.0	5.7	6.0	4.8	7.3	5.5	4.6	6.3	-	-	-
202	6.1	5.9	6.3	4.0	3.6	4.8	3.8	2.6	4.5	4.2	3.2	5.0	4.6	3.9	5.6	-	-	-
207	7.2	6.5	8.2	6.0	5.8	6.2	5.4	4.7	6.7	5.7	4.9	6.2	5.6	5.2	5.9	-	-	-
301	5.3	5.2	5.4	4.9	4.8	5.0	5.5	5.5	5.5	4.3	4.0	4.6	5.1	4.9	5.2	-	-	-
302A	5.8	5.5	6.2	5.7	5.4	6.1	6.6	5.8	9.2	5.3	4.4	8.1	5.7	3.4	10.1	-	-	-
304	17.3	17.3	17.3	16.6	16.6	16.6	11.4	11.4	11.4	12.2	12.2	12.2	14.8	14.8	14.8	-	-	-
309	6.3	6.3	6.3	6.0	6.0	6.0	5.8	5.8	5.8	5.8	5.6	6.8	5.8	5.0	10.0	-	-	-
402-1	11.1	11.0	11.1	8.7	8.7	8.7	9.1	7.4	10.4	11.5	11.0	11.9	12.8	9.1	15.1	6.5	6.5	6.5
402-2	11.9	11.9	11.9	8.8	8.8	8.8	8.5	8.0	9.2	10.6	10.2	11.0	9.4	7.9	10.9	6.3	6.3	6.3
402-3	-	-	-	-	-	-	-	-	-	11.5	11.5	11.5	12.4	12.4	12.4	-	-	-
402A	11.0	10.3	11.9	7.8	7.3	8.2	9.0	6.8	10.1	7.4	7.0	7.5	10.0	9.4	10.2	6.8	6.8	6.8
402B	12.0	12.0	12.0	10.2	10.2	10.2	8.8	8.6	9.3	7.7	7.2	8.1	10.7	9.5	12.2	6.5	6.5	6.5
405	16.0	16.0	16.0	12.8	12.8	12.8	10.4	7.7	14.8	8.0	6.1	12.2	14.1	9.6	17.5	9.7	7.3	13.4
407	11.2	11.2	11.2	8.7	7.9	8.9	7.9	7.9	8.0	6.1	5.8	6.3	11.2	9.4	13.1	7.8	7.4	8.2
408	15.9	15.9	15.9	10.4	8.8	11.2	11.6	9.7	13.5	9.3	8.7	10.1	18.4	18.2	18.6	11.4	9.4	11.8
409	11.8	10.9	12.7	10.6	10.6	10.6	8.1	7.7	9.2	9.4	9.3	9.5	11.6	10.9	12.8	-	-	-
414	12.6	12.6	12.6	9.1	9.1	9.1	18.9	11.4	30.2	18.3	16.0	19.0	10.7	10.4	11.1	-	-	-

(CONTINUED)

SUMMARY OF TEMPERATURE AND DISSOLVED OXYGEN BY LOCATION AND TRIP

	TRIP																	
	30 MAY			6 JUN			13 JUN			20 JUN			26 JUN			9 JUL		
	DISSOLVED OXYGEN (ppm)			DISSOLVED OXYGEN (ppm)			DISSOLVED OXYGEN (ppm)			DISSOLVED OXYGEN (ppm)			DISSOLVED OXYGEN (ppm)			DISSOLVED OXYGEN (ppm)		
SAMPLING LOCATION	MEAN	MIN	MAX	MEAN	MIN	MAX	MEAN	MIN	MAX	MEAN	MIN	MAX	MEAN	MIN	MAX	MEAN	MIN	MAX
104	6.1	5.9	6.3	6.3	5.2	7.2	6.5	6.1	6.8	6.1	5.7	6.5	6.2	5.7	6.7	5.9	5.9	6.0
105	5.4	2.8	6.3	6.5	5.8	6.8	6.6	6.5	6.8	5.9	5.3	6.7	5.4	4.8	6.0	5.6	4.4	6.5
202	5.5	4.1	6.4	6.3	5.9	6.9	6.2	5.9	6.5	5.8	5.3	6.5	6.6	6.0	7.2	5.3	4.5	6.0
207	5.8	4.7	6.5	6.0	5.2	7.8	6.2	6.1	6.7	5.4	4.3	7.9	5.9	5.6	6.4	5.8	4.8	6.0
301	3.2	3.0	3.3	4.5	3.7	4.9	3.9	3.7	4.0	4.5	4.3	4.7	4.9	4.7	4.9	4.1	4.0	4.2
302A	3.9	2.3	6.1	7.1	5.3	9.7	4.8	3.7	6.7	5.5	4.2	7.2	5.2	4.6	6.5	6.0	4.5	7.2
304	6.9	6.2	8.9	11.2	10.1	11.8	6.9	5.4	12.2	9.8	7.9	10.4	6.4	6.1	6.7	13.6	11.9	14.1
309	3.1	2.8	4.1	4.6	4.3	4.8	3.9	3.8	4.0	4.0	3.8	4.3	4.8	4.6	5.0	5.5	5.2	5.9
402-1	7.4	5.6	8.7	7.0	6.9	7.1	6.3	6.0	6.5	6.6	6.1	6.9	7.2	6.4	8.1	7.6	6.7	8.2
402-2	7.2	6.5	8.1	7.1	6.9	7.3	6.2	6.0	6.5	6.8	6.6	6.9	7.2	6.6	7.6	7.5	6.8	8.0
402-3	8.9	8.9	8.9	5.5	5.5	5.5	7.2	7.2	7.2	6.4	6.4	6.4	7.6	7.6	7.6	7.7	7.7	7.7
402A	6.9	6.7	7.0	6.9	6.5	7.8	5.7	5.3	6.4	5.7	5.6	6.2	7.5	6.9	7.8	8.7	6.8	9.9
402B	6.8	6.0	8.1	7.9	7.6	8.2	5.8	5.6	5.9	6.4	6.0	6.6	7.3	6.8	8.9	7.1	6.3	8.8
405	9.3	7.3	14.2	10.2	8.9	12.2	6.0	5.4	6.8	6.7	5.9	7.6	8.7	6.9	13.5	7.2	6.3	8.6
407	7.6	7.5	7.8	8.3	7.8	9.5	5.8	5.4	6.4	6.6	6.5	6.7	7.4	7.1	7.7	6.7	6.5	6.8
408	9.4	8.6	10.4	12.1	11.0	13.1	6.8	5.1	7.3	5.3	4.0	6.2	8.8	7.9	10.2	8.2	6.5	10.6
409	6.8	5.8	10.0	9.8	7.8	15.2	6.3	5.8	6.5	5.7	5.4	6.0	6.9	6.4	7.6	10.9	7.9	13.4
414	9.0	8.2	10.6	11.5	11.2	12.5	7.1	5.4	9.8	6.7	6.3	7.5	7.7	7.2	8.4	12.5	12.0	12.8

(CONTINUED)

SUMMARY OF TEMPERATURE AND DISSOLVED OXYGEN BY LOCATION AND TRIP

	TRIP								
	24 JUL			7 AUG			22 AUG		
	DISSOLVED OXYGEN (ppm)			DISSOLVED OXYGEN (ppm)			DISSOLVED OXYGEN (ppm)		
SAMPLING LOCATION	MEAN	MIN	MAX	MEAN	MIN	MAX	MEAN	MIN	MAX
104	5.7	4.2	7.3	7.0	6.7	7.3	5.8	5.5	6.1
105	6.0	3.7	7.8	7.0	6.4	7.5	6.6	6.2	7.4
202	7.4	6.7	7.7	6.7	6.3	7.1	6.2	5.8	6.9
207	6.4	6.2	6.6	6.1	5.5	7.9	5.4	4.9	7.6
301	4.9	4.8	5.0	4.4	4.0	4.5	4.3	3.8	4.4
302A	5.3	4.3	6.7	5.4	4.8	6.6	5.2	4.5	7.6
304	5.5	5.3	5.7	14.8	11.4	18.3	13.1	6.7	15.0
309	5.6	5.6	5.6	4.2	4.1	4.4	5.1	5.1	5.1
402-1	7.7	6.8	8.3	7.1	6.7	7.5	10.3	7.7	11.8
402-2	7.2	6.8	7.5	6.9	6.6	7.1	6.6	6.5	7.4
402-3	7.5	7.5	7.5	7.2	7.2	7.2	8.5	8.5	8.5
402A	7.8	7.5	7.9	6.6	6.2	7.2	5.2	4.6	5.6
402B	7.6	7.4	8.0	6.9	6.7	7.1	5.9	4.8	6.7
405	8.5	6.1	13.2	6.9	6.4	7.5	6.5	5.8	7.7
407	7.1	6.7	7.5	6.2	6.2	6.4	6.4	5.2	6.9
408	8.0	6.6	9.5	6.3	5.7	7.0	8.6	6.8	10.8
409	9.0	6.5	12.2	6.8	6.5	6.9	9.4	6.9	15.5
414	8.5	7.8	8.9	11.9	11.9	12.0	16.6	15.2	17.6

APPENDIX E

RAW DATA LISTING

Upper Illinois Waterway Ichthyoplankton Study -- 1994

The enclosed computer disks (on inside of back cover) contain the raw data listing. One disk contains RAWDATA.PRN which is in ASCII (DOS) format. It is formatted to be printed from DOS in "condensed mode": 132 characters per line and 8 lines per inch. The other disk contains RAWDATA.DOC which is in WordPerfect 5.1 (for DOS) format. It is formatted to be printed from WordPerfect 5.1 to a Hewlett Packard LaserJet III (font=line printer 16.67; left/right margins=0.29", 0.25"; top/bottom margins=0.25"). Exhibit E-1 presents an example of the format and types of data included in the raw data listing. Units are not provided for duration and volume - duration is in minutes and volume is in cubic meters.

EXHIBIT E-1

SITE: LOCKPORT POOL LOCATION: 302A GEAR: PHYSICAL VEGETATION MESOHABITAT: MAIN CHANNEL BORDER
START DATETIME: 08JUN94:11:40 END DATETIME: 08JUN94:11:50 DURATION: 10
DEPTH/REPLICATE: VOLUME: . TEMP (C): 22.1 DO (mg/l): 7.3

SPECIES	LIFE STAGE	PLUS COUNT
COMMON CARP	YOLKSAC	1
CARP/GOLDFISH	EGG	1
UNIDENTIFIED	EGG	78

SITE: LOCKPORT POOL LOCATION: 302A GEAR: VEGETATIVE LIGHT TRAP MESOHABITAT: MAIN CHANNEL BORDER
START DATETIME: 08JUN94:20:34 END DATETIME: 08JUN94:22:00 DURATION: 86
DEPTH/REPLICATE: A VOLUME: . TEMP (C): 18.0 DO (mg/l): 9.7

SITE: LOCKPORT POOL LOCATION: 302A GEAR: VEGETATIVE LIGHT TRAP MESOHABITAT: MAIN CHANNEL BORDER
START DATETIME: 08JUN94:20:35 END DATETIME: 08JUN94:21:40 DURATION: 65
DEPTH/REPLICATE: B VOLUME: . TEMP (C): 18.0 DO (mg/l): 9.7

SITE: LOCKPORT POOL LOCATION: 302A GEAR: VEGETATIVE LIGHT TRAP MESOHABITAT: MAIN CHANNEL BORDER
START DATETIME: 08JUN94:20:29 END DATETIME: 08JUN94:21:34 DURATION: 65
DEPTH/REPLICATE: C VOLUME: . TEMP (C): 18.0 DO (mg/l): 9.7

SPECIES	LIFE STAGE	PLUS COUNT
COMMON CARP	POST YOLKSAC	22
COMMON CARP	YOLKSAC	337
UNID PIMEPHALES	POST YOLKSAC	4

SITE: LOCKPORT POOL LOCATION: 302A GEAR: NONVEGETATIVE LIGHT TRAP MESOHABITAT: MAIN CHANNEL BORDER
START DATETIME: 08JUN94:20:29 END DATETIME: 08JUN94:21:25 DURATION: 56
DEPTH/REPLICATE: A VOLUME: . TEMP (C): 22.3 DO (mg/l): 5.3

SITE: LOCKPORT POOL LOCATION: 302A GEAR: NONVEGETATIVE LIGHT TRAP MESOHABITAT: MAIN CHANNEL BORDER
START DATETIME: 08JUN94:20:23 END DATETIME: 08JUN94:21:13 DURATION: 50
DEPTH/REPLICATE: B VOLUME: . TEMP (C): 22.3 DO (mg/l): 5.3

SITE: LOCKPORT POOL LOCATION: 302A GEAR: NONVEGETATIVE LIGHT TRAP MESOHABITAT: MAIN CHANNEL BORDER
START DATETIME: 08JUN94:20:22 END DATETIME: 08JUN94:21:05 DURATION: 43
DEPTH/REPLICATE: C VOLUME: . TEMP (C): 22.3 DO (mg/l): 5.3

SPECIES	LIFE STAGE	PLUS COUNT
COMMON CARP	YOLKSAC	7
COMMON CARP	POST YOLKSAC	1

SITE: BRANDON POOL LOCATION: 304 GEAR: PUMP MESOHABITAT: TRIBUTARY MOUTH
START DATETIME: 08JUN94:16:50 END DATETIME: 08JUN94:17:03 DURATION: 13
DEPTH/REPLICATE: VOLUME: . TEMP (C): 19.8 DO (mg/l): 11.8

SPECIES	LIFE STAGE	PLUS COUNT
NO FISH	.	0

SITE: BRANDON POOL LOCATION: 304 GEAR: GRID MESOHABITAT: TRIBUTARY MOUTH
START DATETIME: . END DATETIME: . DURATION: .
DEPTH/REPLICATE: VOLUME: . TEMP (C): . DO (mg/l): .

SPECIES	LIFE STAGE	PLUS COUNT
NO SAMPLE	.	.