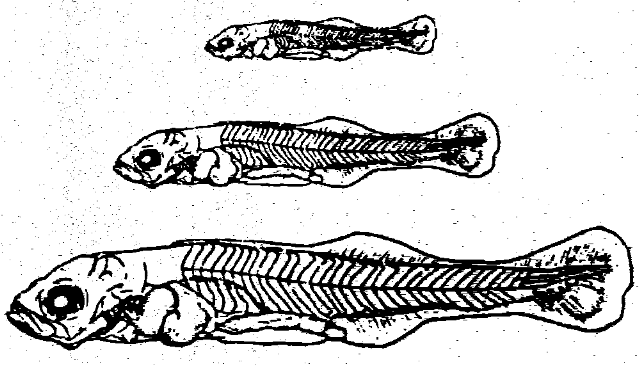

Progress Report: Lake Chautauqua Fish Production Study, 1998

Submitted to the Rock Island District, U.S. Army Corps of Engineers
December 1999

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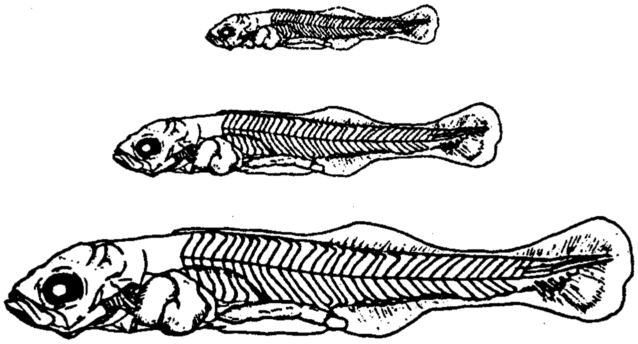
Center for Aquatic Ecology Technical Report # 99/17



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ABSTRACT

(See General Assessment)

Key words: Moist soil unit, larval fish, zooplankton, management, Lake Chautauqua, Wasenza Pool, floodplain lake

INTRODUCTION

Moist soil management units usually are manipulated to maximize benefits for migratory waterfowl. However, if prudently managed, it appears some of these same units may be used for production of larval fish (Irons et al. 1997, Stoeckel et al. 1999). Lake Chautauqua (a floodplain lake of the Illinois River) is currently divided into two pools: Kikunessa and Wasenza. Wasenza Pool is managed primarily as a moist soil unit for the benefit of waterfowl and shorebirds. This pool is typically flooded from fall to early summer and the sediments are compacted by annual dewatering in summer and fall. In 1996 and 1997, millions of fish, represented by up to 34 taxa, were produced and escaped from Wasenza Pool (Irons et al 1997, Stoeckel et al. 1999), demonstrating it may provide valuable spawning and nursery habitat for fishes.

In 1997, we began examining such factors as food availability and competition among species (Stoeckel et al. 1999), as well as documenting taxonomic diversity and numbers of fish produced and released in a given year. Previous studies from Midwestern reservoirs into which gizzard shad were stocked as forage for piscivores have shown that high densities of young-of-year (YOY) gizzard shad can severely deplete zooplankton resources to the point where YOY of later-spawning taxa such as centrarchids are severely limited by food availability ((Dettmers and Stein 1992, Dettmers and Stein 1996, Stein et al. 1995). Because the YOY fish community in Wasenza Pool is overwhelmingly dominated by clupeid (gizzard shad) larvae, we hypothesized that the same sort of clupeid-mediated bottleneck that had been documented in Midwestern reservoirs might occur in floodplain lakes of the Illinois River. In 1997, a low-water year during which the Chautauqua levees were overtopped for only a brief time during the study period, we found extremely high zooplankton production and little evidence for suppression of food resources by early-spawning gizzard shad (Stoeckel et al. 1999).

Although zooplankton production was high enough to withstand the predation pressure of clupeids in the low-water study season of 1997, we hypothesized that this may not be the case in high-water years (Stoeckel et al. 1999). Overtopping of levees by the river for long periods of time may have a detrimental effect on zooplankton due to the flushing out of the pool by zooplankton-poor, sediment-rich river water. On the other hand, flooding of the levees allows adult fish easy access to the backwater habitat, and thus may increase spawning success, resulting in higher initial abundances of larval fish. Over the years, moist-soil units such as Wasenza Pool are likely to exhibit a wide range in YOY fish/zooplankton interactions. At one extreme, extended flooding may allow for high initial fish production (and high zooplanktivory rates) while at the same time suppressing zooplankton production. Under this scenario, YOY fish would experience reduced growth and survivorship rates due to food limitation. At the other extreme, if levees are not overtopped and zooplankton production is high, limited access to the lake by adult fish may result in low spawning success. Under this scenario, fewer YOY fish would be produced, but they would presumably exhibit higher growth rates and higher survivorship due to increased food abundance. In 1996, the protocol of Irons et al. (1997) did not include zooplankton sampling, so we were not able to compare zooplankton production between high and low water regimes in 1997. However in 1998, Wasenza Pool levees were again overtopped during the majority of the sampling season and zooplankton were collected along with larval fish.

The 1998 Wasenza Pool fish production study was designed to continue and expand upon the work begun by Irons et al.(1997). Study goals were as follows:

1) Document the various fish taxa utilizing Wasenza Pool as spawning habitat, and the approximate timing of spawning for dominant taxa.

2) Estimate number of young-of-year (YOY) fish produced and released from Wasenza Pool in 1998.

3) Assess the food resources available to zooplanktivorous YOY fish by examining zooplankton abundance and community structure.

4) Determine whether zooplanktivory by YOY clupeids resulted in a food-limitation bottleneck for YOY centrarchids.

5) Determine the effect of various management strategies involving the filling and draining of Wasenza Pool, water level management, and vegetation control (i.e. emergent willow stands) on YOY fish production.

METHODS

Random Site Sampling

Sampling of water quality, and YOY fish was conducted at sites selected at random from a geographic information system (GIS) coverage of the pool. Sites were stratified by nearshore (within 50 m of shore) and offshore (greater than 50 m from shore) habitats. Random site sampling was conducted from April 21, 1998 - July 27, 1998.

Water Quality: We monitored temperature (°C), dissolved oxygen (mg/L), and nephelometric turbidity (NTU) twice a week, at five nearshore and five offshore random sites throughout the study. Temperature and DO (dissolved oxygen) were measured 0.25 m below the surface using either a YSI model 57 or 55 oxygen meter. Turbidity of water samples collected just below the surface was measured by means of a Hach turbidometer.

Larval Fish Sampling: We collected larval fish twice per week from Wasenza Pool using ichthyoplankton nets. We towed paired ichthyoplankton nets (500 m mesh) just under the surface for 10 min at five nearshore and five offshore random sites twice per week. In order to keep sampling regimes consistent with the 1997 data set we used the smaller, rectangular nets (12"X18" frame, 1.0 m long) as opposed to the larger, round nets (0.5 m diameter, 2.0 m long). used by Irons et al (1997). Upon collection, larval fish were anesthetized with alka-seltzer to prevent regurgitation of gut contents and immediately preserved using 10% buffered sugar formalin. To estimate the volume of water sampled we used General Oceanics digital flowmeters (Model 2030, General Oceanics, Inc., Miami, FL) mounted in the center of each net. The volume of water sampled by each net was calculated using the following formula:

$$\text{Volume } (m^3) = A*(2.687*r*0.01)$$

Where
A = area of net opening in m^2
2.687 = constant from flowmeter
r = number of revolutions from flowmeter
0.01 = conversion factor to m^3

The total number of fish caught in both nets (left and right) was divided by the total volume of water sampled by both nets to yield an estimate of the number of fish / m^3 sampled. In the laboratory, larval fish were viewed under 1x to 4x magnification and identified to family, genus, and species as practical using keys by Auer (1982), Hogue et al. (1976), and May and Gasaway (1967). Cross polarized lighting was used to count myomeres. Fish lengths (total length) were measured using a video imaging system and Optimas image analysis software.

Standing stock estimates were calculated from plankton tow samples. Total catch/volume sampled (fish/m^3) of larval fish for both shoreline and offshore habitats was multiplied by the estimated volume of the respective habitat type (shoreline and offshore). At a water surface elevation of 435 ft, volume of nearshore and offshore habitat were estimated to be 542,000 and 7,600,000 m^3 respectively (pers. comm., Jim Rogala, NBS-EMTC, data from GIS coverage). On each sampling date, volume of shoreline and offshore habitat was calculated by multiplying the depth of the water column above elevation 435 by the area of each habitat type (shoreline=$8.6X10^5$ m^2, offshore=$8.684X10^6$ m^2), and adding this volume to the baseline volume at elevation 435.

Fixed Site Sampling

Zooplankton Sampling: Zooplankton were collected once a week at three fixed sites (open water) by means of a hand-operated diaphragm pump. A 10 lb down rigger weight was hung 0.25 m below the bottom of the suction hose which was raised and lowered to sample the entire water column.. One 60- L sample was collected at each fixed-site location.. Water was pumped through 55- m mesh to retain zooplankton. Zooplankton were rinsed into a collection vial, anesthetized with alka-seltzer to reduce egg loss, and preserved with 10% buffered sugar formalin. Zooplankton were identified and enumerated using an imaging and analysis system and Optimus software. Copepods were identified as either cyclopoid or calanoid, but both taxa were lumped together for this report. Nauplius larvae were not divided into cyclopoid or calanoid taxa and are reported simply as nauplius larvae. Cladocerans and rotifers were identified to genus and species where possible using Hebert (1995), Pennak (1978), and Edmondson (1959). For each sample, 5-ml subsamples were examined until at least 100 individuals of the most common taxa had been enumerated or organisms in 60% of the sample had been counted. For cladocerans, total lengths and egg counts were obtained for at least 25 individuals of common taxa/sample. Biomass of cladocerans was estimated using the regressions of Culver et al (1985) and Dumont et al (1975) and Rosen (1981).

Escapement Sampling

The control structure at Wasenza Pool consists of four gates approximately 1.5 m wide (see Irons et al. 1997 for a complete description). We collected fish escaping from the Wasenza Pool via the south control structure on June 10-11 as water levels receded below levee height and water left the pool only through the south control structure. Samples were collected using a small mesh hoop net (standard LTRMP hoop net [1.2 m diameter] lined with 3-mm "Ace"-type nylon netting) and an ichthyoplankton net (500-µm mesh, described in Irons et al 1997). Nets were set in the effluent for 1 minute each. A total of 14 hoop and ichthyoplankton collections were conducted over the two day sampling period.

All fish collected by the ichthyoplankton net were identified and measured in the same manner as those collected at the random sites. Hoop net catches often contained larval fish that had been retained by the net but could obviously fit through the mesh. These numbers were documented, but not used in hoop net escapement summaries because we did not know how many fish in these small size-classes had gone through the hoop nets. Only those fish which were too large to easily fit through the 3 mm mesh were used for hoop net escapement estimates. Flow meters were used to determine the amount of water sampled by each net.

Escapement sampling was halted as water levels began to rise and water began to flow back into Wasenza Pool. On July 19, river height once again dropped below flood stage and water began exiting the pool only through the south control structure. We began discussing the resumption of escapement sampling the week of July20-24 as water levels once again began to fall and water exited only through the control structure. However, the rapid decline in water level resulted in a very narrow window of opportunity for sampling. During this time, large head differentials on either side of the control structure combined with scheduling conflicts due to the suddenness of the drop prevented us from obtaining escapement samples. Using methods described in Stoeckel et al. (1999), we estimated that approximately 30% of the pool volume drained during July 20 - 24. The drainage rate increased over the weekend, and nearly 100% of the pool had drained by July 28.

RESULTS

Habitat

Vegetation: Aquatic macrophytes were extremely rare or absent in Wasenza Pool in 1998. However, some sections of the pool were characterized by stands of emergent vegetation, primarily willows. Sites with emergent vegetation are referred to as vegetated sites in this report, while sites without emergent vegetation are referred to as open.

Depth: Water levels were much higher in 1998 as compared with 1997, exceeding flood stage for nearly the entire sampling period (Fig. 1). During this time, the control structure and much of the levee surrounding Wasenza pool were submerged. Average depth of shoreline and offshore sites was highest in late May and lowest in late July (Fig. 2). Significant differences in depth were found between shoreline and offshore sites during the duration of the study (paired T-test, $p<0.05$), with offshore sites being an average 1.3 m deeper than nearshore sites. Mean depth of nearshore sites was 1.6 m whereas mean depth of offshore sites was 2.9 m.

Water Quality: Water temperature increased from 13° C in mid April to near 30° C by early July (Fig. 3A). Dissolved oxygen (DO) measurements fluctuated between 6 and 18 mg/L during the study (Fig. 3B). Nephelometric turbidity ranged from 12 to 92 ntu during the course of the study (Fig. 3C).

Random Site Collections

Taxonomic diversity and habitat preference: In 1998, random site, plankton net tows collected YOY fish from nine families. Within these families, we were able to identify 11 genera, and seven species (Table 1). Ichthyoplankton tows indicated the larval fish community of Wasenza Pool was dominated by Clupeidae (96.56%) followed by Cyprinidae (1.28%), Percichthyidae (0.94%) and Centrarchidae (0.56%), Sciaenidae (0.37%), and Catostomidae (0.21%). Within these dominant taxa, no significant differences in abundance were found between vegetated and clear sites (Kruskal Wallis, $p>0.05$). No significant differences in abundance between nearshore and offshore sites (Kruskal Wallis, $p>0.05$) were found for any of the dominant taxa except for centrarchids which were more abundant ($\#/m^3$) at nearshore sites (Kruskal Wallis, $p<0.05$) (see Figs. 4-5).

Spawning and Growth: Standing stock and size-distribution data from random site collections (ichthyoplankton tows) suggest the following spawning patterns (see Figs. 6-7). Clupeids spawned from early May to mid-June with peak abundances occurring late May and early June. Mean length of general (unidentifiable beyond the family level) clupeid larvae increased from approximately 5 mm at time of first collection to approximately 15 mm by mid-June, and from ~5 mm to 10 mm from mid-June to late July. Clupeid larvae were identifiable to species at lengths >20 mm. Dorosoma cepedianum (gizzard shad) had reached an average length of 30 mm by the end of June. Catostomids spawned in late April through mid-May. No distinct patterns in average size were observed, probably due to the low numbers collected on most dates. Cyprinids likely spawned from late April to early July, with heaviest spawning occurring in mid May. Within the Cyprinids, Carassius carpio (common carp) spawned from late April to early June, and Notropis atherinoides (emerald shiner) spawned in June. Centrarchids spawned from early April through July with peak spawning occurring from mid June to early July. Sciaenids likely spawned from mid to late June and had reached an average size of ~ 8 mm befrore disappearing from the ichthyoplankton catch by mid June. Percichthyids spawned from late April through early June and had reached an average size of ~30 mm before disappearing from the ichthyoplankton tows in mid June.

Zooplankton production

Initially, total *Daphnia spp.* abundance in offshore, open sites followed nearly the same pattern as clupeid abundance with a small peak in early May followed by a larger peak in early June. However the largest peak in *Daphnia* abundance occurred following the clupeid decline from mid June through July (Fig. 8A). The early June peak in daphnid abundance was comprised almost entirely of native daphnids (primarily *D. mendotae* and *D. parvula*) whereas the mid-June through July peak was comprised primarily of the invasive species, *Daphnia lumholtzi* (Fig. 8B).

Bosmina longirostris began to increase dramatically during the period of peak clupeid abundance but then declined and never recovered (Fig. 9A). *Leptodora kindti* (a large, predatory cladoceran) reached peak abundances following the clupeid decline (Fig. 9B). Peak abundances of other cladocerans (primarily *Diaphanosoma*) occurred following the clupeid and *Leptodora* peaks (Fig. 9C).

Nauplius larvae and post-naupliar copepod abundances followed a pattern nearly identical to that of the clupeids with peak abundances occurring in early May, and late May to early June (Fig. 10A,B).

Rotifers were the most abundant of all the zooplankton taxa, reaching abundances well over 1000/L. Peak rotifer abundances occurred during and after the decline in clupeid abundance (Fig. 11 A).

Escapement Sampling

Escapement sampling yielded 195 fish captured by hoop nets, and 541 fish captured by ichthyoplankton nets (Table 1). The hoop net catch was dominated by the family Clupeidae (61.5%) followed by Sciaenidae (22.5%), Cyprinidae (14.3%), and Percichthyidae (1.5%). The ichthyoplankton net catch was dominated by the family Clupeidae (99.3%) followed by Cyprinidae (0.71%). Because escapement sampling was conducted only for two days (June 10 and 11) and was not conducted during the period of major drainage (for reasons discussed in the methods section) we did not analyze this data further. We did not feel that we could accurately assess escapement from Wasenza Pool in 1998.

DISCUSSION

Larval Fish Habitat Preferences: In 1997, a low water year, ichthyoplankton tow data indicated that clupeids were more abundant at open vs vegetated sites, while no differences in abundance was found for centrarchids, cyprinids, or catostomids. In 1998, a high water year, no differences in abundance were found for any of the dominant taxa. The lack of habitat preference between clear and vegetated sites by most of the dominant Wasenza pool taxa in 1997 and 1998 may have been due to the lack of plant diversity. Vegetated sites were dominated by emergent stands of willows. No beds of submersed aquatic macrophytes were observed in either year. In 1998, most of the willow stands were submerged by high water throughout much of the study. Emergent and/or aquatic plants seemed to play a minor role (if any) in larval fish abundance patterns in 1997 and 1998.

In 1996, Irons et al. (1997) found that plankton tow catches of larval fish were much higher in nearshore as opposed to offshore habitats, but suggested that this difference may be reduced in low water years. This hypothesis was supported by the 1997 data (Stoeckel et al. 1999). In 1997 (a low water year) ichthyoplankton tow data did not indicate a preference for shoreline or offshore habitat for any of the taxa collected. However, in 1998, only the centrarchid larvae (representing <1% of the total catch) occurred in significantly higher numbers at nearshore as opposed to offshore sites. The strong differences between shoreline and offshore catches in 1996, and the lack of differences in 1997 and 1998 cannot be easily explained by water level since (1) water levels in 1998 were as high as in 1996 (Fig. 12), (2) river level exceeded the flood stage, and overtopped the levees, for roughly the same amount of time during 1996 and 1998, and (3) stronger differences between nearshore and offshore depths occurred in 1996 and 1998 as opposed to 1997. However, there were differences between collection methods in 1996 as opposed to 1997 and 1998. In 1996, ichthyoplankton tows were conducted 0.50 m diameter ichthyoplankton nets towed for 1 minute at each site. In 1997 and 1998, we used smaller, rectangular nets (0.30m x 0.45m frame) towed for 10 minutes at each site. The longer tow time in 1997 and 1998 resulted in a greater volume of water being sampled at each site and, theoretically, would increase sampling accuracy. Although the differences in shoreline vs offshore catches seemed obvious in 1996, they were not statistically tested. The 1997 and 1998 data indicates that habitat heterogeneity in terms of nearshore vs offshore and clear vs vegetated sites did not occur to a strong enough degree in Wasenza Pool to significantly affect larval fish distribution of most taxa. For the most part, variation in larval fish abundance (#/L) was not related to proximity to shore or the presence/absence of vegetation (emergent willows).

Larval Fish Production: In 1998, as in 1997 and 1996, the family Clupeidae (represented primarily by gizzard shad and threadfin shad) overwhelmingly dominated random site catches. During all three years, clupeids represented 87-96% of the random-site, larval fish catch (Irons et al. 1997, Stoeckel et al. 1999) despite a wide range in water regimes (Fig. 1). In terms of numeric dominance, Wasenza Pool consistently produced more forage fish than sport fish such as centrarchids and white bass, or commercially harvested species such as buffalo and common carp.

However, although the relative proportions of clupeids vs other taxa did not vary strongly with year-to-year changes in water regime, total larval fish production did vary greatly. Stoeckel et al. (1999) hypothesized that sustained flood waters (overtopping the Wasenza Pool levees) may a strong effect on larval fish production. Overtopping of the levees by the river for long periods of time allows adult fish easy access to the backwater habitat, and thus may increase spawning success, resulting in higher initial abundances of larval fish. In 1996 and 1998 (high water years) larval fish standing stock estimates (all species combined) were clearly higher than those of 1997, peaking at ~600 to 700 million as opposed to ~200 million (Fig. 12). Not all taxa were affected in the same manner. Standing stock estimates of clupeids, percichthyids, and sciaenids were all much higher in 1998 than in 1997 (Fig. 13A,B,C). Standing stock estimates of catostomids, cyprinids, and centrarchids were only somewhat higher in 1998 as opposed to 1997 (Fig. 14A,B,C). Standing stock estimates of individual taxa were not calculated by Irons et al (1997), but are being calculated at this time.

Zooplankton/Clupeid Interactions: Previous studies in Midwestern reservoirs have shown that predation by gizzard shad larvae and early juveniles can result in depletion of zooplankton numbers (Stein et al 1995, DeVries et al. 1991, DeVries and Stein 1992) with strongest effects occurring in reservoirs with low zooplankton biomass and dominated by copepods rather than by cladocerans (Dettmers and Stein 1992). In 1998, the native *Daphnia* community crashed in mid-June, immediately following the peak in clupeid abundance (Fig. 8B), as did the bosminid population (Fig. 9A). Only the exotic cladoceran, *Daphnia lumholtzi*, attained high abundances after mid-June (Fig. 8B). The large spines produced by this species are thought to protect it from predation by larval fishes (source). Therefore, the large population of *D. lumholtzi* that developed after mid-June was probably not a valuable food resource for the larval fish community. All other cladocerans combined (primarily *Diaphanosoma*) never attained an average abundance >10/L (Fig. 9C). Copepods and their nauplius larvae also decreased dramatically following the peak in clupeid larval fish abundance, but copepods remained numerically dominant to the cladocerans throughout the entire study (Fig. 11B). *Daphnia* (native species), *Bosmina*, copepods, and nauplius larvae were all present in lower numbers in 1998 as opposed to 1997 (Figs. 15A,B and 16A,B). The low number of zooplankters in 1998 as compared with 1997, dominance of copepods over cladocerans, crash of most cladoceran and copepod taxa following the peak in larval clupeid abundance, and the dramatically higher number of clupeid larvae in 1998 all indicate that a clupeid mediated depression of food resources, similar to that observed in reservoirs, likely occurred in Wasenza Pool in 1998. Because peak centrarchid standing stock occurred immediately following the zooplankton crash, it is highly likely that survival and growth of YOY centrarchids was decreased due to food limitation in 1998.

General Assessment: In 1998, Wasenza Pool again provided excellent habitat for forage fish production with clupeids being the numerically dominant taxa produced. The 1998 data supports the hypothesis of increased fish production, but reduced food resources (zooplankton) in high water years when the levees are overtopped throughout much of the season. Overall standing stock of larval/early juvenile fishes was much greater in 1998 as compared to 1997. This increase in larval fish production was not reflected equally amongst all taxa. Larval/early juvenile fishes belonging to the families Clupeidae, Percichthyidae, and Sciaenidae all occurred in much higher numbers in 1998 than in 1997. Catostomids, cyprinids, and centrarchids occurred in equal or slightly higher numbers than in 1997. Zooplankton abundance showed the opposite trend with much lower abundances of cladocerans and copepods (all stages) observed in 1998 as opposed to 1997. Rotifers occurred in high numbers in 1998, but were not counted in 1997, so no direct comparisons of this taxa can be made between years. The low numbers of cladocerans and copepods, particularly after mid-June, indicate the possibility that larval fish growth and survivorship was limited by food availability in 1998. The reduced zooplankton abundances in 1998 were likely due to a combination of factors including:

1) increased predation pressure due to higher abundances (#/L) and standing stock of larval fishes (particularly clupeids).

2) flushing of Wasenza Pool by zooplankton poor, sediment rich river water during most of the study season.

The food-limitation bottleneck observed in reservoirs and mediated by high clupeid zooplanktivory rates is most likely to occur in high-water years if the trends of increased clupeid production and decreased zooplankton production hold true. This bottleneck will probably have a greater effect on later spawning taxa such as Centrarchidae than on earlier spawning taxa such as Percichthyidae.

Interestingly, the exotic cladoceran *Daphnia lumholtzi* followed the opposite trend of the native *Daphnia* and occurred in higher numbers during the high water year of 1998. Previous studies have indicated that *Daphnia lumholtzi* may be better adapted to riverine conditions and high levels of suspended solids (Stoeckel et al. 1996, Soeken 1998) than are native *Daphnia*. There has been some concern that *D. lumholtzi* may begin to replace native *Daphnia* due to the protection from predation afforded by it's large spines (Source). However recent work suggests that *D. lumholtzi* may in fact be filling a midsummer niche that is underutilized by native *Daphnia* (Work and Gophen 1999). Whatever the ultimate effect of this invasive species proves to be, it is likely to have its greatest impact on Wasenza Pool during high water years when the pool is inundated by flood waters through mid-summer.

Unlike the effect of sustained flood waters, habitat heterogeneity in Wasenza Pool (nearshore/offshore, vegetated/clear) did not seem to play a large role in larval fish abundance patterns in either high-water or low-water years with the possible exception of nearshore/offshore stratification in 1996. It is suggested that future studies of fish production in Wasenza Pool focus on the role of hydrological regimes in regulating fish/zooplankton interactions. The following questions should be addressed:

1) Does the observed pattern of higher fish production and lower zooplankton production in high-water as opposed to low-water years hold true? Although the present data provides support for this scenario, we only have complete data from one high-water and one low-water year.

2) How does the hydrologic regime affect movement of adult fish in and out of Wasenza Pool? It makes sense that overtopping of the levees results in increased access by adult fish, but this has yet to be tested.

3) Do larval fish actually exhibit lowered survivorship and growth rates in high-water years? This question could at least be partially answered by otolith studies.

4) If zooplankton production is consistently lower in high-water years, what are the relative roles of clupeid predation, suspended sediments, and advection (flushing) in this depression of zooplankton resources?

5) How does the hydrologic regime affect survivorship of YOY fish flushed from Wasenza Pool into the river system. When the levees are overtopped, YOY fish of many sizes may be continually flushed into the river system (which will contain more floodplain habitat due to flooding). During low-water years, YOY fish are held within the pool until it is drained in mid-summer. Presumably, these fish will be released at a larger size, but into a system with less floodplain habitat due to low water.

The management of Wasenza Pool as a moist-soil unit does not preclude it from being valuable spawning habitat for fish. Studies of fish production in Wasenza Pool from 1996-1998 indicate that hydrologic regime (degree and duration of connectivity to the river) has a huge effect on YOY fish production and possibly on YOY fish survivorship and growth. There are pros and cons associated with both ends of the hydrologic spectrum (isolation vs connection) that need to be considered when making management decisions with regards to optimal levee height, and timing of draining. This study suggests that neither total isolation nor unlimited connectivity to/from the main channel will result in optimal larval fish production and survival. It is hoped that future studies will encompass a hydrologic regime of initial inundation followed by isolation, so as to obtain data from the middle of the spectrum.

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Table 1. Number and percent of catch of various fish taxa collected by sampling regimes and gear types used in this study.

			Random Site Sampling		Escapement Sampling					
			icthyoplankton net		icthyoplankton net			hoop net		
						estimated escapement			estimated escapement	
Family	genus	species (common name)	#	%	#	#	%	#	#	%
Clupeidae										
	unknown		93,780	92.63	541			96		
	Dorosoma spp.		6	0.01	0	-	-	0	-	-
		cepedianum (gizzard shad)	3,938	3.89	51			23		
		petenense (threadfin shad)	1	0.00	0	-	-	0	-	-
	Alosa spp.		0	0.00	0	-	-	0	-	-
		chrysochloris (skipjack herring)	0	0.00	0	-	-	1		
	Total		97,725	96.52	592			120		
Catostomidae										
	unknown		211	0.21	0	-	-	0	-	-
	Moxostoma spp.		0	0.00	0	-	-	0	-	-
		erythrurum (golden redhorse)	0	0.00	0	-	-	0	-	-
		macrolepidotum (shorthd rdhrse)	0	0.00	0	-	-	0	-	-
	Carpoides spp.		0	0.00	0	-	-	0	-	-
		carpio (river carpsucker)	1	0.00	0	-	-	0	-	-
		cyprinus (quillback)	0	0.00	0	-	-	0	-	-
		velifer (highfin carpsucker)	0	0.00	0	-	-	0	-	-
	Ictiobus spp.		0	0.00	0	-	-	0	-	-
		bubalus (smallmouth buffalo)	0	0.00	0	-	-	0	-	-
		cyprinellus (bigmouth buffalo)	0	0.00	0	-	-	0	-	-
		niger (black buffalo)	0	0.00	0	-	-	0	-	-
	Total		212	0.21	0	-	-	0	-	-
Percichthyidae										
	unknown		955	0.94	0	-	-	0	-	-
	Morone spp.		0	0.00	0	-	-	0	-	-
		americana (white perch)	0	0.00	0	-	-	0	-	-
		chrysops (white bass)	0	0.00	0	-	-	3	-	-
		mississippiensis (yellow bass)	0	0.00	0	-	-	0	-	-
		stipeXwhite bass hybrid	0	0.00	0	-	-	0	-	-
	Total		989	0.98	0	-	-	3	-	-
Lepisosteidae										
	unknown		0	0.00	0	-	-	0	-	-
	Lepisosteus spp.		1	0.00	0	-	-	0	-	-
		oculatus (spotted gar)	0	0.00	0	-	-	0	-	-
		osseus (longnose gar)	0	0.00	0	-	-	0	-	-
		platostomus (shortnose gar)	0	0.00	0	-	-	0	-	-
	Total		1	0.00	0	-	-	0	-	-

Table 1. Cont.

Family	genus	species (common name)	Random Site Sampling		Escapement Sampling					
			icthyoplankton net		icthyoplankton net			hoop net		
						estimated escapement			estimated escapement	
			#	%	#	#	%	#	#	%
Centrarchidae										
	unknown		391	0.39	0	-	-	0	-	-
	Micropterus spp.		0	0.00	0	-	-	0	-	-
		salmoides (largemouth bass)	0	0.00	0	-	-	0	-	-
	Pomoxis spp.		67	0.07	0	-	-	0	-	-
		annularis (white crappie)	0	0.00	0	-	-	0	-	-
		nigromaculatus (black crappie)	0	0.00	0	-	-	0	-	-
	Lepomis spp.		105	0.10	0	-	-	0	-	-
		cyanellus (green sunfish)	0	0.00	0	-	-	0	-	-
		humilis (orange-spotted sunfish)	0	0.00	0	-	-	0	-	-
		machrochirus (bluegill)	0	0.00	0	-	-	0	-	-
		green sunfishXbluegill hybrid	0	0.00	0	-	-	0	-	-
	Total		563	0.56	0	-	-	0	-	-
Percidae										
	unknown		67	0.07	0	-	-	0	-	-
	Perca spp.		0	0.00	0	-	-	0	-	-
		flavescens (yellow perch)	0	0.00	0	-	-	0	-	-
	Stizostedion spp.		0	0.00	0	-	-	0	-	-
		canadense (sauger)	0	0.00	0	-	-	0	-	-
		vitreum (walleye)	0	0.00	0	-	-	0	-	-
	Percina spp.		0	0.00	0	-	-	0	-	-
		carpodes (logperch)	0	0.00	0	-	-	0	-	-
	various (darters)		0	0.00	0	-	-	0	-	-
	Total		67	0.07	0	-	-	0	-	-
Sciaenidae										
	unknown		371	0.37	0	-	-	0	-	-
	Applodinotus spp.		0	0.00	0	-	-	0	-	-
		grunniens (freshwater drum)	0	0.00	0	-	-	44		
	Total		371	0.37	0	-	-	44		
Atherinidae										
	unknown		2	0.67	0	-	-	0	-	-
	Labidesthes spp.		0	0	0	-	-	0	-	-
		sicculus (brook silverside)	1	0.33	0	-	-	0	-	-
	Total		3	0.00	0	-	-	0	-	-

Table 1. Cont.

			Random Site Sampling		Escapement Sampling					
			icthyoplankton net		icthyoplankton net			hoop net		
						estimated escapement			estimated escapement	
Family	genus	species (common name)	#	%	#	#	%	#	#	%
Cyprinidae										
	unknown		67	0.07	2			3		
	Notemigonus spp.		0	0.00	0	-	-	0	-	-
		crysoleucas (golden shiner)	1	0.00	0	-	-	0	-	-
	Notropis spp.		3	0.00	0	-	-	0	-	-
		atherinoides (emerald shiner)	157	0.16	2			24		
		blennius (river shiner)	0	0.00	0	-	-	0	-	-
		shumardi (silverband shiner)	0	0.00	0	-	-	0	-	-
	Cyprinella spp.		0	0.00	0	-	-	0	-	-
		lutrensis (red shiner)	0	0.00	0	-	-	0	-	-
	Lythrurus spp.		0	0.00	0	-	-	0	-	-
		umbratilis (redfin shiner)	0	0.00	0	-	-	0	-	-
	Campostoma spp.		0	0.00	0	-	-	0	-	-
		anomalum (stoneroller)	0	0.00	0	-	-	0	-	-
	Pimephales spp.		0	0.00	0	-	-	0	-	-
		vigilax (bullhead minnow)	0	0.00	0	-	-	0	-	-
	Carassius spp.		0	0.00	0	-	-	0	-	-
		auratus (goldfish)	0	0.00	0	-	-	0	-	-
		carpio (common carp)	1,066	1.05	0	-	-	1		
		carpXgoldfish hybrid	0	0.00	0	-	-	0	-	-
	Ctenopharyngodon spp.		0	0.00	0	-	-	0	-	-
		idella (grass carp)	1	0.00	0	-	-	0	-	-
	Hypopthalmichthys spp.		0	0.00	0	-	-	0	-	-
		molitrix (bighead carp)	0	0.00	0	-	-	0	-	-
	Total		1,295	1.28	4			28		

Hiodontidae										
	unknown		0	-	0	-	-	0	-	-
	Hiodon spp.		0	-	0	-	-	0	-	-
		alosoides (goldeye)	0	-	0	-	-	0	-	-
	Total		0	-	0	-	-	0	-	-

Table 1. Cont.

			Random Site Sampling		Escapement Sampling					
			icthyoplankton net		icthyoplankton net			hoop net		
						estimated escapement			estimated escapement	
Family	genus	species (common name)	#	%	#	#	%	#	#	%
Ictaluridae										
	unknown		0	-	0	-	-	0	-	-
	Ictalurus spp.		0	-	0	-	-	0	-	-
		punctatus (channel catfish)	0	-	0	-	-	0	-	-
	Ameiurus spp.		0	-	0	-	-	0	-	-
		catus (black bullhead)	0	-	0	-	-	0	-	-
		natalis (yellow bullhead)	0	-	0	-	-	0	-	-
		nebulosus (brown bullhead)	0	-	0	-	-	0	-	-
	Total		0	-	0	-	-	0	-	-
Amiidae										
	unknown		0	-	0	-	-	0	-	-
	Amia spp.		0	-	0	-	-	0	-	-
		calva (bowfin)	0	-	0	-	-	0	-	-
	Total		0	-	0	-	-	0	-	-
Esoscidae										
	unknown		0	-	0	-	-	0	-	-
	Esox spp.		0	-	0	-	-	0	-	-
		lucius (northern pike)	0	-	0	-	-	0	-	-
	Total		0	-	0	-	-	0	-	-
Unidentifiable			19	0.02	0	-	-	0	-	-
Combined Total			101,245	-	596		-	195		-

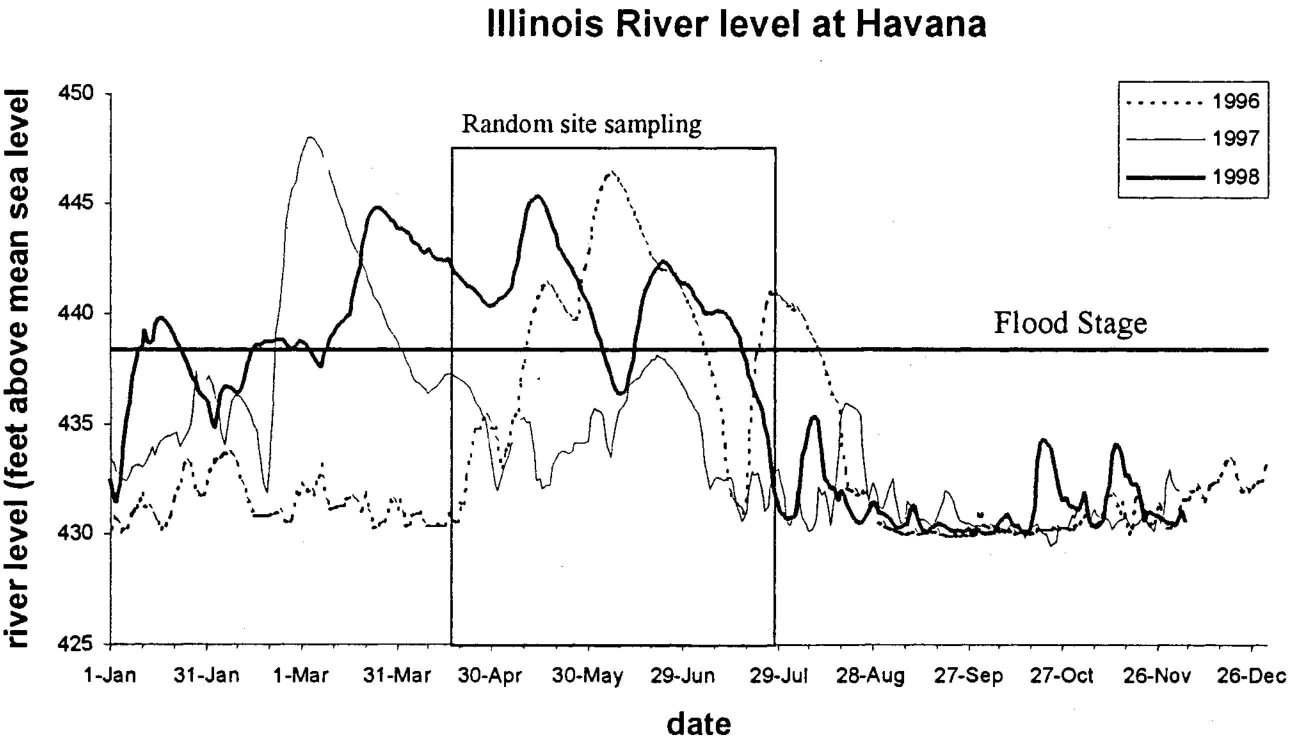


Figure 1. Illinois River levels at Havana, Illinois from 1996-1997. Sampling times shown are for sampling in 1998.

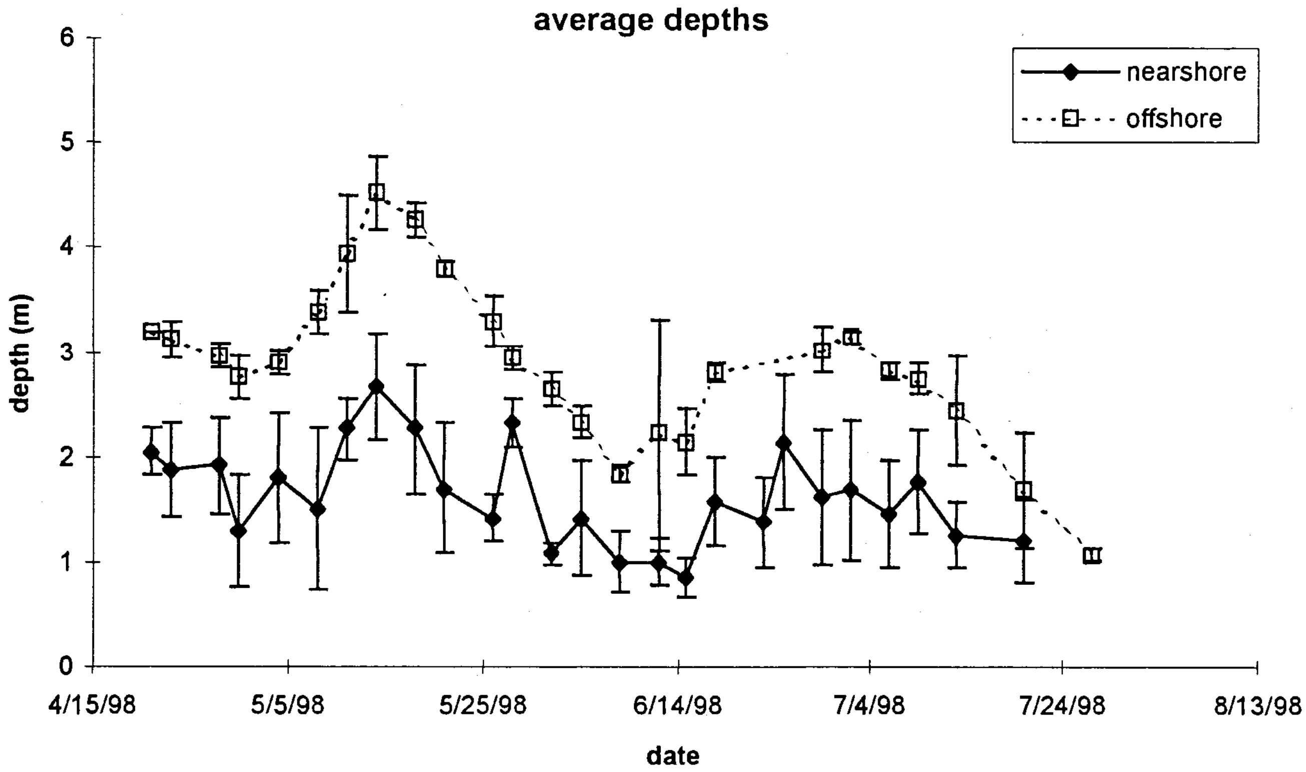


Figure 2. Mean depth of nearshore and offshore sampling sites for random site portion of the study

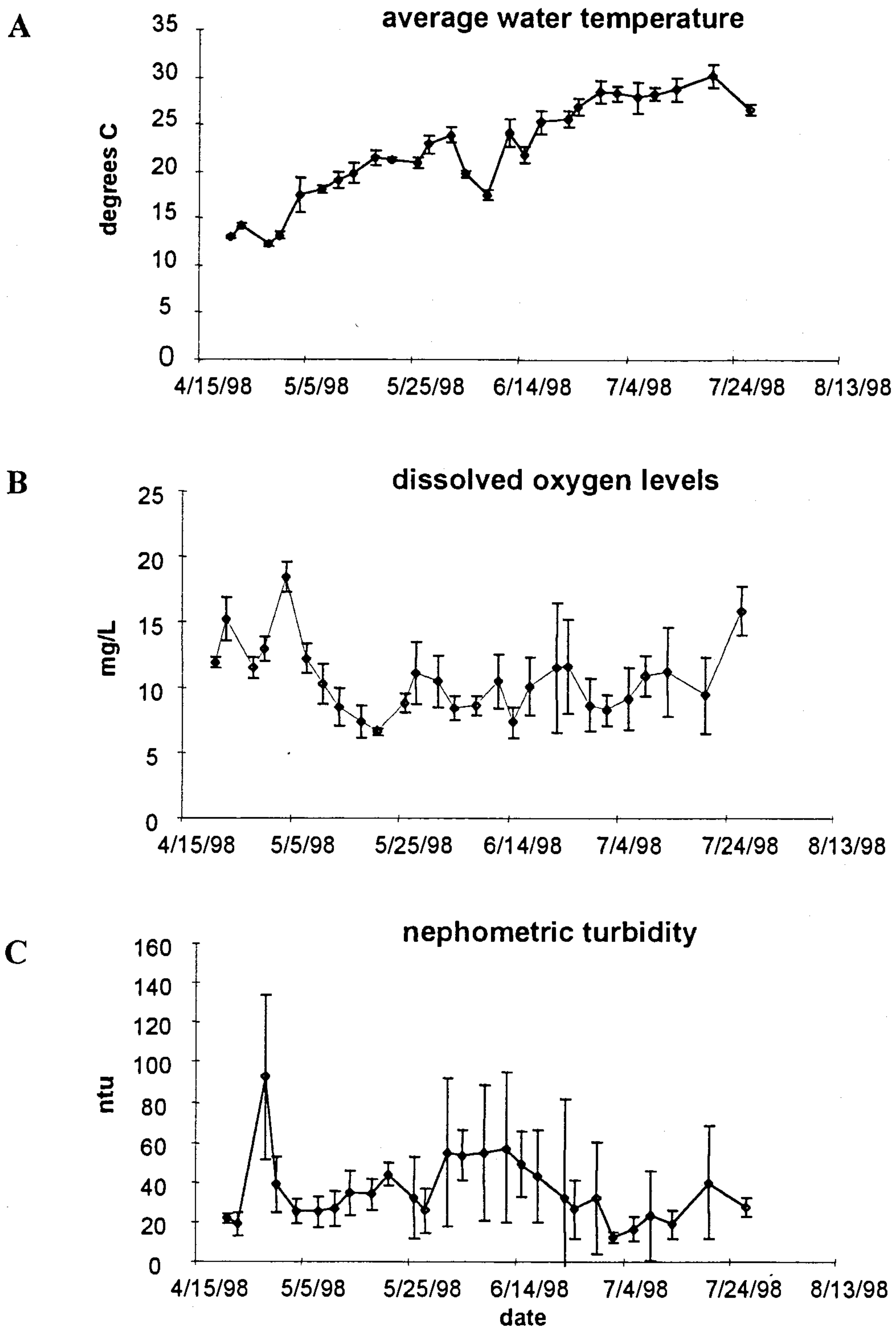


Figure 3. Water quality data from random site samples throughout the study season.

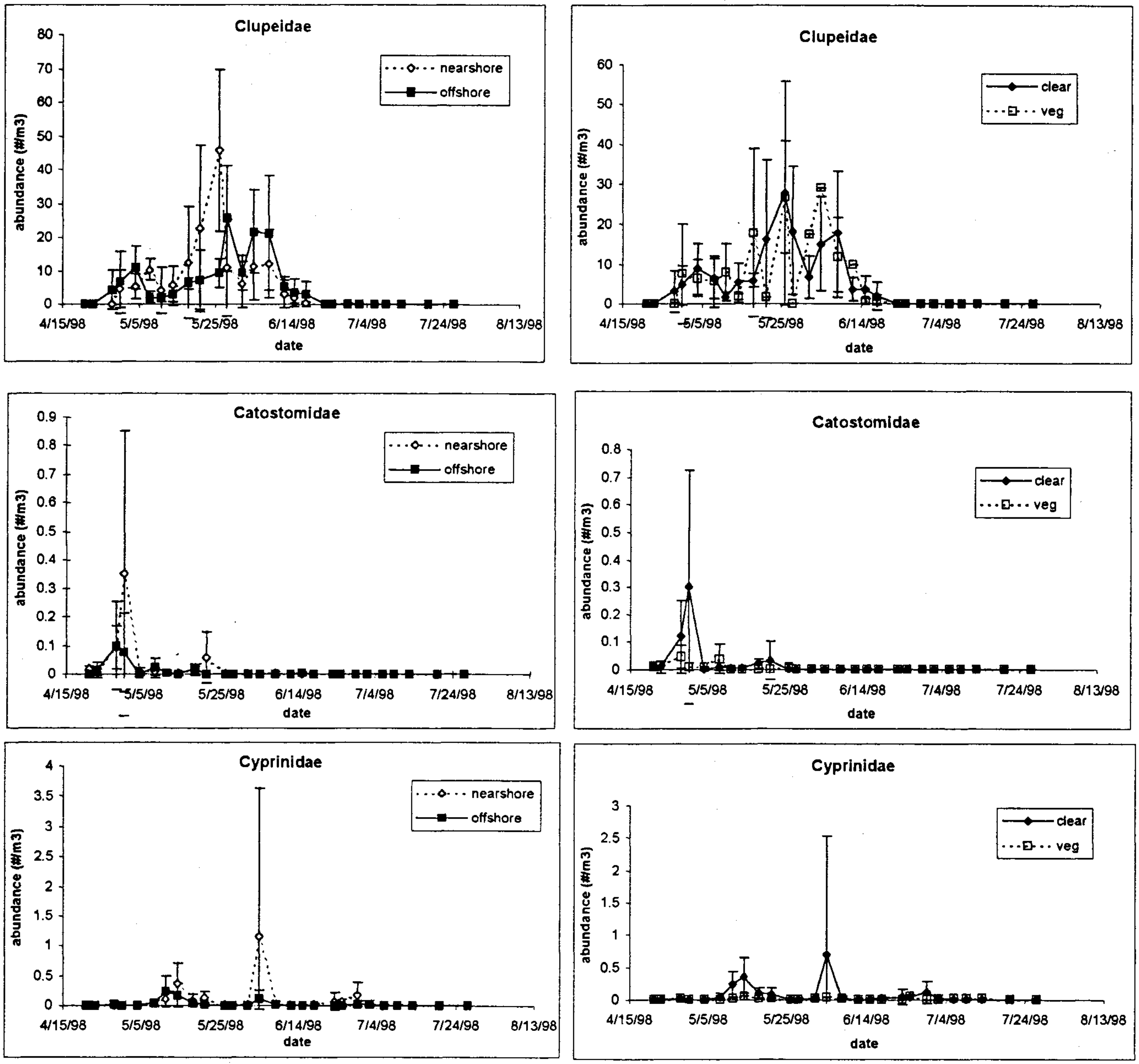


Figure 4. Larval fish abundances in different habitat types during random site (ichthyoplankton tow) sampling

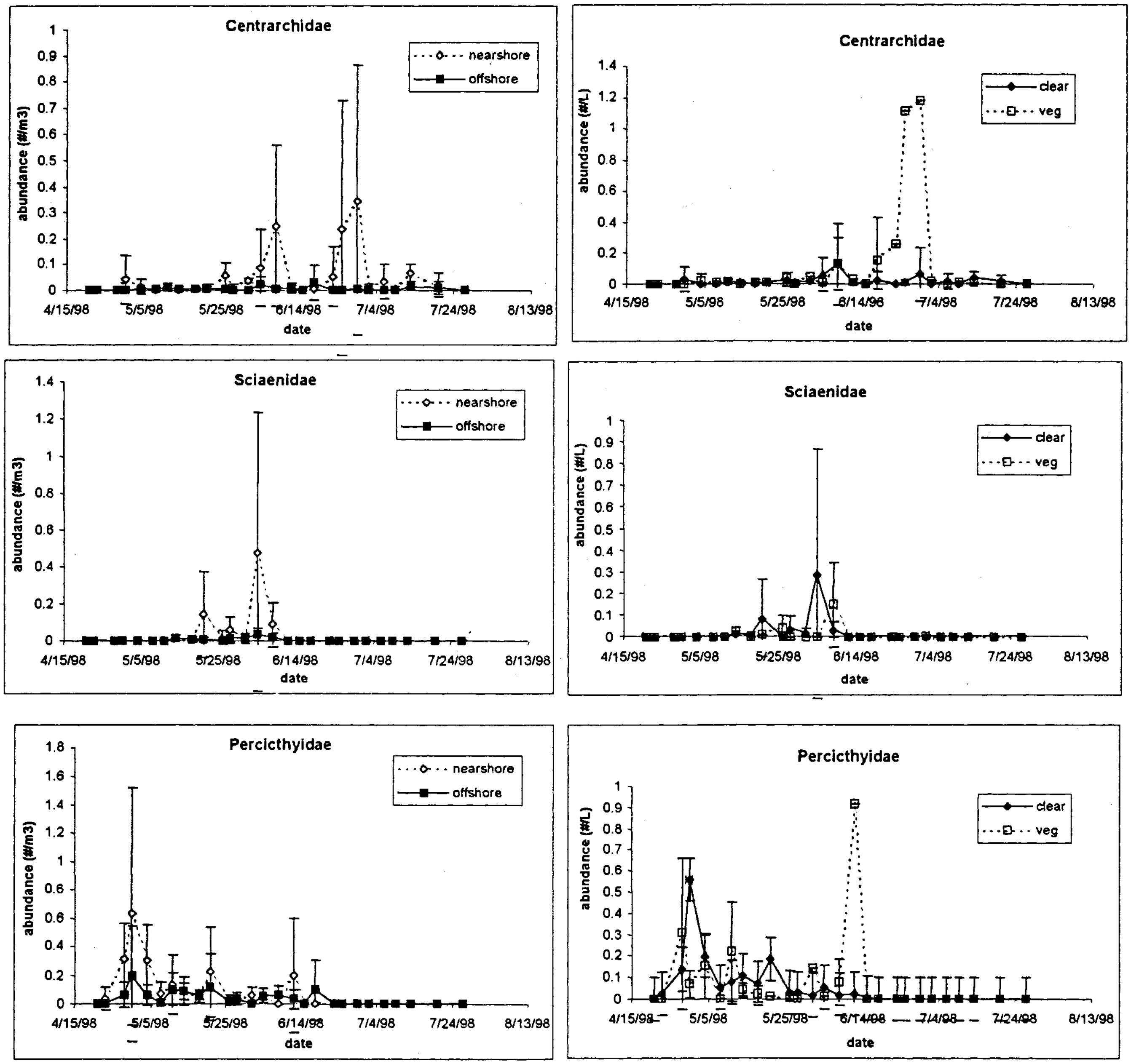


Figure 5. Larval fish abundances in different habitat types during random site (ichthyoplankton tow) sampling (cont'd).

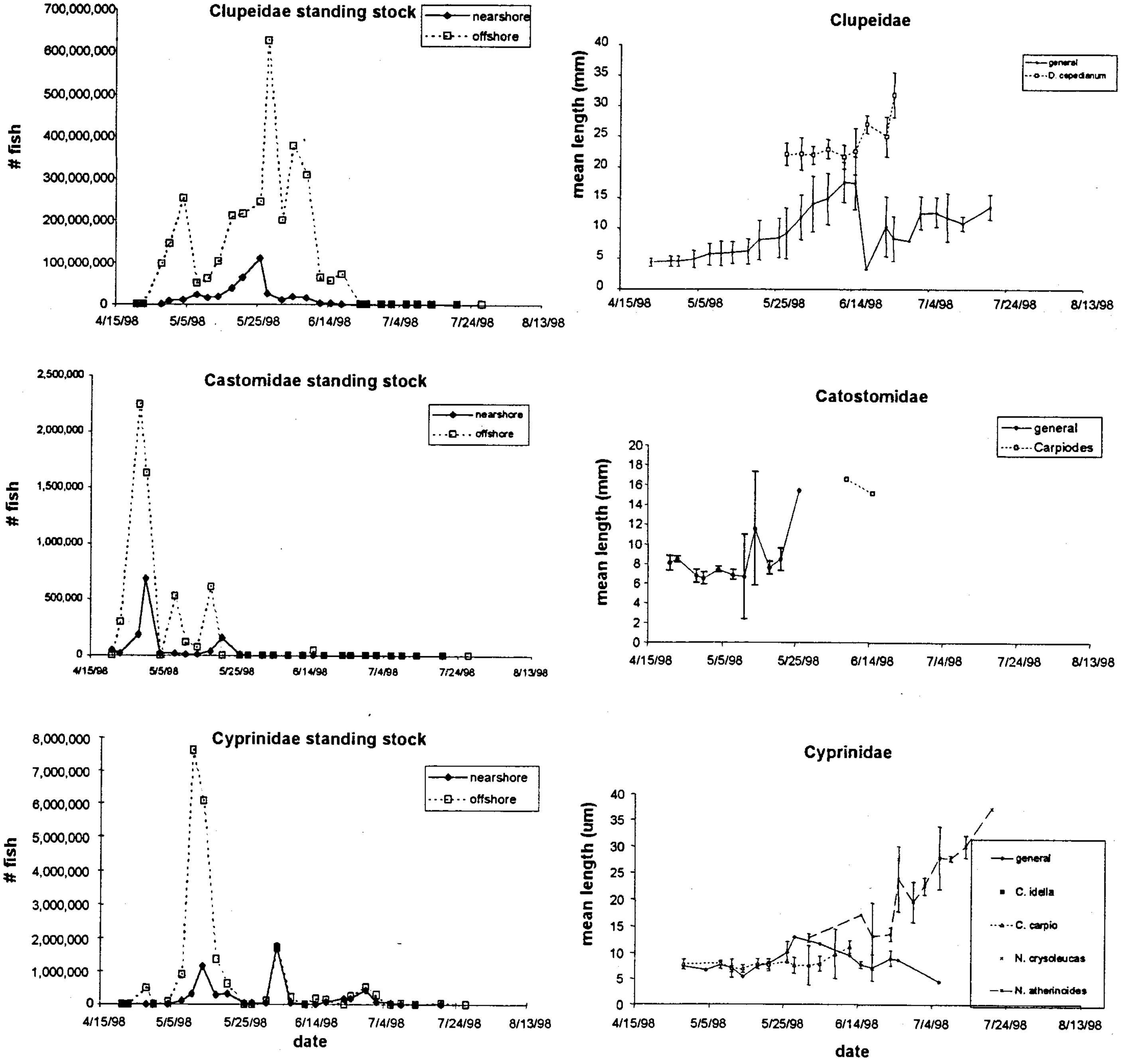


Figure 6. Standing stock and average size of various taxa estimated from random site ichthyoplankton tows

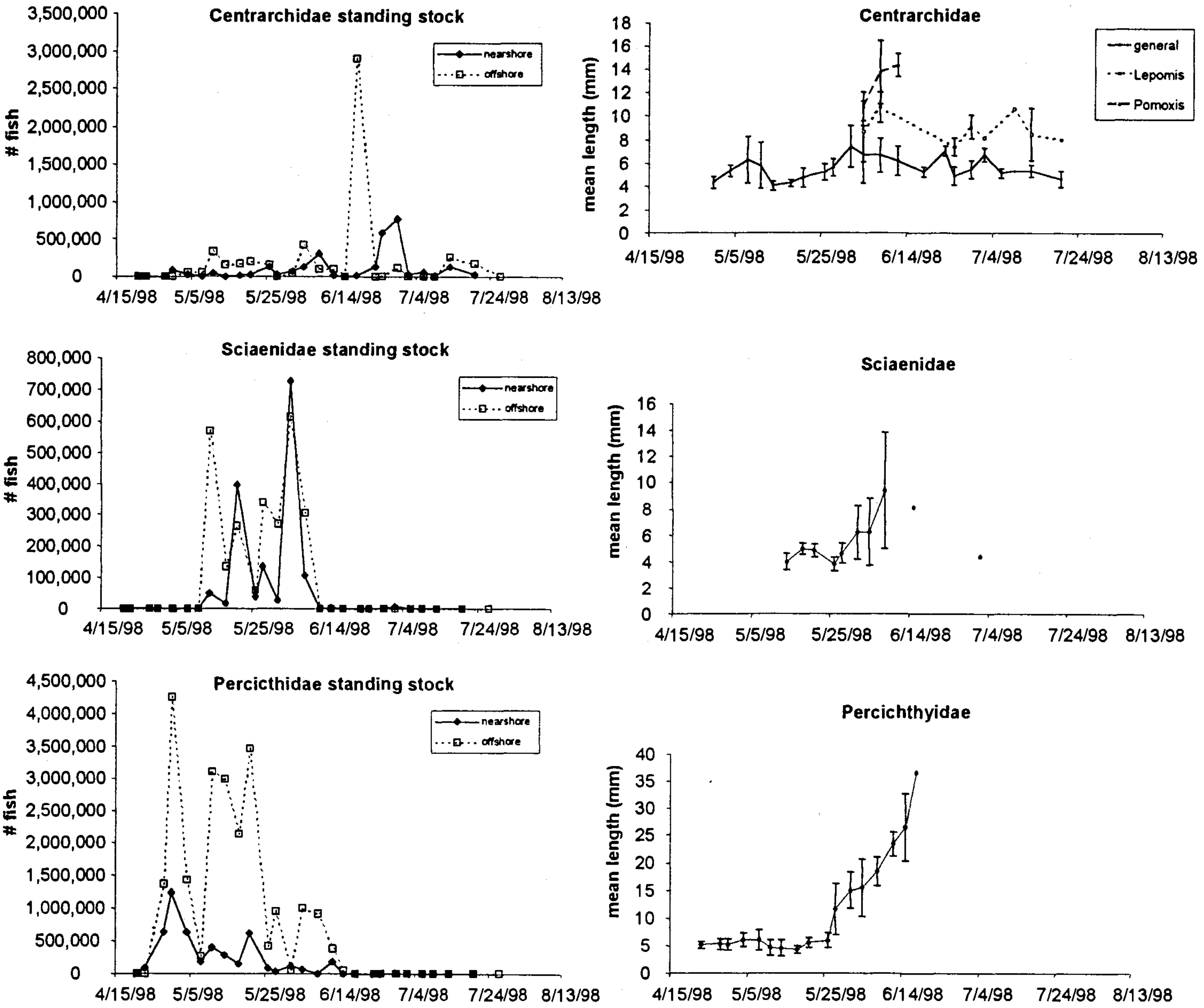


Figure 7. Standing stock and average size of various taxa estimated from random site ichthyoplankton tows (cont'd).

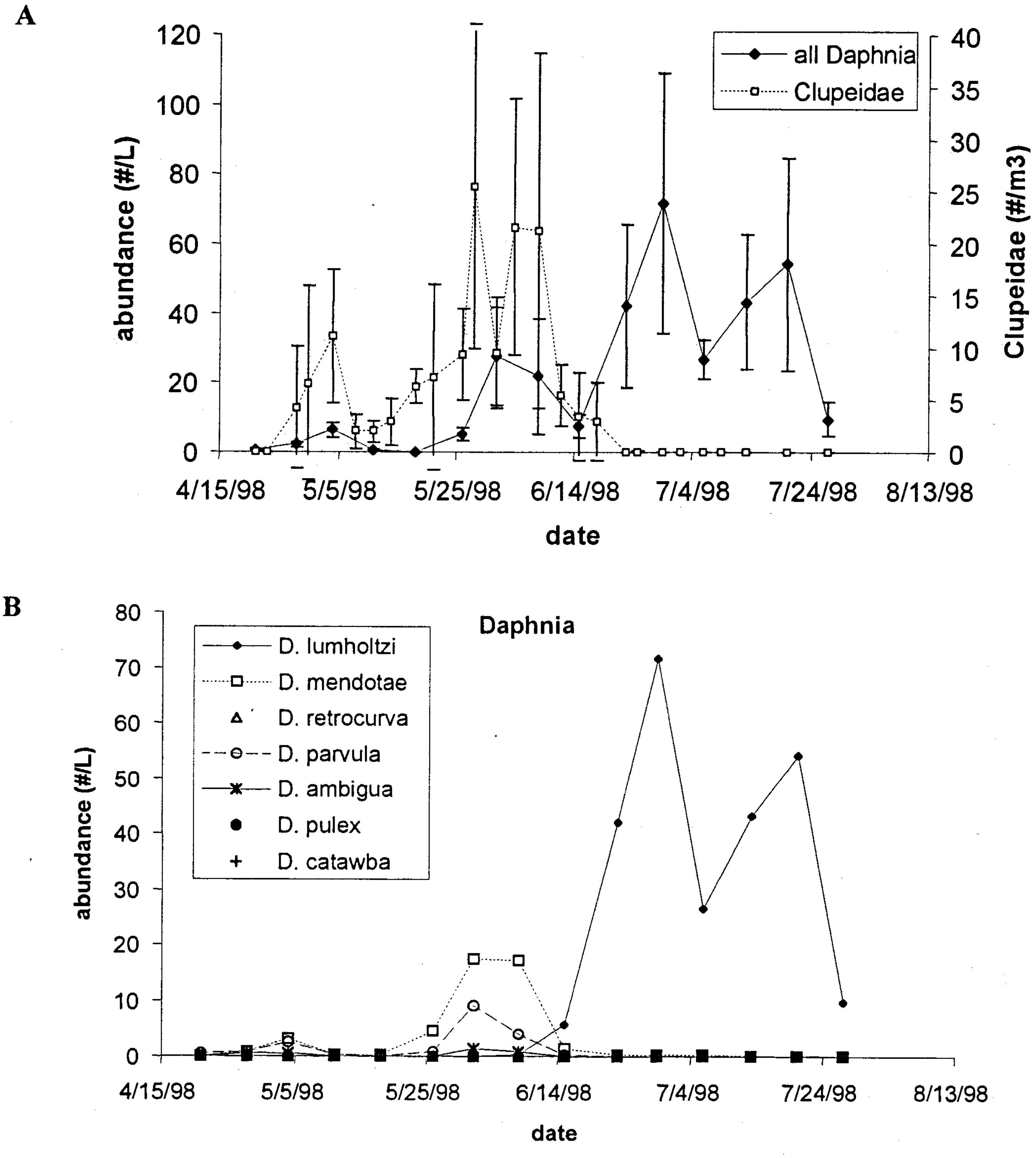


Figure 8. Abundance of all *Daphnia spp.* and clupeids (A) and abundances of individual *Daphnia* species (B) estimated from random site collections at offshore sites.

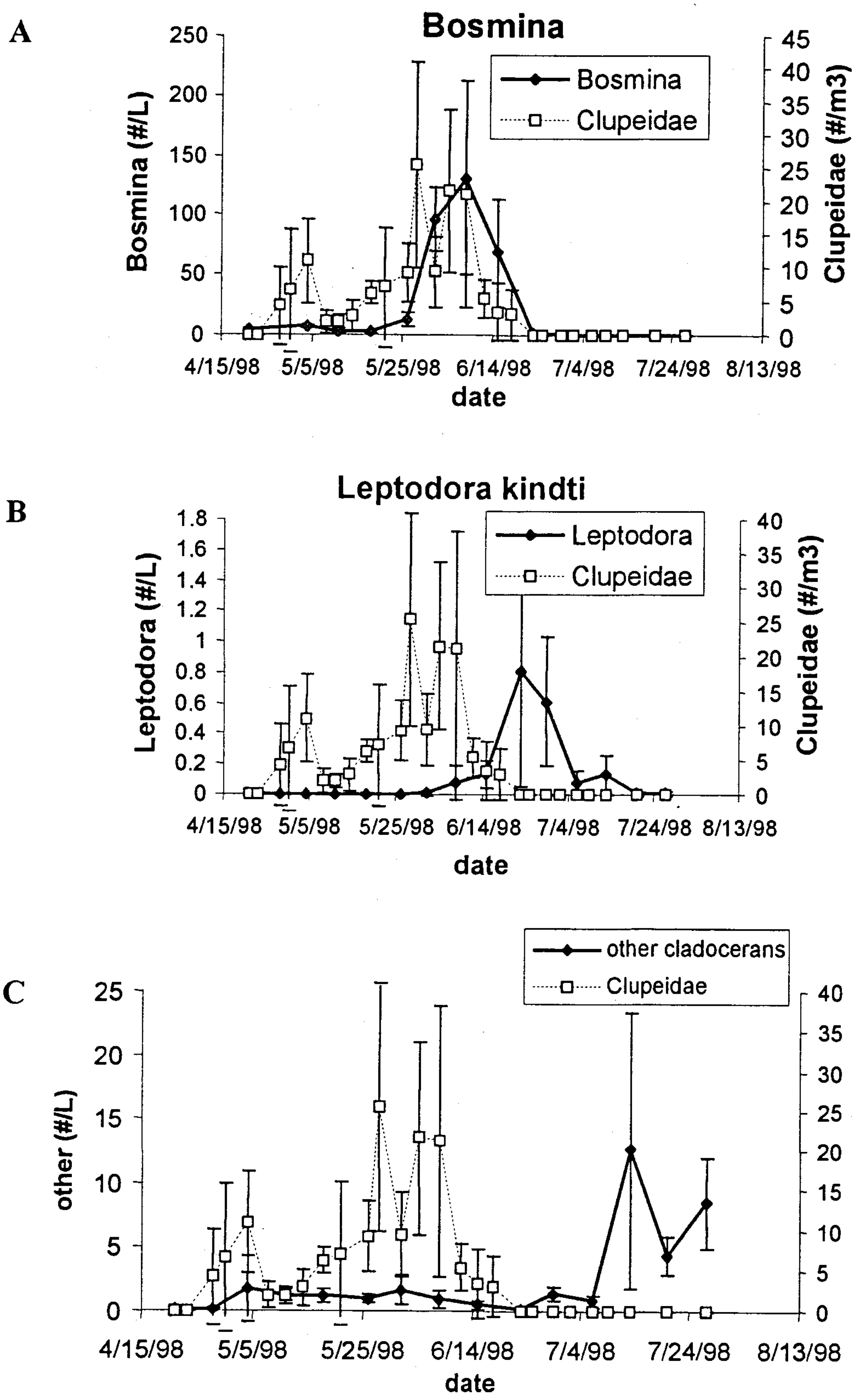


Figure 9. Abundance of Bosmina (A), Leptodora (B), and other cladocerans, primarily Diaphanosoma (C) as compared to abundance of Clupeidae.

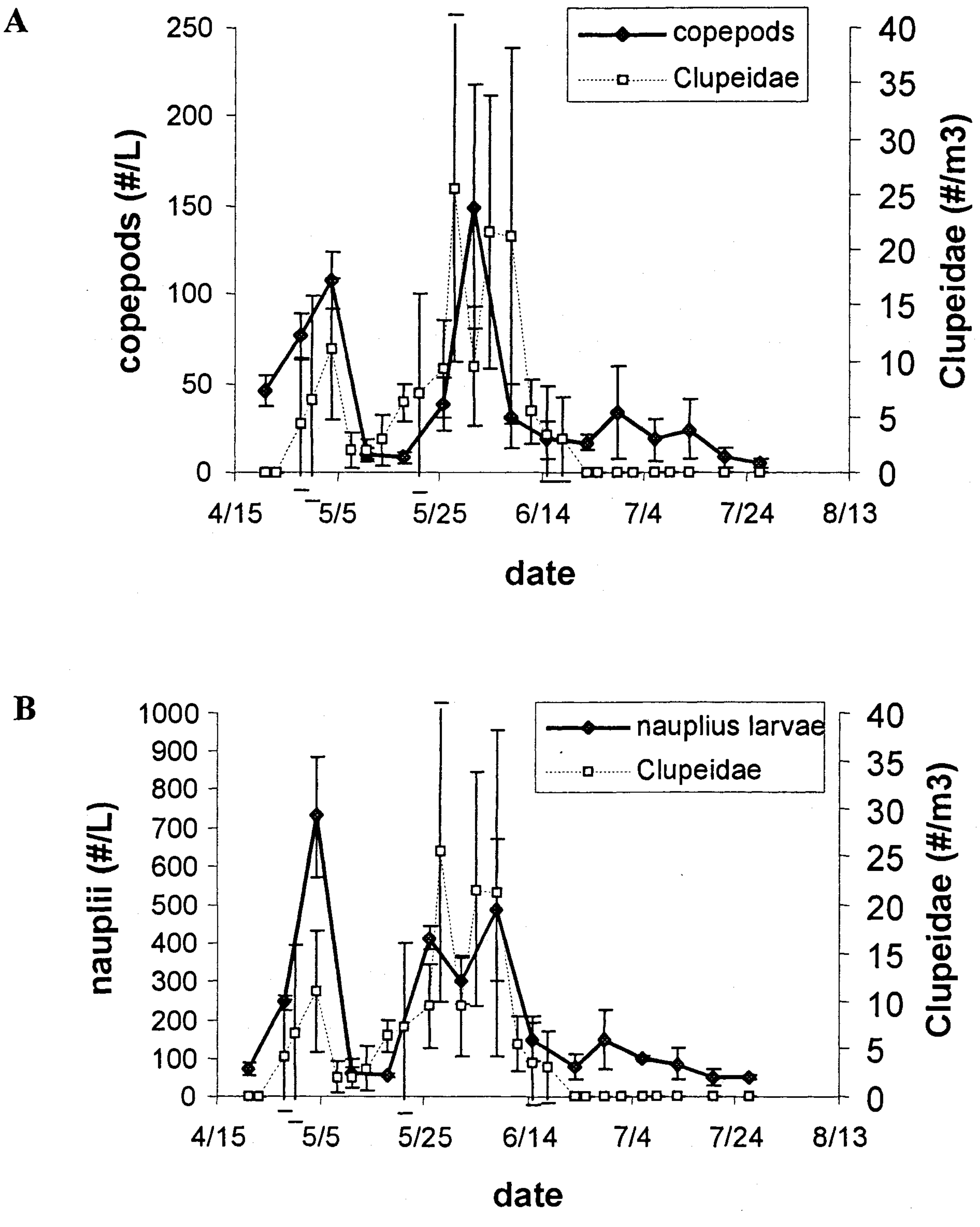


Figure 10. Abundance of Copepods (A), and their nauplius larvae (B) as compared to abundance of Clupeidae.

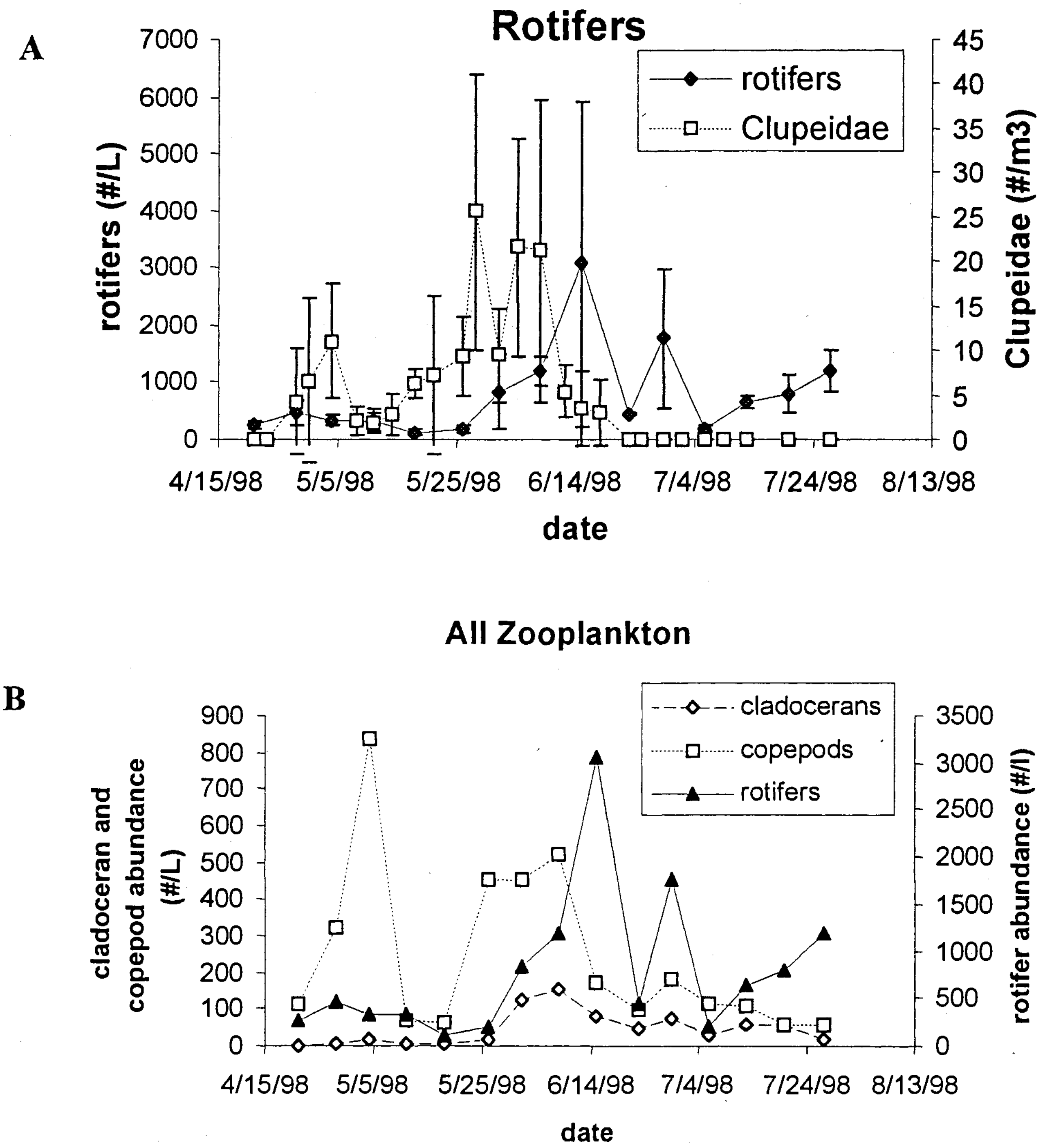


Figure 11. Abundance of rotifers as compared to abundance of Clupeidae (A) and relative abundance of three major zooplankton taxa (B).

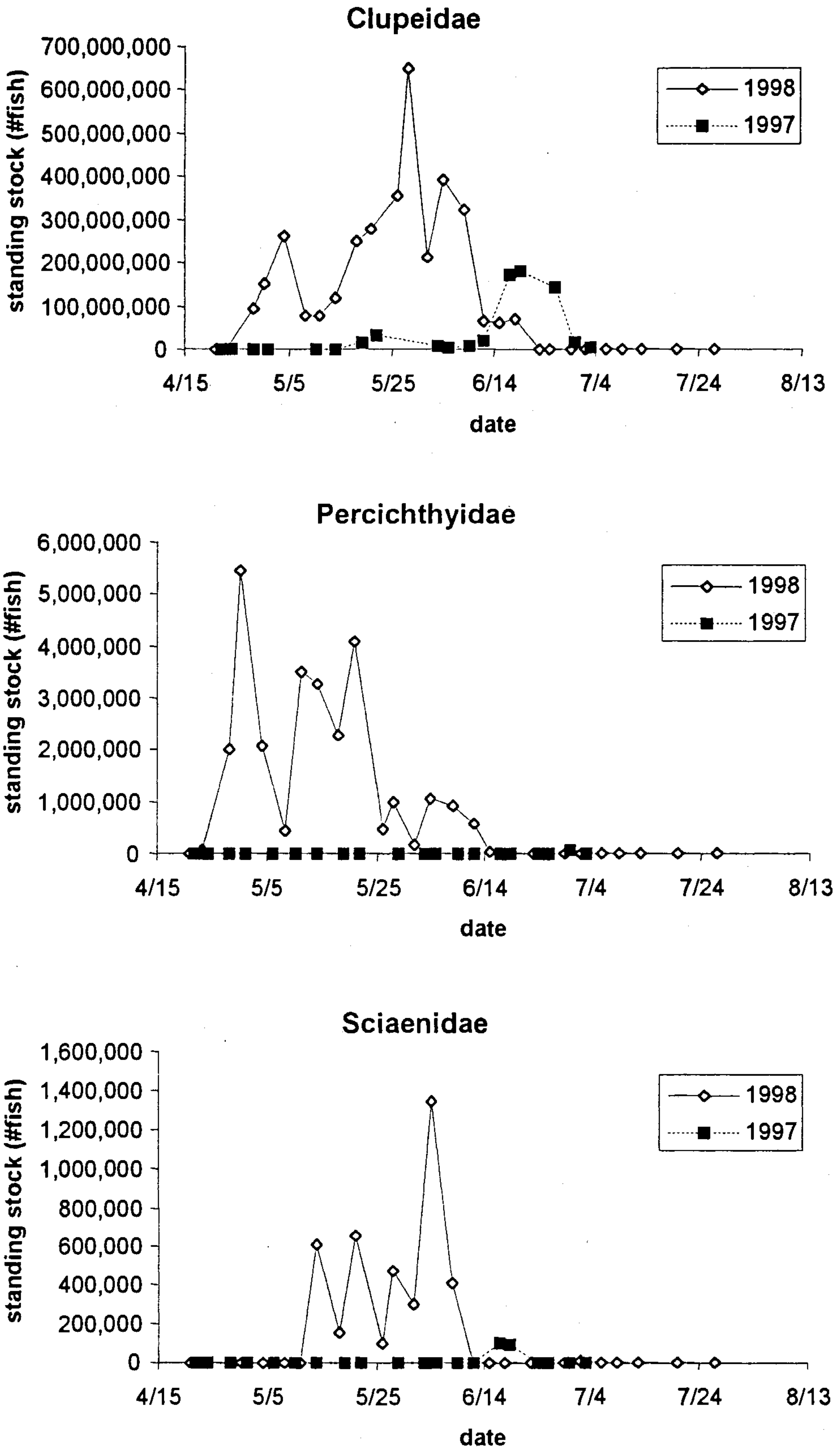


Figure 13. Standing stock of Clupeidae, Percichthyidae and Sciaenidae in 1997 and 1998

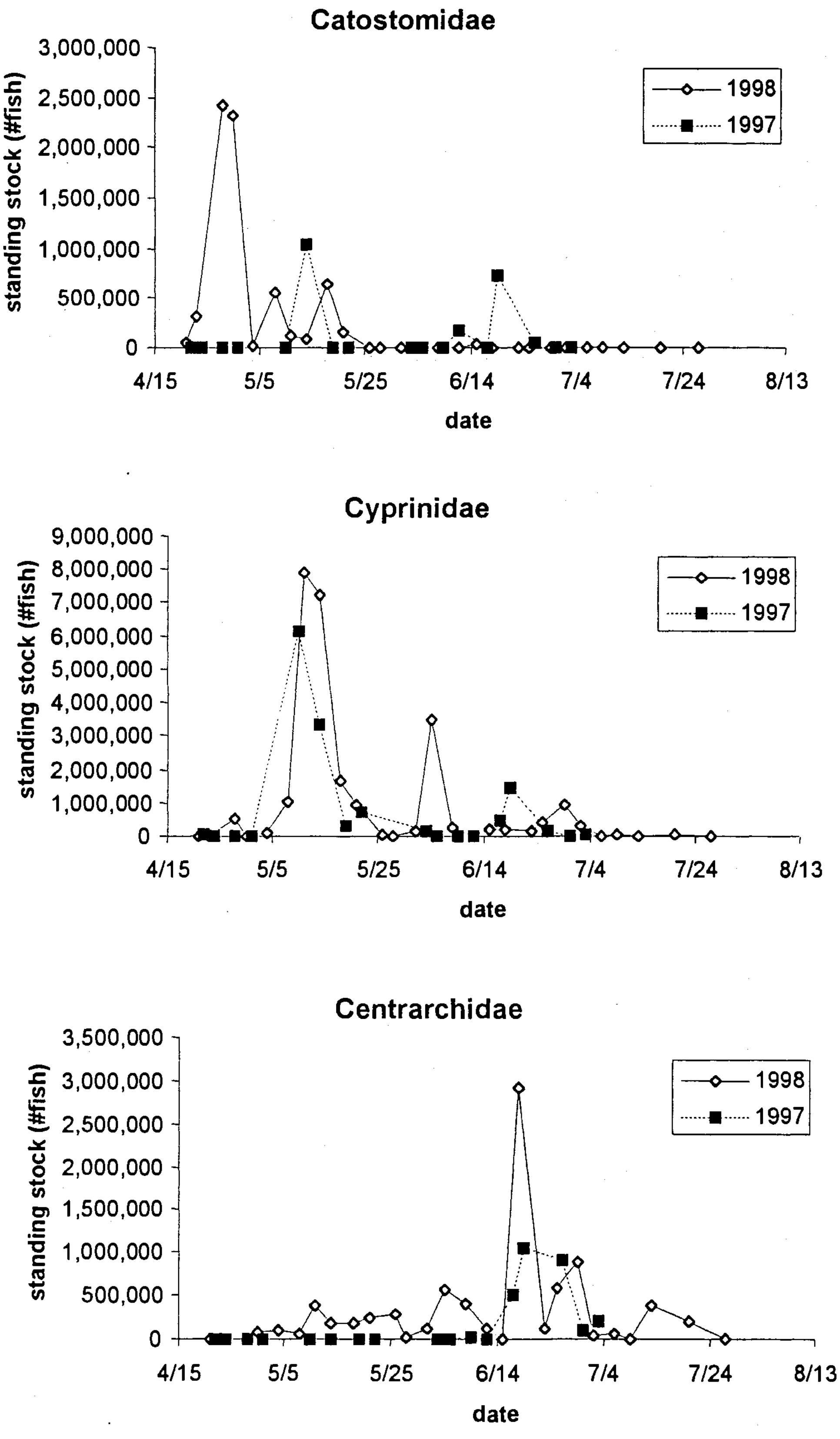


Figure 14. Standing stock of Catostomidae, Cyprinidae, and Centrarchidae in 1997 and 1998

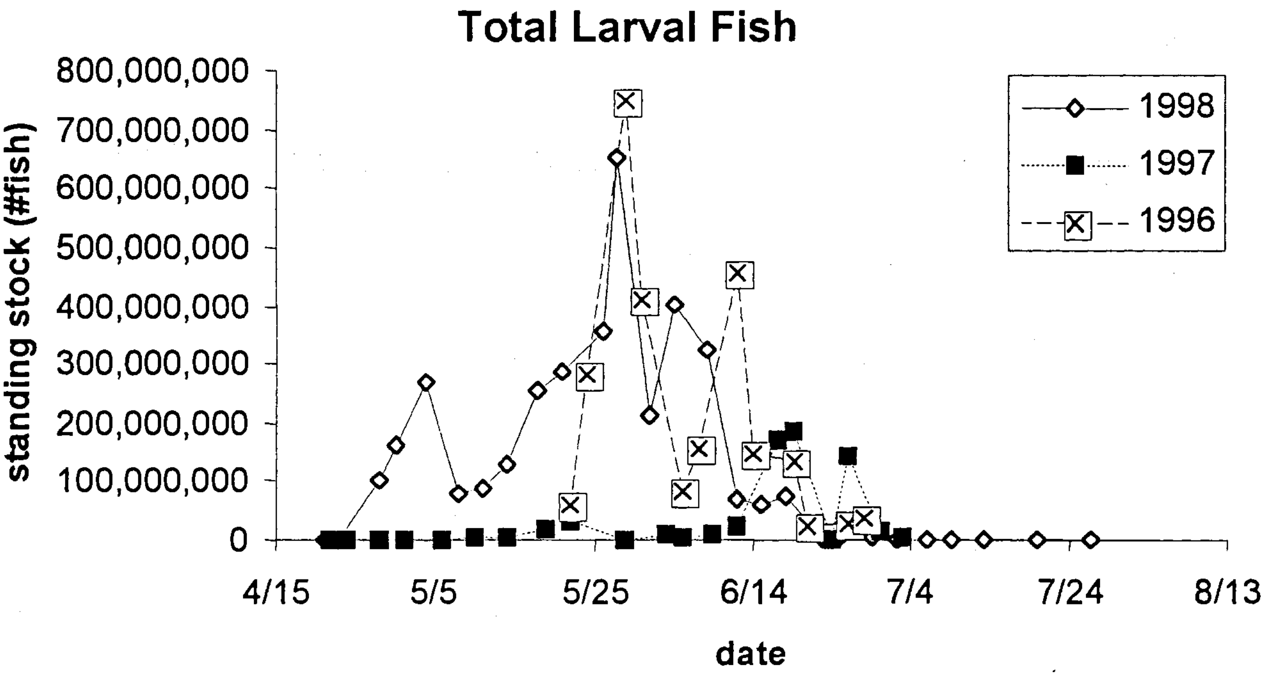


Figure 12. Standing stock of all larval/early juvenile fish taxa combined for 1996-1998

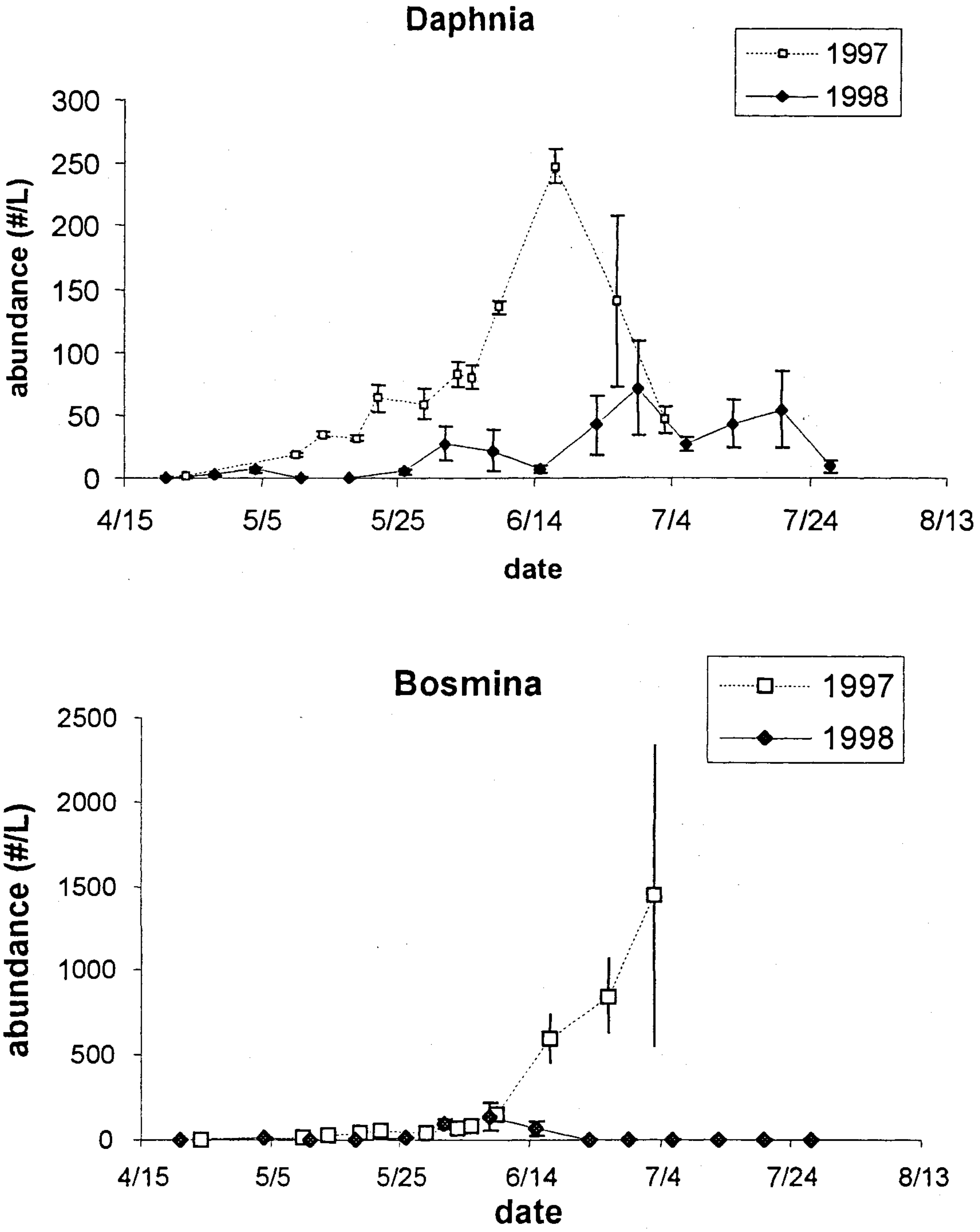
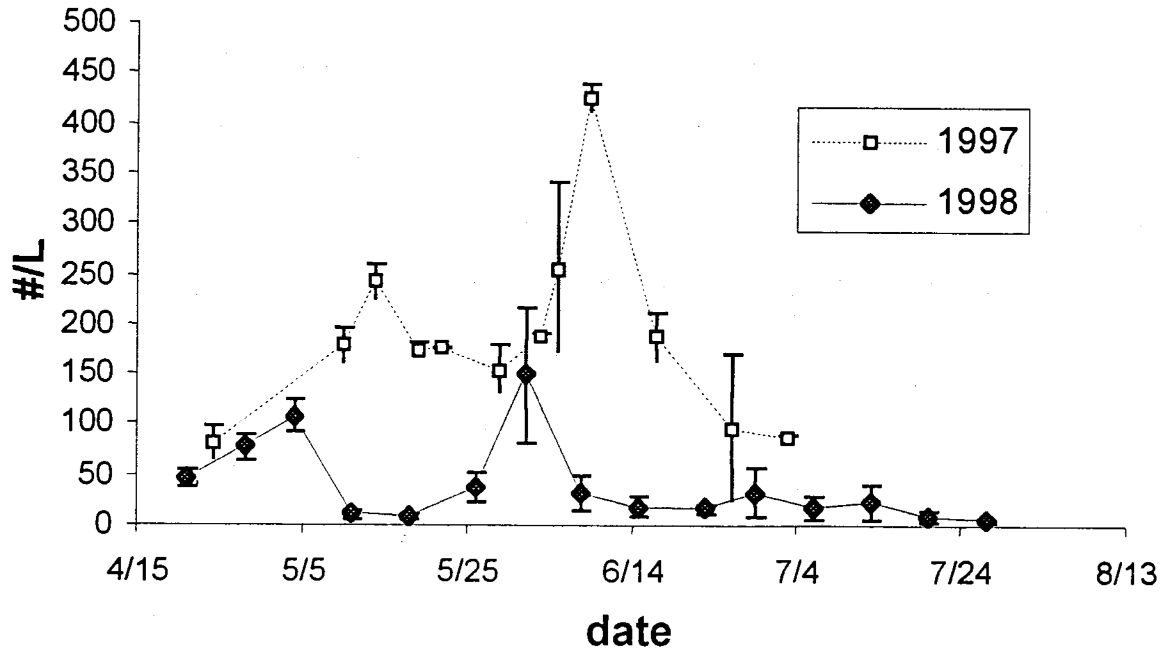


Figure 15. Abundance of Daphnia (A) and Bosmina (B) in 1997 and 1998


Copepods

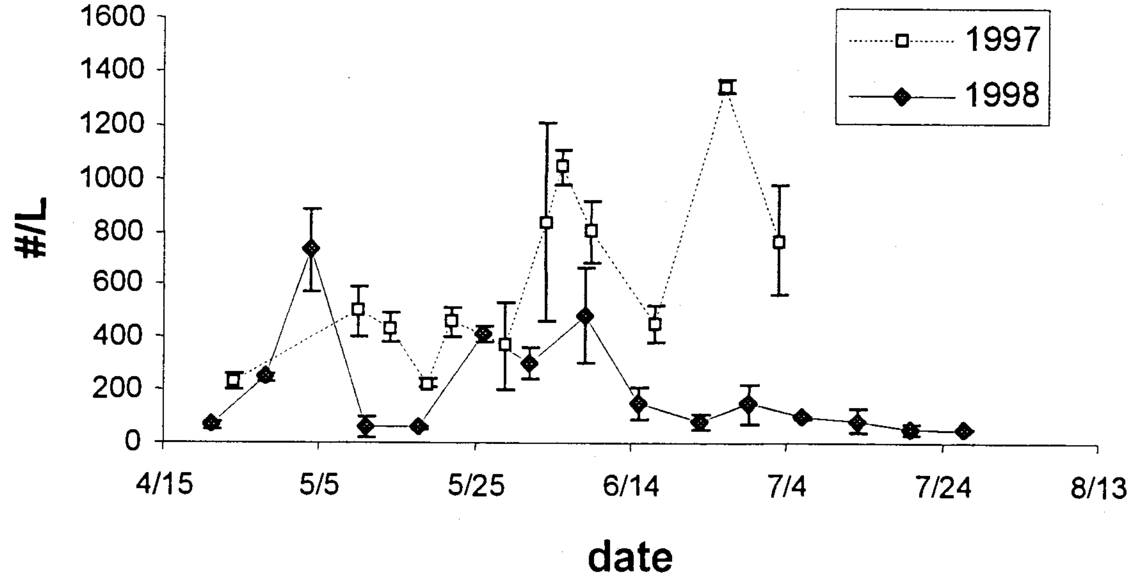

Nauplius larvae

Figure 16. Abundance of copepods (A) and nauplius larvae (B) in 1997 and 1998