ILLINOIS

UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

PRODUCTION NOTE

University of Illinois at
Urbana-Champaign Library
Large-scale Digitization Project, 2007.

ILLINOIS NATURAL HISTORY SURVEY

Progress Report: Lake Chautauqua Fish Production Study, 1996

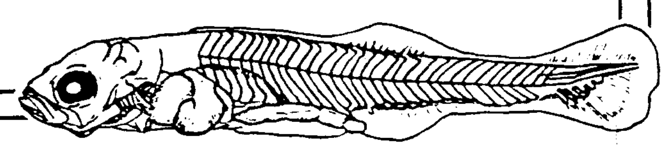
CENTER FOR AQUATIC ECOLOGY

KEVIN S. IRONS, PAUL T. RAIBLEY,
K. DOUGLAS BLODGETT, AND RICHARD E. SPARKS

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

OCTOBER 1997

Aquatic Ecology Technical Report 97/13



Progress Report: Lake Chautauqua Fish Production Study, 1996

Submitted to the Rock Island District, U.S. army Corps of Engineers

Kevin S. Irons, Paul T. Raibley, K. Douglas Blodgett, and Richard E. Sparks

Illinois Natural History Survey
La Grange Reach Long Term Resource Monitoring Program
704 N. Schrader Avenue
Havana, IL 62644

October 1997

Kevin S. Irons
Center for Aquatic Ecology
Illinois Natural History Survey

K. Douglas Blodgett
Center for Aquatic Ecology
Illinois Natural History Survey

Dr. Richard E. Sparks, Director
River Research Laboratories
Center for Aquatic Ecology
Illinois Natural History Survey

Dr. David P. Philipp, Director
Center for Aquatic Ecology
Illinois Natural History Survey

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. Today, watery sediments in permanently wetted areas of backwaters and management units provide poor anchorage for rooted plants and are easily resuspended by wind-generated waves which increases turbidity levels. Such substrates are usually unsuitable spawning and nesting habitat for many native fishes such as bass and sunfish. Dewatering and drying of these substrates, as once occurred naturally during late summer low-flow periods, is often accomplished in management units and consolidates sediments thereby facilitating plant production. Moist soil and rooted aquatic plants can reduce wind-generated waves and further stabilize sediments, which in turn reduces sediment resuspension and generally improves water quality. Substrate stabilized by vegetation provides better spawning and nesting habitat for many fish species and increased cover for larval fish. While drawdowns can have beneficial impacts on both plants and animals, timing is critical for both groups. A "mitigative management strategy" may help achieve both vegetation and fish management goals simultaneously (French 1997).

Many riverine fish have evolved to take advantage of the natural flood cycle that was characteristic of temperate, large floodplain-river ecosystems. Predictable spring floods gave fish access to backwaters for spawning and nesting. According to the flood pulse concept (Junk et al. 1989), during the normal spring flood, newly inundated soils release nutrients that stimulate phytoplankton production and result in increased food supply for zooplankton just at the time larval fish are beginning to feed on zooplankton. In the natural system, as spring floods slowly receded, fish could search for deeper backwater areas or move into the river proper. Today, changes in river levels are both more frequent and of greater magnitude, and coupled with decreases in the quanity and quality of backwaters available to fish, these fluctuations are more likely to negatively impact fish.

If management units are to benefit fisheries, fish must have access into and out of these areas. Some factors may be critical, for example timing of unit filling and drawdown in relation to water quality factors such as temperature. Understanding the effects these and other factors have on larval fish production could allow development and implementation of management strategies to produce fish while still benefiting migratory waterfowl. One moist soil unit that possibly could be used to produce larval fish is the Wasenza Pool of Lake Chautauqua. This study was initiated to assess fish production in and escapement from the Wasenza Pool of Lake Chautauqua during 1996.

Study Area

Lake Chautauqua is a backwater lake on La Grange Reach of the Illinois River near Havana, IL. The lake is part of the Illinois River National Fish and Wildlife Refuges and is owned and managed by the U.S. Fish and Wildlife Service. The lake is an important resting area for migrating waterfowl in the Illinois River Valley portion of the Mississippi River Flyway: it is probably the most important waterfowl refuge in the Illinois River Valley (Havera 1997, personal communication).

About 1968, the approximately 1450-hectare lake was divided into two compartments by a cross dike approximately 1.6 kilometers long to create two management units -- a 480-hectare north or upper cell and a 970-hectare south or lower cell. The water surface area varies with water levels. The cross dike failed in 1970, and ensuing attempts to repair the dike were unsuccessful.

In 1992, Lake Chautauqua was selected as a site for a Habitat Rehabilitation and Enhancement Project (HREP) of the Environmental Management Program for the Upper Mississippi River System. A major feature of the project was the repair of the cross dike, which effectively divided the lake into the northern cell, now called the Kikunessa Pool, and the southern cell called the Wasenza Pool. Also, the spillway in Wasenza Pool was reconstructed to facilitate more thorough dewatering of the pool for moist soil plant production.

Before HREP construction, Lake Chautauqua was characterized as shallow and silty, and resuspension of sediments occurred frequently. In 1994, during HREP construction, the lake was dewatered. Drying and sediment compaction resulted in a firmer substrate as evidenced by construction equipment being able to drive across much of the drained lake bottom. The Kikunessa Pool is designed to be managed for a combination of submersed and emergent aquatic plants around the margin of the pool for waterfowl, fish, and recreational use (primarily fishing). Wasenza Pool is to be managed as a moist soil unit to benefit both waterfowl and shorebirds by providing a refuge and food for the fall migration.

The management strategy for Wasenza Pool (French 1997) includes manipulation of water levels to mimic a natural flood cycle similar to that described by the flood-pulse concept (Junk et al. 1989). Normal spring flooding should provide fish access to the pool for feeding and spawning. Water quality within the pool during the spawning months should improve as a result of annual compaction of sediments (during the summer dewatering) with the previous year's emergent vegetation reducing sediment resuspension by wind and wave action. After spawning, managed dewatering via a stop-log structure could allow both adult and juvenile fish to escape from the pool into the river. The resulting dewatered conditions are intended to stimulate the development of moist soil plants, and reflooding in fall should allow waterfowl access to this food. We sampled fish during spring 1996 in the Wasenza Pool, to assess fish production in and escapement from the pool.

Methods

Staff of the Fish and Wildlife Service's Illinois River Refuges began letting water into Wasenza Pool of Lake Chautauqua (Figure 1) on 22 March (Figure 2) via a culvert connecting the pool to Quiver Creek. The culvert had a 5- x 10-cm-mesh steel grate covering it on the Quiver Creek side. On 22 March we sampled the water coming out of the culvert using a large-mesh hoop net

(3.7-cm-diameter bar mesh) to see if fish were passing into Wasenza Pool. Those net sets ranged in duration from 1 to 6 hours. The stop logs were removed from the south control structure (Figure 1) on 23 April to allow water and fish into the pool from Quiver Creek as the river level rose. The river rose steadily until the end of April then began falling, so on 1 May the stop logs were replaced to keep the pool from draining. On 6 May the river level rose again and the stop logs were removed to allow more water into the pool. River levels continued to rise, and by mid-May the south levee had been overtopped making Wasenza Pool contiguous with the Illinois River and allowing fish unrestricted access.

Water Quality

We monitored temperature (°C) and dissolved oxygen (mg/L) in Wasenza Pool throughout the study; we also monitored nephelometric turbidity (NTU) during larval fish sampling because high turbidities may have negative impacts on catches in light traps. All sampling (fish and water quality) was conducted at sites selected at random from a geographic information system (GIS) coverage of the pool stratified by shoreline (within 50 m of shore) and offshore (greater than 50 m from shore) habitats.

Adult Fish Sampling

On 9 May we conducted preliminary sampling (three 15-minute electrofishing runs) along the shoreline of Wasenza Pool as it was filling to determine if adult fish were present. We initiated adult fish sampling using multiple gears to assess the fish community present in the pool on 13 May and continued through 16 May (Figure 3). Our adult fish sampling consisted of 13 electrofishing runs (15 minutes each) during daylight hours, 16 fyke net sets (24 hours each) at shoreline sites, and 6 tandem fyke net sets (24 hours each) at offshore sites (Table 1). The pulsed-DC electrofishing rig, fyke nets, and tandem fyke nets we used were the same gears and methods used during Long Term Resource Monitoring Program (LTRMP) sampling and are described in detail by Gutreuter et al. (1995). All fish collected during adult fish sampling were identified to species, enumerated, and measured. Naming conventions, both common and scientific, for fish follow the American Fisheries Society (1991) and are listed in Table 2.

Larval Fish Sampling

We began sampling larval fish on 16 May after observing larval fish in shallow water along the shoreline of Wasenza Pool; larval fish sampling continued through 28 June when river levels began to fall rapidly (Figure 3). We set 55 light traps at offshore sites and 53 light traps at shoreline sites (Table 3). Light traps followed the design of Kilgore and Morgan (1993) but were modified by attaching a funnel to the bottom of the trap to facilitate draining of the traps after retrieval (Figure 4). Light traps were deployed for approximately 12 hours each, beginning at sunset. We also sampled larval fish by pulling paired, conical ichthyoplankton nets (0.5 m diameter, 2.0 m long, and 500-μm mesh) for approximately one minute each at 59 offshore sites and 58 shoreline sites; we refer to these samples as plankton tows (Table 3). To determine the flow of water through the nets 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 the two nets was calculated using the following formula:

$$\text{Volume Sampled by Paired Plankton Nets } (m^3) = (\pi r^2)*(2.667*\mu*0.01)*2$$

where: r = radius of net opening (0.245 m)
2.667 = constant from flowmeter
μ = average number of revolutions from the two flow meters
0.01 = conversion factor to m^3
2 = number of nets

The total number of fish caught in the paired nets was divided by the volume of water sampled and then multiplied by 100 to yield an estimate of the number of fish/100 m^3 sampled. We attempted to set 10 light traps (five offshore and five shoreline) and pull 10 paired plankton tows (five offshore and five shoreline) twice per week throughout the study period. Larval fish were preserved in 10% formalin and returned to the laboratory for identification and enumeration. 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). As necessary, cross-polarized lighting was used. Fish lengths (total length) were measured to the nearest millimeter. Mean catch-per-unit-effort (CPUE) values were calculated to compare catch rates between shoreline versus offshore light traps (fish/trap) and shoreline versus offshore plankton tows (fish/100 m^3).

Standing stock estimates for larval fish were calculated from plankton tow samples collected 22 May through 28 June. Total catch/volume sampled (fish/m^3) of larval fish for both shoreline and offshore habitats from plankton tows was multiplied by the estimated volume of the respective habitat type (shoreline and offshore). Volumes for the two habitats were calculated only once by multiplying the area (from a GIS coverage) of each habitat (98 hectares for shoreline and 872 hectares for offshore) by the average depth from the tow sites when the samples were taken (2.79 m for shoreline [SD = 1.2] and 3.8 m for offshore [SD = 0.7]). Total volume was calculated as 35,870,200 m^3 (shoreline = 2,734,200 m^3, offshore = 33,136,000 m^3). We used these same volume estimates for all standing stock calculations from plankton tows.

Escapement Sampling

We began collecting fish escaping from the Wasenza Pool via the south control structure on 28 June as river levels fell and the pool began to drain. Escapement sampling continued through 19 July when river levels rose again, reflooding the pool. We discontinued sampling at that time because fish likely moved from Quiver Creek and Quiver Lake into Wasenza Pool as it refilled, so subsequent escapement catches would not necessarily be representative of fish production in the pool.

The control structure consists of four gates approximately 1.5 m wide (Figure 5). We set a small-mesh hoop net (standard LTRMP hoop net [1.2 m diameter] lined with 3-mm "Ace"-type nylon netting) in gate 1 and an ichthyoplankton net (as described previously for larval fish sampling) in gate 4. Nets were set in the effluent for 1 to 15 minutes; 1 minute when flows and fish catches were high and up to 15 minutes when flows and catches were low. On 18 July we set three standard LTRMP large-mesh hoop nets in gate 4 to collect adult fish moving out of the pool and set two more on 19 July. The first net was set for 30 minutes and subsequent sets were 60 minutes. We also conducted one 12-minute electrofishing run in the effluent below the control structure (Quiver Creek) on 16 July. Larval and juvenile fish caught during escapement sampling were measured and identified to family and to the genus and species levels when possible.

We calculated the volume of water filtered by small-mesh hoop and plankton nets as described previously for larval fish sampling; the formula was modified to accommodate data from just one net at a time. The radius of the plankton net was 0.245 m, and the small-mesh hoop nets were 0.515 m.

Estimates of the total numbers of fish escaping from Wasenza Pool were calculated separately for small-mesh hoop nets and plankton nets. We multiplied the actual catch in these gears by a conversion factor (estimated total pool volume/volume sampled) to extrapolate the catch in the volume of water we sampled to the volume of the entire pool. For this purpose we estimated the area of the pool at the time we began escapement sampling as 809.39 hectares and used an estimated mean depth of 2.13 m which yielded an estimate of 17,245,873 m^3 of water in the pool on 28 June. Our estimates assumed the density of fish throughout the pool was uniform and equal to the density of fish passing through the outlet structures. It is likely some species avoid exiting backwaters, and they would be underestimated by sampling the outflow. Conversely, species attracted to the outflow would be overestimated.

Results

Water Quality

Water temperature increased from 16° C on 13 May to 23° C on 23 May (Figure 6). This was followed by a decline to about 16° C by 28 May. Water temperature increased steadily thereafter before leveling off near 27° C during late June and early July. Temperatures dropped about 2 C° from 7 to 11 July before rising to nearly 30° C by the end of the study on 19 July. Dissolved oxygen values increased from 8 mg/L on 13 May to 14 mg/L on 15 May, stabilizing until 22 May when the pool reached a high of about 18 mg/L (Figure 6). Dissolved oxygen decreased thereafter but remained between 5 and 10 mg/L throughout mid-July.

Nephelometric turbidity increased from just over 20 NTU on 20 May to more than 100 NTU on 28 May (Figure 7). This increase seemed largely due to wind-generated waves which eroded shorelines and resuspended bottom sediments in shallow areas. Because water depths were 3-4 m in offshore areas during most of the study, resuspension of bottom sediments did not appear to be a problem there. Turbidity had decreased to about 50 NTU by 30 May and continued to decline throughout most of June.

While we did not plan on quantifying zooplankton production, it was evident large zooplankton were relatively abundant in Wasenza Pool: throughout all sampling, our 500-μm plankton nets were packed with zooplankton including the exotic *Daphnia lumholtzi*. We quantified the zooplankton in two samples collected on 22 May and densities of individuals were estimated at 1,016/m^3 and 11,606/m^3.

Total Fish Collected

We collected a total of 80,205 fish representing 54 taxa during all sampling combined (adult, larval, and escapement sampling) at Wasenza Pool of Lake Chautauqua in 1996 (Table 4). Some specimens could not be identified to species, so six of the taxa listed consisted of individuals identified only to family (sunfishes [Centrarchidae], suckers [Catostomidae], minnows [Cyprinidae], and perches [Percidae]) or genus (buffaloes [*Ictiobus*] and shiners [*Notropis*]). These groupings followed LTRMP protocols (Gutreuter 1995) and are listed in Table 2. One hybrid cross (green sunfish x bluegill, *Lepomis cyanellus* x *macrochirus*) was also among the 54 taxa. Gizzard shad (*Dorosoma cepedianum*) was the most numerically abundant species (54,107), followed by emerald shiner (*Notropis atherinoides*, 16,342), suckers (3,622), freshwater drum (*Aplodinotus grunniens*, 1,396), and white bass (*Morone chrysops*, 1,261). We caught fewer than 4,000 individuals of all other taxa combined.

Adult Fish Sampling

On 22 March we sampled the water entering Wasenza Pool from Quiver Creek through the culvert and did not collect any fish. Because of the 5- x 10-cm-mesh steel grate over the culvert, it is doubtful many large adult fish could enter through the culvert.

During three electrofishing runs on 9 May we collected 75 fish representing 12 taxa (Table 1). Common carp (*Cyprinus carpio*, 33.3%), gizzard shad (24.0%), and white bass (10.7%) accounted for 68% of all the fish collected. Thereafter, adult fish sampling using electrofishing, fyke nets, and tandem fyke nets yielded 2,542 fish representing 31 taxa which included one hybrid cross (Table 1). Freshwater drum (26.6%), shortnose gar (*Lepisosteus platostomus*) (18.9%), and common carp (12.2%) accounted for 58% of the catch. Gamefish species collected during adult fish sampling included white bass, largemouth bass (*Micropterus salmoides*), black crappie (*Pomoxis nigromaculatus*), white crappie (*Pomoxis annularis*), bluegill, sauger (*Stizostedion canadense*), walleye (*Stizostedion vitreum*), and channel catfish (*Ictalurus punctatus*). From these two sampling efforts we documented a total of 32 adult fish taxa in the pool prior to larval fish sampling.

Larval Fish Sampling

During larval fish sampling we collected 37,126 larval fish representing 16 taxa (Table 3). Numerically, gizzard shad dominated the catch (87.3%), followed by suckers (8.1%), minnows (2.0%), and white bass (1.4%); combined, these four taxa made up almost 99% of the catch. Gamefish collected included white bass, sunfishes, and a single largemouth bass.

Light traps yielded 11,186 fish representing 16 taxa, and plankton tows yielded 25,954 fish representing 10 taxa (Table 5). The catches from both gears were dominated by the same three taxa (gizzard shad, suckers, and minnows) with gizzard shad accounting for nearly equal percentages of the catch from both gears (86.4% and 87.7%). Taxa collected in light traps but not in plankton tows were river carpsucker (*Carpiodes carpio*), perches, central stoneroller (*Campostoma anomalum*), johnny darter (*Etheostoma nigrum*), largemouth bass, and red shiner (*Cyprinella lutrensis*). All taxa collected by plankton tows were also collected in light traps.

Data from both light traps and plankton tows indicate shoreline collections caught more fish than offshore collections (Table 6). The mean CPUE in shoreline light traps (209.66 fish/trap) was 155 times greater than the mean for offshore light traps (1.35 fish/trap); and the mean for shoreline plankton tows (1939.3 fish/100 m^3) was nearly four times greater than offshore plankton tows (508.9 fish/100 m^3). Catches in shoreline light traps ranged from 0 to 1,600 fish/trap while catches in offshore light traps ranged from 0 to 11 fish/trap. Catches in shoreline plankton tows ranged from 5.33 to 37,696 fish/100 m^3 while catches in offshore plankton tows ranged from 14.67 to 4344 fish/100 m^3. Data used to calculate mean CPUEs for plankton tows are listed in Table 7 (offshore) and Table 8 (shoreline).

Catch rates were highly variable both within and among sample dates and habitats. As a result, our estimates of standing stocks were highly variable as well (Figure 8). The average standing stock estimate was 214 million (SD = 222 million) larval fish from 22 May to 28 June. Standing stock estimates were highest for 29 May at 748 million larval fish with a second peak of 455 million on 12 June. Although much higher concentrations of fish were collected in shoreline habitats (Table 6), standing stock estimates were much greater for offshore habitat due to its greater volume (Figure 9).

We plotted CPUE over time for five taxa which were abundant during larval fish sampling (Figures 10-14) . We first caught larval gizzard shad on 21 May and they were present in our collections throughout June (Figure 10). Catches from all four gear combinations indicated peak production likely occurred from late May through mid-June. Larval buffaloes were first caught on 22 May and, like gizzard shad, also were present throughout June (Figure 11); peak production likely occurred from late May through early June. We first caught larval minnows on 16 May and they were present throughout June (Figure 12); peak production likely occurred in mid-June. Larval white bass were first caught on 24 May and were present throughout June (Figure 13); production appeared to peak from late May to mid-June. Larval sunfishes first appeared in our collections on 25 May and were present through 21 June (Figure 14); peak production was difficult to pinpoint due to the small sample size of only 51 fish. The date on which selected species were first captured and last captured during larval fish sampling along with length ranges at time of capture are listed in Table 9. As of late June we were still collecting individuals of these five taxa that were less than 20 mm long, indicating most species were still reproducing in mid-June.

Mean CPUEs (Figure 15) indicate peaks in gizzard shad catches from late May through mid-June. Gizzard shad catch rates were magnitudes higher than those of other species in all gears except offshore light traps for which no species averaged more than 4 individuals/light trap. Mean catches for all species had declined by late June.

We constructed a time series of length distributions to depict how the size structure of larval fish in our collections changed during the study period (Figures 16-24). Weekly catches of species other than gizzard shad were frequently small resulting in small sample sizes for most distributions. Most of the larval gizzard shad we collected through early June were less than 15 mm long with larger fish becoming more abundant in later weeks (Figure 16). Larval suckers we collected were 5-19 mm throughout the study period with no clear trend toward increasing size over time (Figure 17). Larval buffaloes were 8-16 mm in late May and 22-24 mm in late June (Figure 18); a clear trend of increasing size over time was apparent. From late May through late June we collected larval minnows that were 3-16 mm (Figure 19); a slight trend toward increasing size over time was evident. Only one larval shiner (3 mm) was collected prior to 18 June; in mid-June, larval shiners were 14-21 mm long and by late June some were as large as 25 mm (Figure 20). Larval carp showed a trend of increasing size over time (Figure 21), ranging from 7 to 14 mm during late May and from 10 to 21 mm in early June. Larval carp were absent from collections made after early June. During late May, larval white bass were 4-11 mm increasing in size by late June to 6-21 mm (Figure 22). Larval sunfishes 4-6 mm were captured from late May through late June with the largest specimen 19 mm in mid-June (Figure 23). Larval freshwater drum were 5-8 mm long through early June and by late June ranged from 7 to 15 mm (Figure 24).

Escapement Sampling

We collected 39,649 larval, juvenile, and adult fish representing 34 taxa during escapement sampling with small-mesh hoop nets and plankton nets (Table 10). Numerically, gizzard shad (53.0%) and emerald shiners (40.8%) dominated the catch, followed by skipjack herring (*Alosa chrysochloris*) (2.0%), freshwater drum (1.7%), and white bass (1.2%). Gamefish species accounted for only 1.4% of the catch. The following fourteen species caught during escapement sampling were not caught during adult or larval fish sampling: bluntnose minnow (*Pimephales notatus*), goldeye (*Hiodon alosoides*), golden shiner (*Notemigonus crysoleucas*), logperch (*Percina caprodes*), mud darter (*Etheostoma asprigene*), mooneye (*Hiodon tergisus*), western mosquitofish (*Gambusia affinis*), paddlefish (*Polyodon spathula*), silverband shiner (*Notropis shumardi*), skipjack herring, sand shiner (*Notropis stramineus*), spottail shiner (*Notropis hudsonius*), silver chub (*Macrhybopsis storeriana*), and threadfin shad (*Dorosoma petenense*). Some of these species may have been collected during larval fish sampling but could not be identified to the species level (e.g. silverband shiner, sand shiner, and spottail shiner may have been listed as shiners or minnows). The three mooneyes we collected were the first we have documented in La Grange Reach since LTRMP fisheries monitoring began in 1990. The lone paddlefish in our collections was a 700-mm-long (total length) adult specimen which swam into the plankton net. Species identified during adult/larval sampling in the pool that were not identified during escapement sampling included black buffalo (*Ictiobus niger*), black bullhead (*Ameiurus melas*), brown bullhead (*Ameiurus nebulosus*), central stoneroller, goldfish (*Carassius auratus*), golden redhorse (*Moxostoma erythrurum*), green sunfish, grass carp (*Ctenopharyngodon idella*), johnny darter, quillback (*Carpiodes cyprinus*), shorthead redhorse (*Moxostoma macrolepidotum*), spotted gar (*Lepisosteus oculatus*), walleye, warmouth (*Lepomis gulosus*), yellow bullhead (*Ameiurus natalis*) and yellow bass (*Morone mississippiensis*).

The five large-mesh hoop nets we set in the effluent caught just 29 adult fish of six taxa (Table 10). Gizzard shad dominated the catch (55.2%) followed by bluegill (13.8%) and smallmouth buffalo (*Ictiobus bubalus*, 13.8%). The single day electrofishing sample in Quiver Creek at the Wasenza Pool effluent yielded 784 fish representing 21 taxa. As was the case with small-mesh hoop and plankton nets, gizzard shad (67.5%) and emerald shiner (19.5%) dominated the catch. All 21 taxa collected in the effluent during electrofishing had been captured during either adult, larval, or escapement sampling.

Small-mesh hoop nets caught 36,178 fish representing 31 taxa, while plankton nets caught 3,471 fish representing 18 taxa (Table 11). Catches from both gears were dominated by gizzard shad and emerald shiner; skipjack herring was third most abundant in both cases. Data on catch rates of fish in small-mesh hoop (Table 12) and plankton nets (Table 13) were used to calculate weekly mean CPUEs for each gear. Mean CPUEs were related to river level which affected discharge from Wasenza Pool (Figure 25); CPUEs were low throughout early July before increasing as river levels fell drastically. As river levels fell throughout July the head differential between Wasenza Pool and Quiver Creek increased resulting in increased discharge. On 12 July the water was moving through the gates of the control structure so fast that setting nets in the effluent proved extremely difficult. Note that no value exists for plankton nets for that day because they were not deployed for fear that they would be torn apart by the current. We were unable to sample the effluent again until 17 July when Wasenza Pool had drained enough to decrease the head between the pool and the creek. Mean CPUEs in small-mesh hoop and plankton nets were highest on 17 and 18 July, but even higher CPUEs may have resulted had we been able to sample the effluent during the four previous days when discharge was highest. Mean CPUEs declined on 19 July when the river level increased, equalizing the water level in Quiver Creek with the pool and eventually reflooding the pool.

We estimated about 27 million larval and juvenile fish escaped from Wasenza Pool based upon our catches in small-mesh hoop nets (Table 14) and an average depth of 2.13 m. When an average depth of 2.44 m was used to calculate the pool volume, the estimate increased to about 31 million, so total estimated escapement varied by approximately 4 million fish per 0.3 m of depth used in the volume calculation. An estimate of about 18 million fish escaping from the pool was calculated from plankton net catches based on an average depth of 2.13 m. The volume of water sampled with small-mesh hoop nets was approximately seven times the volume sampled with plankton nets. While both nets caught mostly age-0 juveniles and a few adult fish, plankton nets also caught some larval fish small enough to pass through the mesh in the hoop nets. However, overall catches from the two gears were similar as about 94% of the small-mesh hoop net catch and 90% of the plankton net catch consisted of comparably-sized gizzard shad and emerald shiner juveniles.

The date on which selected species were first captured and last captured during escapement larval fish sampling along with length ranges at time of capture are listed in Table 15. Most fish caught during escapement sampling were larger than those caught during larval fish sampling. Freshwater drum and suckers less than 20 mm were collected in early July, indicating spawning for these taxa extended at least through late June. Gizzard shad collected during escapement sampling ranged from less than 10 mm long up to 110 mm, but most were between 10 and 80 mm (Figure 26). We caught emerald shiners up to 70 mm, but most were 20-49 mm (Figure 27). White bass from small-mesh hoop nets were slightly larger than those caught with plankton nets, with some specimens as large as 90 mm; the majority were 20-49 mm (Figure 28). Skipjack herring from small-mesh hoop nets were 10-89 mm, while red shiners and buffaloes were 10-69 mm (Figure 29). Suckers and minnows captured in plankton nets during escapement sampling were between 0 and 19 mm; these taxa were only identified to family (Figure 30).

Discussion

We documented 32 adult fish taxa in Wasenza Pool prior to larval fish sampling. The pool had been drained during winter 1995-1996, but some fish likely survived the winter in dredged channels that held water throughout the winter. Fish probably moved into the pool from Quiver Creek and Quiver Lake when the river began rising in late April and the stop logs were removed from the south control structure. River levels dropped subsequently and the stop logs were replaced which likely interrupted fish movement into the pool. The flood event that overtopped the south levee in mid-May allowed fish easy access to the pool from other nearby areas, and we believe most migration into the pool took place during this time. Had the south levee not been overtopped by floodwaters, we likely would have collected fewer adult fish and subsequently fewer larval fish. Had the levee been overtopped sooner (e.g., in late April), more fish may have moved into the pool, perhaps resulting in higher catch rates of adult and larval fish during the study. For example, largemouth bass frequently spawn in mid-May but may begin moving to spawning areas months before, possibly as early as mid-March (Raibley et al. 1997).

Larval fish were first visible in shallow areas along shorelines in mid-May, so spawning already had been initiated by some species before we began larval fish sampling. The majority of fish we collected were gizzard shad, minnows, and suckers, with relatively few gamefish. Adult, larval, and juvenile gamefish were present in the pool but were likely much less numerous than gizzard shad, minnows, and suckers which commonly dominate fish abundance in the Illinois River system (LTRMP unpublished data and Illinois Natural History Survey unpublished data). Light traps caught more species than plankton tows. Catches along shoreline habitats were much higher than in offshore habitats, possibly indicating most reproduction occurred along shorelines or that fish produced offshore moved to shorelines. If fish do seek shallow water (i.e., 1-2 m) for spawning, catches in offshore habitats may be higher in years when the spring flood is not as high which could result in a lesser overall pool depth than the 3-4 m we documented throughout June 1996.

Nearly all the taxa we collected during larval fish sampling were initially collected in late May and seemed to peak before late June, although many were still reproducing in late June. Length distributions of individuals from these taxa over time indicate new individuals were constantly being produced throughout the study period which was evident by the presence of age-0 fish of varying lengths. The data suggest peak production for most species occurred in mid- to late May, so in 1996, draining the pool in early July would probably not have disrupted spawning for a majority of the fish present. However, under different temperature regimes, results would likely be different. Furthermore, survival and growth of the young fish might be better in the pool than in the river.

The south control structure provided an opportunity to quantify fish movement out of the pool because it was the only exit point for fish as the pool drained. Escapement sampling proved to be an effective way to assess fish production in the pool and resulted in 14 species not previously collected during adult/larval sampling in this study. We were unable to document mass movements of adult fish out of the pool during our sampling with large-mesh hoop nets, but age-0 fish were moving out or being swept out the entire time we sampled the effluent. Although few adult fish were collected in the effluent, we did catch one paddlefish in a plankton net as it moved out of the pool. We suspected paddlefish used Lake Chautauqua and other Illinois River backwater lakes during floods; catching one coming out confirmed our suspicions. The presence of small mooneye indicates they are not only present in the system but reproduced successfully in Wasenza Pool in 1996. Escapement sampling verified that the fish produced in the pool can be released back into the system via the south control structure. Larval fish were still being collected in plankton nets at the end of sampling in July, but these were few in number in comparison with the larger juveniles which dominated the catch. The electrofishing catch below the effluent was similar in composition to the escapement catch (i.e., dominated by gizzard shad and emerald shiner) indicting fish were surviving the trip out of the pool, although it is possible some delayed mortality may have occurred later.

It appears Wasenza Pool of Lake Chautauqua has potential as a multiple-use unit which could be managed to produce fish during spring and grow moist soil plants during summer. Our estimates of 18 and 27 million fish (from plankton nets and small-mesh hoop nets, respectively), representing up to 34 taxa, produced and escaping from the pool indicates the potential of Wasenza Pool as a spawning and nursery area for many species of fish. In addition to the production of forage species, thousands of gamefish were also likely produced. Standing stock estimates from plankton tows indicate fish production in the pool was much higher than the escapement estimates. Total fish production, especially gamefish, may have been even greater had fish been able to access the pool during April and early May when many species were migrating to spawning locations. The culvert on Quiver Creek appears to be of little use as a fish passage structure, so the only access fish have to the pool when the levee is not overtopped is the south control structure which is a very small point of entry relative to the size of the pool. Thus, floods that overtop levees probably play a key role in allowing fish broad access to the pool.

In 1996, fish were able to escape from Wasenza Pool through the south control structure. Although most of the fish produced in the pool were forage species, thousands of individuals of other species were also produced and released back into the river system. The juvenile fish probably provided forage for other fish in the area and some may have been recruited to adult populations.

Recommendations

Further investigation is needed to determine fish production in Wasenza Pool of Lake Chautauqua under different water level, temperature, and management regimes, for example, during years when river levels do not overtop the levees or when floods have receded by July. During non-flood years, fish access to the pool would be restricted to open gates in the south control structure. Getting brood stock into the pool might limit fish production because it is generally drained during summer, leaving few fish in the pool at the beginning of spring. A post-drawdown electrofishing survey we conducted in pockets of water remaining in the pool in 1995 yielded few fish (mostly rough fish) and it seemed likely most fish had escaped as the pool drained. Fish that do not escape may have difficulty surviving stressful conditions accompanying low water during summer and winter (e.g. rapid temperature changes, low dissolved oxygen). To help insure brood stock enters the pool, it may be beneficial to allow fish access beginning in March or April. Filling the pool via the culvert on Quiver Creek (as in 1996) does not appear to allow fish passage but does provide a means of filling the pool when river levels are low during late winter or early spring. Once spring river levels are equal or higher than the elevation of the pool, the stop logs should be removed from the south control structure to fill the pool and allow fish access. Stop logs should be replaced to hold water in the pool should river levels decline. If river levels rise again the stop logs can be removed to allow more water and fish into the pool until the river drops. During a spring flood high enough to overtop the levees, fish would have unlimited access to the pool. In non-flood years, managers would have greater control of water levels in the pool. By investigating fish production during early-flood and non-flood years, an adaptive management plan could be developed based upon the water regime during any given year. Zooplankton production appeared to be significant in 1996 and without these organisms fish production would be impossible. Because of the importance of zooplankton to fish production, baseline data on plankton production should be collected in conjunction with future fish sampling.

Acknowledgments

Funding for this research was provided by the Rock Island District, U.S. Army Corps of Engineers through the Environmental Management Technical Center of the Biological Resources Division, U.S. Geological Survey with assistance from the Illinois Department of Natural Resources. The views expressed in this report are those of the authors.

We are indebted to the following Survey employees for their assistance in the field and lab: Kim Elkin, Mark Hoecker, T. Matt O'Hara, Mike Perfetti, Kip Stevenson, Lori Soeken, and Mike Ward; Cammy Smith was office manager during this project. Jim Stoeckel and Todd Koel (both of the Survey) reviewed an earlier draft of this report and provided valuable suggestions. The cooperation of staff at the U.S. Fish and Wildlife Service's Illinois River Refuges was appreciated. Charlene Carmack, U.S. Army Corps of Engineers, was the project manager for this work.

Literature Cited

American Fisheries Society. 1991. Common and scientific names of fishes from the United States and Canada. 5th ed. Bethesda, MD: Amer. Fish. Soc. Spec. Publ. 20: 324 pp.

Auer, N.A., ed. 1982. Identification of larval fishes of the Great Lakes basin with emphasis on the Lake Michigan drainage. Ann Arbor, MI: Great Lakes Fishery Commission, Spec. Publ. 82-3. 744 pp.

French, A. 1997. Illinois River National Wildlife and Fish Refuges: Water Management Strategy U.S. Fish Wildlife Serv. Draft. 16 pp.

Gutreuter, S., R. Burkhardt, and K. Lubinski. 1995. Long Term Resource Monitoring Program Procedures: Fish Monitoring. National Biological Service, Environmental Management Technical Center, Onalaska, Wisconsin, July 1995. LTRMP 95-P002-1. 42 pp. + Appendixes A-J

Hogue, J.J. Jr., R. Wallus, and L. Kay. 1976. Preliminary guide to the identification of larval fishes in the Tennessee River. Tennessee Val. Auth., Norris. Tech. Note B19. 66 pp.

Junk, W. J., P. B. Bayley, and R. E. Sparks. 1989. The flood pulse concept in river-floodplain systems. Can. Spec. Publ. Fish. Aquat. Sci., 106: 110-127.

Killgore, K.J. and R. Morgan. 1993. Easily constructed light trap helps scientists collect larval fishes in wetlands. The Wetland Research Program Bulletin. U.S. Army Corps of Engineers, Waterways Experiment Station. 3(4). 4 pp.

May, B.B., and C.R. Gasaway. 1967. A preliminary key to the identification of larval fishes of Oklahoma, with particular reference to Canton Reservoir, including a selected bibliography. Okla. Fish. Res. Lab., Bull. No. 5. 42 pp.

Raibley, P.T., K.S. Irons, T.M. O'Hara, K.D. Blodgett, and R.E. Sparks. 1997. Winter habitats used by largemouth bass in the Illinois River, a large river-floodplain ecosystem. N. Am. J. Fish. Manage. 17:401-412.

Sparks, R.E., K.S. Lubinski, J.C. Nelson, and Y. Yin. Submitted. Can the flood regime be restored in rivers managed for navigation and flood control? BioScience.

Table 1. Dates, efforts, and catch composition for preliminary electrofishing and adult fish sampling.

Preliminary Electrofishing
05/09/96

Gear	Effort
Day Electrofishing (15 min)	3

Taxa	No.	%
Common Carp	25	33.33%
Gizzard Shad	18	24.00%
White Bass	8	10.67%
Bigmouth Buffalo	5	6.67%
Freshwater Drum	5	6.67%
Smallmouth Buffalo	4	5.33%
Emerald Shiner	2	2.67%
Largemouth Bass	2	2.67%
Black Crappie	2	2.67%
Sauger	2	2.67%
Red Shiner	1	1.33%
River Carpsucker	1	1.33%
Total fish	75	
Total taxa	12	

Adult Fish Sampling
05/13/96-05/16/96

Gear	Effort
Day Electrofishing (15 min)	13
Fyke Nets	16
Tandem Fyke Nets	6

Taxa	No.	%
Freshwater Drum	675	26.55%
Shortnose Gar	480	18.88%
Common Carp	310	12.20%
White Bass	227	8.93%
Bluegill	161	6.33%
Gizzard Shad	108	4.25%
River Carpsucker	107	4.21%
Black Crappie	100	3.93%
Smallmouth Buffalo	96	3.78%
White Crappie	52	2.05%
Yellow Bass	41	1.61%
Brown Bullhead	39	1.53%
Channel Catfish	28	1.10%
Bigmouth Buffalo	19	0.75%
Yellow Bullhead	17	0.67%
Black Bullhead	17	0.67%
Emerald Shiner	16	0.63%
Shorthead Redhorse	11	0.43%
Spotted Gar	8	0.31%
Sauger	8	0.31%
Bowfin	4	0.16%
Black Buffalo	4	0.16%
Largemouth Bass	3	0.12%
Goldfish	2	0.08%
Golden Redhorse	2	0.08%
Green Sunfish X Bluegill	2	0.08%
Walleye	1	0.04%
Warmouth	1	0.04%
Green Sunfish	1	0.04%
Grass Carp	1	0.04%
Quillback	1	0.04%
Total fish	2,542	
Total taxa	31	

Table 2. Common and scientific names of fishes.

Common name	Scientific name
Black Buffalo	*Ictiobus niger*
Black Bullhead	*Ameiurus catus*
Black Crappie	*Pomoxis nigromaculatus*
Bluegill	*Lepomis macrochirus*
Bigmouth Buffalo	*Ictiobus cyprinellus*
Brown Bullhead	*Ameiurus nebulosus*
Bluntnose Minnow	*Pimephales notatus*
Bowfin	*Amia calva*
Common Carp	*Cyprinus carpio*
Central Stoneroller	*Campostoma anomalum*
Channel Catfish	*Ictalurus punctatus*
Emerald Shiner	*Notropis atherinoides*
Freshwater Drum	*Aplodinotus grunniens*
Goldeye	*Hiodon alosoides*
Goldfish	*Carassius auratus*
Golden Redhorse	*Moxostoma erythrurum*
Golden Shiner	*Notemigonus crysoleucas*
Green Sunfish	*Lepomis cyanellus*
Green Sunfish x Bluegill	*Lepomis cyanellus x macrochirus*
Grass Carp	*Ctenopharyngodon idella*
Gizzard Shad	*Dorosoma cepedianum*
Johnny Darter	*Etheostoma nigrum*
Logperch	*Percina caprodes*
Largemouth Bass	*Micropterus salmoides*
Mud Darter	*Etheostoma asprigene*
Mooneye	*Hiodon tergisus*
Paddlefish	*Polyodon spathula*
Quillback	*Carpiodes cyprinus*
Red Shiner	*Cyprinella lutrensis*
River Carpsucker	*Carpiodes carpio*
Silverband Shiner	*Notropis shumardi*
Sauger	*Stizostedion canadense*
Shorthead Redhorse	*Moxostoma macrolepidotum*
Skipjack Herring	*Alosa chrysochloris*
Smallmouth Buffalo	*Ictiobus bubalus*
Shortnose Gar	*Lepisosteus platostomus*
Sand Shiner	*Notropis stramineus*
Spotted Gar	*Lepisosteus oculatus*
Spottail Shiner	*Notropis hudsonius*
Silver Chub	*Macrhybopsis storeriana*
Threadfin Shad	*Dorosoma petenense*
Walleye	*Stizostedion vitreum*
Warmouth	*Lepomis gulosus*
Western Mosquitofish	*Gambusia affinis*
White Bass	*Morone chrysops*
White Crappie	*Pomoxis annularis*
Yellow Bullhead	*Ameiurus natalis*
Yellow Bass	*Morone mississippiensis*
Buffaloes	*Ictiobus spp.*
Sunfishes	Centrarchidae
Suckers	Catostomidae
Minnows	Cyprinidae
Shiners	*Notropis spp.*
Perches	Percidae

Table 3. Dates, efforts, and catch composition for larval fish sampling.

Larval Fish Sampling
05/16/96-06/28/96

Gear	Effort
Offshore Light Traps	55
Shoreline Light Traps	53
Offshore Plankton Tows	59
Shoreline Plankton Tows	58

Taxa	No.	%
Gizzard Shad	32,408	87.29%
Suckers	2,992	8.06%
Minnows	754	2.03%
White Bass	511	1.38%
Shiners	128	0.34%
Common Carp	126	0.34%
Buffaloes	118	0.32%
Sunfishes	51	0.14%
Freshwater Drum	26	0.07%
Shortnose Gar	4	0.01%
Perches	2	0.01%
River Carpsucker	2	0.01%
Red Shiner	1	0.00%
Central Stoneroller	1	0.00%
Johnny Darter	1	0.00%
Largemouth Bass	1	0.00%
Total fish	37,126	
Total taxa	16	

Table 4. Number of individuals collected by species and gear for fish production sampling of Wasenza Pool of Lake Chautauqua.

	Adult and Larval fish sampling within pool								Escapement sampling				
Taxa	Day EF	Day EF	Fyke Nets	Tandem Fyke Nets	Offshore Plankton Tows	Shoreline Plankton Tows	Offshore Light Traps	Shoreline Light Traps	Small Mesh Hoop Nets	Plankton Nets	Large Mesh Hoop Nets	Day EF	All
Black Buffalo	0	3	1	0	0	0	0	0	0	0	0	0	4
Black Bullhead	0	0	16	1	0	0	0	0	0	0	0	0	17
Black Crappie	2	0	98	2	0	0	0	0	4	0	0	0	106
Bluegill	0	1	160	0	0	0	0	0	11	0	4	4	180
Bigmouth Buffalo	5	17	2	0	0	0	0	0	12	0	2	5	43
Brown Bullhead	0	1	35	3	0	0	0	0	0	0	0	1	40
Bluntnose Minnow	0	0	0	0	0	0	0	0	1	0	0	0	1
Bowfin	0	1	3	0	0	0	0	0	0	0	0	1	5
Common Carp	25	53	207	50	28	15	0	83	2	0	0	25	488
Central Stoneroller	0	0	0	0	0	0	0	1	0	0	0	0	1
Channel Catfish	0	0	15	13	0	0	0	0	1	0	0	4	33
Emerald Shiner	2	16	0	0	0	0	0	0	14,550	1,621	0	153	16,342
Freshwater Drum	5	16	637	22	6	3	6	11	628	58	0	4	1,396
Goldeye	0	0	0	0	0	0	0	0	1	0	0	0	1
Goldfish	0	0	2	0	0	0	0	0	0	0	0	0	2
Golden Redhorse	0	1	0	1	0	0	0	0	0	0	0	1	3
Golden Shiner	0	0	0	0	0	0	0	0	17	1	0	1	19
Green Sunfish	0	0	1	0	0	0	0	0	0	0	0	0	1
Green Sunfish X Bluegill	0	0	2	0	0	0	0	0	0	0	0	0	2
Grass Carp	0	0	1	0	0	0	0	0	0	0	0	0	1
Gizzard Shad	18	51	56	1	5,118	17,629	37	9,624	19,526	1,502	16	529	54,107
Johnny Darter	0	0	0	0	0	0	0	1	0	0	0	0	1
Logperch	0	0	0	0	0	0	0	0	20	2	0	1	23
Largemouth Bass	2	3	0	0	0	0	0	1	9	2	0	9	26
Mud Darter	0	0	0	0	0	0	0	0	2	0	0	0	2
Mooneye	0	0	0	0	0	0	0	0	3	0	0	0	3
Paddlefish	0	0	0	0	0	0	0	0	0	1	0	0	1
Quillback	0	0	1	0	0	0	0	0	0	0	0	0	1
Red Shiner	1	0	0	0	0	0	0	1	38	1	0	0	41
River Carpsucker	1	13	81	13	0	0	0	2	2	0	2	2	116
Silverband Shiner	0	0	0	0	0	0	0	0	7	0	0	1	8
Sauger	2	3	4	1	0	0	0	0	34	0	0	5	49
Shorthead Redhorse	0	0	7	4	0	0	0	0	0	0	0	0	11
Skipjack Herring	0	0	0	0	0	0	0	0	698	87	0	0	785
Smallmouth Buffalo	4	33	54	9	0	0	0	0	11	5	4	3	123
Shortnose Gar	0	9	471	0	1	1	0	2	1	0	1	2	488
Sand Shiner	0	0	0	0	0	0	0	0	1	1	0	0	2
Spotted Gar	0	0	8	0	0	0	0	0	0	0	0	0	8
Spottail Shiner	0	0	0	0	0	0	0	0	7	1	0	0	8
Silver Chub	0	0	0	0	0	0	0	0	0	1	0	0	1
Threadfin Shad	0	0	0	0	0	0	0	0	48	0	0	1	49
Walleye	0	0	0	1	0	0	0	0	0	0	0	0	1
Warmouth	0	0	1	0	0	0	0	0	0	0	0	0	1
Western Mosquitofish	0	0	0	0	0	0	0	0	1	0	0	0	1
White Bass	8	3	200	24	72	141	0	298	424	64	0	27	1,261
White Crappie	0	0	51	1	0	0	0	0	1	1	0	0	54
Yellow Bullhead	0	0	17	0	0	0	0	0	0	0	0	0	17
Yellow Bass	0	0	39	2	0	0	0	0	0	0	0	0	41
Buffaloes	0	0	0	0	9	10	0	99	101	14	0	5	238
Sunfishes	0	0	0	0	17	15	0	19	0	0	0	0	51
Suckers	0	0	0	0	386	2,067	8	531	15	76	0	0	3,083
Minnows	0	0	0	0	148	265	21	320	0	33	0	0	787
Shiners	0	0	0	0	3	6	2	117	2	0	0	0	130
Perches	0	0	0	0	0	0	0	2	0	0	0	0	2
Total Fish	75	224	2,170	148	5,788	20,152	74	11,112	36,178	3,471	29	784	80,205
Total Taxa	12	16	27	16	10	10	5	16	31	18	6	21	54

Table 5. Catches in light traps and net tows during larval fish sampling.

Light Traps

Taxa	No.	%
Gizzard Shad	9,661	86.37%
Suckers	539	4.82%
Minnows	341	3.05%
White Bass	298	2.66%
Shiners	119	1.06%
Buffaloes	99	0.89%
Common Carp	83	0.74%
Sunfishes	19	0.17%
Freshwater Drum	17	0.15%
River Carpsucker	2	0.02%
Shortnose Gar	2	0.02%
Perches	2	0.02%
Central Stoneroller	1	0.01%
Johnny Darter	1	0.01%
Largemouth Bass	1	0.01%
Red Shiner	1	0.01%
Total fish	11,186	
Total taxa	16	

Plankton Tows

Taxa	No.	%
Gizzard Shad	22,760	87.69%
Suckers	2,454	9.46%
Minnows	413	1.59%
White Bass	213	0.82%
Common Carp	43	0.17%
Sunfishes	32	0.12%
Buffaloes	19	0.07%
Shiners	9	0.03%
Freshwater Drum	9	0.03%
Shortnose Gar	2	0.01%
Total fish	25,954	
Total taxa	10	

Table 6. Mean catches of larval fish in light traps and plankton tows.

	Offshore Light Traps	Shoreline Light Traps	All Light Traps	Offshore Plankton Tows	Shoreline Plankton Tows	All Plankton Tows
n	55	53	108	59	58	117
Total Fish Collected	74	11,112	11,186	5,788	20,152	25,940
Mean CPUE*	1.35	209.66	103.57	508.90	1,939.34	1,218
SE	0.34	50.19	26.5	97.49	833.38	419.5
Min	0	0	0	14.67	5.33	5.33
Max	11	1,600	1,600	4,344	37,696	37,696

* Units are number of fish/12 hour light trap set and number of fish/100 cubic meters of water sampled.

Table 7. Calculations for offshore paired plankton tow CPUEs during larval fish sampling and means for flow volume and CPUE

Sample	Date	Time	Mins	Net 1 (revs)	Net 2 (revs)	Difference (revs)	Mean (revs)	m3 sampled both nets	Number of Fish	CPUE fish/m3	CPUE fish/100m3
P1.RS	05/22/96	11:00	1	3,306	3,417	111	3,361.5	33.8	134	3.96	396
P5.RS	05/22/96	11:15	1	2,978	3,829	851	3,403.5	34.2	13	0.38	38
P3.RS	05/22/96	11:45	1	2,146	2,146	0	2,146.0	21.6	10	0.46	46
P2.RS	05/22/96	11:55	1	2,434	2,466	32	2,450.0	24.6	30	1.22	122
P8.RS	05/24/96	10:00	1	1,870	1,052	818	1,461.0	14.7	89	6.06	606
P7.RS	05/24/96	10:23	1	1,998	1,703	295	1,850.5	18.6	55	2.95	295
P6.RS	05/24/96	10:30	1	1,680	1,550	130	1,615.0	16.2	221	13.60	1,360
P9.RS	05/24/96	10:59	1	2,355	2,054	301	2,204.5	22.2	119	5.37	537
P10.RS	05/24/96	11:05	1	3,239	2,834	405	3,036.5	30.5	388	12.70	1,270
P11.RS	05/29/96	08:47	1	2,214	2,347	133	2,280.5	22.9	181	7.89	789
P13.RS	05/29/96	09:09	1	1,502	1,518	16	1,510.0	15.2	215	14.16	1,416
P4.RS	05/29/96	09:15	1	1,828	1,696	132	1,762.0	17.7	103	5.81	581
P14.RS	05/29/96	09:24	1	1,782	1,986	204	1,884.0	19.0	146	7.70	770
P12.RS	05/29/96	09:54	1	1,467	1,565	98	1,516.0	15.2	495	32.46	3,246
P16.RS	05/31/96	09:55	1	2,651	2,842	191	2,746.5	27.6	429	15.53	1,553
P17.RS	05/31/96	10:35	1	2,035	1,898	137	1,966.5	19.8	48	2.43	243
P15.RS	05/31/96	10:45	1	2,097	1,878	219	1,987.5	20.0	56	2.80	280
P19.RS	05/31/96	10:56	1	2,103	2,129	26	2,116.0	21.3	281	13.20	1,320
P18.RS	05/31/96	11:04	1	1,767	1,943	176	1,855.0	18.7	61	3.27	327
P20.RS	06/05/96	09:28	1	1,929	2,120	191	2,024.5	20.4	9	0.44	44
P21.RS	06/05/96	09:51	1	1,611	1,919	308	1,765.0	17.8	10	0.56	56
P22.RS	06/05/96	09:56	1	1,777	1,976	199	1,876.5	18.9	5	0.26	26
P23.RS	06/05/96	10:04	1	2,332	2,646	314	2,489.0	25.0	51	2.04	204
P24.RS	06/05/96	10:30	1	2,257	1,866	391	2,061.5	20.7	109	5.26	526
P26.RS	06/07/96	08:30	1	2,565	2,145	420	2,355.0	23.7	294	12.41	1,241
P25.RS	06/07/96	08:45	1	2,117	1,954	163	2,035.5	20.5	36	1.76	176
P28.RS	06/07/96	08:50	1	1,519	1,620	101	1,569.5	15.8	23	1.46	146
P27.RS	06/07/96	09:00	1	2,040	2,181	141	2,110.5	21.2	85	4.00	400
P29.RS	06/07/96	09:05	1	2,517	2,542	25	2,529.5	25.4	46	1.81	181
P34.RS	06/12/96	08:55	1	1,980	1,727	253	1,853.5	18.6	154	8.26	826
P31.RS	06/12/96	09:15	1	1,675	1,387	288	1,531.0	15.4	669	43.44	4,344
P33.RS	06/12/96	09:50	1	2,248	2,395	147	2,321.5	23.4	23	0.98	98
P32.RS	06/12/96	10:00	1	1,548	1,673	125	1,610.5	16.2	176	10.86	1,086
P30.RS	06/12/96	10:05	1	1,547	1,698	151	1,622.5	16.3	66	4.04	404
P39.RS	06/14/96	08:55	1	1,823	1,679	144	1,751.0	17.6	88	5.00	500
P38.RS	06/14/96	09:05	1	1,916	1,857	59	1,886.5	19.0	92	4.85	485
P37.RS	06/14/96	09:15	1	2,057	2,149	92	2,103.0	21.2	83	3.92	392
P36.RS	06/14/96	09:20	1	1,670	1,617	53	1,643.5	16.5	80	4.84	484
P35.RS	06/14/96	09:55	1	1,475	1,608	133	1,541.5	15.5	48	3.10	310
P40.RS	06/19/96	09:38	1	2,038	2,054	16	2,046.0	20.6	30	1.46	146
P44.RS	06/19/96	10:26	1	2,136	2,222	86	2,179.0	21.9	60	2.74	274
P42.RS	06/19/96	10:37	1	2,356	2,400	44	2,378.0	23.9	147	6.15	615
P41.RS	06/19/96	10:44	1	2,163	2,052	111	2,107.5	21.2	22	1.04	104
P43.RS	06/19/96	10:52	1	2,114	1,963	151	2,038.5	20.5	109	5.32	532
P48.RS	06/21/96	08:50	1	1,057	1,292	235	1,174.5	11.8	3	0.25	25
P49.RS	06/21/96	09:00	1	1,272	1,411	139	1,341.5	13.5	20	1.48	148
P46.RS	06/21/96	09:08	1	1,243	1,218	25	1,230.5	12.4	7	0.57	57
P47.RS	06/21/96	09:48	1	1,221	1,353	132	1,287.0	12.9	5	0.39	39
P45.RS	06/21/96	09:55	1	1,354	1,247	107	1,300.5	13.1	5	0.38	38
P53.RS	06/26/96	13:34	1	1,474	1,540	66	1,507.0	15.2	5	0.33	33
P54.RS	06/26/96	13:42	1	1,970	2,095	125	2,032.5	20.4	3	0.15	15
P52.RS	06/26/96	13:48	1	2,057	1,770	287	1,913.5	19.2	6	0.31	31
P50.RS	06/26/96	14:15	1	1,351	1,419	68	1,385.0	13.9	33	2.37	237
P51.RS	06/26/96	14:21	1	1,485	1,641	156	1,563.0	15.7	13	0.83	83
P55.RS	06/28/96	08:58	1	2,110	2,018	92	2,064.0	20.8	4	0.19	19
P57.RS	06/28/96	09:06	1	1,757	1,676	81	1,716.5	17.3	35	2.03	203
P59.RS	06/28/96	09:40	1	1,992	2,161	169	2,076.5	20.9	6	0.29	29
P56.RS	06/28/96	09:47	1	1,994	2,071	77	2,032.5	20.4	33	1.61	161
P58.RS	06/28/96	09:52	1	1,940	1,810	130	1,875.0	18.9	21	1.11	111
N = 59			59				Total	1,157.6	5,788		
							Mean	19.62		5.09	508.90
							Std	4.63		7.42	742.48
							SE	0.61		0.97	97.49
							Max	34.23		43.44	4,344.26
							Min	11.81		0.15	14.67

Table 8. Calculations for shoreline paired plankton tow CPUEs during larval fish sampling and means for flow volume and CPUE.

Sample	Date	Time	Mins	Net 1 (revs)	Net 2 (revs)	Diff (revs)	Mean (revs)	m3 sampled both nets	Number of Fish	CPUE fish/m3	CPUE fish/100m3
PS3.RS	05/22/96	09:55	5	10,099	10,237	138	10,168.0	102.3	112	1.10	110
PS4.RS	05/22/96	10:20	5	8,541	8,541	0	8,541.0	85.9	95	1.11	111
PS1.RS	05/22/96	10:40	5	8,599	9,363	764	8,981.0	90.3	171	1.89	189
PS5.RS	05/22/96	11:30	1	2,471	4,080	1,609	3,275.5	32.9	29	0.88	88
PS2.RS	05/22/96	12:05	1	1,919	2,206	287	2,062.5	20.7	301	14.51	1,451
PS6.RS	05/24/96	10:42	1	1,751	1,488	263	1,619.5	16.3	92	5.65	565
PS9.RS	05/24/96	10:53	1	1,541	1,649	108	1,595.0	16.0	108	6.73	673
PS7.RS	05/24/96	11:15	1	2,340	2,084	256	2,212.0	22.2	147	6.61	661
PS8.RS	05/29/96	08:59	1	1,760	1,664	96	1,712.0	17.2	327	18.99	1,899
PS13.RS	05/29/96	09:32	1	1,887	1,997	110	1,942.0	19.5	152	7.78	778
PS11.RS	05/29/96	09:44	1	1,912	1,817	95	1,864.5	18.8	300	16.00	1,600
PS12.RS	05/29/96	10:00	1	1,816	1,898	82	1,857.0	18.7	2445	130.90	13,090
PS10.RS	05/29/96	10:10	1	1,603	1,834	231	1,718.5	17.3	6516	376.96	37,696
PS16.RS	05/31/96	09:42	1	2,801	2,586	215	2,693.5	27.1	402	14.84	1,484
PS17.RS	05/31/96	10:10	1	1,436	1,978	542	1,707.0	17.2	61	3.55	355
PS14.RS	05/31/96	10:20	1	1,682	1,784	102	1,733.0	17.4	25	1.43	143
PS15.RS	05/31/96	10:29	1	1,857	1,716	141	1,786.5	18.0	21	1.17	117
PS18.RS	05/31/96	11:20	1	1,618	1,648	30	1,633.0	16.4	4622	281.39	28,139
PS22.RS	06/05/96	09:19	1	2,058	2,525	467	2,291.5	23.0	17	0.74	74
PS19.RS	06/05/96	09:36	1	2,991	3,386	395	3,188.5	32.1	20	0.62	62
PS23.RS	06/05/96	09:45	1	1,286	1,504	218	1,395.0	14.0	19	1.35	135
PS21.RS	06/05/96	10:15	1	1,764	1,792	28	1,778.0	17.9	1490	83.31	8,331
PS20.RS	06/05/96	10:21	1	1,770	1,692	78	1,731.0	17.4	1135	65.19	6,519
PS26.RS	06/07/96	08:40	1	2,141	2,428	287	2,284.5	23.0	189	8.22	822
PS25.RS	06/07/96	09:15	1	1,865	1,665	200	1,765.0	17.8	19	1.07	107
PS27.RS	06/07/96	09:55	1	1,764	1,565	199	1,664.5	16.7	8	0.48	48
PS24.RS	06/07/96	10:05	1	2,050	2,188	138	2,119.0	21.3	371	17.41	1,741
PS28.RS	06/07/96	10:20	1	1,731	2,028	297	1,879.5	18.9	73	3.86	386
PS29.RS	06/12/96	09:10	1	1,837	1,700	137	1,768.5	17.8	69	3.88	388
PS32.RS	06/12/96	09:20	1	2,051	1,802	249	1,926.5	19.4	30	1.55	155
PS30.RS	06/12/96	09:30	1	1,748	2,338	590	2,043.0	20.5	51	2.48	248
PS33.RS	06/12/96	09:40	1	1,407	1,591	184	1,499.0	15.1	94	6.23	623
PS31.RS	06/12/96	09:45	1	2,044	2,233	189	2,138.5	21.5	8	0.37	37
PS34.RS	06/14/96	09:26	1	1,685	1,660	25	1,672.5	16.8	11	0.65	65
PS37.RS	06/14/96	09:36	1	1,518	1,468	50	1,493.0	15.0	59	3.93	393
PS38.RS	06/14/96	09:46	1	1,429	1,492	63	1,460.5	14.7	13	0.88	88
PS35.RS	06/14/96	10:05	1	1,494	1,517	23	1,505.5	15.1	19	1.25	125
PS36.RS	06/14/96	10:11	1	1,697	1,617	80	1,657.0	16.7	23	1.38	138
PS41.RS	06/19/96	09:47	1	1,996	1,521	475	1,758.5	17.7	68	3.84	384
PS42.RS	06/19/96	09:56	1	3,006	3,038	32	3,022.0	30.4	13	0.43	43
PS40.RS	06/19/96	10:06	1	2,534	2,442	92	2,488.0	25.0	53	2.12	212
PS43.RS	06/19/96	10:16	1	2,127	1,836	291	1,981.5	19.9	67	3.36	336
PS39.RS	06/19/96	11:02	1	1,672	1,672	0	1,672.0	16.8	110	6.54	654
PS46.RS	06/21/96	09:21	1	1,005	1,245	240	1,125.0	11.3	4	0.35	35
PS48.RS	06/21/96	09:31	1	1,059	1,221	162	1,140.0	11.5	2	0.17	17
PS47.RS	06/21/96	09:40	1	1,873	1,860	13	1,866.5	18.8	1	0.05	5
PS44.RS	06/21/96	10:02	1	1,405	1,450	45	1,427.5	14.4	53	3.69	369
PS45.RS	06/21/96	10:14	1	1,347	1,201	146	1,274.0	12.8	10	0.78	78
PS49.RS	06/26/96	13:07	1	1,741	1,664	77	1,702.5	17.1	10	0.58	58
PS51.RS	06/26/96	13:16	1	1,697	1,780	83	1,738.5	17.5	11	0.63	63
PS52.RS	06/26/96	13:22	1	1,608	1,608	0	1,608.0	16.2	21	1.30	130
PS50.RS	06/26/96	13:55	1	1,472	1,591	119	1,531.5	15.4	20	1.30	130
PS53.RS	06/26/96	14:05	1	1,686	1,539	147	1,612.5	16.2	9	0.55	55
PS54.RS	06/28/96	09:12	1	2,144	2,026	118	2,085.0	21.0	9	0.43	43
PS57.RS	06/28/96	09:17	1	2,309	2,066	243	2,187.5	22.0	17	0.77	77
PS56.RS	06/28/96	09:25	1	2,310	1,752	558	2,031.0	20.4	6	0.29	29
PS58.RS	06/28/96	09:34	1	1,926	1,910	16	1,918.0	19.3	6	0.31	31
PS55.RS	06/28/96	09:59	1	1,911	1,869	42	1,890.0	19.0	18	0.95	95
N = 58			70				Total	1,311.9	20,152		
							Mean	22.62		19.39	1,939.34
							Std	17.01		62.92	6,291.88
							SE	2.25		8.33	833.38
							Max	102.28		376.96	37,696.11
							Min	11.32		0.05	5.33

Table 9. Date and size ranges of larval fish caught with light traps and plankton tows (05/16/96 - 06/28/96).

	Date First Captured	Length Range (mm)	Date Last Captured	Length Range (mm)
Common Carp	05/21	7-8	06/27	12-15
Freshwater Drum	05/29	5-7	06/27	10-14
Gizzard Shad	05/21	5-8	06/28	6-18
Largemouth Bass	06/04	13		
Shortnose Gar	05/21	8-16	06/18	14-42
Buffaloes	05/22	9-14	06/20	18-24
Sunfishes	05/24	4-6	06/21	5-6
Suckers	05/21	6-8	06/28	6-12
Minnows	05/16	3-7	06/28	8-12
Shiners	05/21	3	06/28	10-20
White Bass	05/24	4-7	06/27	9-18

Table 10. Dates, efforts, and catch composition for escapement sampling.

Escapement Juvenile Sampling
06/28/96-07/19/96

Gear	Effort
Small Mesh Hoop Nets	70
Plankton Nets	50

Taxa	No.	%
Gizzard Shad	21,028	53.04%
Emerald Shiner	16,171	40.79%
Skipjack Herring	785	1.98%
Freshwater Drum	686	1.73%
White Bass	488	1.23%
Buffaloes	115	0.29%
Suckers	91	0.23%
Threadfin Shad	48	0.12%
Red Shiner	39	0.10%
Sauger	34	0.09%
Minnows	33	0.08%
Logperch	22	0.06%
Golden Shiner	18	0.05%
Smallmouth Buffalo	16	0.04%
Bigmouth Buffalo	12	0.03%
Largemouth Bass	11	0.03%
Bluegill	11	0.03%
Spottail Shiner	8	0.02%
Silverband Shiner	7	0.02%
Black Crappie	4	0.01%
Mooneye	3	0.01%
River Carpsucker	2	0.01%
Sand Shiner	2	0.01%
White Crappie	2	0.01%
Common Carp	2	0.01%
Mud Darter	2	0.01%
Shiners	2	0.01%
Shortnose Gar	1	0.00%
Goldeye	1	0.00%
Western Mosquitofish	1	0.00%
Paddlefish	1	0.00%
Silver Chub	1	0.00%
Bluntnose Minnow	1	0.00%
Channel Catfish	1	0.00%
Total fish	39,649	
Total taxa	34	

Escapement Adult Sampling
06/28/96-07/19/96

Gear	Effort
Large Mesh Hoop Nets	5

Taxa	No.	%
Gizzard Shad	16	55.17%
Bluegill	4	13.79%
Smallmouth Buffalo	4	13.79%
Bigmouth Buffalo	2	6.90%
River Carpsucker	2	6.90%
Shortnose Gar	1	3.45%
Total fish	29	
Total taxa	6	

Escapement Electrofishing
07/16/96 - Quiver Creek

Gear	Effort
Day Electrofishing (12 min)	1

Species	No.	%
Gizzard Shad	529	67.47%
Emerald Shiner	153	19.52%
White Bass	27	3.44%
Common Carp	25	3.19%
Largemouth Bass	9	1.15%
Bigmouth Buffalo	5	0.64%
Sauger	5	0.64%
Buffaloes	5	0.64%
Channel Catfish	4	0.51%
Bluegill	4	0.51%
Freshwater Drum	4	0.51%
Smallmouth Buffalo	3	0.38%
River Carpsucker	2	0.26%
Shortnose Gar	2	0.26%
Bowfin	1	0.13%
Brown Bullhead	1	0.13%
Golden Redhorse	1	0.13%
Threadfin Shad	1	0.13%
Logperch	1	0.13%
Silverband Shiner	1	0.13%
Golden Shiner	1	0.13%
Total fish	784	
Total taxa	21	

Table 11. Catches in small-mesh hoop nets and plankton nets during escapement sampling.

Small Mesh Hoop Nets

Taxa	No.	%
Gizzard Shad	19,526	53.97%
Emerald Shiner	14,550	40.22%
Skipjack Herring	698	1.93%
Freshwater Drum	628	1.74%
White Bass	424	1.17%
Buffaloes	101	0.28%
Threadfin Shad	48	0.13%
Red Shiner	38	0.11%
Sauger	34	0.09%
Logperch	20	0.06%
Golden Shiner	17	0.05%
Suckers	15	0.04%
Bigmouth Buffalo	12	0.03%
Smallmouth Buffalo	11	0.03%
Bluegill	11	0.03%
Largemouth Bass	9	0.02%
Spottail Shiner	7	0.02%
Silverband Shiner	7	0.02%
Black Crappie	4	0.01%
Mooneye	3	0.01%
Shiners	2	0.01%
River Carpsucker	2	0.01%
Common Carp	2	0.01%
Mud Darter	2	0.01%
White Crappie	1	<0.01%
Sand Shiner	1	<0.01%
Shortnose Gar	1	<0.01%
Western Mosquitofish	1	<0.01%
Goldeye	1	<0.01%
Channel Catfish	1	<0.01%
Bluntnose Minnow	1	<0.01%
Total fish	36,178	
Total taxa	31	

Plankton Nets

Taxa	No.	%
Emerald Shiner	1,621	46.70%
Gizzard Shad	1,502	43.27%
Skipjack Herring	87	2.51%
Suckers	76	2.19%
White Bass	64	1.84%
Freshwater Drum	58	1.67%
Minnows	33	0.95%
Buffaloes	14	0.40%
Smallmouth Buffalo	5	0.14%
Logperch	2	0.06%
Largemouth Bass	2	0.06%
Silver Chub	1	0.03%
Spottail Shiner	1	0.03%
Red Shiner	1	0.03%
Sand Shiner	1	0.03%
Paddlefish	1	0.03%
White Crappie	1	0.03%
Golden Shiner	1	0.03%
Total fish	3,471	
Total taxa	18	

Table 12. Calculations for individual small-mesh hoop net CPUEs during escapement sampling and means for flow volume and CPUE.

Date	Minutes	Revs	Flow Volume m3 sampled	Number of Fish	CPUE Fish/m3	CPUE Fish/100m3
07/02/96	5	2546	56.58	71	1.25	125
07/02/96	5	2,136	47.47	8	0.17	17
07/02/96	5	2,901	64.47	4	0.06	6
07/02/96	5	2,601	57.80	19	0.33	33
07/02/96	15	10,775	239.44	391	1.63	163
07/02/96	15	7,768	172.62	111	0.64	64
07/02/96	15	8,816	195.91	107	0.55	55
07/02/96	15	10,355	230.11	121	0.53	53
07/02/96	15	12,717	282.60	55	0.19	19
07/03/96	15	12,540	278.67	11	0.04	4
07/03/96	15	6,089	135.31	14	0.10	10
07/03/96	15	15,690	348.67	13	0.04	4
07/03/96	15	16,537	367.49	7	0.02	2
07/03/96	15	17,418	387.07	20	0.05	5
07/05/96	15	20,751	461.13	186	0.40	40
07/05/96	15	25,307	562.38	70	0.12	12
07/05/96	15	25,307	562.38	49	0.09	9
07/05/96	15	22,874	508.31	418	0.82	82
07/05/96	15	23,301	517.80	842	1.63	163
07/08/96	15	10,009	222.42	100	0.45	45
07/08/96	15	25,392	564.27	84	0.15	15
07/08/96	15	21,103	468.96	388	0.83	83
07/08/96	15	26,594	590.98	114	0.19	19
07/08/96	15	26,372	586.04	1553	2.65	265
07/08/96	15	29,706	660.13	307	0.47	47
07/08/96	15	32,163	714.73	304	0.43	43
07/08/96	15	32,163	714.73	517	0.72	72
07/08/96	15	29,816	662.58	506	0.76	76
07/08/96	15	12,910	286.89	361	1.26	126
07/09/96	15	34,475	766.11	1320	1.72	172
07/09/96	5	12,751	283.36	217	0.77	77
07/09/96	5	12,374	274.98	207	0.75	75
07/09/96	5	12,215	271.44	267	0.98	98
07/09/96	5	12,303	273.40	166	0.61	61
07/09/96	5	9,969	221.53	62	0.28	28
07/09/96	5	12,742	283.16	281	0.99	99
07/10/96	5	12,797	284.38	592	2.08	208
07/10/96	5	12,086	268.58	889	3.31	331
07/10/96	5	6,947	154.38	27	0.17	17
07/10/96	5	9,876	219.47	36	0.16	16
07/10/96	5	15,377	341.71	853	2.50	250
07/10/96	5	13,406	297.91	28	0.09	9
07/10/96	5	13,232	294.04	33	0.11	11
07/10/96	5	11,429	253.98	190	0.75	75
07/10/96	5	11,507	255.71	17	0.07	7
07/10/96	5	13,308	295.73	553	1.87	187
07/10/96	5	11,128	247.29	3056	12.36	1,236
07/11/96	5	11,576	257.24	110	0.43	43
07/11/96	5	14,207	315.71	34	0.11	11
07/11/96	10	26,244	583.20	302	0.52	52
07/11/96	10	25,981	577.36	928	1.61	161
07/11/96	10	24,829	551.76	4082	7.40	740
07/12/96	2	7,892	175.38	361	2.06	206
07/12/96	2	7,820	173.78	46	0.26	26
07/12/96	5	16,325	362.78	736	2.03	203
07/12/96	16	83,262	1,850.27	1194	0.65	65
07/17/96	5	15,062	334.71	1862	5.56	556
07/17/96	3	10,501	233.36	1062	4.55	455
07/17/96	2	7,256	161.24	1167	7.24	724
07/17/96	3	10,317	229.27	2288	9.98	998
07/18/96	2	5,798	128.84	1622	12.59	1,259
07/18/96	1	2,868	63.73	535	8.39	839
07/18/96	1	2,600	57.78	1607	27.81	2,781
07/18/96	1	2,928	65.07	1050	16.14	1,614
07/18/96	1	3,014	66.98	1286	19.20	1,920
07/19/96	1	1,397	31.04	36	1.16	116
07/19/96	2	2,388	53.07	72	1.36	136
07/19/96	5	4,817	107.04	107	1.00	100
07/19/96	5	4,587	101.93	99	0.97	97
07/19/96	5	3,860	85.78	47	0.55	55
N=70	597	Total	22,802	36,178		
		Mean	325.75		2.54	253.87
		Std	263.58		4.87	487.12
		SE	31.73		0.59	58.64
		Max	1,850.27		27.81	2,781.35
		Min	31.04		0.02	1.90

Table 13. Calculations for individual plankton net CPUEs during escapement sampling and means for flow volume and CPUE.

Date	Minutes	Revs	Flow Volume m3 sampled	Number of Fish	CPUE Fish/m3	CPUE Fish/100m3
07/02/96	15	13,426	67.52	9	0.13	13
07/02/96	15	12,887	64.81	10	0.15	15
07/02/96	15	15,111	76.00	20	0.26	26
07/02/96	15	13,993	70.37	7	0.10	10
07/03/96	15	14,068	70.75	77	1.09	109
07/03/96	15	14,274	71.79	68	0.95	95
07/03/96	15	13,157	66.17	25	0.38	38
07/03/96	15	13,348	67.13	39	0.58	58
07/03/96	15	13,411	67.45	74	1.10	110
07/05/96	15	25,492	128.21	10	0.08	8
07/05/96	15	25,314	127.31	17	0.13	13
07/05/96	15	25,623	128.87	19	0.15	15
07/05/96	15	23,912	120.26	11	0.09	9
07/05/96	15	22,617	113.75	11	0.10	10
07/08/96	15	33,629	169.13	11	0.07	7
07/08/96	15	32,116	161.52	33	0.20	20
07/08/96	15	29,564	148.69	18	0.12	12
07/08/96	15	31,130	156.56	8	0.05	5
07/08/96	15	23,273	117.05	2	0.02	2
07/08/96	15	23,181	116.58	6	0.05	5
07/08/96	15	24,481	123.12	6	0.05	5
07/08/96	15	20,007	100.62	2	0.02	2
07/08/96	15	21,996	110.62	9	0.08	8
07/08/96	15	19,399	97.56	6	0.06	6
07/09/96	5	4,269	21.47	1	0.05	5
07/09/96	5	3,700	18.61	2	0.11	11
07/09/96	5	3,873	19.48	0	0.00	0
07/09/96	5	4,392	22.09	1	0.05	5
07/09/96	5	4,359	21.92	2	0.09	9
07/10/96	5	12,321	61.97	83	1.34	134
07/10/96	2	6,051	30.43	6	0.20	20
07/10/96	2	4,719	23.73	5	0.21	21
07/10/96	2	4,977	25.03	9	0.36	36
07/10/96	2	4,887	24.58	27	1.10	110
07/11/96	2	5,694	28.64	28	0.98	98
07/11/96	2	5,566	27.99	10	0.36	36
07/11/96	5	12,000	60.35	96	1.59	159
07/11/96	5	12,000	60.35	873	14.47	1,447
07/11/96	5	11,787	59.28	11	0.19	19
07/17/96	1	3,773	18.98	61	3.21	321
07/17/96	2	5,994	30.15	632	20.97	2,097
07/17/96	2	6,718	33.79	82	2.43	243
07/17/96	2	6,816	34.28	61	1.78	178
07/18/96	2	5,859	29.47	174	5.91	591
07/18/96	1	2,652	13.34	237	17.77	1,777
07/18/96	1	2,347	11.80	220	18.64	1,864
07/18/96	1	2,471	12.43	240	19.31	1,931
07/18/96	1	2,658	13.37	103	7.71	771
07/19/96	5	512	2.57	5	1.94	194
07/19/96	5	566	2.85	4	1.41	141
N=50	440	Total	3,250.77	3,471		
		Mean	65.02		2.56	256.29
		Std	46.96		5.45	545.30
		SE	6.71		0.78	77.90
		Max	169.13		20.97	2,096.50
		Min	2.57		0.00	0.00

Table 14. Catches in small mesh hoop nets and plankton nets during escapement sampling and estimated total numbers of fish produced and escaping from Wasenza Pool of Lake Chautauqua.

Small Mesh Hoop Nets

	Actually Sampled	Mean Depth 2.13 m (7 ft)
Volume of Water (cubic meters)	22,802	17,245,873
Conversion Factor		756
Gizzard Shad	19,526	14,761,656
Emerald Shiiner	14,550	10,999,800
Skipjack Herring	698	527,688
Freshwater Drum	628	474,768
White Bass	424	320,544
Buffaloes	101	76,356
Threadfin Shad	48	36,288
Red Shiner	38	28,728
Sauger	34	25,704
Logperch	20	15,120
Golden Shiner	17	12,852
Suckers	15	11,340
Bigmouth Buffalo	12	9,072
Smallmouth Buffalo	11	8,316
Bluegill	11	8,316
Largemouth Bass	9	6,804
Spottail Shiner	7	5,292
Silverband Shiner	7	5,292
Black Crappie	4	3,024
Mooneye	3	2,268
Shiners	2	1,512
River Carpsucker	2	1,512
Common Carp	2	1,512
Mud Darter	2	1,512
White Crappie	1	756
Sand Shiner	1	756
Shortnose Gar	1	756
Western Mosquitofish	1	756
Goldeye	1	756
Channel Catfish	1	756
Bluntnose Minnow	1	756
Total	36,178	27,350,568

Plankton Nets

	Actually Sampled	Mean Depth 2.13 m (7 ft)
Volume of Water (cubic meters)	3,250	17,245,873
Conversion Factor		5,306
Emerald Shiner	1,621	8,601,026
Gizzard Shad	1,502	7,969,612
Skipjack Herring	87	461,622
Suckers	76	403,256
White Bass	64	339,584
Freshwater Drum	58	307,748
Cyprinids	33	175,098
Buffaloes	14	74,284
Smallmouth Buffalo	5	26,530
Logperch	2	10,612
Largemouth Bass	2	10,612
Silver Chub	1	5,306
Spottail Shiner	1	5,306
Red Shiner	1	5,306
Sand Shiner	1	5,306
White Crappie	1	5,306
Golden Shiner	1	5,306
Total	3,470	18,411,820

Table 15. Date and size ranges of larval and juvenile fish caught with small-mesh hoop and plankton nets during escapement sampling 06/28/96 - 07/19/96.

	Date First Captured	Length Range (mm)	Date Last Captured	Length Range (mm)
Black Crappie	07/11	50		
Bluegill	07/08	60-90	07/12	60-170
Bigmouth Buffalo	07/10	50-60	07/12	60
Common Carp	07/10	10	07/12	370
Emerald Shiner	07/05	20-30	07/12	40
Freshwater Drum	07/05	0-30	07/11	0-30
Golden Shiner	07/03	30-40	07/12	50-90
Gizzard Shad	07/01	10-20	07/12	30-50
Logperch	07/08	40-50	07/12	40-60
Largemouth Bass	07/05	20-90	07/09	20-50
Red Shiner	07/05	30-50	07/12	40-70
Sauger	07/08	90-100	07/12	80
Skipjack Herring	07/05	40-70	07/12	50-80
Threadfin Shad	07/09	30	07/12	80-120
Buffaloes	07/02	30-60	07/12	40-50
Suckers	07/03	0-20	07/08	10-20
White Bass	07/01	20-50	07/12	30-90

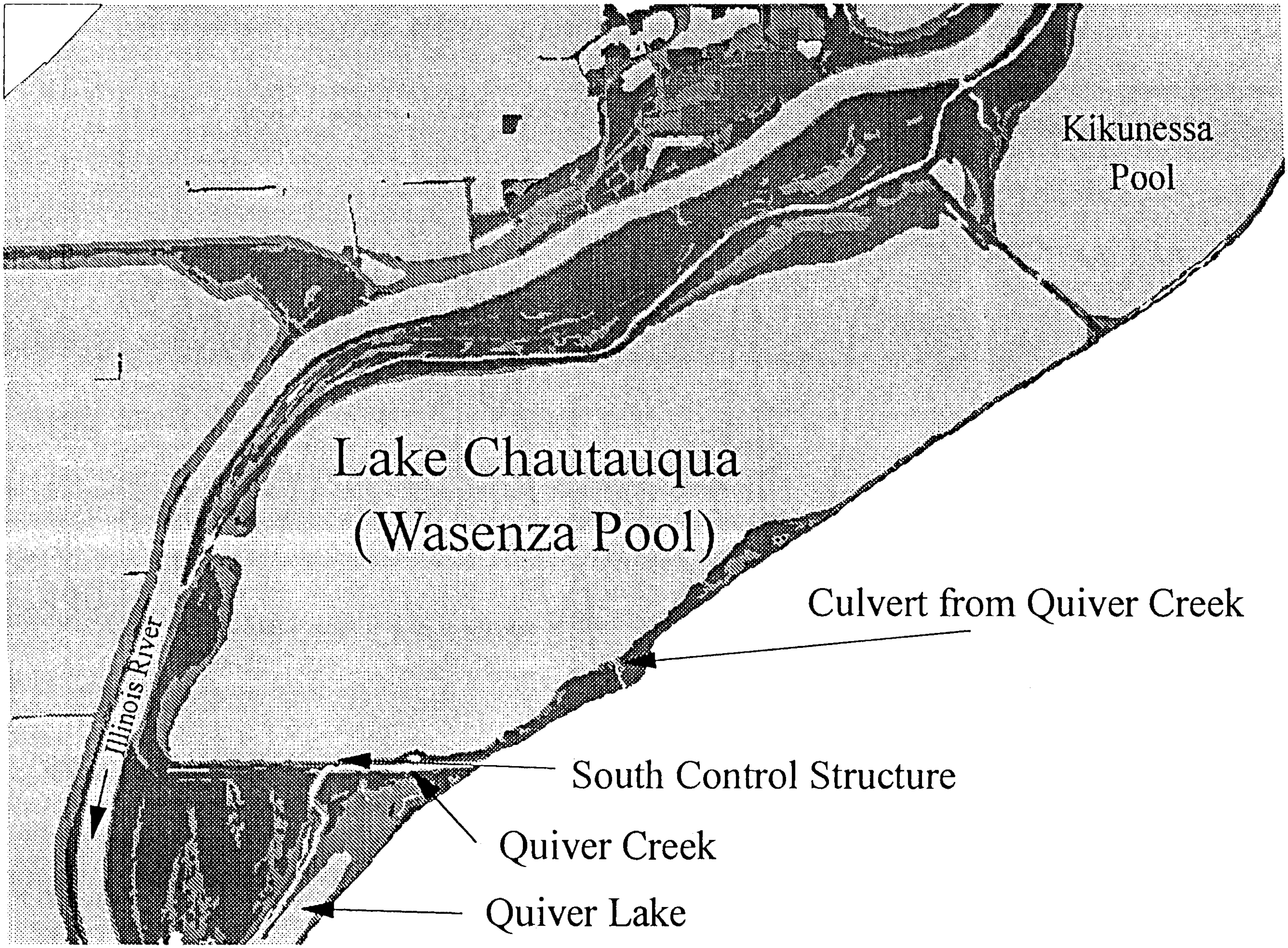


Figure 1. South cell of Lake Chautauqua.

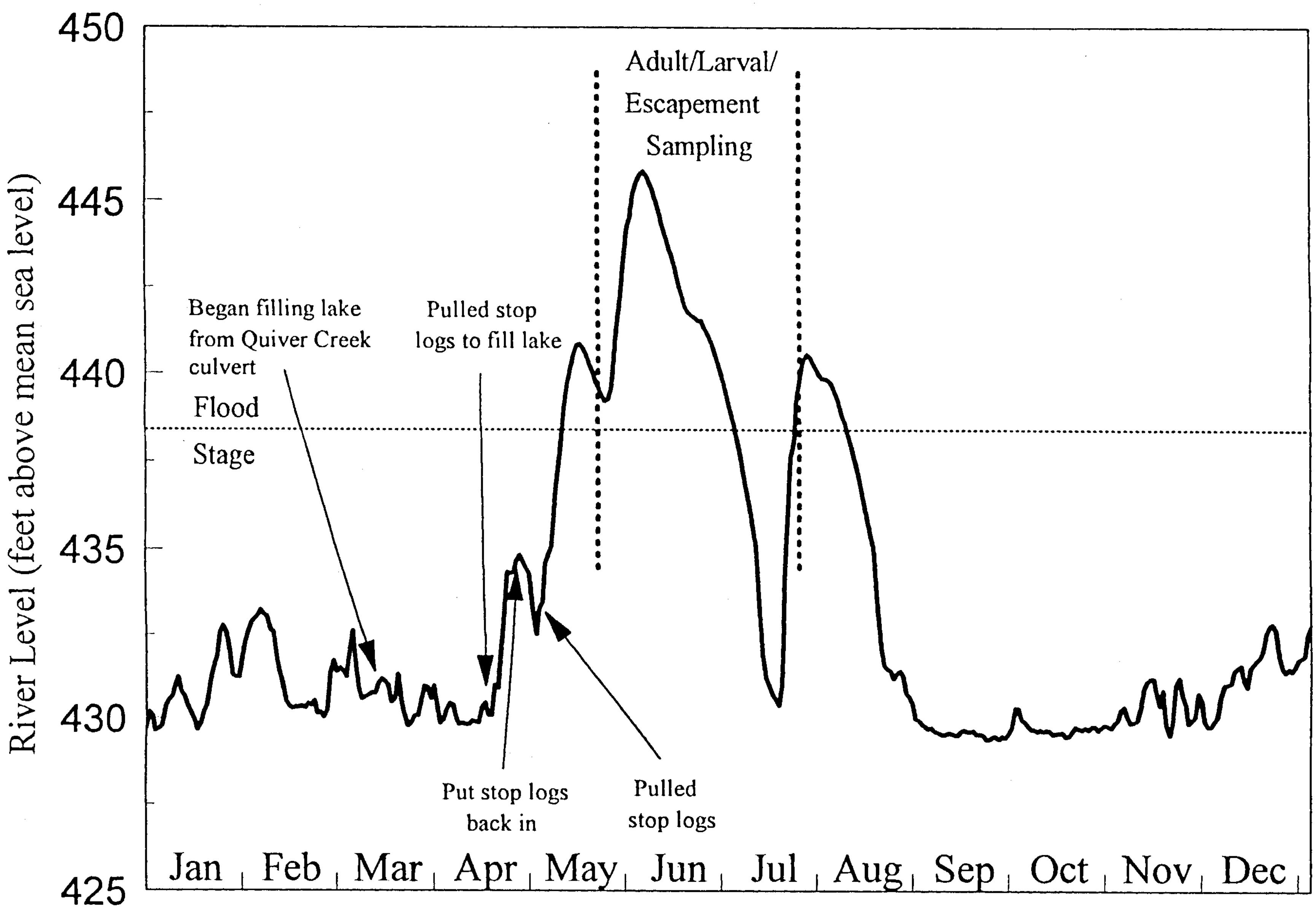


Figure 2. Illinois River level at Havana during period of study.

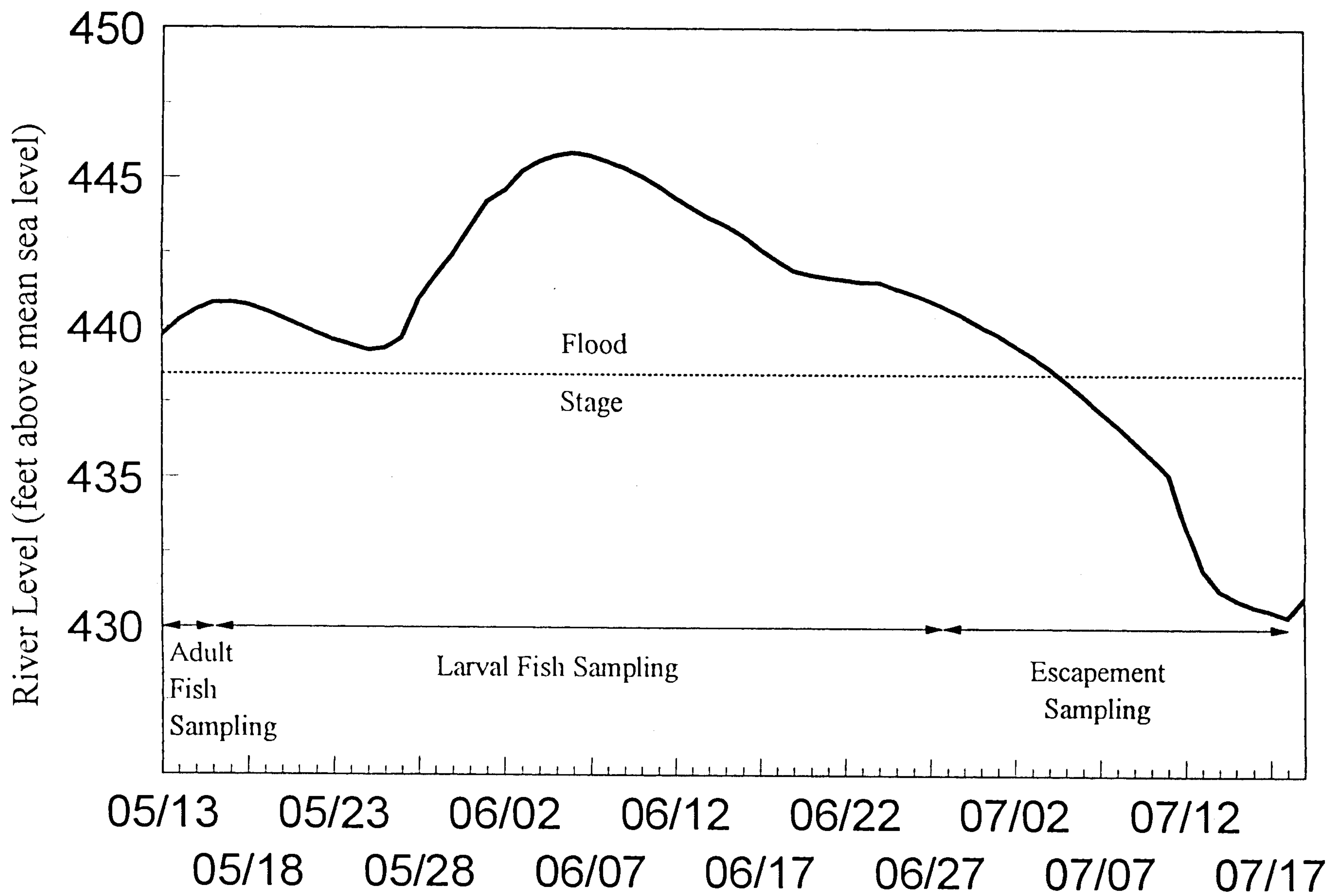


Figure 3. Sampling time line relative to river level at Havana.

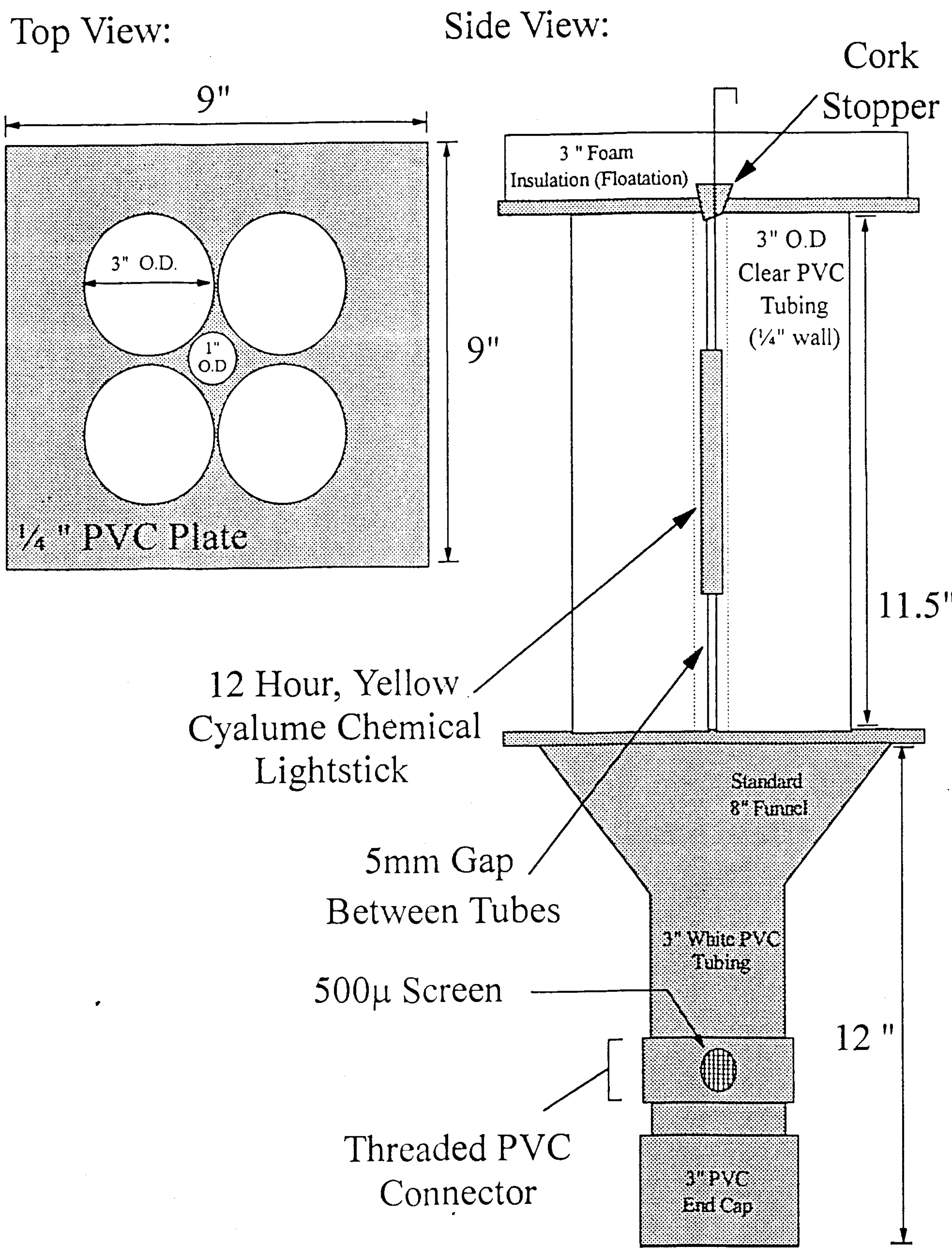
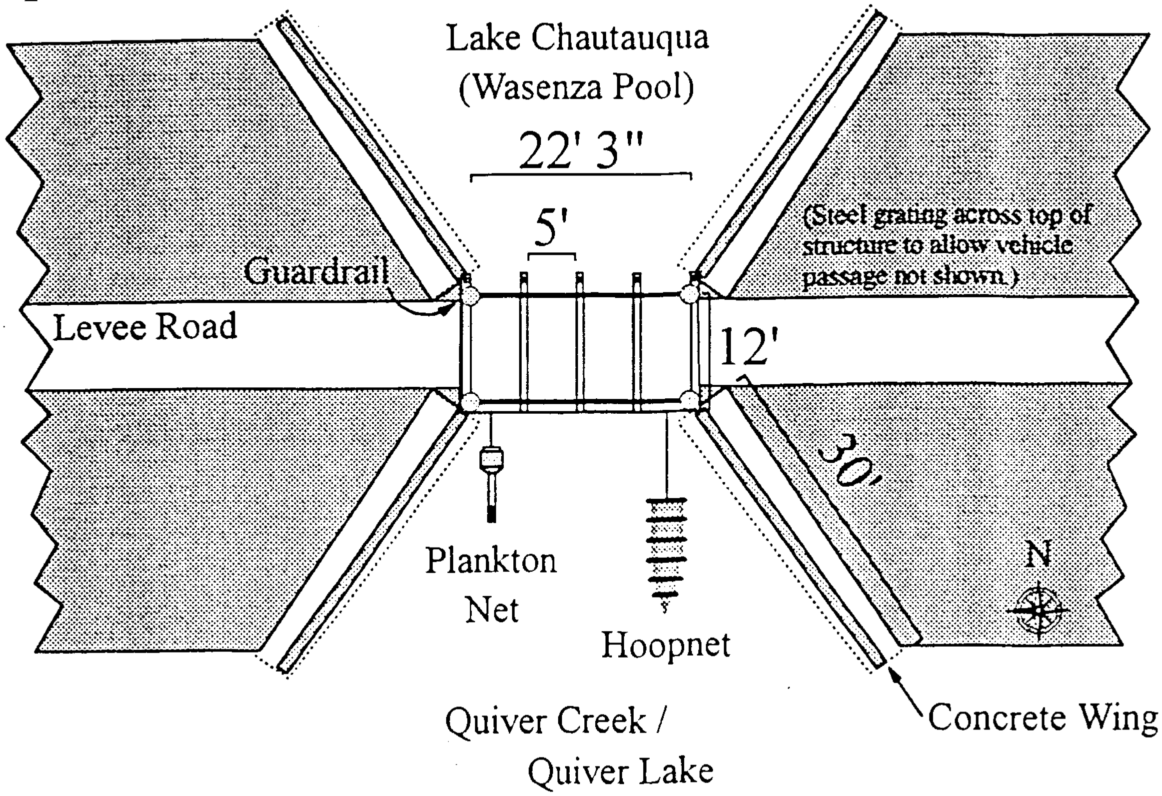


Figure 4. Diagram of Light traps used during larval fish sampling.

Top View:



Side View:

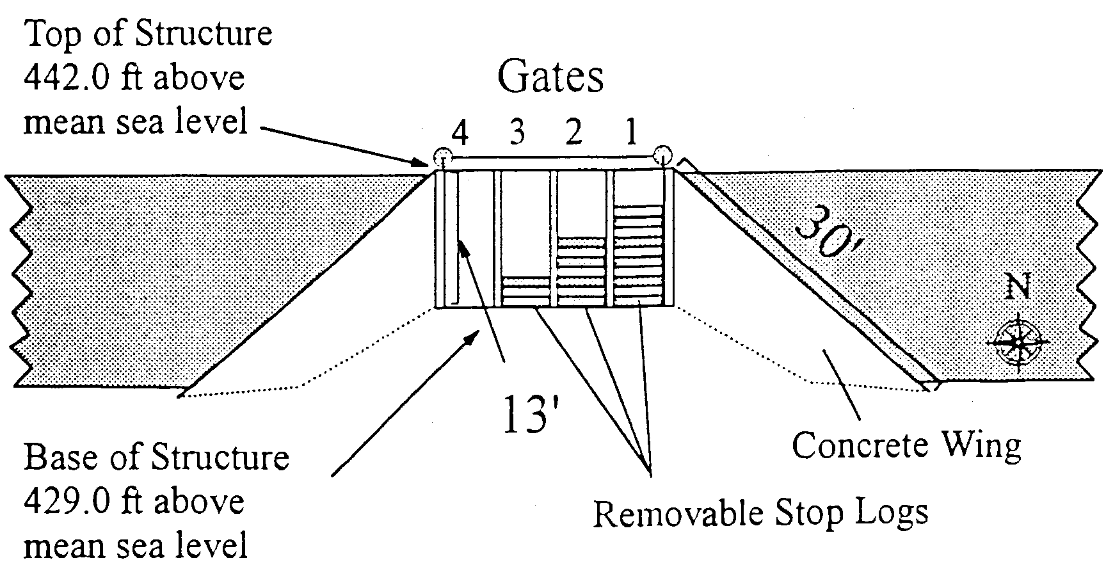


Figure 5. Diagram of the south control structure.

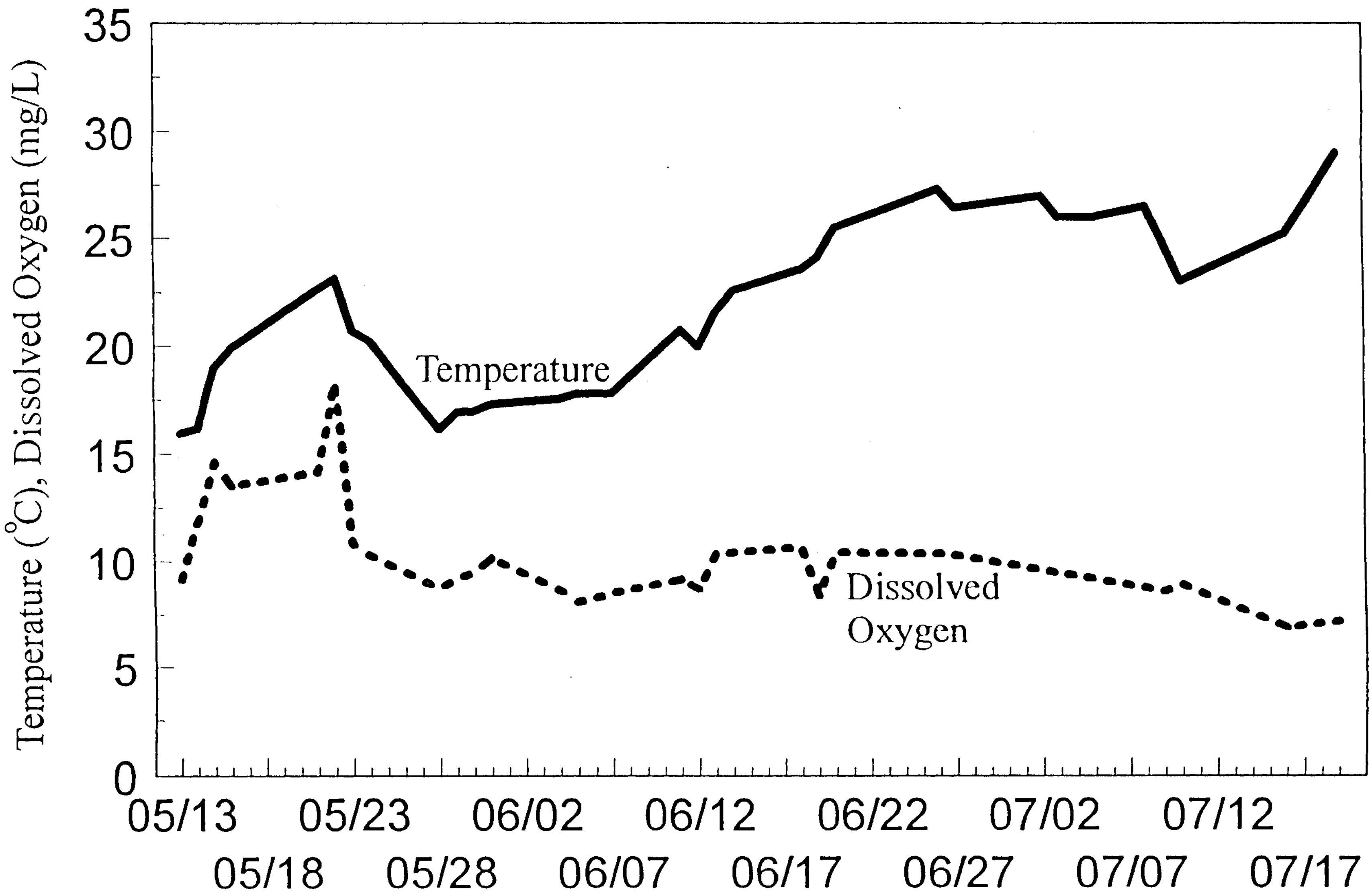


Figure 6. Temperature and dissolved oxygen in Wasenza Pool of Lake Chautauqua.

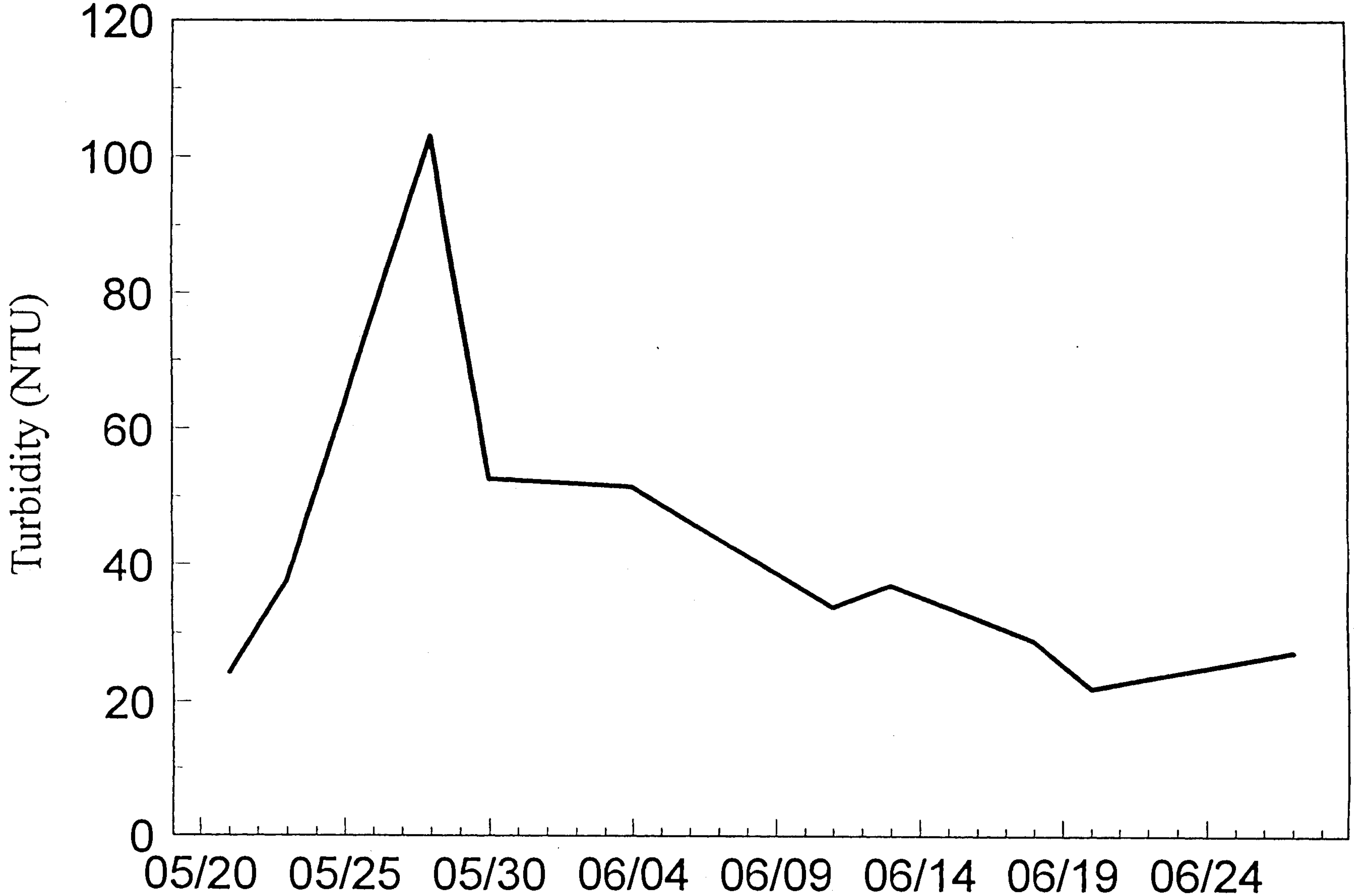


Figure 7. Mean nephelometric turbidity values during larval fish sampling.

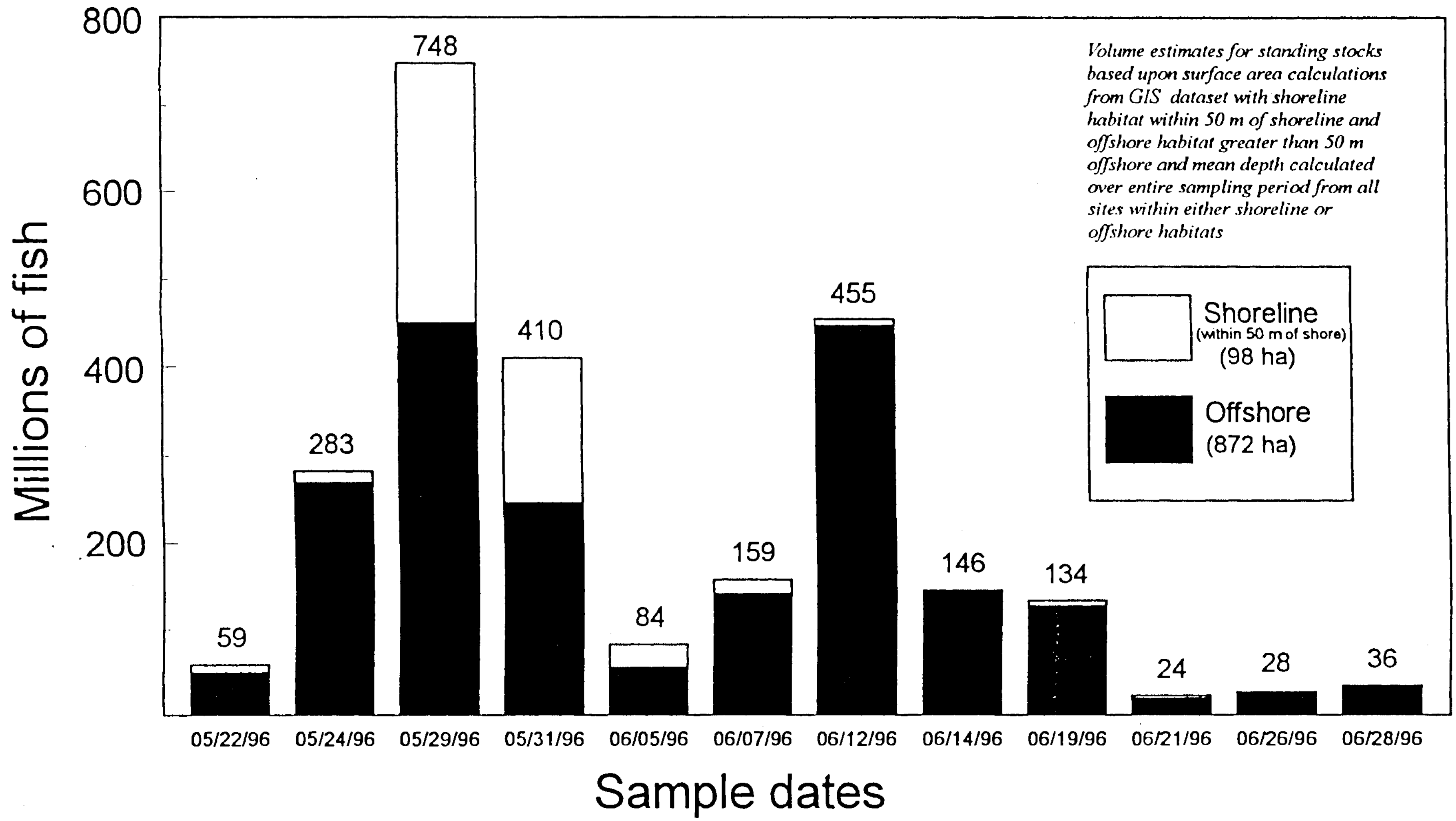


Figure 8. Estimated standing stock of larval fish from icthyoplankton tows in Wasenza Pool.

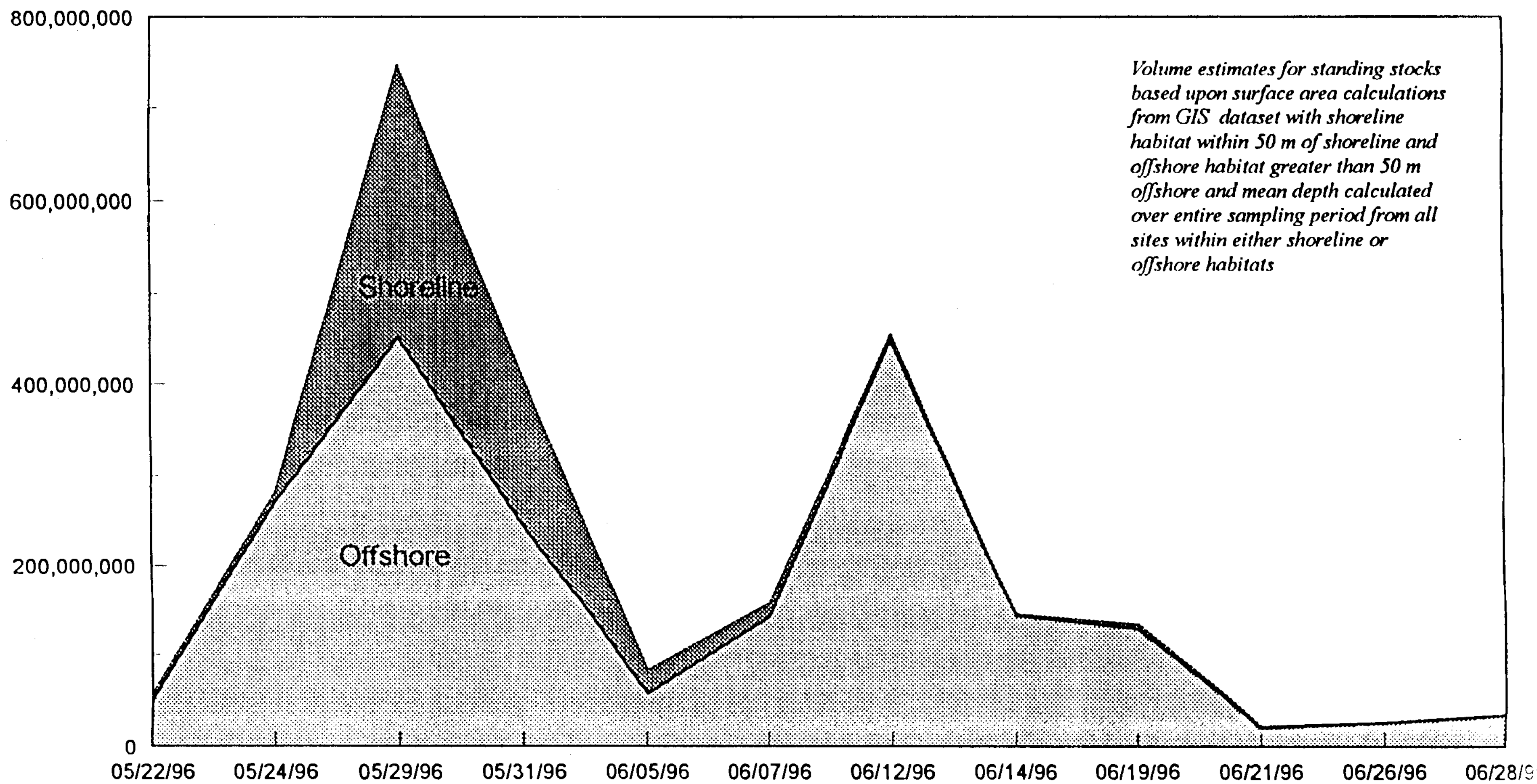


Figure 9. Estimated standing stock of larval fish from icthyoplankton tows by habitat in Wasenza Pool.

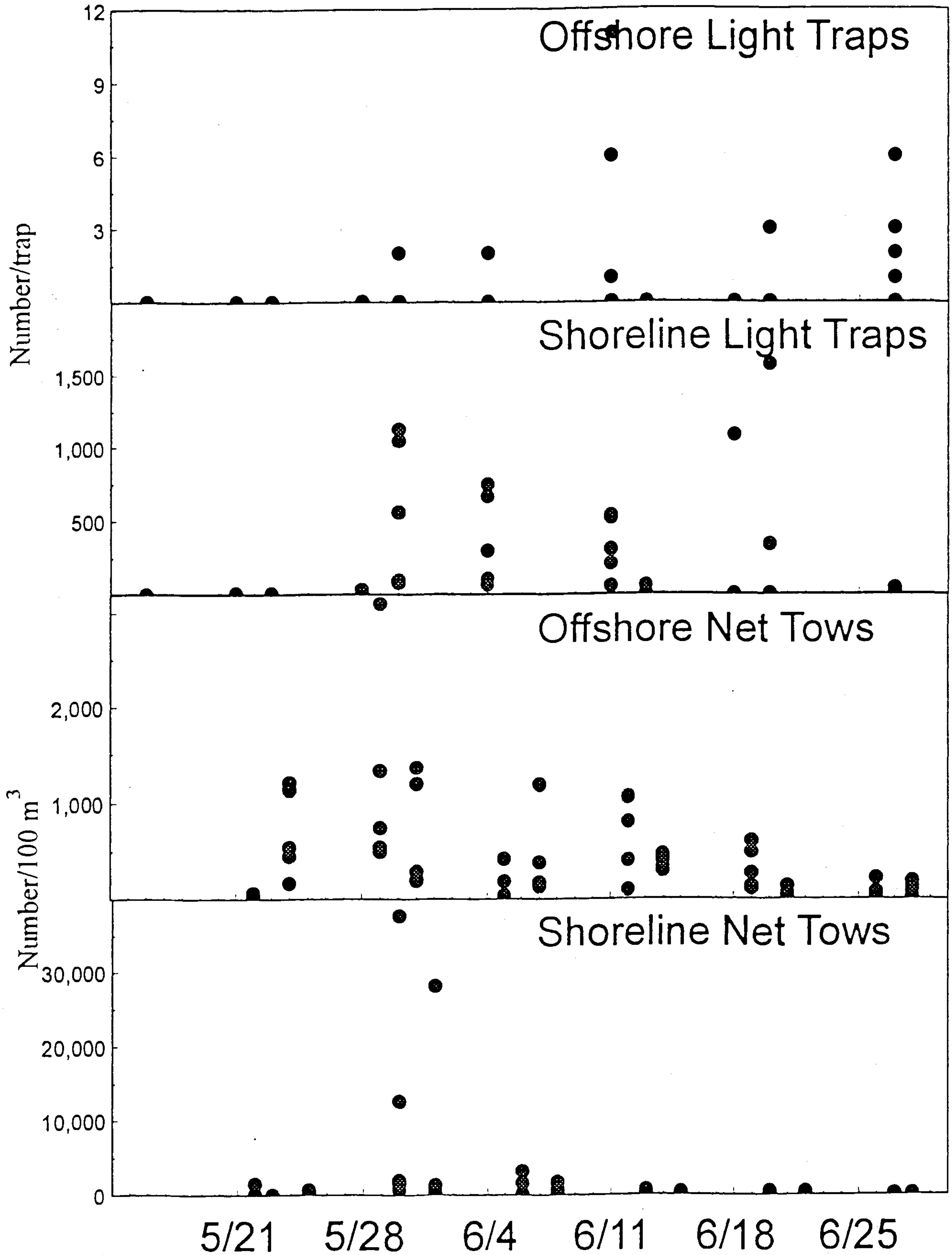


Figure 10. Larval gizzard shad CPUEs in Wasenza Pool.

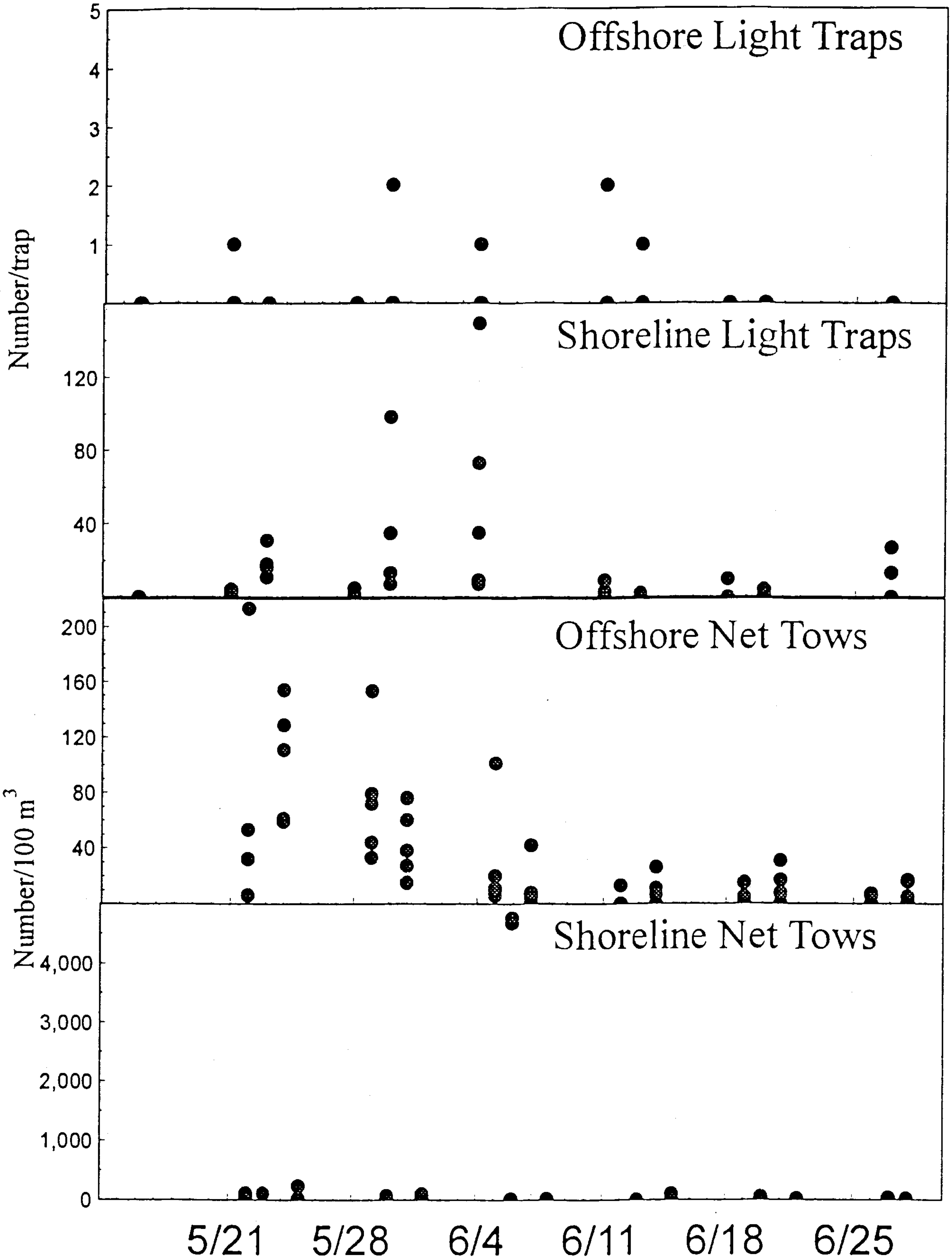


Figure 11. Larval buffaloes CPUEs in Wasenza Pool.

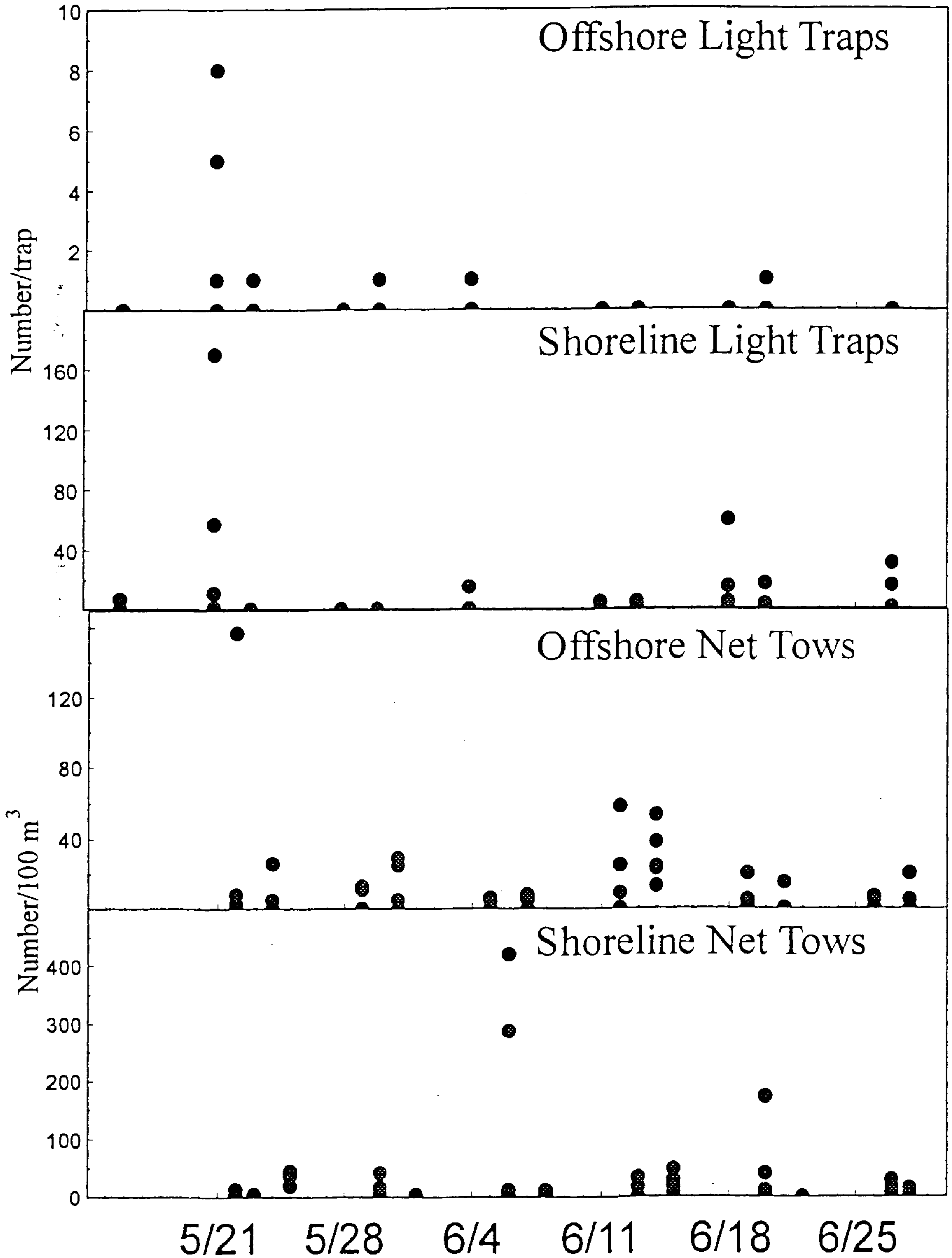


Figure 12. Larval minnows CPUEs in Wasenza Pool.

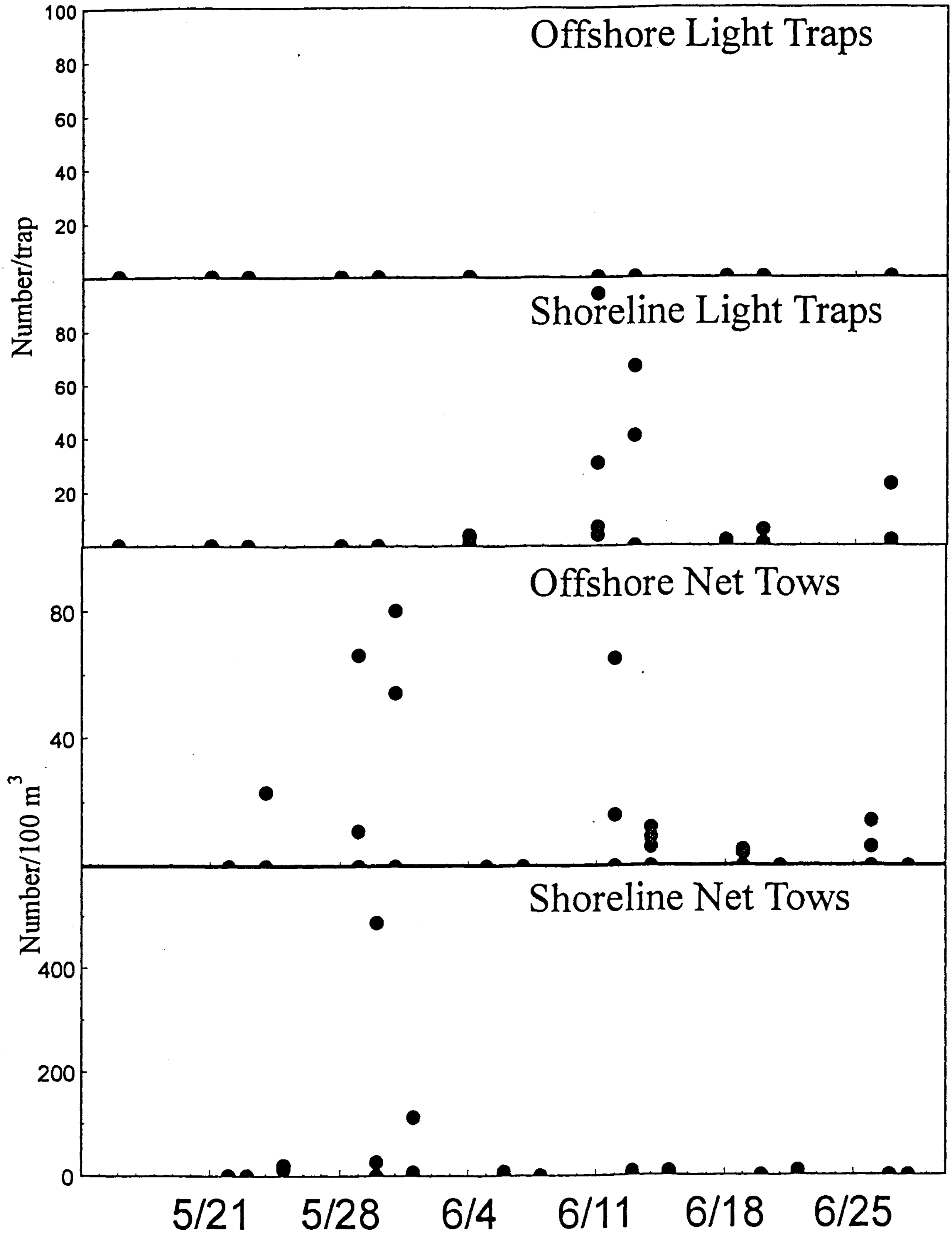


Figure 13. Larval white bass CPUEs in Wasenza Pool.

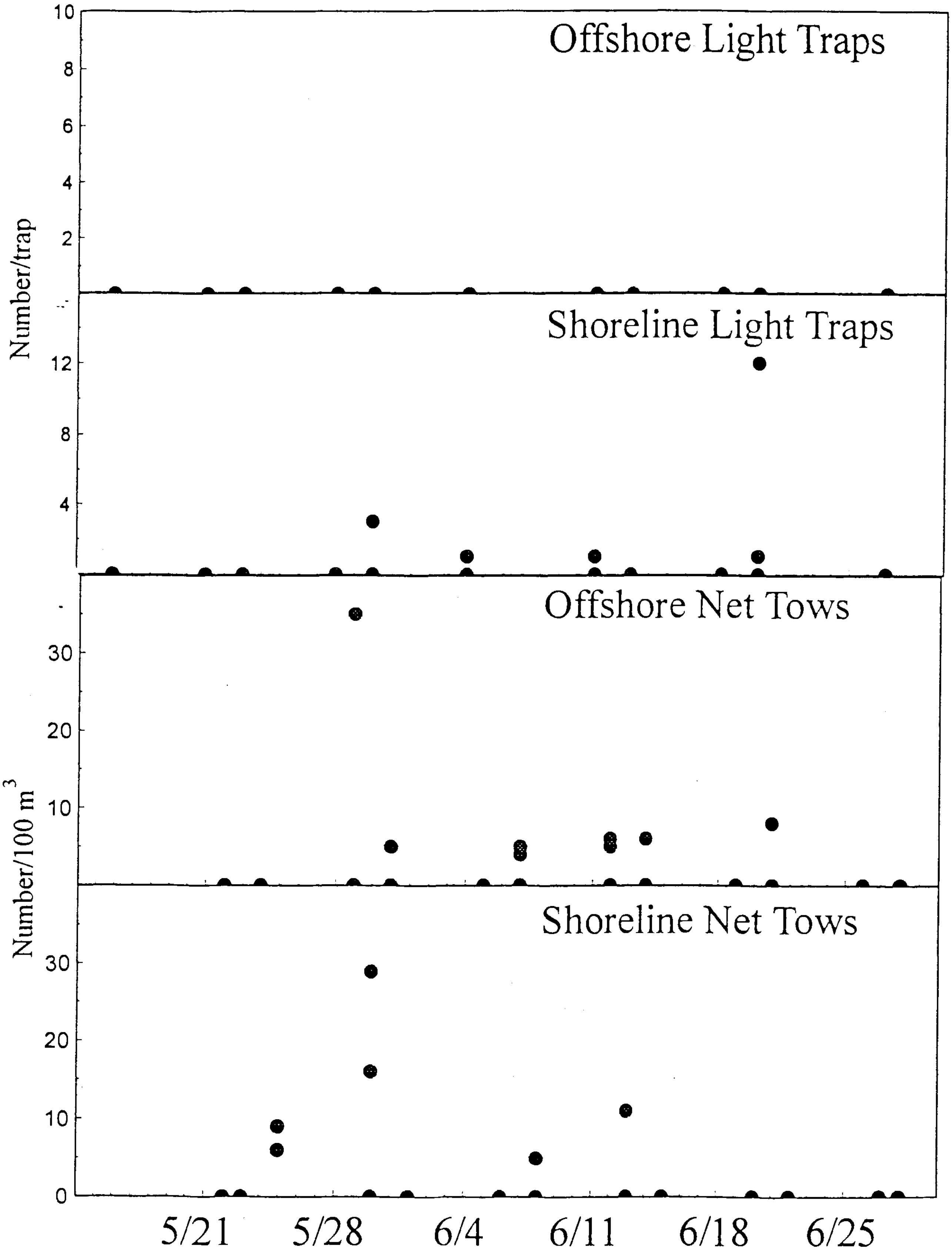


Figure 14. Larval sunfishes CPUEs in Wasenza Pool.

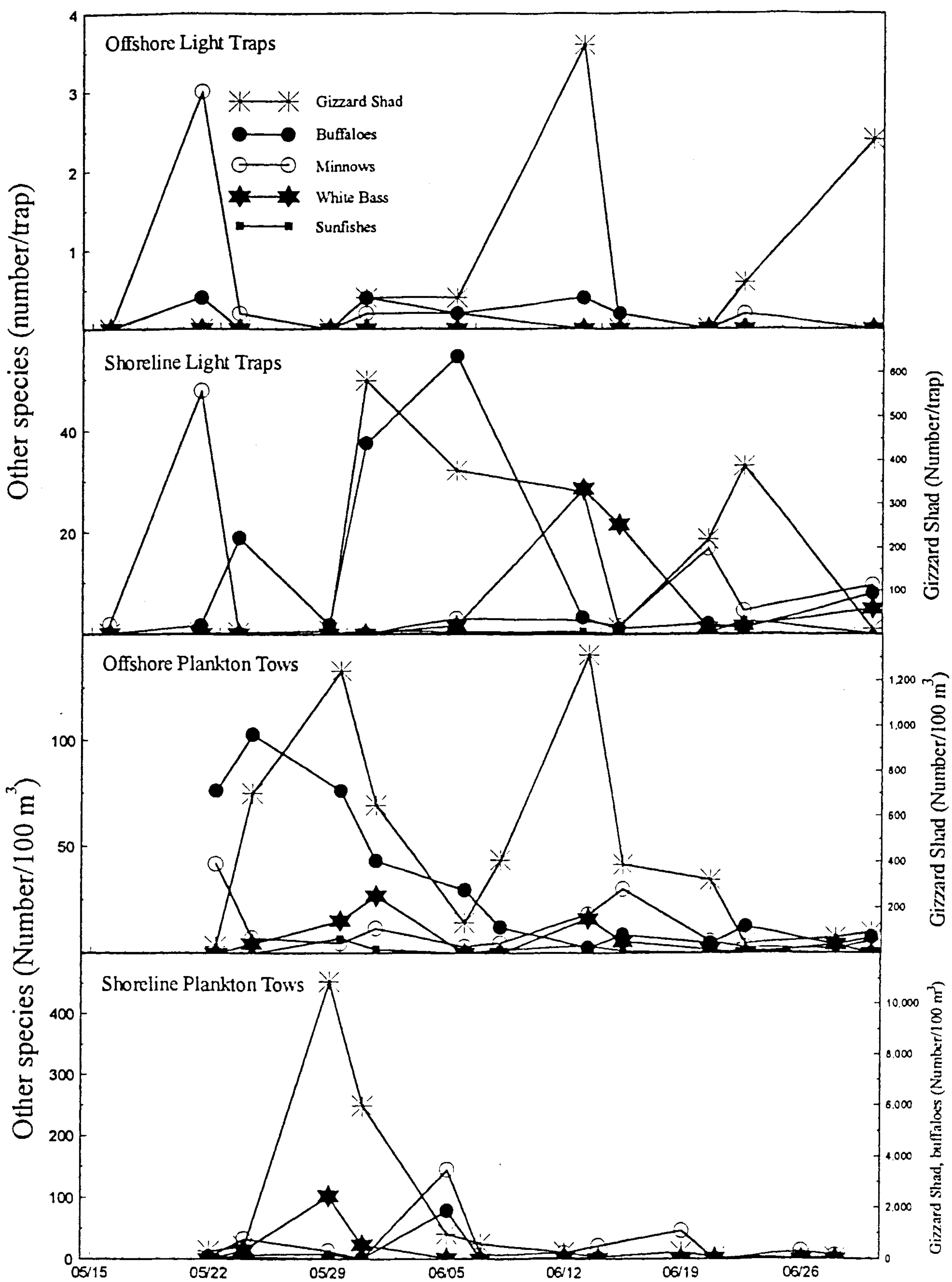


Figure 15. Mean CPUE of five taxa during larval fish sampling (based upon data from scatter plots in figures 8-12). Some species were collected in much higher numbers than other taxa so a second y-axis was used as necessary.

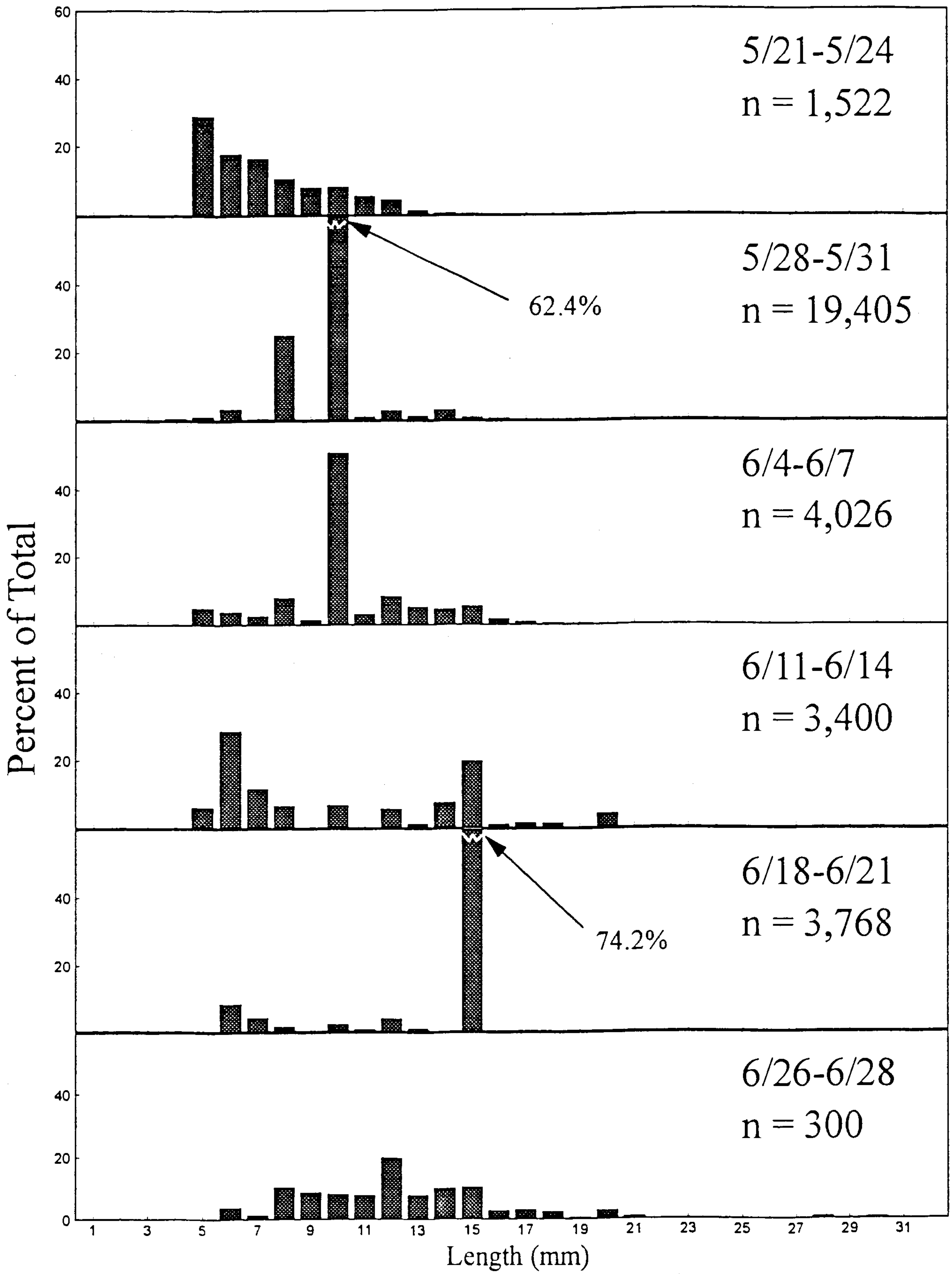


Figure 16. Length distributions of larval gizzard shad caught in light traps and plankton tows by week from 5/21 to 6/28.

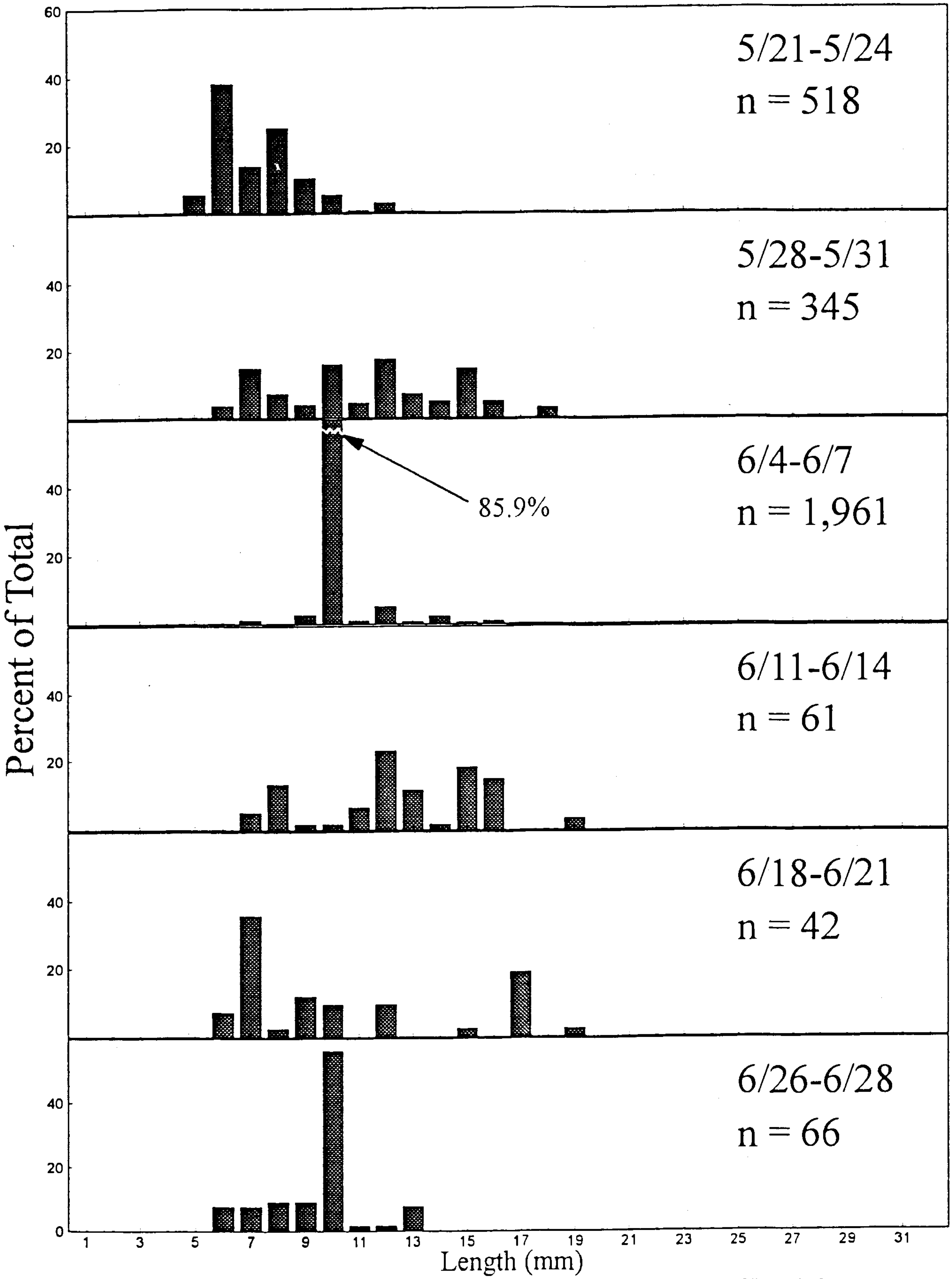


Figure 17. Length distributions of larval suckers caught in light traps and plankton tows by week from 5/21 to 6/28.

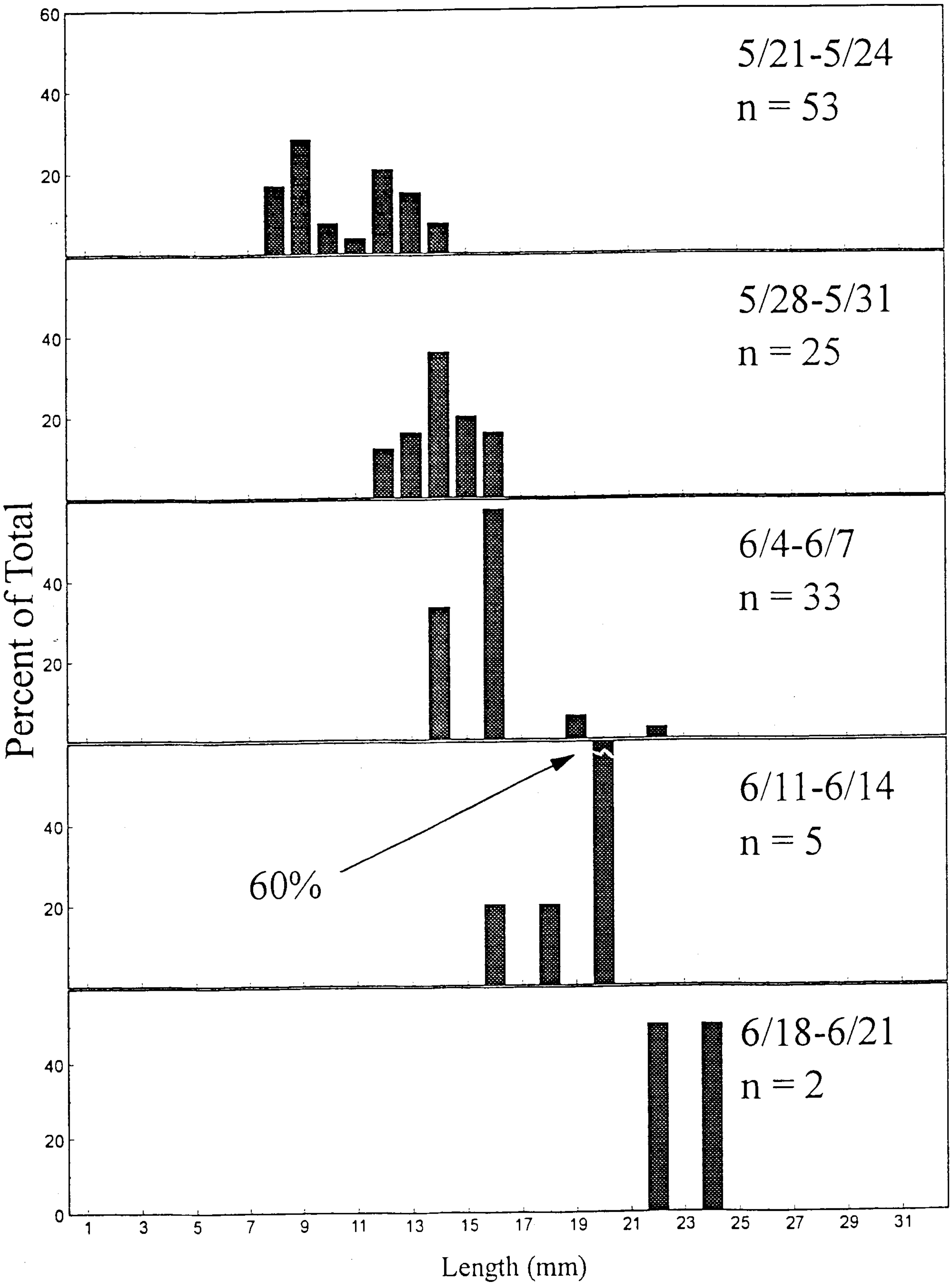


Figure 18. Length distributions of larval buffaloes caught in light traps and plankton tows by week from 5/21 to 6/21.

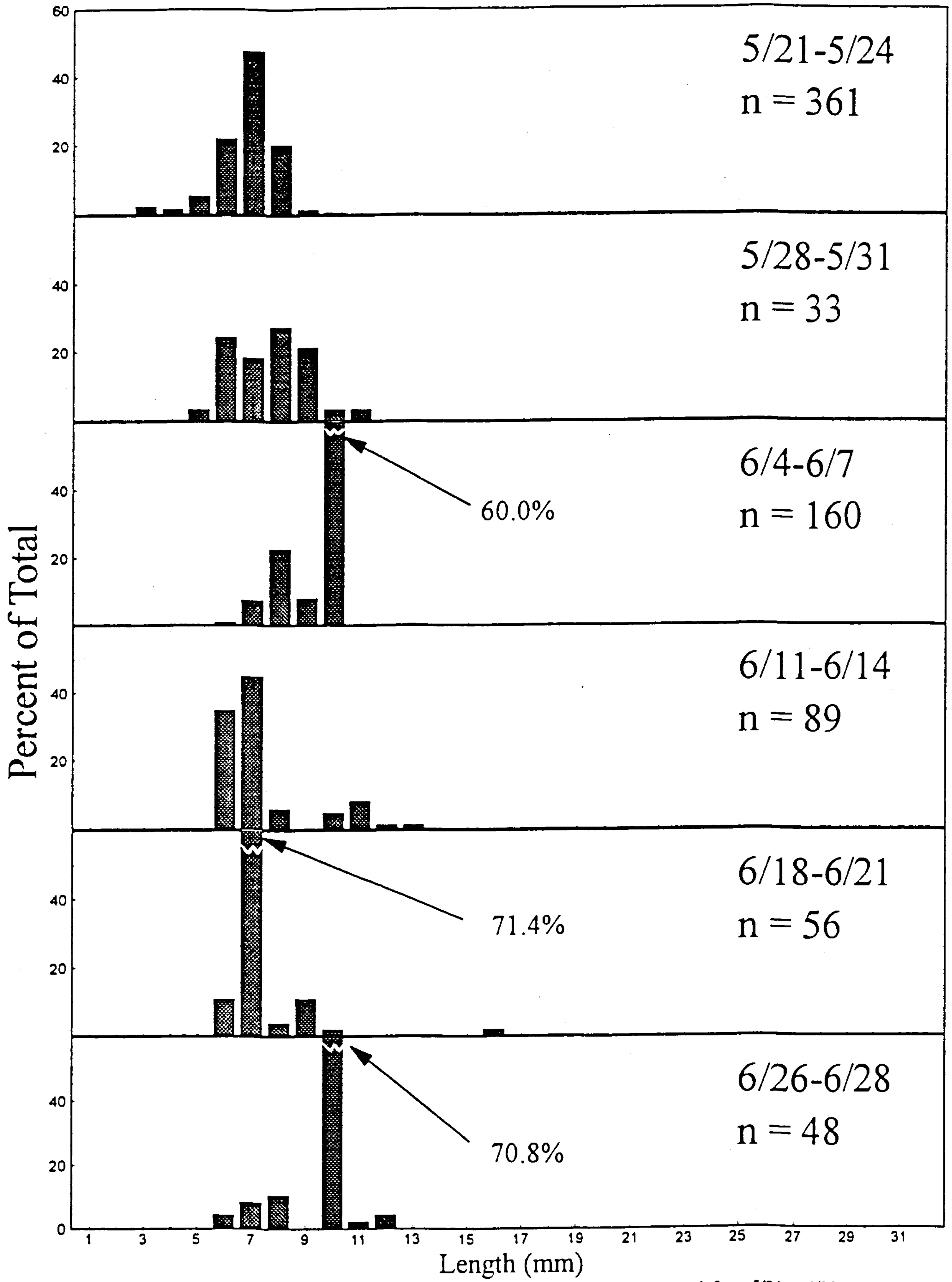


Figure 19. Length distributions of larval minnows caught in light traps and plankton tows by week from 5/21 to 6/28.

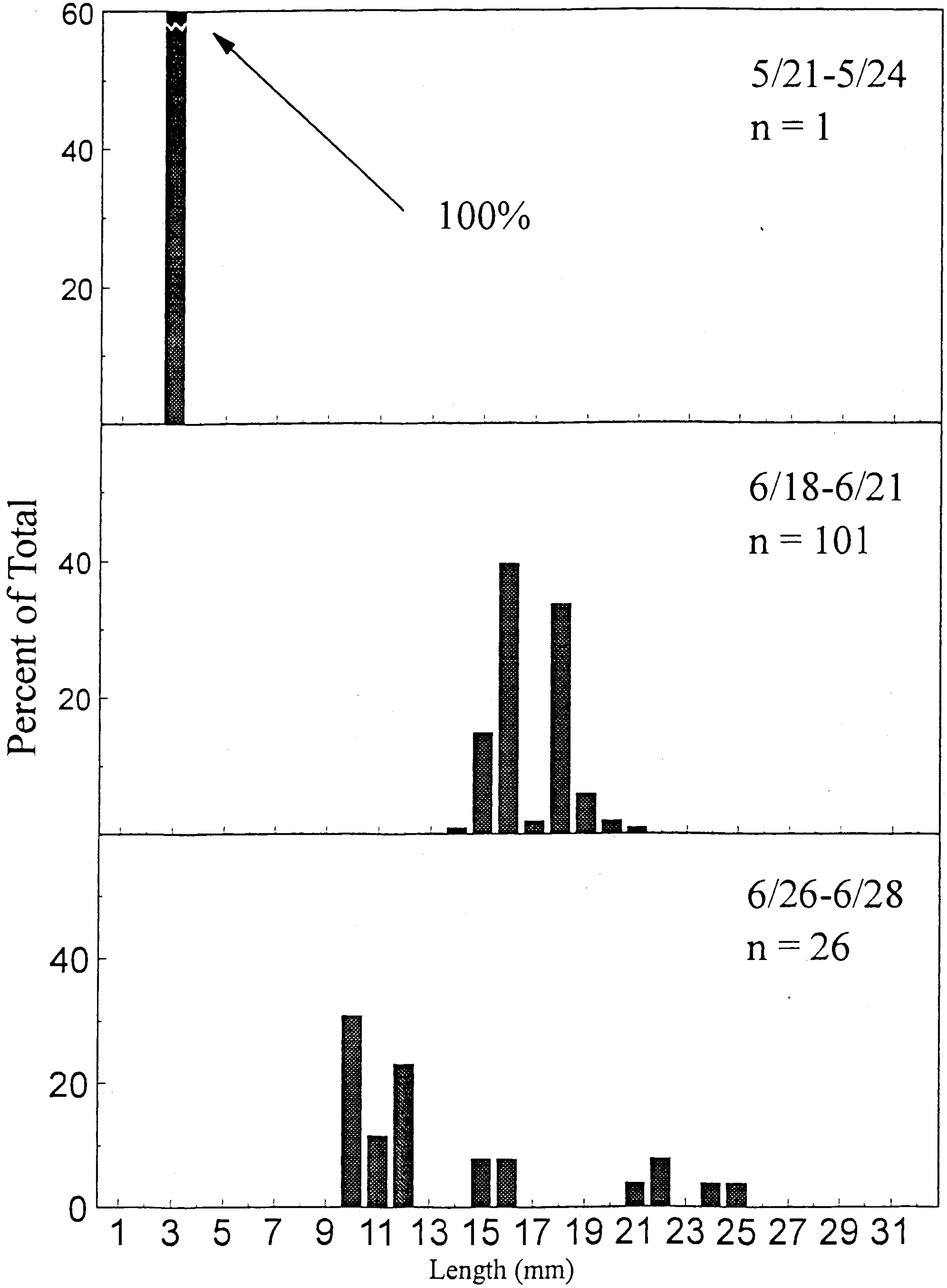


Figure 20. Length distributions of larval shiners caught in light traps and plankton tows by week from 5/21 to 6/28.

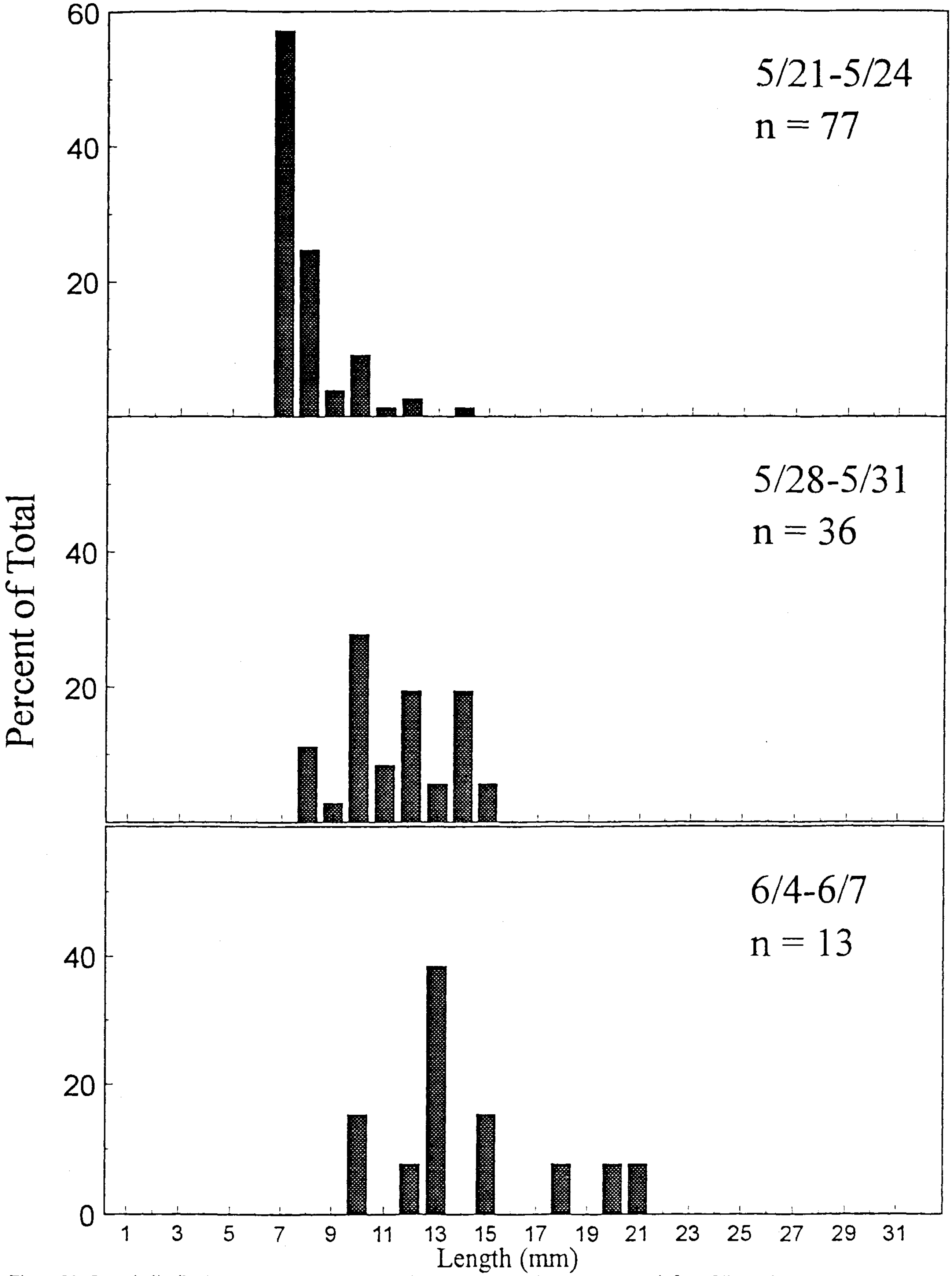


Figure 21. Length distributions of larval carp caught in light traps and plankton tows by week from 5/21 to 6/7.

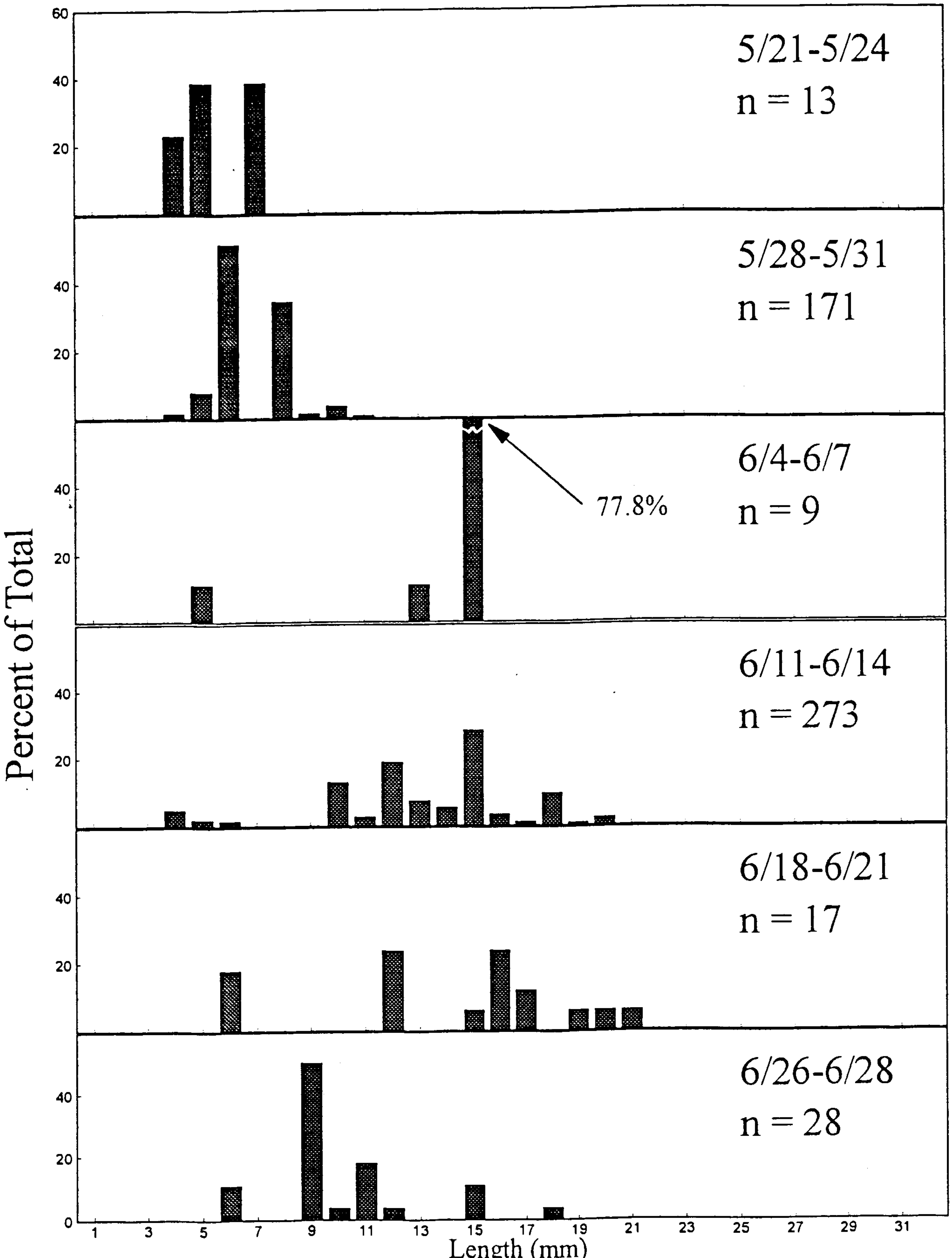


Figure 22. Length distributions of larval white bass caught in light traps and plankton tows by week from 5/21 to 6/28.

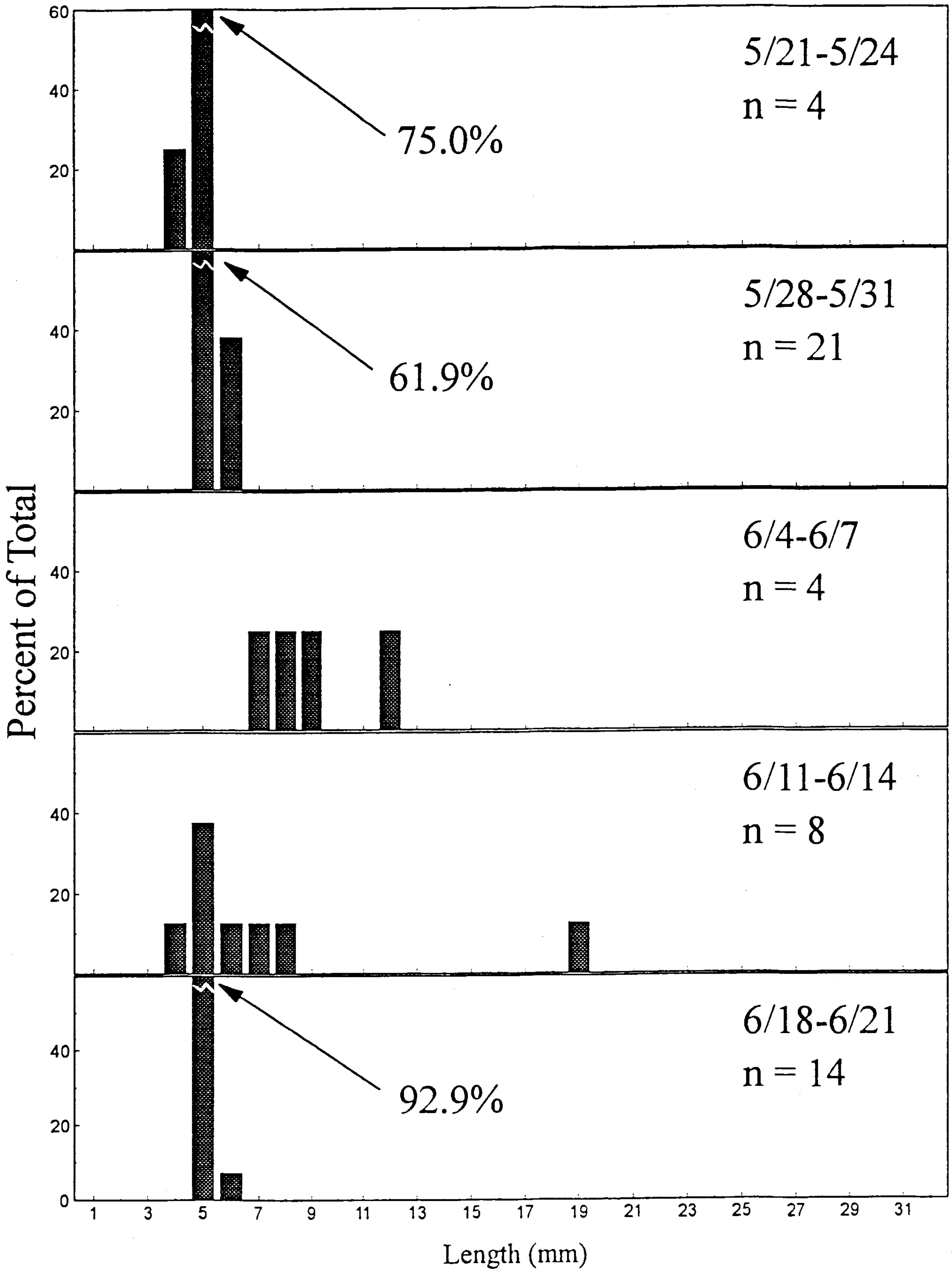


Figure 23. Length distributions of larval sunfishes caught in light traps and plankton tows by week from 5/21 to 6/21.

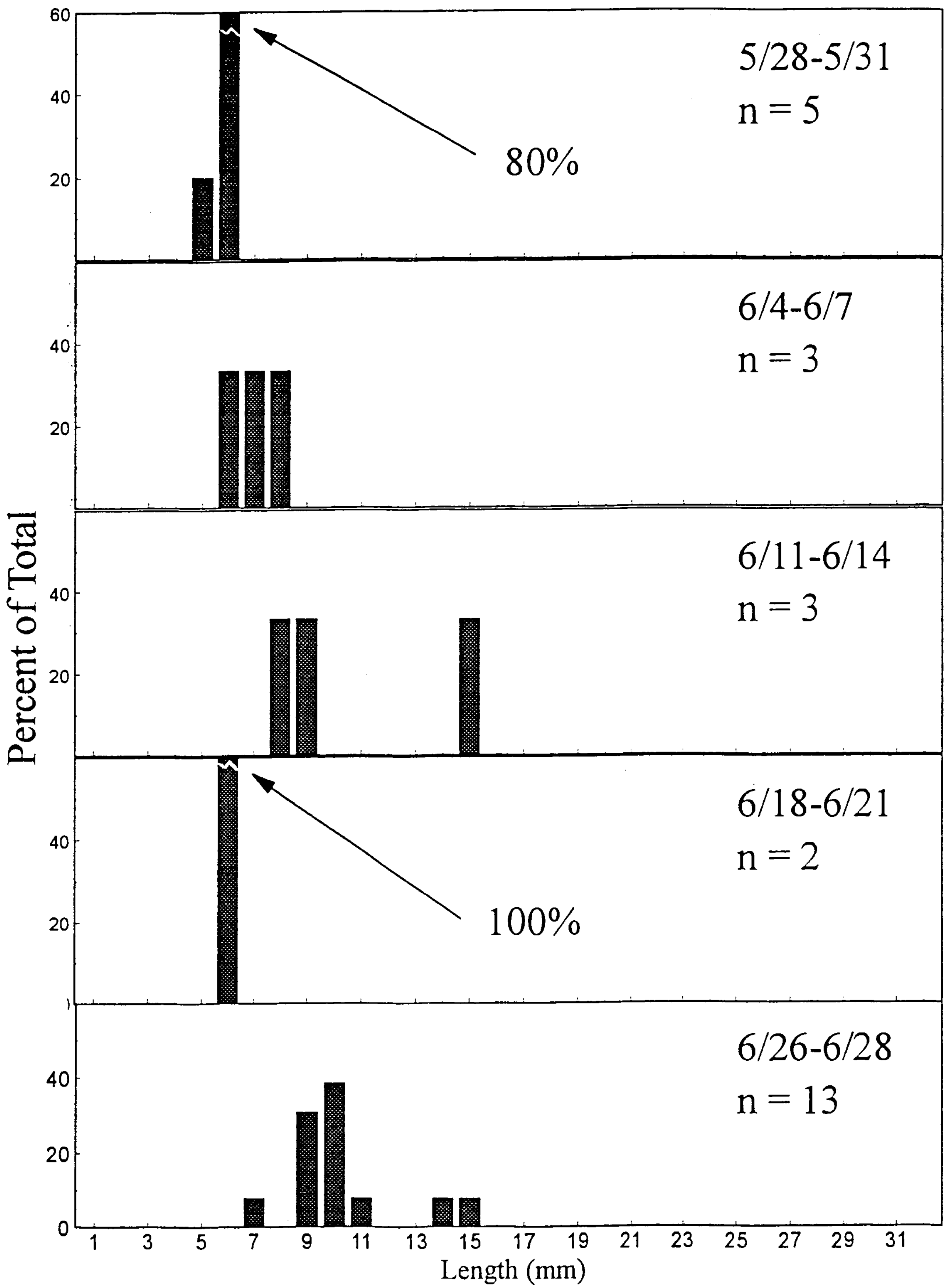


Figure 24. Length distributions of larval freshwater drum caught in light traps and plankton tows by week from 5/28 to 6/28.

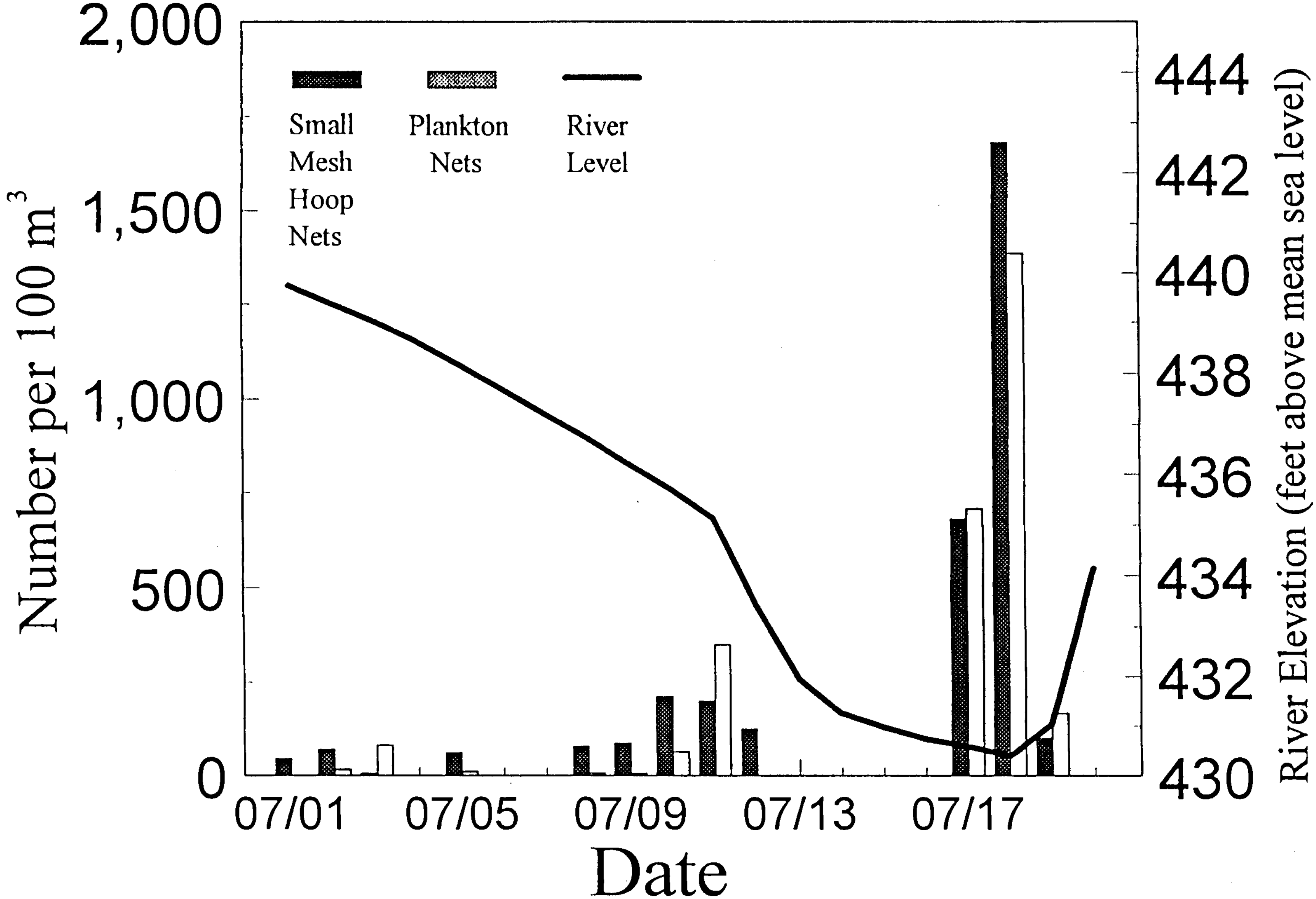


Figure 25. Fish escapement catch per unit effort and Illinois River level.

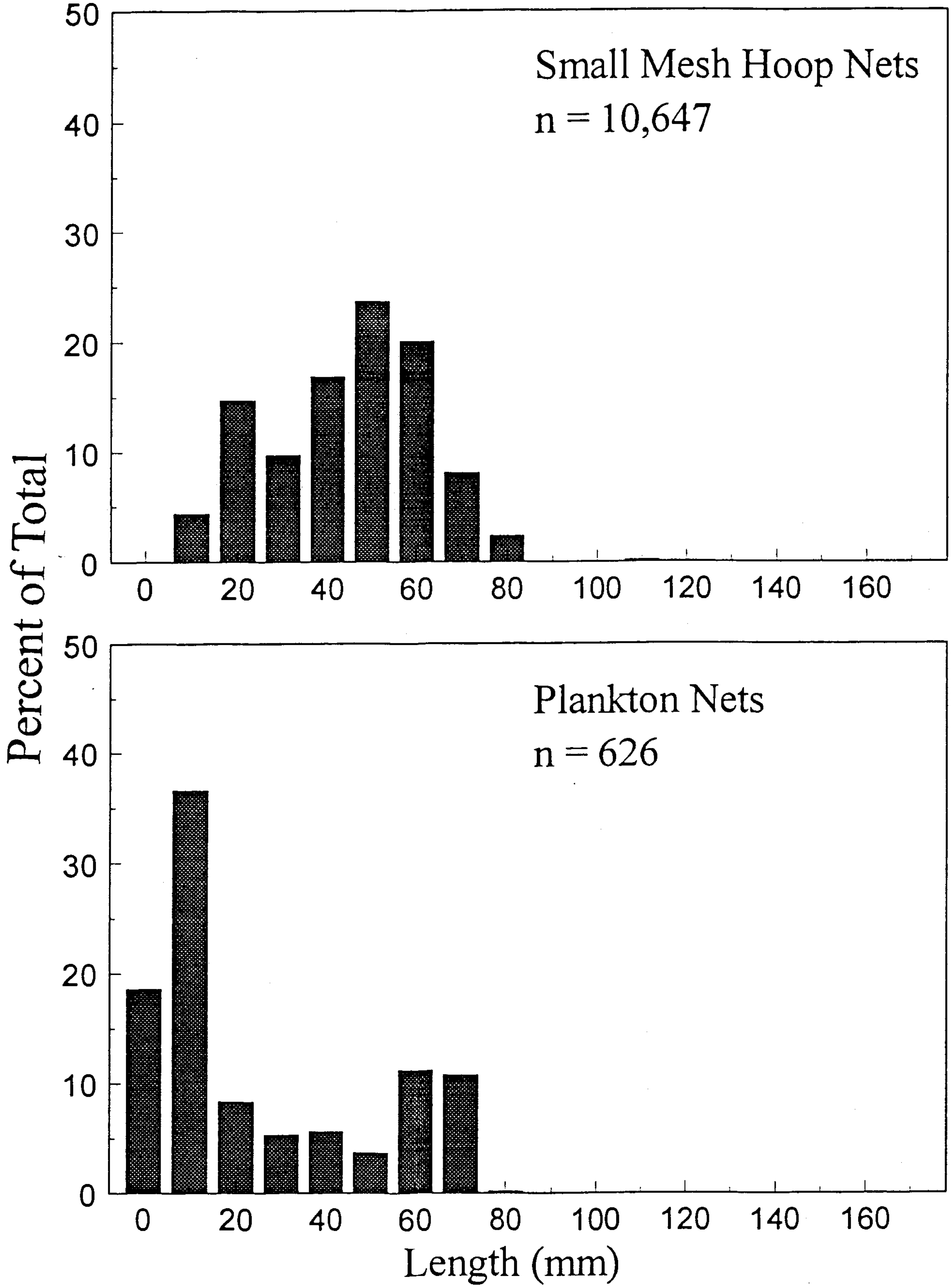


Figure 26. Length distributions of gizzard shad from escapement sampling.

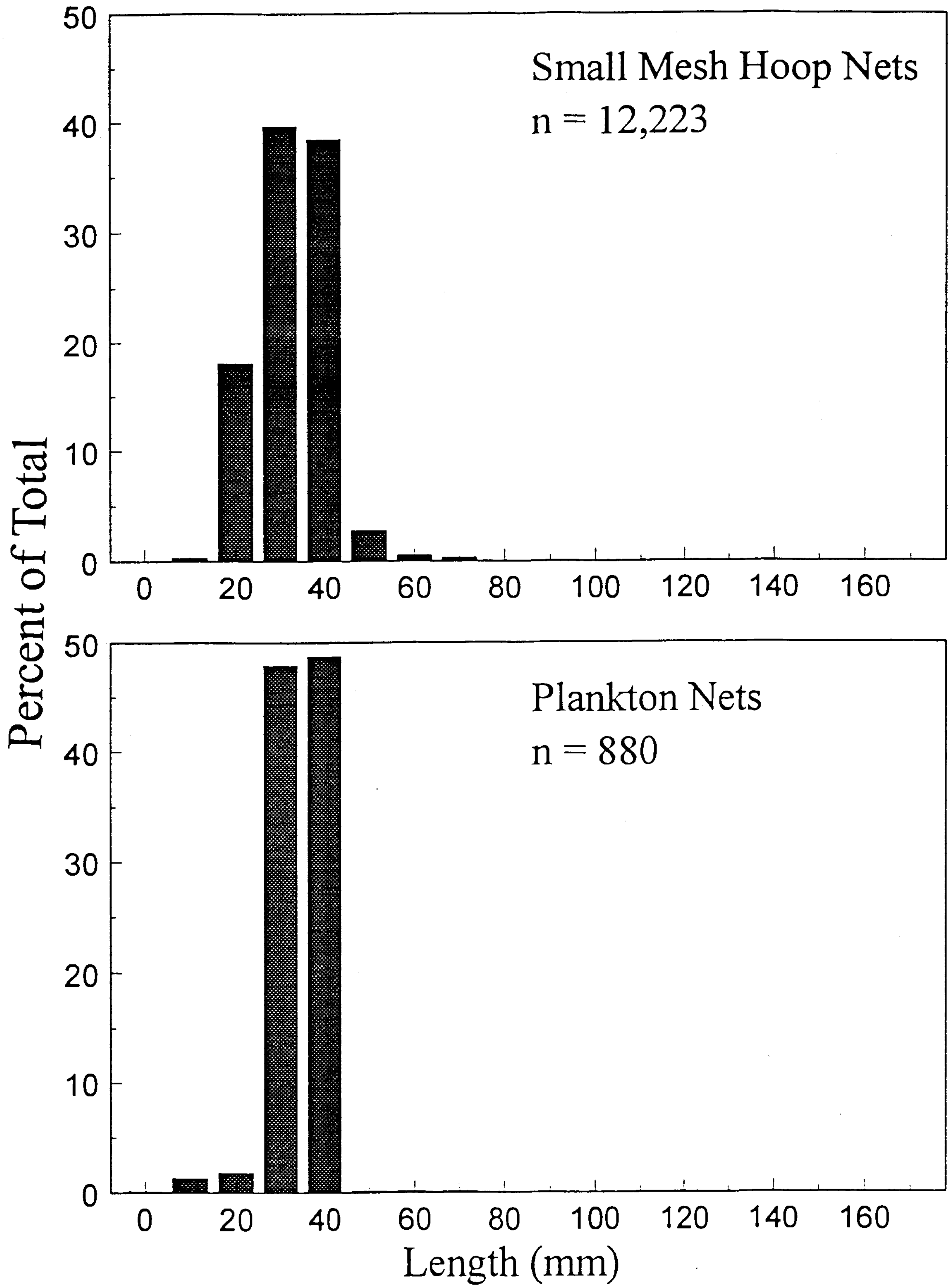


Figure 27. Length distributions of emerald shiners from escapement sampling.

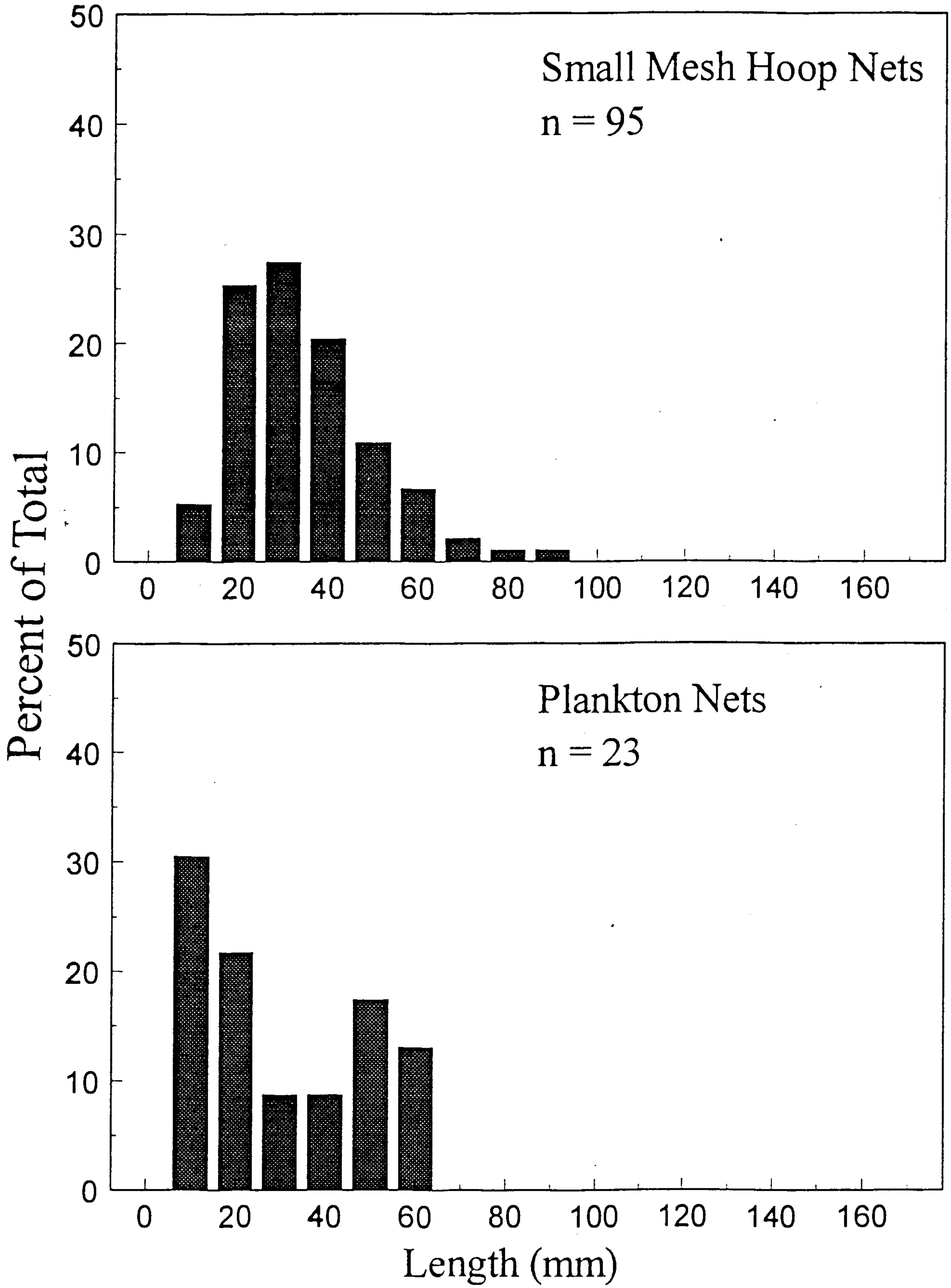


Figure 28. Length distributions of white bass from escapement sampling.

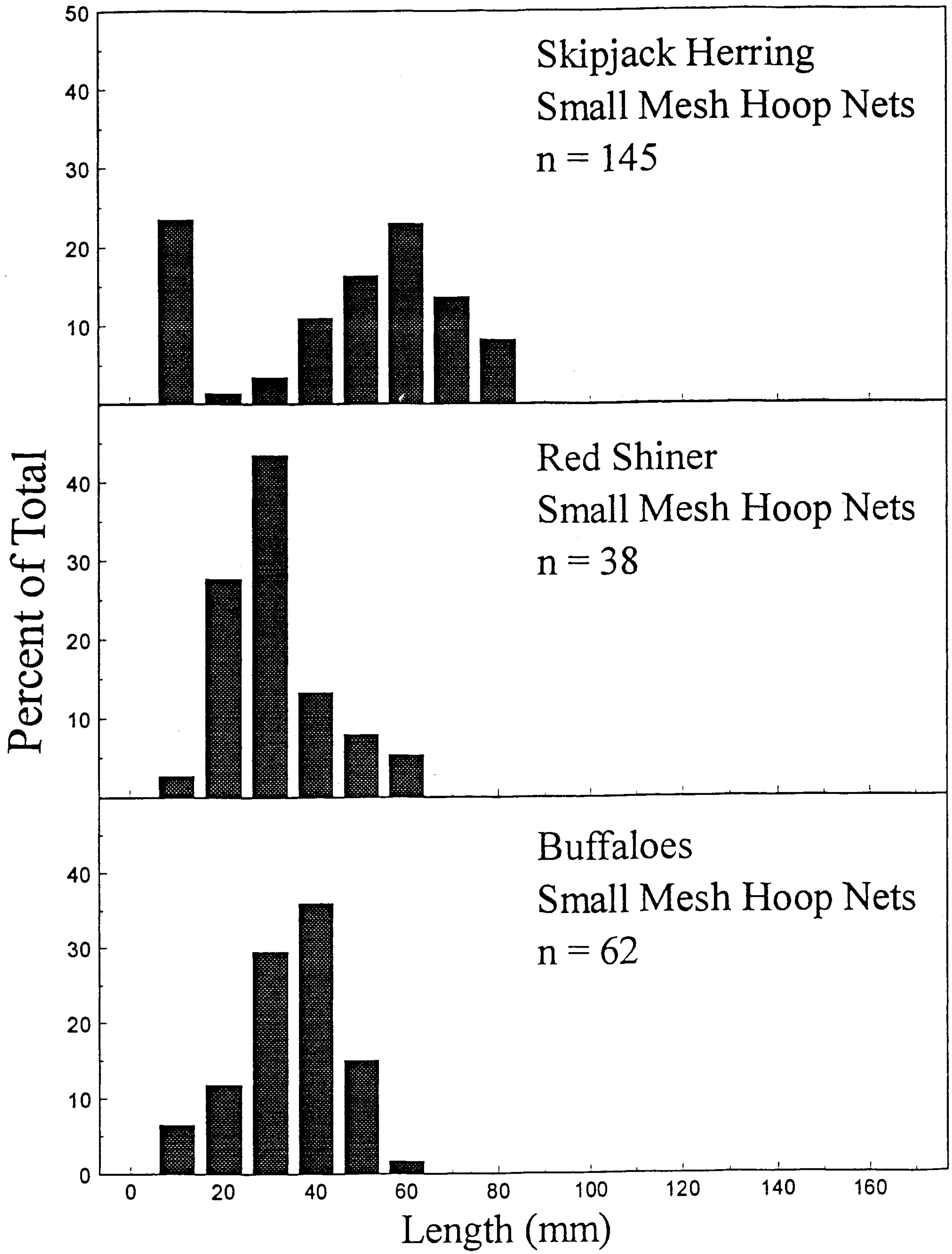


Figure 29. Length distributions of three taxa from escapement sampling with small-mesh hoop nets.

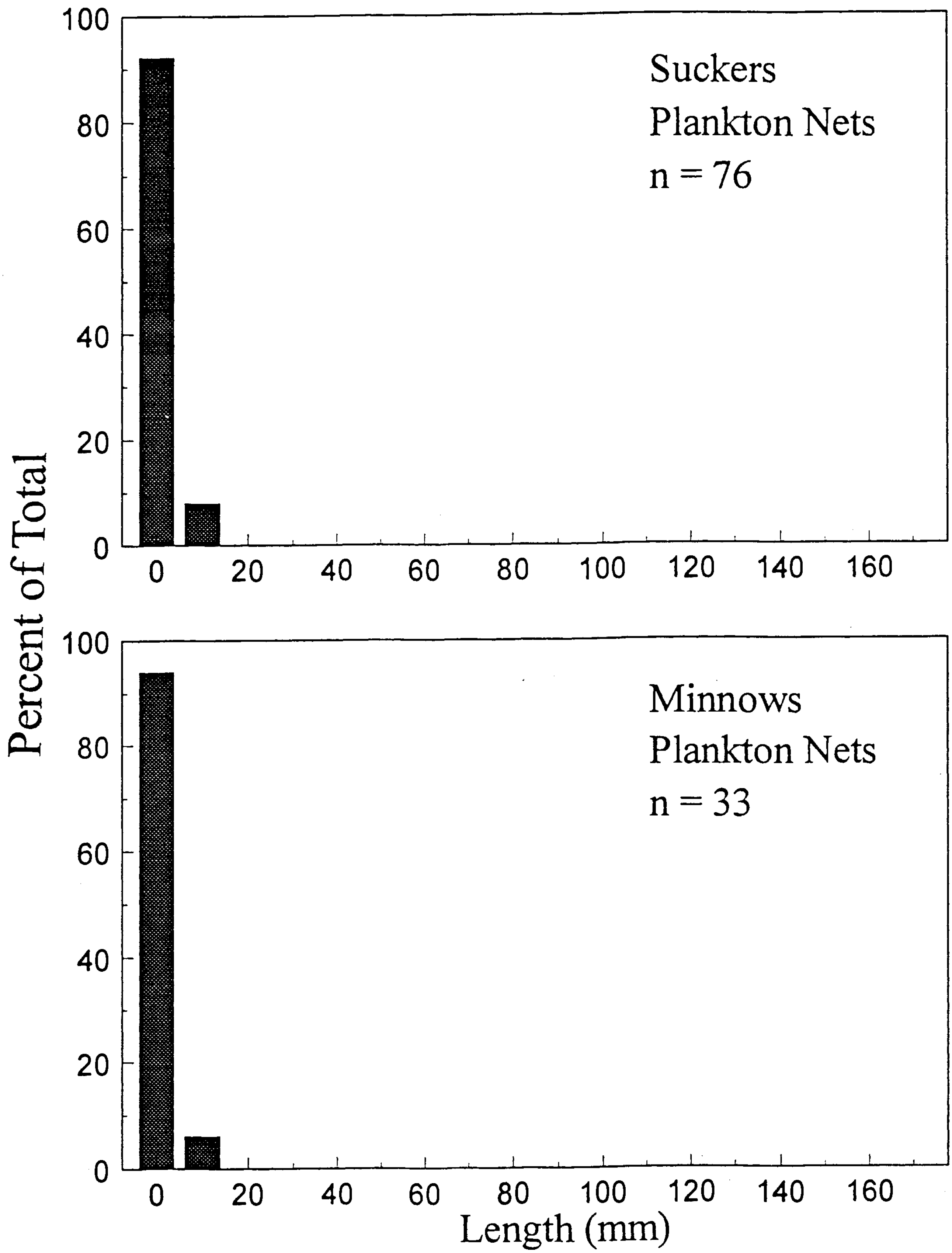


Figure 30. Length distributions of two taxa from escapement sampling with plankton nets.