To the Graduate Council:

I am submitting herewith a thesis written by Mark S. Garner entitled "Seasonal Abundance, Habitat Preference, and Spawning Success of Crappie in Norris Reservoir, Tennessee." I have examined the final copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Wildlife and Fisheries Science.

J. Larry Wilson, Major Professor

We have read this thesis
and recommend its acceptance:

Thomas K. Hill

Accepted for the Council:

Associate Vice Chancellor
and Dean of the Graduate School

SEASONAL ABUNDANCE, HABITAT PREFERENCE, AND SPAWNING SUCCESS OF CRAPPIE IN NORRIS RESERVOIR, TENNESSEE

A Thesis

Presented for the

Master of Science

Degree

The University of Tennessee, Knoxville

Mark S. Garner

August 1995

To Angela

With Love

Thanks

ACKNOWLEDGMENTS

First, and most appreciated is Dr. J. Larry Wilson, my major professor, I can not say enough, thank you. I would like to thank Dr. Tom Hill and Doug Peterson, the other committee members for reviewing this thesis and for their helpful comments. Also, thanks to Dr. George Hopper for substituting in the absence of one of the committee members.

I want to thank many TWRA and TVA personnel for their much needed assistance. Especially thanks to Mike Smith and Jim Negus of TWRA for their patience, advice, and equipment. Robert Wallus of TVA also played a very big part in the completion of this thesis, thank you.

Much thanks to Keith Patrick and Willie Fraser, fellow graduate students, for their assistance and dependablity. Thanks to Kelli Key, our secretary, for her time and talent with the computer. I thank many UTK under graduate students for their help with the field work. A special thanks is owed to the following undergraduate students, Robert Bondurant and Lamar Pearson, because they were always there and ready to help. Again, Angela thanks for substituting when others didn't make it and for your patience and love throughout this experience.

I owe much thanks to the Norris Reservoir Task Force for creating this project and supporting me in this project. Also much thanks is extended to TWRA for funding this project.

ABSTRACT

Trap nets and electrofishing were used to evaluate seasonal abundance of black (Pomoxis nigromaculatus) and white crappie (P. annularis) in fish attractor and non-attractor areas. Catch rates (CPUE) for electrofishing for spring and fall combined were as follows: in the fish attractor areas, 16.0 for young-of-year (YOY), 33.0 for preharvestable, and 9.1 for harvestable sized black crappie; in the non-attractor area, 0.6 for YOY, 13.7 for preharvestable, and 5.2 for harvestable sized crappie. White crappie rates were much different: in the attractor areas, 0.1 for YOY, 2.1 for preharvestable fish, and 3.8 for harvestable white crappie. Only harvestable sized white crappie were collected from non-attractor area CPUE of 0.6. Catch rates with trap nets during fall sampling only were substantially lower than catch rates by electrofishing. It was concluded that: (1) electrofishing was more efficient than trap netting for sampling crappie in Lost Creek, (2) black crappie are much more abundant than white crappie, and (3) fish attractors areas are very beneficial to crappie their entire life.

The spawning period of black crappie in Lost Creek was determined to be from 18 April, when the temperature was 15.7 C, to 12 May 1994, when the temperature was 18.5 C; 55 female black crappie were used in the determination. The white crappie spawning period could not be determined because only 3 were collected. A total of 132 larval crappie were sampled

by light traps; their diet consisted mainly of copepods with fewer numbers of cladocerans, i.e., 18.5 copepods to every 1.0 cladoceran eaten.

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CHAPTER 1

Introduction

Fishing is usually best in a reservoir within its first twenty years of existence, but as those days end the reservoir becomes less productive. Norris Reservoir was the first reservoir completed by the Tennessee Valley Authority (TVA) in 1936 and its best days for fishing have long since passed. A common expression of faithful Norris fishermen is, "Fishing on Norris is not as good as it use to be". The concerns of the fishermen motivated the Tennessee Wildlife Resources Agency (TWRA) to establish an advisory board called the Norris Reservoir Task Force (NRTF) in 1992. The purpose of this task force was to strengthen the communication between the anglers and the biologists (NRTF 1994) while developing a comprehensive management plan for the Norris fishery. The NRTF committee was composed of biologists from TWRA, TVA, the University of Tennessee (UT-Knoxville), and Tennessee Technological University (TTU). It also included two local Norris Reservoir anglers and a dock owner/operator. One of the primary complaints of fishermen has been that crappie (Pomoxis sp.) fishing has been very poor for some time. These observations and complaints motivated the NRTF to initiate a research project on crappie abundance and spawning success. Lost Creek was chosen as the study site for this investigation because the area was preferred by crappie fishermen. It is an area with substantial areas of habitat enhancement (fish attractors including half-log structures, brush, and stake beds) as well as areas with no habitat modification. The NRTF wanted an evaluation of the relative abundance of the crappie population within two different habitats; those areas where fish attractors were placed and those areas where fish attractors were not placed. To evaluate the relative abundance of the Lost Creek crappie population, several different approaches were taken and several different techniques were used. The approaches included: ascertaining when the crappie spawn took place, estimating the production of the spawn in different habitats, and comparing the spawn production to the abundance of young-of-year (YOY). Other variables that were evaluated included: available food for larval crappie, diet of larval crappie, and competing larval fishes of the larval crappie.

CHAPTER 2

Literature Review

Many hours have been spent researching all aspects of crappie biology in the United States. Hansen (1951) evaluated a variety of methods for collecting crappie. Trapnetting was preferred by Powell et al. (1971), Yeh (1977), and Boxrucker (1984) because trap nets collected larger numbers of crappie than other methods. Boxrucker and Ploskey (1988) and Schorr and Miranda (1989) stated that trapnetting caught more of all ages than did any other method; it was an efficient method for assessing absolute abundance. Miranda et al. (1990) reported trapnetting was better for larger crappie and electrofishing was better for smaller crappie.

Trap nets have been shown to be more accurate at estimating populations if left set for 2 to 3 days (Schorr and Miranda 1989). However, Webb and Ott (1992) claimed that the accuracy of their estimates did not increase after leaving trap nets set 2 to 3 days. The number of mortalities increased if the crappie were left in the net too long (Mooneyhan 1989).

Hansen (1944 ,1953), Grinstead (1970), Miller (1983), and Somerton and Merritt (1986) all stated that the efficiency of trap nets was influenced by certain environmental variables, such as temperature, dissolved oxygen, turbidity, and substrate. Trap nets worked best in Missouri at certain water temperatures (Colvin and Vasey 1986).

Kolz and Reynolds (1989) used electrofishing as a way of collecting fish and stated that it was a very productive method. Cichra et al. (1981) preferred electrofishing as the way of collecting crappie and recommended that it be done during the daytime hours. Hubbard and Miranda (1986) also used electrofishing and preferred it to other methods. Electrofishing was not very effective when used in places other than shallow warm bodies of water (Nielsen and Johnson 1983). They also claimed electrofishing was better for collecting adult crappie but, if used correctly, young crappie could be captured. According to Hubbard and Miranda (1986), electrofishing was more productive for crappie when they used DC pulsed gear. If the sampling was not done in proper water temperatures and dissolved oxygen concentrations, the fish would not be there to collect (Gebhart and Summerfelt 1975). Crumpton et al. (1988) thought it was necessary to use both electrofishers and trap nets along with other sampling methods to make the most accurate estimates.

According to Faber (1982), a very productive way of collecting larval crappie was with lighted traps. Turner et al. (1994) reported that differing varieties and densities of larval fish would be collected because of interfering variables, such as temperature, dissolved oxygen, turbidity, and substrate. Braum (1967), Crowl and Boxrucker (1988), Dettmers and Stein (1992), and

Welker et al. (1994) all reported that larval fish experienced difficulties finding adequate food because of competition from high densities of other larval fish. Etnier and Starnes (1993) identified which fish spawn in similar temperatures, a situation which may result in competition among some larval fish. Larval fish had difficulties finding food from lack of mobility (Barwick 1978). Silvells (1949), Bulkley et al. (1976), and Barwick (1978) found larval crappie preferred cladocerans as their food of choice.

CHAPTER 3

Description of the Study Area

Norris Dam was completed in 1936 and is located approximately 40.3 km north of Knoxville, Tennessee. The reservoir it impounds was the first built by TVA with its primary purposes for flood control, power generation, and recreation. The reservoir has two major tributaries, the Clinch and the Powell Rivers (Figure 1). It extends 116 km up the Clinch River and 90 km up the Powell River. It has 1,288 km of shoreline with a maximum width of 1.9 km and a surface area of 13,840 ha (TVA 1991). Throughout the year, the water level of Norris Reservoir fluctuates with an average yearly change of 9.2 m. The reservoir reduces to winter pool by January 1 and normally rebounds to maximum pool by the end of May; during maximum pool period it will maintain an elevation of 306 m (TVA 1991).

The area of the reservoir which contains most of its open water is called the Loyston Sea. Loyston Sea can be found between Clinch River Mile 98 (CRM 98) and CRM 103 and includes the waters of Mill Creek on the western end and Lost Creek on the eastern end.

The Lost Creek area makes up approximately one-third of the total area of the Loyston Sea. The area extends from the mouth of Clear Creek in an eastern direction 5.6 km to the confluence of Lost Creek with the

NORRIS RESERVOIR

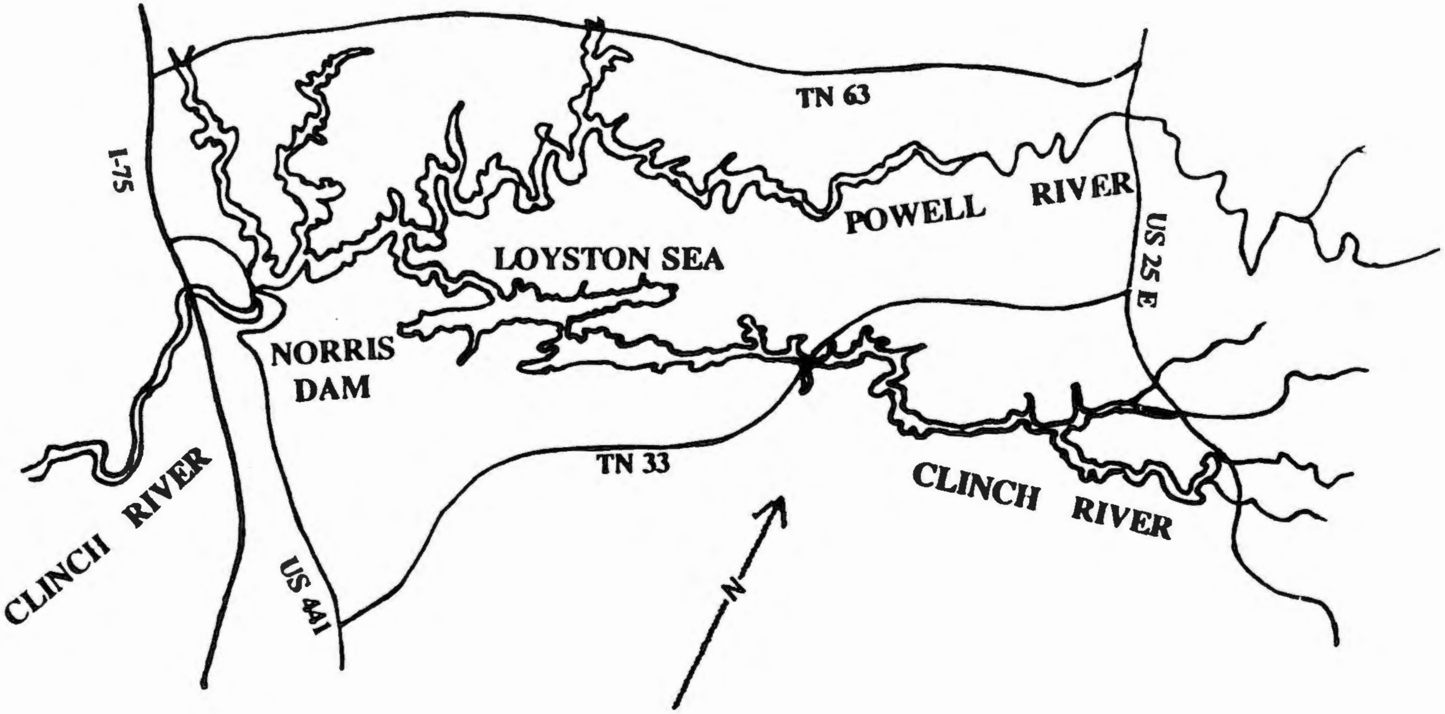


Figure 1. Map of Norris Reservoir including major tributaries and local highways.

reservoir embayment (Figure 2). The Lost Creek study area was composed of two primary creeks and many coves and inlets. The first area, 83 Cove, had fish attractors of anchored cedar trees and oak stake beds which have been in place for the past three years. During the low pool periods, 83 Cove may be completely dry. The substrate was identified as mostly clay with very few rocky areas. An adjacent cove, 60 Cove, was added to the 83 cove study area to make the area similar to other study areas. The names 83 Cove and 60 Cove were given because these numbers of fish attractors (anchored cedar trees) were originally placed in these two coves. Throughout this paper, 83 Cove and 60 Cove will be referred to as 83 Cove.

The second sampling area was White Creek, which is located in the central portion of the Lost Creek area (Figure 2). Except for periods of low pool, when it is nothing more than a narrow swift flowing creek, White Creek is a very clear, deep inlet. White Creek had no fish attractors or other habitat enhancement work.

The third sampling area was a cove called Sawmill Hollow. It is located between Clear Creek and White Creek on the northern side of the Lost Creek area (Figure 2). This cove was so named because it was the site of a sawmill before the reservoir was completed. Since 1985, TWRA and TVA have been placing anchored cedar trees and cedar half logs for fish attractors in Sawmill Hollow. The water color here is usually clearer than 83

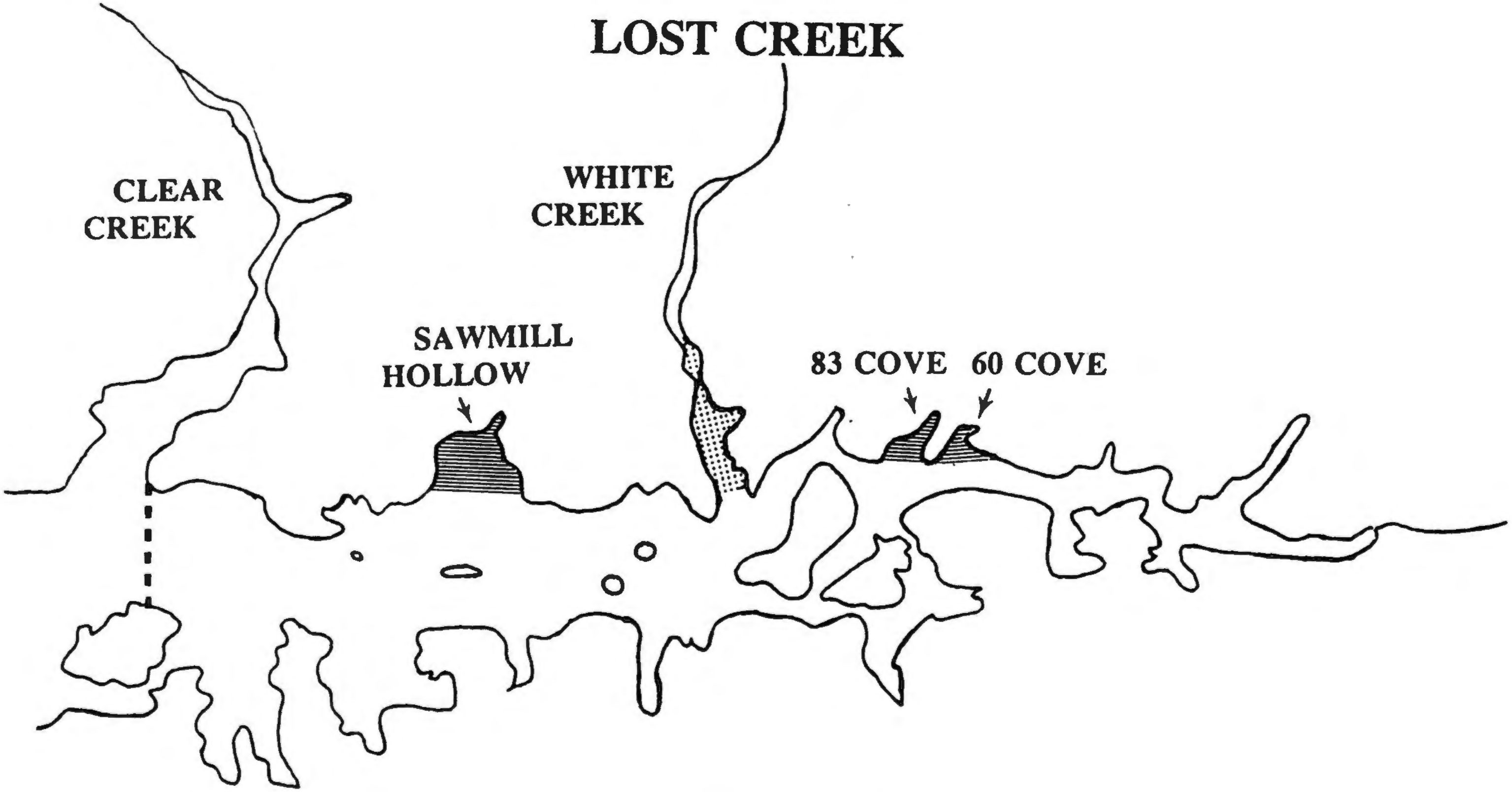


Figure 2. Map of Lost Creek indicating sampling sites.

▤ - Area with fish attractors
▦ - Area without fish attractors

Cove, but not as clear as White Creek. The substrate was mostly clay and gravel with a few rocky areas. Sawmill Hollow has several islands present during the summer which become ridges connected to the shoreline during low pool.

CHAPTER 4

Methods

Data for this project were collected from three sampling areas within Lost Creek: 83 Cove, Sawmill Hollow, and White Creek (Figure 2). Sampling began in November of 1993 and was continued through December 1994.

Light Traps

Light traps were used in the spring of 1994 to determine the productivity of the crappie spawn in the Lost Creek embayment. Trapping began on 26 April 1994 when the water temperature was 18.5 C and continued until 26 May 1994 when the water temperature was 19.0 C.

The light traps used consisted of a cylinder approximately 60.9 cm long by 45.8 cm in diameter. Spaced evenly around the cylinder were four clear plexiglas windows. These windows were used to funnel the larval fish and aquatic invertebrates toward the light into the trap. Centered between the four windows was a clear tube which extended from the top of the cylinder to the bottom. Within this tube two chemical light sticks (Cyalume 9-27017) were placed to provide illumination to attract the larval fishes. The lights were colored either yellow or white. Attached to the bottom of the cylinder was a tray with a screen bottom approximately 17.8 cm in diameter and 7.6 cm deep. The aquatic organisms attracted to the light entered the trap and remained there until the trap was retrieved.

Two light traps were placed in each of the three sampling areas at depths of 3.5 to 6.5 m of water. They remained vertical in position with the help of a float at the surface and an anchor at the bottom. Light traps were placed in the same locations as those sampled by the trap nets and the electrofisher. They were set once a week for a time period of 1 to 2 hours with each area was sampled equally. When a trap was retrieved, it was pulled up by the float. The entrapped species were forced into the screened tray by the water escaping the trap. After all the water was drained, the sample was put into labeled jars with 10% formalin to preserve the sample.

Trap Nets

Trapnetting was used in the fall of 1993 to estimate both black crappie (Pomoxis nigromaculatus) and white crappie (P. annularis) populations in attractor and non-attractor areas in the Lost Creek embayment. Trap nets were set for 4 consecutive nights beginning 30 November 1993 and continuing through 3 December. On 7 December 1993 they were reset for another 4 consecutive nights. The water temperature on the first day of sampling was 12.9 C and on the last day it was 11.8 C. During the 1993 trapnetting period, the water elevation was approximately 300.2 m; near maximum drawdown level for the reservoir.

A total of six nets were set in three separate areas: (1) two in 83 Cove which had new fish attractors, (2) two in Sawmill Hollow which had old fish attractors, and (3) two in White Creek, with no attractors. Lengths and weights of individual fish were recorded. Fins of captured crappie were clipped for identification in case of recapture.

The trap nets used in the Lost Creek embayment consisted of a lead net (1.1 m deep and 25 m long) which connected the trap to the bank. The framed box of the trap was approximately 1.09 m wide x 1.09 m deep x 2.18 m long. The trap had four hoops which were 0.78 m in diameter with the last hoop having a drawstring on the end forming the basket. The netting of that entire structure from lead to basket was square nylon mesh of 15.9 mm. A rope tied to the drawstring of the basket had a float which reached the surface; this allowed easy location of the net. Also, an anchor was tied to the drawstring to keep the trap net at the desired location.

Trap nets were not used in the spring of 1994 for fear of disturbing crappie spawning. Trapnetting was initiated in the same manner as in the previous fall again in the fall of 1994. This time the nets were set on October 18 and trapping ceased on October 28; again a total of 8 nights were sampled. Trapnetting in 1994 was initiated approximately a month earlier in the fall than in 1993. During this period the water elevation was approximately 301.6 m, more than 1.5 m higher than the 1993 trapping period. The water temperature on the first day of sampling was 28.9 C and dropped slightly to 27.9 C on the last day.

Electrofishing

Electrofishing was used in the spring of 1994 in an attempt to pinpoint the black and white crappie spawn in the Lost Creek embayment. Electrofishing began on 4 April 1994 when the water temperature was 10.6 C and continued through 26 May 1994, at which time the water temperature was 19.0 C. Sampling was conducted during the daytime hours within the same three sampling areas as trapnetting. Sampling times were recorded to allow equal amounts of time in each area. Fish collected were identified, measured, weighed, and then released. Crappie were identified as either black or white crappie and the sex of the fish was determined by the presence of prespawning characteristics.

The electrofishing boat was equipped with a Smith-Root 60 cycle DC Model 5.0 generator power pulsator. While this equipment was being used, the amperes were maintained between 7.5 and 8.0.

Before electrofishing again in December of 1994, trap nets were fished in October and November to obtain an estimation of the YOY recruitment.

After two weeks, electrofishing was resumed with the extra time included to give the fish time to recover from the stress of trapnetting. The water level during the fall electrofishing period was approximately 20% of the level during the spring electrofishing; therefore, the time spent electrofishing in the spring (10.65 hours) was reduced 80% to provide proportional time spent electrofishing in the fall, i.e., 2.67 hours.

Divisions by Size Classes

The gamefish collected by trap nets and electrofishing were divided into size classes to distinguish the frequencies of YOY, pre-harvestable (fish old enough to spawn, but not harvestable size), and harvestable (those fish of legal creel length). For example, crappie were divided into YOY = crappie up to 76.0 mm in length; preharvestable (PH) = crappie greater than 76.0 mm but less than 254.0 mm in length; and harvestable (H) = crappie which were equal to or greater than 254.0 mm in length. The three length categories for the black bass (Micropterus sp.) were: fish less than or equal to 152.0 mm classified as YOY, fish greater than 152.0 mm but less than 354.0 mm classified as PH fish, and fish equal to or greater than 354.0 mm classified as H fish. The three length categories for the walleye (Stizostedion vitreum) were: fish less than or equal to 152.0 mm classified as YOY, fish greater than 152.0 mm but less than 381.0 mm classified as PH fish, and fish equal to or greater than 381.0 mm classified as H fish. Two other species, bluegill (Lepomis macrochirus) and gizzard shad (Dorosoma cepedianum), were also divided into length classes, but they were only divided into two categories: YOY fish were those equal to or less than 76 mm, and H fish were those greater than 76mm. There is not a legal creel length on either of these fish, but it was necessary to divide these fish into those that were considered unable to spawn (YOY) and those able to spawn (H).

Determining the Crappie Spawn

Crappie spawn was documented while electrofishing in April and May of 1994. When a sexually mature female crappie was captured, it was determined if she was gravid with eggs (prespawn) or if it had no eggs at all (postspawn). It was also determined if the female was a black or white crappie. The date was recorded when the first postspawned female crappie was discovered. This indicated that the spawning period had started since the last sampling period. Also, the date was recorded at which all female crappie were in a postspawn condition. This would indicate that the females had all spawned since the last sampling period and an approximate end of the spawning period could be determined.

Age and Growth

Age and growth data of crappie were determined from scales collected during the late fall electrofishing of 1994. Scales were taken from below the lateral line and behind the pectoral fin as suggested by Nielsen and Johnson (1983). Approximately five scales were placed in each envelope and labeled with the date, species, length, and weight. Scales were taken from 66 crappie of varying sizes ranging from 114.3 to 342.9 mm. A microfiche projector was used in aging the scales and after an estimated age of the scales was determined, it was recorded on the appropriate envelope. Lastly, nineteen of the envelopes were randomly selected and the information from those envelopes used to backcalculate the length at age of the black crappie based on backcalculation formulas from Carlander (1977). Backcalculations were not determined for the white crappie because not enough fish were collected to make an accurate estimation.

Identification of Larval Fish

Larval fish from the light trap samples were separated from aquatic invertebrates. Both of these were placed into labeled jars which indicated the collection date and location. Larval fish were then keyed to the correct genus with the help of three books: Great Lakes Larval Fishes by Nancy

Auer (1982), Larval Fishes in the Tennessee River by Hogue et al. (1976), and Reproductine Biology and Early Life History of Fishes in the Ohio River Drainage (Vol. 1) by Wallus et al. (1990). Robert Wallus (TVA) checked the fish to verify the author's identifications. After these steps were completed, individual species were counted and recorded with proper labeling.

Identification of Sampled Invertebrates

After separating larval fish from the rest of the sample collected from the light traps, invertebrate samples from each area were emptied into a 3790 ml container and filled with water. The contents were then stirred and a subsample was randomly taken with a 1 ml pipet. The process was repeated 5 times in each sample, which resulted in subsamples of 5 ml in total volume. Pennak's key (1978) was used to identify all the invertebrate species in the subsamples and then they were counted.

Larval Fish Diets

Larval fish diets were determined by removing the stomach of the fish, smearing it on a slide, covering it with a coverslip, and then viewing the contents with a binocular microscope. Invertebrates in the stomachs were identified to its correct order, counted, and recorded for the appropriate fish.

CHAPTER 5

Results and Discussion

Trapnetting

During some of the fall trap net sampling the water was at such a low level that sampling in the designated areas was not feasible. In these cases, collections were taken from the area adjacent to the designated sampling areas. Water levels in the fall of 1993 were at 300.2 m elevation while in 1994 the level was at 301.6 m. The largest number of black crappie sampled (N = 143) was in 83 Cove in the fall of 1993 when the fish were more concentrated state due to low water (Figure 3). Sawmill Hollow had the second largest number of black crappie in the fall of 1993.

The largest number (N = 6) of white crappie collected was from 83 Cove in the fall of 1994 (which was the period with a higher water level) (Figure 4). The second largest number of white crappie was collected in the fall of 1993, again from 83 Cove. Sawmill Hollow was a very poor place to catch white crappie (Figure 4). White Creek (the non-attractor area) showed very poor catch-per-unit-effort (CPUE) rates for each species each year; this seemed to be directly related to the lack of fish attractors. All size classes of black crappie were collected in the largest numbers in the fall of 1993, except for the harvestable size in 83 Cove in 1994 (Figure 3). According to

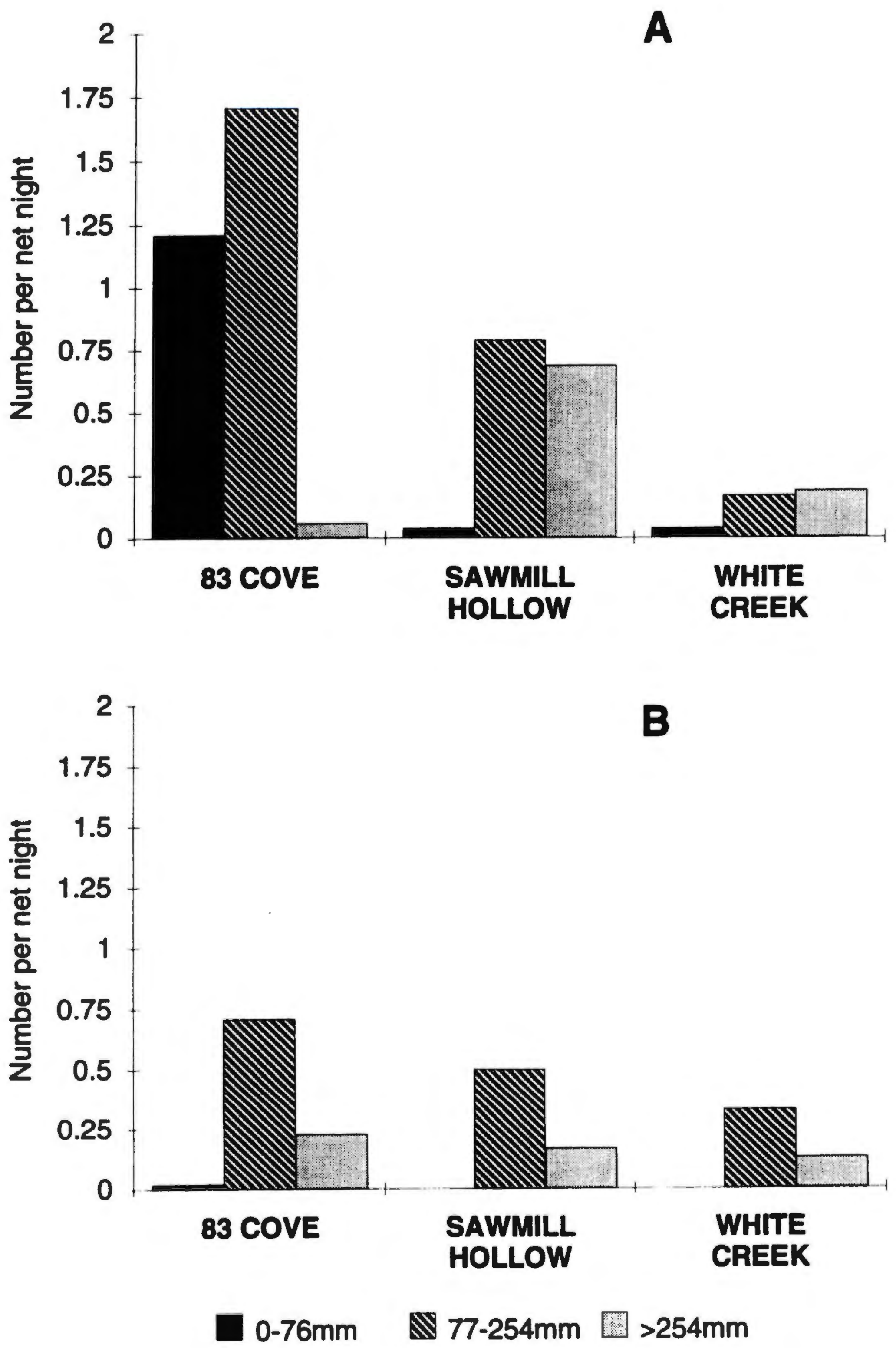


Figure 3. Catch per unit effort (CPUE) of black crappie collected during fall trapnetting; A) 1993, B)1994.

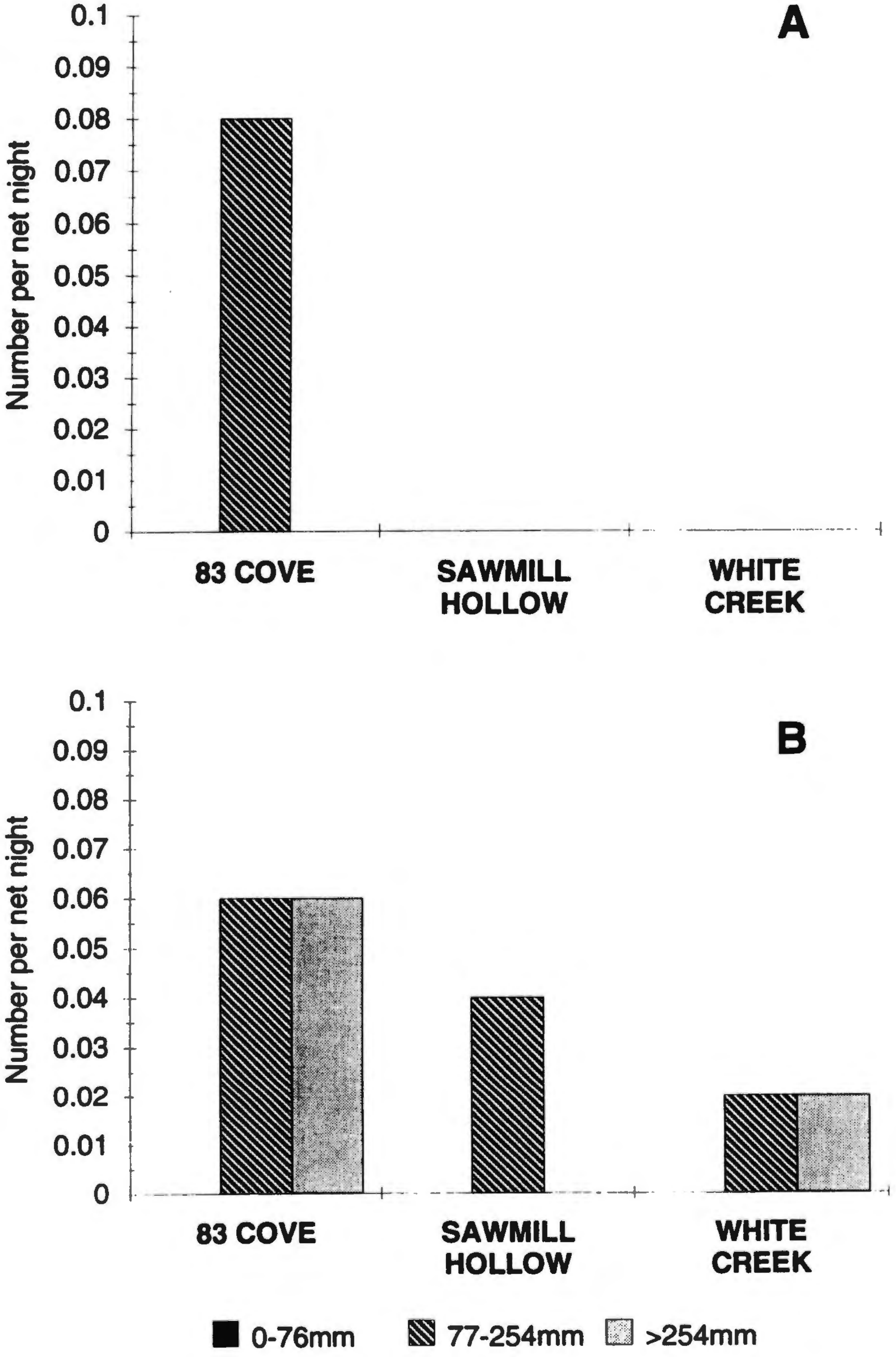


Figure 4. Catch per unit effort (CPUE) of white crappie collected during fall trapnetting; A) 1993, B) 1994.

the data, 83 Cove was an excellent refuge for YOY and PH black crappie during both years in comparison to the other areas, but especially in the fall of 1993. In contrast, Miranda et al. (1990) reported that trapnetting was better for catching larger fish whereas electrofishing seemed more efficient in capturing smaller fish.

In our study, collections of white crappie were totally different; more were caught in 1994 except the 1993 PH white crappie in 83 Cove (Figure 4). The lower water level during the 1993 sampling seemed to greatly facilitate the capture of black crappie. In contrast, white crappie were sampled more effectively during the higher water level in the 1994 sampling. No white crappie YOY were collected in either year; very few adults were collected in either the non-attractor or the attractor areas (Figure 4). Trapnetting indicated that white crappie were scarce in the Lost Creek embayment. The efficiency of trapnetting appears to be influenced by environmental variables as well as sampling techniques (Hansen 1944,1953; Grinstead 1970; Miller 1983; Somerton and Merritt 1986).

All species captured with trap nets in 1993 and 1994 are listed in Table 1; there were no recaptures of crappie during the 96 net-nights. No largemouth bass (Micropterus salmoides) were caught during either trap net period and only two smallmouth bass (M. dolomieui) were caught; both were netted during the fall 1993 trapping period. A total of 113 spotted bass (M.

Table 1. Fish collected and time spent during trapnetting.

Species	Fall 1993	Fall 1994
Black crappie	235	100
White crappie	4	10
Bluegill	674	79
Largemouth bass	0	0
Spotted bass	16	97
Smallmouth bass	2	0
Walleye	0	4
Gizzard shad	64	13
Drum	2	0
Log perch	1	0
Bluntnose minnow	0	1
Total fish collected	998	304
Total time spent	48 net nights	48 net nights

punctulatus) were collected during the trapnetting periods, with most being caught in White Creek. Spotted bass were collected in greater numbers in the non-attractor area (White Creek) than in 83 Cove and Sawmill Hollow combined (Figure 5). White Creek was apparently a preferred habitat of the spotted bass and the fall of 1994 was the better period for collecting them. Not only were the spotted bass found in the non-attractor area in the higher numbers, but more were collected during the higher water levels of fall 1994.

Only four walleye were collected during both years of trapnetting and these were collected in the fall of 1994 (Table 1). Bluegill were collected at much higher rates in the fall of 1993 from 83 Cove than in the other areas (Figure 6). In the 1994 collections, fish attractor areas had the highest CPUE rates with fairly even scores; again, the fall of 1993 had much higher CPUE rates. Bluegill seemed to prefer the fish attractor areas to the non-attractor area. Gizzard shad were only caught from 83 Cove each year and the lower water of 1993 was a better collecting period (Figure 7). Muoneke et al. (1992) found in Lake Carl Blackwell in Oklahoma that white crappie preferred gizzard shad as their primary food, but they were not readily available. This caused many problems such as poor fish condition, slow growth, and high mortality.

After combining the fall sampling periods of 1993 and 1994, the area

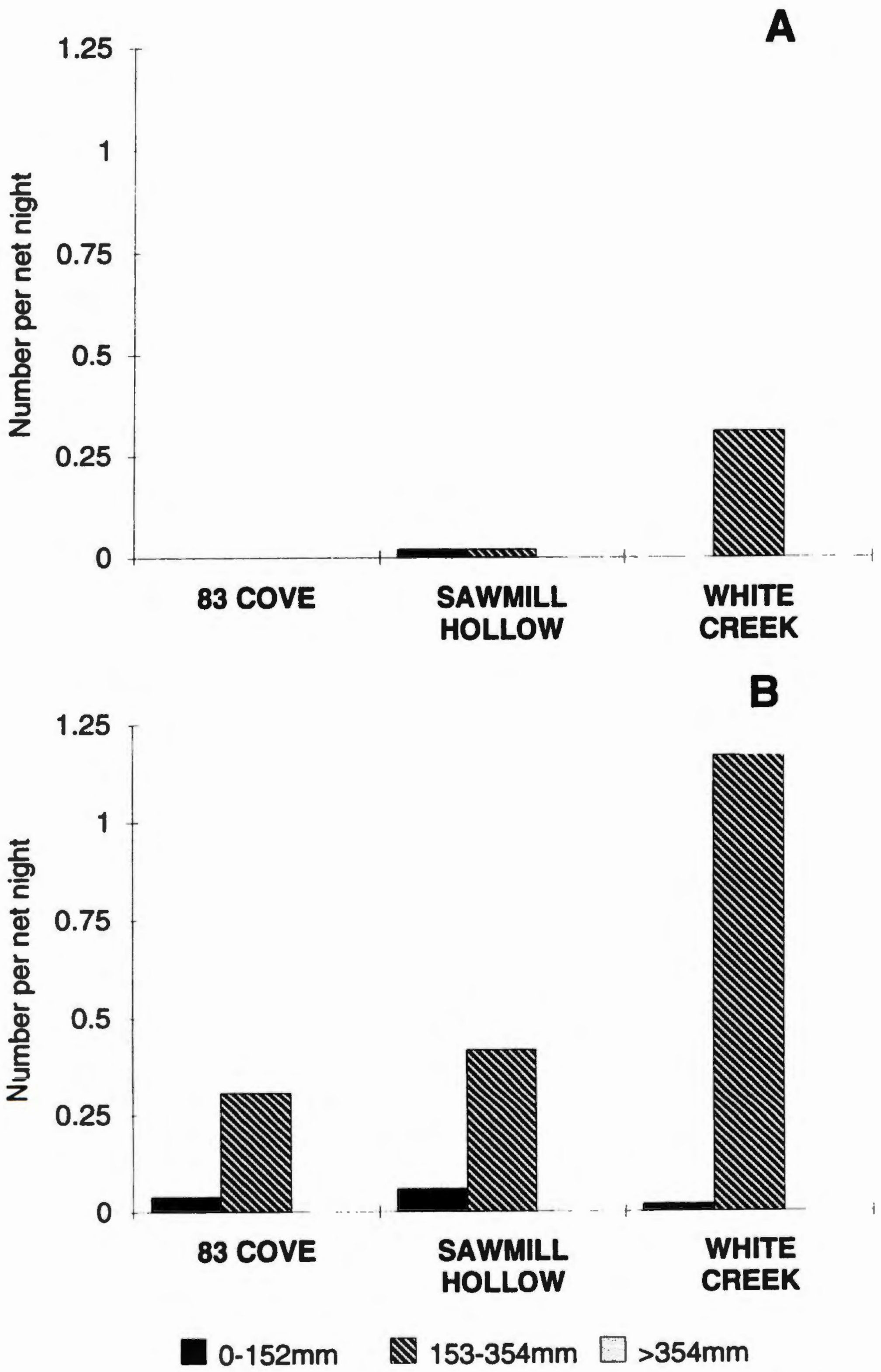


Figure 5. Catch per unit effort (CPUE) of spotted bass collected during fall trapnetting; A) 1993, B) 1994.

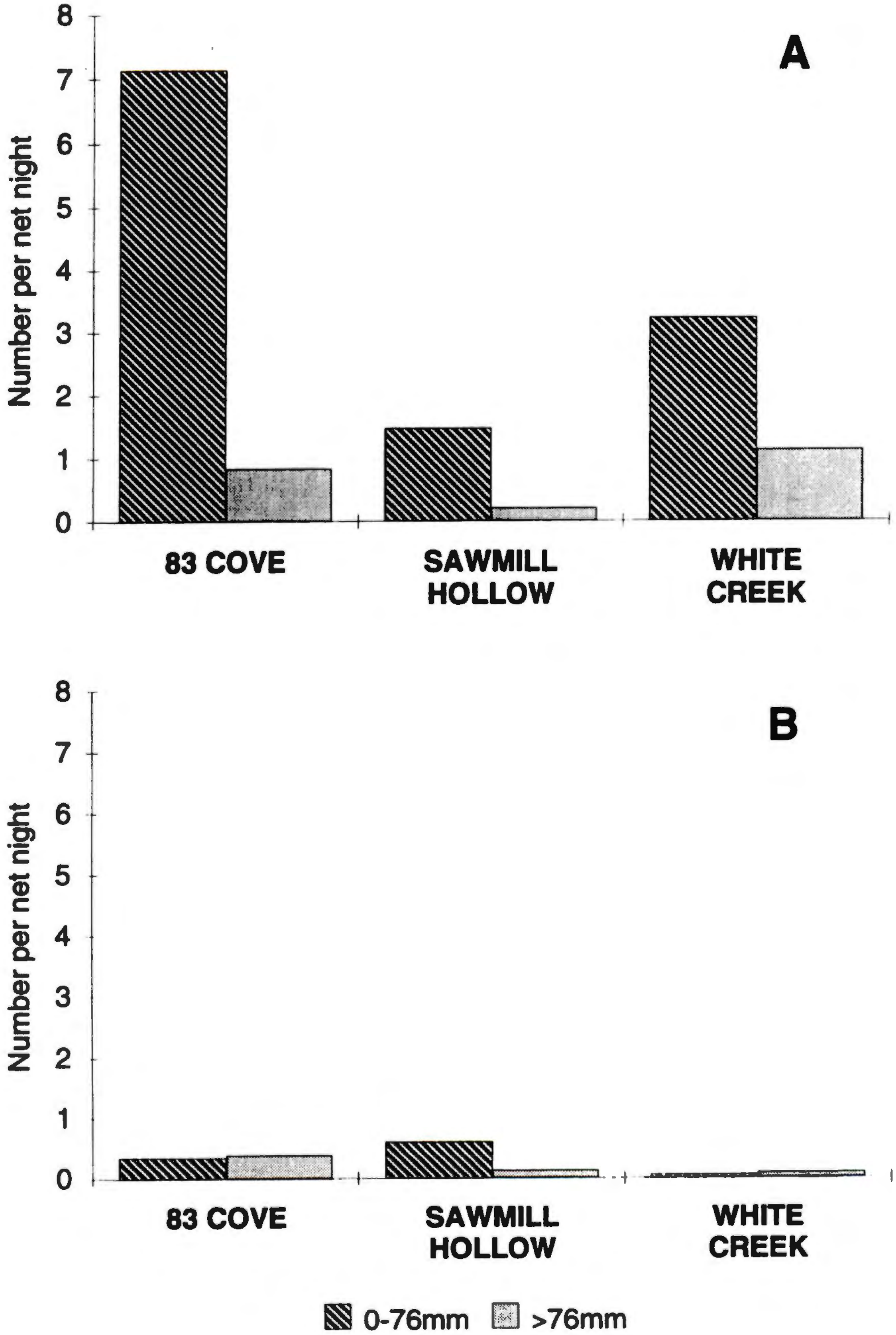


Figure 6. Catch per unit effort (CPUE) of bluegill collected during fall trapnetting; A) 1993, B) 1994.

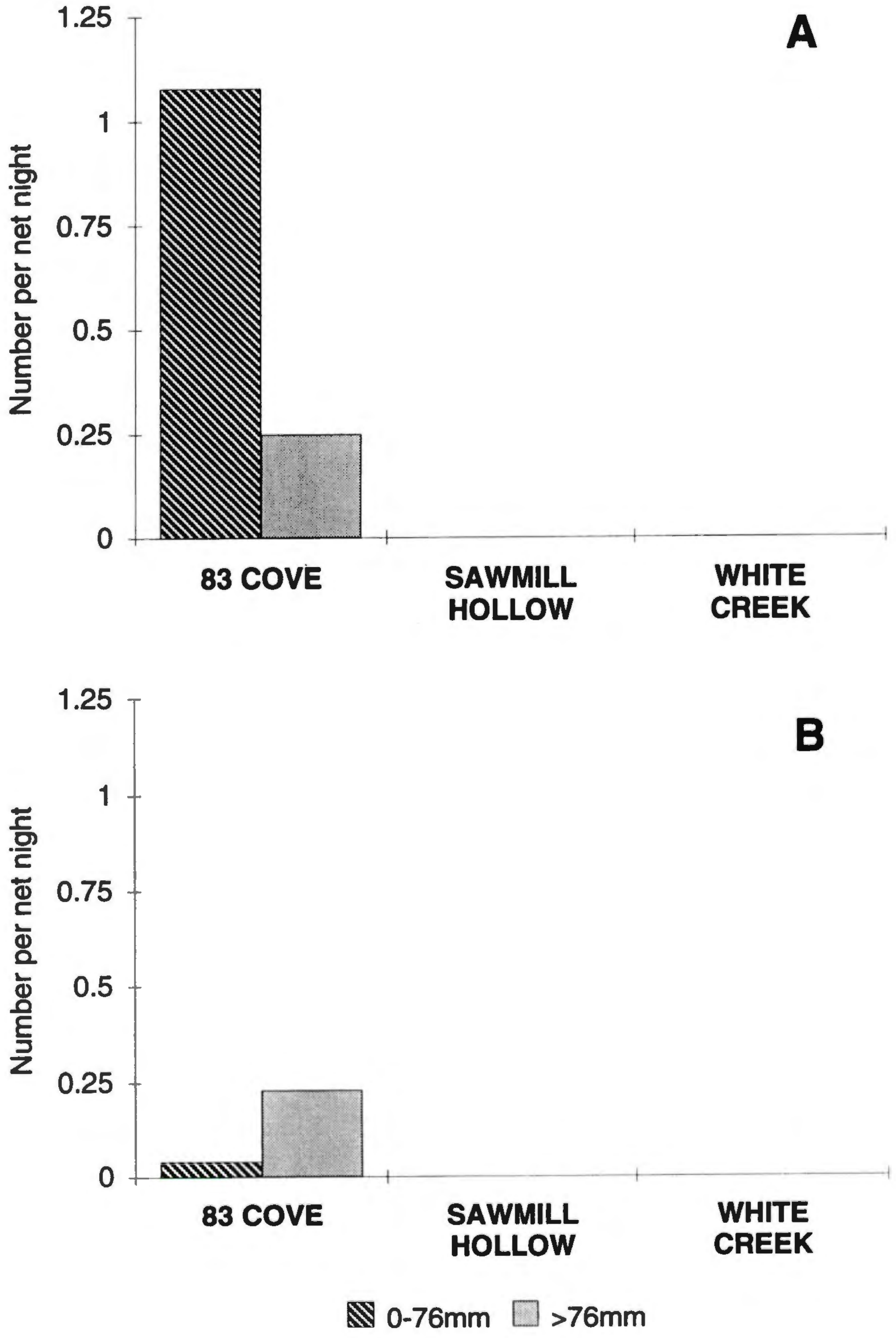


Figure 7. Catch per unit effort (CPUE) of gizzard shad collected during fall trapnetting; A) 1993, B) 1994.

of most preference or benefit to the crappie could be identified; 83 Cove's CPUE was 3.94 for the black crappie and 0.20 for the white crappie. Sawmill Hollow's CPUE was 2.19 for black crappie and 0.04 for the white crappie. Lastly, White Creek's CPUE was 0.86 for the black crappie and 0.04 for the white crappie. In comparing the fish attractor areas to White Creek (the area with no fish attractors), the fish attractor areas showed a higher density of crappie (Figures 3 and 4). Individually, 83 Cove had higher concentrations of both black and white crappie than did Sawmill Hollow.

The reason trapnetting was done earlier in the fall of 1994 than in the previous year was because we also wanted to electrofish. It was believed that electrofishing should be done last since it would be the more successful sampling method of the fish. The main purpose of electrofishing was to compare efficiencies of the two methods. Trapnetting alone was indicating little to no recruitment of YOY crappie; the electrofishing samples proved that trapnetting alone would have misrepresented the true crappie conditions in Lost Creek. Trapnetting may have been more productive if conducted earlier in the fall when the water was warmer. The fall of 1993 was the earliest period of trapnetting; at this time water temperatures ranged from 12.9 to 11.8 C. Colvin and Vasey (1986) reported that trap net sampling in Missouri was best when water temperatures were between 12.8

and 20 C. Schorr and Miranda (1989) recommended checking the nets after 2 to 3 net nights for higher catch rates. They also noted predation on small crappie by larger fish inside the nets. Webb and Ott (1992) stated that both 1- and 3-night sets yielded similar estimates of catch per unit effort. Also, Mooneyhan (1989) pointed out that the numbers of mortality increased as the time of entrapment increased. These were some of the reasons the nets were checked daily.

Electrofishing

Data were collected during the daylight hours in the spring of 1993 and fall of 1994. Kolz and Reynolds (1989) pointed out that electrofishing has gained prominence in recent years as a method for the capture and control of fish in research. Electrofishing can be used to determine the abundance of many fish species; it is best for sampling larger fish, but if used properly, the trends of younger fish can be observed as well (Nielsen and Johnson 1983). Electrofishing during the day seemed to be more productive for sampling crappie than at night (Mooneyhan 1989). Cichra et al. (1981) preferred sampling for crappie during the day with nonpulsed DC equipment. Spring is the best time of the year for electrofishing according to Nielsen and Johnson (1983) because the fish are in the shallow, warmer waters and are easier to capture. Norris Reservoir would be an exception to this because it fluctuates so much in the fall. Fall is the better season to electrofish because all the fish are present in a smaller volume of water than in the spring.

Spring electrofishing was a productive way of sampling the crappie in the Lost Creek embayment; 99 black crappie and 3 white crappie were collected during the spring sampling of 1994 (Table 2). Fall electrofishing was much more productive at collecting crappie; 151 black crappie and 19 white crappie were captured. The difference in collections was probably due to the lower water level during the fall shocking period (Table 2).

Crappie collected during the electrofishing periods were divided into the same three size categories that were used with the trapnetting data (YOY, PH, and H fish). No YOY black crappie were captured during the spring sampling, but there was a CPUE of 65.13 for YOY black crappie and a CPUE of 46.84 for PH black crappie in the fall collection. 83 Cove had a much higher CPUE in the fall than a combination of the others (Figure 8). During the fall electrofishing of 1994, 83 Cove had a large area of shallow water. There was no structure in this area in which the fish could hide except for a few sunken cedar trees; fish seemed to be crowded around those trees. During both the spring and the fall electrofishing periods, 83 Cove had a very poor CPUE for H black crappie; this could be due to the fishing pressure in that area.

Table 2. Fish collected and time spent during electrofish sampling.

Species	Spring 1994	Fall 1994
Black crappie	99	151
White crappie	3	19
Bluegill	413	1,124
Largemouth bass	200	221
Spotted bass	65	81
Smallmouth bass	3	24
Walleye	25	3
Striped bass	1	1
Rock bass	0	2
White bass	16	1
Channel catfish	3	0
Flathead catfish	2	0
Gizzard shad	71	20
Common carp	63	2
Carpsucker	1	0
Drum	6	1
Gar	6	0
Log perch	0	3
Bluntnose minnow	1	0
Total fish collected	978	1,653
Total hours spent	10.65 hrs	2.67 hrs

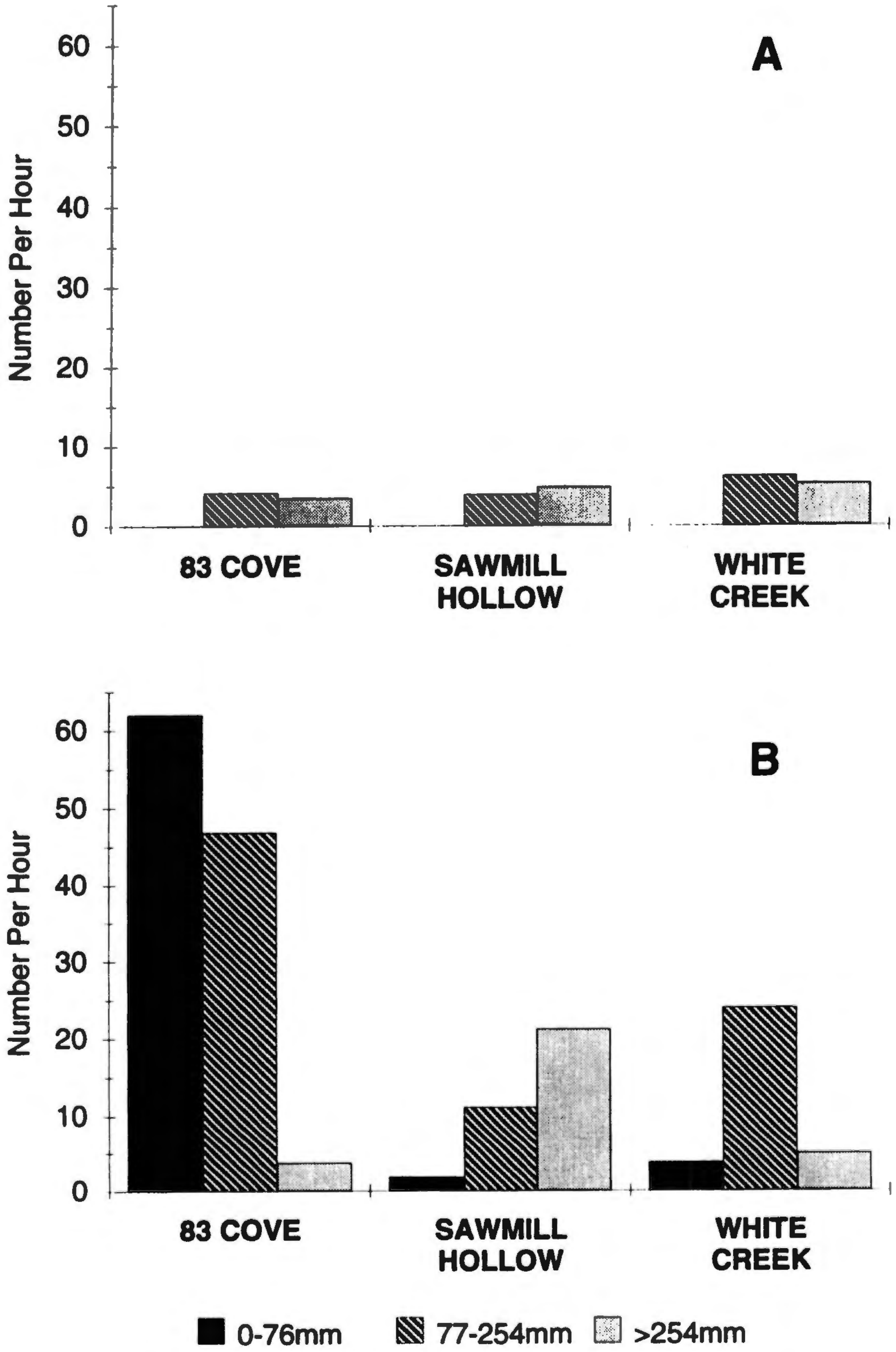


Figure 8. Catch per unit effort (CPUE) of black crappie collected during 1994 electrofishing; A) Spring, B) Fall.

Sawmill Hollow had poor catch rates for all sizes, and especially YOY black crappie; the YOY black crappie numbers were lower here than in the non-attractor area (White Creek). Overall, Sawmill Hollow had fair CPUE rates for PH black crappie, but had higher CPUE rates for H black crappie than the other areas. The higher CPUE for H black crappie was probably due to the lack of fishing pressure in that area. During the reservoir's water level drawdown (during the winter), YOY fish are subject to easy predator access; there is very little to no structure in which they may find refuge. White Creek had very poor CPUE rates for all sizes, which was probably due to the fact that White Creek had no fish attractors; the CPUE for PH crappie was the highest and it was only 21.25 (Figure 8).

CPUE values for white crappie were very poor during both spring and fall sampling periods (Figure 9). No white crappie were collected in Sawmill Hollow by electrofishing and only one white crappie was collected in White Creek; it was an H fish. 83 Cove had the highest CPUE by far for white crappie; in the spring, 1 YOY and 2 PH fish were captured, and in the fall 6 PH and 12 H fish were captured, resulting in very low CPUE rates. These poor catch rates were expected because, as previously mentioned, the white crappie population is on the decline in Norris Reservoir.

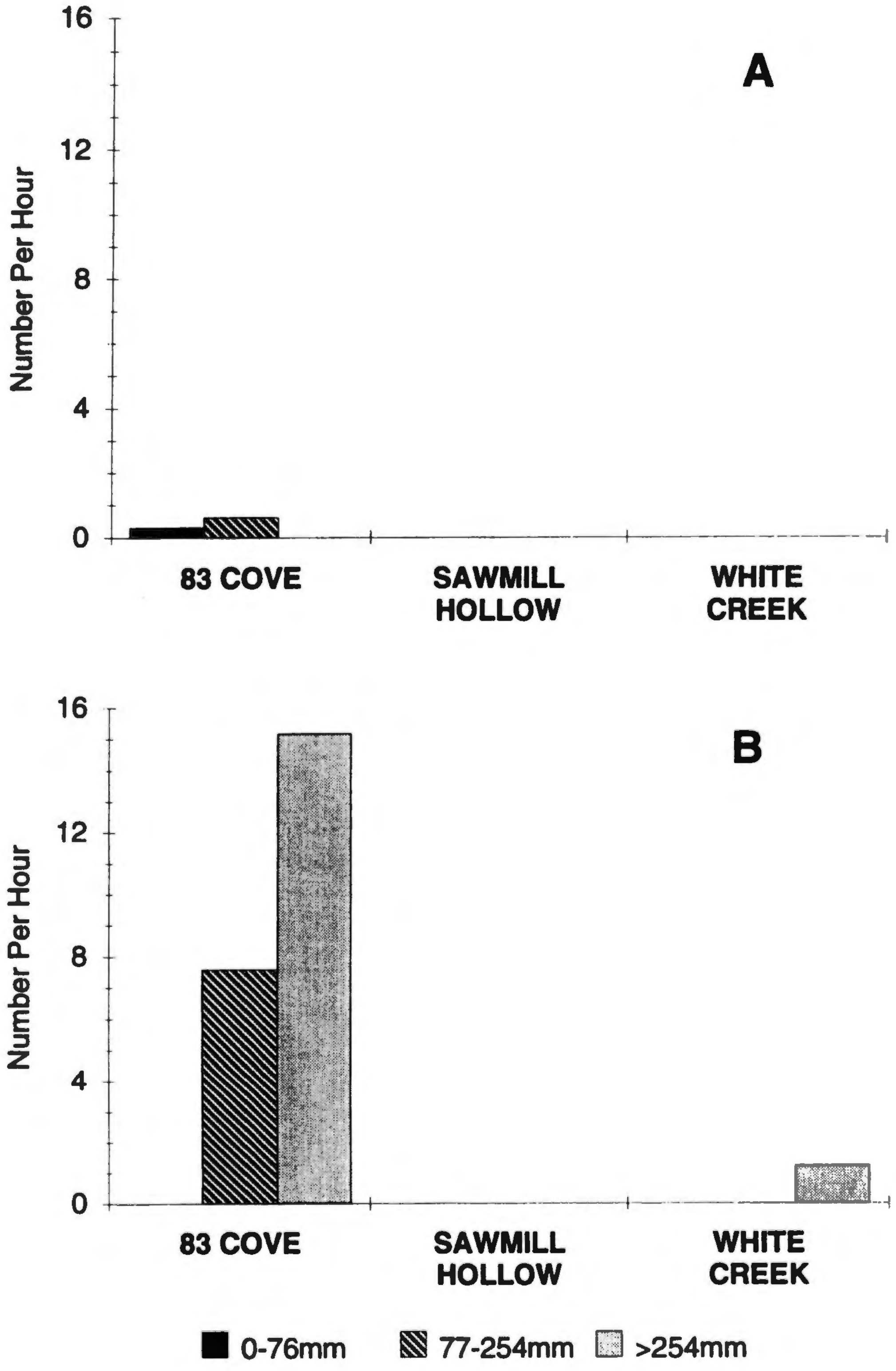


Figure 9. Catch per unit effort (CPUE) of white crappie collected during 1994 electrofishing; A) Spring, B) Fall.

While electrofishing, six other species were also collected (Table 2). Largemouth bass were easy to collect during either sampling period (Figure 10). Several things were surprising after evaluating the largemouth bass samples: one was that White Creek's average catch rates were very high (191.8 PH largemouth bass); another was that White Creek had the highest CPUE average (48.5 H largemouth bass); and lastly, Sawmill Hollow had the lowest average catch rate (19.9 largemouth bass) for both PH and H bass. It was surprising to find so few fish (N = 9.7) while electrofishing because of the present day practice of "catch and release"; perhaps the H bass released from anglers have high mortality rates. It appears from these data that largemouth bass prefer the non-attractor area to the attractor areas.

Catch rates for spotted bass were variable; in the spring, 83 Cove had the highest CPUE (0.93) for all three size categories, White Creek was second with 0.71, and surprisingly Sawmill Hollow rated last with 0.22 in all three categories (Figure 11). In the fall, the catch rate from 83 Cove was lowest in all three categories with a rate of 5.2, White Creek was second with a rate of 11.7, and Sawmill led in CPUE in all three categories with the rate of 15.6.

Catch rates for the smallmouth bass were nothing like the other basses; not one smallmouth bass was collected from 83 Cove during either

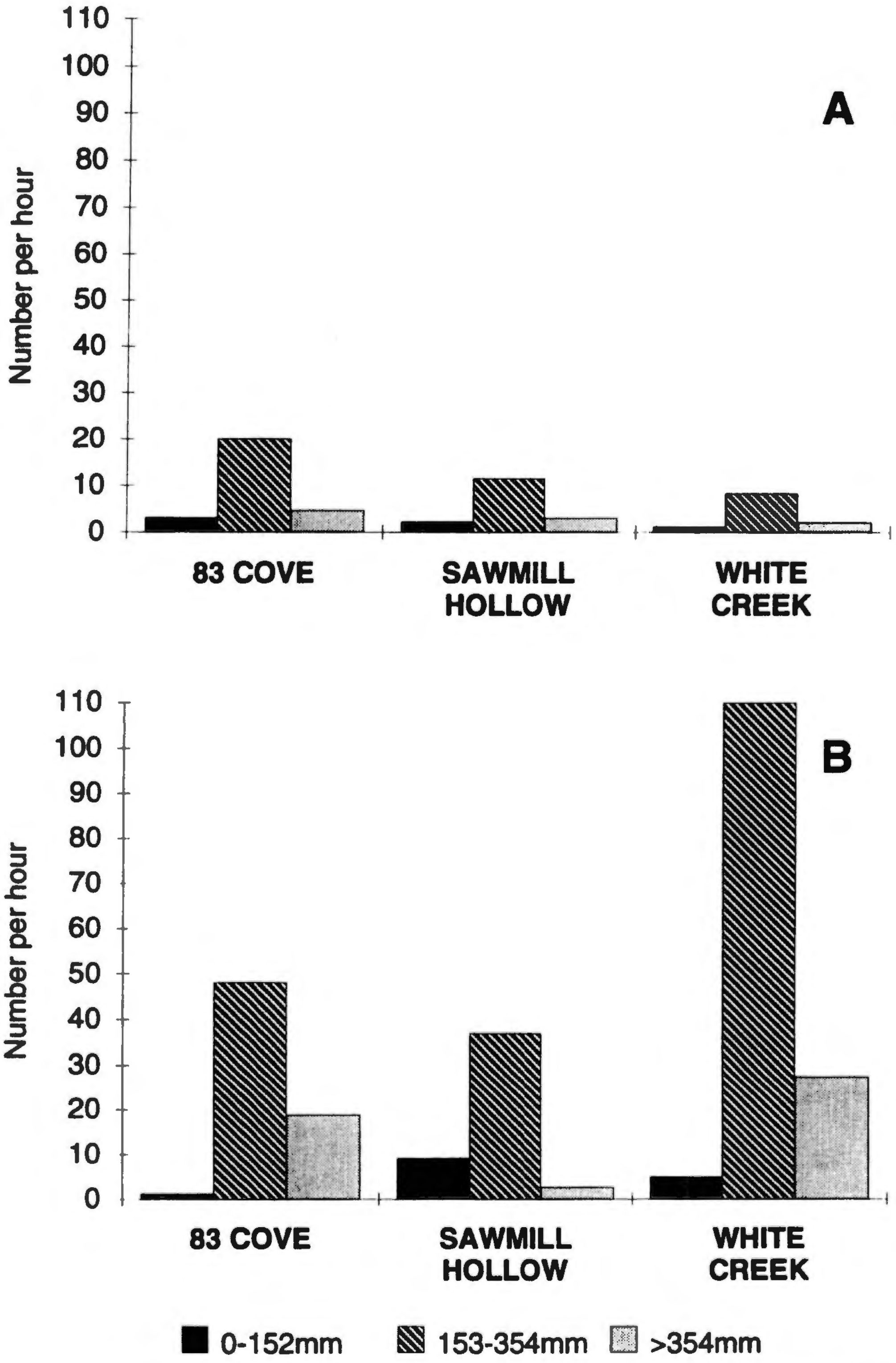


Figure 10. Catch per unit effort (CPUE) of largemouth bass collected during 1994 electrofishing; A) Spring, B) Fall.

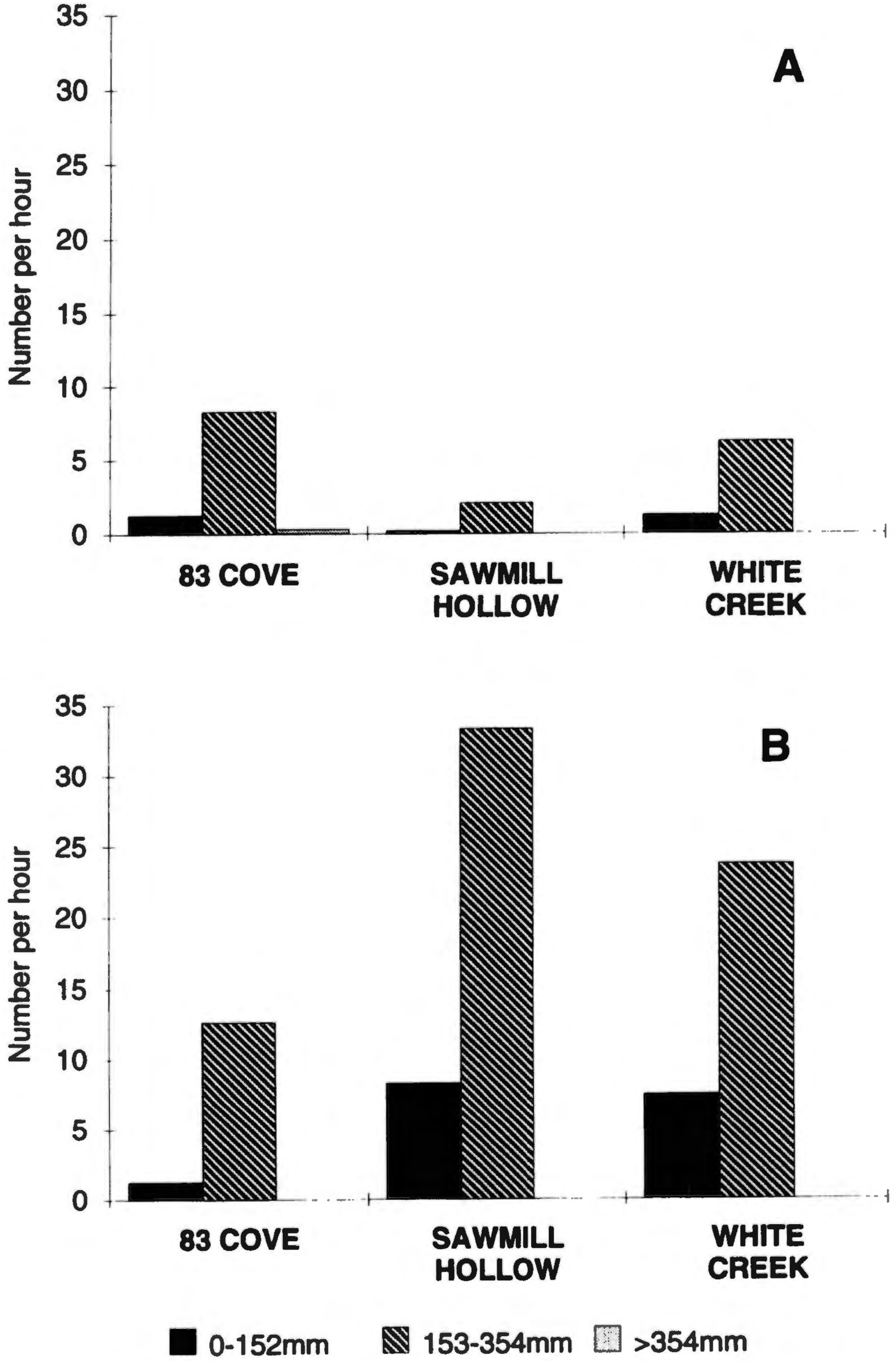


Figure 11. Catch per unit effort (CPUE) of spotted bass collected during 1994 electrofishing; A) Spring, B) Fall.

period, and no H smallmouth bass were collected from any area during either period (Figure 12). During the spring electrofishing, no YOY or H smallmouth bass were collected; 7 PH fish in Sawmill Hollow were the only fish collected and they were collected at a rate of 0.69 per hour. During the fall electrofishing, the largest number of smallmouth bass (N = 47) were collected from Sawmill Hollow followed by White Creek with 16.7 smallmouth bass captured. According to the data, smallmouth bass were collected most often in the old fish attractor area (Sawmill Hollow). Overall, it appears the black basses show no preference for either the non-attractor area or the fish attractor areas.

Walleye were also collected during the electrofishing periods, but with very low catch rates (Figure 13). Only 10 walleye were collected from White Creek during the spring electrofishing. 83 Cove's catch rates (spring = 3.2, and fall = 1.27) and Sawmill Hollow's catch rates (spring = 2.77, and fall = 1.86) were much higher than White Creek's catch rates (spring = 0.94, and fall = 0) in the PH and H categories for both electrofishing periods. Perhaps the walleye were more abundant in the attractor areas because they are predators and these areas have higher numbers of juvenile fish which could be used as forage.

Two other species captured during electrofishing were the gizzard shad and the bluegill. 83 Cove had 48.6 the highest CPUE rate for bluegill

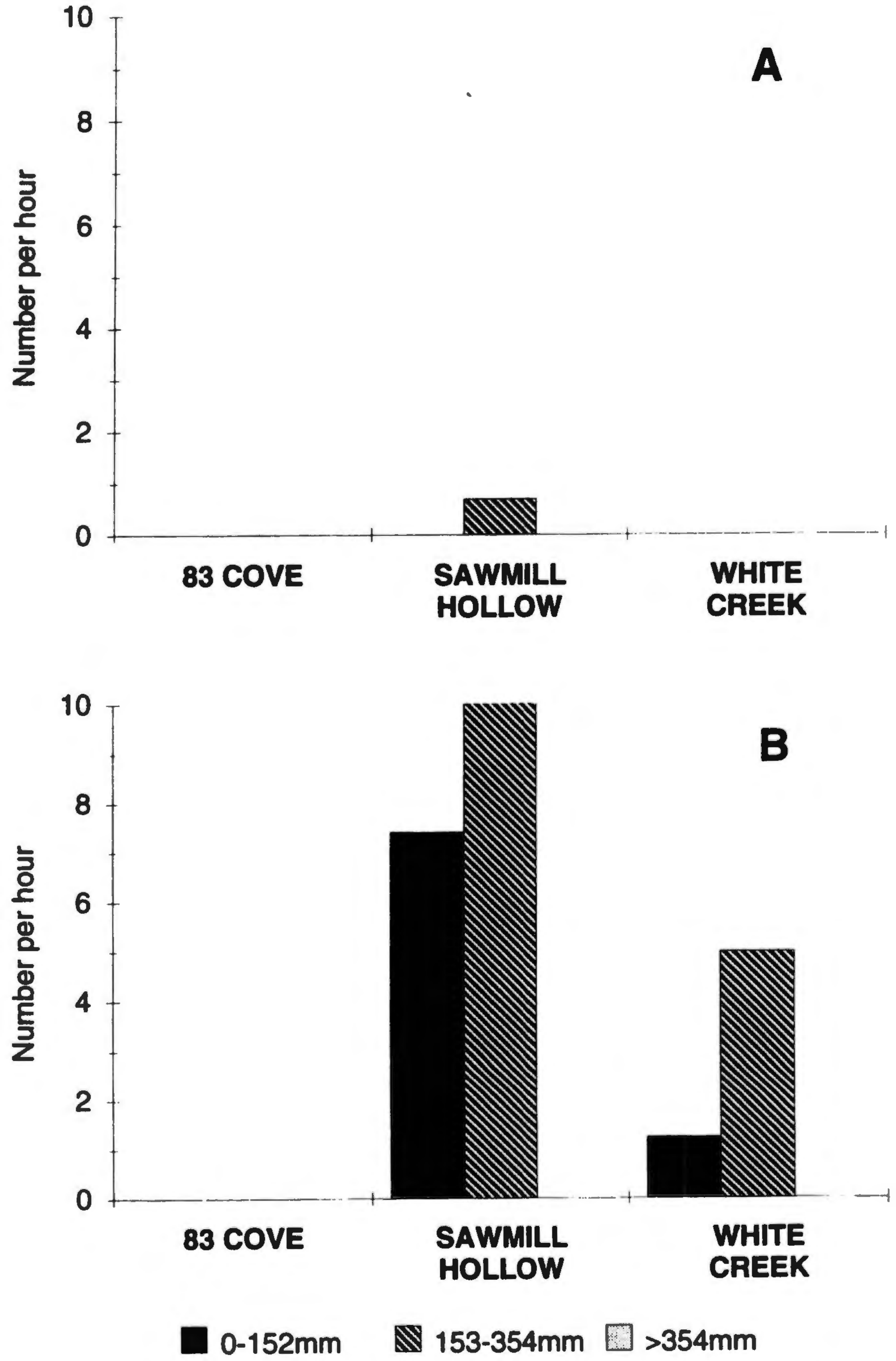


Figure 12. Catch per unit effort (CPUE) of smallmouth bass collected during 1994 electrofishing; A) Spring, B) Fall.

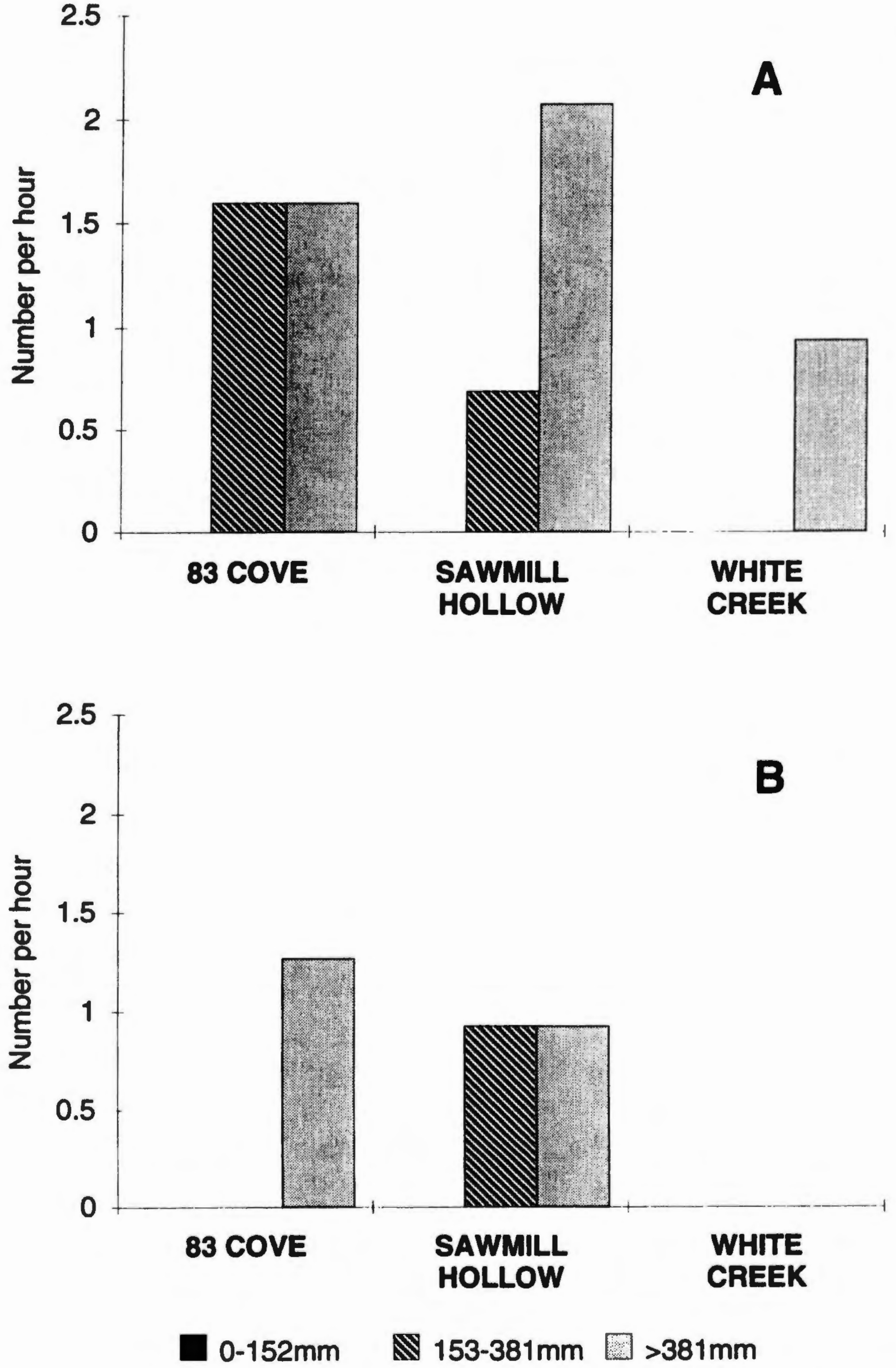


Figure 13. Catch per unit effort (CPUE) of walleye collected during 1994 electrofishing; A)Spring B) Fall.

during the spring electrofishing while Sawmill Hollow had 35.9 and White Creek had 33.1 approximately the same CPUE rates (Figure 14). During the fall sampling period, 83 Cove had 186 the highest catch rate for YOY bluegill, with White Creek close behind. White Creek had 428.8 the highest numbers for H bluegill collected during the fall period. White Creek probably had more bluegill because of its more desirable substrate, including more rocky areas, more drop-offs areas, and also many areas of shallow water. Overall, it appeared that bluegill preferred the non-attractor area over the attractor areas.

Gizzard shad were collected with highest catch rates from 83 Cove in the spring period (Figure 15). During the fall electrofishing period, no gizzard shad were collected from either 83 Cove or White Creek, but 50 were collected from Sawmill Hollow. Overall, gizzard shad seemed to prefer the fish attractor areas.

The effectiveness of electrofishing depends on the conductivity of the water in relation to the conductivity of the fish (Kolz and Reynolds 1989). Reynolds (1983) agreed that fish characteristics, habitat characteristics, and operating conditions will affect the efficiency of sampling by electrofishing. Gebhart and Summerfelt (1975) claimed that sampling crappie can be unreliable with any type of sampling gear because crappie are going to be in the areas of desired temperature and dissolved oxygen; this may be in a

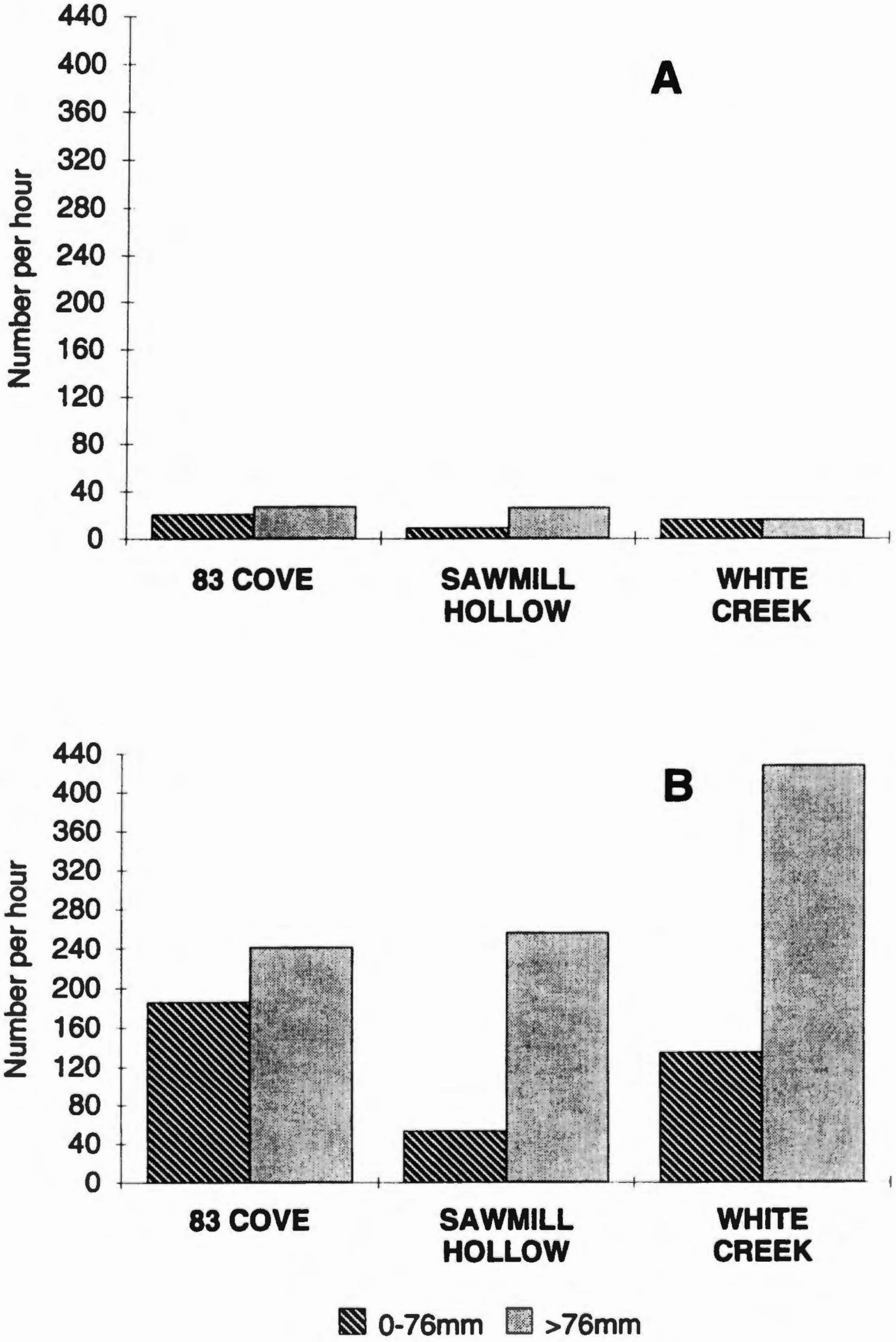


Figure 14. Catch per unit effort (CPUE) of bluegill collected during 1994 electrofishing; A) Spring, B) Fall.

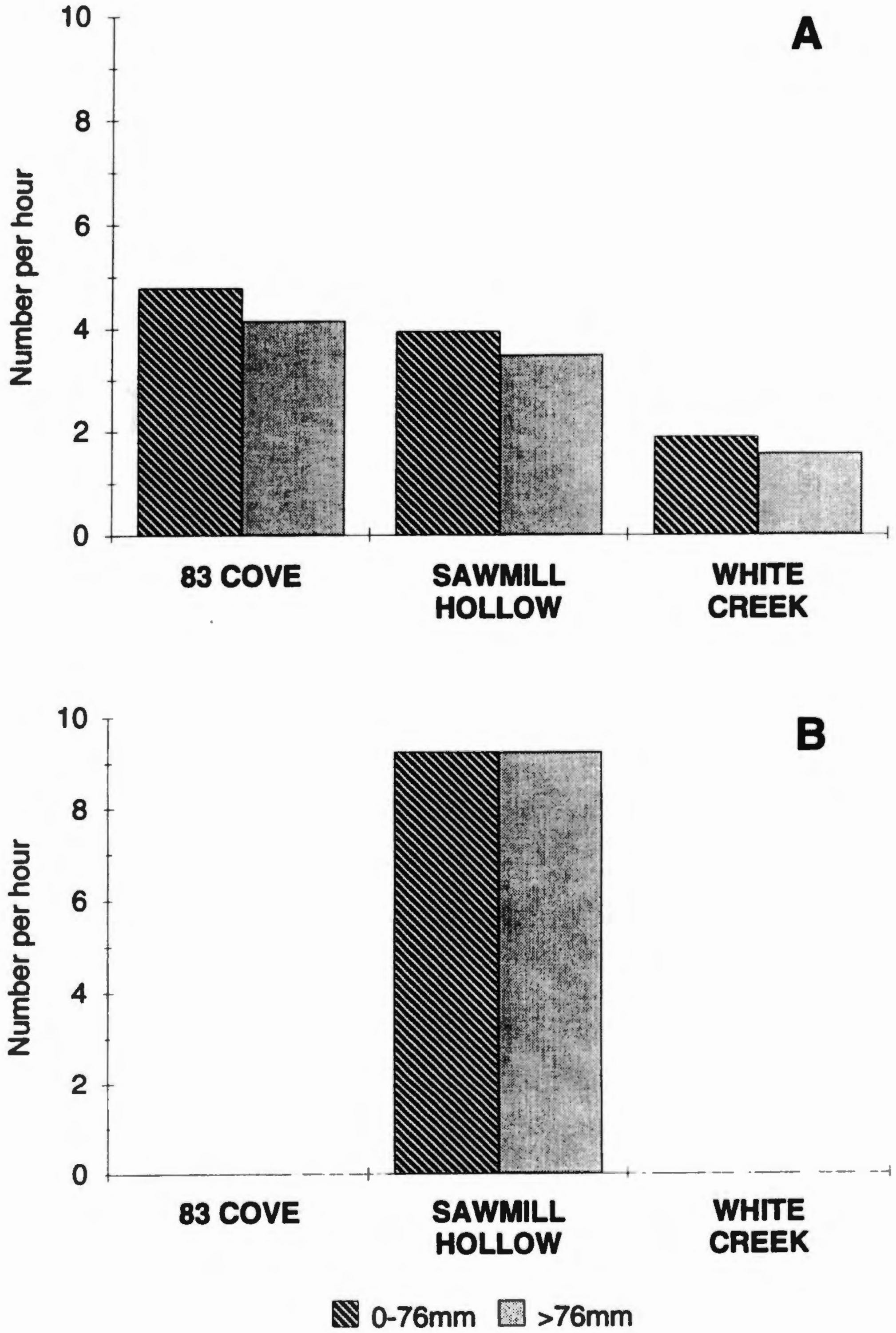


Figure 15. Catch per unit effort (CPUE) of gizzard shad collected during 1994 electrofishing; A) Spring, B) Fall.

totally different area or depth than is sampled. Crumpton et al. (1988) thought it was necessary to sample with electrofishing, hoop nets, and pound nets to get an accurate sample.

Spawning Period

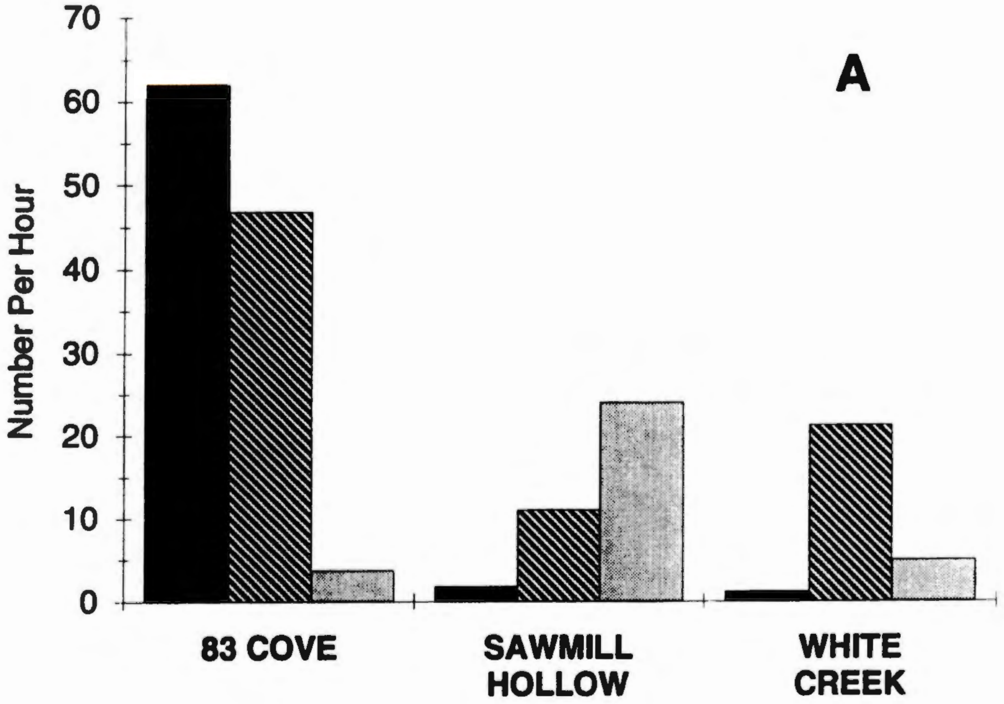
Electrofishing in the spring of 1994 was a tool used to identify the spawning period for crappie. The spawning period for black crappie in the Lost Creek embayment was determined to be from 18 April to 12 May, when the temperature ranged from 15.7 to 18.5 C. A total of 55 female black crappie were examined to document this time period. These females were identified to be in one of three stages; either in prespawn (N = 5), spawn (N = 17), or postspawn (N = 33) conditions. The spawning period of the white crappie could not be determined since they spawn during a restricted period and also that only 3 white crappie were collected during that time.

Age and Growth

It was determined from age and growth data that black crappie in Lost Creek reached 6.4 cm at age one, 14.0 cm at age two, 22.9 cm at age three, 29.2 cm at age four, and 33.0 cm at age five. Black crappie from other areas of Norris have been reported to be similar in size at a given age to Lost Creek crappie (J. Negus, TWRA, pers. comm.). He reported the average lengths are 8.1 cm for the first year, 17.3 cm for the second, 23.6 for the third, and 27.2 cm for the fourth year. Therefore, it appears crappie growth is approximately the same in the Lost Creek embayment area as in the other areas of Norris Reservoir. Carlander (1977) reported similar growth for the first year for black crappie in Norris; however, subsequent year's growth was substantially higher. This was reported 15-20 years after Norris was impounded; the faster growth was probably due to the higher level of productivity of the "recently-impounded" reservoir.

Trapnetting vs. Electrofishing

When using the per hour units to discuss the two methods used to sample black crappie, it is easily seen that electrofishing was by far the most efficient (Figure 16). For example, trapnetting averaged 0.016 fish per hour whereas electrofishing averaged 11.4 black crappie per hour. It must be remembered that electrofishing is an active collection method while trapnetting is a passive method. Similar results were seen for white crappie (Figure 17), largemouth, smallmouth, and spotted bass (Figure 18), and bluegill (Figure 19). No graphs were made for largemouth and smallmouth bass because either very few or none were captured by trap nets. In some places trapnetting can be a very poor sampling technique of crappie (J.



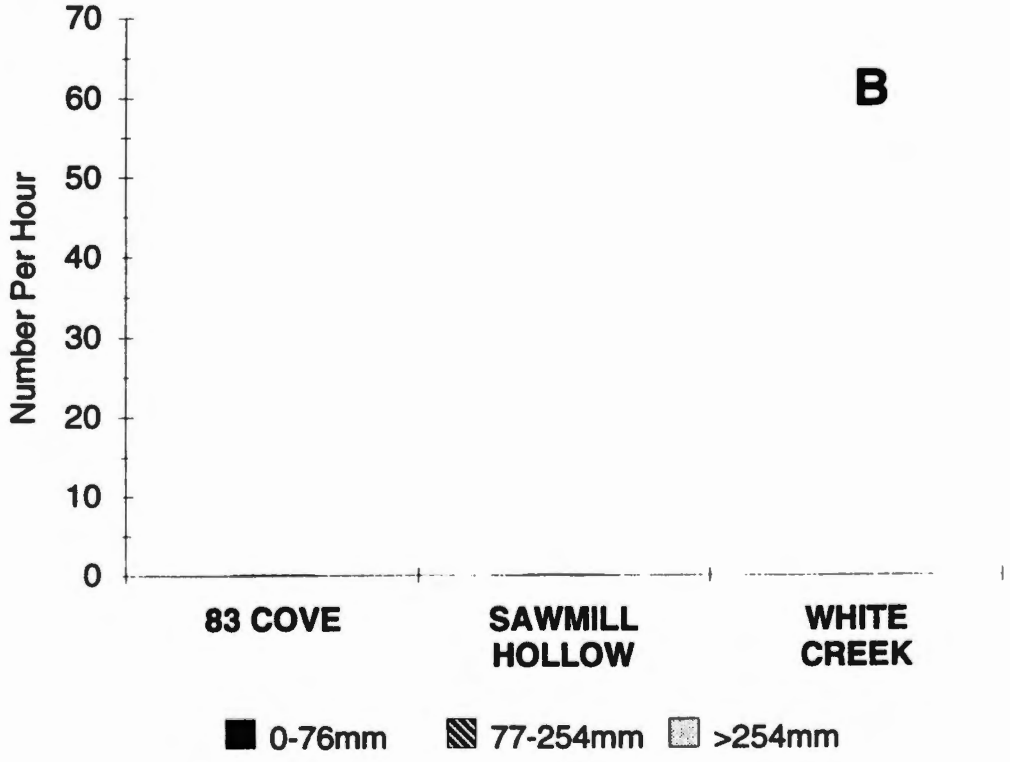


Figure 16. Catch per unit effort (CPUE) of black crappie collected during the fall 1994 ; A) electrofishing, B) trapnetting.

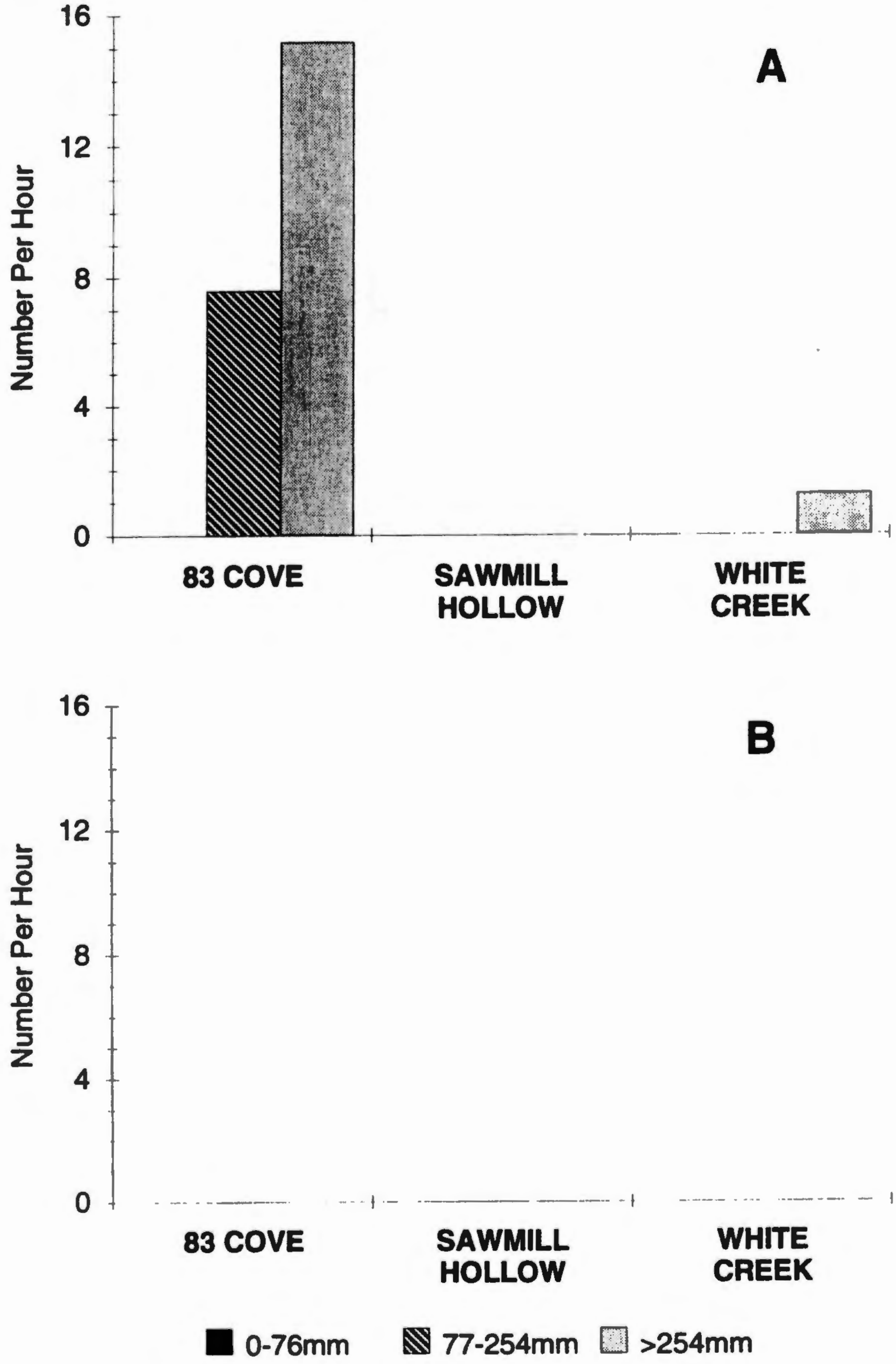


Figure 17. Catch per unit effort (CPUE) of white crappie collected during fall 1994; A) electrofishing, B) trapnetting.

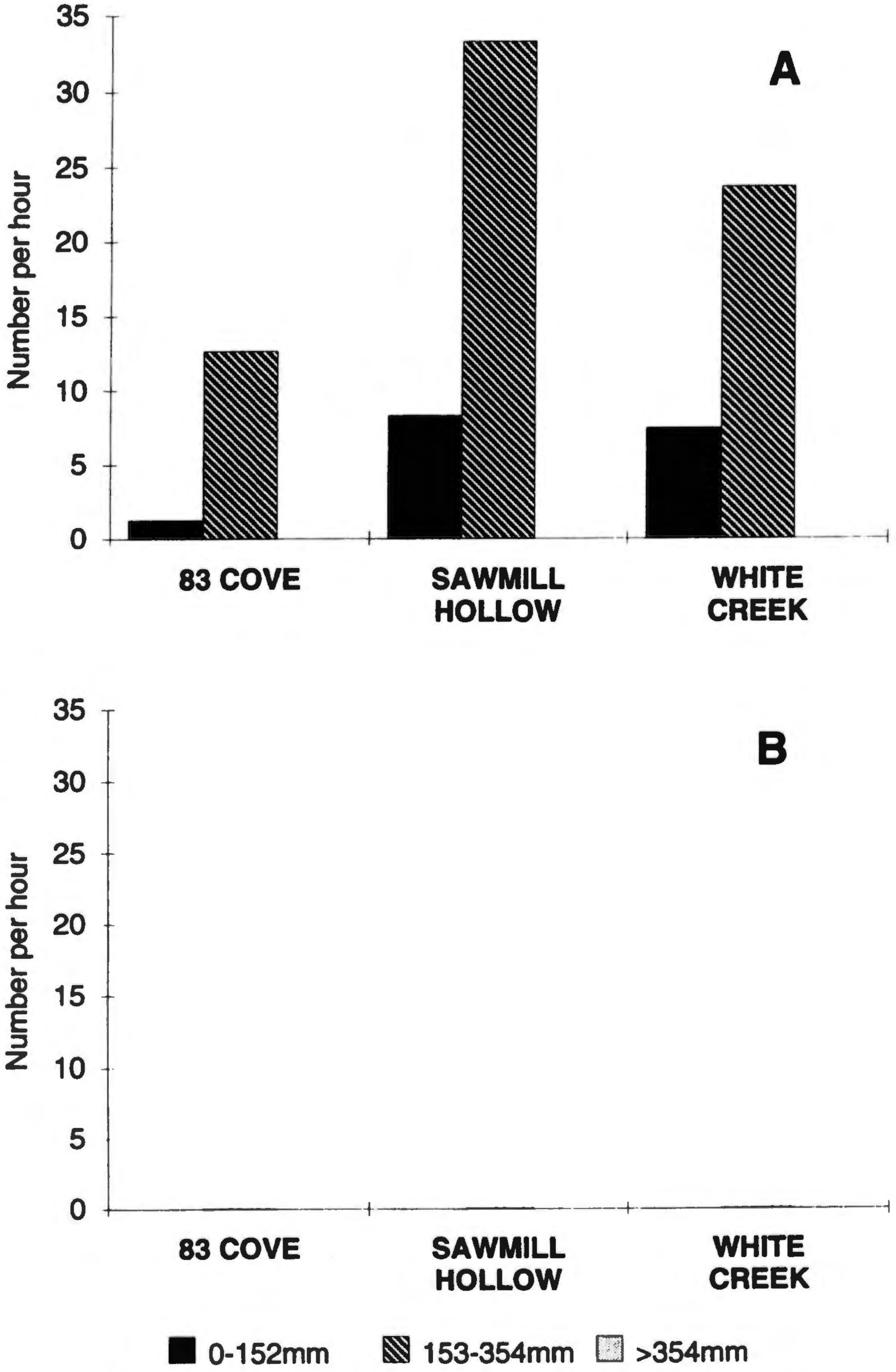


Figure 18. Catch per unit effort (CPUE) of spotted bass collected during fall 1994; A) electrofishing, B) trapnetting.

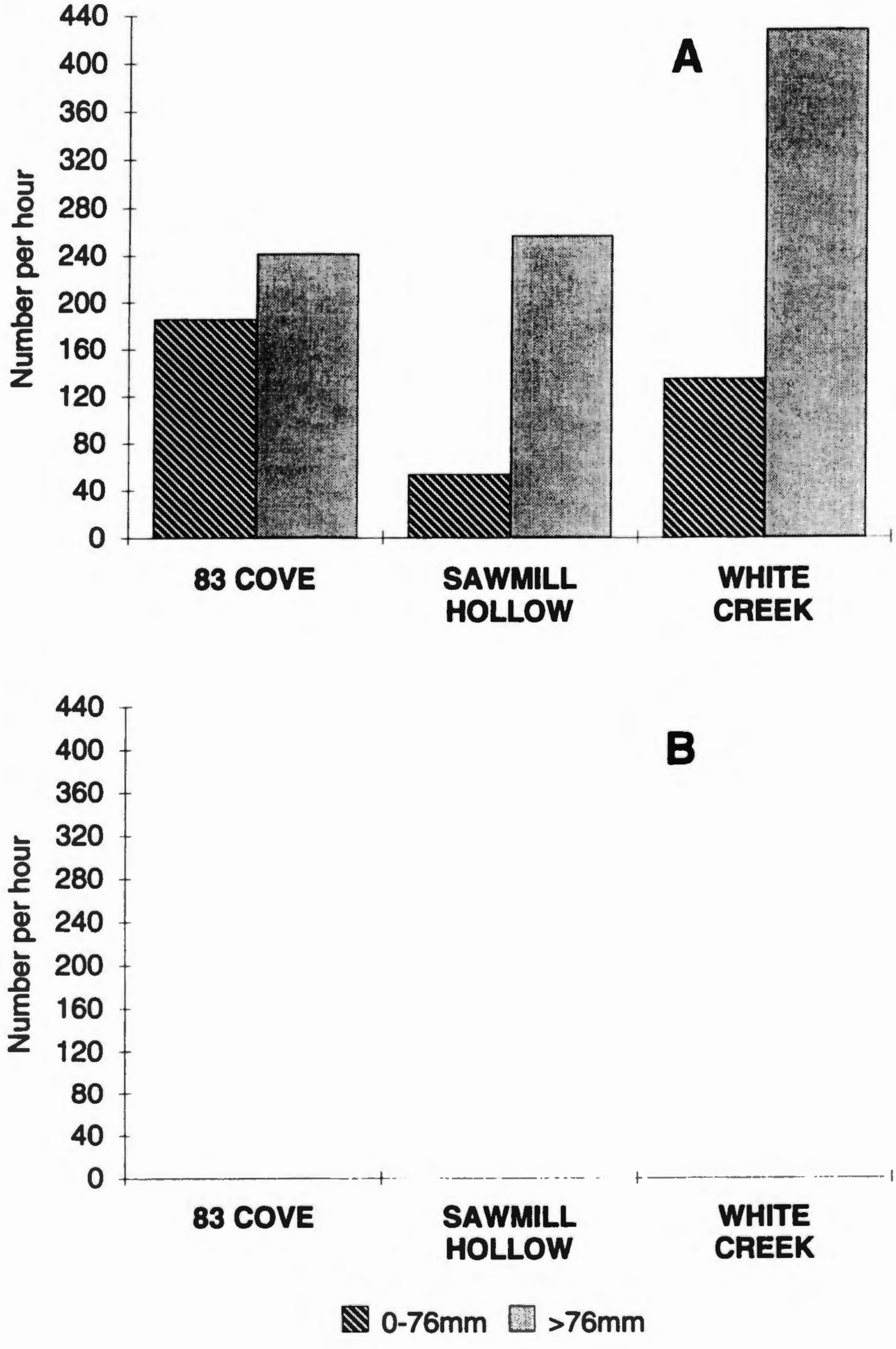


Figure 19. Catch per unit effort (CPUE) of bluegill collected during fall 1994; A) electrofishing, B) trapnetting.

Boxrucker, Oklahoma Fishery Research Laboratory, pers. comm.). Trapnetting seems to be less efficient as a sampling technique for crappie and other species than electrofishing in the Lost Creek embayment area.

Light Trap Samples

A very productive way of sampling larval and early juvenile fish is with lighted entrapment gear at night (Faber 1982). Different samples of larval fish varieties and densities can be collected depending on place and time (Turner et al. 1994). Light traps are selective for organisms that desire to be in close proximity to light or those that are predators of organisms that are lured to light. Some organisms may not be trapped because they tend to avoid the light. Therefore, the organisms sampled may not be a true representation of all the organisms which are in the area. This fact should be considered when reading these results. It must also be understood that all these organisms were limited to the distance they could travel in the 1.0 hour sample period.

Light trapping in the spring of 1994 was a very effective way of quantitatively sampling Lost Creek's larval fish and aquatic invertebrates during the time period of the crappie spawn. A total of 2,609 larval fish were sampled which consisted of 12 different species (Table 3); of these, there were 146 larval crappie collected. The two fish attractor areas

Table 3. Lost Creek embayment light trap samples of larval fish collected during April and May of 1994; the total time spent trapping was 6 hours.

Species	Number Collected
Lepomis sp.	1,610
Dorosoma petenense	422
Pimephales sp.	162
Micropterus L/S [1]	158
Pomoxis sp.	146
Percina caprodes	42
Alosa psuedoharengus	40
Dorosoma cepedianum	11
Cyprinus carpio	10
Labidesthes sicculus	4
Ambloplites rupestris	2
Micropterus dolomieui	2
Total	2609

[1] L/S = largemouth and spotted basses

dominated in the total numbers of fish collected in comparison to the non-attractor area (Figure 20). When considering the crappie alone, the results were again much higher in fish attractor areas (Figure 21). The first night of light trapping 83 Cove was identified as having the most larval crappie with a CPUE of 13.5, White Creek came in second with a CPUE of 5.0, and Sawmill Hollow came in third with a CPUE of 1.5. Figure 22 shows the changes in CPUE rates of larval crappie throughout the light trapping period. The fact that Sawmill Hollow had the lowest numbers of crappie in the first night of trapping was slightly unusual in comparison with the overall results; most of the time Sawmill Hollow had the highest CPUE for larval crappie. 83 Cove had two strong showings of crappie, but surprisingly had three nights with very poor catch rates; these nights were May 2, May 10, and May 16. White Creek's catch rates were consistently low with only one night in which no crappie were caught.

The larval Lepomis collected must be referred to as simply Lepomis sp. because these fishes could not be differentiated by species. The majority of these fish were probably bluegill. The first collection of any Lepomis larvae was on May 2 where they were found in 83 Cove; the CPUE was 2.0. They were not found again until the last night of sampling, which was 26 May 1994. On that date, they were found in Sawmill Hollow with a CPUE of 1,550 and White Creek with a CPUE of 58 (Figure 23). It

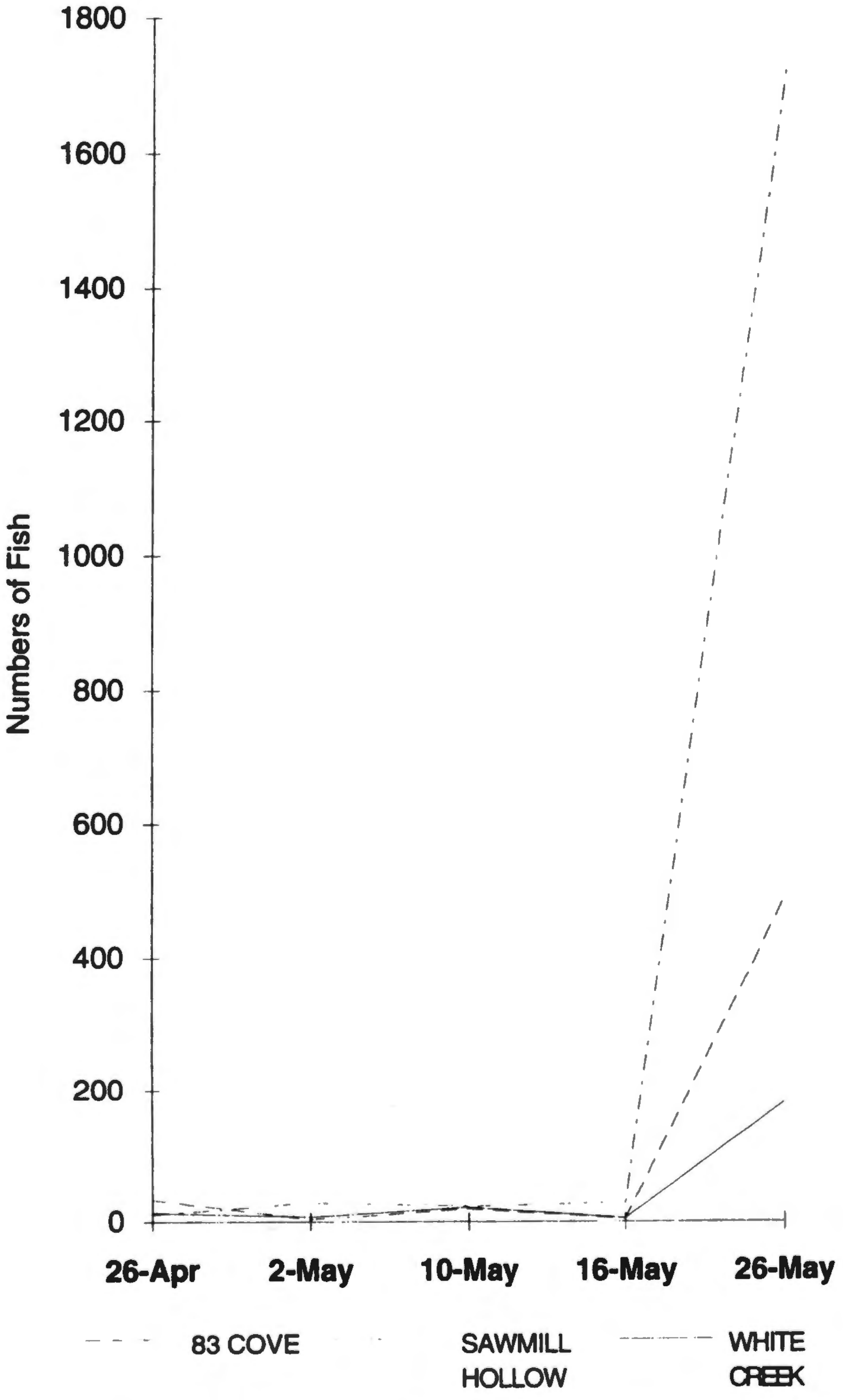


Figure 20. Larval fish collected during 1994 light trapping.

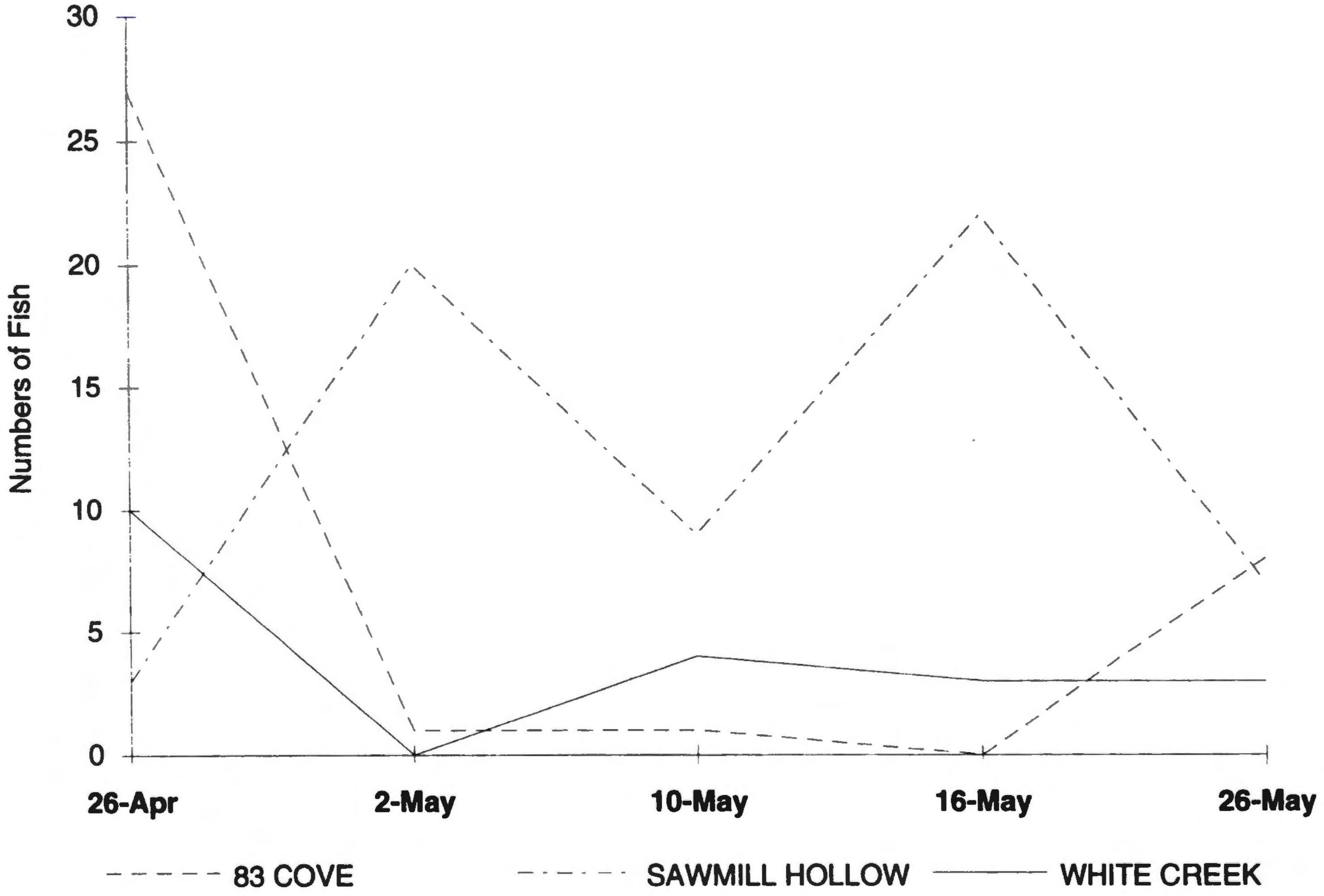


Figure 21. Larval crappie collected during spring 1994 light trapping.

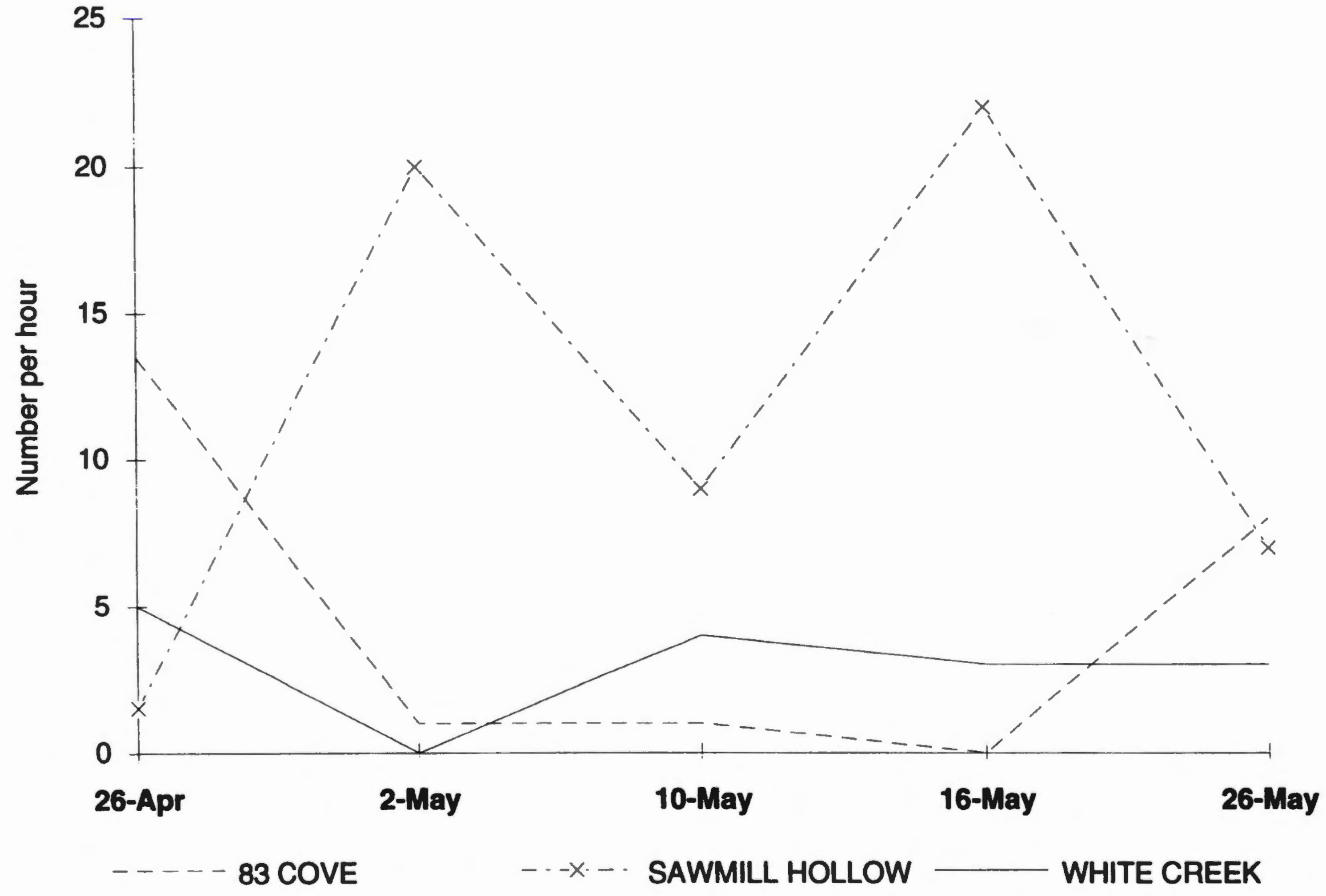


Figure 22 . Catch per unit effort (CPUE) of larval crappie collected during spring 1994 light trapping.

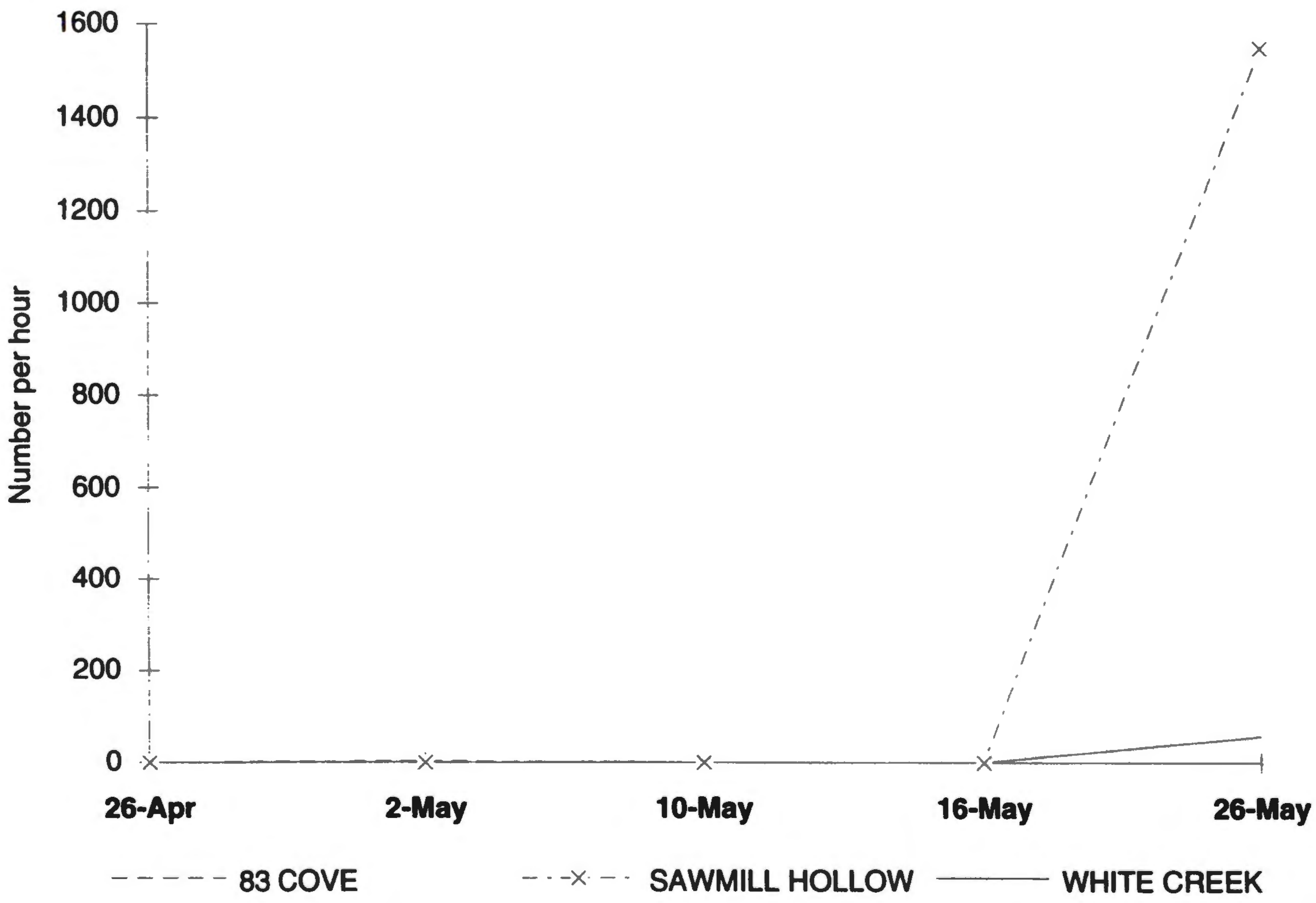


Figure 23. Catch per unit effort (CPUE) of larval Lepomis species collected during spring 1994 light trapping.

was obvious that crappie spawned earlier than the Lepomis; perhaps this resulted in less competition between these species. To some degree, the Lepomis sp. did as the crappie did; on one night they were collected in large numbers, and the next night they were not. In the May 16 sample in Sawmill Hollow, Lepomis increased in number and while crappie decreased (Figures 22 and 23). From the data, it appears that Sawmill Hollow was preferred as a Lepomis spawning area.

Only 2 smallmouth bass were collected May 26 and they were both from Sawmill Hollow (Table 3). According to D. Etnier (Univ. Tenn., pers. comm.), they spawn in water temperatures of 15-18 C, so they would have already spawned by this date. Also, by this time, most of the newly-hatched fish would have probably been too big to enter the traps. Larval largemouth and spotted bass could not be differentiated so they were lumped together and referred to as L/S bass. The L/S bass appeared in greater numbers than smallmouth; they first appeared in Sawmill Hollow May 16 with a CPUE of 1.0 and again the following week with appearances in all three areas (Figure 24). 83 Cove had a very impressive catch rate of 135.0 on 26 May while the other areas had much lower catch rates. It would have been good to continue light trapping a few more weeks to see if the L/S species appeared in other areas. It appears from the data that L/S bass preferred 83 Cove over Sawmill Hollow and White Creek as spawning

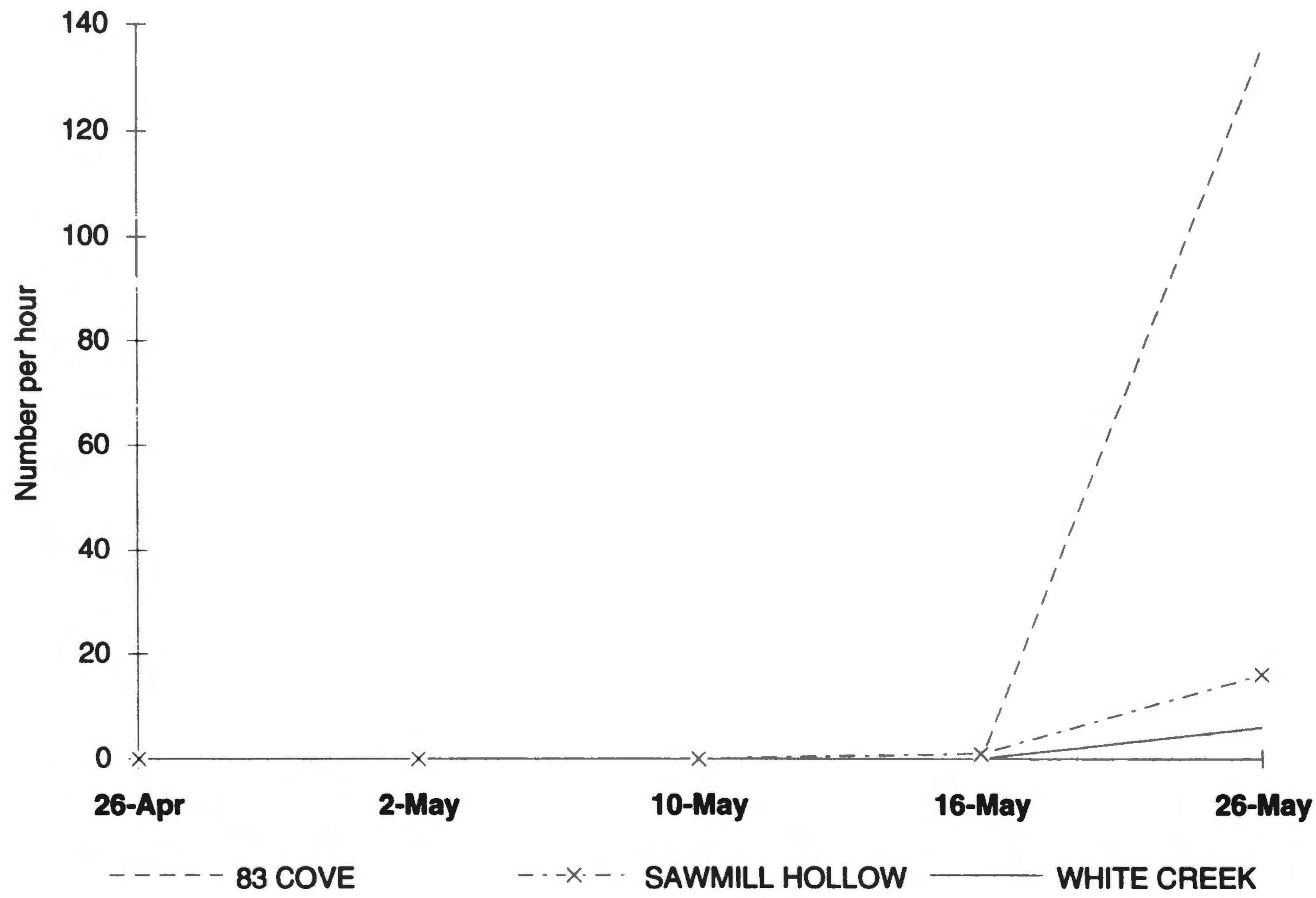


Figure 24. Catch per unit effort (CPUE) of larval largemouth/spotted bass collected during spring 1994 light trapping.

habitat. Trapping was conducted during the peak of the spotted bass spawning season, so most of the other black bass that were collected were probably spotted bass. Largemouth bass usually spawn from late April to June in Norris.

Gizzard shad had a poor showing throughout the trapping period; only 11 were captured from all three areas (Figure 25), with most from Sawmill Hollow. Gizzard shad have their peak spawning period from mid-May until mid-June so the water was probably too cold for their peak spawn at the time of sampling. Larval gizzard shad have been known to be heavily preyed upon by alewives of all ages (Tisa and Ney 1991). Threadfin shad (D. petenense) had much better catch rates, but were very low until the last trap night when they increased dramatically in all areas (Figure 26). This time corresponded with their peak spawning time, which was approximately 21 C (their desired spawning temperature). Again, it is assumed the larval crappie will outcompete the two larval shad species because crappie spawn earlier, thus giving them a size advantage.

Alewives (Alosa pseudoharengus) are on the increase in Norris Reservoir and are a primary concern of the fisheries biologists; they were present in the light traps. Kohler and Ney (1982) stated that alewives are zooplanktivores their whole life, but at times they may feed heavily on larval fish. The alewives did not appear until the last night of trapping and were

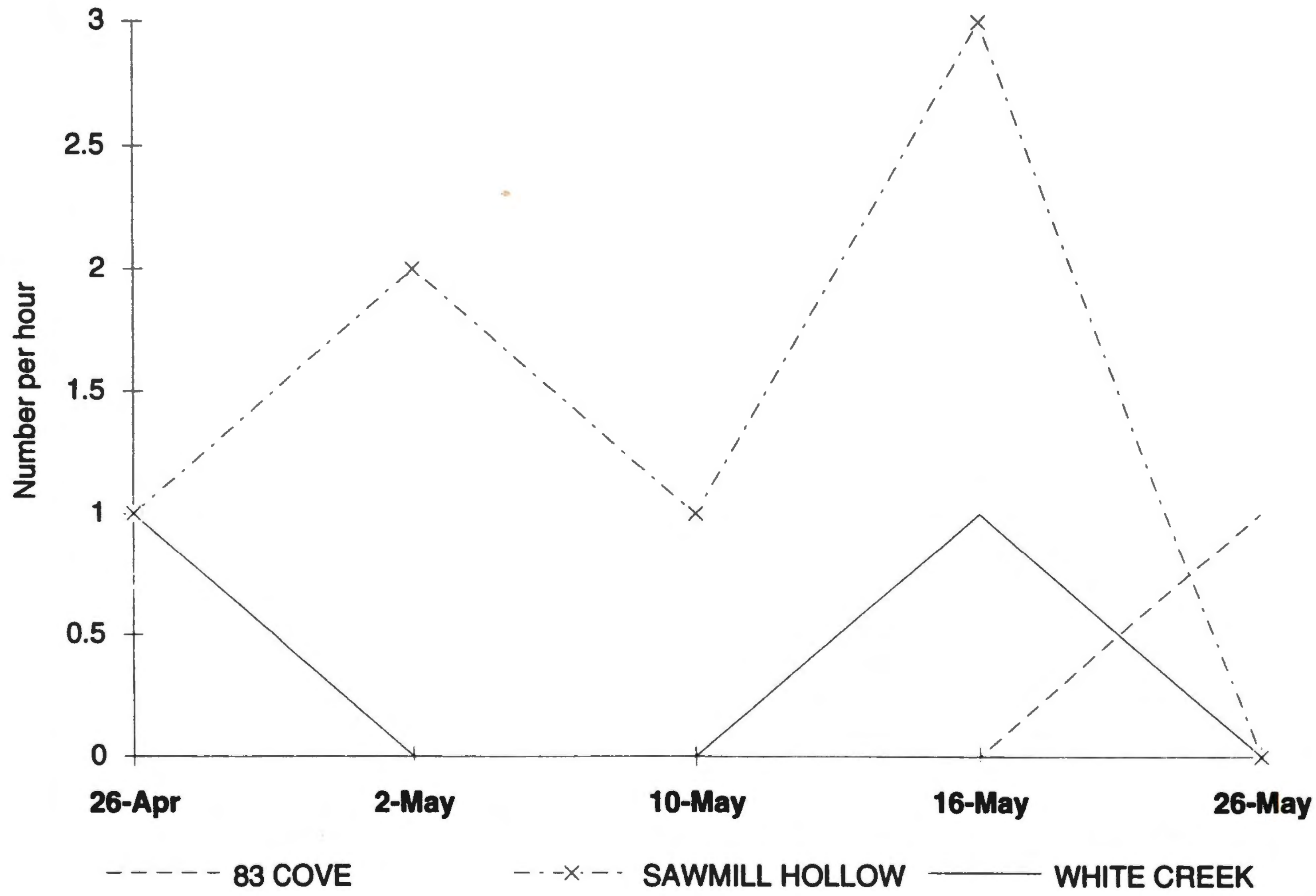


Figure 25. Catch per unit effort (CPUE) of larval gizzard shad collected during spring 1994 light trapping.

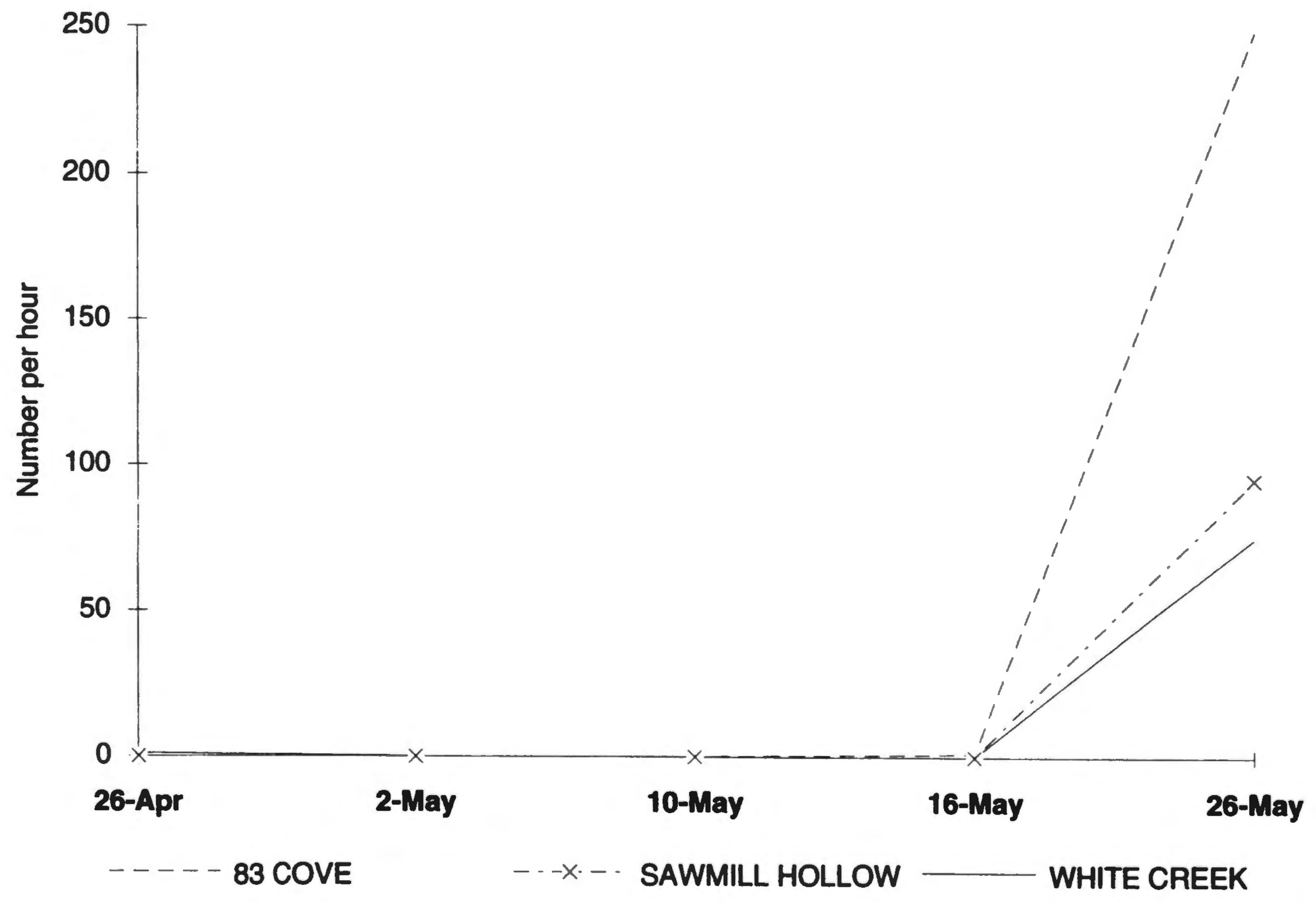


Figure 26 . Catch per unit effort (CPUE) of larval threadfin shad collected during spring 1994 light trapping.

only captured in the fish attractor areas (Figure 27). Etnier (pers.comm.) reports that their peak spawning period is during July, so the water temperature was too cold for the peak alewife spawn. Alewives were collected in 83 Cove at a CPUE of 4.0 and in Sawmill Hollow at a CPUE of 36.0.

Pimephales species could not be differentiated so they will simply be referred to as *Pimephales* sp.. They appeared in the May 10 samples in 83 Cove and White Creek with high catch rates; the following night they showed up with a very low CPUE and then the last night they appeared again in very high numbers (Figure 28). The decrease could have been the result of predation and the subsequent increase on 26 May may have been the peak of their spawn or they may simply have patchy distribution. *Pimephales* sp. throughout the trapping period were scarce in 83 Cove, but were collected in large numbers in both Sawmill Holow and White Creek.

Logperch (*Percina caprodes*) were found more frequently in Sawmill Hollow, White Creek was somewhat lower than Sawmill Hollow, and 83 Cove had the lowest CPUE of logperch (Figure 29). Logperch seemed to prefer the old fish attractor or the non-attractor areas to the new attractor areas. It should also be noted that as the CPUE rates increased for logperch in Sawmill Hollow on May 2 and 10, the catch decreased for crappie; similar results were seen in White Creek on April 26 and May 2

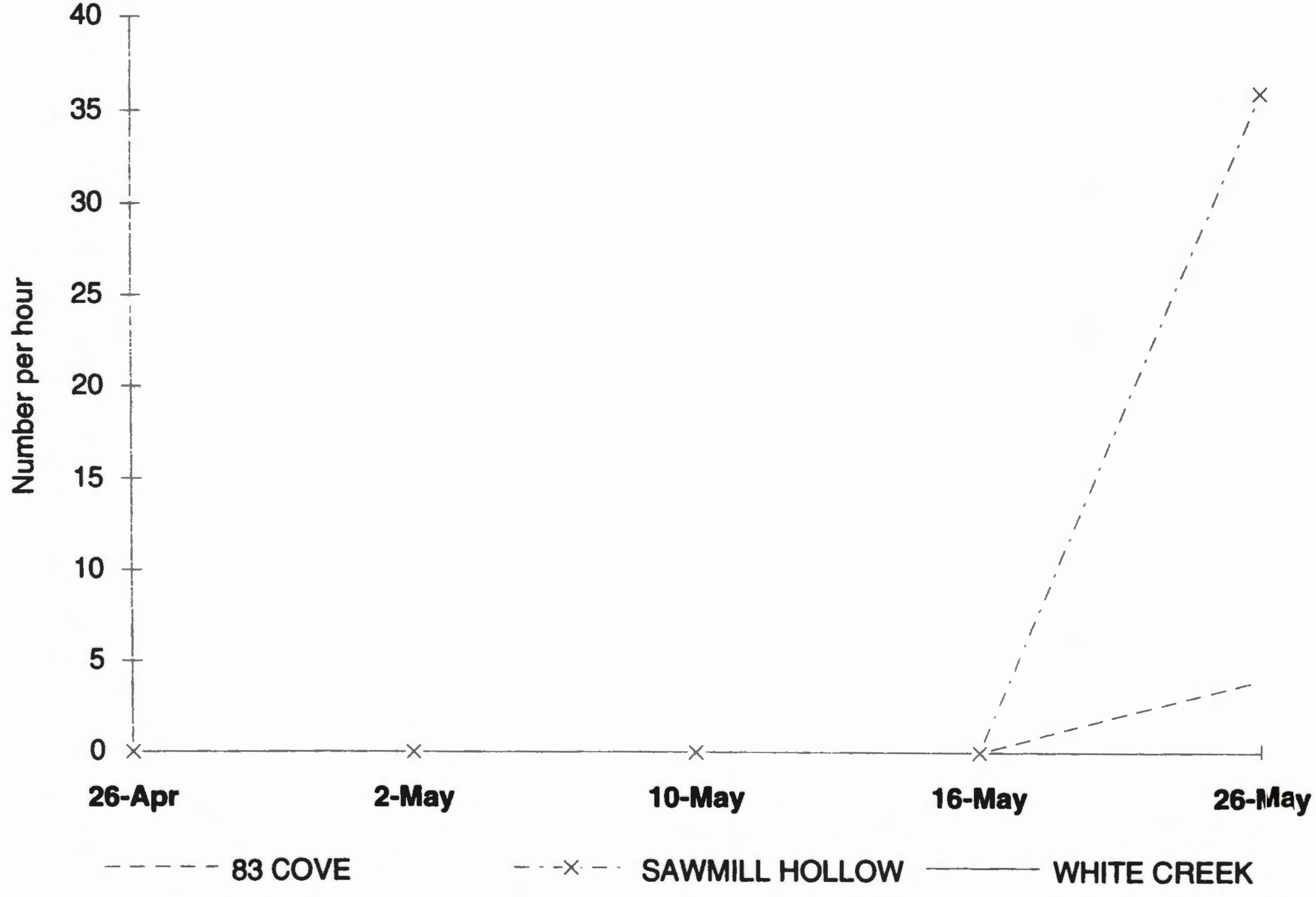


Figure 27. Catch per unit effort (CPUE) of larval alewife collected during spring 1994 light trapping.

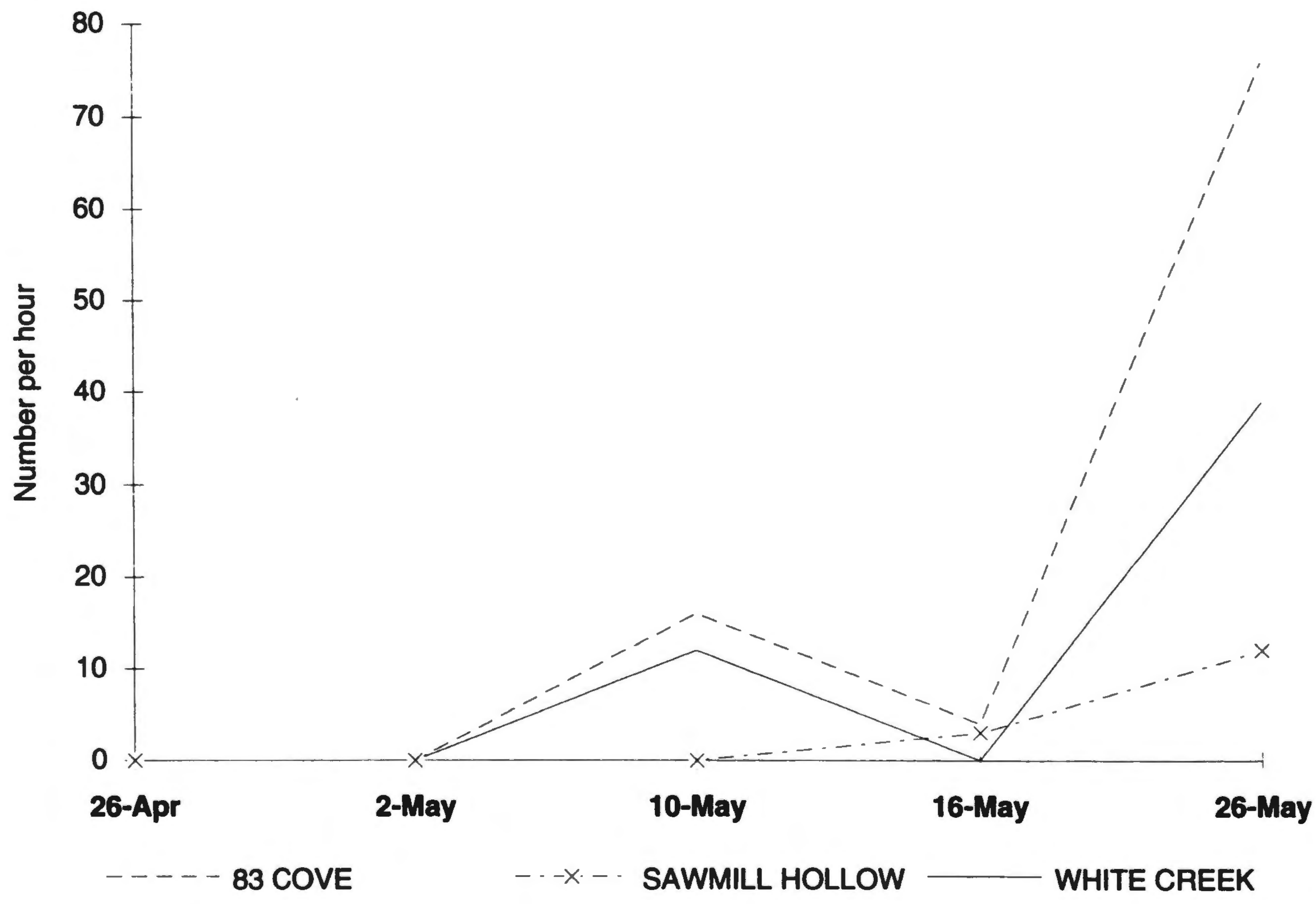


Figure 28. Catch per unit effort (CPUE) of larval Pimephales sp. collected during spring 1994 light trapping.

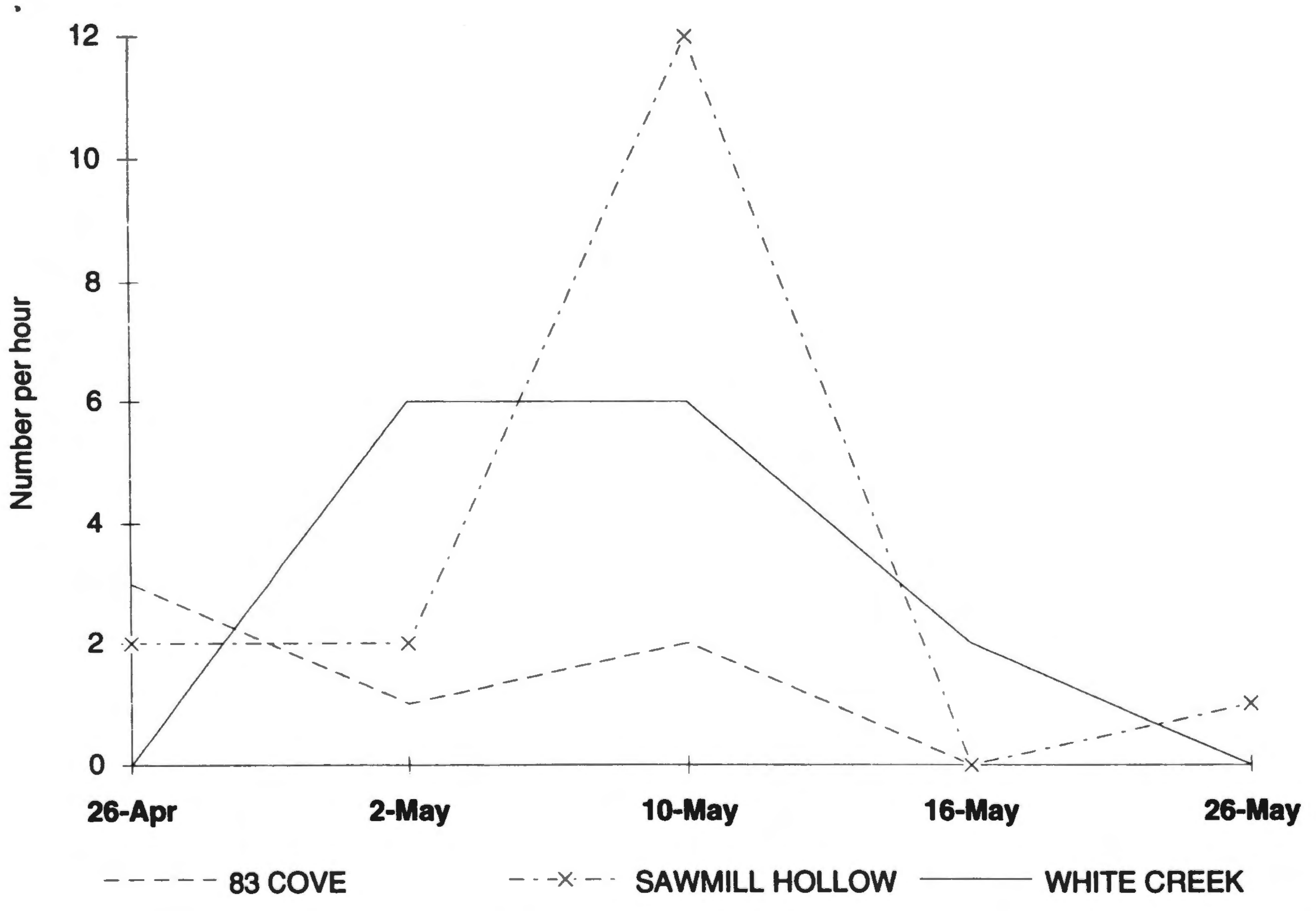


Figure 29. Catch per unit effort (CPUE) of larval logperch collected during spring 1994 light trapping.

(Figures 22 and 29).

The other species in the light trap samples were collected in very small numbers and are listed in Table 3. Brook silversides (Labidesthes sicculus) as adults may be aggressive competitors with juvenile crappie, but should not be a threat to them because of the small incidence of occurrence. Etnier (pers. comm.) reported that their peak spawning period is June through August.

Data from this project indicate that fish attractors do help in the production and survival of larval fish because the higher CPUE values are in the attractor areas. In the Lost Creek area, TVA and their volunteers deserve all the credit for their placement. At this point it is impossible to determine if productivity of the 1994 crappie spawn in Lost Creek was above or below average.

If this project is continued, trends in the crappie population may be identified. Mitzner (1991) stated that turbidity, water storage, temperature, substrate firmness and wind can adversely affect the production and abundance of young crappie. Crappie productivity in 1994 in Norris appears to be lower than previous years when comparing to the 1992 Norris Reservoir annual report (Peterson and Negus 1992). The factors that are causing the decrease in Lost Creek crappie abundance are yet to be determined, but the elements described by Mitzner (1991) can be a major part of the problem. For example, at times Lost Creek was turbid in the spring of 1994; according to Mitzner (1991), turbidity was correlated with fewer larval crappie. Availability of food could be a problem for larval crappie, either because of competition or of not much being produced.

The period of time larval fish are in the transition stage from the yolk-sac to feeding may be the most difficult time in the life of a fish (Braum 1967). Accessibility of food for larval crappie is a significant obstacle because they are not very mobile (Barwick 1978). Welker et al. (1994) claimed that the availability of zooplankton prey affected the growth and survival of larval gizzard shad and larval bluegill. In their study, the lack of food was due to high densities of larval fish. Dettmers and Stein (1992) stated that competition for limited food caused by predator density or poor zooplankton production is critical to sport-fish recruitment. Therefore, monitoring the larval prey abundance in Lost Creek could prove to be very important.

Crowl and Boxrucker (1988) reported that inland silversides and threadfin shad prefer the same food (Daphnia) as does the white crappie. It appears that the Pomoxis species are hatching earlier than most of the other fishes that have similar spawning seasons and this is very beneficial. Miranda and Muncy (1987) discovered that larger females of largemouth bass and gizzard shad spawn earlier than the smaller ones. This might be true of crappie; if there were larger females in Lost Creek, this could be an advantage to the larval crappie by hatching earlier than their competitors. More research on which larval fish directly compete with larval crappie and also the abundance of these competitors in Lost Creek could be very useful.

In addition to identifying the aquatic invertebrates and larval fish, we determined what aquatic invertebrates the larval fish preferred as food. Of the 146 larval crappie sampled, 70 of them had their stomachs removed so their diet might be identified. The fish used were taken from every night of sampling and a variety of sizes were also used. Sizes ranged from 4 to 13 mm; most of the smaller crappie had nothing in their stomachs and only 12 of the fish fell into this category. The 70 larval crappie studied had 627 copepods and 34 cladocerans species in their stomachs; most of these fish had nothing but copepods in the stomachs (Figure 30).

Silvells (1949) and Bulkley et al. (1976) discovered the larval crappie preferred a cladoceran species (Bosmina) and two copepod species (Nauplii and Cyclops) as their food source. Barwick (1978) claimed the larval crappie preferred two cladoceran species (Diaphanosoma and Bosmina) and one copepod species (Cyclops), but of these invertebrates the larval crappie preferred the Diaphanosoma sp. to the others. The diet of Lost Creek larval crappie were somewhat diverse: one larval crappie

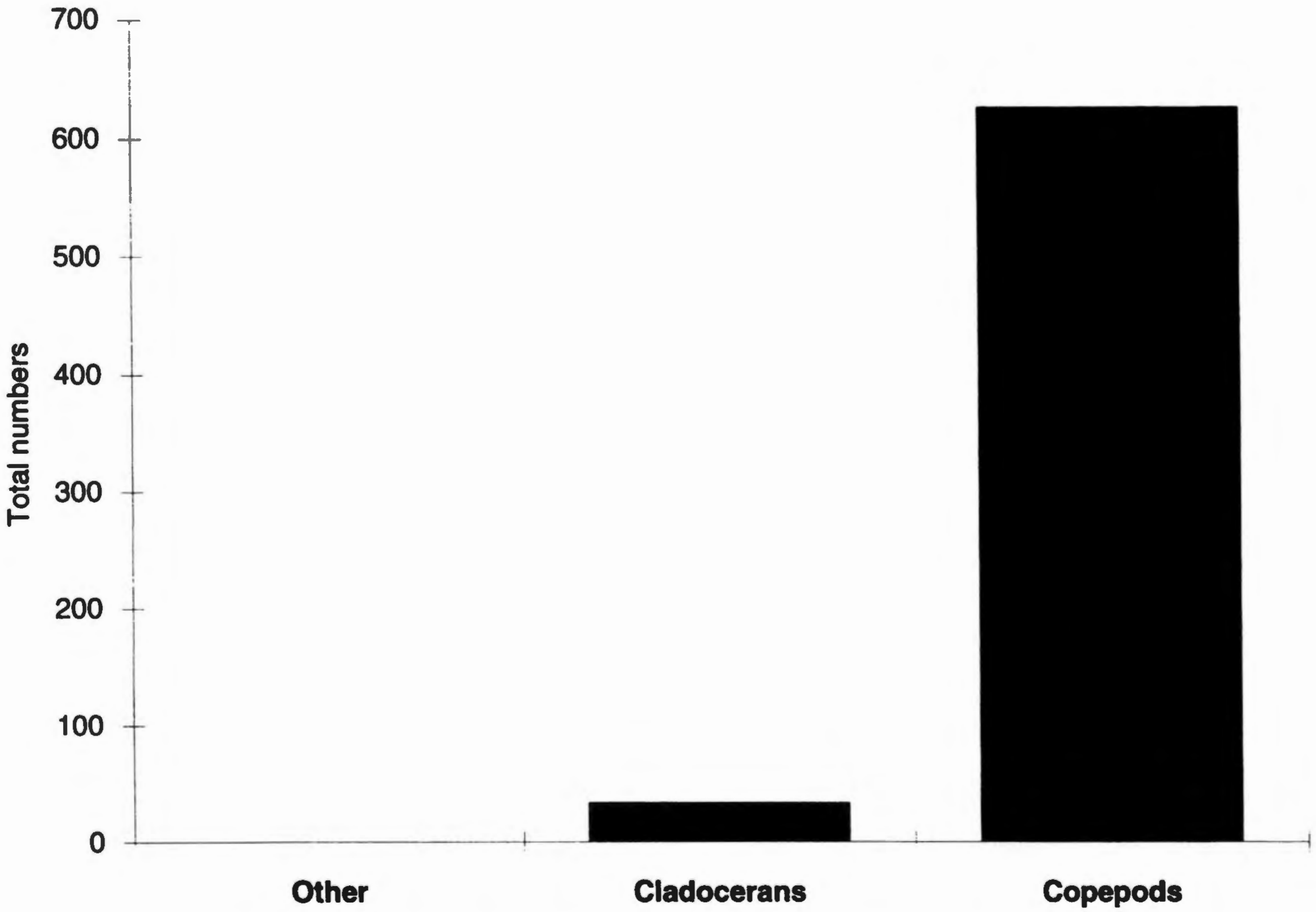


Figure 30. Stomach contents of 70 larval crappie that were collected spring 1994 with light traps (cladocerans include species other than Leptodora sp.).

was 13 mm long and was one of the larger crappie; it had a gape size of approximately 1.5 mm wide and had eaten 52 copepods. This fish had nothing but copepods in its stomach and had the largest copepod observed in any stomach; the copepod was 1 mm long and 0.5 mm wide.

It appears from the data that crappie are selectively feeding on copepods; the fish may have eaten them while they were in the trap. That is probably not the case because copepods came in third when comparing the numbers of invertebrates in the traps and were not even close in number to the top two. The diets of the other fish species that were trapped were also investigated, but not as intensively studied as the crappie. The attempt was made to study at least two of each species, but sometimes this was not possible because the specimens were not available due to their being destroyed in the process of identification.

Lepomis averaged 8.0 copepods and 15.0 cladocerans per fish; this led the author to believe that Lepomis do compete with the crappie for food. The Lepomis sp. do seem to prefer the cladoceran species, but they are eating a significant amount of the copepods (Table 4). The two smallmouth bass averaged 4 copepods, 2 hydracarinas, and 10 cladocerans in their stomachs. The L/S group averaged 8.7 copepods and 11.0 cladocerans; the only Leptodora sp. observed was found in one of these fish. Neither gizzard shad nor threadfin shad had anything in their stomachs. Some

Table 4. Food habits of larval fish collected during spring 1994 light trapping.

Species	Av. Length (mm)	Number Dissected	Average Number of Invertebrates in Stomachs [1]
Pomoxis sp.	8.5	70	9.0 CO, 0.5 CL
Micropterus L/S [2]	13.2	4	8.7 CO, 11.0 CL
Micropterus dolomieui	18.0	2	4.0 CO, 10.0 CL, 2.0 HY
Lepomis sp.	11.0	2	8.0 CO, 15.0 CL
Dorosoma petenense	13.0	4	0
Dorosoma cepedianum	16.0	4	0
Alosa pseudoharengus	24.0	3	9.0 CO, 2.0 CL
Pimephales sp.	11.0	2	7.0 CL
Percina caprodes	13.0	2	3.0 CO, 5.0 CL
Labidesthes sicculus	5.0	2	0
Ambloplites rupestris	6.0	1	0
Cyprinus carpio	7.0	2	0

[1] CO = copepods

CL = cladocerans

HY = Hydracarina

[2] L/S = largemouth and spotted basses

biologists claim some fish throw-up their stomach contents when entrapped and this might be the case.

Alewives averaged 9.0 copepods and 2.0 cladocerans per fish; they seemed to prefer copepods over anything else. The diet of larval alewives is something that needs to be investigated more in Lost Creek. Some brook silversides, common carp (Cyprinus carpio), and rock bass (Ambloplites rupestris) were other species with empty stomachs; only two of each of these species were available because the others were destroyed in identification or only two were captured. The Pimephales sp. seemed to prefer cladocerans; they averaged 7.0 in their stomachs and had no other organisms present. Lastly, log perch averaged 3.0 copepods and 5.0 cladocerans in their stomach contents. It appears from these data that many species of larval fish compete with each other for food and many compete with the crappie for the copepods (Table 4).

The invertebrates that were collected in the light trap samples were surprisingly abundant. When the traps were retrieved, they were so full that they were difficult to handle. It was assumed the light traps collected the invertebrates and larval fish in proportional numbers to their existence in the Lost Creek embayment. Nine different species were collected in these samples; overall, Leptodora dominated the samples (Table 5) but only one was found in a larval crappie stomach. Daphnia and Leptodora maintained

Table 5. Aquatic invertebrates collected during spring 1994 light trapping.

Invertebrate Species	26 Apr.	2 May	10 May	16 May	26 May	Totals
Leptodora (water flea)	2,182	597	530	766	1,486	5,561
Daphnia (water flea)	2,064	1,138	28	33	111	3,374
Daphnia ephippia (Daph.egg)	142	17	26	1	10	196
Chydorus (water flea)	87	27	67	43	31	255
Copepoda	642	72	13	25	73	825
Ostracoda (seed shrimps)	4	54	0	8	8	74
Chironomidae (midges)	1	1	1	2	0	5
Hydracarina (water mites)	0	0	0	0	4	4

similar numbers until approximately 10 May 1994; from this point until the last sample was collected, Daphnia numbers decreased nearly to zero before rebounding and Leptodora continued in higher numbers (Figure 31). It is speculated that Daphnia numbers could have dropped off due to overgrazing (Figure 32). Welker et al. (1991) noted that the preferred food was limited because of high densities of larval fish. Leptodora were found in high numbers; the question is, is that good or bad? Leptodora are known to be aggressive predators as evidenced by them feeding on larval fish (J. Drake, UT-Knoxville, pers. comm.).

The copepods which were the preferred food of crappie decreased dramatically about the time the larval fish appeared; they remained in suppressed numbers throughout the light trapping period (Figure 33). The trends of larval crappie verses copepods in the spawning season can be seen in Figure 34. As copepods decreased in 83 Cove and White Creek, numbers of larval crappie decreased throughout the entire light trapping period. Except for 16 May in 83 Cove, both copepods and crappie increased; copepods and crappie numbers seemed to be directly proportional. Sawmill Hollow crappie did not seem to act in the same way; on the average, they had to compete with more fish than in the other two areas. It also seemed that the increase of larval crappie from 26 April to 2 May in Sawmill Hollow may have been more than the copepods could

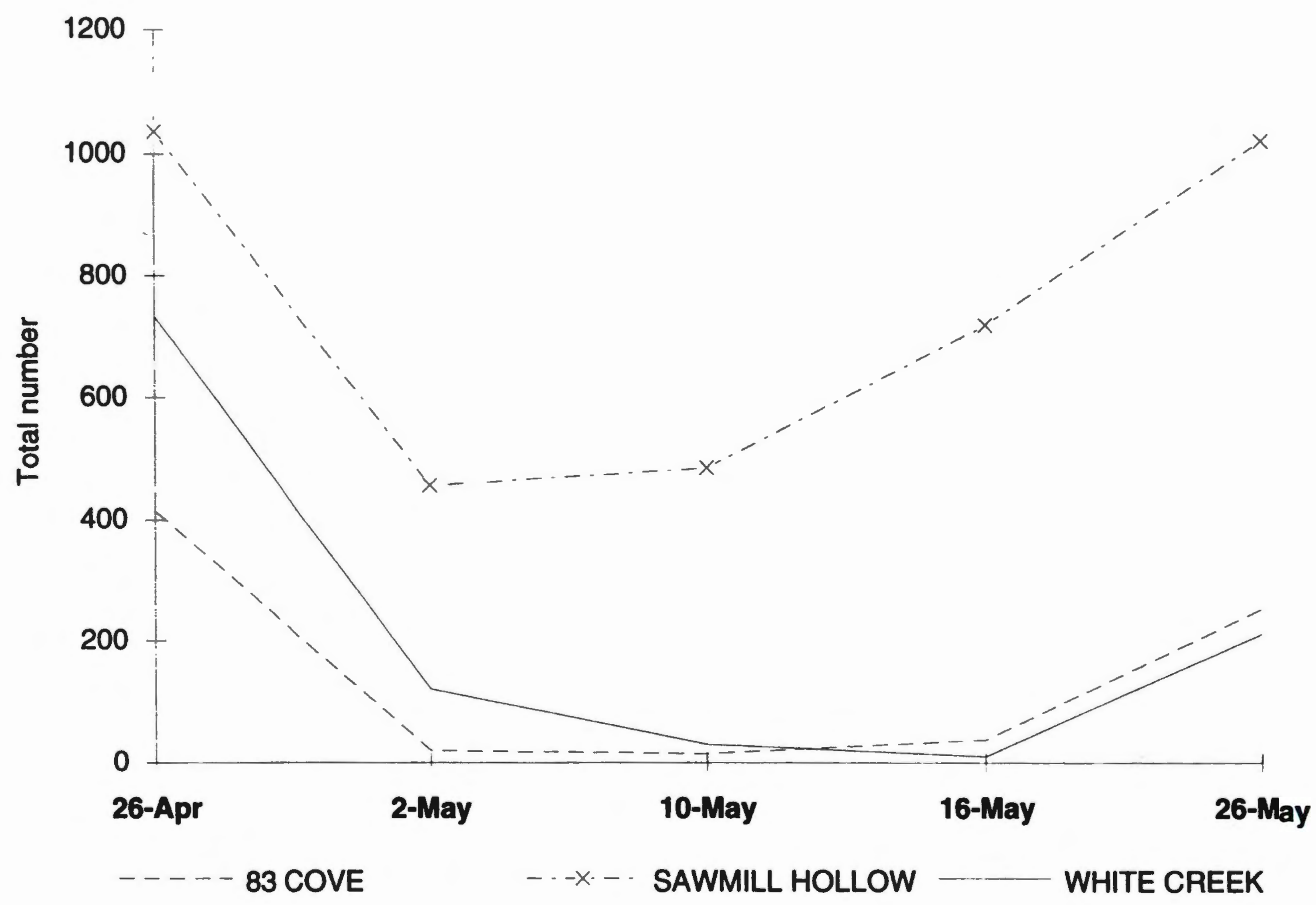


Figure 31. Leptodora counted from each subsample showing relative abundance in fish attractor verses non-fish attractor areas.

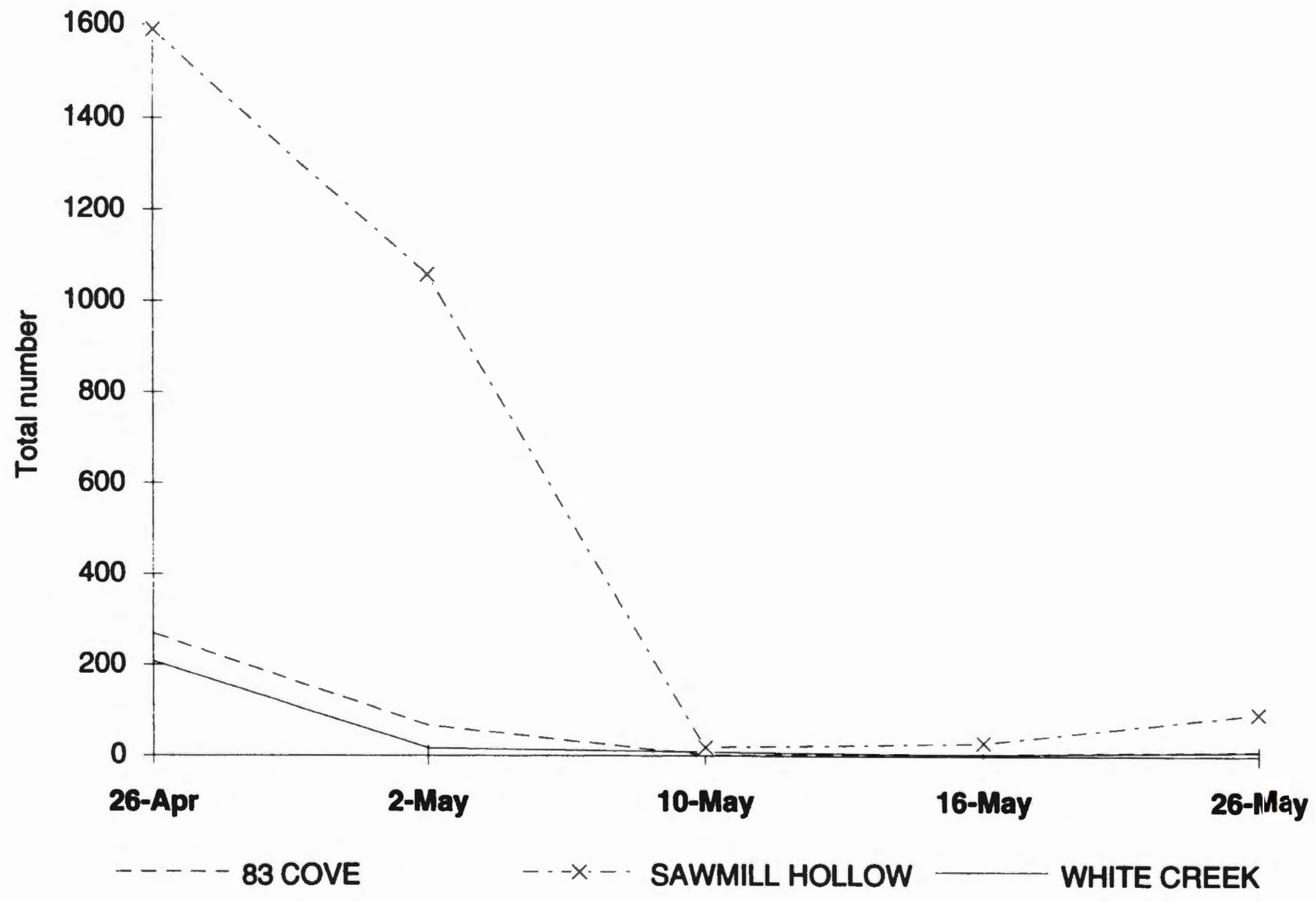


Figure 32. Daphnia counted from each subsample showing relative abundance in fish attractor verses non-fish attractor areas.

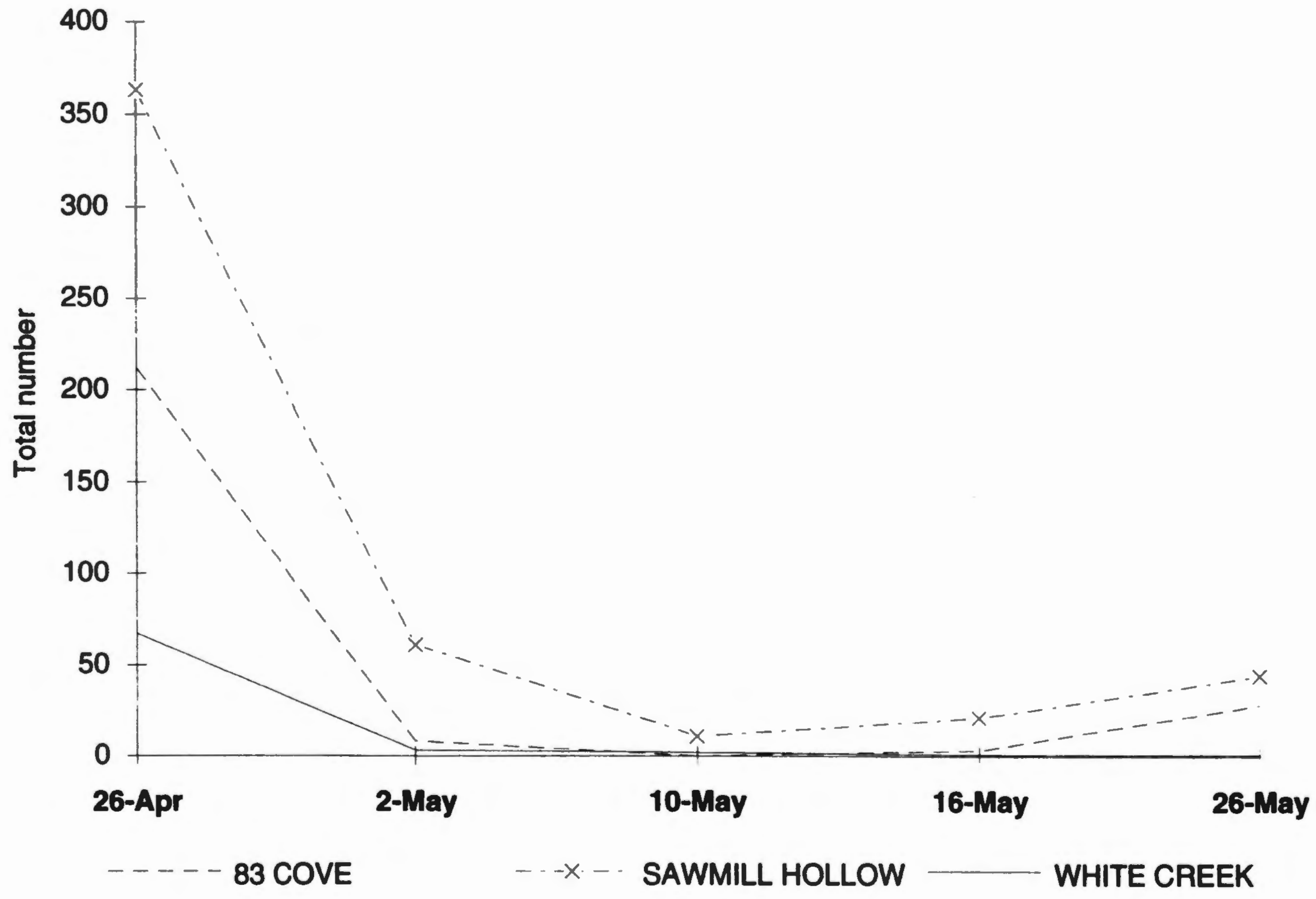


Figure 33. Copepoda counted from each subsample showing relative abundance in fish attractor verses non-fish attractor areas.

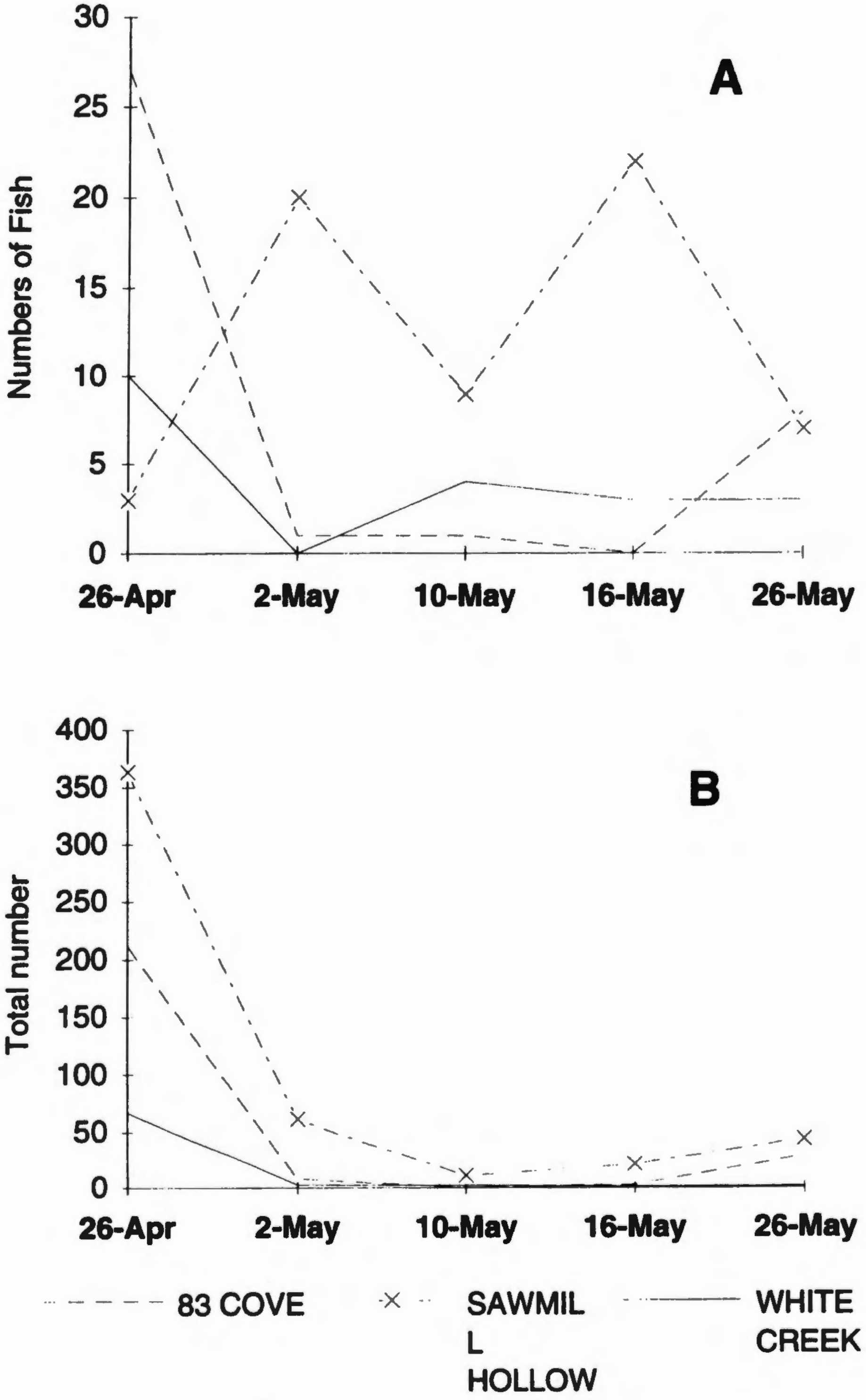


Figure 34. Trends during light trapping;
A) larval crappie, B) copepods.

support throughout the light trapping period. Other invertebrates in the light trap subsamples and in the larval fish stomachs were found in numbers so low they seemed to be of little or no significance.

Larval fish were found in greater numbers in the fish attractor locations than in the non-attractor area, but this can not be said of the invertebrates. Invertebrates were found in greater numbers in the old fish attractor area when compared to the others, but they were as abundant in the non-attractor area as they were in the new fish attractor area. Therefore, the older fish attractor was a preferred and beneficial habitat to the invertebrates; it enabled higher production of aquatic invertebrates and this helped support a higher production of larval fish.

Crappie overall preferred the attractor areas over the non-attractor areas. Petit (1972) found that crappie preferred stake bed areas to non-stake bed areas; crappie were caught at a rate of 7 per hour from the stake beds and 2 per hour from the areas with no stake beds. Of the attractor areas in our study, Sawmill Hollow was the area where the most H black crappie were found; it is believed that these greater numbers of larger crappie may have resulted in greater numbers of larval crappie. Sawmill Hollow had a very productive crappie spawn in comparison to the others, but larval crappie disappeared before they reached the YOY age (Figure 16). If larval crappie survive to the YOY age, they have a good chance of making it to harvestable size; therefore, many of these H crappie should spawn the following year due to lack of crappie fishing pressure.

The other attractor area (83 Cove) had a smaller hatch of larval crappie but they had a much better chance of surviving through the YOY age. It is suggested that the YOY black crappie in 83 Cove do survive through PH age, but once they reach H age they are vulnerable because of the fishing pressure. A check of the creel in the Lost Creek area revealed approximately 80% of the crappie fishing in Lost Creek was in the 83 Cove area. These fishermen were probably taking quite a few of the PH crappie from 83 Cove, too. It is believed that 83 Cove is the best of the two attractor areas for black crappie. If more of the harvestable fish were left in the area, 83 Cove would probably experience a more productive spawning period the following spring. These fish would probably have a better chance to survive through the YOY age and, unlike in Sawmill Hollow, eventually produce a significant number of H crappie.

CHAPTER 6

Recommendations

From the results of this study the author recommends trapnetting as a sampling method for crappie in Lost Creek embayment supplemented with electrofishing since it was a much more productive method. The sampling should be done during the fall periods as was done in the fall of 1994 to determine YOY recruitment, but instead of trapnetting earlier and electrofishing later, electrofish both times. Sampling should be performed in two sessions in the fall: one during higher water levels and one close to maximun drawdown. Black crappie and many other fishes were collected better during lower water levels, but white crappie and spotted bass were collected better during higher water levels.

The fish attractor work has been very benefical to the crappie in the Lost Creek embayment and it needs to continue. Thomas (1983) stated that the fish attractors on Norris reservoir were very benefical to the sport fish. It is recommend that not only should the structure be placed in water levels which are preferred depths of spawning, but also in areas and depths which will allow refuges for the YOY during winter drawdown. During this time, Lost Creek has very few of these structures and many YOY fish may be lost due to this lack of cover.

During the winter drawdown when YOY crappie are accessible to predators, it would be a great time to execute a predator study in Lost Creek. Flathead catfish are aggressive predators and may be damaging the crappie poulation. Walleye and black bass may also be predators to investigate for the crappies benefit. Something was happening to great numbers of the young crappie, especially in Sawmill Hollow.

The investigation of the crappie spawning success needs to continue; after years of study, trends may be identified as well as both positive and negative influences. For example, one year might stand out with high larval crappie numbers and that year had a lot of flooding during the spawn. More work needs to be done with the white crappie spawn as to when are they spawning, what habitats they prefer, and are they having successful spawns.

Relative abundance, survival, and feeding habits of larval crappie need more research. They seemed to be selectively feeding on copepods in Lost Creek, but does the survival depend on the copepods abundance? Do the alewives compete with larval crappie and other larval fish as much as rumored? Are the high numbers of spotted bass in Sawmill Hollow what keeps the larval and YOY crappie from reaching PH age? Answers to these and many other questions about larval crappie could benefit their present situation.

Leptodora is found in very high numbers in Lost creek and none of the fish seemed to utilize them. Some investigation needs to be done on the impacts of Leptodora in the Lost Creek embayment. They are known to be aggressive predators of other aquatic invertebrates, and also are known to feed on larval fish.

White crappie are said to primarily feed on gizzard shad, but are these fish accessible in the sizes needed? An extensive forage base study in Norris Reservoir could reveal relevant information on the decline of the white crappie. Also, additional research on the effects of alewives on Norris Reservoir should be planned.

CHAPTER 7

Summary

1. In the Lost Creek embayment, trapnetting seemed to be less productive as a sampling techique for crappie when compared to electrofishing. For example, fall trapnetting results of 1994 would have left the impression there was very little or no YOY crappie recruitment in Lost Creek; later that fall, electrofishing showed much different results.

2. Most fish were collected with higher CPUE rates during the lower water elevations of the winter drawdown. White crappie and spotted bass are the only exceptions; they were collected at higher rates during the higher water.

3. The black crappie spawn of 1994 in Lost Creek embayment was determined to be from 18 April, when the water temperature was 15.7 C, to 12 May, when the water temperature was 18.5 C.

4. The white crappie spawning period was impossible to determine because very few fish were collected.

5. Larval crappie seemed to hatch earlier than most of their competitors. They were greatly selective to feeding on copepods. Many of the other larval fishes competed with the crappie for the copepods.

6. Copepods were much less in abundance than the cladocerans during the spring 1994 sampling period.

7. The best area to find YOY and PH black crappie was 83 Cove; there were fewer H crappie in this area. The highest numbers of H black crappie were in the old fish attractor area (Sawmill Hollow); more larval crappie were found there, too. Although there was a very productive spawn there, the crappie disappeared between the larval and the YOY stages.

8. White Creek, the non-attractor area, had low numbers of black crappie from the larval stage through the H age.

9. Overall, the fish attractor areas seemed to be much more preferred and beneficial to the black crappie than the non-attractor area.

10. White crappie abundance seemed to be in very low numbers everywhere; not one YOY white crappie was collected. The new fish attractor area 83 Cove was the best area to find white crappie. Sawmill Hollow had lower numbers than White Creek.

11. Bluegill were found in very high numbers in the Lost Creek embayment; the highest numbers were found in the non attractor area.

12. Spotted bass seemed to be in high numbers in all three areas; especially in Sawmill Hollow and White Creek. Black bass, in general, did not seem to prefer attractor over non-attractor areas.

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VITA

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