316(b) DEMONSTRATION FOR THE
VIRGIL C. SUMMER NUCLEAR STATION
FOR THE SOUTH CAROLINA DEPARTMENT OF
HEALTH AND ENVIRONMENTAL CONTROL AND THE
NUCLEAR REGULATORY COMMISSION

MARCH 1985

Dames & Moore

Job No. 5182-108-09

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

OBJECTIVES OF THIS 316(b) DEMONSTRATION

Section 316(b) of the "Federal Water Pollution Control Act Amendments of 1972" (P.L. 92-500) requires that the "location, design, construction, and capacity of cooling water intake structures reflect the best technology available for minimizing adverse environmental impact" (USEPA, 1977). What constitutes "best technology available," however, must necessarily be determined on a case-by-case basis, since environmental conditions and plant operating characteristics vary widely from location to location and combine uniquely to create different technological requirements at any one site. For new power plants, design studies and ecological assessments are used to provide direction as to the best intake technology for that site, and constitute the demonstration required under 316(b).

The Virgil C. Summer Nuclear Station (VCSNS) was designed and built by South Carolina Electric & Gas (SCE&G). The plant began operation January 1, 1983 for purposes of regulatory requirements as it relates to the studies described herein. This was after the 1972 enactment of P.L. 92-500. The objectives of this demonstration are to obtain sufficient information on the VCSNS intake structure; determine the relationship of facility operation with the fish community, and determine whether the technology selected by SCE&G constitutes the best technology available for minimizing adverse impacts.

STUDY APPROACH

The detailed impact assessment of the water body associated with the VCSNS and its biological communities, uses an evaluative approach combining quantitative data with qualitative observations and interpretations. The aquatic system under investigation is the 6800 acre Monticello Reservoir. This water body provides the once through condenser cooling water for the Summer station, as well as power generation associated with the Fairfield Pumped Storage Hydroelectric Station.

Fish were selected as the representative biotic group for the 316(b) demonstration under conditions established in the Study Plan. This plan is part of the requirements in the National Pollutant Discharge Elimination System (NPDES) Permit issued by the South Carolina Department of Health and Environmental Control (SCDHEC, 1978). These organisms were selected for the following reasons:

1. Fish are at the top of the food web. Their abundance and diversity depend in large part, on the characteristics of the ecosystem, therefore serving as an excellent indicator of the reservoir's conditions.

2. Fish are more easily studied than other aquatic biota because of their large size, and because more data are available on their life histories, i.e., preferred habitats and spawning and feeding characteristics.

3. Fish are important for recreational fishing.

Sampling of impinged organisms at the intake structure began in October 1983, and continued at two week intervals through September 1984. The data collected on the impinged fish included the species identification, number impinged, weight, length, and incidence of parasites. A detailed description of this methodology is described in Appendix A.

Ichthyoplankton were collected during this same period of time at seven stations in Monticello Reservoir (Stations I-O), to show distribution of larval fish in the reservoir. Sampling of three stations (I, L, and M) were specified in the Study Plan to meet the entrainment requirements of Section 316(b). Station M was located in front of the VCSNS intake structure, Station I was farthest from the VCSNS and served as a control, and Station L was near the FPSF Intake (Figure 1).

The approach to impact assessment is reflected in the organization of the remaining sections of this report, as follows:

- Generating Station Description - This section describes the plant operating data, cooling water requirement, and intake structure, of the VCSNS, and the environmental setting of the reservoir.

- Impingement - This section provides results and analysis of the data from fish collected at intake traveling screens.

- Entrainment - This section provides results and analysis of larval fish studies conducted at selected locations in Monticello Reservoir.

For clarity of presentation, all tables and figures are at the end of the narrative portion of this document. Additional supporting technical data have been placed in appendices as follows:

Appendix A - Sampling Procedures for Larval and Adult Fish
Appendix B - Average Intake and Discharge Temperatures, Average Flow and Gross Thermal Power
Appendix C - Organisms Impinged at the V.C. Summer Nuclear Station Intake Screens
Appendix D - Ecological Summaries of Important Fish Species
Appendix E - Life History Information of Impinged Fish

V.C. SUMMER GENERATING STATION DESCRIPTION

The Virgil C. Summer Nuclear Station (VCSNS) is a 900 megawatt facility located in Fairfield County approximately 26 miles northeast of Columbia, South Carolina. The station is situated on Monticello Reservoir, which supplies all necessary cooling water for the plant.

Personnel from SCE&G provided data related to the operation of the VCSNS, including the average intake and discharge temperatures, average flow of circulating water through the plant, and gross thermal power. This information was tabulated by month and appears in Appendix B.

The circulating water system is designed to remove 6.67×10^9 Btu/hr of heat from the main and auxiliary condensers as well as the turbine auxiliaries. When operating at full capacity, cooling water is withdrawn from Monticello Reservoir at a rate of 2030 m^3/min (534,000 gpm), passed through the system, and ultimately returned to Monticello Reservoir through a discharge canal. The intake structure, located along the south shoreline of the reservoir, has three pump bays, each with two entrances. Each entrance is 4 m (13 ft) wide and 7.8 m (25.5 ft) high, extending from the bottom of the pump house [elevation 119 m (390.0 ft)] to the bottom of a skimmer wall [elevation 126.5 m (415.5 ft)]. The entrances are each equipped with two sets of trash racks, and conventional vertical traveling screens (mesh size 0.4 x 0.35 in). The velocities within the intake structure for specific reservoir levels with all pumps operating are as follows:

	Emergency drawdown [elevation 127m (418ft)]	Normal low level [elevation 128m (420.5 ft)]	Normal high level [elevation 129.5 m(425 ft)]
Approach velocity measured midway between traveling screen and trash rack, m/sec (fps)	0.17 (0.55)	0.16 (0.51)	0.13 (0.44)

	Emergency drawdown [elevation 127m (418ft)]	Normal low level [elevation 128m (420.5 ft)]	Normal high level [elevation 129.5 m(425 ft)]
Velocity through the screen, m/sec (fps), when screens are			
100% clean	0.38 (1.24)	0.34 (1.13)	0.30 (1.00)
75% clean	0.50 (1.65)	0.46 (1.51)	0.40 (1.32)
50% clean	0.76 (2.48)	0.69 (2.27)	0.60 (1.98)

Further design details of the intake structure are shown in Figure 2.

The heated water is returned to Monticello Reservoir through a discharge canal. Circulating water is delivered through a 12-foot-diameter concrete pipe, to a semi-enclosed basin created by the dam for the service water pond. The outlet canal for this basin is a canal that discharges the water to a sidearm of the reservoir while a jetty, 792.5 m (2600 feet) long, inhibits recirculation of the heated water. A plan view of the power plant, its intake structure, and discharge canal is shown in Figure 3.

ENVIRONMENTAL SETTING

Monticello Reservoir was formed in the Frees Creek drainage area, reaching the full pool level during February of 1978. The water sources of the reservoir are as follows:

- The Broad River, with an average annual flow of 173 m^3/sec (6100 cfs), reaches Monticello Reservoir through the Fairfield Pumped Storage Facility, located on Parr Reservoir (Figure 1).

- The runoff from Frees Creek drainage basin into Monticello Reservoir.

- Direct rainfall.

Biological monitoring has been conducted on Monticello Reservoir since June 1978, and data have been collected at stations shown on Figure 1 through December 1984. This information has been compiled in annual and two semi-annual reports (Dames & Moore, 1978, 1979, 1979a, 1980, 1981, 1982, 1983).

The sampling results have shown that Monticello Reservoir's fish community is composed largely of centrarchids (sunfish, bass, and crappie) and gizzard shad (Dames & Moore, 1983). Sixty-eight species have been identified from Monticello Reservoir and other areas of the Broad River watershed (Dames & Moore, 1983).

IMPINGEMENT

RESULTS

The objective of this portion of the study was to collect data on the species, number, length, and weight of fish impinged on the traveling screens. A detailed tabulation of the twice monthly sampling results are provided in Appendix C. In addition to showing the numbers of species and their length and weight, Table C-12 shows damaged specimens that were impinged. Ecological summaries of the important fish species are presented in Appendix D. Life history information, including preferred habitat, spawning sites and temperatures, and egg types of all impinged fish species, is presented in Appendix E.

The total number of fish collected during the study was 5,140 (Figure 4) which can be projected to an estimated 85,000 fish/year (days/year [365] ÷ days sampled [22] x numbers or weight of fish collected.) The total weight collected was 31 kilograms (kg) which amounts to 515 kg/yr or 0.47 percent of the 1984 estimated standing crop (110,500 kg) of Monticello Reservoir (Table 1). The greatest number of fish were impinged during January through March 1984 (Figure 4). No direct correlation can be made between the number of fish impinged and the Monticello Reservoir water level. There is a greater velocity at the intake screens when the reservoir level is lowered dramatically below the normal pool level of 425 ft. elevation (Figure 2). The largest total number of fish were impinged during January 1984 when the pool level elevation was 424.8 feet. The high number of fish (primarily clupeids) collected during that time was probably attributed to cold shock, and the fish were already in a moribund condition or were stunned when they reached the intake screens. The water temperature measured at the VCSNS intake during December 1983 through March 1984 ranged from a high of 56.3°F on 12/13/83 to a low of 45.8°F on February 6, 1984. The average during the four months was 49.7°F. The collected fish were represented by 17 species belonging to six families

(Figure 5). The family Clupeidae was by far the most abundant. The Clupeids were represented by gizzard shad (82.63 percent) and threadfin shad (0.76 percent). Second in abundance was the family Percidae, comprising 7.57 percent of the sample and represented by a single species, yellow perch. Even though the sunfish (Centrarchidae) are represented by 8 species in the reservoir, this family comprised only 4.61 percent of the sample and ranked third in abundance, of the impinged species.

Nearly all the fish impinged were small and an analysis of their lengths shows them to be predominantly young-of-the-year or first-year class fish (Figure 6). This observation has been noted previously in other studies (Dames & Moore, 1977) (Loar, et al., 1978, McFadden, 1977, and McClean, etc., 1981).

A discussion of findings relative to the most commonly impinged and most important species (gizzard shad, yellow perch, white catfish, bluegill, and largemouth bass) follows. Life history information for these species is presented in Appendix D.

Gizzard Shad (Dorosoma cepedianum) - Gizzard shad were by far the most abundant fish collected from the intake screens (82.6 percent, Figure 5). However, nearly all of these were impinged during December through March with the greatest number (2,834) occurring in January (Figure 7). The large number impinged during this time indicates the possible influence of cold stress or cold kill, on this species. This theory is supported by the extremely cold weather which was encountered during this period. The average water temperature during the month of January was 47.9°F. Although, no unusual numbers of dead or dying shad were noted in Monticello Reservoir during this time, the cold stress may have resulted in impaired swimming response making them unable to avoid impingement.

The gizzard shad in the impinged samples were almost consistently fish of the young-of-the-year class fish (Figure 6). Similar findings have been reported in other studies (Dames & Moore, 1976). Jester and Jensen (1972) also indicate that young-of-the-year fish are more susceptible to shock and cold kill, than older adults. It is unlikely that the VCSNS had an adverse effect on the gizzard shad population, since this species has an extremely high reproductive capability and the generating station removes almost exclusively young-of-the-year fish rather than reproducing adults.

Yellow Perch (Perca flavescens) - Yellow perch was the second most abundant species of fish impinged, comprising 7.6 percent of the fish collected (Figure 5). The greatest numbers were impinged during January (139) and March (121) (Figure 8). The fish collected were either young-of-the-year or first-year-class fish (Figure 6). Since yellow perch are not very strong swimmers and are found in large wandering schools (McClane, 1974) it is expected that they would be impinged en masse. However, like other forage species, this species has little recreational value and has high fecundity and fertility, that should offset losses associated with impingement.

White Catfish (Ictalurus catus) - White catfish are common in Monticello Reservoir and are quite prevalent around riprapped areas such as occur near the intake structure. White catfish ranked third in abundance of the impinged fish and represented 2.4 percent of the total collection (Figure 5). Unlike the other major species collected the white catfish impinged did not demonstrate a correlation between age or size (Figure 6) nor seasonal distribution of fish collected (Figure 9). These data indicate that the white catfish are impinged with little relationship between avoidance ability and age class.

Bluegill (Lepomis macrochirus) - Standing crop estimates indicate that bluegill are the most common fish in Monticello Reservoir (Table 1); however, they account for a total of only 1.3 percent of the impinged fish collected (Figure 5). The greatest numbers were collected during December (Figure 10) and included mostly young-of-the-year and first-year class fish (Figure 6). The low percentage of impinged fish for this species may result from their habitat preference which appears to be in the littoral zone and in the riprapped area of the shoreline. In addition, like most other sunfish, bluegill are prolific breeders (Douglas, 1974) and impingement should result in minimal impact to the bluegill population of Monticello Reservoir.

Largemouth Bass (Micropterus salmoides) - The collection of impinged largemouth bass was limited to one individual, comprising only 0.02 percent of the total number of impinged fish (Figure 5). This low number illustrates this important sport species is not being impacted by the VCSNS intake screens. Although largemouth bass are common in the vicinity of the intake structure, their sedentary nature and a highly developed sensory system enhances their avoidance of the intake screens.

INTERPRETATION AND ANALYSIS

The previous section indicates that, although fish are being removed from Monticello Reservoir by impingement, these losses should result in minimal impact to the resident adult fish community. The following section expands this thesis by discussing these issues:

1. The perturbation to the fish community caused by the intake structure.

2. The characteristics of the fish community potentially affected by the intake structure, as illustrated by:

   a. A composite description of the fish community in Monticello Reservoir, based on electrofishing and gillnet data, standing crop estimates, and impingement studies.

b. Life history data on important fish species, emphasizing preferred habitats, spawning time, and location.

3. The results of impingement on the available fish community, to include:

   a. Community stability, evaluated using previous studies on Monticello Reservoir (Dames & Moore, 1983).

   b. Impairment of ecological function.

   c. Reduction in optimum sustained yield of sport fish or other important species.

   d. Unmitigable loss to the ecosystem.

Following the examination of the above issues: A rationale is provided for predicting continued stability in the fishes community of the Monticello Reservoir, and the effect of impingement of this community is evaluated.

<u>The Perturbation Produced by the Intake Structure.</u> - In assessing the impact of intake structure on fish communities it is important to understand the nature of the action of these structures on individual populations, which, as McFadden notes (1977), can be compared to predation:

> "Most of the current environmental awareness is built on public recognition of these two classes of problems - wholesale destruction of environmental resources and the release of exotic toxic substances. A third class of man-caused problems - the imposition on a population of increased mortality that takes a form similar to natural predation - has an entirely different effect on most species. This is the kind of impact to which the

population has been adapted by thousands or millions of years of evolutionary experience. The agent of mortality - predatory fish, commercial or sport fishermen, or power plants - is an indifferent matter from the standpoint of population response. When the population is reduced in numbers, the survival rate or reproductive rate among the remaining members tends to increase; a compensating response is generated."

Furthermore, the effect of predation by the VCSNS is limited primarily to the populations of young-of-the-year fish, as shown in a previous section. Therefore, the following assessment is a characterization of the adult fish community that results from predation by the generating station on the young-of-the-year fish in Monticello Reservoir.

AVAILABLE FISH COMMUNITY

Electrofishing and Gillnetting - Sampling adult fish on Monticello Reservoir by electrofishing and gillnetting has been performed since 1978 (Dames & Moore 1978, 1979, 1979a, 1980, 1981, 1982, 1983). This sampling was performed in shoreline (littoral) areas and was thus biased against open water fishes. These data demonstrated a community comprising 35 species, 28 of which were collected in the immediate vicinity of the plant intake during the impingement study. The results of the 1984 (Dames & Moore, 1985 Biological Monitoring Report, in press) collections near the VCSNS intake (Station M) are shown in Table 2. The most abundant species collected were bluegill and gizzard shad, although sport and pan fish such as largemouth bass, white catfish, channel catfish, and yellow perch were common in the area.

Standing Crop - Annual standing crop estimates have been from 1978 through 1984 (Dames & Moore 1978, 1979, 1979a, 1980, 1981, 1982, 1983). These estimates were made by applying rotenone near Stations I and K in Monticello Reservoir. Although neither station is in proximity to the intake structure of the VCSNS, the figures from these two sites are considered representative of the reservoir as a whole and, therefore, are of value in assessing the impact of impingement on the fish community of the reservoir. Standing crop estimates for 1984 are presented in Table 1.

Impingement - Impingement studies were performed at the VCSNS from October 1983 through September 1984. These studies indicate impingement was selective for certain species (i.e., gizzard shad and yellow perch, Figure 5), and certain size classes of fish (i.e., young-of-the-year and first-year class fish, Figure 6). These findings are similar to those reported in previous studies (Dames & Moore, 1977). Fishes which have more sedentary behavior (i.e., sunfish, bullheads) come in contact with the intake structure less than the more active species (i.e., gizzard shad, yellow perch, white catfish). Also, more active species of fishes usually occur in large schools (i.e., gizzard shad, yellow perch) and, therefore, are more likely to be impinged in great numbers. The sedentary species, on the other hand, are often solitary or occur in small schools and are likely to be impinged in fewer numbers.

Summary - The results from the individual sampling programs discussed above demonstrated a difference in the dominant fish populations. The active sampling programs, use data from electrofish, gillnet, and standing crop studies, indicated that bluegill were most abundant, followed closely by gizzard shad, while yellow perch were very low in density. However, the passive sampling data obtained by analysis of impinged fish, resulted in much higher numbers of gizzard shad and yellow perch than of bluegill. However, the habits of these taxa appear to explain these skewed differences. As noted above, gizzard shad are very susceptible to cold shock, while yellow perch typically occur in large schools, both species thereby becoming more susceptible to intake currents. Bluegill, however, tend to remain in the littoral area along the shoreline, resulting in fewer individuals being impinged by the intake.

IMPACTS OF IMPINGEMENT ON THE ADULT FISH COMMUNITY

Effects on Community Stability - On the basis of data presented in past Dames & Moore reports (1978, 1979, 1979a, 1980, 1981, 1982, 1983, 1984) it seems likely that the fish in Monticello Reservoir are representative of a stable ecosystem. This stability has occurred through preadaptive responses of the community to the artificial perturbations associated with the VCSNS operation. Additional stresses, such as high temperature and low dissolved oxygen in the summer, introduced during critical time periods may affect this stability and result in seasonal mass mortality of sensitive forage fish species such as gizzard shad.

Effect on Ecosystem - Due to the relatively low percentages of fish being impinged and the apparent stability of Monticello Reservoir, the impingement of organisms appears to have little impact on the aquatic ecosystem of the reservoir.

Sustained Yield of Sport Fish or Other Important Species - As illustrated in Figure 5, the numbers of sport fish impinged per year is minimal. These findings indicate that there is no reduction in optimum sustained yield of sport or other important fish.

Unmitigable Loss to the Ecosystem - The highest percentage of the fish populations being impinged are those species with the highest reproductive potential. Therefore, there appears to be no unmitigable loss to the ecosystem due to impingement.

Explanations for Projected Phenomena - The numbers of fishes impinged by the VCSNS appear sufficiently low so as to have minimal effect on the fish community. The numbers of fish being impinged could probably be greater and still have little significant effect. The basis for these projections are:

1. The action of intake structures is similar to predation, a process to which most natural fish populations are preadapted to .chstand.

2. The majority of the fish affected by impingement are young-of-the-year. The effect of removing young-of-the-year fish was discussed by McFadden (1977) as follows:

> "It turns out that the question whether it is different (possibiy worse) to kill young fish than to kill older fish was answered more than 20 years ago by Ricker (1954, p. 607):
>
> Exploitation that takes fish at an age when natural mortality is still compensatory means, for practical purposes, a fishery for young during the first year or two of their life - the earlier the better. The removal of such young is at least partly balanced by increased survival and/or growth of the remainder.
>
> ...it is clear that any general prejudice against exploiting young fish is unsound."

This theorem is applicable to the removal of fish by impingement in that the loss of some individuals of a particular year/age class can increase the survivorship of those remaining, thus, minimizing the effect of impingement on the stability of the adult community. In Monticello Reservoir, where gizzard shad and yellow perch are the species most heavily affected by the intake structure, the abundance of adult populations should remain constant or increase. Adaptation for survival of these species is expected, considering the naturally high mortality rate of newly hatched fish, and the fact that the generating station is removing these fisn during the first year of life, a period of naturally high mortality.

ENTRAINMENT

INTRODUCTION

Entrainment is used in this study to describe the passage of organisms through an intake screen into the cooling water system of a generating station. Entrained organisms generally suffer very high to total mortality. Of particular concern are fish, which have long reproductive cycles and delicate life stages. Smaller organisms and life stages with limited swimming ability are generally more subject to entrainment. Phytoplankton and zooplankton are entrained in cooling systems, but their loss is generally of minimal importance compared to larval fish (ichthyoplankton) because of their high abundance and relatively rapid reproductive cycle. In addition, the amount of water used daily for condensor cooling at the VCSNS represents only 0.5 percent of the total Monticello Reservoir volume (SCDHEC, 1978), further minimizing substantive impacts to these communities.

In conventional intake systems, screens allow passage of fish eggs, larvae, juveniles, and the adults of small species. All species of fish in Monticello Reservoir produce eggs and larvae of a size that can be entrained through such systems. Larval fish, which are suspended in the water column, become entrained when the water which they inhabit is drawn into the plant. The fishes may either be planktonic (free floating) or actively swimming but unable to overcome the water velocity at the intake. Therefore, the entrained loss of fish is more a function of their availability than plant operational features.

The primary means of reducing the number of organisms entrained by conventional intake systems include: (1) locating the intake in an area where the numbers of organisms available for entrainment are lower (generally offshore, away from more productive nearshore areas); and (2) reducing the approach velocity by reducing intake water volume requirements or by intake design modifications.

STUDY APPROACH

The objective of the entrainment monitoring program was to demonstrate utilization of the best technology available by evaluating the ichthyoplankton community in Monticello Reservoir. The monitoring program was established following the approach specified in the study plan issued by SCDHEC, 1978. No samples were taken inside the VCSNS to determine the number of organisms that passed through the intake screens, but rather collections of ichthyoplankton were made at selected locations (Stations I, L, and M) in Monticello Reservoir (Figure 1). This approach assumed all fish available in the water column would be lost by entrainment and, therefore, provided a conservative estimate of the larval fish community affected.

Station M in Monticello Reservoir was the closest sampling station to the VCSNS intake and Station I at the extreme northern section of Monticello Reservoir served as the control station. Station L was located near the intake for the Fairfield Pumped Storage Facility, and was included in the study to assess distribution of larval fish in this area of the reservoir. Samples were collected at the stations during the same time period (usually within 1 hour of each other) and, at Stations I and M, samples were collected approximately one-half hour after sunset. In addition to sampling at Stations I, L, and M to address the entrainment section of the 316(b) study, larval fish also were sampled at Stations J, K, N, and O. The purpose of sampling at these latter locations was to determine if the distribution of larval fish was uniform throughout Monticello Reservoir. The sampling procedure for ichthyoplankton is described in Appendix A.

STUDY RESULTS

The results of the ichthyoplankton collections throughout the study period are presented in Tables 3 and 4. Table 3 summarizes the total densities for each station throughout the study period, while Table 4 shows the density distribution by months among the sampling locations. Table 5 provides a statistical comparison of the mean total densities at Stations I, L, and M. This sampling program resulted in the collection of nine taxa that represented six families. The clupeid family probably consisting mostly of gizzard shad was the most dominant taxon collected at all the stations (both surface and mid-depth), and the white bass was the next most abundant organism. The greatest density of larval fish from surface collections occurred at Station M, located in front of the intake structure of the VCSNS. The highest density values from mid-depth collections occurred at the control area, Station I, located at the northern end of the Monticello Reservoir (Figure 1).

Station I. The total density of larval fish both at the surface (18.3/100 m^3) and mid-depth (17.9/100 m^3) were similar. Gizzard shad was the most dominant organism collected and comprised approximately 93 percent for combined surface and mid-depth samples of the organisms collected. Other taxa collected in small numbers included: white bass, perch, crappie, and sunfish.

Station L. Collections at this station showed that the gizzard shad comprised about 80 percent of all larval fish collected, followed by white bass which represented about 12 pe.cent of the collection. Other taxa collected in small numbers included: minnows, suckers, sunfish, and perch. Approximately 87 percent of the larvae were collected from the surface samples.

Station M. The overall surface density at Station M during the study period was 53.9 larval fish per 100 m^3 of water, and at the mid-depth level there were 11.8 fish/100 m^3 of water. Gizzard shad dominated the collections at both depths (61.9/100 m^3) and represented 94 percent of the collection. Combined white bass density for both depths was 3.1/100 m^3 and represented approximately 5 percent of the samples. Other taxa collected at Station M, in small numbers, included: minnows, suckers, sunfish, and perch. Total densities at the surface of Station M were more than four and one-half times those at mid-depth.

Monthly Distribution. The results of the monthly sampling effort are presented in Table 4. During this study program the first larval fish were collected during February 1984, at Stations K through N. The surface samples produced white bass at quantities of 10.1/100 m^3 and 11.5/100 m^3 at Stations L and M, respectively. Mid-depth collections showed white bass to be abundant at Stations M and N (5.61/100 m^3 and 11.2/100 m^3, respectively).

During March the collections includes shad (Stations K and N) and perch at Stations J, K, and O, along with white bass at all stations. In April six taxa were collected among the sampling stations. Dorosoma spp. and percids appeared at all stations, and white bass were found at all stations except K. During May the larval fish reached their greatest total density for all stations in the reservoir (664/100 m^3). The greatest total density (209/100 m^3) for both the surface and mid-depths occurred at Station I; shad comprised more than 96 percent of the collection. At Station M, in front of the VCSNS intake, the total number of larval fish was 96.8/100 m^3 at both surface and mid-depth collections; shad again comprised more than 96 percent of the collection at this station.

Surface and mid-depth collections at Station N (near the discharge canal) produced a total of 84.0/100 m^3 fish larva. At Station I mid-depth collections produced a total of 209/100 m^3 ichthyoplankton. In general, at all stations the shad appeared in similar numbers at the surface and mid-depth samples. The exception to this occurred at Stations L and O. At Station L, surface vs. mid-depth densities were 24.3/100 m^3 vs. 12.5/100 m^3; at Station O the surface densities were three times greater than mid-depth, 45.4 - 14.3/100 m^3, respectively.

During June, large numbers of larval fish continued to be present in the collections (total of 592.1/100 m^3), again with shad dominating at all stations. These organisms were particularly abundant at Station M (338/100 m^3); the surface collections p duced 310/100 m^3 and the mid-depth samples 28/100 m^3. The shad represented more than 99 percent of all the larvae collected at this location. During June, Station O had the most diversity, five identified taxa were collected from surface or mid-depth samples. During July, August, and September the collections yielded low densities and few taxa. The number of organisms collected in the individual samples during these months ranged from 0.16/100 m^3 to 3.2/100 m^3. Shad were the only larve collected through September, but only at the surface at Station I. A comparison of the frequency of fish larvae present throughout the study period for Stations I and M shows that organisms were collected at least 7 of the 8 months during the study period at these locations. At four of the other stations (J, K, L, and N) the fish larvae appeared during 5 months, and only 4 months at Station O.

A statistical comparison, using the Students t-test, of the mean larval fish densities at Stations I, L, and M during the months of April, May, and June was completed and the results are presented in Table 5. These tests showed a significant difference between the stations during the sampling period.

During May and June at all the locations, with the exception of Stations I and L in June, the values showed a highly significant difference.

DISCUSSION

An analysis of the larval fish collected at Station M and the abundance of adult fish at Station M shows the potential entrainable species during the course of a year. The entrainment of any component of the fish community is related to the reproductive season of the separate fish populations, with entrainment most likely to occur between spawning and the time the larvae either grow too large to pass through the 0.4 x 0.35 inch traveling screen mesh, or become strong enough to swim against the intake current. An analysis of the fishery survey data and observations of the fish community during the past several years (Dames & Moore, 1982 and 1983) indicate that the extreme southwest part of Monticello Reservoir (that area bordered on the east by the jetty separating the intake and discharge structure of the VCSNS, and on the west by the main dam south of the Fairfield Pumped Storage Facility (FPSF) intake, Figure 3) is supporting a large number (both density and diversity) of fish (Dames & Moore, 1982, 1983). This area is rich in nutrients since the water is replenished from the Broad River through the pumping operation of the FPSF. Some fish are also probably transported to Monticello Reservoir through the FPSF operation and colonize this area.

The larval fish data for the study period indicate that the greatest density of larval fish occur in the south end of the reservoir in the vicinity of Station M. These data indicate that the larval fish are not evenly distributed in the reservoir with the density at Station M nearly two (1.8) times that at the control Station I, although this number is skewed somewhat by the large number (339/100 m^3) of shad collected during June. These data suggest that the most abundant species near Station M, and therefore, the species that are most susceptible to entrainment are the clupeids (gizzard and threadfin shad), particularly during the months of May and June.

CONCLUSIONS

Section 316(b) of P.L. 92-500 requires that the "...location, design, construction, and capacity of the cooling water intake structures reflect the best technology available for minimizing adverse environmental impact." What constitutes the "best technology available," however, must be determined on a case-by-case basis because of the biological characteristics of the water bodies where the generating structure is located, and the variation in the operating characteristics of the power plant.

The 316(b) Environmental Protection Agency Guidance Manual (May 1977) contains the following statement:

> Adverse environmental impact from the location, design, construction, and capability of cooling water intake structures, for the purpose of this document is damage to individuals, populations, or communities of organisms such that:
>
> 1. The ecological functioning of the unit is impaired or reduced to the point such that long term stability at pre-existing levels is decreased; or
>
> 2. A reduction in optimum sustained yield to sport and/or commercial fisheries results; or
>
> 3. Threatened or endangered species of aquatic life are directly or indirectly adversely affected; or
>
> 4. The magnitude of the damage constituents an unmitigable loss to the aquatic system.

The following conclusions concerning the impact of the VCSNS's intake structures on the aquatic organisms of Monticello Reservoir are presented in terms of these four criteria.

Question 1: Is the ecological functioning of the unit (ecological community) impaired or reduced to the point such that long-term stability at pre-existing levels is decreased?

The answer to this question is no. The fish community of Monticello Reservoir is comprised primarily of gizzard shad and sunfish. Although the study results show that 83 percent of the fish impinged were gizzard shad, the loss is easily sustained by this species. Gizzard shad have a high reproductive potential and rapid rate of growth (Jester & Jensen, 1972), and is the second most abundant species in the reservoir, having an average standing crop of about 14 kg/ha (based on rotenone sampling conducted by Dames & Moore in 1984). Given a normal pool surface area of 6,800 acres and even distribution, the total standing crop of gizzard shad in the reservoir is estimated at 37,679 kg. Because the standing crop estimates are conducted in cove areas, it is likely that the standing crop of open water species, such as shad, were underestimated. The VCSNS was estimated to impinge a total of only 16 kg of shad during the study period.

Question 2. Do the VCSNS intake structures cause a reduction in optimum sustained yield to sport and/or commercial fisheries results?

The answer to this question is no. There is no reported commercial fishing in Monticello Reservoir. Even if there were commercial fishing, the losses sustained by the two major species impinged by the plant would not affect the results of such fishing. The effect on sport species and their prey is minimal and constitutes no risk to those species.

Question 3. Are threatened or endangered species of aquatic life directly or indirectly adversely affected by the intake structure of the VCSNS.

The answer to this question is no, since no rare or endangered species of aquatic life are found in the water body and none were found in the impingement collections.

Question 4. Does the magnitude of the damage caused by the VCSNS intake structures constitute an unmitigable loss to the aquatic system?

The answer to this question is no. The effect of entrainment of fish eggs and larvae on fish populations of the Monticello Reservoir depends on a number of factors, particularly the ratio of total removed to the total entrainable. Because the total number of entrainable organisms is unknown, the impact of plant entrainment was estimated by considering the distribution of larval fish in Monticello Reservoir. There are no apparent ill effects on the fish community of Monticello Reservoir due to impingement and entrainment by the VCSNS.

SUMMARY

Monticello Reservoir my be considered as a young, recently stabilized, warm water impoundment. The fish community in this water body is characterized by a moderately high diversity, dominated in numbers and biomass by highly productive species (gizzard shad and bluegill).

An evaluation in terms of the criteria provided in the USEPA 316(b) guidelines demonstrates that the VCSNS intake structures are comparable in function to the role of a predator, removing primarily only the young-of-the-year fish, mainly the gizzard shad in Monticello Reservoir. However, based on standing crop information, the impact is considered to be negligible and should not destabilize the adult fish community. The VCSNS design has no features that are clearly attracting fish into the immediate vicinity of the intake structure. However, the area near the intake has high densities of larval fish present, and supports a large community of adult fish. This skewed distribution in Monticello Reservoir may be attributed to the area being rich in nutrients since the water is replenished by the pumping operations of the FPSF.

The continued success and stability of the dominant fish populations in the Monticello Reservoir, during the 7 years of monitoring, along with the relatively low percentage of these populations impinged by the plant's intake structures, demonstrate that the VCSNS is not causing any apparent ill effects to the aquatic community of the reservoir.

REFERENCES

*Bell, M.C., 1973. Fisheries handbook of engineering requirements and biological criteria. Fisheries Engineering Research Program, Corps of Engineers. North Pacific Division, Portland, Oregon.

*Calhoun, Alex, ed., 1966. Inland fisheries management department of fish and game. State of California, 546 pp.

*Carlander, K.D., 1969. Handbook of freshwater fishery biology, Volume I. Iowa State University Press. 752 pp.

Clay, William M., 1975. The fishes of Kentucky. Kentucky Department of Fish and Wildlife Resources, Frankfort, Ken. 416 pp.

Dames & Moore, 1976. 316(b) Report - Allen Steam Plant. 36 pp.

__________, 1977. 316(b) demonstration for the Cayuga and Wabash River Generating Stations. 76 pp.

__________, 1978. Environmental monitoring report June 1978 - December 1978. For the Federal Energy Regulatory Commission project license number 1894 and the South Carolina Department of Health and Environmental Control. Distributed - May 1979.

__________, 1979. Environmental monitoring report January 1979 - June 1979. For South Carolina Department of Health and Environmental Control. Distributed - November 1979.

__________, 1979a. Environmental monitoring report July 1979 - December 1979. For the Federal Energy Regulatory Commission Project License Number 1894 and the South Carolina Department of Health and Environmental Control. Distributed - May 1980.

__________, 1980. Environmental monitoring report January 1980 - December 1980. For the Federal Energy Regulatory Commission Project License Number 1894 and the South Carolina Department of Health and Environmental Control. Distributed - June 1981.

__________, 1981. Environmental monitoring report January 1981 - December 1981. For the Federal Energy Regulatory Commission Project License Number 1894 and the South Carolina Department of Health and Environmental Control. Distributed - September 1982.

__________, 1982. Environmental monitoring report January 1982 - December 1982. For the Federal Energy Regulatory Commission Project License Number 1894. 196 pp. Distributed - January 1984.

__________, 1983. Environmental monitoring report, January 1983 - September 1983. For the South Carolina Department of Health and Environmental Control, and the Nuclear Regulatory Commission. Distributed - February 1984.

__________, 1984. Environmental monitoring report, October 1983-March 1984. For the South Carolina Department of Health and Environmental Control, and the Nuclear Regulatory Commission. Distributed - June 1984.

*Douglas, Neil, 1974. Freshwater fishes of Louisiana. La. Wildlife and Fisheries Commission, Baton Rouge, La. 443 pp.

Jester, D.B. and Buddy L. Jensen, 1972. Life history and ecology of the gizzard shad, Dorosoma cepedianum, with reference to Elephant Butte Lake. New Mexico State University, Agricultural Experiment Station Research, Report 218, 56 pp.

Loar, L.M., J.S. Griffith, and K.D. Kumar, 1978. An analysis of factors influencing the impingement of threadfin shad at power plants in the southern United States. pp. 245-255. In Jensen, L.D., ed., Fourth National Workshop on Entrainment and Impingement. Chicago, Ill., December 5, 1977. Ecological Analysis, Inc., Melville, NY, 415 pp.

McClane, A.J., 1974. McClane's field guide to freshwater fishes of North America. Holt, Reinhart, and Winston. 212 pp.

McFadden, J.T., 1977. An argument supporting the reality of compensation in fish populations and a plea to let them exercise it, pp. 153-183. In Proceedings of the Conference on Assessing the Effects of Power-Plant-Induced Morality on Fish Populations. Gatlinburg, Tenn., May 3-6, 1977. Oak Ridge National Laboratory, Oak Ridge, Tenn. 361 pp.

McLean, R.B., P.T. Singley, and D. Lodge, 1981. Threadfin shad impingement, population response. 70 pp.

Pflieger, William L., 1975. The fishes of Missouri. The Missouri Department of Conservation, 343 pp.

*Scott, W.B., and E.J. Crosman, 1973. Freshwater fishes of Canada. Bulletin 184. Fisheries Research Board of Canada, Ottawa, Canada. 966 p.

South Carolina Department of Health and Environmental Control (SCDHEC), 1978. 316(b) Demonstration Study Plan. South Carolina Electric & Gas Company, Virgil C. Summer Nuclear Station, Unit 1, NPDES Permit Number SC0030856.

U.S. Environmental Protection Agency (USEPA), 1977. Guidance for evaluating the adverse impact of cooling water intake structures on the aquatic environment: Section 316(b) P.L. 92-500.

* Not cited.

Table 1. Standing crop of fish in Monticello Reservoir based on rotenone sampling at Stations I and K during 1984.

	Mean kg/ha	Total Standing Crop in Reservoir (kg)
Bluegill	14.69	40,430.99
Gizzard shad	13.69	37,678.71
Pumpkinseed	3.48	9,577.93
Channel catfish	2.78	7,651.34
Warmouth	0.98	2,697.23
White catfish	0.70	1,926.60
Largemouth bass	1.04	2,862.37
Brown bullhead	0.61	1,678.89
Yellow perch	0.59	1,623.85
Redear	0.49	1,348.62
Silver redhorse	0.20	550.46
Threadfin shad	0.14	385.32
Whitefin shiner	0.46	1,266.05
Flat bullhead	0.15	412.84
Black crappie	0.03	82.57
Tesselated darter	0.07	192.66
Silver minnow	0.02	55.05
Swamp darter	0.01	27.52
Total	40.13	110,449.00

* Total standing crop was derived by taking the average of the standing crop from Stations I and K (mean kg/ha) in 1984 and multiplying these numbers by the area of Lake Monticello (2752.28 ha).

Table 2. Fish species collected by gillnetting and electrofishing (Station M) during the quarterly surveys in 1984.

Species	Number Collected
Longnose gar	1
Gizzard shad	145
Threadfin shad	30
Carp	3
Silvery Minnow	11
Whitefin shiner	9
White sucker	1
Quillback	59
Shorthead redhorse	1
Silver redhorse	19
Striped jumprock	1
White catfish	69
Yellow bullhead	3
Brown bullhead	5
Channel catfish	57
Flat bullhead	9
Snail bullhead	6
White bass	7
Hybrid sunfish	3
Redbreast sunfish	20
Warmouth	23
Bluegill	510
Pumpkinseed	27
Redear sunfish	8
Largemouth bass	69
White crappie	1
Black crappie	3
Yellow perch	13
Total	1,113

Table 3 Mean density of larval fish (number/100 m^3) for Stations I through O during October 1983 through September 1984.

Species	Scientific Name	Station	I	J	K	L	M	N	O
Gizzard shad	Dorosoma	Surface	16.37	6.77	12.96	10.84	51.57	8.95	9.88
		Mid-depth	17.38	6.86	11.96	1.71	10.33	9.05	3.13
Minnow	Cyprinidae	Surface	--	--	--	--	0.11	--	0.04
		Mid-depth	--	--	--	0.06	0.15	--	--
Sucker	Catostomidae	Surface	--	--	--	0.61	0.11	--	0.24
		Mid-depth	--	--	--	--	--	--	0.00
White bass	Morone chrysops	Surface	0.08	0.04	--	1.64	1.94	1.67	2.29
		Mid-depth	0.04	0.12	0.83	0.25	1.13	1.86	0.34
Sunfish	Centrarchidae	Surface	--	--	--	--	--	--	--
		Mid-depth	0.04	--	--	--	0.03	--	--
Sunfish	Lepomis spp.	Surface	0.09	--	--	0.04	0.04	--	0.20
		Mid-depth	--	--	--	--	--	--	--
Crappie	Pomoxis spp.	Surface	0.12	--	--	0.03	--	--	0.08
		Mid-depth	0.03	--	--	--	--	--	0.04
Yellow perch	Perca flavescens	Surface	0.10	--	--	--	--	--	--
		Mid-depth	--	--	0.01	--	--	--	--
Percid	Percidae	Surface	0.86	0.19	0.03	0.21	0.08	0.17	1.37
		Mid-depth	0.17	0.13	0.17	0.04	--	0.02	0.04
	Damaged Unid.	Surface	0.74	0.04	0.08	0.23	0.07	0.18	0.15
		Mid-depth	0.24	0.04	0.09	--	0.18	0.19	--
Total Surface			18.34	7.03	13.07	13.60	53.92	10.93	14.25
Total Mid-Depth			17.89	7.14	12.58	2.06	11.82	11.12	2.55

Table 4 Mean monthly densities of larval fish (number/100 m^3) collected in net tows, October 1983 through September 1984. (Larval fish first appeared in the February 1984 collections.)

FEBRUARY 1984

Scientific or Family Name	Common Name	Station	I	J	K	L	M	N	O
Morone chrysops	White bass	Sfc	--	--	--	10.13	11.53	3.99	--
		Mid	--	--	1.82	--	5.61	11.19	--
Total		Sfc	--	--	--	10.13	11.53	8.99	--
		Mid	--	--	1.82	--	5.61	11.19	--

MARCH 1984

Scientific or Family Name	Common Name	Station	I	J	K	L	M	N	O
Dorosoma spp.	Shad	Sfc	--	--	--	--	--	0.70	--
		Mid	--	--	0.12	--	--	0.45	--
Morone chrysops	White bass	Sfc	--	0.27	--	0.40	1.28	1.00	0.85
		Mid	0.13	0.29	0.29	0.32	0.92	0.57	--
Perca flavescens	Perch	Sfc	--	--	--	--	--	--	--
		Mid	--	--	0.09	--	--	--	--
Percidae	Perch	Sfc	--	0.27	0.11	--	--	--	1.99
		Mid	--	0.29	0.72	--	--	--	0.26
Total		Sfc	--	0.54	0.11	0.40	1.28	1.60	2.83
		Mid	0.13	0.58	1.22	0.32	0.92	1.02	0.26

APRIL 1984

Scientific or Family Name	Common Name		I	J	K	L	M	N	O
Dorosoma spp.	Shad	Sfc	--	--	--	--	1.30	2.17	0.76
		Mid	0.26	0.28	0.20	0.29	0.60	12.32	0.60
Cyprinidae	Minnows	Sfc	--	--	--	--	--	--	--
		Mid	--	--	--	0.28	--	--	--
Morone chrysops	White bass	Sfc	0.53	--	--	0.48	0.78	1.31	15.19
		Mid	--	0.56	--	--	0.60	0.21	2.38
Centrarchidae	Sunfish	Sfc	--	--	--	--	--	--	--
		Mid	0.26	--	--	--	--	--	--
Pomoxis spp.	Crappie	Sfc	0.47	--	--	--	--	--	--
		Mid	--	--	--	--	--	--	0.30
Percidae	Perch	Sfc	5.64	0.57	--	0.25	0.25	0.97	3.88
		Mid	0.81	0.58	0.43	0.26	--	--	--
Damaged Unid.		Sfc	--	--	--	--	--	--	0.51
		Mid	--	--	--	--	--	0.21	--
Total		Sfc	6.63	0.57	--	0.73	2.33	4.49	20.34
		Mid	1.32	1.43	0.63	0.84	1.20	12.73	3.27

MAY 1984

Scientific or Family Name	Common Name	Station	I	J	K	L	M	N	O
Dorosoma spp.	Shad	Sfc	89.22	44.73	48.28	18.60	49.75	38.16	43.69
		Mid	113.37	33.87	48.78	10.93	43.08	41.81	14.31
Cyprinidae	Minnows	Sfc	--	--	--	--	--	--	--
		Mid	--	--	--	0.15	0.38	--	--
Catostomidae	Sucker	Sfc	--	--	--	4.26	0.51	--	--
		Mid	--	--	--	--	--	--	--
Morone chrysops	White bass	Sfc	--	--	--	0.47	--	0.37	--
		Mid	0.17	--	0.21	1.41	0.75	1.03	--
Centrarchidae	Sunfish	Sfc	--	--	--	--	--	--	--
		Mid	--	--	--	--	0.19	--	--
Pomoxis spp.	Crappie	Sfc	0.35	--	--	0.24	--	--	0.59
		Mid	0.18	--	--	--	--	--	--
Perca flavescens	Perch	Sfc	0.69	--	--	--	--	--	--
		Mid	--	--	--	--	--	--	--
Percidae	Perch	Sfc	0.35	0.27	--	0.71	0.33	0.19	0.89
		Mid	0.38	--	0.21	--	--	--	--
Damaged Unid.		Sfc	3.08	0.27	0.56	--	0.50	1.29	0.26
		Mid	1.64	0.27	0.37	--	1.28	1.12	--
Total		Sfc	93.67	45.26	48.85	24.28	51.09	40.01	45.42
		Mid	115.73	34.14	49.55	12.48	45.69	43.96	14.31

JUNE 1984

Scientific or Family Name	Common Name	Station	I	J	K	L	M	N	O
Dorosoma spp.	Shad	Sfc	21.72	2.65	42.30	57.25	309.51	21.39	24.70
		Mid	7.26	13.57	34.62	0.78	28.03	8.78	6.98
Cyprinidae	Minnows	Sfc	--	--	--	--	0.76	--	0.28
		Mid	--	--	--	--	0.51	--	--
Catostomidae	Sucker	Sfc	--	--	--	--	0.25	--	1.69
		Mid	--	--	--	--	--	--	--
Morone chrysops	White bass	Sfc	--	--	--	--	--	--	--
		Mid	--	--	--	--	--	--	--
Lepomis spp.	Sunfish	Sfc	--	--	--	0.27	0.27	--	1.41
		Mid	--	--	--	--	--	--	--
Percidae	Perch	Sfc	--	0.22	0.13	0.53	--	--	2.81
		Mid	--	--	--	--	--	0.14	--
Damaged Unid.		Sfc	1.58	--	--	1.60	--	--	0.28
		Mid	--	--	0.19	--	--	--	--
Total		Sfc	23.30	2.86	42.12	59.65	310.79	21.39	31.17
		Mid	7.26	13.57	34.81	0.78	28.54	8.91	6.98

JULY 1984

Scientific or Family Name	Common Name	Station	I	J	K	L	M	N	O
Dorosoma spp.	Shad	Sfc	3.20	--	--	--	0.27	--	--
		Mid	0.79	0.27	--	--	0.26	--	--
Damaged Unid.		Sfc	0.49	--	--	--	--	--	--
		Mid	--	--	--	--	--	--	--
Total		Sfc	3.69	--	--	--	0.27	--	--
		Mid	0.79	0.27	--	--	0.26	--	--

AUGUST 1984

Scientific or Family Name	Common Name	Station	I	J	K	L	M	N	O
Dorosoma spp.	Shad	Sfc	--	--	--	--	0.16	--	--
		Mid	--	--	--	--	0.32	--	--
Cyprinidae	Minnows	Sfc	--	--	--	--	--	--	--
		Mid	--	--	--	--	0.18	--	--
Lepomis spp.	Sunfish	Sfc	0.62	--	--	--	--	--	--
		Mid	--	--	--	--	--	--	--
Total		Sfc	0.62	--	--	--	0.16	--	--
		Mid	--	--	--	--	0.50	--	--

Table 4 (Continued)

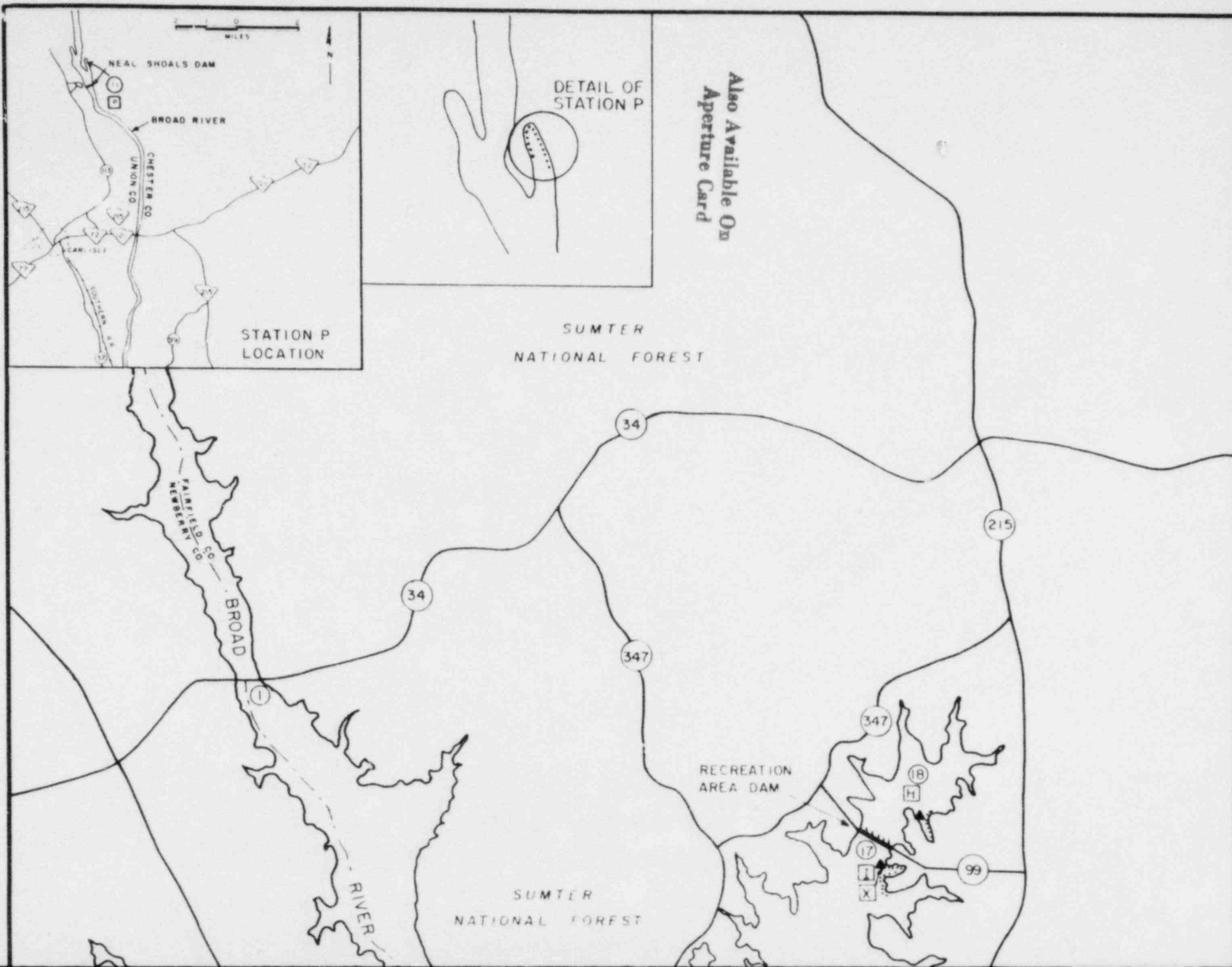
SEPTEMBER 1984

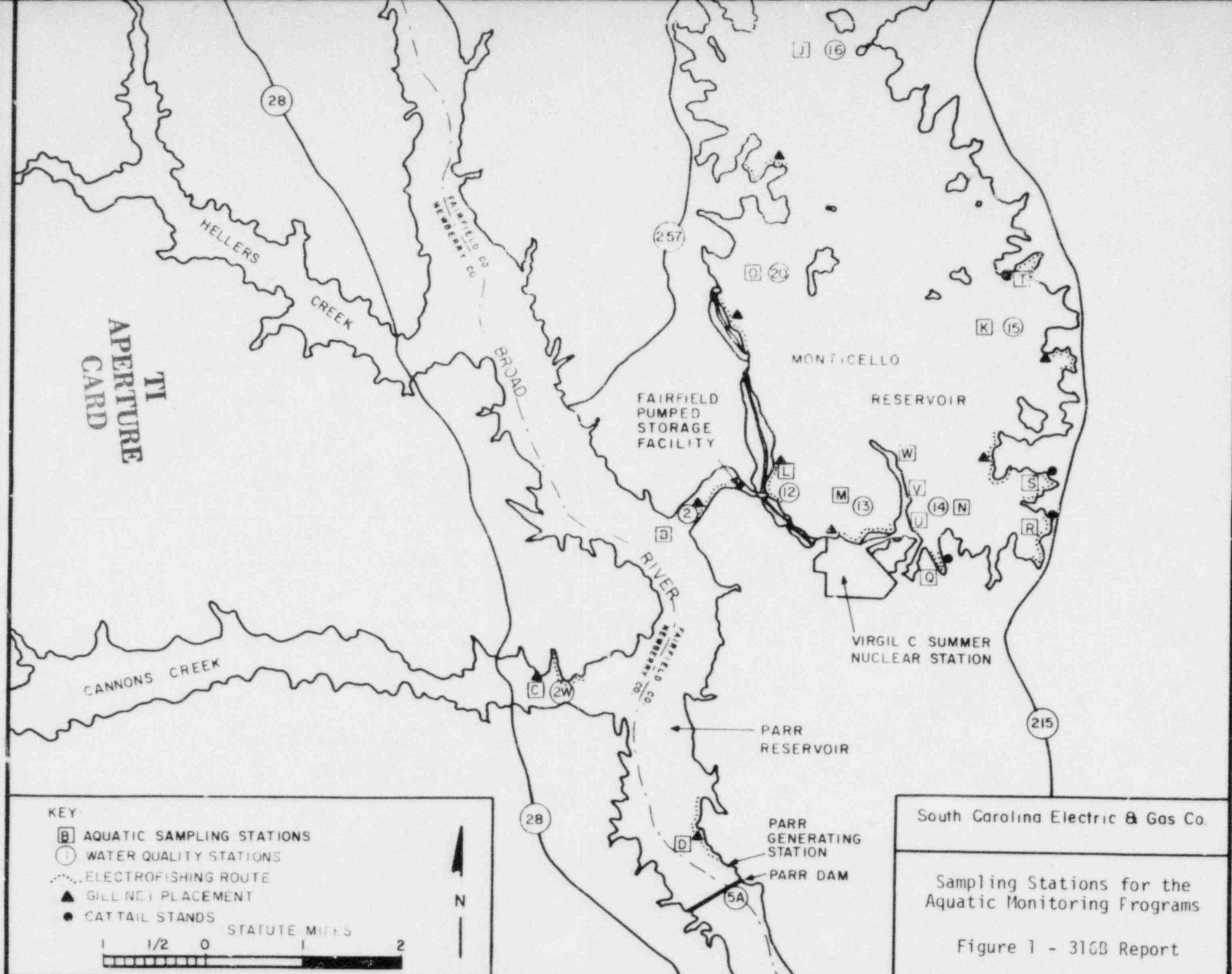
Scientific or Family Name	Common Name	Station	I	J	K	L	M	N	O
Dorosoma spp.	Shad	Sfc	0.45	--	--	--	--	--	--
		Mid	--	--	--	--	--	--	--
Total		Sfc	0.45	--	--	--	--	--	--
		Mid	--	--	--	--	--	--	--

Table 5 A comparison of larval fish mean densities at Stations I, L, and M for the dates indicated.[a]

	Stations					
	I	L	I	M	L	M
April 1984	7.96	1.57	7.96	3.53	1.57	3.53
	$p<0.001$		$(0.02<p<0.05)$		$0.01<p.0.02$	
May 1984	209.40	36.76	209.40	96.78	36.76	96.78
	$p<0.001$		$p<0.001$		$p<0.001$	
June 1984	30.52	60.43	30.52	339.33	60.43	339.33
	$(0.01<p<0.05)$		$p<0.001$		$p<0.001$	

[a] Mean densities have been calculated by using combined surface and mid-depth samples, and are given in organisms/100 m^3.

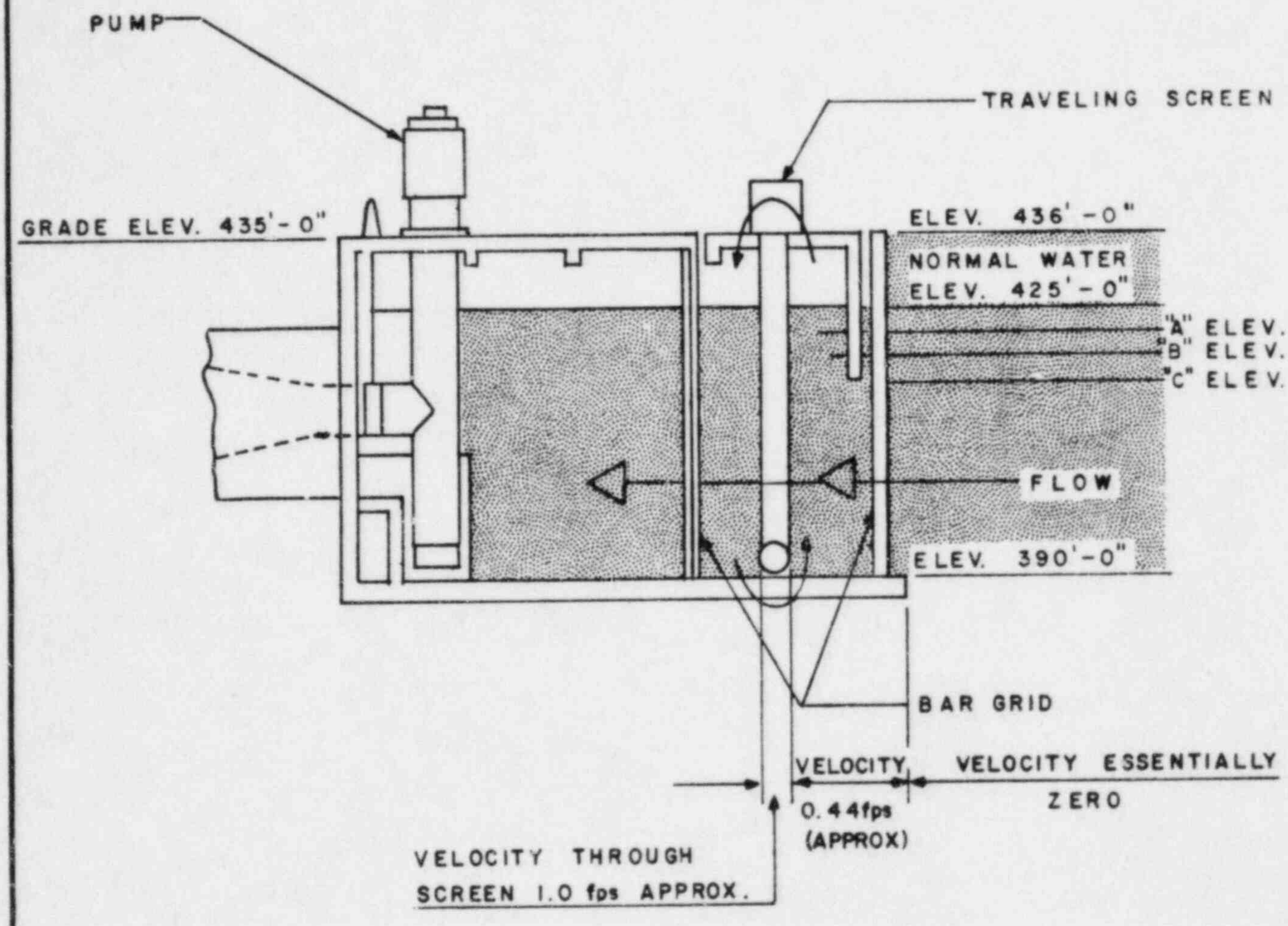

NEAL SHOALS DAM
BROAD RIVER
MILES
CHESTER CO.
UNION CO.
CARLISLE
SOUTHERN R.R.
STATION P
LOCATION
DETAIL OF
STATION P
SUMTER
NATIONAL FOREST
34
34
347
347
215
99
18
17
H
X
1
FAIRFIELD CO.
NEWBERRY CO.
BROAD
RIVER
RECREATION
AREA DAM
SUMTER
NATIONAL FOREST



South Carolina Electric & Gas Co.

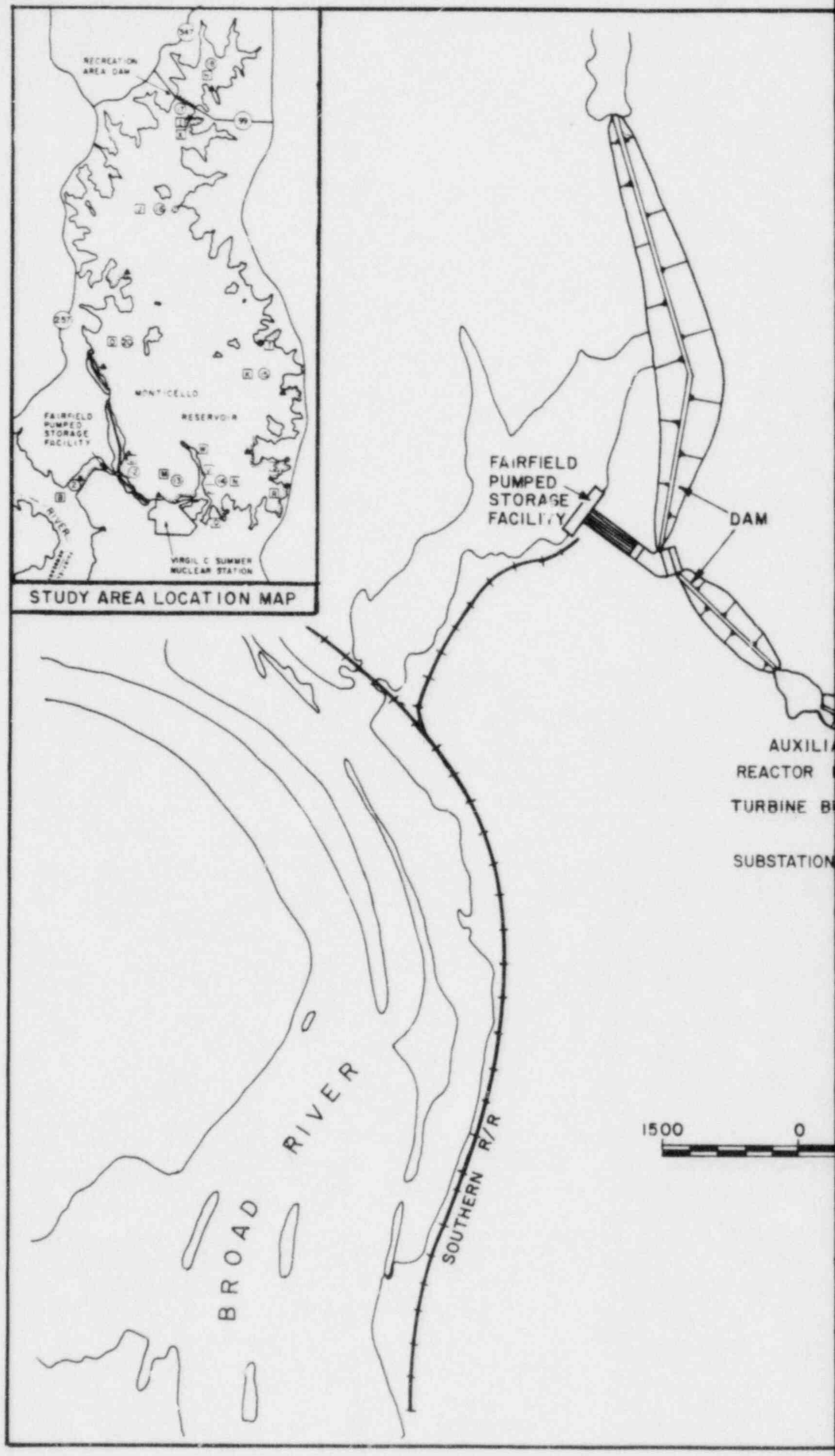
Sampling Stations for the Aquatic Monitoring Programs

Figure 1 - 316B Report



"A" ELEVATION = 420'-5" (NORMAL DRAWDOWN)
"B" ELEVATION = 418'-0" (EMERGENCY DRAWDOWN)
"C" ELEVATION = 415'-6" (BOTTOM OF SKIMMER WALL)

Figure 2. Intake Structure - Condenser Cooling Water
V.C. Summer Nuclear Station.


RECREATION AREA DAM
MONTICELLO RESERVOIR
FAIRFIELD PUMPED STORAGE FACILITY
VIRGIL C SUMMER NUCLEAR STATION
RIVER
STUDY AREA LOCATION MAP
FAIRFIELD PUMPED STORAGE FACILITY
DAM
REACTOR
SUBSTATION
1500
0
BROAD RIVER
SOUTHERN R/R

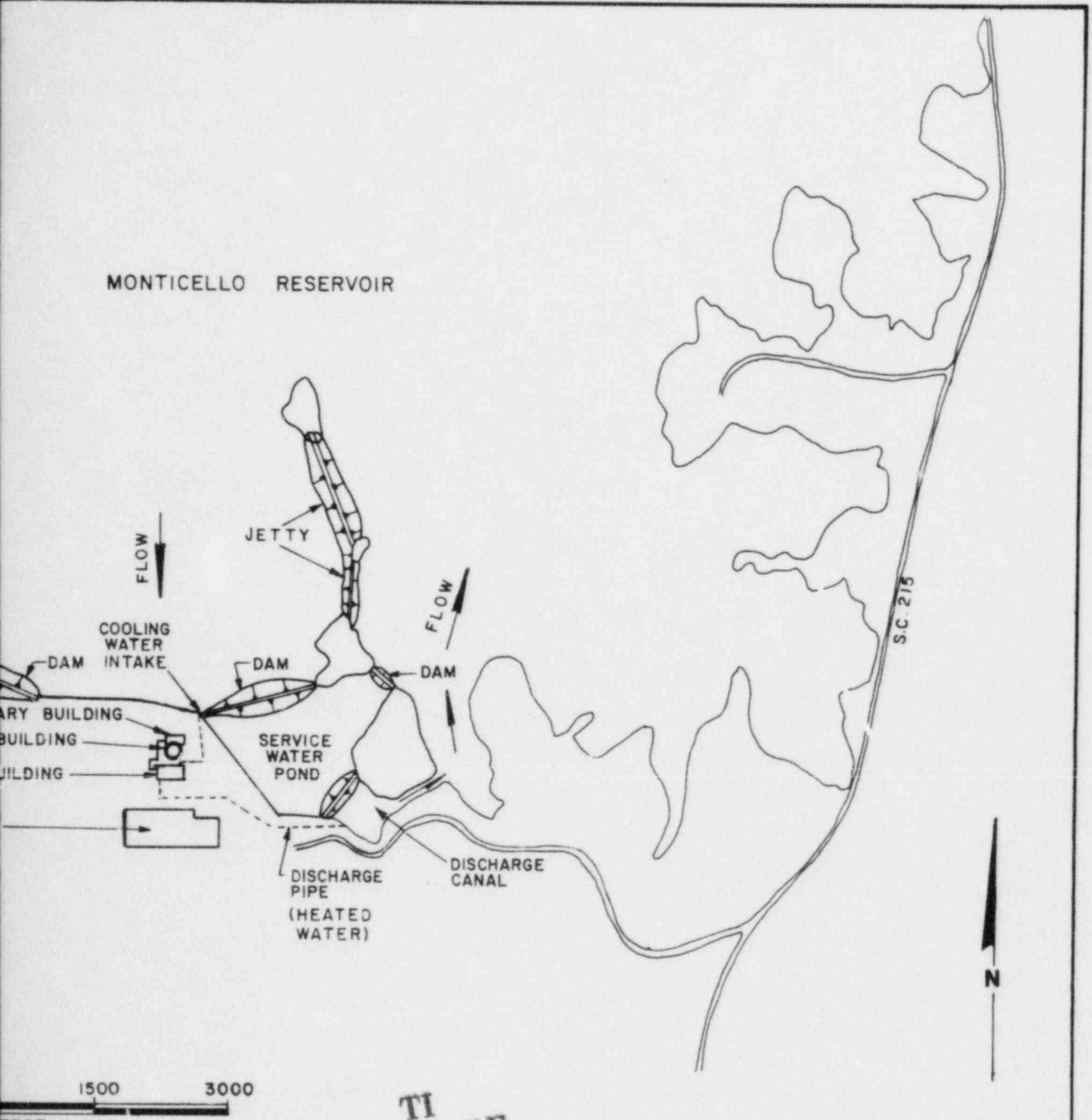


Figure 3. Study Area Map

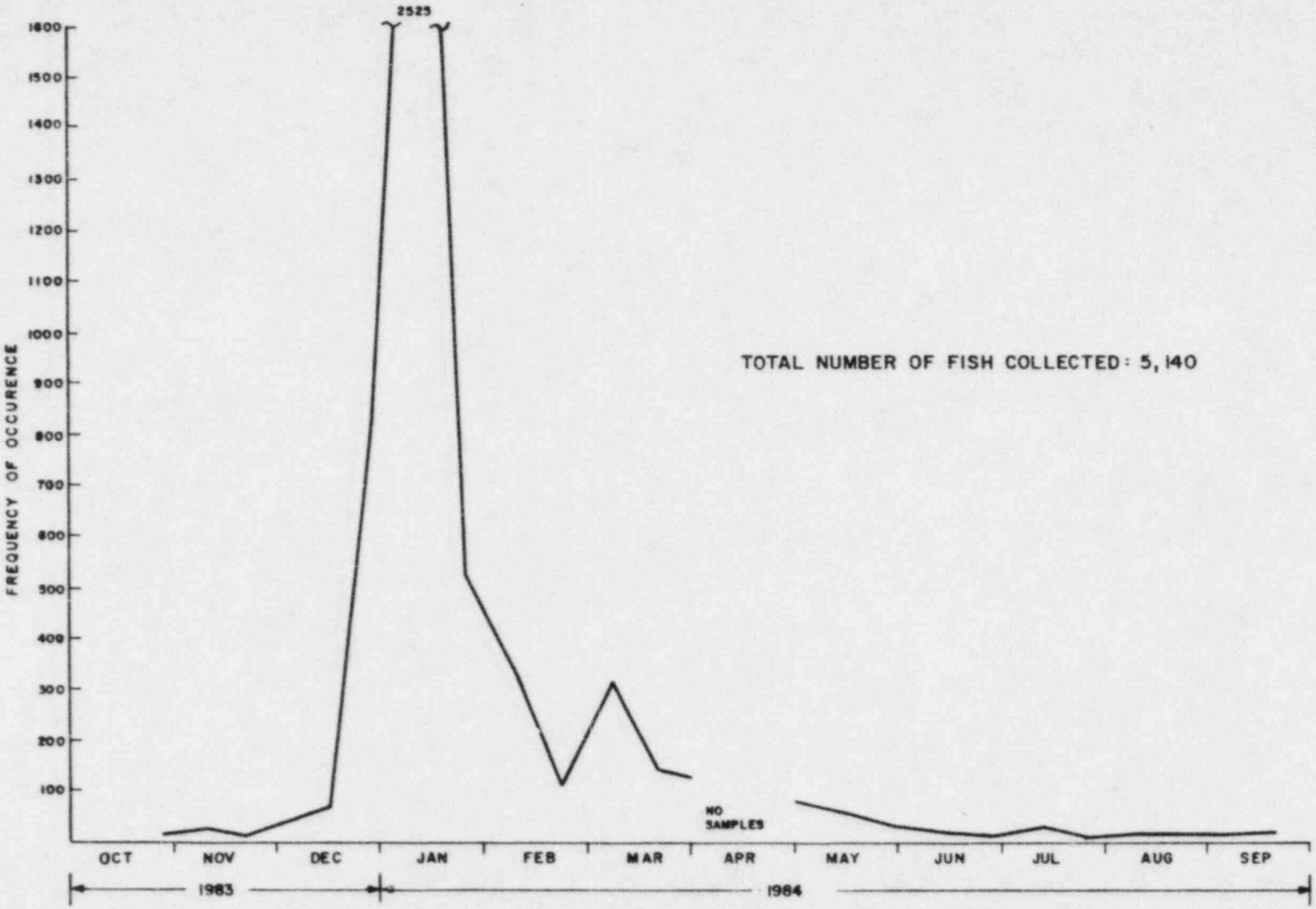


Figure 4. Total Number of Impinged Fish Collected During the Study Period.

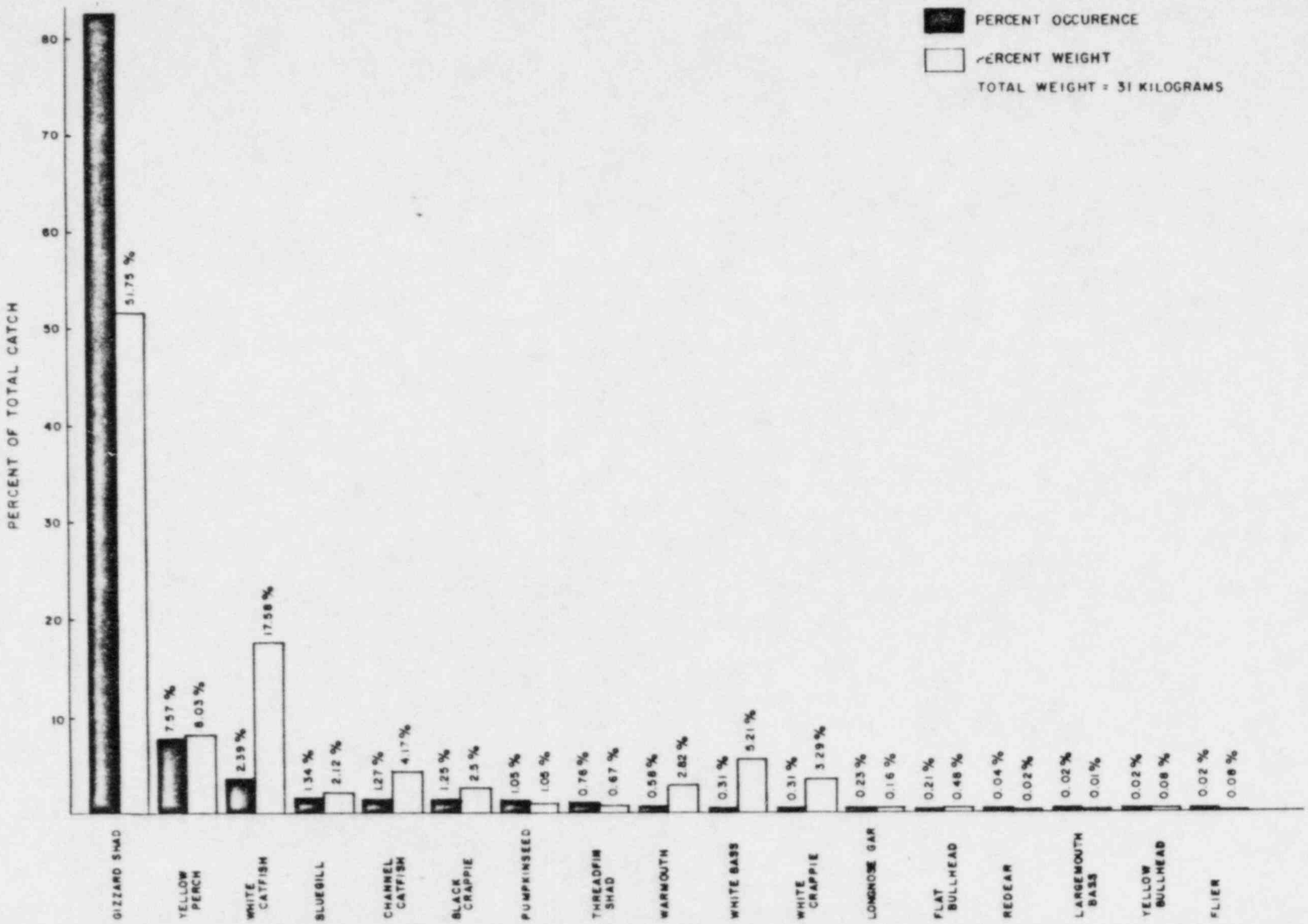


Figure 5. Species of Impinged Fish, including percent occurence and weight, collected during the study.

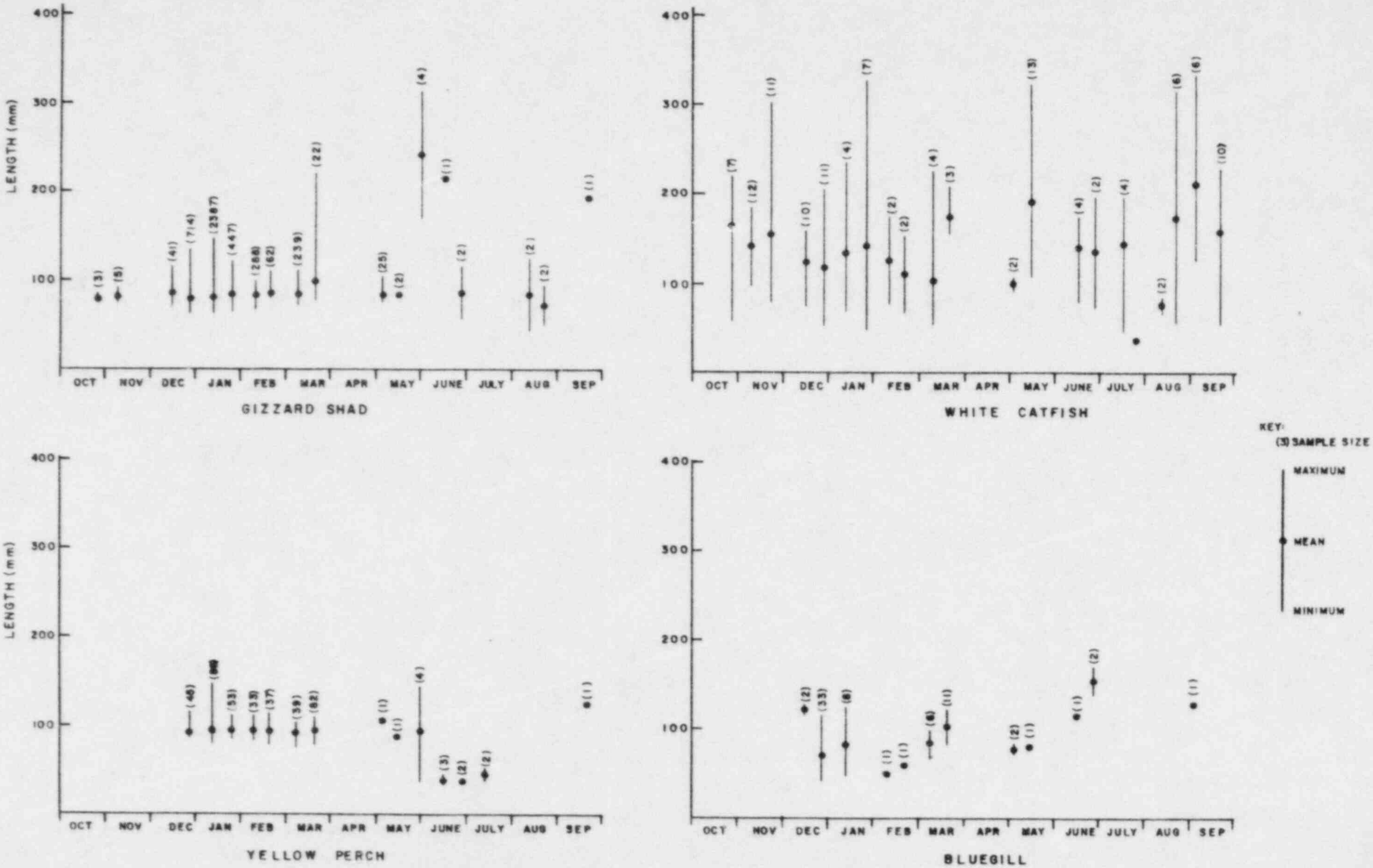


Figure 6. Number and length of fish impinged during October 1983 through September 1984.

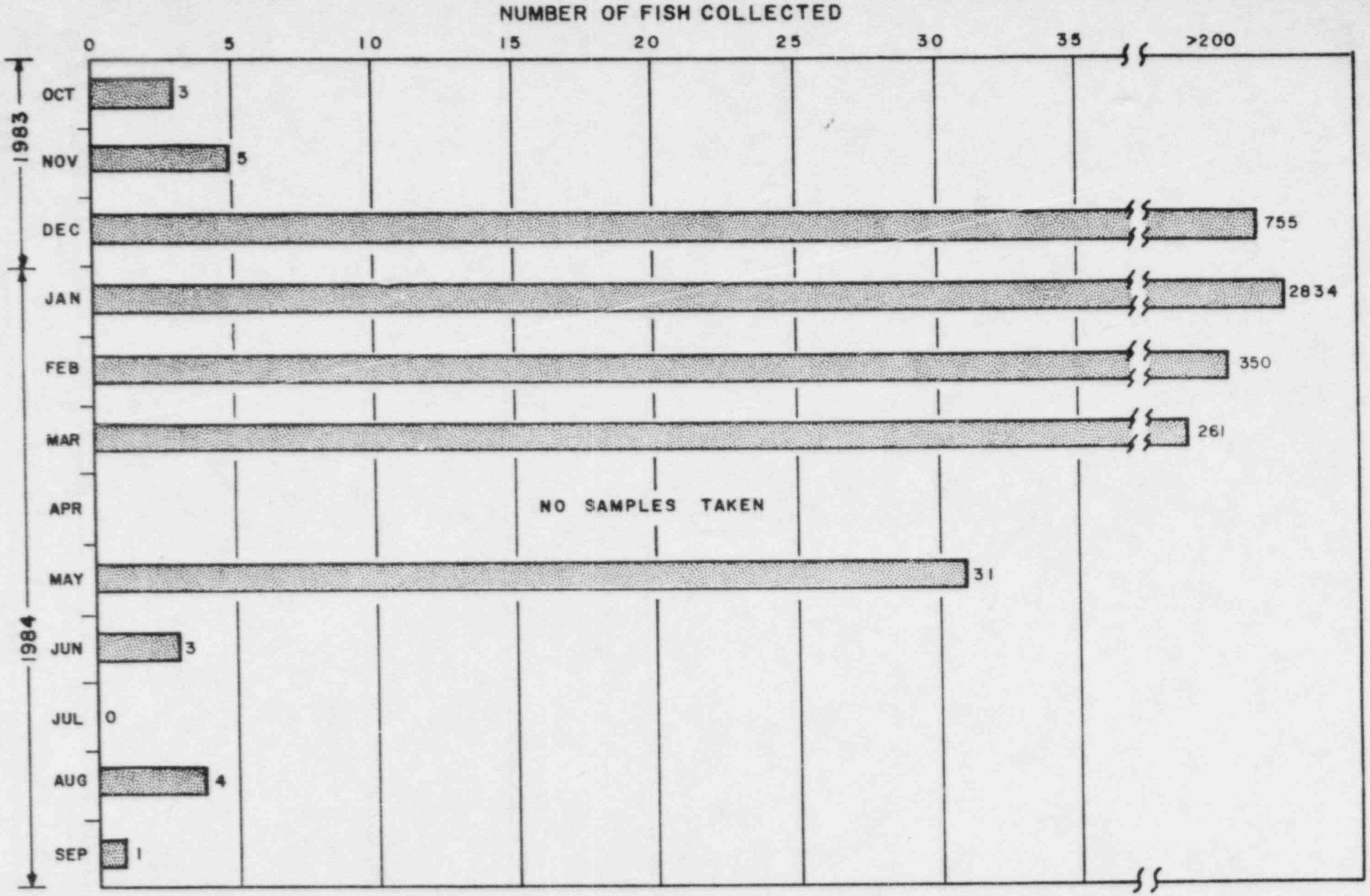


Figure 7. Total Numbers of Impinged Gizzard Shad, by Month.

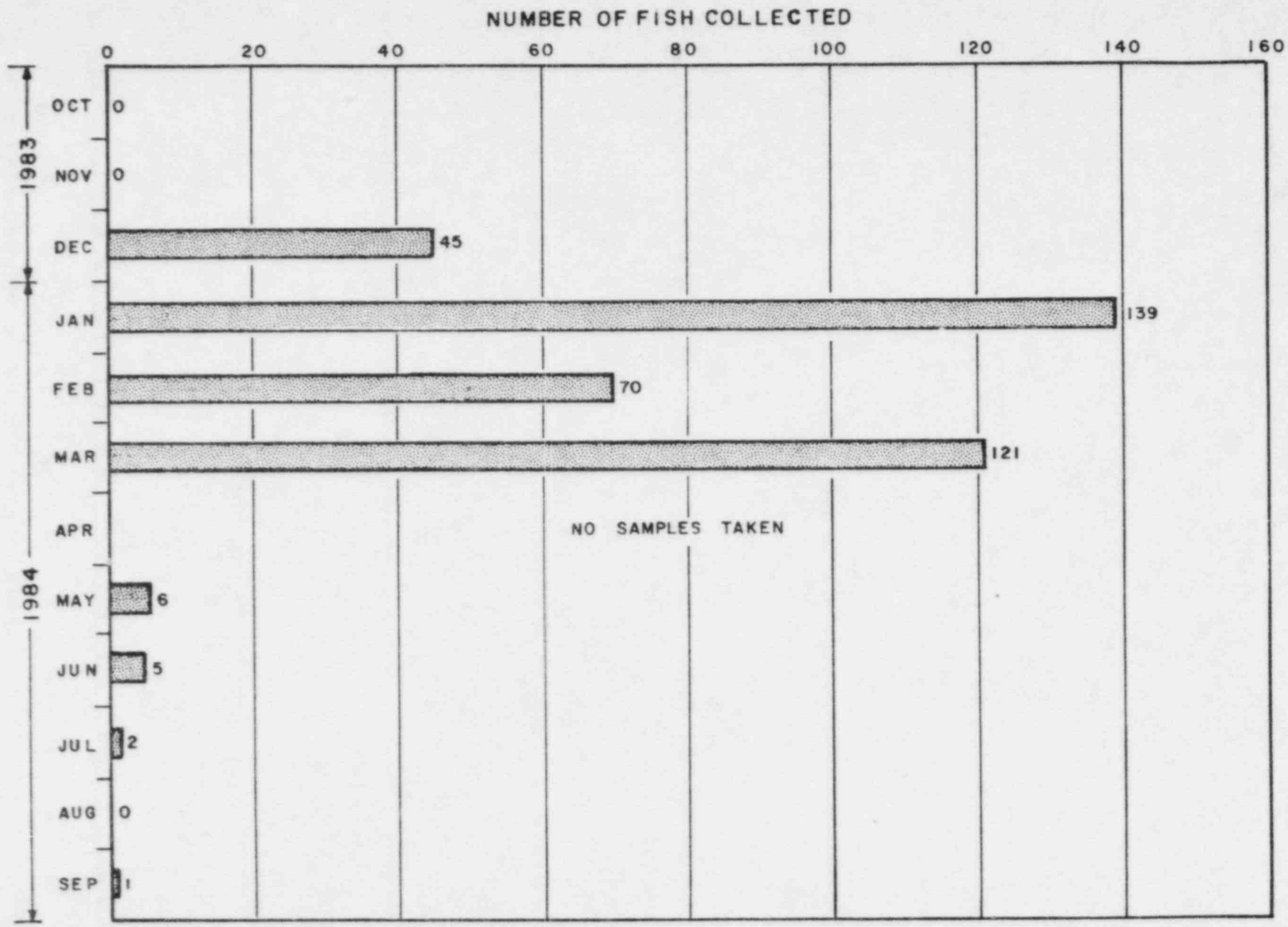


Figure 8. Total Numbers of Impinged Yellow Perch, by Month.

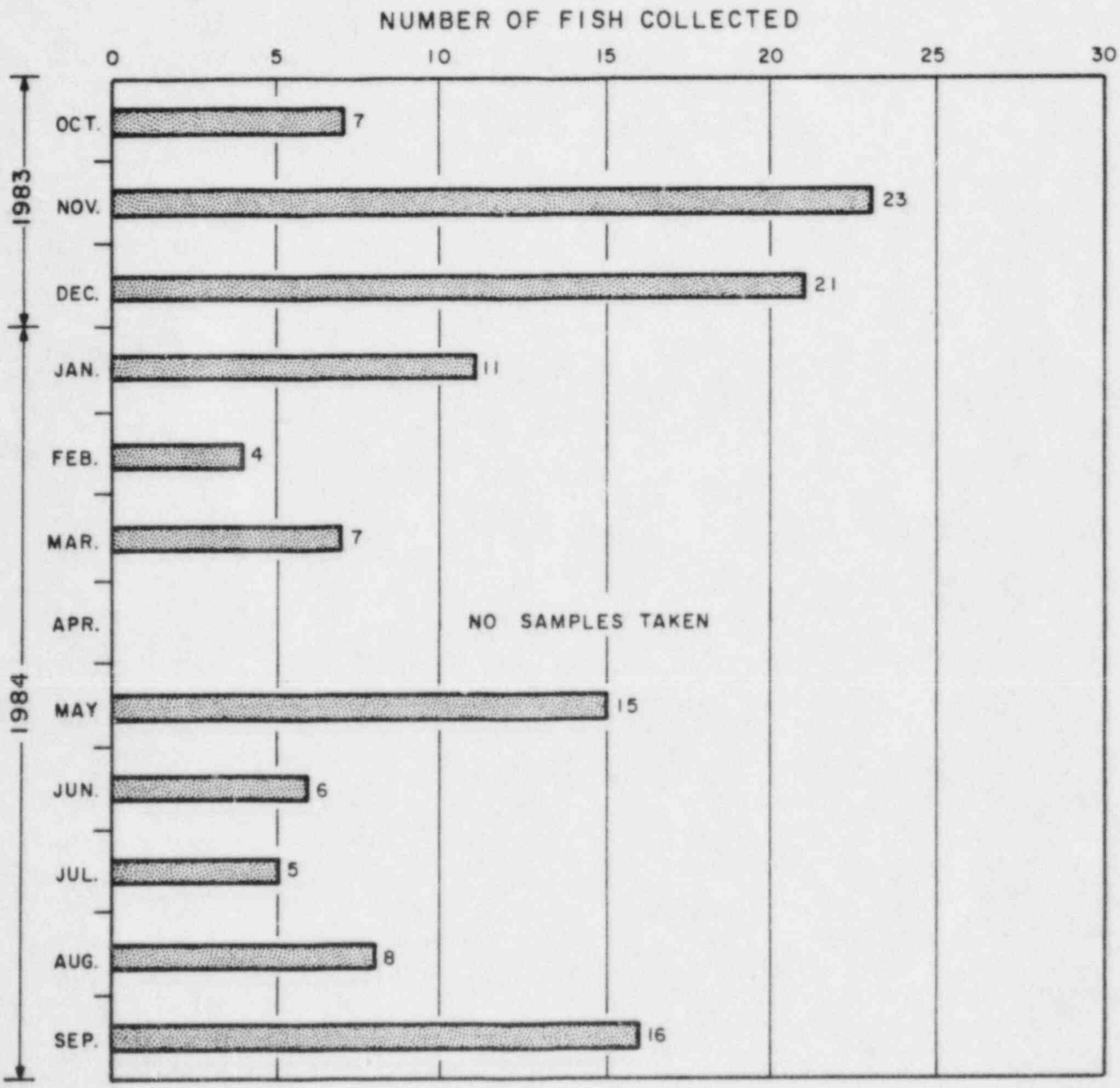


Figure 9. Total Numbers of Impinged White Catfish, by Month.

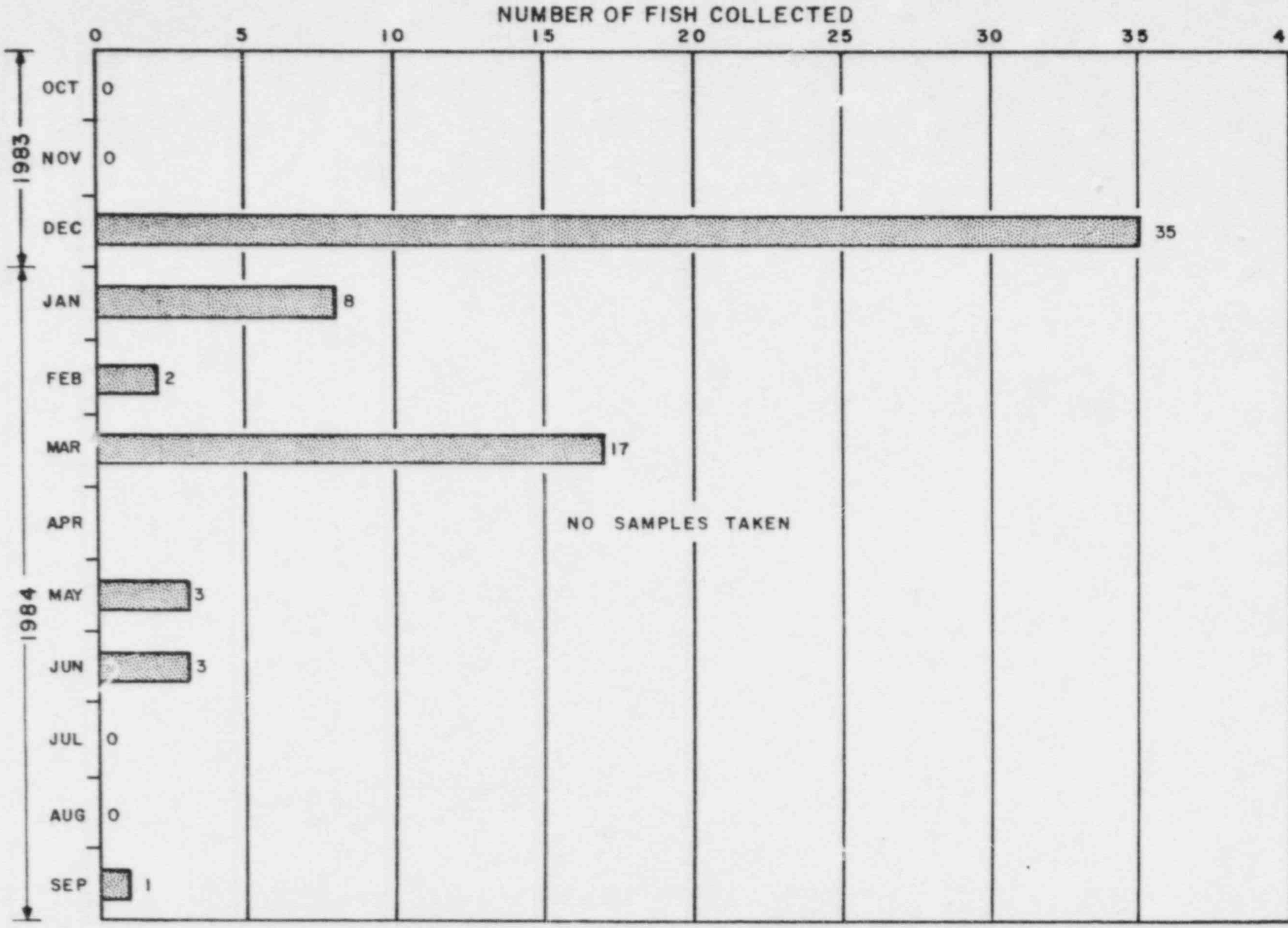


Figure 10. Total Numbers of Impinged Bluegill, by Month.

APPENDIX A

SAMPLING PROCEDURES FOR LARVAL AND ADULT FISH

APPENDIX A

SAMPLING PROCEDURES FOR LARVAL AND ADULT FISH

Impingement - The VCSNS pumps approximately 530,000 gpm from Monticello Reservoir through the cooling water intake when the nuclear station is operating at full capacity. The intake structure utilizes six traveling screens which cycle on a pressure differential basis. All impinged organisms were sequentially washed from each of the traveling screens during each cycle into a catch basin.

This 316(b) investigation was conducted by collecting impinged organisms from all six screens approximately every 8 hours over a 24-hour period. These investigations began within 2 weeks of commercial operation and continued every 2 weeks for 1 year. The screens were washed immediately before each 8-hour sampling period. At the end of the 8-hour impingement test, the wash cycle (of approximately 5 minutes duration) was initiated and all impinged organisms were collected in a basket inserted into the catch basin. The impinged organisms were placed in containers, packed in ice, and returned to the laboratory for identification, enumeration, length and weight by species. The fish were also examined for incidence of ectoparasites. Data sheets were completed for impinged organisms and included job number, date and time of collection, number of the traveling screen, and name of collector(s).

Entrainment - The entrainment studies evaluated potential impacts of cooling water intake on the ichthyoplankton during plant operation to confirm utilization of best technology available. Duplicate ichthyoplankton samples were collected at Stations I, L, and M at both the surface and mid-depth. Collections at Stations I and M were obtained approximately one-half hour after sunset. Station L was sampled during the generation phase of the Fairfield Pumped Storage Facility. All samples were collected by towing flow-metered plankton nets, having

0.75 meter diameter mouth openings, and a mesh size of 363 micrometers. Sampling was conducted until approximately 100 cubic meters of water had passed through the net. Sampling frequency was weekly during mid-February through June, every two weeks from July through September, and monthly from October through January.

The collected organisms were preserved and returned to the laboratory for identification, measurement, and enumeration. Densities of eggs and larvae collected as ichthyoplankton were compared for spatial and temporal variations in distribution, with particular emphasis on characterizing the ichthyoplankters in the vicinity of the plant intake (Station M), as compared to those near the Fairfield Pumped Storage Facility intake (Station L), and the farthest point from the intake (Station I).

Data Analysis - A summary of the fish impinged was presented in tabular form by enumeration of species, length and weight, and by collection period.

Analysis for entrained organisms was by comparing ichthyoplankton densities at the northern section (Station I) of Monticello Reservoir with those at the southern section (Stations L and M). Composite sample densities were calculated to determine if significant differences occurred at the stations.

Larval Fish Collections - Larval fish collections were also made at Stations J, K, L, and O in Monticello Reservoir as part of the overall biological monitoring requirements for the VCSNS license requirements. The samples were collected at these locations by identical methods as described earlier.

APPENDIX B

AVERAGE INTAKE AND DISCHARGE TEMPERATURES, AVERAGE FLOW, AND GROSS THERMAL POWER[1]

[1] All data in Appendix B was provided by SCE&G personnel.

TABLE B-1

VIRGIL C. SUMMER NUCLEAR STATION
CIRCULATING WATER, 1983-1984

AVERAGE INTAKE TEMPERATURE (°F)

	1983			1984								
Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	75.0	68.0	--	48.5	46.1	49.1	--	--	71.5	77.4	79.3	81.0
2	75.1	67.7	--	48.3	46.0	48.9	--	--	71.2	76.85	78.6	80.5
3	74.8	67.9	--	48.2	46.3	49.1	--	58.4	71.0	77.6	78.8	79.6
4	74.6	67.7	--	48.7	48.0	49.3	--	59.7	71.8	76.6	79.5	80.2
5	74.8	67.4	--	48.8	47.0	48.9	--	61.4	71.4	76.5	79.8	80.5
6	75.6	66.8	--	48.9	45.8	51.2	--	62.4	71.0	77.7	80.2	80.1
7	75.8	66.5	--	49.4	46.4	52.7	--	64.0	72.5	78.4	80.4	79.4
8	75.3	66.2	--	49.3	46.4	50.1	--	63.0	72.5	79.4	80.7	78.7
9	75.2	66.0	--	47.9	46.5	49.8	--	63.6	72.9	78.7	80.5	78.2
10	74.8	66.4	--	48.1	46.0	50.1	--	64.0	73.05	78.6	81.6	78.4
11	74.5	65.1	--	49.3	46.9	50.4	--	63.4	73.4	79.0	81.3	78.8
12	74.0	64.5	--	48.3	46.8	49.9	--	64.0	73.8	79.2	81.0	79.1
13	73.5	64.2	56.3	48.1	46.9	50.9	--	65.8	74.4	79.8	80.9	78.9
14	72.9	63.7	55.8	--	48.9	52.2	--	67.0	75.1	79.6	81.0	78.5
15	73.1	63.1	55.7	--	50.7	52.7	--	68.8	75.3	79.4	81.5	78.3
16	72.5	62.7	55.2	47.7	50.9	52.1	--	68.9	75.0	--	81.1	77.6
17	73.0	62.0	55.0	47.5	49.8	52.8	--	68.8	76.1	--	81.4	76.8
18	72.7	61.5	--	47.0	50.5	54.2	--	67.4	76.5	--	81.1	76.1
19	72.6	61.5	53.7	47.6	50.6	54.2	--	66.3	76.6	--	80.8	76.1
20	72.8	60.9	52.9	47.7	50.4	52.7	--	--	77.9	--	81.5	75.8
21	72.0	61.1	52.5	47.9	52.9	51.5	--	68.5	78.0	--	81.3	75.5
22	70.9	61.3	52.5	47.1	53.2	52.4	--	68.3	78.4	--	81.2	75.2
23	69.9	60.9	51.8	46.5	53.8	52.5	--	68.9	78.0	--	81.8	75.9
24	70.2	61.0	51.4	47.4	51.4	--	57.2	72.1	77.7	--	81.7	76.3
25	69.9	60.7	49.7	47.6	51.2	--	58.1	70.5	78.5	80.9	81.6	76.4
26	70.1	--	48.7	47.7	51.6	--	--	70.8	78.7	80.0	80.7	76.5
27	69.4	--	49.3	48.4	50.9	--	--	70.0	76.4	79.6	79.8	78.0
28	69.0	--	49.1	47.7	49.7	--	--	70.2	77.1	79.5	79.6	76.0
29	68.5	--	49.5	47.0	48.6	--	--	71.9	77.8	79.7	79.8	75.0
30	68.1	--	49.2	46.5		--	--	73.6	77.2	79.2	80.2	--
31	67.8	--	48.7	46.6		--	--	73.0	--	79.4	80.5	--

TABLE B-2

VIRGIL C. SUMMER NUCLEAR STATION
CIRCULATING WATER, 1983-1984

AVERAGE DISCHARGE TEMPERATURE (°F)

	1983			1984								
Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	99.8	93.2	--	75.7	73.0	74.8	--	--	96.1	97.6	104.3	103.7
2	99.5	92.6	--	75.9	72.9	75.5	--	--	96.4	96.9	103.9	103.0
3	99.5	93.0	--	75.5	73.4	76.1	--	73.5	96.45	97.7	104.35	102.2
4	99.8	92.5	--	75.4	74.6	75.8	--	81.65	97.3	97.1	105.2	102.2
5	99.8	91.5	--	75.1	73.6	74.9	--	67.4	96.8	97.0	105.5	102.2
6	100.2	91.3	--	75.0	72.4	76.7	--	64.9	96.5	98.0	105.9	101.4
7	100.4	91.0	--	74.5	64.3	78.8	--	76.2	98.0	98.7	106.1	100.5
8	99.5	91.2	--	75.3	52.3	76.6	--	87.5	97.9	99.5	106.3	99.8
9	99.6	91.0	--	74.4	49.7	75.3	--	88.1	98.15	98.7	106.2	99.0
10	99.1	91.4	--	75.3	49.1	75.6	--	88.8	98.35	99.0	107.2	99.1
11	98.8	89.5	--	75.6	66.0	76.0	--	88.7	98.7	99.8	106.9	99.6
12	98.9	89.8	--	74.2	73.7	76.0	--	89.5	99.1	100.0	106.5	99.8
13	97.4	89.3	57.8	73.5	74.0	76.6	--	91.25	99.6	100.5	106.3	99.4
14	95.1	86.5	59.4	--	75.8	77.7	--	92.4	100.4	84.1	106.6	98.9
15	95.6	87.9	59.9	--	76.4	78.0	--	93.4	100.7	80.3	107.0	98.3
16	95.1	86.9	58.5	74.3	76.8	78.1	--	93.2	99.9	--	98.7	97.3
17	95.4	86.3	55.5	61.2	76.1	78.6	--	92.2	99.1	--	83.75	96.4
18	96.3	86.1	--	70.6	76.4	80.1	--	92.2	99.5	--	93.1	95.4
19	97.1	86.4	58.8	79.6	76.9	80.3	--	91.6	99.7	--	101.2	95.4
20	83.0	85.9	73.5	77.8	76.5	78.8	--	--	100.8	--	100.0	95.0
21	77.9	85.5	76.4	74.2	79.3	77.1	--	93.9	100.45	--	105.4	94.6
22	77.4	85.9	78.4	73.7	79.7	78.1	--	93.7	100.5	--	105.9	94.2
23	73.7	84.4	77.7	73.4	79.3	62.6	--	94.4	98.2	--	106.4	94.6
24	89.0	62.8	76.5	74.4	77.0	--	82.7	97.2	97.95	--	106.3	94.9
25	95.1	61.9	75.7	74.2	76.6	--	67.7	95.7	98.9	81.8	106.0	94.8
26	95.2	--	75.3	73.7	76.8	--	--	96.1	99.1	81.2	105.0	94.5
27	94.2	--	76.0	74.4	76.7	--	--	95.5	96.8	84.4	104.0	95.6
28	93.7	--	75.8	73.4	76.3	--	--	95.5	97.7	90.3	103.3	91.1
29	93.6	--	75.7	73.3	75.0	--	--	96.9	98.1	88.2	103.15	75.9
30	93.0	--	75.4	73.1		--	--	98.0	97.7	92.4	103.4	--
31	92.9	--	75.7	73.4		--	--	97.15	--	99.6	103.6	--

TABLE B-3

VIRGIL C. SUMMER NUCLEAR StATION
CIRCULATING WATER, 1983-1984

AVERAGE FLOW (MGD)

	1983			1984								
Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	769.0	769.0	--	769.0	769.0	769.0	--	--	769.0	768.96	768.96	768.96
2	769.0	769.0	--	769.0	769.0	769.0	--	--	769.0	768.96	768.96	768.96
3	769.0	769.0	--	769.0	769.0	769.0	--	769.0	769.0	768.96	768.96	768.96
4	769.0	769.0	--	769.0	769.0	769.0	--	769.0	769.0	768.96	768.96	768.96
5	769.0	769.0	--	769.0	769.0	769.0	--	769.0	769.0	768.96	768.96	768.96
6	769.0	769.0	--	769.0	769.0	769.0	--	769.0	769.0	768.96	768.96	768.96
7	769.0	769.0	--	769.0	769.0	769.0	--	769.0	769.0	768.96	768.96	768.96
8	769.0	769.0	--	769.0	769.0	769.0	--	769.0	769.0	768.96	768.96	768.96
9	769.0	769.0	--	769.0	769.0	769.0	--	769.0	769.0	768.96	768.96	768.96
10	769.0	769.0	--	769.0	769.0	769.0	--	769.0	769.0	768.96	768.96	768.96
11	769.0	769.0	--	769.0	769.0	769.0	--	769.0	769.0	768.96	768.96	768.96
12	769.0	769.0	--	769.0	769.0	769.0	--	769.0	769.0	768.96	768.96	768.96
13	769.0	769.0	769.0	769.0	769.0	769.0	--	769.0	769.0	768.96	768.96	768.96
14	769.0	769.0	769.0	--	769.0	769.0	--	769.0	769.0	566.84	768.96	768.96
15	769.0	769.0	769.0	--	769.0	769.0	--	769.0	769.0	512.64	768.96	768.96
16	769.0	769.0	769.0	769.0	769.0	769.0	--	769.0	769.0	--	768.96	768.96
17	769.0	769.0	769.0	609.0	769.0	769.0	--	769.0	769.0	--	768.96	768.96
18	769.0	769.0	--	513.0	769.0	769.0	--	769.0	769.0	--	768.96	768.96
19	769.0	769.0	769.0	513.0	769.0	769.0	--	769.0	769.0	--	768.96	768.96
20	769.0	769.0	769.0	598.0	769.0	769.0	--	--	769.0	--	768.96	768.96
21	769.0	769.0	769.0	769.0	769.0	769.0	--	769.0	769.0	--	768.96	768.96
22	769.0	769.0	769.0	769.0	769.0	769.0	--	769.0	769.0	--	768.96	768.96
23	769.0	769.0	769.9	769.0	769.0	769.0	--	769.0	769.0	--	768.96	768.96
24	769.0	535.0	769.0	769.0	769.0	--	--	--	769.0	768.96	768.96	768.96
25	769.0	513.0	769.9	769.0	769.0	--	769.0	769.0	769.0	768.96	768.96	768.96
26	769.0	--	769.0	769.0	769.0	--	769.0	769.0	769.0	768.96	768.96	768.96
27	769.0	--	769.0	769.0	769.0	--	--	769.0	769.0	768.96	768.96	768.96
28	769.0	--	769.0	769.0	769.0	--	--	769.0	769.0	768.96	768.96	768.96
29	769.0	--	769.0	769.0	769.0	--	--	769.0	769.0	768.96	768.96	480.60
30	769.0	--	769.0	769.0		--	--	769.0	769.0	768.96	768.96	--
31	769.0	--	769.0	769.0		--	--	--	--	768.96	768.96	--

TABLE B-4

VIRGIL C. SUMMER NUCLEAR STATION
GROSS THERMAL POWER

"GROSS MWHT"

Day	1983 Oct	1983 Nov	1983 Dec	1984 Jan	1984 Feb	1984 Mar	1984 Apr	1984 May	1984 Jun	1984 Jul	1984 Aug	1984 Sep
1	66,340	66,600	0	66,600	66,600	66,333	0	0	66,600	52,947	64,002	56,876
2	66,375	66,267	0	66,600	66,600	66,466	0	55	66,400	53,013	65,800	56,876
3	66,184	66,400	0	66,600	66.467	66,600	0	19,807	66,133	52,347	66,466	56,410
4	66,358	66,134	0	66,267	66,600	66,600	0	54,245	66,333	52,281	66,267	55,411
5	66,444	66,067	0	66,600	66,400	64,629	0	11,209	66,533	52,147	66,000	54,878
6	66,548	66,334	0	66,600	66,467	64,586	0	844	66,466	53,013	66,267	53,679
7	66,496	66,134	0	65,518	37,941	66,200	0	27,701	66,466	52,813	66,267	53,479
8	66,011	66,267	0	66,267	2,775	66,267	0	63,175	66,466	53,413	66,333	53,013
9	66,548	66,267	0	66,400	1,055	66,267	0	66,067	66,400	53,546	66,466	52,414
10	66,410	66,334	0	66,467	638	66,067	0	66,000	66,400	52,880	66,333	52,547
11	66,479	66,467	0	66,334	29,859	66,267	0	66,466	66,400	53,013	66,500	52,680
12	66,427	66,600	0	66,267	65,046	66,133	0	66,133	66,400	52,813	66,666	52,014
13	61,232	66,184	0	66,400	66,600	66,200	0	66,400	66,600	53,013	66,533	51,415
14	60,816	61,630	3,746	66,134	66,600	65,934	0	66,466	66,533	8,295	66,267	51,082
15	60,608	66,267	6,161	66,267	66,466	66,133	0	66,400	66,600	0	66,000	50,083
16	60,245	66,134	4,912	66,200	66,466	66,133	0	66,466	65,268	0	44,554	50,016
17	59,933	66,134	0	26,196	66,466	66,333	0	66,533	60,406	0	3,672	49,417
18	63,206	66,600	0	45,677	66,466	66,333	0	66,333	59,940	0	28,771	48,484
19	66,323	66,600	6,410	66,073	66,400	66,400	0	66,466	59,940	0	55,078	48,351
20	25,248	66,600	50,311	66,267	66,466	66,333	0	66,400	59,806	0	46,753	47,885
21	12,399	66,467	64,408	66,467	66,600	66,133	0	66,400	59,873	0	61,205	47,219
22	17,507	66,600	66,600	66,467	66,400	66,000	2,801	66,400	59,607	0	62,604	46,819
23	7,793	63,033	66,600	66,334	66,600	5,396	43,476	66,333	53,479	0	63,136	46,153
24	49,612	0	65,934	66,400	66,466	0	66,279	66,333	53,213	0	63,403	46,053
25	66,323	0	66,600	66,467	66,466	0	5,581	66,466	53,080	0	62,737	45,621

TABLE B-4

Day	1983 Oct	1983 Nov	1983 Dec	1984 Jan	1984 Feb	1984 Mar	1984 Apr	1984 May	1984 Jun	1984 Jul	1984 Aug	1984 Sep
26	66,600	0	66,600	66,400	66,267	0	582	66,533	53,146	304	62,204	44,289
27	66,660	0	66,600	66,267	66,400	0	0	66,533	53,146	9,598	61,671	44,289
28	66,600	0	65,934	66,600	66,333	0	111	66,533	53,146	24,916	60,306	37,601
29	66,600	0	66,600	66,600	66,399	0	194	66,600	53,546	20,141	59,274	0
30	69,375	0	66,600	66,600		0	0	66,400	53,013	31,713	59,074	0
31	66,600	--	66,600	66,600		0	--	66,533	--	50,888	58,141	--

APPENDIX C

ORGANISMS IMPINGED ON THE INTAKE SCREENS
V.C. SUMMER NUCLEAR STATION

TABLE C-1

SUMMARY OF ORGANISMS IMPINGED DURING OCTOBER 1983 AT THE VCSNS INTAKE

IMPINGEMENT STUDY FOR THE
VIRGIL C. SUMMER NUCLEAR PLANT

OCTOBER YEAR 1983 SPECIES	NUMBER	AVG. LENGTH	(LENGTH-RANGE) (MM)	STD. DEV.	AVG. WEIGHT	(WEIGHT-RANGE) (GRAMS)	STD. DEV.	TOTAL WEIGHT (KG)	TIME-DATE	INFLOW MILLION GAL/DAY	WATER TEMP. DEG(F)
CHANNEL CATFISH	2	159.0	(143 - 175)	16.00	31.0	(21 - 41)	10.00	0.062	0745 10/28	769.0	69.0
FLAT BULLHEAD	1	87.0	(87 - 87)	0.00	6.0	(6 - 6)	0.00	0.006	0745 10/28	769.0	69.0
HOUR-0745 COUNT =	3							HOUR-0745 WEIGHT = 68(GRAMS)			
WHITE CATFISH	5	147.6	(55 - 220)	58.59	34.2	(2 - 73)	25.70	0.171	1145 10/28	769.0	69.0
HOUR-1145 COUNT =	5							HOUR-1145 WEIGHT = 171(GRAMS)			
GIZZARD SHAD	1	84.0	(84 - 84)	0.00	6.0	(6 - 6)	0.00	0.006	1545 10/29	769.0	69.0
WHITE CATFISH	2	207.5	(197 - 218)	10.50	66.0	(41 - 91)	25.00	0.132	1545 10/28	769.0	69.0
HOUR-1545 COUNT =	3							HOUR-1545 WEIGHT = 138(GRAMS)			
GIZZARD SHAD	2	77.5	(76 - 79)	1.50	2.5	(2 - 3)	0.50	0.005	1945 10/29	769.0	69.0
CHANNEL CATFISH	1	180.0	(180 - 180)	0.00	38.0	(38 - 38)	0.00	0.038	1945 10/28	769.0	69.0
WHITE BASS	1	95.0	(95 - 95)	0.00	6.0	(6 - 6)	0.00	0.006	1945 10/28	769.0	69.0
HOUR-1945 COUNT =	4							HOUR-1945 WEIGHT = 49(GRAMS)			

TOTAL COUNT___ 15

TOTAL WEIGHT_____ 426(GRAMS) 0.426(KG)

TABLE C-2

SUMMARY OF ORGANISMS IMPINGED DURING NOVEMBER 1983 AT THE VCSNS INTAKE

IMPINGEMENT STUDY FOR THE
VIRGIL C. SUMMER NUCLEAR PLANT

NOVEMBER YEAR 1983 SPECIES	NUMBER	AVG. LENGTH	(LENGTH-RANGE) (MM)	STD. DEV.	AVG. WEIGHT	(WEIGHT-RANGE) (GRAMS)	STD. DEV.	TOTAL WEIGHT (KG)	TIME-DATE	INFLOW MILLION GAL/DAY	WATER TEMP. DEG(F)
GIZZARD SHAD	2	77.0	(75 - 79)	2.00	5.0	(5 - 5)	0.00	0.010	0400 11/09	769.0	66.0
WHITE CATFISH	1	112.0	(112 - 112)	0.00	10.0	(10 - 10)	0.00	0.010	0400 11/09	769.0	66.0
CHANNEL CATFISH	1	380.0	(380 - 380)	0.00	340.0	(340 - 340)	0.00	0.340	0400 11/09	769.0	66.0
WHITE BASS	1	88.0	(88 - 88)	0.00	4.0	(4 - 4)	0.00	0.004	0400 11/09	769.0	66.0
HOUR-0400 COUNT =	5							HOUR-0400 WEIGHT =	364(GRAMS)		
GIZZARD SHAD	1	90.0	(90 - 90)	0.00	4.0	(4 - 4)	0.00	0.004	0800 11/09	769.0	66.0
WHITE CATFISH	4	131.0	(97 - 170)	32.84	18.0	(5 - 38)	13.91	0.072	0800 11/09	769.0	66.0
BLACK CRAPPIE	1	85.0	(85 - 85)	0.00	5.0	(5 - 5)	0.00	0.005	0800 11/09	769.0	66.0
HOUR-0800 COUNT =	6							HOUR-0800 WEIGHT =	81(GRAMS)		
WHITE CATFISH	1	153.0	(153 - 153)	0.00	30.0	(30 - 30)	0.00	0.030	1200 11/09	769.0	66.0
CHANNEL CATFISH	1	143.0	(143 - 143)	0.00	20.0	(20 - 20)	0.00	0.020	1200 11/09	769.0	66.0
HOUR-1200 COUNT =	2							HOUR-1200 WEIGHT =	50(GRAMS)		
GIZZARD SHAD	1	85.0	(85 - 85)	0.00	4.0	(4 - 4)	0.00	0.004	1600 11/09	769.0	66.0
WHITE CATFISH	3	154.3	(142 - 178)	16.74	22.3	(21 - 24)	1.25	0.067	1600 11/09	769.0	66.0
HOUR-1600 COUNT =	4							HOUR-1600 WEIGHT =	71(GRAMS)		
GIZZARD SHAD	1	75.0	(75 - 75)	0.00	3.0	(3 - 3)	0.00	0.003	2000 11/09	769.0	66.0
WHITE CATFISH	3	1[illegible].0	(110 - 183)	30.47	27.3	(9 - 38)	13.02	0.082	2000 11/09	769.0	66.0
CHANNEL CATFISH	1	73.0	(73 - 73)	0.00	3.0	(3 - 3)	0.00	0.003	2000 11/09	769.0	66.0
WHITE BASS	1	100.0	(180 - 100)	0.00	60.0	(60 - 60)	0.00	0.060	2000 11/09	769.0	66.0
HOUR-2000 COUNT =	6							HOUR-2000 WEIGHT =	148(GRAMS)		
WHITE CATFISH	1	170.0	(170 - 170)	0.00	33.0	(33 - 33)	0.00	0.033	0200 11/22	769.0	61.3
HOUR-0200 COUNT =	1							HOUR-0200 WEIGHT =	33(GRAMS)		
WHITE CATFISH	10	150.9	(79 - 303)	56.81	43.0	(3 - 265)	74.97	0.430	1000 11/22	769.0	61.3
BLACK CRAPPIE	1	83.0	(83 - 83)	0.00	6.0	(6 - 6)	0.00	0.006	1000 11/22	769.0	61.3
HOUR-1000 COUNT =	11							HOUR-1000 WEIGHT =	436(GRAMS)		

TOTAL COUNT____ 35

TOTAL WEIGHT_____ 1183(GRAMS) 1.183(KG)

TABLE C-3

SUMMARY OF ORGANISMS IMPINGED DURING DECEMBER 1983 AT THE VCSNS INTAKE

IMPINGEMENT STUDY FOR THE
VIRGIL C. SUMMER NUCLEAR PLANT

DECEMBER YEAR 1983 SPECIES	NUMBER	AVG. LENGTH	(LENGTH-RANGE) (MM)	STD. DEV.	AVG. WEIGHT	(WEIGHT-RANGE) (GRAMS)	STD. DEV.	TOTAL WEIGHT (KG)	TIME-DATE	INFLOW MILLION GAL/DAY	WATER TEMP. DEG(F)
GIZZARD SHAD	14	95.2	(73 - 114)	9.98	4.3	(2 - 10)	2.12	0.060	0800 12/15	769.0	55.7
WHITE CATFISH	5	123.0	(71 - 155)	29.47	11.4	(2 - 21)	6.93	0.057	0800 12/15	769.0	55.7
BLUEGILL	1	125.0	(125 - 125)	0.00	19.0	(18 - 19)	0.00	0.018	0800 12/15	769.0	55.7
HOUR-0800 COUNT =	20							HOUR-0900 WEIGHT =	135(GRAMS)		
GIZZARD SHAD	27	91.5	(69 - 97)	6.61	3.1	(2 - 6)	1.09	0.083	1600 12/15	769.0	55.7
WHITE CATFISH	5	119.4	(90 - 160)	22.64	12.6	(4 - 27)	7.76	0.063	1600 12/15	769.0	55.7
BLUEGILL	1	116.0	(116 - 116)	0.00	11.0	(11 - 11)	0.00	0.011	1600 12/15	769.0	55.7
BLACK CRAPPIE	13	79.7	(74 - 96)	4.12	4.8	(3 - 6)	0.99	0.062	1600 12/15	769.0	55.7
HOUR-1600 COUNT =	46							HOUR-1600 WEIGHT =	219(GRAMS)		
GIZZARD SHAD	382	78.0	(65 - 119)	6.18	3.3	(1 - 14)	1.17	1.245	0000 12/29	769.0	49.5
WHITE CATFISH	3	96.7	(52 - 176)	56.25	15.0	(1 - 43)	19.80	0.045	0000 12/29	769.0	49.5
BLUEGILL	21	72.4	(39 - 112)	21.85	6.3	(1 - 18)	5.65	0.132	0000 12/29	769.0	49.5
PUMPKINSEED	3	84.3	(58 - 131)	33.09	14.7	(2 - 40)	17.91	0.044	0000 12/29	769.0	49.5
LARGEMOUTH BASS	1	66.0	(66 - 66)	0.00	3.0	(3 - 3)	0.00	0.003	0000 12/29	769.0	49.5
WHITE CRAPPIE	2	85.0	(85 - 85)	0.00	6.0	(5 - 7)	1.00	0.012	0000 12/29	769.0	49.5
BLACK CRAPPIE	19	79.2	(55 - 89)	9.28	5.0	(1 - 7)	1.75	0.095	0000 12/29	769.0	49.5
YELLOW PERCH	26	92.9	(85 - 108)	5.54	6.9	(6 - 10)	1.09	0.179	0000 12/29	769.0	49.5
HOUR-0000 COUNT =	457							HOUR-0000 WEIGHT =	1755(GRAMS)		
GIZZARD SHAD	248	78.7	(61 - 133)	7.23	4.0	(2 - 18)	1.52	0.990	0800 12/29	769.0	49.5
WHITE CATFISH	4	115.9	(66 - 149)	31.14	11.0	(2 - 19)	5.74	0.044	0800 12/29	769.0	49.5
WHITE BASS	1	92.0	(92 - 92)	0.00	6.0	(6 - 6)	0.00	0.006	0800 12/29	769.0	49.5
BLUEGILL	8	66.8	(54 - 110)	17.27	4.6	(2 - 16)	4.39	0.037	0800 12/29	769.0	49.5
PUMPKINSEED	1	67.0	(67 - 67)	0.00	4.0	(4 - 4)	0.00	0.004	0800 12/29	769.0	49.5
WHITE CRAPPIE	1	75.0	(75 - 75)	0.00	4.0	(4 - 4)	0.00	0.004	0800 12/29	769.0	49.5
BLACK CRAPPIE	1	71.0	(71 - 71)	0.00	4.0	(4 - 4)	0.00	0.004	0800 12/29	769.0	49.5
YELLOW PERCH	11	95.7	(89 - 102)	4.99	7.5	(6 - 9)	1.16	0.083	0800 12/29	769.0	49.5
HOUR-0800 COUNT =	275							HOUR-0900 WEIGHT =	1172(GRAMS)		
GIZZARD SHAD	84	80.9	(68 - 113)	6.48	3.6	(2 - 11)	1.25	0.306	1600 12/29	769.0	49.5
WHITE CATFISH	4	159.0	(68 - 207)	56.37	43.0	(2 - 86)	32.05	0.172	1600 12/29	769.0	49.5
BLUEGILL	4	50.0	(54 - 71)	6.52	3.3	(2 - 5)	1.09	0.013	1600 12/29	769.0	49.5
YELLOW PERCH	8	98.5	(87 - 116)	8.31	7.5	(4 - 13)	2.45	0.060	1600 12/29	769.0	49.5
HOUR-1600 COUNT =	100							HOUR-1600 WEIGHT =	551(GRAMS)		

TOTAL COUNT___ 898

TOTAL WEIGHT_____ 3832(GRAMS) 3.832(KG)

TABLE C-4

SUMMARY OF ORGANISMS IMPINGED DURING JANUARY 1984 AT THE VCSNS INTAKE

IMPINGEMENT STUDY FOR THE
VIRGIL C SUMMER NUCLEAR PLANT

JANUARY YEAR 1984 SPECIES	NUMBER	AVG. LENGTH	(LENGTH-RANGE) (MM)	STD. DEV.	AVG. WEIGHT	(WEIGHT-RANGE) (GRAMS)	STD. DEV.	TOTAL WEIGHT (KG)	TIME-DATE	INFLOW MILLION GAL/DAY	WATER TEMP. DEG(F)
GIZZARD SHAD	855	79.9	(67 - 106)	4.94	3.4	(2 - 9)	0.92	2.943	0000 01/12	769.0	48.3
CHANNEL CATFISH	1	179.0	(179 - 179)	0.00	41.0	(41 - 41)	0.00	0.041	0000 01/12	769.0	48.3
FLAT BULLHEAD	1	75.0	(75 - 75)	0.00	4.0	(4 - 4)	0.00	0.004	0000 01/12	769.0	48.3
WHITE BASS	1	80.0	(80 - 80)	0.00	4.0	(4 - 4)	0.00	0.004	0000 01/12	769.0	48.3
BLUEGILL	3	67.0	(59 - 71)	5.66	3.7	(3 - 4)	0.47	0.011	0000 01/12	769.0	48.3
PUMPKINSEED	11	60.5	(50 - 72)	6.76	2.5	(1 - 5)	1.16	0.028	0000 01/12	769.0	48.3
BLACK CRAPPIE	1	79.0	(79 - 79)	0.00	5.0	(5 - 5)	0.00	0.005	0000 01/12	769.0	48.3
YELLOW PERCH	32	94.3	(83 - 112)	6.28	6.6	(4 - 13)	1.95	0.211	0000 01/12	769.0	48.3
HOUR-0000 COUNT = 905								HOUR-0000 WEIGHT = 3247(GRAMS)			
LONGNOSE GAR	12	81.7	(74 - 87)	3.99	4.2	(3 - 5)	0.69	0.050	0800 01/12	769.0	48.3
GIZZARD SHAD	1013	79.2	(60 - 145)	5.68	3.9	(2 - 16)	0.90	3.976	0800 01/12	769.0	48.3
WHITE CATFISH	4	131.0	(66 - 234)	69.02	28.5	(2 - 87)	34.70	0.114	0800 01/12	769.0	48.3
WHITE BASS	1	78.0	(78 - 78)	0.00	2.0	(2 - 2)	0.00	0.002	0800 01/12	769.0	48.3
BLUEGILL	3	99.0	(64 - 123)	25.31	10.3	(3 - 16)	5.44	0.031	0800 01/12	769.0	48.3
PUMPKINSEED	4	64.0	(58 - 72)	5.10	2.8	(2 - 4)	0.83	0.011	0800 01/12	769.0	48.3
YELLOW PERCH	35	94.5	(84 - 111)	6.05	5.8	(4 - 11)	1.37	0.202	0800 01/12	769.0	48.3
HOUR-0800 COUNT = 1072								HOUR-0800 WEIGHT = 4386(GRAMS)			
GIZZARD SHAD	519	77.5	(62 - 101)	5.42	3.5	(1 - 7)	0.76	1.817	1600 01/12	769.0	48.3
WHITE BASS	2	77.0	(75 - 79)	2.00	2.0	(2 - 2)	0.00	0.004	1600 01/12	769.0	48.3
BLUEGILL	2	76.0	(47 - 105)	29.00	6.5	(1 - 12)	5.50	0.013	1600 01/12	769.0	48.3
PUMPKINSEED	3	59.3	(54 - 66)	4.99	2.0	(1 - 3)	0.82	0.006	1600 01/12	769.0	48.3
BLACK CRAPPIE	3	83.7	(81 - 86)	2.05	6.3	(6 - 7)	0.47	0.019	1600 01/12	769.0	48.3
YELLOW PERCH	19	96.5	(80 - 148)	15.06	7.2	(4 - 26)	5.01	0.136	1600 01/12	769.0	48.3
HOUR-1600 COUNT = 548								HOUR-1600 WEIGHT = 1795(GRAMS)			
GIZZARD SHAD	189	90.9	(67 - 120)	5.93	3.9	(2 - 12)	1.24	0.746	0000 01/26	769.0	47.7
WHITE CATFISH	2	162.5	(153 - 172)	9.50	29.0	(22 - 36)	7.00	0.058	0000 01/26	769.0	47.7
CHANNEL CATFISH	1	83.0	(83 - 83)	0.00	5.0	(5 - 5)	0.00	0.005	0000 01/26	769.0	47.7
PUMPKINSEED	2	59.0	(59 - 59)	0.00	3.0	(3 - 3)	0.00	0.006	0000 01/26	769.0	47.7
WHITE CRAPPIE	1	291.0	(281 - 291)	0.00	340.0	(340 - 340)	0.00	0.340	0000 01/26	769.0	47.7
BLACK CRAPPIE	6	87.5	(83 - 97)	4.65	5.5	(4 - 7)	1.12	0.033	0000 01/26	769.0	47.7
YELLOW PERCH	31	93.1	(84 - 101)	4.39	6.3	(4 - 8)	0.99	0.195	0000 01/26	769.0	47.7
HOUR-0000 COUNT = 232								HOUR-0000 WEIGHT = 1383(GRAMS)			
GIZZARD SHAD	126	80.9	(62 - 98)	6.89	3.5	(1 - 8)	1.28	0.435	0800 01/26	769.0	47.7
WHITE CATFISH	1	48.0	(48 - 48)	0.00	2.0	(2 - 2)	0.00	0.002	0800 01/26	769.0	47.7
FLAT BULLHEAD	1	169.0	(169 - 169)	0.00	50.0	(50 - 50)	0.00	0.050	0800 01/26	769.0	47.7
PUMPKINSEED	2	65.0	(63 - 67)	2.00	3.0	(2 - 4)	1.00	0.006	0800 01/26	769.0	47.7
YELLOW PERCH	11	100.4	(93 - 112)	5.84	7.6	(6 - 12)	1.87	0.084	0800 01/26	769.0	47.7
HOUR-0800 COUNT = 141								HOUR-0800 WEIGHT = 577(GRAMS)			
GIZZARD SHAD	132	81.7	(77 - 110)	5.25	3.6	(3 - 10)	0.85	0.478	1600 01/26	769.0	47.7
WHITE CATFISH	4	155.5	(57 - 326)	109.26	85.5	(2 - 300)	124.71	0.342	1600 01/26	769.0	47.7
FLAT BULLHEAD	1	73.0	(73 - 73)	0.00	4.0	(4 - 4)	0.00	0.004	1600 01/26	769.0	47.7
BLACK CRAPPIE	1	90.0	(80 - 90)	0.00	5.0	(5 - 5)	0.00	0.005	1600 01/26	769.0	47.7
YELLOW PERCH	11	92.6	(83 - 104)	5.35	6.1	(4 - 9)	1.50	0.067	1600 01/26	769.0	47.7
HOUR-1600 COUNT = 149								HOUR-1600 WEIGHT = 896(GRAMS)			

TOTAL COUNT___ 3047

TOTAL WEIGHT_____ 12484(GRAMS) 12.484(KG)

TABLE C-5

SUMMARY OF ORGANISMS IMPINGED DURING FEBRUARY 1984 AT THE VCSNS INTAKE

IMPINGEMENT STUDY FOR THE
VIRGIL C. SUMMER NUCLEAR PLANT

FEBRUARY YEAR 1984 SPECIES	NUMBER	AVG. LENGTH	(LENGTH-RANGE) (MM)	STD. DEV.	AVG WEIGHT	(WEIGHT-RANGE) (GRAMS)	STD. DEV.	TOTAL WEIGHT (KG)	TIME-DATE	INFLOW MILLION GAL/DAY	WATER TEMP. DEG(F)
GIZZARD SHAD	76	81.9	(74 - 94)	4.27	3.4	(2 - 5)	0.83	0.257	0100 02/10	767.0	46.0
WHITE CATFISH	2	123.0	(73 - 173)	50.00	24.5	(4 - 45)	20.50	0.049	0100 02/10	767.0	46.0
YELLOW PERCH	20	92.8	(82 - 111)	6.27	6.6	(4 - 13)	1.88	0.131	0100 02/10	767.0	46.0
HOUR-0100 COUNT =	98							HOUR-0100 WEIGHT =	437(GRAMS)		
GIZZARD SHAD	127	91.5	(67 - 96)	4.98	3.6	(2 - 6)	0.98	0.459	0900 02/10	769.0	46.0
YELLOW PERCH	9	92.6	(82 - 101)	6.77	6.1	(4 - 9)	1.79	0.055	0900 02/10	769.0	46.0
HOUR-0900 COUNT =	136							HOUR-0900 WEIGHT =	514(GRAMS)		
GIZZARD SHAD	85	90.9	(65 - 100)	5.54	3.7	(2 - 8)	0.97	0.313	1700 02/10	769.0	46.0
FLAT BULLHEAD	1	68.0	(68 - 68)	0.00	3.0	(3 - 3)	0.00	0.003	1700 02/10	767.0	46.0
BLUEGILL	1	50.0	(50 - 50)	0.00	2.0	(2 - 2)	0.00	0.002	1700 02/10	769.0	46.0
YELLOW PERCH	4	95.5	(86 - 104)	6.73	5.8	(4 - 9)	2.05	0.023	1700 02/10	767.0	46.0
HOUR-1700 COUNT =	91							HOUR-1700 WEIGHT =	341(GRAMS)		
GIZZARD SHAD	19	85.4	(76 - 109)	8.55	3.3	(2 - 9)	1.68	0.062	0100 02/23	769.0	53.8
WHITE CATFISH	2	109.5	(67 - 152)	42.50	11.0	(2 - 20)	9.00	0.022	0100 02/23	767.0	53.8
PUMPKINSEED	1	69.0	(69 - 69)	0.00	4.0	(4 - 4)	0.00	0.004	0100 02/23	769.0	53.8
REDEAR SUNFISH	2	58.0	(57 - 59)	1.00	3.0	(3 - 3)	0.00	0.006	0100 02/23	769.0	53.8
WHITE CRAPPIE	3	80.3	(79 - 82)	1.25	5.7	(5 - 6)	0.47	0.017	0100 02/23	767.0	53.8
YELLOW PERCH	21	92.5	(79 - 101)	5.56	6.6	(4 - 9)	1.22	0.138	0100 02/23	769.0	53.8
HOUR-0100 COUNT =	48							HOUR-0100 WEIGHT =	249(GRAMS)		
GIZZARD SHAD	16	81.2	(76 - 88)	3.34	3.2	(2 - 4)	0.63	0.051	0900 02/23	767.0	53.8
BLUEGILL	1	56.0	(56 - 56)	0.00	2.0	(2 - 2)	0.00	0.002	0900 02/23	769.0	53.8
PUMPKINSEED	1	80.0	(80 - 80)	0.00	8.0	(8 - 8)	0.00	0.008	0900 02/23	769.0	53.8
BLACK CRAPPIE	1	82.0	(82 - 82)	0.00	5.0	(5 - 5)	0.00	0.005	0900 02/23	769.0	53.8
YELLOW PERCH	6	100.7	(94 - 116)	7.39	8.5	(7 - 11)	1.50	0.051	0900 02/23	767.0	53.8
HOUR-0900 COUNT =	25							HOUR-0900 WEIGHT =	117(GRAMS)		
GIZZARD SHAD	27	83.4	(76 - 100)	5.37	3.9	(2 - 7)	0.89	0.104	1700 02/23	769.0	53.8
BLACK CRAPPIE	1	79.0	(79 - 79)	0.00	5.0	(5 - 5)	0.00	0.005	1700 02/23	769.0	53.8
YELLOW PERCH	10	96.0	(87 - 108)	6.13	8.4	(5 - 12)	1.91	0.084	1700 02/23	769.0	53.8
HOUR-1700 COUNT =	38							HOUR-1700 WEIGHT =	193(GRAMS)		

TOTAL COUNT___ 436   TOTAL WEIGHT_____ 1851(GRAMS) 1.851(KG)

TABLE C-6

SUMMARY OF ORGANISMS IMPINGED DURING MARCH 1984 AT THE VCSNS INTAKE

IMPINGEMENT STUDY FOR THE
VIRGIL C. SUMMER NUCLEAR PLANT

MARCH YEAR 1984 SPECIES	NUMBER	AVG. LENGTH	(LENGTH-RANGE) (MM)	STD. DEV.	AVG. WEIGHT	(WEIGHT-RANGE) (GRAMS)	STD. DEV.	TOTAL WEIGHT (KG)	TIME-DATE	INFLOW MILLION GAL/DAY	WATER TEMP. DEG(F)
GIZZARD SHAD	63	85.1	(76 - 110)	6.01	3.8	(2 - 10)	1.37	0.240	0100 03/08	769.0	50.1
WHITE CATFISH	4	102.0	(53 - 225)	71.20	28.0	(1 - 108)	46.19	0.112	0100 03/08	769.0	50.1
BLUEGILL	3	85.3	(78 - 98)	8.99	8.0	(5 - 13)	3.56	0.024	0100 03/08	769.0	50.1
PUMPKINSEED	7	65.1	(52 - 79)	7.51	3.0	(2 - 6)	1.41	0.021	0100 03/08	769.0	50.1
BLACK CRAPPIE	1	264.0	(264 - 264)	0.00	260.0	(260 - 260)	0.00	0.260	0100 03/08	769.0	50.1
YELLOW PERCH	19	90.5	(84 - 99)	4.48	6.2	(4 - 9)	1.15	0.118	0100 03/08	769.0	50.1
HOUR-0100 COUNT =	97							HOUR-0100 WEIGHT =	775(GRAMS)		
GIZZARD SHAD	87	82.4	(75 - 94)	3.98	3.6	(2 - 6)	0.88	0.313	0900 03/08	769.0	50.1
CHANNEL CATFISH	5	115.2	(69 - 223)	57.85	20.2	(2 - 79)	29.30	0.101	0900 03/09	769.0	50.1
BLUEGILL	2	93.5	(93 - 94)	0.50	17.5	(8 - 27)	9.50	0.035	0900 03/08	769.0	50.1
PUMPKINSEED	2	85.0	(53 - 117)	32.00	6.0	(2 - 10)	4.00	0.012	0900 03/08	769.0	50.1
WHITE CRAPPIE	1	92.0	(82 - 92)	0.00	6.0	(6 - 6)	0.00	0.006	0900 03/09	769.0	50.1
YELLOW PERCH	18	92.1	(77 - 104)	7.59	6.7	(4 - 10)	1.99	0.121	0900 03/08	769.0	50.1
HOUR-0900 COUNT =	115							HOUR-0900 WEIGHT =	588(GRAMS)		
GIZZARD SHAD	89	91.6	(70 - 97)	4.[illegible]	2.8	(2 - 6)	0.93	0.251	1700 03/09	769.0	50.1
CHANNEL CATFISH	1	254.0	(254 - 254)	0.00	108.0	(108 - 108)	0.00	0.108	1700 03/08	769.0	50.1
BLUEGILL	1	67.0	(67 - 67)	0.00	4.0	(4 - 4)	0.00	0.004	1700 03/08	769.0	50.1
PUMPKINSEED	1	65.0	(65 - 65)	0.00	4.0	(4 - 4)	0.00	0.004	1700 03/08	769.0	50.1
YELLOW PERCH	2	89.5	(84 - 95)	5.50	6.0	(5 - 7)	1.00	0.012	1700 03/09	769.0	50.1
HOUR-1700 COUNT =	94							HOUR-1700 WEIGHT =	379(GRAMS)		
GIZZARD SHAD	5	91.2	(79 - 99)	3.97	3.0	(2 - 4)	0.63	0.015	0100 03/21	769.0	51.5
WHITE CATFISH	3	172.7	(154 - 208)	25.00	39.0	(24 - 65)	18.46	0.117	0100 03/21	769.0	51.5
CHANNEL CATFISH	3	101.0	(53 - 177)	54.36	13.0	(1 - 36)	16.27	0.039	0100 03/21	769.0	51.5
BLUEGILL	7	101.6	(80 - 121)	12.12	12.9	(4 - 26)	6.33	0.090	0100 03/21	769.0	51.5
PUMPKINSEED	7	66.9	(63 - 73)	3.94	3.4	(2 - 5)	1.05	0.024	0100 03/21	769.0	51.5
YELLOW PERCH	40	90.7	(78 - 105)	6.08	5.0	(3 - 9)	1.26	0.200	0100 03/21	769.0	51.5
HOUR-0100 COUNT =	65							HOUR-0100 WEIGHT =	485(GRAMS)		
GIZZARD SHAD	10	93.5	(79 - 199)	35.40	9.0	(2 - 56)	16.02	0.090	0900 03/21	769.0	51.5
CHANNEL CATFISH	4	63.8	(54 - 79)	9.28	2.5	(2 - 4)	0.87	0.010	0900 03/21	769.0	51.5
WHITE BASS	2	290.0	(274 - 306)	16.00	306.0	(284 - 328)	22.00	0.612	0900 03/21	769.0	51.5
FLIER	1	124.0	(124 - 124)	0.00	25.0	(25 - 25)	0.00	0.025	0900 03/21	769.0	51.5
BLUEGILL	2	97.5	(85 - 110)	12.50	11.0	(7 - 15)	4.00	0.022	0900 03/21	769.0	51.5
PUMPKINSEED	1	97.0	(97 - 97)	0.00	12.0	(12 - 12)	0.00	0.012	0900 03/21	769.0	51.5
WHITE CRAPPIE	2	79.5	(71 - 88)	8.50	4.0	(2 - 6)	2.00	0.008	0900 03/21	769.0	51.5
YELLOW PERCH	23	95.7	(85 - 110)	6.11	6.5	(4 - 10)	1.77	0.149	0900 03/21	769.0	51.5
HOUR-0900 COUNT =	45							HOUR-0900 WEIGHT =	918(GRAMS)		
GIZZARD SHAD	7	113.3	(81 - 220)	45.23	17.1	(5 - 70)	24.75	0.120	1700 03/21	769.0	51.5
CHANNEL CATFISH	1	172.0	(172 - 172)	0.00	49.0	(48 - 49)	0.00	0.048	1700 03/21	769.0	51.5
BLUEGILL	2	102.0	(99 - 105)	3.00	14.0	(14 - 14)	0.00	0.028	1700 03/21	769.0	51.5
PUMPKINSEED	2	121.0	(69 - 173)	52.00	43.0	(4 - 82)	39.00	0.086	1700 03/21	769.0	51.5
WHITE CRAPPIE	1	98.0	(89 - 98)	0.00	6.0	(6 - 6)	0.00	0.006	1700 03/21	769.0	51.5
YELLOW PERCH	19	92.8	(84 - 103)	6.01	5.8	(4 - 8)	1.18	0.111	1700 03/21	769.0	51.3
HOUR-1700 COUNT =	32							HOUR-1700 WEIGHT =	399(GRAMS)		

TOTAL COUNT___ 448

TOTAL WEIGHT_____ 3544(GRAMS) 3.544(KG)

TABLE C-7

SUMMARY OF ORGANISMS IMPINGED DURING MAY 1984 AT THE VCSNS INTAKE

IMPINGEMENT STUDY FOR THE
VIRGIL C. SUMMER NUCLEAR PLANT

MAY YEAR 1984 SPECIES	NUMBER	AVG. LENGTH	(LENGTH-RANGE) (MM)	STD. DEV	AVG. WEIGHT	(WEIGHT-RANGE) (GRAMS)	STD. DEV.	TOTAL WEIGHT (KG)	TIME-DATE	INFLOW MILLION GAL/DAY	WATER TEMP. DEG(F)
GIZZARD SHAD	9	84.6	(77 - 94)	6.13	3.2	(2 - 4)	0.79	0.029	0100 05/04	769.0	59.7
THREADFIN SHAD	1	114.0	(114 - 114)	0.00	11.0	(11 - 11)	0.00	0.011	0100 05/04	769.0	59.7
YELLOW BULLHEAD	1	155.0	(155 - 155)	0.00	25.0	(25 - 25)	0.00	0.025	0100 05/04	769.0	59.7
WARMOUTH	7	105.0	(50 - 134)	27.83	20.7	(2 - 37)	11.50	0.145	0100 05/04	769.0	59.7
PUMPKINSEED	1	67.0	(67 - 67)	0.00	4.0	(4 - 4)	0.00	0.004	0100 05/04	769.0	59.7
BLACK CRAPPIE	4	102.8	(79 - 156)	31.04	13.5	(5 - 34)	11.98	0.054	0100 05/04	769.0	59.7
YELLOW PERCH	1	106.0	(106 - 106)	0.00	12.0	(12 - 12)	0.00	0.012	0100 05/04	769.0	59.7
HOUR-0100 COUNT =	24							HOUR-0100 WEIGHT =	280(GRAMS)		
GIZZARD SHAD	12	94.1	(79 - 95)	4.55	4.3	(3 - 5)	0.72	0.051	0900 05/04	769.0	59.7
THREADFIN SHAD	2	93.0	(85 - 101)	8.00	8.0	(6 - 10)	2.00	0.016	0900 05/04	769.0	59.7
CHANNEL CATFISH	12	74.8	(60 - 93)	10.23	3.8	(2 - 6)	1.28	0.046	0900 05/04	769.0	59.7
WARMOUTH	3	134.0	(125 - 149)	10.68	35.7	(23 - 51)	11.57	0.107	0900 05/04	769.0	59.7
BLUEGILL	2	78.0	(73 - 83)	5.00	6.5	(5 - 8)	1.50	0.013	0900 05/04	769.0	59.7
PUMPKINSEED	3	64.3	(64 - 65)	0.47	4.3	(4 - 5)	0.47	0.013	0900 05/04	769.0	59.7
WHITE CRAPPIE	2	344.0	(86 - 602)	258.00	180.5	(6 - 355)	174.50	0.361	0900 05/04	769.0	59.7
BLACK CRAPPIE	1	85.0	(85 - 85)	0.00	7.0	(7 - 7)	0.00	0.007	0900 05/04	769.0	59.7
HOUR-0900 COUNT =	37							HOUR-0900 WEIGHT =	614(GRAMS)		
GIZZARD SHAD	4	88.5	(79 - 105)	9.94	4.5	(4 - 6)	0.87	0.018	1700 05/04	769.0	59.7
WHITE CATFISH	2	100.5	(93 - 108)	7.50	6.0	(4 - 8)	2.00	0.012	1700 05/04	769.0	59.7
CHANNEL CATFISH	1	184.0	(184 - 184)	0.00	62.0	(62 - 62)	0.00	0.062	1700 05/04	769.0	59.7
BLACK CRAPPIE	1	93.0	(93 - 93)	0.00	8.0	(8 - 8)	0.00	0.008	1700 05/04	769.0	59.7
HOUR-1700 COUNT =	8							HOUR-1700 WEIGHT =	100(GRAMS)		
GIZZARD SHAD	2	83.0	(83 - 83)	0.00	4.0	(4 - 4)	0.00	0.008	0100 05/16	769.0	68.9
WHITE CATFISH	8	213.5	(119 - 324)	75.65	126.3	(13 - 354)	120.57	1.010	0100 05/16	769.0	68.9
CHANNEL CATFISH	8	72.0	(56 - 82)	8.93	2.9	(1 - 4)	1.05	0.023	0100 05/16	769.0	68.9
FLAT BULLHEAD	1	111.0	(111 - 111)	0.00	13.0	(13 - 13)	0.00	0.013	0100 05/16	769.0	68.9
WHITE BASS	1	154.0	(154 - 154)	0.00	41.0	(41 - 41)	0.00	0.041	0100 05/16	769.0	68.9
WARMOUTH	14	111.4	(55 - 156)	21.01	22.6	(2 - 46)	9.66	0.317	0100 05/16	769.0	68.9
BLUEGILL	1	91.0	(81 - 91)	0.00	6.0	(6 - 6)	0.00	0.006	0100 05/16	769.0	68.9
WHITE CRAPPIE	1	94.0	(94 - 94)	0.00	9.0	(9 - 9)	0.00	0.009	0100 05/16	769.0	68.9
BLACK CRAPPIE	2	76.5	(64 - 89)	12.50	4.5	(3 - 6)	1.50	0.009	0100 05/16	769.0	68.9
HOUR-0100 COUNT =	38							HOUR-0100 WEIGHT =	1436(GRAMS)		
WHITE CATFISH	3	169.0	(106 - 207)	44.86	51.7	(9 - 84)	31.48	0.155	0900 05/16	769.0	68.9
CHANNEL CATFISH	7	69.6	(55 - 83)	8.93	2.1	(2 - 3)	0.35	0.015	0900 05/16	769.0	68.9
HOUR-0900 COUNT =	10							HOUR-0900 WEIGHT =	170(GRAMS)		
WHITE CATFISH	2	136.5	(114 - 159)	22.50	17.5	(12 - 23)	5.50	0.035	1700 05/16	769.0	68.9
CHANNEL CATFISH	2	66.5	(63 - 70)	3.50	2.0	(2 - 2)	0.00	0.004	1700 05/16	769.0	68.9
YELLOW PERCH	1	88.0	(88 - 88)	0.00	6.0	(6 - 6)	0.00	0.006	1700 05/16	769.0	68.9
HOUR-1700 COUNT =	5							HOUR-1700 WEIGHT =	45(GRAMS)		
THREADFIN SHAD	1	92.0	(92 - 92)	0.00	7.0	(7 - 7)	0.00	0.007	0100 05/31	769.0	73.0
CHANNEL CATFISH	1	55.0	(55 - 55)	0.00	1.0	(1 - 1)	0.00	0.001	0100 05/31	769.0	73.0
WARMOUTH	2	106.0	(106 - 106)	0.00	21.0	(21 - 21)	0.00	0.042	0100 05/31	769.0	73.0
HOUR-0100 COUNT =	4							HOUR-0100 WEIGHT =	50(GRAMS)		
THREADFIN SHAD	4	101.0	(98 - 111)	5.40	10.0	(9 - 12)	1.22	0.040	0900 05/31	769.0	73.0
CHANNEL CATFISH	2	60.5	(52 - 69)	8.50	1.5	(1 - 2)	0.50	0.003	0900 05/31	769.0	73.0
FLAT BULLHEAD	1	127.0	(127 - 127)	0.00	19.0	(19 - 19)	0.00	0.019	0900 05/31	769.0	73.0

TABLE C-7 (Continued)

IMPINGEMENT STUDY FOR THE
VIRGIL C. SUMMER NUCLEAR PLANT

MAY YEAR 84 SPECIES	NUMBER	AVG. LENGTH	(LENGTH-RANGE) (MM)	STD. DEV.	AVG. WEIGHT	(WEIGHT-RANGE) (GRAMS)	STD. DEV.	TOTAL WEIGHT (KG)	TIME-DATE	INFLOW MILLION GAL/DAY	WATER TEMP. DEG(F)
YELLOW PERCH	4	90.3	(35 - 144)	38.54	9.0	(1 - 15)	5.34	0.032	0900 05/31	769.0	73.0
HOUR-0900 COUNT =	11							HOUR-0900 WEIGHT = 94(GRAMS)			
GIZZARD SHAD	4	240.5	(169 - 312)	71.50	109.0	(42 - 174)	56.00	0.432	1700 05/31	769.0	73.0
THREADFIN SHAD	8	100.5	(87 - 127)	11.60	9.8	(6 - 18)	3.42	0.078	1700 05/31	769.0	73.0
WARMOUTH	4	158.0	(137 - 170)	12.81	65.8	(33 - 96)	23.01	0.263	1700 05/31	769.0	73.0
BLACK CRAPPIE	1	96.0	(95 - 96)	0.00	10.0	(10 - 10)	0.00	0.010	1700 05/31	769.0	73.0
HOUR-1700 COUNT =	17							HOUR-1700 WEIGHT = 783(GRAMS)			

TOTAL COUNT___ 154

TOTAL WEIGHT_____ 3572(GRAMS) 3.572(KG)

TABLE C-8

SUMMARY OF ORGANISMS IMPINGED DURING JUNE 1984 AT THE VCSNS INTAKE

IMPINGEMENT STUDY FOR THE
VIRGIL C. SUMMER NUCLEAR PLANT

JUNE YEAR 1984 SPECIES	NUMBER	AVG. LENGTH	(LENGTH-RANGE) (MM)		STD DEV.	AVG. WEIGHT	(WEIGHT-RANGE) (GRAMS)		STD DEV.	TOTAL WEIGHT (KG)	TIME-DATE	INFLOW MILLION GAL/DAY	WATER TEMP. DEG(F)
GIZZARD SHAD	1	216.0	(216 -	216)	0.00	79.0	(78 -	79)	0.00	0.078	0100 06/14	769.0	75.1
THREADFIN SHAD	1	56.0	(56 -	56)	0.00	3.0	(3 -	3)	0.00	0.003	0100 06/14	769.0	75.1
WHITE CATFISH	1	166.0	(166 -	166)	0.00	42.0	(42 -	42)	0.00	0.042	0100 06/14	769.0	75.1
CHANNEL CATFISH	1	97.0	(97 -	97)	0.00	6.0	(6 -	6)	0.00	0.006	0100 06/14	769.0	75.1
BLACK CRAPPIE	1	105.0	(105 -	105)	0.00	12.0	(12 -	12)	0.00	0.012	0100 06/14	769.0	75.1
HOUR-0100 COUNT =	5									HOUR-0100 WEIGHT = 141(GRAMS)			
WHITE CATFISH	3	131.3	(76 -	173)	40.76	21.0	(4 -	33)	12.36	0.063	0900 06/14	769.0	75.1
BLUEGILL	1	114.0	(114 -	114)	0.00	22.0	(22 -	22)	0.00	0.022	0900 06/14	769.0	75.1
BLACK CRAPPIE	1	198.0	(199 -	198)	0.00	84.0	(84 -	84)	0.00	0.094	0900 06/14	769.0	75.1
YELLOW PERCH	1	43.0	(43 -	43)	0.00	1.0	(1 -	1)	0.00	0.001	0900 06/14	769.0	75.1
HOUR-0900 COUNT =	6									HOUR-0900 WEIGHT = 170(GRAMS)			
THREADFIN SHAD	2	74.5	(46 -	103)	28.50	5.0	(1 -	9)	4.00	0.010	1700 06/14	769.0	75.1
CHANNEL CATFISH	2	145.5	(127 -	164)	18.50	13.0	(12 -	14)	1.00	0.026	1700 06/14	769.0	75.1
YELLOW PERCH	2	37.0	(33 -	41)	4.00	1.0	(1 -	1)	0.00	0.002	1700 06/14	769.0	75.1
HOUR-1700 COUNT =	6									HOUR-1700 WEIGHT = 38(GRAMS)			
GIZZARD SHAD	2	85.5	(55 -	116)	30.50	6.5	(1 -	12)	5.50	0.013	0100 06/28	769.0	77.1
THREADFIN SHAD	1	75.0	(95 -	95)	0.00	8.0	(8 -	8)	0.00	0.008	0100 06/28	769.0	77.1
BLUEGILL	2	153.5	(137 -	170)	16.50	57.5	(37 -	79)	20.50	0.115	0100 06/29	769.0	77.1
BLACK CRAPPIE	1	118.0	(118 -	118)	0.00	18.0	(18 -	18)	0.00	0.018	0100 06/28	769.0	77.1
HOUR-0100 COUNT =	6									HOUR-0100 WEIGHT = 154(GRAMS)			
WHITE CATFISH	1	195.0	(195 -	195)	0.00	62.0	(62 -	62)	0.00	0.062	0900 06/29	769.0	77.1
CHANNEL CATFISH	1	178.0	(178 -	178)	0.00	37.0	(37 -	37)	0.00	0.037	0900 06/28	769.0	77.1
YELLOW PERCH	1	37.0	(37 -	37)	0.00	1.0	(1 -	1)	0.00	0.001	0900 06/28	769.0	77.1
HOUR-0900 COUNT =	3									HOUR-0900 WEIGHT = 100(GRAMS)			
WHITE CATFISH	1	71.0	(71 -	71)	0.00	2.0	(2 -	2)	0.00	0.002	1700 06/28	769.0	77.1
YELLOW PERCH	1	35.0	(35 -	35)	0.00	1.0	(1 -	1)	0.00	0.001	1700 06/28	769.0	77.1
HOUR-1700 COUNT =	2									HOUR-1700 WEIGHT = 3(GRAMS)			

TOTAL COUNT___ 28

TOTAL WEIGHT_____ 606(GRAMS) 0.606(KG)

TABLE C-9

SUMMARY OF ORGANISMS IMPINGED DURING JULY 1984 AT THE VCSNS INTAKE

IMPINGEMENT STUDY FOR THE
VIRGIL C. SUMMER NUCLEAR PLANT

JULY YEAR 1984 SPECIES	NUMBER	AVG. LENGTH	(LENGTH-RANGE) (MM)	STD. DEV.	AVG. WEIGHT	(WEIGHT-RANGE) (GRAMS)	STD. DEV.	TOTAL WEIGHT (KG)	TIME-DATE	INFLOW MILLION GAL/DAY	WATER TEMP. DEG(F)
THREADFIN SHAD	7	58.1	(51 - 63)	3.94	2.1	(2 - 3)	0.35	0.015	0600 07/12	769.0	79.2
WHITE CATFISH	2	117.5	(42 - 193)	75.50	28.5	(1 - 56)	27.50	0.057	0600 07/12	769.0	79.2
PUMPKINSEED	1	96.0	(96 - 96)	0.00	17.0	(17 - 17)	0.00	0.017	0600 07/12	769.0	79.2
YELLOW PERCH	2	49.5	(44 - 55)	5.50	2.5	(2 - 3)	0.50	0.005	0600 07/12	769.0	79.2
HOUR-0600 COUNT =	12							HOUR-0600 WEIGHT =	94(GRAMS)		
THREADFIN SHAD	1	52.0	(52 - 52)	0.00	2.0	(2 - 2)	0.00	0.002	1400 07/12	769.0	79.2
WHITE CATFISH	1	173.0	(173 - 173)	0.00	48.0	(48 - 48)	0.00	0.048	1400 07/12	769.0	79.2
CHANNEL CATFISH	1	110.0	(110 - 110)	0.00	10.0	(10 - 10)	0.00	0.010	1400 07/12	769.0	79.2
WHITE CATFISH	2	107.0	(50 - 164)	57.00	19.5	(2 - 37)	17.50	0.039	2200 07/12	769.0	79.2
CHANNEL CATFISH	1	240.0	(240 - 240)	0.00	90.0	(90 - 90)	0.00	0.070	2200 07/12	767.0	79.2
FLAT BULLHEAD	2	109.5	(55 - 164)	54.50	21.5	(2 - 41)	19.50	0.043	2200 07/12	769.0	79.2
PUMPKINSEED	1	97.0	(97 - 97)	0.00	16.0	(16 - 16)	0.00	0.016	2200 07/12	769.0	79.2
BLACK CRAPPIE	1	148.0	(148 - 148)	0.00	42.0	(42 - 42)	0.00	0.042	2200 07/12	769.0	79.2
HOUR-2200 COUNT =	6							HOUR-2200 WEIGHT =	228(GRAMS)		
THREADFIN SHAD	1	44.0	(44 - 44)	0.00	1.0	(1 - 1)	0.00	0.001	0700 07/26	769.0	80.0
WHITE CATFISH	1	35.0	(35 - 35)	0.00	1.0	(1 - 1)	0.00	0.001	0700 07/26	767.0	80.0
CHANNEL CATFISH	1	225.0	(225 - 225)	0.00	72.0	(72 - 72)	0.00	0.072	0700 07/25	769.0	80.0
BLACK CRAPPIE	1	133.0	(133 - 133)	0.00	24.0	(24 - 24)	0.00	0.024	0700 07/26	769.0	80.0
HOUR-0700 COUNT =	4							HOUR-0700 WEIGHT =	98(GRAMS)		
THREADFIN SHAD	1	54.0	(54 - 54)	0.00	1.0	(1 - 1)	0.00	0.001	2300 07/26	769.0	80.0
CHANNEL CATFISH	2	152.0	(125 - 179)	27.00	28.5	(13 - 44)	15.50	0.057	2300 07/26	769.0	80.0
HOUR-2300 COUNT =	3							HOUR-2300 WEIGHT =	58(GRAMS)		

TOTAL COUNT___ 29 TOTAL WEIGHT_____ 540(GRAMS) 0.540(KG)

TABLE C-10

SUMMARY OF ORGANISMS IMPINGED DURING AUGUST 1984 AT THE VCSNS INTAKE

IMPINGEMENT STUDY FOR THE
VIRGIL C. SUMMER NUCLEAR PLANT

AUGUST YEAR 1984 SPECIES	NUMBER	AVG. LENGTH	(LENGTH-RANGE) (MM)	STD. DEV.	AVG. WEIGHT	(WEIGHT-RANGE) (GRAMS)	STD. DEV.	TOTAL WEIGHT (KG)	TIME-DATE	INFLOW MILLION GAL/DAY	WATER TEMP. DEG(F)
GIZZARD SHAD	2	84.0	(44 - 124)	40.00	6.5	(1 - 12)	5.50	0.013	0730 08/10	769.0	81.6
THREADFIN SHAD	3	65.3	(59 - 70)	4.64	2.0	(2 - 2)	0.00	0.006	0730 08/10	769.0	81.6
WHITE CATFISH	2	79.5	(70 - 89)	9.50	5.0	(3 - 7)	2.00	0.010	0730 08/10	769.0	81.6
FLAT BULLHEAD	1	80.0	(80 - 80)	0.00	4.0	(4 - 4)	0.00	0.004	0730 08/10	769.0	81.6
HOUR-0730 COUNT =	8							HOUR-0730 WEIGHT =	33(GRAMS)		
THREADFIN SHAD	1	51.0	(51 - 51)	0.00	1.0	(1 - 1)	0.00	0.001	2330 08/10	769.0	81.6
WHITE BASS	1	54.0	(54 - 54)	0.00	2.0	(2 - 2)	0.00	0.002	2330 08/10	769.0	81.6
BLACK CRAPPIE	1	61.0	(61 - 61)	0.00	2.0	(2 - 2)	0.00	0.002	2330 08/10	769.0	81.6
HOUR-2330 COUNT =	3							HOUR-2330 WEIGHT =	5(GRAMS)		
GIZZARD SHAD	2	71.5	(49 - 94)	22.50	3.5	(1 - 6)	2.50	0.007	1300 08/23	769.0	81.8
THREADFIN SHAD	3	55.3	(50 - 60)	4.11	2.0	(2 - 2)	0.00	0.006	1300 09/23	769.0	81.8
WHITE CATFISH	5	142.2	(54 - 211)	68.97	20.4	(1 - 35)	15.53	0.102	1300 08/23	769.0	81.8
WHITE BASS	1	263.0	(263 - 263)	0.00	178.0	(178 - 178)	0.00	0.178	1300 08/23	769.0	81.8
HOUR-1300 COUNT =	11							HOUR-1300 WEIGHT =	293(GRAMS)		
WHITE CATFISH	1	317.0	(317 - 317)	0.00	367.0	(367 - 367)	0.00	0.367	2100 08/23	769.0	81.8
HOUR-2100 COUNT =	1							HOUR-2100 WEIGHT =	367(GRAMS)		

TOTAL COUNT___ 23

TOTAL WEIGHT_____ 698(GRAMS) 0.698(KG)

TABLE C-11

SUMMARY OF ORGANISMS IMPINGED DURING SEPTEMBER 1984 AT THE VCSNS INTAKE

IMPINGEMENT STUDY FOR THE
VIRGIL C. SUMMER NUCLEAR PLANT

SEPTEMBER YEAR 1984 SPECIES	NUMBER	AVG. LENGTH	(LENGTH-RANGE) (MM)	STD DEV	AVG. WEIGHT	(WEIGHT-RANGE) (GRAMS)	STD DEV	TOTAL WEIGHT (KG)	TIME-DATE	INFLOW MILLION GAL/DAY	WATER TEMP. DEG(F)
THREADFIN SHAD	1	55.0	(55 - 55)	0.00	1.0	(1 - 1)	0.00	0.001	0330 09/05	769.0	80.5
WHITE CATFISH	2	192.0	(179 - 206)	14.00	50.0	(34 - 66)	16.00	0.100	0330 09/05	769.0	80.5
CHANNEL CATFISH	1	156.0	(156 - 156)	0.00	26.0	(26 - 26)	0.00	0.026	0330 09/05	769.0	80.5
BLUEGILL	1	128.0	(128 - 128)	0.00	30.0	(30 - 30)	0.00	0.030	0330 09/05	769.0	80.5
HOUR-0330 COUNT =	5							HOUR-0330 WEIGHT =	157(GRAMS)		
WHITE CATFISH	1	334.0	(334 - 334)	0.00	451.0	(451 - 451)	0.00	0.451	1130 09/05	769.0	80.5
WHITE CRAPPIE	1	156.0	(156 - 156)	0.00	49.0	(49 - 49)	0.00	0.049	1130 09/05	769.0	80.5
HOUR-1130 COUNT =	2							HOUR-1130 WEIGHT =	500(GRAMS)		
THREADFIN SHAD	1	57.0	(57 - 57)	0.00	2.0	(2 - 2)	0.00	0.002	1930 09/05	769.0	80.5
WHITE CATFISH	3	179.0	(124 - 255)	55.50	67.3	(17 - 153)	60.98	0.202	1930 09/05	769.0	80.5
HOUR-1930 COUNT =	4							HOUR-1930 WEIGHT =	204(GRAMS)		
WHITE CATFISH	4	172.9	(80 - 228)	56.80	53.8	(5 - 90)	33.23	0.215	0000 09/20	769.0	75.8
WHITE BASS	2	264.5	(260 - 269)	4.50	231.5	(206 - 257)	25.50	0.463	0000 09/20	769.0	75.8
WHITE CRAPPIE	1	243.0	(243 - 243)	0.00	209.0	(208 - 209)	0.00	0.208	0000 09/20	769.0	75.8
YELLOW PERCH	1	126.0	(126 - 126)	0.00	20.0	(20 - 20)	0.00	0.020	0000 09/20	769.0	75.8
HOUR-0000 COUNT =	8							HOUR-0000 WEIGHT =	906(GRAMS)		
GIZZARD SHAD	1	191.0	(191 - 191)	0.00	26.0	(26 - 26)	0.00	0.026	0800 09/20	769.0	75.8
WHITE CATFISH	6	144.3	(53 - 217)	61.31	42.8	(1 - 104)	37.68	0.257	0800 09/20	769.0	75.8
WHITE BASS	1	265.0	(265 - 265)	0.00	233.0	(233 - 233)	0.00	0.233	0800 09/20	769.0	75.8
HOUR-0800 COUNT =	8							HOUR-0800 WEIGHT =	516(GRAMS)		

TOTAL COUNT___ 27 TOTAL WEIGHT_____ 2283(GRAMS) 2.293(KG)

GRAND TOTALS FOR ALL COLLECTING PERIODS
NUMBERS ALL SPECIES = 5140
WEIGHT IN GRAMS = 3,019
WEIGHT IN KILOGRAMS = 31.019

NOTE: THESE FIGURES DO NOT INCLUDE DAMAGED SPECIMENS WITH NEITHER WEIGHT NOR LENGTH NOR DO THEY INCLUDE CORBICULA SHELLFISH OR DRAGON FLIES.

COUNT OF INVERTEBRATES NOT INCLUDED IN ABOVE TOTALS
CORBICULA = 46
FRESHWATER SHRIMP = 61
CRAYFISH = 1
DRAGON FLIES = 1

Species - no weight or length - all = 40

TABLE C-12

SUMMARY OF DAMAGED FISH COLLECTED AT THE VCSNS INTAKE DURING THE STUDY PERIOD

IMPINGEMENT STUDY FOR THE
VIRGIL C. SUMMER NUCLEAR PLANT

PATHOLOGY OF ALL SPECIMENS WITH DAMAGE FOUND AT SCREEN INSPECTION.
PLUS NO IMPINGEMENT FOUND AT SCREEN INSPECTION AT DATE-TIME

YEAR 1983

```
NO SPECIMENS IMPINGED AT 0345-10-28  83 INSPECTION OF SCREENS
PATHOLOGY OF WHITE CATFISH       IMPINGED AT  10 28 83 HOUR 1545 IS DAMAGED,NO ACCURATE BODY WT/LEN POSSIBLE.
PATHOLOGY OF WHITE CATFISH       IMPINGED AT  10 28 83 HOUR 1545 IS DAMAGED,NO ACCURATE BODY WT/LEN POSSIBLE.
PATHOLOGY OF WHITE CATFISH       IMPINGED AT  10 28 83 HOUR 1945 IS DAMAGED,NO ACCURATE BODY WT/LEN POSSIBLE.
NO SPECIMENS IMPINGED AT 2345-10-28  83 INSPECTION OF SCREENS
NO SPECIMENS IMPINGED AT 0000-11-09  83 INSPECTION OF SCREENS
PATHOLOGY OF WHITE CATFISH       IMPINGED AT  11 09 83 HOUR 1200 IS DAMAGED,NO ACCURATE BODY WT/LEN POSSIBLE.
NO SPECIMENS IMPINGED AT 1800-11-22  83 INSPECTION OF SCREENS
PATHOLOGY OF GIZZARD SHAD        IMPINGED AT  12 15 83 HOUR 1600 IS SLIGHT DAMAGE,LESIONS-EYES,FINS MISSING,ETC.
PATHOLOGY OF GIZZARD SHAD        IMPINGED AT  12 29 83 HOUR 0000 IS SLIGHT DAMAGE,LESIONS-EYES,FINS MISSING,ETC.
PATHOLOGY OF GIZZARD SHAD        IMPINGED AT  12 29 83 HOUR 0000 IS SLIGHT DAMAGE,LESIONS-EYES,FINS MISSING,ETC.
PATHOLOGY OF GIZZARD SHAD        IMPINGED AT  12 29 83 HOUR 0000 IS SLIGHT DAMAGE,LESIONS-EYES,FINS MISSING,ETC.
PATHOLOGY OF BLACK CRAPPIE       IMPINGED AT  12 29 83 HOUR 0000 IS SLIGHT DAMAGE,LESIONS-EYES,FINS MISSING,ETC.
PATHOLOGY OF BLACK CRAPPIE       IMPINGED AT  12 29 83 HOUR 0000 IS SLIGHT DAMAGE,LESIONS-EYES,FINS MISSING,ETC.
PATHOLOGY OF GIZZARD SHAD        IMPINGED AT  12 29 83 HOUR 0800 IS SLIGHT DAMAGE,LESIONS-EYES,FINS MISSING,ETC.
PATHOLOGY OF GIZZARD SHAD        IMPINGED AT  12 29 83 HOUR 0800 IS SLIGHT DAMAGE,LESIONS-EYES,FINS MISSING,ETC.
PATHOLOGY OF GIZZARD SHAD        IMPINGED AT  12 29 83 HOUR 0800 IS SLIGHT DAMAGE,LESIONS-EYES,FINS MISSING,ETC.
PATHOLOGY OF GIZZARD SHAD        IMPINGED AT  12 29 83 HOUR 0800 IS DAMAGED,NO ACCURATE BODY WT/LEN POSSIBLE.
PATHOLOGY OF GIZZARD SHAD        IMPINGED AT  12 29 83 HOUR 0800 IS DAMAGED,NO ACCURATE BODY WT/LEN POSSIBLE.
PATHOLOGY OF GIZZARD SHAD        IMPINGED AT  12 29 83 HOUR 1600 IS SLIGHT DAMAGE,LESIONS-EYES,FINS MISSING,ETC.
PATHOLOGY OF GIZZARD SHAD        IMPINGED AT  12 29 83 HOUR 1600 IS SLIGHT DAMAGE,LESIONS-EYES,FINS MISSING,ETC.
PATHOLOGY OF GIZZARD SHAD        IMPINGED AT  12 29 83 HOUR 1600 IS SLIGHT DAMAGE,LESIONS-EYES,FINS MISSING,ETC.
PATHOLOGY OF WHITE CATFISH       IMPINGED AT  12 29 83 HOUR 1600 IS SLIGHT DAMAGE,LESIONS-EYES,FINS MISSING,ETC.
PATHOLOGY OF WHITE CATFISH       IMPINGED AT  12 29 83 HOUR 1600 IS BRUISED
PATHOLOGY OF WHITE CATFISH       IMPINGED AT  12 29 83 HOUR 1600 IS BRUISED
PATHOLOGY OF GIZZARD SHAD        IMPINGED AT  01 12 84 HOUR 0000 IS SLIGHT DAMAGE,LESIONS-EYES,FINS MISSING,ETC.
PATHOLOGY OF GIZZARD SHAD        IMPINGED AT  01 12 84 HOUR 0000 IS DAMAGED,NO ACCURATE BODY WT/LEN POSSIBLE.
PATHOLOGY OF GIZZARD SHAD        IMPINGED AT  01 12 84 HOUR 0000 IS SLIGHT DAMAGE,LESIONS-EYES,FINS MISSING,ETC.
PATHOLOGY OF GIZZARD SHAD        IMPINGED AT  01 12 84 HOUR 0000 IS SLIGHT DAMAGE,LESIONS-EYES,FINS MISSING,ETC.
PATHOLOGY OF GIZZARD SHAD        IMPINGED AT  01 12 84 HOUR 0800 IS DAMAGED,NO ACCURATE BODY WT/LEN POSSIBLE.
PATHOLOGY OF GIZZARD SHAD        IMPINGED AT  01 12 84 HOUR 0800 IS SLIGHT DAMAGE,LESIONS-EYES,FINS MISSING,ETC.
PATHOLOGY OF GIZZARD SHAD        IMPINGED AT  01 12 84 HOUR 0800 IS SLIGHT DAMAGE,LESIONS-EYES,FINS MISSING,ETC.
PATHOLOGY OF GIZZARD SHAD        IMPINGED AT  01 12 84 HOUR 0800 IS DAMAGED,NO ACCURATE BODY WT/LEN POSSIBLE.
PATHOLOGY OF GIZZARD SHAD        IMPINGED AT  01 12 84 HOUR 0800 IS SLIGHT DAMAGE,LESIONS-EYES,FINS MISSING,ETC.
PATHOLOGY OF GIZZARD SHAD        IMPINGED AT  01 12 84 HOUR 0800 IS DAMAGED,NO ACCURATE BODY WT/LEN POSSIBLE.
PATHOLOGY OF GIZZARD SHAD        IMPINGED AT  01 12 84 HOUR 0800 IS SLIGHT DAMAGE,LESIONS-EYES,FINS MISSING,ETC.
PATHOLOGY OF GIZZARD SHAD        IMPINGED AT  01 12 84 HOUR 0800 IS DAMAGED,NO ACCURATE BODY WT/LEN POSSIBLE.
PATHOLOGY OF GIZZARD SHAD        IMPINGED AT  01 12 84 HOUR 0800 IS SLIGHT DAMAGE,LESIONS-EYES,FINS MISSING,ETC.
PATHOLOGY OF GIZZARD SHAD        IMPINGED AT  01 12 84 HOUR 0800 IS SLIGHT DAMAGE,LESIONS-EYES,FINS MISSING,ETC.
PATHOLOGY OF GIZZARD SHAD        IMPINGED AT  01 12 84 HOUR 0800 IS SLIGHT DAMAGE,LESIONS-EYES,FINS MISSING,ETC.
PATHOLOGY OF GIZZARD SHAD        IMPINGED AT  01 12 84 HOUR 0800 IS DAMAGED,NO ACCURATE BODY WT/LEN POSSIBLE.
PATHOLOGY OF WHITE CATFISH       IMPINGED AT  01 12 84 HOUR 0800 IS SLIGHT DAMAGE,LESIONS-EYES,FINS MISSING,ETC.
PATHOLOGY OF GIZZARD SHAD        IMPINGED AT  01 12 84 HOUR 1600 IS DAMAGED,NO ACCURATE BODY WT/LEN POSSIBLE.
PATHOLOGY OF GIZZARD SHAD        IMPINGED AT  01 26 84 HOUR 0000 IS SLIGHT DAMAGE,LESIONS-EYES,FINS MISSING,ETC.
```

IMPINGEMENT STUDY FOR THE
VIRGIL C. SUMMER NUCLEAR PLANT

PATHOLOGY OF ALL SPECIMENS WITH DAMAGE FOUND AT SCREEN INSPECTION.
PLUS NO IMPINGEMENT FOUND AT SCREEN INSPECTION AT DATE-TIME

YEAR 84

PATHOLOGY OF GIZZARD SHAD	IMPINGED AT	01 26 84	HOUR 0800	IS SLIGHT DAMAGE, LESIONS-EYES, FINS MISSING, ETC.
PATHOLOGY OF GIZZARD SHAD	IMPINGED AT	01 26 84	HOUR 0800	IS SLIGHT DAMAGE, LESIONS-EYES, FINS MISSING, ETC.
PATHOLOGY OF GIZZARD SHAD	IMPINGED AT	01 26 84	HOUR 0800	IS SLIGHT DAMAGE, LESIONS-EYES, FINS MISSING, ETC.
PATHOLOGY OF WHITE CATFISH	IMPINGED AT	01 26 84	HOUR 1600	IS FIN ROT
PATHOLOGY OF GIZZARD SHAD	IMPINGED AT	02 10 84	HOUR 0900	IS SLIGHT DAMAGE, LESIONS-EYES, FINS MISSING, ETC.
PATHOLOGY OF GIZZARD SHAD	IMPINGED AT	02 10 84	HOUR 0900	IS SLIGHT DAMAGE, LESIONS-EYES, FINS MISSING, ETC.
PATHOLOGY OF GIZZARD SHAD	IMPINGED AT	02 10 84	HOUR 0900	IS SLIGHT DAMAGE, LESIONS-EYES, FINS MISSING, ETC.
PATHOLOGY OF GIZZARD SHAD	IMPINGED AT	02 10 84	HOUR 1700	IS SLIGHT DAMAGE, LESIONS-EYES, FINS MISSING, ETC.
PATHOLOGY OF GIZZARD SHAD	IMPINGED AT	02 10 84	HOUR 1700	IS SLIGHT DAMAGE, LESIONS-EYES, FINS MISSING, ETC.
PATHOLOGY OF WHITE CATFISH	IMPINGED AT	02 23 84	HOUR 0100	IS SLIGHT DAMAGE, LESIONS-EYES, FINS MISSING, ETC.
PATHOLOGY OF GIZZARD SHAD	IMPINGED AT	02 23 84	HOUR 0900	IS SLIGHT DAMAGE, LESIONS-EYES, FINS MISSING, ETC.
PATHOLOGY OF GIZZARD SHAD	IMPINGED AT	02 23 84	HOUR 0900	IS SLIGHT DAMAGE, LESIONS-EYES, FINS MISSING, ETC.
PATHOLOGY OF WHITE CRAPPIE	IMPINGED AT	02 23 84	HOUR 0900	IS DAMAGED, NO ACCURATE BODY WT/LEN POSSIBLE.
PATHOLOGY OF GIZZARD SHAD	IMPINGED AT	03 08 84	HOUR 0100	IS SLIGHT DAMAGE, LESIONS-EYES, FINS MISSING, ETC.
PATHOLOGY OF GIZZARD SHAD	IMPINGED AT	03 08 84	HOUR 0900	IS SLIGHT DAMAGE, LESIONS-EYES, FINS MISSING, ETC.
PATHOLOGY OF GIZZARD SHAD	IMPINGED AT	03 08 84	HOUR 0900	IS SLIGHT DAMAGE, LESIONS-EYES, FINS MISSING, ETC.
PATHOLOGY OF YELLOW PERCH	IMPINGED AT	03 08 84	HOUR 0900	IS SLIGHT DAMAGE, LESIONS-EYES, FINS MISSING, ETC.
PATHOLOGY OF GIZZARD SHAD	IMPINGED AT	03 08 84	HOUR 1700	IS SLIGHT DAMAGE, LESIONS-EYES, FINS MISSING, ETC.
PATHOLOGY OF GIZZARD SHAD	IMPINGED AT	03 08 84	HOUR 1700	IS SLIGHT DAMAGE, LESIONS-EYES, FINS MISSING, ETC.
PATHOLOGY OF GIZZARD SHAD	IMPINGED AT	03 08 84	HOUR 1700	IS SLIGHT DAMAGE, LESIONS-EYES, FINS MISSING, ETC.
PATHOLOGY OF GIZZARD SHAD	IMPINGED AT	03 08 84	HOUR 1700	IS SLIGHT DAMAGE, LESIONS-EYES, FINS MISSING, ETC.
PATHOLOGY OF CHANNEL CATFISH	IMPINGED AT	03 21 84	HOUR 0100	IS SLIGHT DAMAGE, LESIONS-EYES, FINS MISSING, ETC.
PATHOLOGY OF GIZZARD SHAD	IMPINGED AT	03 21 84	HOUR 0900	IS SLIGHT DAMAGE, LESIONS-EYES, FINS MISSING, ETC.
PATHOLOGY OF CHANNEL CATFISH	IMPINGED AT	03 21 84	HOUR 0900	IS SLIGHT DAMAGE, LESIONS-EYES, FINS MISSING, ETC.
PATHOLOGY OF CHANNEL CATFISH	IMPINGED AT	03 21 84	HOUR 0900	IS SLIGHT DAMAGE, LESIONS-EYES, FINS MISSING, ETC.
PATHOLOGY OF WHITE BASS	IMPINGED AT	03 21 84	HOUR 0900	IS FUNGUS
PATHOLOGY OF YELLOW PERCH	IMPINGED AT	03 21 84	HOUR 1700	IS SLIGHT DAMAGE, LESIONS-EYES, FINS MISSING, ETC.
PATHOLOGY OF GIZZARD SHAD	IMPINGED AT	05 04 84	HOUR 0100	IS DAMAGED, NO ACCURATE BODY WT/LEN POSSIBLE.
PATHOLOGY OF THREADFIN SHAD	IMPINGED AT	05 04 84	HOUR 0100	IS SLIGHT DAMAGE, LESIONS-EYES, FINS MISSING, ETC.
PATHOLOGY OF CHANNEL CATFISH	IMPINGED AT	05 04 84	HOUR 0100	IS DAMAGED, NO ACCURATE BODY WT/LEN POSSIBLE.
PATHOLOGY OF CHANNEL CATFISH	IMPINGED AT	05 04 84	HOUR 0900	IS SLIGHT DAMAGE, LESIONS-EYES, FINS MISSING, ETC.
PATHOLOGY OF BLUEGILL	IMPINGED AT	05 04 84	HOUR 0900	IS ENDO PARASITE
PATHOLOGY OF GIZZARD SHAD	IMPINGED AT	05 04 84	HOUR 1700	IS SLIGHT DAMAGE, LESIONS-EYES, FINS MISSING, ETC.
PATHOLOGY OF CHANNEL CATFISH	IMPINGED AT	05 04 84	HOUR 1700	IS DAMAGED, NO ACCURATE BODY WT/LEN POSSIBLE.
PATHOLOGY OF CHANNEL CATFISH	IMPINGED AT	05 04 84	HOUR 1700	IS SLIGHT DAMAGE, LESIONS-EYES, FINS MISSING, ETC.
PATHOLOGY OF WHITE CATFISH	IMPINGED AT	05 16 84	HOUR 0100	IS DAMAGED, NO ACCURATE BODY WT/LEN POSSIBLE.
PATHOLOGY OF WHITE CATFISH	IMPINGED AT	05 16 84	HOUR 0100	IS FUNGUS
PATHOLOGY OF WHITE CATFISH	IMPINGED AT	05 16 84	HOUR 0100	IS DAMAGED, NO ACCURATE BODY WT/LEN POSSIBLE.
PATHOLOGY OF BROWN BULLHEAD	IMPINGED AT	05 16 84	HOUR 0100	IS DAMAGED, NO ACCURATE BODY WT/LEN POSSIBLE.
PATHOLOGY OF CHANNEL CATFISH	IMPINGED AT	05 16 84	HOUR 0100	IS DAMAGED, NO ACCURATE BODY WT/LEN POSSIBLE.
PATHOLOGY OF CHANNEL CATFISH	IMPINGED AT	05 16 84	HOUR 0100	IS DAMAGED, NO ACCURATE BODY WT/LEN POSSIBLE.

IMPINGEMENT STUDY FOR THE
VIRGIL C. SUMMER NUCLEAR PLANT

PATHOLOGY OF ALL SPECIMENS WITH DAMAGE FOUND AT SCREEN INSPECTION
PLUS NO IMPINGEMENT FOUND AT SCREEN INSPECTION AT DATE-TIME

```
    YEAR   84
PATHOLOGY OF CHANNEL CATFISH     IMPINGED AT  05 16 84 HOUR 0100 IS DAMAGED, NO ACCURATE BODY WT/LEN POSSIBLE.
PATHOLOGY OF CHANNEL CATFISH     IMPINGED AT  05 16 84 HOUR 0100 IS DAMAGED, NO ACCURATE BODY WT/LEN POSSIBLE.
PATHOLOGY OF FLAT BULLHEAD       IMPINGED AT  05 16 84 HOUR 0100 IS SLIGHT DAMAGE, LESIONS-EYES, FINS MISSING, ETC.
PATHOLOGY OF WARMOUTH            IMPINGED AT  05 16 84 HOUR 0100 IS DAMAGED, NO ACCURATE BODY WT/LEN POSSIBLE.
PATHOLOGY OF BLUEGILL            IMPINGED AT  05 16 84 HOUR 0100 IS ENDO PARASITE
PATHOLOGY OF BLACK CRAPPIE       IMPINGED AT  05 16 84 HOUR 0100 IS DAMAGED, NO ACCURATE BODY WT/LEN POSSIBLE.
PATHOLOGY OF WHITE CATFISH       IMPINGED AT  05 16 84 HOUR 0900 IS FUNGUS
PATHOLOGY OF WHITE CATFISH       IMPINGED AT  05 16 84 HOUR 0900 IS DAMAGED, NO ACCURATE BODY WT/LEN POSSIBLE.
PATHOLOGY OF CHANNEL CATFISH     IMPINGED AT  05 16 84 HOUR 0900 IS DAMAGED, NO ACCURATE BODY WT/LEN POSSIBLE.
PATHOLOGY OF CHANNEL CATFISH     IMPINGED AT  05 16 84 HOUR 0900 IS DAMAGED, NO ACCURATE BODY WT/LEN POSSIBLE.
PATHOLOGY OF CHANNEL CATFISH     IMPINGED AT  05 16 84 HOUR 0900 IS DAMAGED, NO ACCURATE BODY WT/LEN POSSIBLE.
PATHOLOGY OF WHITE CATFISH       IMPINGED AT  05 16 84 HOUR 1700 IS SLIGHT DAMAGE, LESIONS-EYES, FINS MISSING, ETC.
PATHOLOGY OF CHANNEL CATFISH     IMPINGED AT  05 16 84 HOUR 1700 IS DAMAGED, NO ACCURATE BODY WT/LEN POSSIBLE.
PATHOLOGY OF CHANNEL CATFISH     IMPINGED AT  05 31 84 HOUR 0100 IS DAMAGED, NO ACCURATE BODY WT/LEN POSSIBLE.
PATHOLOGY OF CHANNEL CATFISH     IMPINGED AT  05 31 84 HOUR 0900 IS DAMAGED, NO ACCURATE BODY WT/LEN POSSIBLE.
PATHOLOGY OF WHITE CATFISH       IMPINGED AT  06 14 84 HOUR 0100 IS DAMAGED, NO ACCURATE BODY WT/LEN POSSIBLE.
PATHOLOGY OF BLUEGILL            IMPINGED AT  06 14 84 HOUR 0900 IS SLIGHT DAMAGE, LESIONS-EYES, FINS MISSING, ETC.
PATHOLOGY OF CHANNEL CATFISH     IMPINGED AT  06 28 84 HOUR 0900 IS SLIGHT DAMAGE, LESIONS-EYES, FINS MISSING, ETC.
PATHOLOGY OF THREADFIN SHAD      IMPINGED AT  07 12 84 HOUR 0600 IS DAMAGED, NO ACCURATE BODY WT/LEN POSSIBLE.
PATHOLOGY OF CHANNEL CATFISH     IMPINGED AT  07 12 84 HOUR 1400 IS DAMAGED, NO ACCURATE BODY WT/LEN POSSIBLE.
PATHOLOGY OF BLUEGILL            IMPINGED AT  07 12 84 HOUR 1400 IS DAMAGED, NO ACCURATE BODY WT/LEN POSSIBLE.
PATHOLOGY OF WHITE CATFISH       IMPINGED AT  07 12 84 HOUR 2200 IS DAMAGED, NO ACCURATE BODY WT/LEN POSSIBLE.
NO SPECIMENS IMPINGED AT 1500-07-26  84 INSPECTION OF SCREENS
NO SPECIMENS IMPINGED AT 1530-08-10  84 INSPECTION OF SCREENS
NO SPECIMENS IMPINGED AT 0500-08-23  84 INSPECTION OF SCREENS
PATHOLOGY OF CHANNEL CATFISH     IMPINGED AT  09 05 84 HOUR 0330 IS DAMAGED, NO ACCURATE BODY WT/LEN POSSIBLE.
PATHOLOGY OF WHITE CATFISH       IMPINGED AT  09 20 84 HOUR 0000 IS DAMAGED, NO ACCURATE BODY WT/LEN POSSIBLE.
```

APPENDIX D

ECOLOGICAL SUMMARIES OF IMPORTANT FISH SPECIES

APPENDIX D

ECOLOGICAL SUMMARIES OF IMPORTANT FISH SPECIES

Gizzard Shad (Dorosoma cepedianum)

The gizzard shad is highly esteemed as a forage fish, when less than 2 years old, and forms an important link in the food web of game fish as well as other species. Often they tend to overpopulate, especially in impoundments, and an over abundance of large individuals tends to have a negative effect on the sport fishery. The species is tolerant of excessive turbidity and waters that support little or no vegetation and sparse benthic fauna. Studies of food habits indicate that phytoplankton and zooplankton are their most important food items. Gizzard shad, especially young-of-the-year individuals, are typically found in large schools made up of a single age-class of fish.

Gizzard shad spawn during May and June, and a second spawn may occur in late summer. They spawn at temperatures ranging from 17.8°C to 23.9°C (64°F to 75°F). They spawn pelagically, scattering eggs without any preparation of nest site; they prefer shallow water away from the shore, but have been observed spawning at the surface over deep water. The eggs are very adhesive and may float or sink, or adhere to submerged or floating objects. Fecundity of shad has been determined to be approximately 40,500 ova. A decline in fecundity with increase in size and age of fish has been noted. Gizzard shad are not hardy fish and may quickly succumb to abrupt changes in temperature of the water or reduction in its dissolved oxygen content (Jester, et al., 1972).

Yellow Perch (*Perca flavescens*)

Yellow perch range along the Atlantic coastal states from Nova Scotia to South Carolina. Although they may be found in rivers, yellow perch prefer sluggish or still water and are most typically found in lakes. Sandy or rocky bottoms seem to be favored habitat. Yellow perch are found in schools throughout their life.

Spawning takes place early in the spring (early March in Monticello Reservoir) when the water temperature reaches 8°C to 10°C. The eggs are imbedded in long gelatinous strings that adhere to the substrate. Fecundity ranges between 10,000 to 75,000 ova and up to one-half the ova may become fertilized under favorable conditions (McClane, 1974). The young are heavily preyed upon and the survival rate is very low during the first year of life. During the second and third years of life, mortality accounts for 60 to 80 percent of the population each year. Sexual maturity is reached at 3 to 4 years.

The food of the yellow perch consists of invertebrates, such as insects, crayfish, snails, and small fish.

White Catfish (*Ictalurus catus*)

White catfish are found from New York to Florida in slow flowing streams, rivers, ponds, and lakes. The preferred habitat of white catfish are areas with silty bottoms (although they are common in the riprapped areas of Monticello Reservoir).

Spawning occurs at temperatures of about 20°C in a large concave nest. Eggs are adhesive and fecundity is said to be 4,000 ova for a 12-inch female.

White catfish are omnivorous, but they seem to prefer fish (McClane, 1974).

Bluegill (*Lepomis macrochirus*)

Bluegill originally ranged from southern Ontario south through the Great Lakes and Mississippi drainages to Georgia, Texas, and Northeastern Mexico. Widespread introduction have greatly extended this range.

The bluegill is found mainly in ponds, lakes, and sluggish streams. They prefer protected areas with clear, quiet water, scattered beds of vegetation, or underwater obstructions, and a bottom of sand or gravel.

Bluegill feed mainly on zooplankton and aquatic insects. Other foods ingested include small fish, fish eggs, snails, small crayfish, and amphipods.

Bluegills spawn over an extended period of time, beginning when water temperatures reach 21°C and continue until cool weather occurs in the fall (Pflieger, 1975). The extended period of spawning is due to differential maturity of fish or of eggs within a single fish. The peak of the spawning season usually occurs in May or early June. Fecundity of the bluegill averages about 18,000 ova per fish. The eggs are adhesive and are deposited in a prepared nest which is typically dished out of sand or gravel.

Largemouth Bass (*Micropterus salmoides*)

The original distribution of the largemouth bass ranged from southeastern Canada throughout the Great Lakes region southward through the Mississippi Valley to Mexico and Florida, and on the Atlantic coast as far north as Virginia. It is one of the most important game fishes, and is widely introduced.

Largemouth bass prefer nonflowing waters such as lakes, ponds, and impoundments that have clear water and aquatic vegetation. Largemouth bass are often found in close association with substrate irregularities such as rocks, stumps, tree tops, or riprap. Turbidity is detrimental to growth and reproduction. Young largemouth bass feed largely on zooplankton and small crustaceans, and as the fish mature they eat larger foods such as aquatic insect larvae; adult largemouth bass eat mainly fish, but they also take worms, mussels, frogs, crayfish, and snails (Clay, 1975).

Largemouth bass normally begin spawning in late April and continue until early July when water temperatures range from 16°C to 18°C. Bass prefer a substrate such as sand, gravel, roots, or aquatic vegetation for spawning. They will not spawn on silt bottoms. Fecundity has been estimated to be about 5,000 eggs per fish.

APPENDIX E

LIFE HISTORY INFORMATION OF IMPINGED FISH

TABLE E-1

PREFERRED HABITAT, SPAWNING SITES, SPAWNING TEMPERATURE, TYPE OF EGGS, AND NURSERY AREA OF IMPINGED FISH SPECIES

Species	Preferred Habitat	Spawning Sites	Spawning Temperature (°C)	Type of Eggs	Nursery Area
Longnose gar	Lakes, coves, rivers, backwaters; sluggish current or still water	Shallow bays and sloughs	March-August Peak in April	Adhesive	Open water
Threadfin shad	Open water; impoundments	Underbrush, floating logs or in open water	17-21°C	Adhesive	?
Yellow bullhead	Shallow portions of lakes, sluggish streams, over soft bottoms	Nest under objects or in burrows or holes in bank	? May or June	Adhesive	?
Flat bullhead	Streams, lakes, and ponds; soft muck, mud or sand bottoms	Probably in sheltered area	?	Adhesive	?
Channel catfish	Shelter in deep pools in moderate to swiftly flowing streams; feed in riffles	Nest in natural cavities (e.g., hollow logs) in turbid water	21-29°C (optimum: 27)	Adhesive	Riffles, especially
Flier	Typically in small streams, swamps, or backwaters	Shallow water	17°C	Adhesive	Shallow water
Pumpkinseed	Standing water, soft bottom, organic debris	Nest in sand and gravel in shallow water	15-18°C	Adhesive	Near surface and debri

TABLE E-1 (Continued)

Species	Preferred Habitat	Spawning Sites	Spawning Temperature (°C)	Type of Eggs	Nursery Area
Warmouth	Clear waters with abundant vegetation and mucky bottom; low current or, preferably, oxbows and impoundments	Nest over rubble bottom lightly covered with silt or detritus; nest near objects (e.g., stumps)	?	Adhesive; demersal	?
Redear	Large, quite waters with logs, stumps, or obstructions	Nest in vicinity of obstructions	21-24°C	Adhesive	Shallow water
White crappie	Stilty rivers and lakes, soft or hard bottom common in southern impoundments	Nest in water up to 8 feet deep		Adhesive	?
Black crappie	Clear, slow, warm deep water over hard or soft bottom; often around aquatic vegetation	Nest in bare spots among aquatic vegetation or along undercut river banks	17-27°C	Adhesive; demersal	Move to deep, open water when leaving nest
White bass	School in open; clear water over a hard bottom	Open water over gravel bottom; also riffle areas and shallow water among rocks	13-16°C	Adhesive; demersal	Shallow areas near river banks