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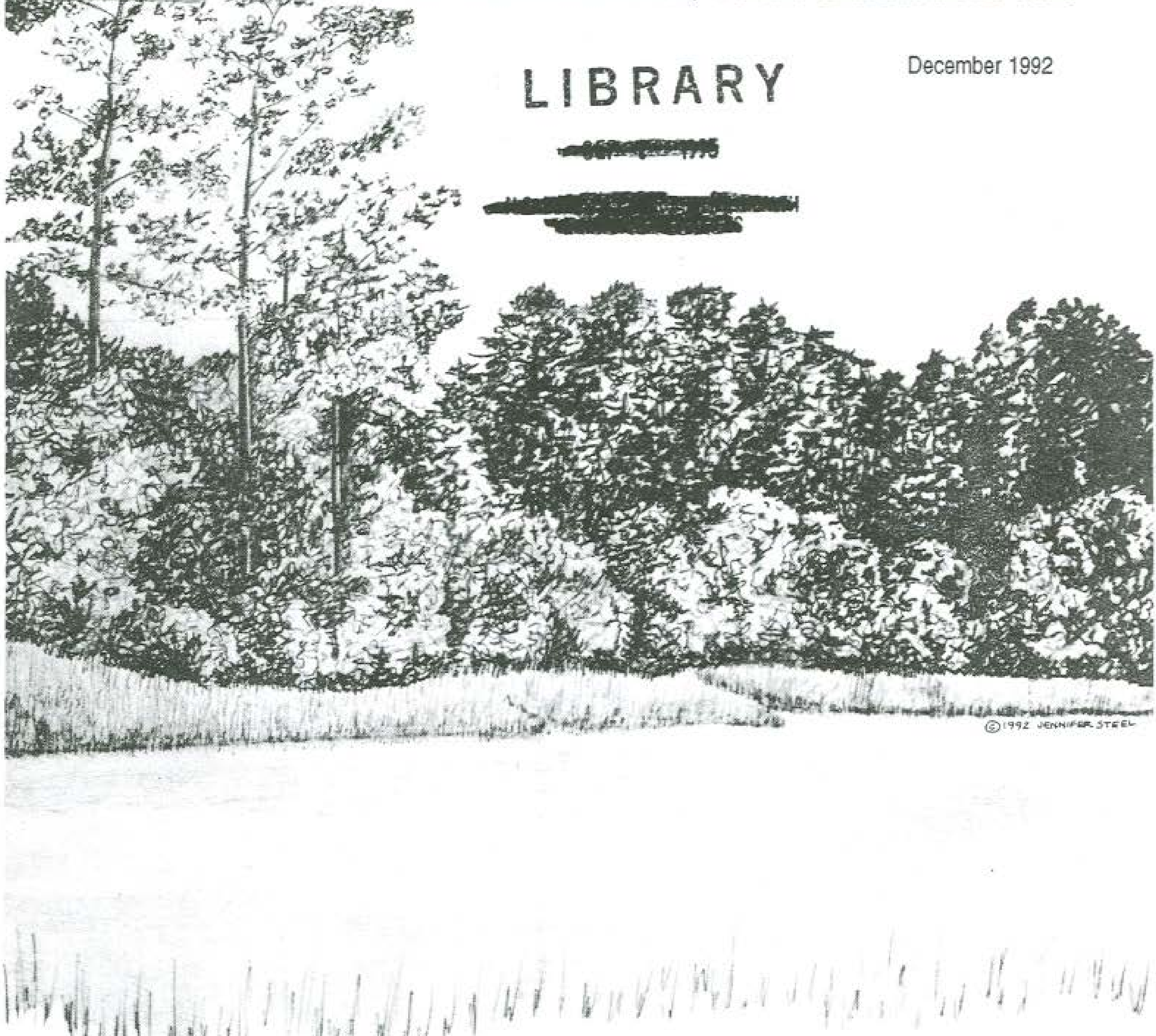

ALBEMARLE-PAMLICO ESTUARINE STUDY

NC Department of
Environment, Health,
and Natural Resources

Environmental
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ABUNDANCE AND VIABILITY OF STRIPED BASS EGGS SPAWNED IN THE ROANOKE RIVER, NORTH CAROLINA, IN 1990

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ABSTRACT

Sampling to estimate production and viability of striped bass eggs was conducted at Barnhill's Landing on the Roanoke River, North Carolina, from 16 April to 15 June 1990. Samples were taken by trailing paired nets at the surface from a small boat for five minutes every four hours for 60 days in the manner established and used by W.W. Hassler since 1959. A total of 5,309 eggs were collected in surface nets: first eggs appeared in samples on 24 April and the last eggs were collected on 12 June for a continuous spawning window of 50 days. The annual egg production estimate was 965,384,988 eggs $\pm$32,190,094. Major egg deposition was observed after water temperature reached 18°C, a phenomenon observed in 1988 and 1989. Three major spawning peaks, all early in the season, were observed in 1990: 2-3 May, 7 May, and 10 May. Although the spawning window was much longer than in 1988 and 1989, nearly half of the seasonal egg production was completed by 9 May, 80% was completed by 16 May, and 98% was completed by 1 June. Egg viability was estimated as 58.5%; only a small portion of data variability was explained by dissolved oxygen and river stage (R^2=0.11). Most eggs passing Barnhill's Landing were less than 10 hours old (71%), and an additional 29% were 10-18 hours old. About 95% of the eggs were collected in water temperatures of 18.0-21.9°C, and most were caught in surface water velocities of less than 100 cm/second. A general decline in dissolved oxygen occurred during the study, from a high of 9.5 mg/L in April to a low of 6.5 mg/L in mid-June. Most eggs were collected in waters of 7.0-8.9 mg/L dissolved oxygen. Roanoke River waters at Barnhill's Landing remained above 7.0 pH during the study; most eggs were collected in water of 7.0-7.74 pH. In 1990, oblique tows collected significantly greater numbers of eggs than surface tows. Daily egg production estimates calculated by the Hassler method (averaging over 24 hours) and on a per trip basis were significantly different. The **yearly** egg production estimates produced by both methods were not statistically different. The Hassler method generates a single daily egg estimate with no estimate of variability. The trip method produces a daily egg estimate and an estimate of data variability. Daily egg production estimates calculated by cross-sectional area of the river, and by river volume, were significantly different. However, in 1990 the **yearly** egg production estimates were statistically similar. Cross-sectional area calculations may underestimate the number of eggs in the river in high flow years provided that the major spawning activity occurred during the periods of high flow. The annual Roanoke River striped bass egg studies should be regarded as a relative index of striped bass activity among years, and daily activity within a season. The value in these studies is the documentation of striped bass spawning activity relative to changing environmental conditions, especially human-related activities such as hydroelectric generation upstream.

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INTRODUCTION

Striped bass (*Morone saxatilis*) inhabiting Albemarle Sound and its tributaries support important recreational and commercial fisheries in coastal North Carolina (Johnson et al. 1986; USDOI and USDOC 1986). The major spawning area for Albemarle Sound striped bass is located in the Roanoke River, which discharges through several channels into the western end of Albemarle Sound (Figure 1). Since the mid-1970s, these fisheries have suffered due to reduced numbers of harvestable adults. Population decline may be caused by a number of factors such as reduced egg viability (Hassler et al. 1981), poor food availability for larvae (Rulifson et al. 1992), and poor survival of juveniles on the nursery grounds of the western Sound.

Studies on egg abundance and viability have been conducted each year since the mid-1950s by Dr. W.W. Hassler and co-workers from North Carolina State University in Raleigh. These daily records have been an important source of information for reconstructing the historical spawning record in relation to exploitation, changes in fishing regulations, and man-induced changes in the flow regime and water quality for the Roanoke River watershed. Funds provided by the Albemarle-Pamlico Estuarine Study (APES) to East Carolina University in the spring of 1988 allowed the continuation of the study. This manuscript follows information obtained during the 1988 and 1989 spawning seasons (Rulifson 1989, 1990), and summarizes the results of the 1990 striped bass spawning season.

The manner in which water is released from dams in this watershed, and its effects on downstream natural resources, has been scrutinized closely at various times since construction of the first dam -- John H. Kerr Reservoir -- in 1952. Many of these studies have focused on striped bass spawning activity, and the resultant survival of eggs and young-of-year.

The primary spawning ground for Albemarle striped bass is located in the Roanoke River between Halifax (RM 120) and Weldon (RM 130), North Carolina. Spawning grounds farther upstream were blocked by construction of the Roanoke Rapids Dam (RM 137) in 1955 (McCoy 1959). Spawning activity begins in April and is completed by mid-June (Hassler et al. 1981). Once spawned, the fertilized eggs develop to the hatching stage as they are transported downstream by currents. After hatching, the larvae are transported through the distributaries of the delta to the nursery grounds of western Albemarle Sound (Rulifson et al. 1992). Under moderate flow conditions, eggs are semi-buoyant and begin to hatch near the town of Hamilton (RM 57). Larvae are then ready to begin feeding in the lower Roanoke River and delta, which is the area of greatest food concentration for this life stage. Under high river flow conditions, the eggs may be carried into the floodplain; those eggs remaining in the river are transported too quickly downstream and are flushed out of the river and into western Albemarle Sound. Under low river conditions, the eggs sink and hatch too far upstream; larvae have little food resources and starve before reaching better foraging areas downstream (Rulifson et al. 1992).

Reservoir discharge effects on striped bass was one of the reasons for forming a Steering Committee for Roanoke River Studies in 1955. The Committee was composed of state, federal, and private agencies and interests whose objective was to conduct a comprehensive study of the river in order to minimize multiple use conflicts (Hassler and Taylor 1986). The findings of the Committee were discussed in detail by Fish (1959). The cooperative Roanoke-Albemarle Striped Bass Studies were initiated in 1955 as part of the Steering Committee studies. Original support for these efforts was provided by the National Council for Stream Improvement, Weyerhaeuser Company, and Albemarle Paper Manufacturing Company. Weyerhaeuser Company continued their support of the studies after 1958 when the Steering Committee studies were terminated; cooperative field work was resumed in 1975 with the U.S. Fish and Wildlife Service and North Carolina Division of Marine Fisheries under the auspices of the Anadromous Fish Conservation Act (PL 89-304).

In the mid-1980s, water quality and watershed management of the lower Roanoke River basin were again key issues for several reasons: the initiation of the Albemarle-Pamlico Estuarine Study; the controversy over interbasin transfer of water for municipal use by the City of Virginia Beach; the establishment of the Roanoke National Wildlife Refuge within the floodplain of the lower Roanoke River; and the continued decline of the Roanoke/Albemarle striped bass stock. These events all had the common concern of how the flow regime is managed by the system of reservoirs located in the Piedmont region of the watershed, especially during the spring spawning season.

In 1988, an *ad hoc* group was formed to investigate the modification of Roanoke River instream flow below Roanoke Rapids Dam for striped bass and other downstream resources. The Roanoke River Water Flow Committee was comprised of 20 representatives of State and Federal agencies and university scientists. The purpose of the Committee was to gather information on all resources of the lower watershed and recommend a flow regime that was beneficial to the downstream resources and their users. Striped bass as a resource received the most attention because of its great social and economic importance to this region, and because of the extensive data base established by Dr. Hassler. Detailed descriptions of the Flow Committee findings were presented elsewhere (Manooch and Rulifson 1989; Rulifson and Manooch 1990a, 1991).

At the present time, the manner in which waters are released from Roanoke Rapids Dam is governed by a tri-party agreement involving the U.S. Army Corps of Engineers, Virginia Power, and the North Carolina Wildlife Resources Commission. Provisions for minimum flows from the reservoir were established by the Memorandum of Understanding (MOU) signed in 1971, but no guidelines were given for maximum flows or for the manner in which the average daily discharge is derived. For example, under present guidelines the dam operator can double or cut in half the rate of discharge through the turbines every two hours to optimize on-demand hydropower generation. A discharge of 5,000 cfs (cubic feet per second) can increase to 10,000 cfs within two hours, and then to 20,000 cfs within three hours. These sudden changes in the flow regime result in dramatic changes in water depth on the spawning grounds within a several-hour period. The effects of reservoir discharge on striped bass spawning activity have been documented (Rulifson and Manooch 1990b, Zincone and Rulifson 1991).

The study described herein was undertaken with several objectives in mind: 1) to continue the data base established by Dr. Hassler; 2) to develop a method to backcalculate Hassler's data in an egg density-per-unit-volume format (to compensate for changes in the flow regime); and 3) to relate striped bass spawning activity (as measured by egg production) to water releases from the reservoir at Roanoke Rapids, North Carolina.

STUDY SITE DESCRIPTION

The Roanoke River is a major coastal floodplain river originating in the Appalachian Ridge in Virginia and discharging into the western end of Albemarle Sound in North Carolina (Figure 1). The watershed encompasses 9,666 square miles (25,033 km^2), making it the largest basin of any North Carolina estuary (Giese et al. 1985). Waters descend 2,900 feet from the origin to the estuary, a distance of 410 miles.

Flow of the Roanoke River is highly regulated by a number of reservoirs upstream: Smith Mountain Lake, Philpott Lake, and Leesville Lake in Virginia; John H. Kerr Reservoir and Lake Gaston in Virginia and North Carolina; and Roanoke Rapids Lake in North Carolina. Of these, the Roanoke Rapids Reservoir located at River Mile (RM) 137 exerts direct influence on instream flow of the lower river; approximately 87% of the flow to the coastal watershed is provided by its discharge (Giese et al. 1985). Average annual discharge of the river at Weldon, North Carolina (USGS gage), is about 8,100 cfs (1912-1990, Rulifson et al. 1992). The watershed itself contributes approximately 50% of the freshwater input to Albemarle Sound.

METHODS

The field station in 1990 was located at Barnhill's Landing (RM 117), the site of Hassler's sampling efforts during the period from 1975 to 1981 and the 1989 egg study (Rulifson 1990). This area is located (Appendix Table A-2) approximately three miles below the primary spawning grounds and about 12 river miles upstream of the Pollock's Ferry site used in the 1988 (Rulifson 1989) study (Figure 2). The study was initiated on 16 April and was terminated on 15 June 1990.

Striped bass eggs were collected in a manner similar to that described in Hassler's annual reports and to that used in the 1988 and 1989 studies (Rulifson 1989, 1990). Samples were taken six times daily at four-hour intervals (0200, 0600, 1000, 1400, 1800, and 2200 hours) by trailing paired 10-inch diameter nets constructed of 500-um nitex mesh (6:1 tail-to-mouth ratio) from a small aluminum boat anchored in mid-stream. A solid cup attached to the tail of each net was used to retain collected eggs. Five-minute tows were made six inches below the surface (Hassler's method). Also, vertical heterogeneity of egg dispersal was estimated by paired-net egg samples at the surface and in an oblique manner. Egg production for each trip was calculated by using the ratio of the opening of the egg net to the estimated cross-sectional area of the river multiplied by the average number of eggs caught in either the surface nets or oblique-towed nets in five minutes. A flowmeter with slow speed propeller was attached to the bongo frame so that the theoretical volume of water filtered could be estimated. This methodology produced two estimates of egg production: 1) an estimate of egg density per unit of water filtered; and 2) an estimate of total eggs in the cross-sectional area of the river (Hassler's method). The cross-sectional area of the river at the sampling site was determined for the range of water levels encountered during the study. River stage, air and water temperature, dissolved oxygen, conductivity, pH, total dissolved solids, and water velocity were recorded for each sample. Secchi visibility depth was recorded for all samples taken during daylight hours.

Samples were returned to the field station for immediate examination. Eggs collected by both nets were enumerated and averaged for each surface tow and each oblique tow. For each sample, all eggs were examined to determine viability and stage of development. Egg viability was determined as described by Hassler et al. (1981): each egg was examined to determine the status of the embryo (development), the yolk and oil globules (intact or broken), the perivitelline space (cloudy or clear), and the chorion (intact or broken). Eggs were staged under a dissecting microscope using the criteria established by Bonn et al. (1976). Stage 1 was eggs less than 10 hours old, which is the time at which the blastula ring appears. Stage 2 was eggs 10 to 18 hours old; at 20 hours old, the larval shape is clearly discernable. Stage 3 eggs were 20 to 28 hours old; at 30 hours, the tail portion detaches from the egg mass. Stage 4 eggs were 30 to 38 hours old. Stage 5 were eggs 40 hours and older, and newly-hatched larvae. Stage of development was based on an assumed water temperature of 17°C; eggs spawned at water temperatures greater than this value will develop faster and hatch earlier (Hassler et al. 1981).

Data were entered into the mainframe computer at East Carolina University and analyzed using the Statistical Analysis System, Version 5 (SAS 1985). The estimated number of striped bass eggs passing the sampling station was calculated on a daily basis using the equation developed by Hassler:

$$N = 514.29\,XY, \qquad (1)$$

where N = the estimated number of striped bass eggs spawned during the 24-hour period; X = the mean number of striped bass eggs collected per surface sample during the 24-hour period (12 samples maximum); and Y = the cross-sectional area of the river in square feet for mean river stage during the 24-hour period. The constant 514.29 was derived from the number of five-minute intervals in a 24-hour period (288) multiplied by the relationship of 1.0 ft^2 of river area to the mouth opening of the 10-inch diameter egg net (0.56 ft^2, equaling a ratio of 1:1.785714). Only surface samples were used in the daily egg production estimates so that data were comparable to Hassler's database.

Statistical analysis of the egg count data was performed using the SAS UNIVARIATE procedure to determine distribution of the data. Normal probability plots indicated that transformation of the count data was required; natural log transformation reduced skewness and kurtosis better than square root transformation. UNIVARIATE was used to test for daily differences in egg counts between paired nets, or between surface and bottom samples. The procedure NPAR1WAY was used to test for differences in the yearly egg production estimates calculated by the Hassler method, the trip method, and by substituting volume for cross-sectional area.

RESULTS

Approximately 98% of the scheduled sampling trips were completed in 1990 (Appendix Table A-3). The remaining trips (8 of 358) were incomplete or were not attempted due to unfavorable weather and equipment failure.

Egg Production and Viability

The estimated number of striped bass eggs produced in 1990 was 965,384,988 (n=61, S.D. 32,190,094) from a total of 5,309 eggs collected in surface nets. Samples were first taken on 16 April; the first eggs appeared in Barnhill samples on 24 April (Table 1). Spawning activity in 1990 occurred later than that observed in 1988 (12 April) and 1989 (16 April). Spawning activity continued through 12 June 1990 at which time the last eggs appeared in the samples. This late spawning activity was prolonged compared to 1988 (2 June) and 1989 (9 June). Sampling was terminated on 15 June. Whether spawning occurred after 15 June is unknown. The 50-day spawning period had only two days (30 May and 8 June) in which eggs were not collected; however, spawning activity on those days was suggested by the age of the eggs collected after midnight the following day. Thus, the 50-day continuous spawning period observed in 1990 was much longer than that observed in 1988 (27 days) and 1989 (23 days).

During the 1990 spawning season, three spawning peaks were observed. All three occurred early in the spawning season: 2-3 May, 7 May, and 10 May (Figure 3). Seasonal egg production was approximately 46% complete by 9 May, 66% complete by 10 May, 80% complete by 16 May, and 98% complete by 1 June (Table 1, Figure 4). Even though the spawning period was later and twice as long as either of the previous two years, most of the egg production was completed 5 days earlier than in 1988 and two weeks earlier than in 1989.

Viability of striped bass eggs for 1990 was estimated to be 58.5% (Table 2). No seasonal trend in egg viability was evident (Table 3, Figure 5). Relationships between surface egg viability and various environmental parameters were examined using several statistical procedures. Striped bass eggs were collected in surface nets on 149 trips. Egg viability data from these trips were not normally distributed (Kolmogorov-D statistic = 0.088; $P<0.01$) using the UNIVARIATE procedure (SAS 1985). The data were transformed using an arcsin square root function, and then subjected to a correlation analysis to determine those environmental variables significantly related (alpha 0.05) to egg viability. Appropriate environmental variables and egg viability were subjected to a weighted least squares analysis, with the analysis weighted by the number of eggs in the sample. Results indicated that none of the environmental variables explained much of the variability in viability of eggs collected at the surface or by oblique tows. Variability in surface egg viability was only partially explained by changes in dissolved oxygen and river stage (df=2, 145; F=8.75; P=0.0003; R^2=0.11; Mallow's statistic=5.02). Variability in oblique egg viability was partially explained by water temperature and dissolved oxygen (df=2, 157; F=7.03; P=0.0012; R^2=0.082; Mallow's statistic=9.77).

A total of 5,761 eggs was examined throughout the season to determine stage of development; nearly all examined were in the early developmental stages. The majority of the eggs (70.8%, or 4,078) was less than 10 hours old. An additional 29% (1,676) were between 10 and 18 hours old. About 0.1% (6 eggs) were 20-28 hours old, and only one egg was more than 30 hours in age. No post-hatch striped bass larvae were observed in the samples.

Water temperatures ranged from 14.0 to 23.5° C during the study. As in years previous, the major spawning activity was initiated after water temperatures reached 18°C (Figure 6). Approximately 95% of all eggs were spawned between 18°C and 21.9°C (Table 4). Water temperatures remained above 18°C after 25 April, with the exception of one observation at 1000 hours on 28 April (Appendix Table A-4). River temperatures changed seasonally more than diurnally. The correlation coefficient for the water temperature-air temperature relationship was only 0.29 (n=355; P=0.0001), due primarily to the rather stable water temperature (Figure 6) relative to the diurnal variability of air temperature (Figure 7). An excessive basinwide rainfall in late May (3.68 inches above normal) resulted in high volume reservoir discharge in late May through mid-June (Figure 8). This pattern of events resulted in a water temperature-date (seasonal) relationship of 0.88 (n=355; P=0.001). No trend in egg viability related to water temperature was evident (Table 4).

Surface water velocities ranged from a low of 56.6 cm/second on 2 May to a high of 125.5 cm/second on 29 May corresponding to the change in river height at Barnhill's Landing (Figure 9). A high positive correlation coefficient of 0.91 (n=349; P=0.0001) between river stage and water velocity was evident. Most eggs were spawned at surface water velocities less than 100 cm/second, with a trend of higher egg viability at the lower velocities (Table 5).

The depth of secchi disk visibility varied between a low of 45 cm on 21 April and 27 May, to a high of 90 cm throughout the study (Figure 10). Low values indicated increased turbidity, a result of changing water level in the river. Although the low values corresponded with river fluctuation events, the overall correlation coefficients between secchi visibility and river stage, and secchi and water velocity, were not significant. This result was expected since the maximum visibility in the system appears to be about 90 cm after waters stabilize.

Conductivity of Roanoke River waters flowing past Barnhill's Landing was low throughout the study, ranging from about 60 to 110 µS (Figure 11). Lowest conductivity values coincided with a sudden decrease in reservoir release in late April (Figures 8 and 9).

Egg distribution patterns in samples indicated a diurnal spawning pattern. Egg abundance was lowest in afternoon and evening samples, and highest between 0200 and 1000 hours (Table 6). Pinpointing the exact upstream location of major spawning activity is difficult. However, a general estimation can be made using the stage of egg development and water velocity. Nearly 71% of the eggs were <10 hours old, and an additional 29% were 10-18 hours old. About 65% of the eggs were collected in water velocities of 60-80 cm/second, and an additional 26% were collected at water velocities 80-100 cm/second. The mean water velocity for the study was approximately 88 cm/second (2.88 ft/second). Thus, major spawning occurred from just downstream of the dam at RM 137 to just upstream of Barnhill's Landing, perhaps RM 119.

Levels of dissolved oxygen in Roanoke River waters decreased gradually throughout the study, falling from a high of 9.5 mg/L to a low of about 6.5 mg/L in mid-June (Figure 12). Increasing water temperature was likely responsible for decreased dissolved oxygen levels; the Pearson correlation coefficient was -0.75 (n=353; P=0.0001). Most eggs were collected at dissolved oxygen levels of 7.0-8.9 mg/L (Table 7).

The pH of Roanoke River waters remained above 7.0 for most of the study (Figure 13). Most eggs were collected between pH values of 7.0-7.74, with approximately 52% collected at pH values of 7.5-7.74 (Table 8).

Vertical Heterogeneity

Sample replications (net A, net B) were tested to determine normality of the data and ascertain whether both samples collected similar numbers of eggs. A total of 11,939 eggs was collected in all nets: 5,309 eggs in surface tows, and 6,630 in oblique tows. Net A collected 3,008 eggs (n=349; mean=8.62; S.D.=32.26), and the surface B net tows collected 2,301 eggs (n=349; mean=6.59; S.D.=21.24). The seasonal difference between surface net collections was 707. A similar pattern was observed for oblique tows. Net A collected 4,035 eggs (n=348; mean=11.59; S.D.=34.47) compared to 2,595 eggs for net B (n=348; mean=7.46; S.D.=21.74). The seasonal difference between paired oblique collections was 1,440 eggs. The actual difference in numbers of eggs between the paired surface net A and surface net B was subjected to the UNIVARIATE procedure; results indicated non-normal distribution of the data. Natural log transformation of the data substantially reduced kurtosis of the data (91.4 to 1.4); there was no significant difference in the paired log-catch of the two surface nets (n=349; S=122960; P=0.69). Results of the analysis on log-transformed data for oblique tows was similar (n=348; S=125355; P=0.11).

Differences between paired observations of surface and oblique egg collections were of mixed results. Log-transformed data indicated that oblique net A was consistently higher in eggs caught than surface net A (n=348; S=126749; P=0.04); the result for B nets was insignificant (n=348; S=123663; P=0.38). Overall, the average number of eggs in oblique nets was higher than that of surface nets collected during the same trip (n=348; S=125570; P=0.11).

Estimating Egg Production on a Per Trip Basis

The original Hassler method of estimating daily egg production (Equation 1 above) produced a point value but no estimate of variability of the data. The trip method of calculating egg production was performed by estimating the number of eggs in the river at the time the sample was collected, then averaging the expanded numbers over the 24-hour period to estimate daily production. The result of this method is a daily egg production estimate and an estimate of variability for the number.

Egg production estimates on a per trip basis were calculated for surface samples, oblique samples, and all samples combined, then compared statistically to those values obtained using the Hassler (daily) averaging method. Table 9 lists the estimated egg abundance (in a five-minute period) for the six sampling periods each day. Table 10 presents the estimated daily egg production for surface, oblique, and all samples calculated by the Hassler and trip methods. As expected, results of analyses (UNIVARIATE) using the paired daily egg production estimates in Table 10 were significantly different. However, in this instance we are particularly concerned with whether the yearly egg production estimates are significantly different from one another. The daily egg production estimates were analyzed using NPAR1WAY. Results indicated that the yearly egg production estimates for 1990, calculated by the Hassler and trip methods, using surface, oblique, and combined egg data, were not significantly different (Table 11).

Estimating Egg Production by Volume

Estimates of striped bass daily egg production can be calculated substituting volume for cross-sectional area of the river, and knowing the water velocity at the time of sample collection. The equation is

$$\text{(2)} \quad \text{Daily egg production} = \text{sample eggs} \times \frac{(\text{river discharge} \times 24 \text{ hrs} \times 60 \text{ min} \times 60 \text{ sec})}{(\text{water velocity} \times 0.9) \times \text{net area} \times 300 \text{ sec}}$$

where

river discharge = ft^3/sec, recorded upstream several hours previous to sample collection;
average water velocity = ft/sec x 0.9 (to correct for surface measurement); and
net area = 0.56 ft^2.

A data set of hourly instream flow records from the USGS gage was merged with the egg collection data so that each trip had seven possible values of flow: the actual flow measured at the time and date of the trip (FLOW), flow recorded one hour previous to the trip (FLOWL1), and so on through flow recorded six hours previous to an egg collection trip (FLOWL6). Correlation analysis was used to determine which record of flow had the highest linear correlation with water velocity measured at the surface during sampling. In 1990, water velocity was highly correlated with discharge, ranging from a low Pearson r value of 0.931 for FLOW, to a maximum of 0.938 for FLOWL3; therefore, instream flow measured three hours previous to sample collection was used in volumetric egg production estimates. Also, in 1990 the estimate of cross-sectional area of the river at Barnhill's Landing was highly correlated with river discharge; all correlation coefficients between cross-section and the seven flow values were greater than 0.95.

In 1990, the Hassler estimate of yearly egg production by cross-sectional area (965,384,988 eggs $\pm$32,190,094) was not significantly different (Table 11) from the Hassler estimate by volume (947,156,441 eggs $\pm$31,471,910). Table 1 provides a daily comparison of both egg production estimates. The two estimates are never the same except in cases where no eggs were collected over the 24-hour period. Also note that the daily estimate by cross-section is often higher than that estimated by volume. Table 12 lists the mean daily values of river characteristics used in estimating egg production by cross-section and by volume. Yearly egg production estimates calculated by the trip method (Table 12) were statistically similar to the Hassler method estimates (Table 11).

DISCUSSION

Estimating yearly egg production by incorporating the volume of the river and the volume of water filtered through the net in a five minute period requires additional measurements of environmental conditions, and several assumptions about the nature of the variables in question. In order for the results of cross-sectional and volume calculations to be similar, water velocity must have a highly-correlated linear relationship with river volume as measured by the USGS gage upstream, and with the estimate of cross-sectional area. In 1990, these correlations were highly related ($r>0.95$) and so the yearly estimates were not significantly different. However, this relationship may not hold for striped bass spawning activity under high flow conditions. For example, in 1989 the major spawning activity occurred during an extended period of high stable discharge from Roanoke Rapids Dam. River stage and cross-sectional area estimates were highly correlated with reservoir discharge ($r>0.95$), but the correlation of water velocity to discharge was lower ($r=0.89$) than in 1990. Several possible explanations may explain this change in relationship. High flows tend to produce roiling of surface waters, making water velocity estimates more difficult. However, the primary problem may be due to a non-linear relationship between water velocity and discharge due to the configuration of the stream banks. From the Barnhill's Landing area extending upstream, the river bank resembles a series of steps where waters have cut into the banks. As the water level rises, water velocity increases until waters flood the next highest cut, thus extending the effective channel width and reducing water velocity. This phenomenon is minimal at low and moderate instream flow rates, but is quite noticeable at high discharge rates. Therefore, we should expect an underestimation of yearly egg production in years of high river flow. The 1989 estimate of nearly 638 million eggs, recalculated using volume, produced a value of approximately 1.16 billion. Thus, it is possible that the Hassler egg production estimates in years of high reservoir discharge may be underestimated. It must be emphasized that this large difference should occur only if peak striped bass spawning activity occurs during rates of high instream flow when estimates of cross-sectional area and water velocity are more difficult.

These possible differences in yearly egg production have little consequence when considering the overall importance of relating striped bass spawning activity to changing environmental and human-induced factors, especially hydroelectric activity upstream. Results of the studies for 1988, 1989, and 1990 clearly demonstrate the influence of water temperature in controlling spawning activity, and how reservoir discharge can alter water temperatures downstream. These results are supported by results of studies conducted concurrently but independently by Hassler and the Wildlife Resources Commission in 1981-1983 (Rulifson 1990). The annual egg studies should be regarded as an important relative index of striped bass activity over many years, and as a daily record of spawning activity and its relationship to environmental conditions.

SUMMARY AND CONCLUSIONS

1. The estimated number of striped bass eggs produced in the Roanoke River for 1990 was 965,384,988 ±32,190,094 from a total of 5,309 eggs collected in surface nets during the period 16 April to 15 June. Spawning prior to 16 April, and after 15 June, was undetermined.

2. Prolonged spawning activity was observed in 1990; the 50-day continuous spawning period was longer than in 1988 (27 days) and 1989 (23 days).

3. Eggs first appeared in surface samples on 24 April. Seasonal egg production was 46% complete by 9 May, 66% complete by 10 May, 80% complete by 16 May, and 98% complete by 1 June. The last eggs were collected on 12 June.

4. Three spawning peaks, all early in the season, were observed in 1990: 2-3 May, 7 May, and 10 May.

5. Major egg deposition occurred after water temperatures reached 18°C, a phenomenon observed in 1988 and 1989.

6. Egg viability for 1990 was 58.5%. No seasonal trend in viability was evident; only a small portion of data variability was explained by dissolved oxygen and river stage (R^2=0.11).

7. Most eggs (71%) passing Barnhill's Landing were less than 10 hours old. An additional 29% were 10-18 hours old.

8. About 95% of all eggs were collected at water temperatures 18-21.9°C. The range of temperatures during the study was 14.0-23.5°C.

9. Most eggs were collected at surface water velocities less than 100 cm/second. Water velocities ranged from 56.6 cm/second to 125.5 cm/second, with a seasonal mean of 88 cm/second.

10. Changes in secchi disk visibility coincided with changes in river level, ranging from 45 cm to 90 cm.

11. Most eggs were collected at dissolved oxygen levels of 7.0-8.9 mg/L; a gradual decrease in dissolved oxygen was observed, from a high of 9.5 mg/L in April to a low of about 6.5 mg/L in mid-June.

12. Most eggs were caught in waters of pH 7.0-7.74; the pH remained above 7.0 for most of the study.

13. In 1990, a significantly higher number of eggs was collected in nets towed in an oblique manner compared to surface samples.

14. In 1990, the daily estimates of egg production calculated by the Hassler method and by the trip method were statistically different. However, the **yearly** egg production estimate was not statistically different. The trip method produces a daily egg estimate with an estimate of data variability; the Hassler daily estimate is a single point value with no estimate of variability.

15. In 1990, the daily egg production estimates calculated by cross-sectional area of the river, and by volume, were significantly different. However, the **yearly** egg production estimates of both methods were statistically similar. Cross-sectional area calculations (Hassler's method) may underestimate the number of eggs in the river during high flow years if spawning activity occurs during high flows.

16. The value of the annual egg studies is the documentation of striped bass spawning activity relative to changing environmental conditions, especially human-related activities such as hydroelectric generation upstream. The annual studies should be regarded as an important relative index of striped bass activity among years, and daily activity within the season.

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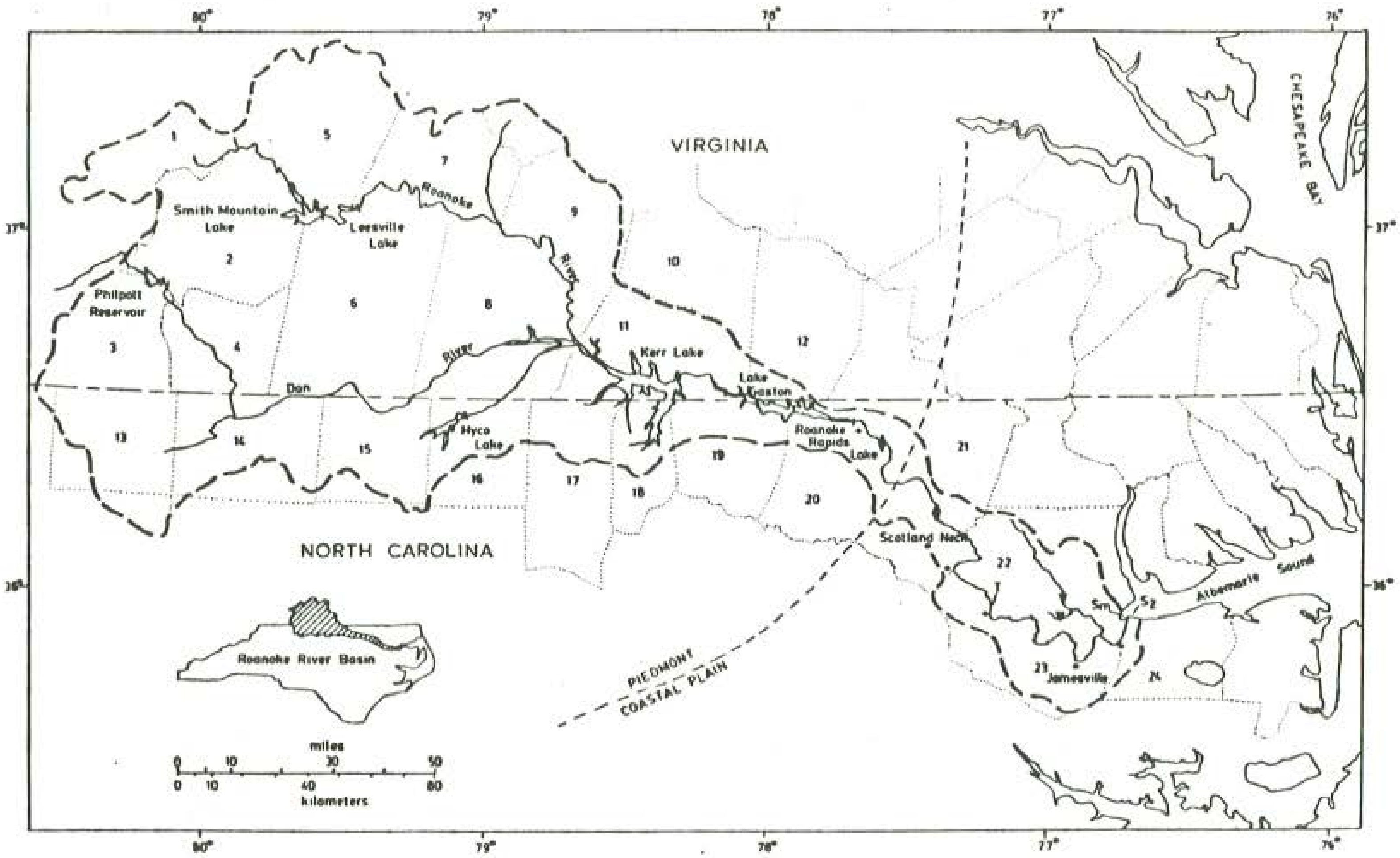


Figure 1. Drainage area of the Roanoke River Basin. Dashed line indicated approximate location of the Fall Line; diamonds=locations of USGS water quality and gaging stations; inverted triangle=USGS water quality station; T=upstream limit of tidal influence; S2=mean upstream intrusion limit of saltwater front (200 mg/L chloride); Sm=maximum upstream intrusion of saltwater front (Giese et al. 1985). Counties containing Roanoke watershed are enumerated and listed in Appendix Table A-1.

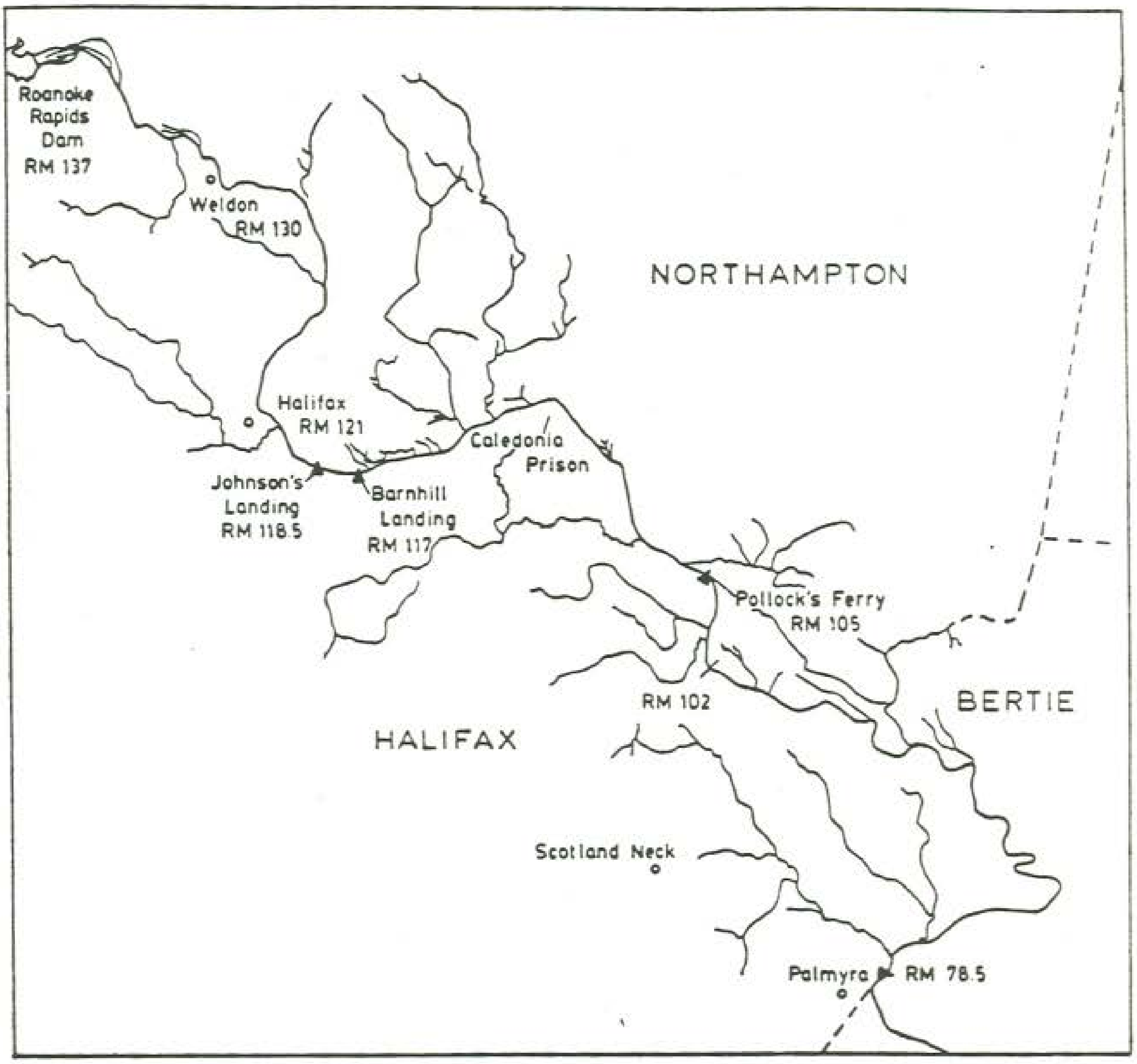


Figure 2. Roanoke River watershed downstream of Roanoke Rapids Reservoir showing the historical sampling stations for striped bass eggs: Palmyra (1959-60), Halifax (1961-74), Barnhill's Landing (1975-81, 1989-1990), Johnson's Landing (1982-87), and Pollock's Ferry (1988).

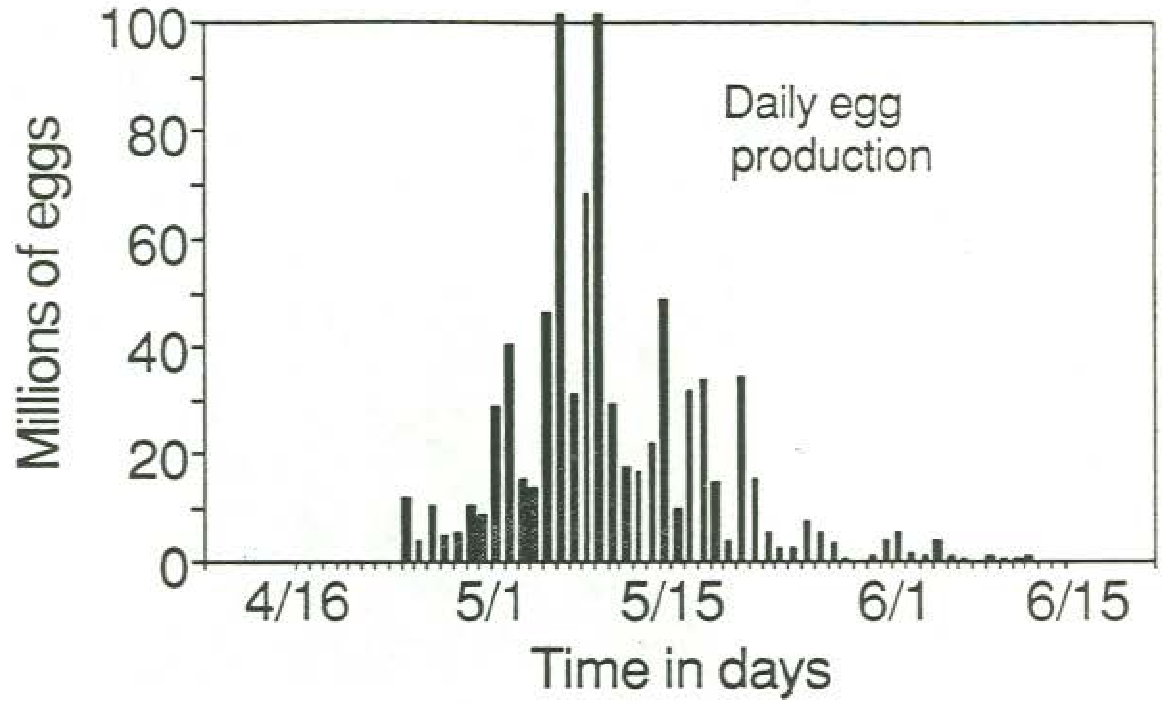


Figure 3. Estimated daily production of striped bass eggs in the Roanoke River based on samples collected at Barnhill's Landing, NC, for the period 16 April to 15 June 1990.

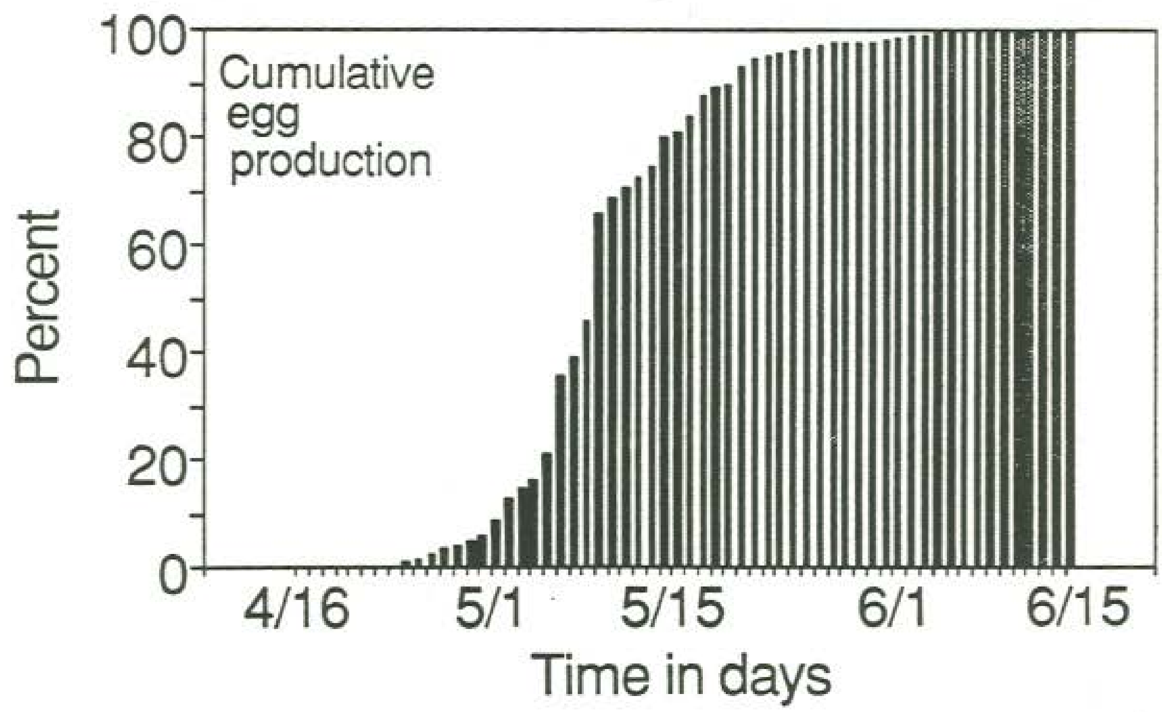


Figure 4. Estimated production of striped bass eggs in the Roanoke River based on samples collected at Barnhill's Landing, NC, in 1990, presented as percentage of total production.

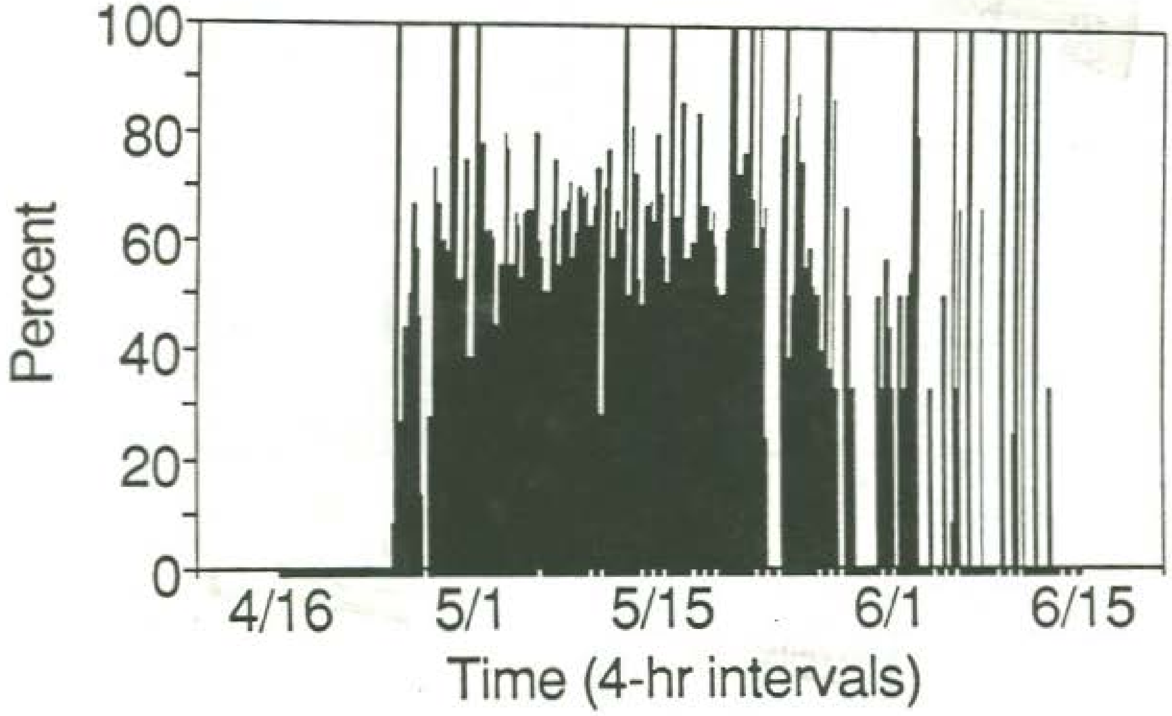


Figure 5. Daily viability estimates of striped bass eggs in the Roanoke River based on samples collected at Barnhill's Landing, NC, in 1990.

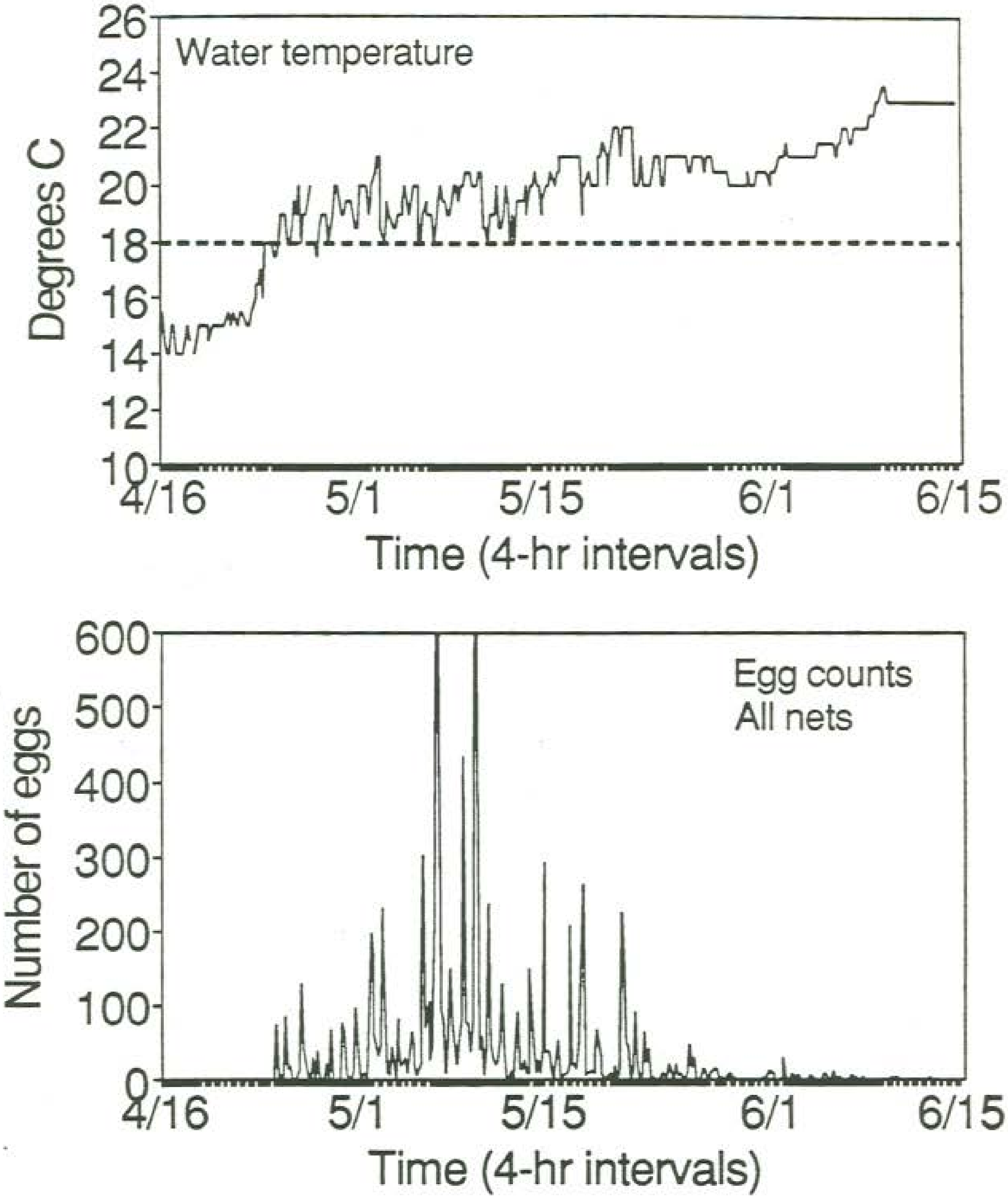


Figure 6. Number of striped bass eggs collected in all nets during each trip, and corresponding water temperatures (°C) at Barnhill's Landing, NC, for the period 16 April to 15 June 1990.

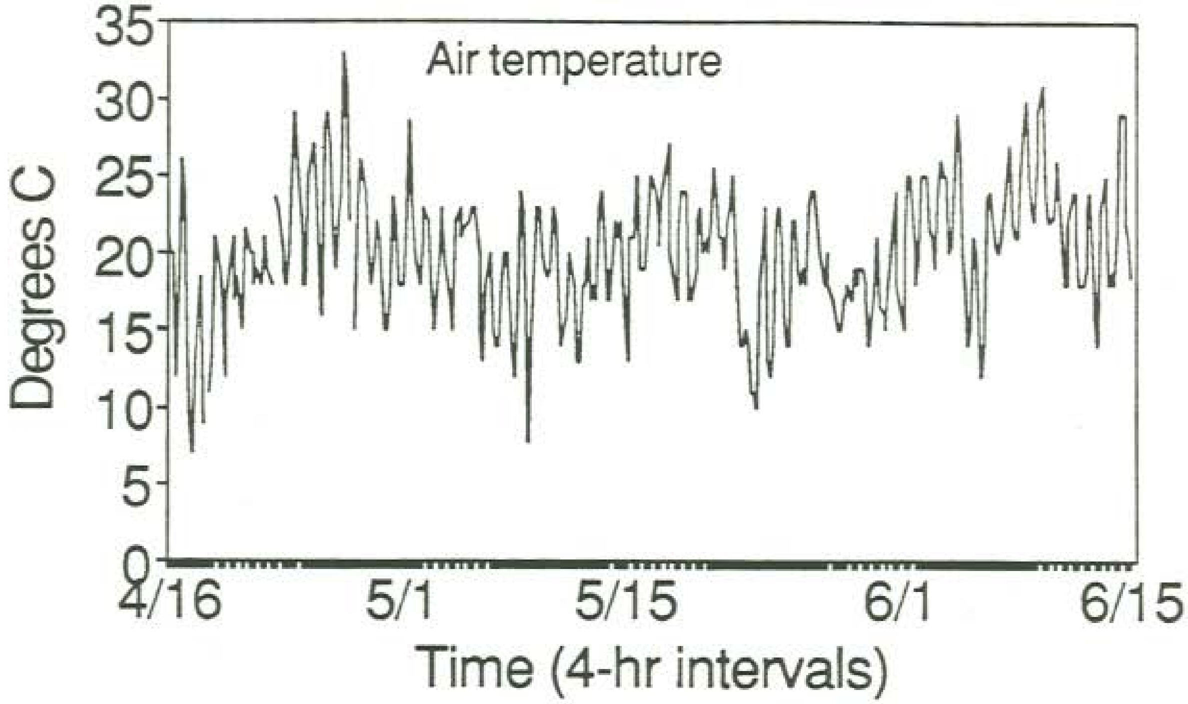


Figure 7. Air temperature (°C) measured at Barnhill's Landing, NC, for the period 16 April to 15 June 1990.

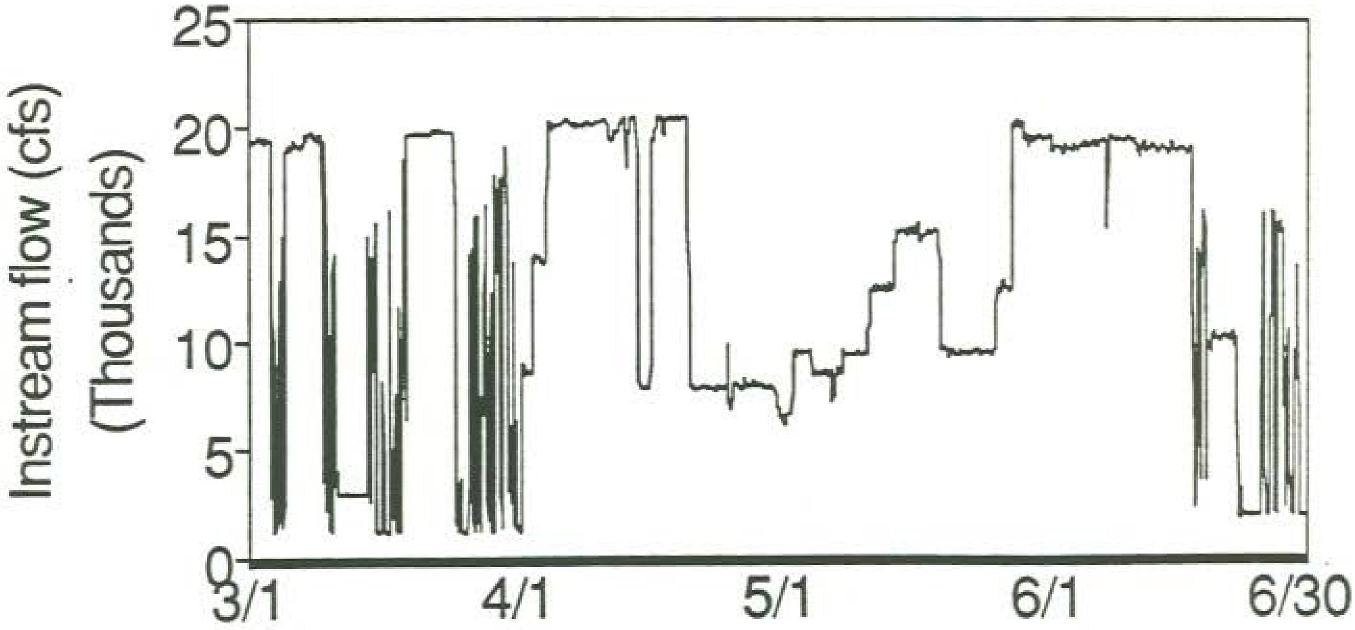
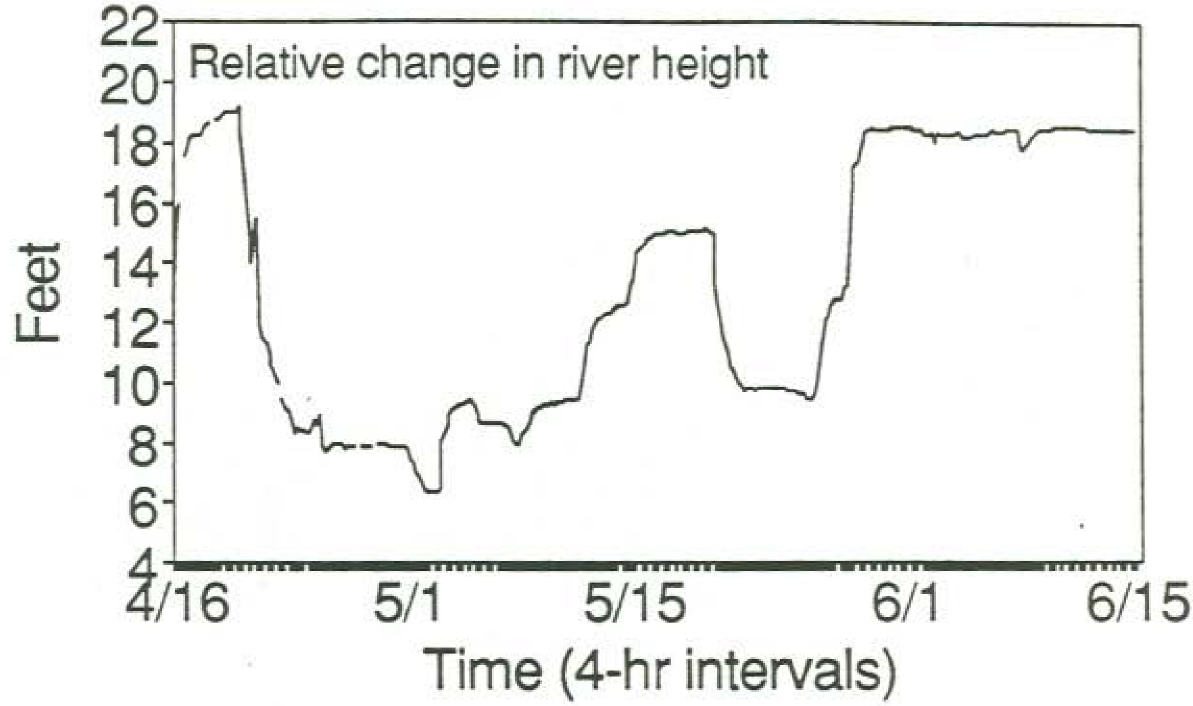


Figure 8. Hourly record of Roanoke River instream flow (cfs) downstream of the Roanoke Rapids Reservoir (USGS data), March through June 1990.



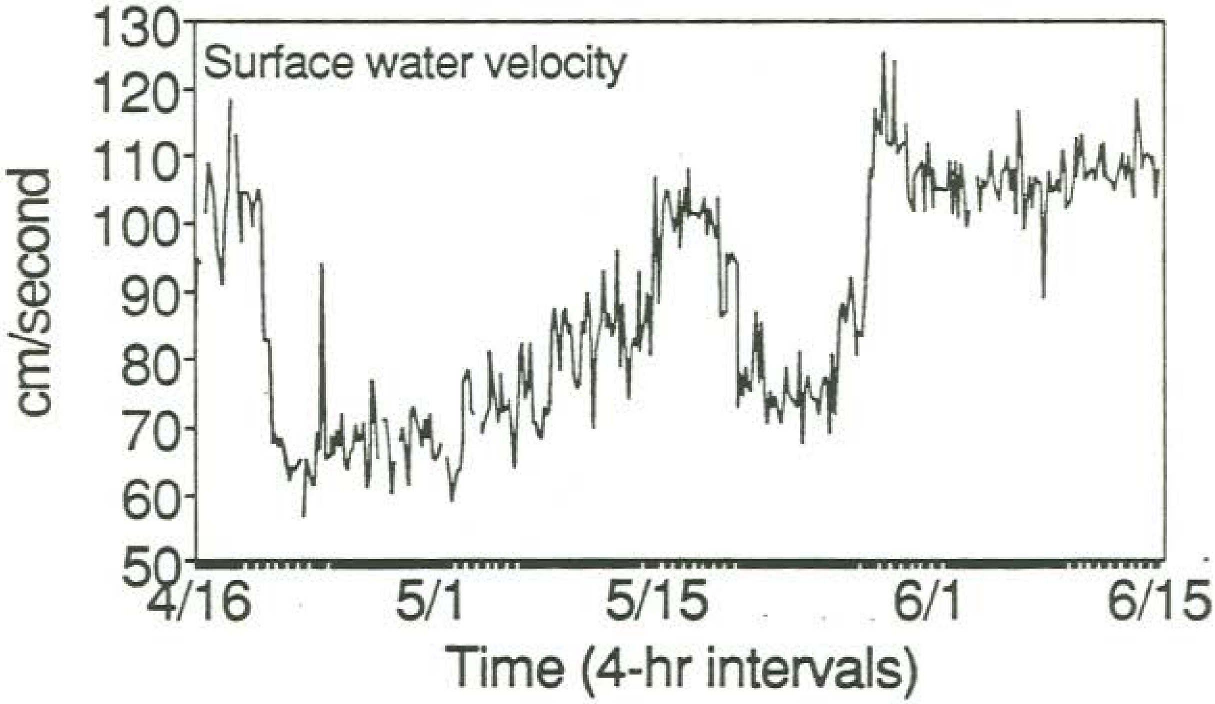


Figure 9. Relative change in river height (ft) and corresponding surface water velocity at Barnhill's Landing, Roanoke River, NC, for the period 16 April to 15 June 1990.

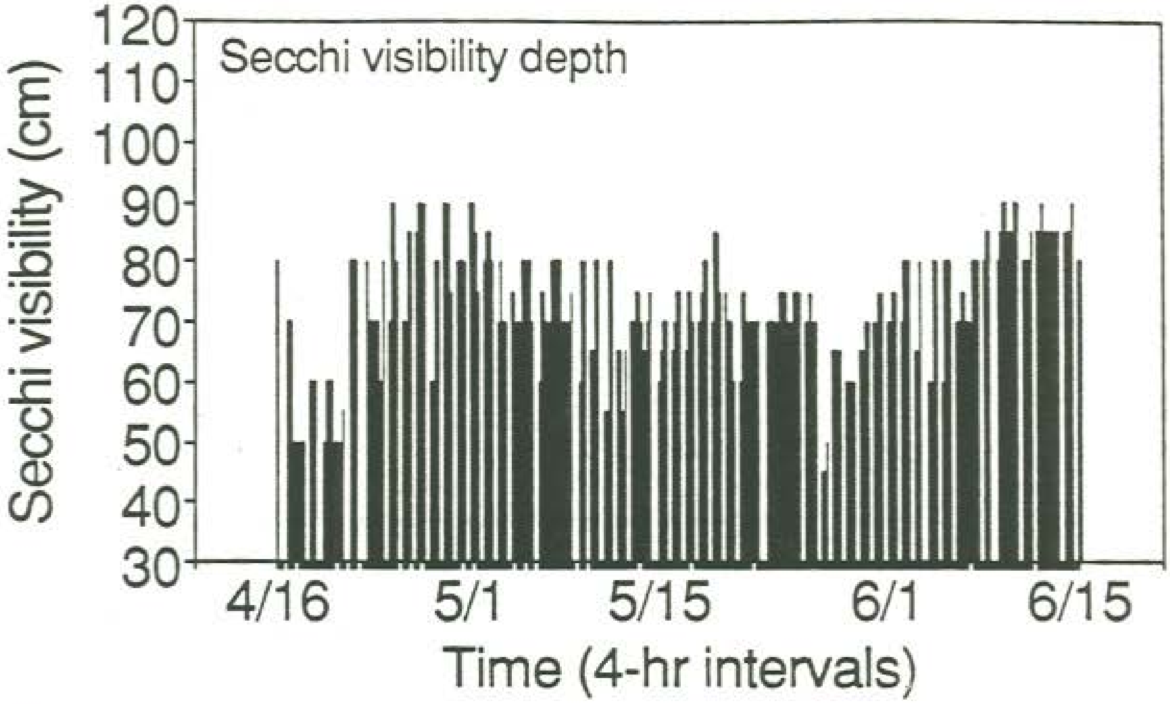


Figure 10. Depth (cm) of secchi disk visibility in the Roanoke River at Barnhill's Landing, NC, for the period 16 April to 15 June 1990. Unfilled bars indicate no information available.

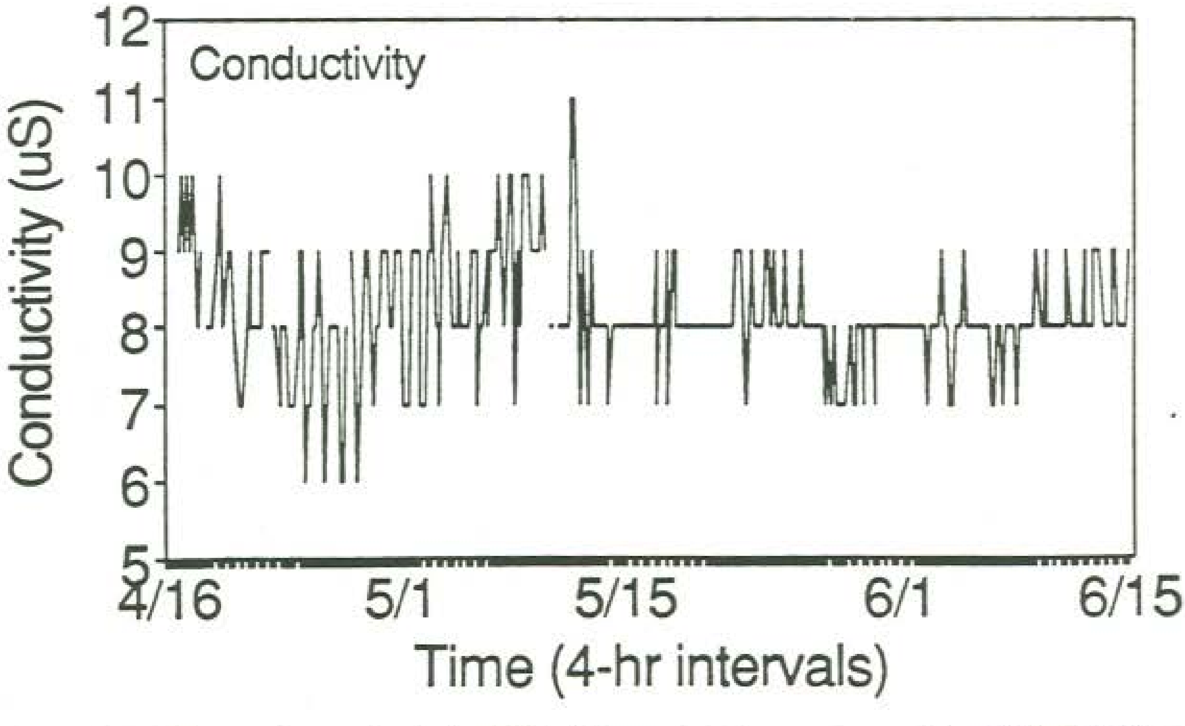


Figure 11. Changes in conductivity (μS) of Roanoke River waters at Barnhill's Landing, NC, for the period 16 April to 15 June 1990.

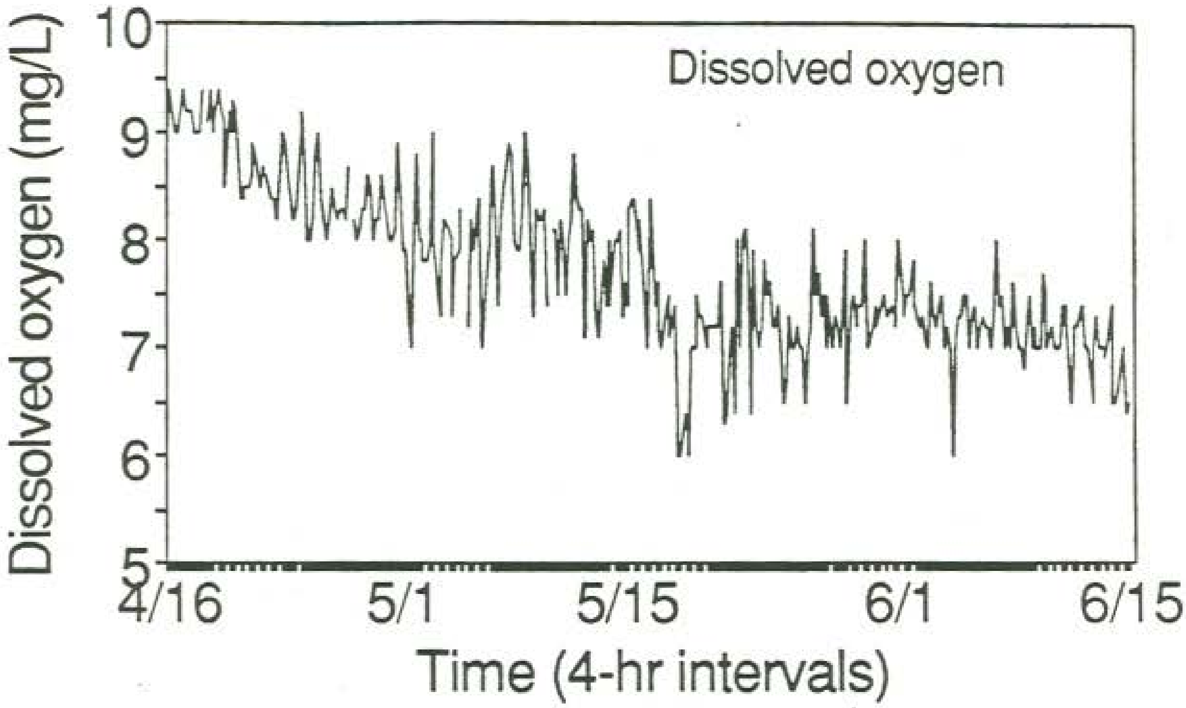


Figure 12. Changes in dissolved oxygen (mg/L) of Roanoke River waters at Barnhill's Landing, NC, for the period 16 April to 15 June 1990.

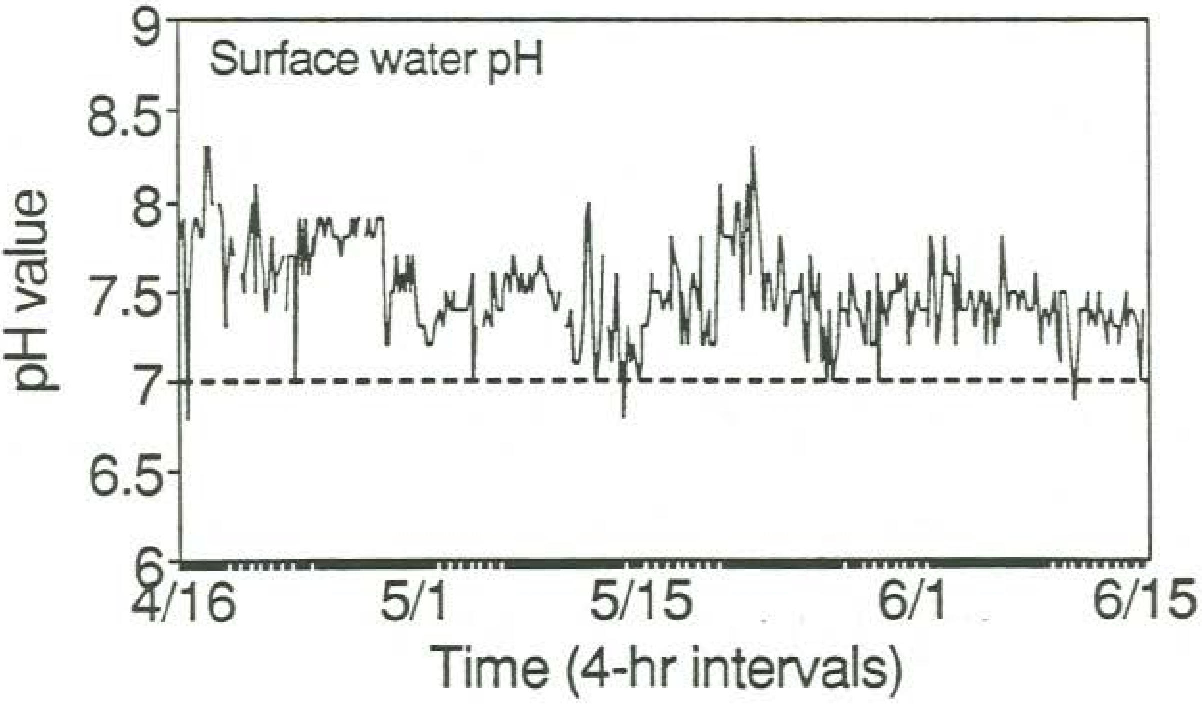


Figure 13. Changes in pH of Roanoke River surface waters at Barnhill's Landing, NC, for the period 16 April to 15 June 1990.

Table 1. Striped bass spawning in the Roanoke River, NC, estimated by the Hassler method and by river discharge, 1990.

Date	Number samples	River discharge (cfs)	Average eggs/net	Estimated eggs/day (Hassler)	Percent of total spawned (Hassler)	Cumulative percent (Hassler)	Estimated eggs/day (Volume)	Percent of total spawned (Volume)	Cumulative percent (Volume)
900416	4	17,400	0	0	0.0	0.0	0	0.0	0.0
900417	10	20,254	0	0	0.0	0.0	0	0.0	0.0
900418	12	20,261	0	0	0.0	0.0	0	0.0	0.0
900419	10	20,453	0	0	0.0	0.0	0	0.0	0.0
900420	12	19,988	0	0	0.0	0.0	0	0.0	0.0
900421	12	8,293	0	0	0.0	0.0	0	0.0	0.0
900422	12	7,895	0	0	0.0	0.0	0	0.0	0.0
900423	10	7,855	0	0	0.0	0.0	0	0.0	0.0
900424	12	7,875	0	161,508	0.0	0.0	161,849	0.0	0.0
900425	12	7,827	6	11,857,332	1.2	1.2	12,178,817	1.3	1.3
900426	12	7,891	2	4,163,415	0.4	1.7	4,595,413	0.5	1.8
900427	12	7,965	6	10,639,889	1.1	2.8	11,677,175	1.2	3.0
900428	10	8,005	3	5,181,163	0.5	3.3	5,827,874	0.6	3.6
900429	10	7,960	3	5,403,789	0.6	3.9	5,925,879	0.6	4.3
900430	12	7,870	6	10,177,285	1.1	4.9	10,744,688	1.1	5.4
900501	10	6,892	5	9,107,369	0.9	5.9	9,440,721	1.0	6.4
900502	12	6,537	20	28,931,818	3.0	8.9	35,785,824	3.8	10.2
900503	12	9,543	21	40,569,991	4.2	13.1	48,115,195	5.1	15.3
900504	10	9,527	7	15,222,129	1.6	14.6	16,569,089	1.7	17.0
900505	12	8,701	7	13,679,568	1.4	16.1	13,759,284	1.5	18.5
900506	12	8,587	24	46,579,940	4.8	20.9	46,926,381	5.0	23.4
900507	12	8,195	74	142,809,984	14.8	35.7	143,132,676	15.1	38.5
900508	12	8,962	16	31,303,896	3.2	38.9	32,877,488	3.5	42.0
900509	12	9,462	33	68,519,085	7.1	46.0	64,785,372	6.8	48.8
900510	12	9,484	92	193,313,468	20.0	66.0	186,350,915	19.7	68.5
900511	12	9,757	14	29,469,988	3.1	69.1	28,211,798	3.0	71.5
900512	12	12,532	7	17,773,400	1.8	70.9	18,228,739	1.9	73.4
900513	12	12,556	6	16,451,869	1.7	72.6	16,686,290	1.8	75.2
900514	12	12,860	8	22,239,687	2.3	75.0	21,197,411	2.2	77.4
900515	12	15,141	16	48,628,584	5.0	80.0	42,484,201	4.5	81.9

Table 1. Continued.

Date	Number samples	River discharge (cfs)	Average eggs/net	Estimated eggs/day (Hassler)	Percent of total spawned (Hassler)	Cumulative percent (Hassler)	Estimated eggs/day (Volume)	Percent of total spawned (Volume)	Cumulative percent (Volume)
900516	12	15,207	3	9,673,704	1.0	81.0	8,016,595	0.8	82.7
900517	12	15,114	10	31,872,876	3.3	84.3	25,942,634	2.7	85.5
900518	12	15,134	11	33,943,776	3.5	87.8	28,294,074	3.0	88.5
900519	12	15,221	5	14,814,283	1.5	89.3	13,186,882	1.4	89.9
900520	12	10,574	1	3,832,803	0.4	89.7	3,297,221	0.3	90.2
900521	12	9,500	15	34,273,486	3.6	93.3	31,252,664	3.3	93.5
900522	12	9,494	7	15,129,846	1.6	94.9	15,896,172	1.7	95.2
900523	12	9,516	2	5,237,071	0.5	95.4	5,350,422	0.6	95.7
900524	12	9,554	1	2,341,524	0.2	95.6	2,399,103	0.3	96.0
900525	12	9,544	1	2,669,990	0.3	95.9	2,793,511	0.3	96.3
900526	12	11,044	3	7,256,233	0.8	96.7	7,605,415	0.8	97.1
900527	12	12,673	2	5,556,403	0.6	97.2	5,323,898	0.6	97.7
900528	12	17,290	1	3,344,055	0.3	97.6	3,093,043	0.3	98.0
900529	12	20,004	0	632,754	0.1	97.7	495,161	0.1	98.0
900530	12	19,480	0	0	0.0	97.7	0	0.0	98.0
900531	12	19,583	0	972,936	0.1	97.8	808,015	0.1	98.1
900601	12	19,363	1	4,207,717	0.4	98.2	3,430,649	0.4	98.5
900602	12	19,089	2	5,745,301	0.6	98.8	4,739,900	0.5	99.0
900603	8	19,120	0	1,436,328	0.1	98.9	1,198,463	0.1	99.1
900604	12	19,065	0	955,626	0.1	99.0	778,985	0.1	99.2
900605	12	19,206	1	4,141,064	0.4	99.5	3,395,518	0.4	99.6
900606	12	19,354	0	1,283,139	0.1	99.6	1,049,264	0.1	99.7
900607	12	19,425	0	644,775	0.1	99.7	535,004	0.1	99.7
900608	12	18,307	0	0	0.0	99.7	0	0.0	99.7
900609	12	19,512	0	967,163	0.1	99.8	801,132	0.1	99.8
900610	12	19,512	0	648,624	0.1	99.8	517,781	0.1	99.9
900611	12	19,230	0	649,265	0.1	99.9	512,998	0.1	99.9
900612	12	19,120	0	969,087	0.1	100.0	778,855	0.1	100.0
900613	12	19,112	0	0	0.0	100.0	0	0.0	100.0
900614	12	19,081	0	0	0.0	100.0	0	0.0	100.0
900615	4	18,949	0	0	0.0	100.0	0	0.0	100.0
				============			============		
Total egg production estimate:				965,384,988			947,156,441		

Table 2. Estimated number of striped bass eggs spawned in the Roanoke River, NC, and the corresponding egg viability, 1959-1987 (Hassler reports), 1988-1989 (Rulifson reports), and 1990 (this study).

Year	Sampling period	Estimated number of eggs	Egg viability (%)	Site of egg collection
1959	8 May-23 May[1]	300,000,000	92.88	Palmyra (RM 78.5)
1960	23 Apr-8 Jun[1]	740,000,000	92.88	Palmyra
1961	29 Apr-14 Jun	2,065,232,519	79.74	Halifax (RM 121)
1962	24 Apr-5 Jun	1,088,076,294	86.22	Halifax
1963	18 Apr-8 Jun[2]	918,652,436	79.94	Halifax
1964	24 Apr-27 May	1,285,351,276	95.77	Halifax
1965	21 Apr-28 May	823,522,540	95.91	Halifax
1966	26 Apr-31 May	1,821,385,754	94.51	Halifax
1967	21 Apr-11 Jun	1,333,312,869	96.20	Halifax
1968	24 Apr-4 Jun	1,483,102,338	86.20	Halifax
1969	27 Apr-6 Jun	3,229,715,526	89.86	Halifax
1970	30 Apr-1 Jun	1,464,841,490	89.23	Halifax
1971	1 May-2 Jun	2,833,119,620	80.81	Halifax
1972	2 May-28 May	4,932,000,707	90.51	Halifax
1973	29 Apr-3 Jun	1,501,498,887	87.21	Halifax
1974	1 May-2 Jun	2,163,239,468	87.31	Halifax
1975	7 May-2 Jun	2,193,008,096	55.69	Barnhill's (RM 117)
1976	1 May-30 May	1,496,768,659	50.73	Barnhill's Landing
1977	29 Apr-31 May	1,775,957,318	52.72	Barnhill's Landing
1978	29 Apr-22 Jun	1,691,227,585	37.72	Barnhill's Landing
1979	10 May-11 Jun	1,613,382,382	43.62	Barnhill's Landing
1980	1 May-1 Jun	870,322,832	43.39	Barnhill's Landing
1981	29 Apr-29 May	344,364,065	73.70	Barnhill's Landing
1982	3 May-2 Jun	1,698,888,853	71.93	Johnson's (RM 118)
1983	6 May-12 Jun	1,352,611,202	33.29	Johnson's Landing
1984	9 May-9 Jun	703,879,559	22.73	Johnson's Landing
1985	23 Apr-23 May	600,562,645	72.21	Johnson's Landing
1986	28 Apr-31 May	2,279,071,483	51.10	Johnson's Landing
1987	27 Apr-9 Jun	1,382,496,006	42.87	Johnson's Landing
1988	10 Apr-7 Jun	2,082,130,728	89.00	Pollock's Ferry (RM 105)
1989	16 Apr-15 Jun	637,919,162	41.80	Barnhill's Landing
1990	16 Apr-15 Jun	965,384,988	58.49	Barnhill's Landing

[1]Incomplete sampling season; estimates are partial.
[2]Spawning season interrupted from 21 April to 1 May because of an extensive fish kill just after a 10-day minimum flow period (Hassler et al. 1963).

Table 3. Striped bass daily egg viability at Barnhill's Landing, Roanoke River, NC, 1990.

Date	Number of samples	Number non-viable eggs	Number viable eggs	Percentage viable eggs
900416	4	0	0	0.00
900417	10	0	0	0.00
900418	12	0	0	0.00
900419	10	0	0	0.00
900420	12	0	0	0.00
900421	12	0	0	0.00
900422	12	0	0	0.00
900423	10	0	0	0.00
900424	12	1	0	0.00
900425	12	58	15	20.55
900426	12	14	13	48.15
900427	12	43	26	37.68
900428	10	7	21	75.00
900429	10	11	18	62.07
900430	12	31	35	53.03
900501	10	30	23	43.40
900502	12	90	146	61.86
900503	12	118	139	54.09
900504	10	36	37	50.68
900505	12	38	43	53.09
900506	12	129	153	54.26
900507	12	344	544	61.26
900508	12	82	111	57.51
900509	12	139	258	64.99
900510	12	419	686	62.08
900511	12	56	110	66.27
900512	12	35	51	59.30
900513	12	22	53	70.67
900514	12	33	66	66.67
900515	12	78	116	59.79
900516	12	13	24	64.86
900517	12	58	63	52.07
900518	12	75	54	41.86
900519	12	25	31	55.36
900520	12	5	12	70.59
900521	12	70	112	61.54
900522	12	31	53	63.10
900523	12	24	5	17.24
900524	12	7	6	46.15
900525	12	3	12	80.00
900526	12	22	17	43.59
900527	12	12	13	52.00
900528	12	7	6	46.15
900529	12	1	1	50.00
900530	12	0	0	0.00
900531	12	3	0	0.00

Table 3. Continued.

Date	Number of samples	Number non-viable eggs	Number viable eggs	Percentage viable eggs
900601	12	9	4	30.77
900602	12	7	11	61.11
900603	8	1	2	66.67
900604	12	2	1	33.33
900605	12	7	6	46.15
900606	12	0	4	0.00
900607	12	2	0	0.00
900608	12	0	0	0.00
900609	12	1	2	66.67
900610	12	2	0	0.00
900611	12	1	1	50.00
900612	12	2	1	33.33
900613	12	0	0	0.00
900614	12	0	0	0.00
900615	4	0	0	0.00

Table 4. Striped bass egg viability at Barnhill's Landing, Roanoke River, NC, 1990, relative to water temperature.

Temperature range (°C)	Number non-viable eggs	Number viable eggs	Percent viable eggs	Percent of all eggs collected
missing	.	.	.	.
14.0-15.9	0	0	0.00	0.000
16.0-17.9	34	6	15.00	0.753
18.0-19.9	1,047	1,495	58.81	47.881
20.0-21.9	1,047	1,498	58.86	47.937
22.0-23.9	76	106	58.24	3.428
	=====	=====		=======
	2,204	3,105		100.000

Table 5. Striped bass egg viability at Barnhill's Landing, Roanoke River, NC, 1990, related to surface water velocity.

Water velocities (cm/second)	Number non-viable eggs	Number viable eggs	Percent viable eggs	Percent of all eggs collected
missing	.	.	.	.
40.0-59.9	29	58	66.67	1.639
60.0-79.9	1,422	2,062	59.18	65.624
80.0-99.9	569	820	59.04	26.163
100.0-119.9	184	165	47.28	6.574
120.0-139.9	0	0	0.00	0.000
	=====	=====		=======
	2,204	3,105		100.000

Table 6. Striped bass egg viability at Barnhill's Landing, Roanoke River, NC, 1990, related to time of day.

Time of collection	Number non-viable eggs	Number viable eggs	Percent viable eggs	Percent of all eggs collected
0200	664	832	55.61	28.179
0600	818	1,423	63.50	42.211
1000	296	366	55.29	12.469
1400	136	174	56.13	5.839
1800	119	118	49.79	4.464
2200	171	192	52.89	6.837
	=====	=====		=======
	2,204	3,105		100.000

Table 7. Striped bass egg viability at Barnhill's Landing, Roanoke River, NC, 1990, related to dissolved oxygen (mg/L).

Dissolved oxygen values	Number non-viable eggs	Number viable eggs	Percent viable eggs	Percent of all eggs collected
missing	6	11	64.71	0.320
6.0-6.9	60	120	66.67	3.390
7.0-7.9	973	1,538	61.25	47.297
8.0-8.9	1,087	1,352	55.43	45.941
9.0-9.9	78	84	51.85	3.051
	=====	=====		=======
	2,204	3,105		100.000

Table 8. Striped bass egg viability at Barnhill's Landing, Roanoke River, NC, 1990, related to surface water pH.

Range of pH values	Number non-viable eggs	Number viable eggs	Percent viable eggs	Percent of all eggs collected
missing	21	35	62.50	1.055
6.75-6.99	18	33	64.71	0.961
7.00-7.24	276	370	57.28	12.168
7.25-7.49	561	733	56.65	24.374
7.50-7.74	1,105	1,670	60.18	52.270
7.75-7.99	176	158	47.31	6.291
8.0 or more	47	106	69.28	2.882
	=====	=====		=======
	2,204	3,105		100.000

Table 9. Raw data and egg production estimates by trip for striped bass egg samples taken at Barnhill's Landing, Roanoke River, North Carolina, in 1990. Combined production is the average of surface and oblique samples.

Date	Time	Egg count Surface (rep A)	Egg count Surface (rep B)	Egg count Oblique (rep A)	Egg count Oblique (rep B)	River stage (feet)	Cross-section (sq.ft.)	Egg production Surface	Egg production Oblique	Egg production Combined
900416	1800	0	0	0	0	12.7	5,241	0	0	0
	2200	0	0	0	0	15.0	6,120	0	0	0
900417	600	.	.	.	.	.	.	.	.	.
	200	0	0	0	0	16.0	6,515	0	0	0
	1000	0	0	0	0	17.5	7,133	0	0	0
	1400	0	0	0	0	17.8	7,263	0	0	0
	1800	0	0	0	0	18.1	7,395	0	0	0
	2200	0	0	0	0	18.2	7,440	0	0	0
900418	200	0	0	0	0	18.2	7,440	0	0	0
	600	0	0	0	0	18.2	7,440	0	0	0
	1000	0	0	0	0	18.2	7,440	0	0	0
	1400	0	0	0	0	18.5	7,575	0	0	0
	1800	0	0	0	0	18.6	7,620	0	0	0
	2200	0	0	0	0	18.7	7,665	0	0	0
900419	200	.	.	.	.	.	.	.	.	.
	600	0	0	0	0	18.8	7,709	0	0	0
	1000	0	0	0	0	18.8	7,709	0	0	0
	1400	0	0	0	0	18.9	7,754	0	0	0
	1800	0	0	0	0	18.9	7,754	0	0	0
	2200	0	0	0	0	19.0	7,799	0	0	0
900420	2200	0	0	0	0	18.4	7,530	0	0	0
	200	0	0	0	0	19.0	7,799	0	0	0
	600	0	0	0	0	19.0	7,799	0	0	0
	1000	0	0	0	0	19.0	7,799	0	0	0

Table 9. Continued.

Date	Time	Egg count Surface (rep A)	Egg count Surface (rep B)	Egg count Oblique (rep A)	Egg count Oblique (rep B)	River stage (feet)	Cross-section (sq.ft.)	Egg pro-duction Surface	Egg pro-duction Oblique	Egg pro-duction Combined
	1400	0	0	0	0	19.0	7,799	0	0	0
	1800	0	0	0	0	19.2	7,889	0	0	0
900421	2200	0	0	0	0	12.6	5,204	0	0	0
	1400	0	0	0	0	14.0	5,732	0	0	0
	1000	0	0	0	0	14.8	6,042	0	0	0
	1800	0	0	0	0	15.5	6,317	0	0	0
	600	0	0	0	0	15.7	6,396	0	0	0
	200	0	0	0	0	17.5	7,133	0	0	0
900422	2200	0	0	0	0	10.4	4,417	0	0	0
	1800	0	0	0	0	10.6	4,485	0	0	0
	1400	0	0	0	0	10.9	4,588	0	0	0
	1000	0	0	0	0	11.3	4,731	0	0	0
	600	0	0	0	0	11.6	4,839	0	0	0
	200	0	0	0	0	12.0	4,983	0	0	0
900423	600	.	.	.	.	.	.	.	.	.
	2200	0	0	0	0	8.9	3,918	0	0	0
	1800	0	0	0	0	9.0	3,950	0	0	0
	1400	0	0	0	0	9.2	4,016	0	0	0
	1000	0	0	0	0	9.5	4,115	0	0	0
	200	0	0	0	0	10.0	4,280	0	0	0
900424	600	0	0	0	0	8.3	3,726	0	0	0
	2200	1	0	1	0	8.3	3,726	3,327	3,327	3,327
	1400	0	0	0	0	8.4	3,758	0	0	0
	1800	0	0	0	0	8.4	3,758	0	0	0
	1000	0	0	0	0	8.5	3,790	0	0	0
	200	0	0	0	0	8.7	3,854	0	0	0

Table 9. Continued.

Date	Time	Egg count Surface (rep A)	Egg count Surface (rep B)	Egg count Oblique (rep A)	Egg count Oblique (rep B)	River stage (feet)	Cross-section (sq.ft.)	Egg production Surface	Egg production Oblique	Egg production Combined
900425	2200	15	16	34	20	7.9	3,598	99,587	173,475	136,531
	200	1	2	1	1	8.3	3,726	9,980	6,653	8,316
	600	17	19	20	17	8.5	3,790	121,818	125,202	123,510
	1400	0	1	5	0	8.6	3,822	3,412	17,062	10,237
	1000	2	0	1	0	8.8	3,886	6,939	3,470	5,205
	1800	0	0	0	0	8.9	3,918	0	0	0
900426	200	4	5	1	6	7.7	3,535	28,405	22,093	25,249
	600	6	2	5	4	7.8	3,567	25,475	28,659	27,067
	1000	1	0	0	1	7.9	3,598	3,212	3,212	3,212
	1400	1	0	0	0	8.0	3,630	3,241	0	1,620
	1800	0	0	2	1	8.0	3,630	0	9,722	4,861
	2200	7	1	2	2	8.0	3,630	25,925	12,962	19,444
900427	600	6	10	12	13	7.8	3,567	50,950	79,609	65,280
	1000	2	4	7	9	7.9	3,598	19,275	51,400	35,337
	1400	0	1	3	0	7.9	3,598	3,212	9,637	6,425
	1800	1	0	2	1	7.9	3,598	3,212	9,637	6,425
	2200	5	12	4	8	7.9	3,598	54,612	38,550	46,581
	200	10	18	75	26	8.0	3,630	90,737	327,303	209,020
900428	200	.	.	.	.	.	.	.	.	.
	600	9	5	18	6	7.9	3,598	44,975	77,100	61,037
	1000	2	0	1	0	7.9	3,598	6,425	3,212	4,819
	1400	0	0	0	0	7.9	3,598	0	0	0
	1800	0	0	0	0	7.9	3,598	0	0	0
	2200	3	9	1	7	7.9	3,598	38,550	25,700	32,125
900429	200	.	.	.	.	.	.	.	.	.
	2200	0	0	0	0	7.9	3,598	0	0	0
	600	13	16	12	26	8.0	3,630	93,978	123,144	108,561

Table 9. Continued.

Date	Time	Egg count Surface (rep A)	Egg count Surface (rep B)	Egg count Oblique (rep A)	Egg count Oblique (rep B)	River stage (feet)	Cross-section (sq.ft.)	Egg production Surface	Egg production Oblique	Egg production Combined
	1000	0	0	1	0	8.0	3,630	0	3,241	1,620
	1400	0	0	0	0	8.0	3,630	0	0	0
	1800	0	0	2	0	8.0	3,630	0	6,481	3,241
900430	200	8	26	13	31	7.9	3,598	109,225	141,350	125,287
	600	6	13	23	22	7.9	3,598	61,037	144,562	102,800
	1000	0	1	3	3	7.9	3,598	3,212	19,275	11,244
	1400	0	1	3	0	7.9	3,598	3,212	9,637	6,425
	1800	0	0	0	0	7.9	3,598	0	0	0
	2200	4	7	2	0	7.9	3,598	35,337	6,425	20,881
900501	2200	.	.	.	.	6.7	3,081	.	.	.
	1800	2	3	3	1	6.9	3,237	14,449	11,559	13,004
	1400	0	1	4	0	7.0	3,314	2,959	11,837	7,398
	1000	0	0	0	3	7.3	3,409	0	9,131	4,565
	600	10	4	11	19	7.4	3,440	43,005	92,154	67,579
	200	18	15	33	32	7.8	3,567	105,084	206,984	156,034
900502	600	36	38	71	52	6.4	2,848	188,138	312,716	250,427
	1000	39	18	53	54	6.4	2,848	144,917	272,038	208,478
	1400	13	17	22	9	6.4	2,848	76,272	78,815	77,544
	1800	5	7	12	10	6.4	2,848	30,509	55,933	43,221
	2200	5	13	10	15	6.4	2,848	45,763	63,560	54,662
	200	17	28	21	28	6.5	2,925	117,534	127,982	122,758
900503	200	42	75	73	41	6.5	2,925	305,589	297,754	301,672
	600	53	48	45	56	8.1	3,662	330,198	330,198	330,198
	1000	1	1	4	4	8.4	3,758	6,710	26,841	16,776
	1400	2	4	4	3	8.7	3,854	20,647	24,088	22,368
	1800	2	0	1	2	8.9	3,918	6,997	10,495	8,746
	2200	7	22	11	3	9.1	3,983	103,136	49,790	76,463

Table 9. Continued.

Date	Time	Egg count Surface (rep A)	Egg count Surface (rep B)	Egg count Oblique (rep A)	Egg count Oblique (rep B)	River stage (feet)	Cross-section (sq.ft.)	Egg production Surface	Egg production Oblique	Egg production Combined
900504	200	.	.	.	.	9.2	4,016	.	.	.
	600	26	1	22	32	9.3	4,049	97,612	195,224	146,418
	1000	9	7	12	18	9.3	4,049	57,844	108,458	83,151
	1400	5	2	4	6	9.3	4,049	25,307	36,153	30,730
	1800	4	5	12	9	9.4	4,082	32,802	76,537	54,670
	2200	4	10	9	3	9.4	4,082	51,025	43,736	47,380
900505	1800	1	3	0	1	8.7	3,854	13,765	3,441	8,603
	2200	4	9	3	4	8.7	3,854	44,735	24,088	34,412
	1400	4	5	7	6	8.8	3,886	31,228	45,107	38,167
	1000	12	8	10	17	8.9	3,918	69,968	94,457	82,212
	600	21	11	15	18	9.2	4,016	114,746	118,331	116,539
	200	3	0	5	1	9.5	4,115	11,022	22,044	16,533
900506	200	56	11	46	10	8.7	3,854	230,558	192,705	211,631
	600	75	21	169	37	8.7	3,854	330,351	708,879	519,615
	1000	16	25	19	11	8.7	3,854	141,088	103,235	122,161
	1400	26	26	25	28	8.7	3,854	178,940	182,381	180,661
	1800	7	9	6	6	8.7	3,854	55,059	41,294	48,176
	2200	8	2	18	18	8.7	3,854	34,412	123,882	79,147
900507	2200	1	2	5	2	8.0	3,630	9,722	22,684	16,203
	1800	13	17	20	29	8.1	3,662	98,079	160,195	129,137
	1400	17	33	22	22	8.3	3,726	166,326	146,367	156,346
	600	222	199	338	284	8.6	3,822	1,436,662	2,122,575	1,779,618
	1000	188	119	162	125	8.6	3,822	1,047,637	979,387	1,013,512
	200	64	13	101	28	8.7	3,854	264,969	443,910	354,439
900508	200	14	22	5	11	8.0	3,630	116,662	51,850	84,256
	600	43	15	51	40	8.3	3,726	192,938	302,713	247,826
	1000	21	15	29	11	8.4	3,758	120,786	134,207	127,497

Table 9. Continued.

Date	Time	Egg count Surface (rep A)	Egg count Surface (rep B)	Egg count Oblique (rep A)	Egg count Oblique (rep B)	River stage (feet)	Cross-section (sq.ft.)	Egg production Surface	Egg production Oblique	Egg production Combined
	1400	10	14	17	8	8.5	3,790	81,212	84,596	82,904
	1800	2	5	5	9	8.7	3,854	24,088	48,176	36,132
	2200	14	18	16	5	9.0	3,950	112,866	74,068	93,467
900509	200	20	18	22	20	9.1	3,983	135,144	149,370	142,257
	600	129	106	124	73	9.2	4,016	842,664	706,403	774,533
	1000	31	6	30	9	9.2	4,016	132,675	139,846	136,261
	1400	19	15	28	16	9.3	4,049	122,919	159,072	140,995
	1800	10	6	15	9	9.3	4,049	57,844	86,766	72,305
	2200	22	15	10	23	9.3	4,049	133,765	119,304	126,534
900510	600	336	228	246	175	9.3	4,049	2,039,011	1,522,028	1,780,519
	200	342	143	287	63	9.4	4,082	1,767,652	1,275,625	1,521,638
	1000	5	9	18	10	9.4	4,082	51,025	102,050	76,537
	1400	9	8	22	19	9.4	4,082	61,959	149,430	105,695
	1800	4	3	.	.	9.4	4,082	25,512	.	25,512
	2200	15	3	20	2	9.5	4,115	66,132	80,828	73,480
900511	200	48	38	92	60	9.5	4,115	315,965	558,451	437,208
	600	17	5	12	14	9.5	4,115	80,828	95,524	88,176
	1000	7	5	13	5	9.5	4,115	44,088	66,132	55,110
	1400	4	2	8	7	9.5	4,115	22,044	55,110	38,577
	1800	10	4	9	2	9.5	4,115	51,436	40,414	45,925
	2200	18	8	11	13	10.0	4,280	99,346	91,704	95,525
900512	200	40	23	39	26	10.6	4,485	252,292	260,302	256,297
	600	11	4	15	9	11.3	4,731	63,355	101,368	82,361
	1000	1	0	1	0	11.4	4,767	4,256	4,256	4,256
	1400	0	0	0	0	11.8	4,911	0	0	0
	1800	2	3	3	4	12.0	4,983	22,246	31,144	26,695
	2200	1	1	0	0	12.2	5,057	9,030	0	4,515

Table 9. Continued.

Date	Time	Egg count Surface (rep A)	Egg count Surface (rep B)	Egg count Oblique (rep A)	Egg count Oblique (rep B)	River stage (feet)	Cross-section (sq.ft.)	Egg production Surface	Egg production Oblique	Egg production Combined
900513	200	8	2	36	7	12.2	5,057	45,151	194,149	119,650
	600	9	27	25	31	12.3	5,094	163,726	254,685	209,206
	1000	2	3	8	2	12.4	5,131	22,904	45,809	34,357
	1400	2	3	6	4	12.4	5,131	22,904	45,809	34,357
	1800	6	5	9	7	12.4	5,131	50,390	73,294	61,842
	2200	3	5	1	0	12.5	5,168	36,911	4,614	20,762
900514	200	2	3	3	1	12.5	5,168	23,069	18,455	20,762
	600	28	23	71	27	12.6	5,204	236,986	455,385	346,185
	1000	11	8	25	6	12.6	5,204	88,289	144,050	116,170
	1400	2	6	2	1	12.6	5,204	37,174	13,940	25,557
	1800	5	4	9	8	12.7	5,241	42,118	79,555	60,837
	2200	6	1	2	1	13.2	5,428	33,924	14,539	24,231
900515	200	13	8	6	13	13.5	5,542	103,907	94,011	98,959
	600	112	30	124	28	14.1	5,770	731,591	783,112	757,352
	1000	4	10	18	8	14.4	5,887	73,586	136,660	105,123
	1400	5	5	10	20	14.5	5,926	52,908	158,724	105,816
	1800	1	4	3	4	14.6	5,965	26,627	37,278	31,953
	2200	2	0	0	0	14.7	6,003	10,720	0	5,360
900516	200	3	1	0	2	14.8	6,042	21,579	10,790	16,184
	600	16	8	20	10	14.9	6,081	130,309	162,887	146,598
	1000	0	1	0	0	15.0	6,120	5,464	0	2,732
	1400	0	0	0	0	15.0	6,120	0	0	0
	1800	2	1	3	1	15.0	6,120	16,393	21,857	19,125
	2200	3	2	1	3	15.0	6,120	27,321	21,857	24,589
900517	200	5	3	4	9	15.0	6,120	43,714	71,035	57,374
	2200	4	7	28	5	15.0	6,120	60,106	180,318	120,212
	600	16	46	95	52	15.1	6,159	340,967	808,421	574,694

Table 9. Continued.

Date	Time	Egg count Surface (rep A)	Egg count Surface (rep B)	Egg count Oblique (rep A)	Egg count Oblique (rep B)	River stage (feet)	Cross-section (sq.ft.)	Egg production Surface	Egg production Oblique	Egg production Combined
	1000	9	7	9	0	15.1	6,159	87,991	49,495	68,743
	1400	3	2	7	3	15.1	6,159	27,497	54,995	41,246
	1800	11	8	12	16	15.1	6,159	104,490	153,985	129,237
900518	200	54	33	134	44	15.0	6,120	475,385	972,627	724,006
	600	13	11	19	14	15.0	6,120	131,141	180,318	155,730
	1000	0	3	2	1	15.0	6,120	16,393	16,393	16,393
	1400	4	1	3	1	15.1	6,159	27,497	21,998	24,748
	1800	3	1	4	5	15.1	6,159	21,998	49,495	35,747
	2200	5	1	1	1	15.1	6,159	32,997	10,999	21,998
900519	200	8	6	12	9	15.1	6,159	76,992	115,489	96,241
	600	10	12	26	19	15.1	6,159	120,988	247,476	184,232
	1000	6	7	8	10	15.1	6,159	71,493	98,990	85,242
	2200	1	1	0	0	15.1	6,159	10,999	0	5,499
	1400	3	1	0	5	15.2	6,199	22,139	27,674	24,906
	1800	1	0	2	1	15.2	6,199	5,535	16,604	11,069
900520	2200	5	0	4	2	11.3	4,731	21,118	25,342	23,230
	1800	0	1	1	1	11.7	4,875	4,353	8,705	6,529
	1400	3	2	7	7	12.3	5,094	22,740	63,671	43,205
	1000	1	0	0	0	12.7	5,241	4,680	0	2,340
	600	2	0	2	6	13.4	5,504	9,828	39,312	24,570
	200	0	3	5	0	15.0	6,120	16,393	27,321	21,857
900521	2200	2	3	3	4	9.9	4,247	18,958	26,541	22,750
	1800	0	0	1	0	10.0	4,280	0	3,821	1,910
	1400	12	5	16	11	10.2	4,348	65,998	104,820	85,409
	1000	12	5	10	24	10.4	4,417	67,038	134,075	100,557
	600	23	34	63	36	10.5	4,451	226,519	393,428	309,973
	200	30	56	101	40	11.0	4,622	354,927	581,914	468,421

Table 9. Continued.

Date	Time	Egg count Surface (rep A)	Egg count Surface (rep B)	Egg count Oblique (rep A)	Egg count Oblique (rep B)	River stage (feet)	Cross-section (sq.ft.)	Egg production Surface	Egg production Oblique	Egg production Combined
900522	200	25	13	29	25	9.7	4,181	141,845	201,569	171,707
	1800	13	18	19	15	9.7	4,181	115,716	126,914	121,315
	600	5	1	10	6	9.8	4,214	22,573	60,196	41,385
	1000	0	0	1	0	9.8	4,214	0	3,762	1,881
	1400	0	0	0	0	9.8	4,214	0	0	0
	2200	5	4	10	5	9.8	4,214	33,860	56,433	45,147
900523	200	23	5	9	5	9.8	4,214	105,342	52,671	79,007
	600	0	0	0	0	9.8	4,214	0	0	0
	1000	0	1	2	0	9.8	4,214	3,762	7,524	5,643
	1400	0	0	0	0	9.8	4,214	0	0	0
	1800	0	0	0	0	9.8	4,214	0	0	0
	2200	0	0	0	0	9.8	4,214	0	0	0
900524	1800	1	3	3	6	9.7	4,181	14,931	33,595	24,263
	2200	0	0	0	0	9.7	4,181	0	0	0
	200	1	2	3	2	9.8	4,214	11,287	18,811	15,049
	600	1	1	1	2	9.8	4,214	7,524	11,287	9,406
	1000	1	0	0	3	9.8	4,214	3,762	11,287	7,524
	1400	1	2	13	5	9.8	4,214	11,287	67,720	39,503
900525	2200	2	0	6	1	9.5	4,115	7,348	25,718	16,533
	1000	0	2	2	4	9.6	4,148	7,407	22,220	14,814
	1400	2	2	0	0	9.6	4,148	14,814	0	7,407
	1800	0	0	0	0	9.6	4,148	0	0	0
	200	3	2	13	4	9.7	4,181	18,664	63,457	41,060
	600	0	2	0	4	9.7	4,181	7,466	14,931	11,198
900526	200	7	18	9	13	9.5	4,115	91,850	80,828	86,339
	600	3	6	5	3	9.5	4,115	33,066	29,392	31,229
	1000	4	1	15	11	9.6	4,148	18,517	96,288	57,403

Table 9. Continued.

Date	Time	Egg count Surface (rep A)	Egg count Surface (rep B)	Egg count Oblique (rep A)	Egg count Oblique (rep B)	River stage (feet)	Cross-section (sq.ft.)	Egg production Surface	Egg production Oblique	Egg production Combined
	1400	0	0	0	1	10.1	4,314	0	3,852	1,926
	1800	0	0	0	0	10.8	4,554	0	0	0
	2200	0	0	2	2	11.5	4,803	0	17,152	8,576
900527	200	2	1	5	7	12.1	5,020	13,446	53,786	33,616
	600	5	1	5	2	12.3	5,094	27,288	31,836	29,562
	1000	0	1	1	0	12.6	5,204	4,647	4,647	4,647
	1400	0	0	1	2	12.7	5,241	0	14,039	7,020
	1800	2	4	4	1	12.8	5,278	28,276	23,563	25,919
	2200	2	7	4	2	12.8	5,278	42,413	28,276	35,344
900528	200	5	3	2	5	12.8	5,278	37,701	32,988	35,344
	600	0	0	1	0	13.2	5,428	0	4,846	2,423
	1000	1	0	2	0	13.2	5,428	4,846	9,692	7,269
	1400	0	0	0	0	14.9	6,081	0	0	0
	1800	1	1	0	0	16.7	6,795	12,134	0	6,067
	2200	0	2	1	0	17.2	7,003	12,504	6,252	9,378
900529	200	0	1	3	6	17.4	7,089	6,330	56,968	31,649
	600	0	0	2	0	17.8	7,263	0	12,970	6,485
	1000	1	0	2	0	18.1	7,395	6,603	13,206	9,904
	1400	0	0	0	0	18.3	7,485	0	0	0
	1800	0	0	0	0	18.4	7,530	0	0	0
	2200	0	0	0	0	18.4	7,530	0	0	0
900530	600	0	0	0	0	18.4	7,530	0	0	0
	1000	0	0	0	0	18.4	7,530	0	0	0
	1400	0	0	0	0	18.4	7,530	0	0	0
	1800	0	0	0	0	18.4	7,530	0	0	0
	2200	0	0	0	0	18.4	7,530	0	0	0
	200	0	0	0	0	18.5	7,575	0	0	0

Table 9. Continued.

Date	Time	Egg count Surface (rep A)	Egg count Surface (rep B)	Egg count Oblique (rep A)	Egg count Oblique (rep B)	River stage (feet)	Cross-section (sq.ft.)	Egg production Surface	Egg production Oblique	Egg production Combined
900531	200	0	0	0	1	18.4	7,530	0	6,723	3,362
	600	0	0	2	0	18.5	7,575	0	13,526	6,763
	1000	0	0	0	2	18.5	7,575	0	13,526	6,763
	1400	1	0	1	1	18.5	7,575	6,763	13,526	10,145
	1800	1	0	0	0	18.5	7,575	6,763	0	3,382
	2200	0	1	1	5	18.5	7,575	6,763	40,579	23,671
900601	1400	0	0	1	0	18.4	7,530	0	6,723	3,362
	1800	0	0	0	0	18.4	7,530	0	0	0
	2200	0	1	3	0	18.4	7,530	6,723	20,169	13,446
	200	1	4	4	3	18.5	7,575	33,816	47,342	40,579
	600	4	0	2	3	18.5	7,575	27,052	33,816	30,434
	1000	0	3	0	0	18.5	7,575	20,289	0	10,145
900602	2200	0	0	0	2	18.0	7,350	0	13,126	6,563
	600	0	3	2	1	18.2	7,440	19,929	19,929	19,929
	1000	1	0	0	0	18.2	7,440	6,643	0	3,321
	1400	1	1	0	0	18.2	7,440	13,286	0	6,643
	1800	4	2	4	1	18.3	7,485	40,098	33,415	36,756
	200	3	3	22	1	18.4	7,530	40,338	154,630	97,484
900603	600	1	0	2	3	18.2	7,440	6,643	33,215	19,929
	1000	1	0	1	0	18.2	7,440	6,643	6,643	6,643
	1400	0	0	1	0	18.2	7,440	0	6,643	3,321
	1800	.	.	.	.	18.2	7,440	.	.	.
	2200	.	.	.	.	18.2	7,440	.	.	.
	200	1	0	2	2	18.3	7,485	6,683	26,732	16,707
900604	1400	0	0	0	0	18.1	7,395	0	0	0
	1800	0	0	0	0	18.1	7,395	0	0	0
	2200	0	0	0	0	18.1	7,395	0	0	0

Table 9. Continued.

Date	Time	Egg count Surface (rep A)	Egg count Surface (rep B)	Egg count Oblique (rep A)	Egg count Oblique (rep B)	River stage (feet)	Cross-section (sq.ft.)	Egg production Surface	Egg production Oblique	Egg production Combined
	200	2	1	1	2	18.2	7,440	19,929	19,929	19,929
	600	0	0	0	3	18.3	7,485	0	20,049	10,024
	1000	0	0	0	0	18.3	7,485	0	0	0
900605	200	0	3	3	3	18.1	7,395	19,809	39,617	29,713
	600	3	1	2	0	18.2	7,440	26,572	13,286	19,929
	1000	0	0	0	0	18.2	7,440	0	0	0
	1400	0	0	0	0	18.2	7,440	0	0	0
	1800	6	0	2	4	18.2	7,440	39,858	39,858	39,858
	2200	0	0	2	0	18.2	7,440	0	13,286	6,643
900606	200	0	1	1	1	18.2	7,440	6,643	13,286	9,964
	600	1	1	1	0	18.3	7,485	13,366	6,683	10,024
	1400	0	0	0	0	18.3	7,485	0	0	0
	1800	0	0	1	1	18.3	7,485	0	13,366	6,683
	2200	1	0	1	0	18.3	7,485	6,683	6,683	6,683
	1000	0	0	0	0	18.4	7,530	0	0	0
900607	200	0	2	2	1	18.3	7,485	13,366	20,049	16,707
	600	0	0	0	0	18.4	7,530	0	0	0
	1000	0	0	1	2	18.4	7,530	0	20,169	10,085
	1400	0	0	1	0	18.4	7,530	0	6,723	3,362
	1800	0	0	0	0	18.4	7,530	0	0	0
	2200	0	0	2	1	18.4	7,530	0	20,169	10,085
900608	600	0	0	2	0	17.7	7,220	0	12,893	6,446
	200	0	0	0	2	17.8	7,263	0	12,970	6,485
	1000	0	0	0	0	17.9	7,307	0	0	0
	1400	0	0	0	0	18.0	7,350	0	0	0
	1800	0	0	0	0	18.1	7,395	0	0	0
	2200	0	0	0	0	18.2	7,440	0	0	0

Table 9. Continued.

Date	Time	Egg count Surface (rep A)	Egg count Surface (rep B)	Egg count Oblique (rep A)	Egg count Oblique (rep B)	River stage (feet)	Cross-section (sq.ft.)	Egg production Surface	Egg production Oblique	Egg production Combined
900609	200	0	0	0	0	18.3	7,485	0	0	0
	600	1	0	0	0	18.4	7,530	6,723	0	3,362
	1000	0	0	0	1	18.4	7,530	0	6,723	3,362
	1400	0	1	0	1	18.4	7,530	6,723	6,723	6,723
	1800	0	0	0	0	18.4	7,530	0	0	0
	2200	0	1	0	0	18.4	7,530	6,723	0	3,362
900610	200	0	2	2	0	18.4	7,530	13,446	13,446	13,446
	600	0	0	1	0	18.5	7,575	0	6,763	3,382
	1000	0	0	3	0	18.5	7,575	0	20,289	10,145
	1400	0	0	0	0	18.5	7,575	0	0	0
	1800	0	0	0	0	18.5	7,575	0	0	0
	2200	0	0	0	1	18.5	7,575	0	6,763	3,382
900611	200	0	0	0	0	18.5	7,575	0	0	0
	600	0	0	1	0	18.5	7,575	0	6,763	3,382
	1000	1	0	0	1	18.5	7,575	6,763	6,763	6,763
	1400	0	0	0	0	18.5	7,575	0	0	0
	1800	0	0	1	0	18.5	7,575	0	6,763	3,382
	2200	0	1	0	0	18.5	7,575	6,763	0	3,382
900612	600	0	0	0	0	18.4	7,530	0	0	0
	1000	0	0	0	0	18.4	7,530	0	0	0
	1400	0	0	0	0	18.4	7,530	0	0	0
	1800	0	0	0	0	18.4	7,530	0	0	0
	2200	0	3	0	0	18.4	7,530	20,169	0	10,085
	200	0	0	0	0	18.5	7,575	0	0	0
900613	200	0	0	1	0	18.4	7,530	0	6,723	3,362
	600	0	0	0	0	18.4	7,530	0	0	0
	1000	0	0	0	0	18.4	7,530	0	0	0

Table 9. Continued.

Date	Time	Egg count Surface (rep A)	Egg count Surface (rep B)	Egg count Oblique (rep A)	Egg count Oblique (rep B)	River stage (feet)	Cross-section (sq.ft.)	Egg production Surface	Egg production Oblique	Egg production Combined
	1400	0	0	0	0	18.4	7,530	0	0	0
	1800	0	0	0	0	18.4	7,530	0	0	0
	2200	0	0	0	0	18.4	7,530	0	0	0
900614	200	0	0	0	0	18.4	7,530	0	0	0
	600	0	0	0	0	18.4	7,530	0	0	0
	1000	0	0	0	0	18.4	7,530	0	0	0
	1400	0	0	0	0	18.4	7,530	0	0	0
	1800	0	0	0	0	18.4	7,530	0	0	0
	2200	0	0	0	0	18.4	7,530	0	0	0
900615	200	0	0	0	0	18.4	7,530	0	0	0
	600	0	0	0	0	18.4	7,530	0	0	0

Table 10. Daily egg production of striped bass at Barnhill's Landing, Roanoke River, North Carolina, in 1990, estimated by two methods and two depths.

Date	Number of samples	Total eggs surface only (trip method)	Total eggs oblique only (trip method)	Total eggs all depths (trip method)	Total eggs surface only (Hassler)	Total eggs oblique only (Hassler)	Total eggs all depths (Hassler)
900416	8	0	0	0	0	0	0
900417	20	0	0	0	0	0	0
900418	24	0	0	0	0	0	0
900419	20	0	0	0	0	0	0
900420	24	0	0	0	0	0	0
900421	24	0	0	0	0	0	0
900422	24	0	0	0	0	0	0
900423	20	0	0	0	0	0	0
900424	24	159,674	159,674	159,674	161,508	161,508	161,508
900425	24	11,603,484	15,641,522	13,622,503	11,857,332	16,080,492	13,968,912
900426	24	4,140,446	3,679,201	3,909,823	4,163,415	3,700,814	3,932,115
900427	24	10,656,089	24,774,806	17,715,448	10,639,889	24,672,206	17,656,047
900428	20	5,181,163	6,106,371	5,643,767	5,181,163	6,106,371	5,643,767
900429	20	5,413,185	7,653,124	6,533,154	5,403,789	7,639,840	6,521,814
900430	24	10,177,285	15,420,128	12,798,707	10,177,285	15,420,128	12,798,707
900501	20	9,532,720	19,104,043	14,318,381	9,107,369	18,214,738	13,661,053
900502	24	28,950,713	43,730,494	36,340,604	28,931,818	43,765,505	36,348,661
900503	24	37,117,642	35,480,280	36,298,961	40,569,991	38,991,392	39,780,692
900504	20	15,240,521	26,502,464	20,871,493	15,222,129	26,482,333	20,852,231
900505	24	13,702,336	14,758,589	14,230,462	13,679,568	14,692,869	14,186,218
900506	24	46,579,940	64,914,597	55,747,268	46,579,940	64,914,597	55,747,268
900507	24	145,124,204	186,007,233	165,565,718	142,809,984	183,015,498	162,912,741
900508	24	31,130,801	33,389,588	32,260,195	31,303,896	33,574,645	32,439,270
900509	24	68,401,106	65,317,106	66,859,106	68,519,085	65,412,426	66,965,755
900510	22	192,543,602	180,287,286	172,003,808	193,313,468	180,962,399	187,699,346
900511	24	29,458,231	43,552,469	36,505,350	29,469,988	43,672,393	36,571,190
900512	24	16,856,755	19,059,515	17,958,135	17,773,400	20,046,741	18,910,070
900513	24	16,415,485	29,681,519	23,048,502	16,451,869	29,832,723	23,142,296
900514	24	22,155,056	34,844,703	28,499,880	22,239,687	35,044,355	28,642,021

Table 10. Continued.

Date	Number of samples	Total eggs surface only (trip method)	Total eggs oblique only (trip method)	Total eggs all depths (trip method)	Total eggs surface only (Hassler)	Total eggs oblique only (Hassler)	Total eggs all depths (Hassler)
900515	24	47,968,737	58,070,190	53,019,463	48,628,584	58,655,096	53,641,840
900516	24	9,651,265	10,434,798	10,043,032	9,673,704	10,458,059	10,065,881
900517	24	31,908,990	63,276,484	47,592,737	31,872,876	63,218,927	47,545,901
900518	24	33,859,979	60,088,341	46,974,160	33,943,776	60,256,781	47,100,279
900519	24	14,791,148	24,299,380	19,545,264	14,814,283	24,337,751	19,576,017
900520	24	3,797,359	7,888,939	5,843,149	3,832,803	7,891,066	5,861,935
900521	24	35,205,379	59,741,306	47,473,343	34,273,486	58,189,599	46,231,542
900522	24	15,071,860	21,546,180	18,309,020	15,129,846	21,614,066	18,371,956
900523	24	5,237,071	2,889,418	4,063,245	5,237,071	2,889,418	4,063,245
900524	24	2,341,995	6,849,640	4,595,818	2,341,524	6,844,454	4,592,989
900525	24	2,673,515	6,063,728	4,368,621	2,669,990	6,051,978	4,360,984
900526	24	6,884,869	10,920,708	8,902,788	7,256,233	11,349,493	9,302,863
900527	24	5,571,394	7,495,061	6,533,227	5,556,403	7,556,709	6,556,556
900528	24	3,224,950	2,581,419	2,903,184	3,344,055	2,829,585	3,086,820
900529	24	620,774	3,990,959	2,305,866	632,754	4,112,900	2,372,827
900530	24	0	0	0	0	0	0
900531	24	973,898	4,218,301	2,596,099	972,936	4,216,056	2,594,496
900601	24	4,218,301	5,186,426	4,702,363	4,207,717	5,178,729	4,693,223
900602	24	5,774,140	10,612,837	8,193,488	5,745,301	10,533,051	8,139,176
900603	16	1,437,768	5,272,778	3,355,273	1,436,328	5,266,537	3,351,433
900604	24	956,592	1,918,945	1,437,768	955,626	1,911,252	1,433,439
900605	24	4,139,460	5,090,280	4,614,870	4,141,064	5,096,694	4,618,879
900606	24	1,281,216	1,920,865	1,601,040	1,283,139	1,924,709	1,603,924
900607	24	641,568	3,221,311	1,931,440	644,775	3,223,877	1,934,326
900608	24	0	1,241,427	620,714	0	1,256,456	628,228
900609	24	968,125	645,417	806,771	967,163	644,775	805,969
900610	24	645,417	2,268,580	1,456,999	648,624	2,270,184	1,459,404
900611	24	649,265	973,898	811,582	649,265	973,898	811,582
900612	24	968,125	0	484,063	969,087	0	484,544
900613	24	0	322,708	161,354	0	322,708	161,354

Table 10. Continued.

Date	Number of samples	Total eggs surface only (trip method)	Total eggs oblique only (trip method)	Total eggs all depths (trip method)	Total eggs surface only (Hassler)	Total eggs oblique only (Hassler)	Total eggs all depths (Hassler)
900614	24	0	0	0	0	0	0
900615	8	0	0	0	0	0	0
Total eggs		962,003,596	1,259,095,033	1,096,137,680	965,384,988	1,261,47,8780	1,113,993,296
S.D.		± 32,225,569	±35,831,596	± 32,627,708	± 32,190,094	± 35,666,052	± 33,739,616

Table 11. Results of statistical analyses (NPAR1WAY, SAS 1985) testing whether significant differences exist in yearly egg production estimates calculated by the Hassler method and trip method using cross-sectional area of the river or discharge from the dam three hours previous, and surface and oblique sampling techniques. Significance tests with 2 df = Kruskal-Wallis with chi-square statistic; 1 df = Wilcoxon signed-rank with Z statistic.

Class	Comparison	n	df	Statistic	P>statistic
River cross-section only					
Hassler	Surface, Oblique, All	61	2	1.0800	0.5837
Trip	Surface, Oblique, All	61	2	1.0700	0.5845
All samples	Hassler, Trip	61	1	0.0385	0.9693
Oblique	Hassler, Trip	61	1	0.0206	0.9876
Surface	Hassler, Trip	61	1	0.0180	0.9856
Cross-section vs volume (surface samples only)					
Hassler	Xsect, Volume	61	1	-0.0077	0.9938
Trip	Xsect, Volume	61	1	-0.0180	0.9856
Volume	Hassler, Trip	61	1	-0.1106	0.9119
Xsect	Hassler, Trip	61	1	-0.0900	0.9283

Table 12. Striped bass spawning in the Roanoke River, NC, as estimated by two methods (trip, Hassler) and two calculations (cross-sectional area, reservoir discharge three hours previous) from samples collected in surface waters at Barnhill's Landing, 1990.

Date	No. of samples	Mean River stage	Mean surface velocity	Mean X-section (sq.ft.)	Mean river discharge	Mean eggs/ day	Mean volume filtered (cfs)	Total eggs-surface (by trip)	Total eggs Flow13 (by trip)	Total eggs-surface (Hassler)	Total eggs Flow13 (Hassler)
900416	8	13.8	2.9	5,681	17,400	0	493	0	0	0	0
900417	20	17.5	3.4	7,149	20,254	0	569	0	0	0	0
900418	24	18.4	3.3	7,530	20,261	0	557	0	0	0	0
900419	20	18.9	3.4	7,745	20,453	0	576	0	0	0	0
900420	24	18.9	3.4	7,769	19,988	0	566	0	0	0	0
900421	24	15.0	2.4	6,137	8,293	0	403	0	0	0	0
900422	24	11.1	2.1	4,674	7,895	0	358	0	0	0	0
900423	20	9.3	2.0	4,056	7,855	0	342	0	0	0	0
900424	24	8.4	2.3	3,768	7,875	0	389	159,674	172,391	161,508	161,849
900425	24	8.5	2.2	3,790	7,827	6	375	11,603,484	12,026,096	11,857,332	12,178,817
900426	24	7.9	2.2	3,598	7,891	2	371	4,140,446	4,582,311	4,163,415	4,595,413
900427	24	7.9	2.2	3,598	7,965	6	377	10,656,089	11,906,540	10,639,889	11,677,175
900428	20	7.9	2.2	3,598	8,005	3	369	5,181,163	5,706,770	5,181,163	5,827,874
900429	20	8.0	2.2	3,623	7,960	3	374	5,413,185	5,964,696	5,403,789	5,925,879
900430	24	7.9	2.3	3,598	7,870	6	387	10,177,285	10,520,496	10,177,285	10,744,688
900501	22	7.2	2.2	3,341	6,892	5	371	9,532,720	9,829,642	9,107,369	9,440,721
900502	24	6.4	2.1	2,860	6,537	20	345	28,950,713	35,847,134	28,931,818	35,785,824
900503	24	8.3	2.4	3,683	9,543	21	408	37,117,642	49,358,194	40,569,991	48,115,195
900504	22	9.3	2.4	4,055	9,527	7	403	15,240,521	16,683,723	15,222,129	16,569,089
900505	24	9.0	2.4	3,941	8,701	7	410	13,702,336	13,754,806	13,679,568	13,759,284
900506	24	8.7	2.5	3,854	8,587	24	413	46,579,940	48,435,011	46,579,940	46,926,381
900507	24	8.4	2.4	3,752	8,195	74	407	145,124,204	141,922,412	142,809,984	143,132,676
900508	24	8.5	2.5	3,785	8,962	16	421	31,130,801	33,174,834	31,303,896	32,877,488
900509	24	9.2	2.8	4,027	9,462	33	464	68,401,106	67,214,613	68,519,085	64,785,372
900510	24	9.4	2.7	4,082	9,484	92	450	192,543,602	197,175,426	193,313,468	186,350,915
900511	24	9.6	2.7	4,142	9,757	14	459	29,458,231	27,747,267	29,469,988	28,211,798
900512	24	11.5	2.8	4,822	12,532	7	473	16,856,755	17,895,358	17,773,400	18,228,739
900513	24	12.4	2.7	5,118	12,556	6	451	16,415,485	16,611,071	16,451,869	16,686,290
900514	24	12.7	2.9	5,242	12,860	8	481	22,155,056	21,680,489	22,239,687	21,197,411
900515	24	14.3	3.3	5,849	15,141	16	553	47,968,737	44,824,776	48,628,584	42,484,201
900516	24	14.9	3.3	6,100	15,207	3	562	9,651,265	8,145,222	9,673,704	8,016,595
900517	24	15.1	3.4	6,146	15,114	10	564	31,908,990	25,421,338	31,872,876	25,942,634

Table 12. Continued.

Date	No. of samples	Mean River stage	Mean surface velocity	Mean X-section (sq.ft.)	Mean river discharge	Mean eggs/ day	Mean volume filtered (cfs)	Total eggs-surface (by trip)	Total eggs Flow13 (by trip)	Total eggs-surface (Hassler)	Total eggs Flow13 (Hassler)
900518	24	15.0	3.3	6,140	15,134	11	552	33,859,979	27,420,188	33,943,776	28,294,074
900519	24	15.1	3.1	6,173	15,221	5	517	14,791,148	13,516,660	14,814,283	13,186,882
900520	24	12.7	2.6	5,261	10,574	1	436	3,797,359	3,296,385	3,832,803	3,297,221
900521	24	10.3	2.6	4,394	9,500	15	443	35,205,379	31,877,214	34,273,486	31,252,664
900522	24	9.8	2.4	4,203	9,494	7	401	15,071,860	16,066,223	15,129,846	15,896,172
900523	24	9.8	2.5	4,214	9,516	2	413	5,237,071	5,432,044	5,237,071	5,350,422
900524	24	9.8	2.5	4,203	9,554	1	414	2,341,995	2,386,613	2,341,524	2,399,103
900525	24	9.6	2.4	4,153	9,544	1	410	2,673,515	2,800,420	2,669,990	2,793,511
900526	24	10.2	2.7	4,341	11,044	3	453	6,884,869	6,853,289	7,256,233	7,605,415
900527	24	12.5	2.8	5,186	12,673	2	476	5,571,394	5,290,393	5,556,403	5,323,898
900528	24	14.7	3.5	6,002	17,290	1	581	3,224,950	2,872,728	3,344,055	3,093,043
900529	24	18.1	3.8	7,382	20,004	0	646	620,774	509,872	632,754	495,161
900530	24	18.4	3.7	7,537	19,480	0	615	0	0	0	0
900531	24	18.5	3.5	7,567	19,583	0	582	973,898	809,584	972,936	808,015
900601	24	18.4	3.5	7,552	19,363	1	587	4,218,301	3,414,058	4,207,717	3,430,649
900602	24	18.2	3.5	7,448	19,089	2	580	5,774,140	4,685,583	5,745,301	4,739,900
900603	20	18.2	3.4	7,448	19,120	0	574	1,437,768	1,189,319	1,436,328	1,198,463
900604	24	18.2	3.5	7,433	19,065	0	587	956,592	771,401	955,626	778,985
900605	24	18.2	3.5	7,433	19,206	1	588	4,139,460	3,399,151	4,141,064	3,395,518
900606	24	18.3	3.5	7,485	19,354	0	590	1,281,216	1,065,441	1,283,139	1,049,264
900607	24	18.4	3.5	7,522	19,425	0	581	641,568	542,888	644,775	535,004
900608	24	17.9	3.4	7,329	18,307	0	565	0	0	0	0
900609	24	18.4	3.5	7,522	19,512	0	585	968,125	796,449	967,163	801,132
900610	24	18.5	3.6	7,567	19,512	0	603	645,417	500,498	648,624	517,781
900611	24	18.5	3.6	7,575	19,230	0	600	649,265	507,782	649,265	512,998
900612	24	18.4	3.5	7,537	19,120	0	589	968,125	748,165	969,087	778,855
900613	24	18.4	3.6	7,530	19,112	0	601	0	0	0	0
900614	24	18.4	3.6	7,530	19,081	0	605	0	0	0	0
900615	8	18.4	3.5	7,530	18,949	0	585	0	0	0	0
Total egg production estimate:								962,003,596	963,352,968	965,384,988	947,156,441
Standard deviation:								±32,225,569	±32,531,356	±32,190,094	±31,471,910

APPENDIX

Table A-1. List of Counties Enumerated in Figure 1.

Virginia	North Carolina
1. Roanoke	13. Stokes
2. Franklin	14. Rockingham
3. Patrick	15. Caswell
4. Henry	16. Person
5. Bedford	17. Granville
6. Pittsylvania	18. Vance
7. Campbell	19. Warren
8. Halifax	20. Halifax
9. Charlotte	21. Northampton
10. Lunenburg	22. Bertie
11. Mecklenburg	23. Martin
12. Brunswick	24. Washington

Table A-2. Location of the historical sampling locations used by W.W. Hassler and co-workers (1959-1987) and Rulifson (1988-present).

Location	River mile	Latitude	Longitude
Halifax	120	77°35'5"E	36°20'6"N
Johnson's Landing	118.5	77°18'23"E	36°33'20"N
Barnhill's Landing	117	77°18'23"E	36°32'15"N
Pollock' Ferry	105	77°24'30"E	36°15'30"N
Palmyra	78.5	77°19'30"E	36°4'32"N

Table A-3. Hourly sample grid for the 1990 striped bass egg study, Barnhill's Landing, Roanoke River, North Carolina.

Day	Date	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Total
0	900416	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	.	.	.	4	.	.	8
1	900417	.	4	.	.	.	.	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	20
2	900418	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	24
3	900419	.	.	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	20
4	900420	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	24
5	900421	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	24
6	900422	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	24
7	900423	.	4	.	.	.	.	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	20
8	900424	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	24
9	900425	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	24
10	900426	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	24
11	900427	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	24
12	900428	.	.	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	20
13	900429	.	.	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	20
14	900430	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	24
15	900501	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	.	.	.	20
16	900502	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	24
17	900503	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	24
18	900504	.	.	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	20
19	900505	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	24
20	900506	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	24
21	900507	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	24
22	900508	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	24
23	900509	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	24
24	900510	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	2	.	.	.	4	.	.	22
25	900511	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	24
26	900512	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	24
27	900513	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	24

Table A-3. Hourly sample grid for 1990, continued.

Day	Date	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Total
28	900514	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	24
29	900515	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	24
30	900516	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	24
31	900517	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	24
32	900518	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	24
33	900519	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	24
34	900520	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	24
35	900521	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	24
36	900522	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	24
37	900523	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	24
38	900524	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	24
39	900525	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	24
40	900526	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	24
41	900527	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	24
42	900528	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	24
43	900529	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	24
44	900530	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	24
45	900531	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	24
46	900601	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	24
47	900602	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	24
48	900603	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	.	.	.	.	.	.	.	16
49	900604	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	24
50	900605	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	24
51	900606	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	24
52	900607	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	24
53	900608	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	24
54	900609	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	24
55	900610	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	24
56	900611	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	24

Table A-3. Hourly sample grid for 1990, continued.

Day	Date	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Total
57	900612	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	24
58	900613	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	24
59	900614	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	.	4	.	.	24
60	900615	.	4	.	.	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	8

Table A-4. Water quality data collected at Barnhill's Landing, Roanoke River, North Carolina, from 16 April to 15 June 1990.

PAGE	DATE	TIME	ATEMP	WTEMP	PH	DO	TDS	SECCHI	WVEL	RSTAGE	XSECT	SREVS	OREVS
1	900416	1800	21.0	15.5	7.8	8.8	.	80.0	84.0	12.7	5241.3	5446	6253
2	900416	2200	20.0	15.5	7.8	9.4	.	.	94.8	15.0	6119.9	7086	6647
3	900417	200	20.0	14.5	7.9	9.2	.	.	94.3	16.0	6514.7	6187	6556
4	900417	600	12.0	14.0	6.8	9.0	.	.	.	.	.	6699	7130
5	900417	1000	18.0	14.0	7.5	9.0	.	.	101.6	17.5	7132.9	5067	7154
6	900417	1400	26.0	15.0	7.8	9.2	5.0	70.0	108.9	17.8	7263.3	7153	7345
7	900417	1800	24.0	15.0	7.9	9.4	5.0	70.0	107.2	18.1	7395.2	7030	7398
8	900417	2200	15.0	14.0	7.9	9.2	5.0	.	104.1	18.2	7440.1	6987	6547
9	900418	200	9.0	14.0	7.8	9.2	5.0	.	96.5	18.2	7440.1	1549	5081
10	900418	600	7.0	14.0	7.8	9.2	5.0	50.0	94.0	18.2	7440.1	6859	7714
11	900418	1000	13.0	14.0	8.3	9.0	5.0	50.0	91.2	18.2	7440.1	7027	1416
12	900418	1400	16.0	14.5	8.3	9.0	4.0	50.0	101.1	18.5	7574.7	6525	7477
13	900418	1800	18.5	15.0	8.0	9.0	4.0	50.0	105.1	18.6	7619.6	6973	6363
14	900418	2200	9.0	14.5	8.0	9.4	5.0	.	118.5	18.7	7664.5	7045	6823
15	900419	200	.	.	.	.	.	.	.	.	.	.	.
16	900419	600	11.0	14.0	8.0	9.1	4.0	60.0	113.5	18.8	7709.3	7050	7551
17	900419	1000	13.0	14.5	7.9	9.4	4.0	60.0	102.6	18.8	7709.3	7168	7076
18	900419	1400	20.0	15.0	7.3	9.0	4.0	60.0	97.4	18.9	7754.2	6451	7099
19	900419	1800	21.0	15.0	7.5	9.1	4.0	60.0	104.6	18.9	7754.2	6525	6592
20	900419	2200	19.0	15.0	7.8	9.4	5.0	.	104.6	19.0	7799.1	7531	7279
21	900420	200	17.0	15.0	7.7	9.2	5.0	.	103.6	19.0	7799.1	6588	6947
22	900420	600	12.0	15.0	.	9.1	4.0	50.0	99.7	19.0	7799.1	6563	6839
23	900420	1000	17.0	14.5	.	8.5	4.0	50.0	102.1	19.0	7799.1	6555	6667
24	900420	1400	20.0	15.0	7.6	9.2	5.0	60.0	105.1	19.0	7799.1	6911	7028
25	900420	1800	21.0	15.0	7.5	9.0	4.0	60.0	103.1	19.2	7888.9	6716	7019
26	900420	2200	17.0	15.0	7.6	9.3	4.0	.	103.1	18.4	7529.8	6280	6394
27	900421	200	18.5	15.0	7.7	9.2	4.0	.	83.0	17.5	7132.9	5276	5361
28	900421	600	15.0	15.0	8.0	8.4	4.0	50.0	83.0	15.7	6396.3	4011	558
29	900421	1000	21.5	15.0	7.5	8.4	4.0	50.0	67.5	14.8	6042.2	3954	2527
30	900421	1400	21.5	15.0	8.1	8.5	4.0	45.0	69.5	14.0	5731.5	4021	1299

Table A-4. Continued.

PAGE	DATE	TIME	ATEMP	WTEMP	PH	DO	TDS	SECCHI	WVEL	RSTAGE	XSECT	SREVS	OREVS
31	900421	1800	20.0	15.5	7.7	8.5	4.0	55.0	67.3	15.5	6317.3	4098	4223
32	900421	2200	20.0	15.0	7.6	8.6	5.0	.	68.4	12.6	5204.4	4260	3770
33	900422	200	18.0	15.0	7.5	8.9	4.0	.	68.4	12.0	4983.1	3242	3633
34	900422	600	19.0	15.5	7.4	8.8	4.0	60.0	66.7	11.6	4838.8	4123	4136
35	900422	1000	18.0	15.0	7.8	8.5	4.0	80.0	62.4	11.3	4730.5	3949	3770
36	900422	1400	20.0	15.5	7.5	8.7	4.0	80.0	64.3	10.9	4588.0	3595	3801
37	900422	1800	21.0	15.5	7.6	8.6	4.0	70.0	64.3	10.6	4485.2	3941	3622
38	900422	2200	19.0	15.5	7.6	8.6	4.0	.	63.7	10.4	4416.6	3875	4126
39	900423	200	18.0	15.0	7.7	8.4	4.0	.	65.4	10.0	4279.5	3714	3926
40	900423	600	.	.	.	.	.	.	.	.	.	.	.
41	900423	1000	23.5	15.0	7.4	8.4	4.0	.	56.6	9.5	4114.9	4532	4537
42	900423	1400	23.0	15.5	7.7	8.2	4.0	80.0	65.3	9.2	4016.1	3564	3943
43	900423	1800	20.0	16.0	7.7	8.9	4.0	70.0	61.8	9.0	3950.3	3951	3953
44	900423	2200	19.0	16.5	7.0	9.0	4.0	.	61.3	8.9	3918.2	3752	4304
45	900424	200	18.0	16.5	7.6	8.9	5.0	.	61.7	8.7	3854.1	3761	3949
46	900424	600	20.0	17.0	7.9	8.6	4.0	70.0	69.3	8.3	3725.7	4599	4004
47	900424	1000	25.0	16.0	7.6	8.4	4.0	60.0	66.9	8.5	3789.9	4196	2942
48	900424	1400	29.0	18.0	7.9	8.2	3.0	60.0	94.4	8.4	3757.8	4429	1883
49	900424	1800	26.0	18.0	7.6	8.3	4.0	80.0	65.3	8.4	3757.8	4492	5230
50	900424	2200	21.0	18.0	7.8	9.0	4.0	.	66.3	8.3	3725.7	4388	4052
51	900425	200	18.0	18.0	7.7	9.2	5.0	.	68.6	8.3	3725.7	4204	3700
52	900425	600	18.0	17.5	7.8	8.8	5.0	70.0	66.3	8.5	3789.9	4182	3958
53	900425	1000	25.0	17.5	7.9	8.0	4.0	90.0	69.7	8.8	3886.1	4325	3059
54	900425	1400	26.0	18.0	7.9	8.0	4.0	90.0	67.1	8.6	3822.0	4770	4436
55	900425	1800	27.0	19.0	7.8	8.2	4.0	80.0	71.8	8.9	3918.2	4434	3212
56	900425	2200	24.0	19.0	7.9	8.8	4.0	.	65.0	7.9	3598.0	4015	3444
57	900426	200	19.0	19.0	7.9	9.0	4.0	.	63.9	7.7	3534.9	4595	3799
58	900426	600	16.0	18.0	7.8	8.4	5.0	70.0	66.5	7.8	3566.5	2873	3100
59	900426	1000	28.0	18.0	7.8	8.2	4.0	70.0	66.7	7.9	3598.0	4655	3806
60	900426	1400	29.0	18.5	7.8	8.0	4.0	70.0	70.4	8.0	3629.5	4126	2723
61	900426	1800	27.0	19.5	7.7	8.2	5.0	85.0	67.9	8.0	3629.5	4497	4348
62	900426	2200	21.5	19.0	7.8	8.5	4.0	.	68.4	8.0	3629.5	3213	5258
63	900427	200	19.0	20.0	7.8	8.3	5.0	.	70.9	8.0	3629.5	3996	3644

Table A-4. Continued.

PAGE	DATE	TIME	ATEMP	WTEMP	PH	DO	TDS	SECCHI	WVEL	RSTAGE	XSECT	SREVS	OREVS
64	900427	600	22.0	18.0	7.8	8.2	4.0	85.0	61.0	7.8	3566.5	3949	3555
65	900427	1000	24.0	19.0	7.9	8.3	4.0	90.0	62.9	7.9	3598.0	3675	3943
66	900427	1400	33.0	19.0	7.8	8.3	3.0	90.0	77.0	7.9	3598.0	4523	4446
67	900427	1800	31.0	19.5	7.9	8.2	3.0	90.0	72.8	7.9	3598.0	4016	3963
68	900427	2200	22.0	20.0	7.9	8.7	4.0	.	65.3	7.9	3598.0	5925	5208
69	900428	200	.	.	.	.	.	.	.	.	.	.	.
70	900428	600	15.0	18.0	7.8	8.2	5.0	60.0	71.1	7.9	3598.0	3873	984
71	900428	1000	23.0	17.5	7.9	8.0	4.0	60.0	71.1	7.9	3598.0	4626	1244
72	900428	1400	26.0	18.5	7.8	8.1	3.0	80.0	67.7	7.9	3598.0	5201	3684
73	900428	1800	25.0	19.0	7.8	8.3	3.0	80.0	60.1	7.9	3598.0	3464	3794
74	900428	2200	24.0	19.0	7.9	8.3	4.0	.	64.8	7.9	3598.0	4555	4581
75	900429	200	20.0	19.0	7.9	8.6	5.0	.	.	.	.	.	.
76	900429	600	18.0	18.0	7.9	8.5	5.0	90.0	68.2	8.0	3629.5	4015	3886
77	900429	1000	19.5	18.5	7.2	8.0	4.0	70.0	70.2	8.0	3629.5	4805	4612
78	900429	1400	22.0	19.0	7.2	8.2	4.0	90.0	66.9	8.0	3629.5	3908	3822
79	900429	1800	21.0	20.0	7.5	8.2	5.0	75.0	61.5	8.0	3629.5	4819	4581
80	900429	2200	18.0	20.0	7.5	8.6	5.0	.	72.5	7.9	3598.0	4384	3963
81	900430	200	15.0	19.5	7.7	8.4	5.0	.	73.1	7.9	3598.0	4501	4355
82	900430	600	15.0	19.0	7.5	8.2	5.0	80.0	71.4	7.9	3598.0	4842	4416
83	900430	1000	17.5	19.0	7.6	8.0	5.0	80.0	69.7	7.9	3598.0	4783	4527
84	900430	1400	23.5	19.5	7.5	8.0	4.0	80.0	67.1	7.9	3598.0	4636	4700
85	900430	1800	22.0	19.5	7.7	8.1	4.0	80.0	71.4	7.9	3598.0	4770	4272
86	900430	2200	18.0	19.5	7.5	8.9	5.0	.	68.4	7.9	3598.0	2635	4593
87	900501	200	18.0	19.0	7.7	8.5	5.0	.	72.1	7.8	3566.5	4725	4520
88	900501	600	18.0	18.5	7.5	7.9	5.0	85.0	65.8	7.4	3440.4	4205	5415
89	900501	1000	23.0	18.5	7.3	7.9	4.0	90.0	65.3	7.3	3408.9	4931	3441
90	900501	1400	28.5	20.0	7.3	7.3	4.0	85.0	66.1	7.0	3314.3	4247	3922
91	900501	1800	23.0	20.0	7.3	7.0	4.0	75.0	67.7	6.9	3236.5	4158	3335
92	900501	2200	20.0	20.0	7.2	8.0	4.0	.	.	6.7	3080.9	.	.
93	900502	200	19.0	20.0	7.2	8.8	4.0	.	65.8	6.5	2925.3	4203	4966
94	900502	600	18.0	19.0	7.2	8.0	4.0	80.0	63.1	6.4	2847.5	3062	3755
95	900502	1000	21.0	19.5	7.3	8.0	4.0	85.0	59.1	6.4	2847.5	4456	3556

Table A-4. Continued.

PAGE	DATE	TIME	ATEMP	WTEMP	PH	DO	TDS	SECCHI	WVEL	RSTAGE	XSECT	SREVS	OREVS
96	900502	1400	23.0	20.0	7.3	7.8	4.0	85.0	59.8	6.4	2847.5	4154	3861
97	900502	1800	22.0	20.5	7.4	7.8	4.0	80.0	63.9	6.4	2847.5	3866	3012
98	900502	2200	18.0	21.0	7.3	8.0	5.0	.	63.7	6.4	2847.5	4493	4091
99	900503	200	16.0	21.0	7.4	9.0	5.0	.	68.2	6.5	2925.3	4559	4960
100	900503	600	15.0	18.5	7.5	8.0	5.0	70.0	76.8	8.1	3661.6	5215	4739
101	900503	1000	19.5	18.0	7.4	7.5	4.0	80.0	78.4	8.4	3757.8	4927	4871
102	900503	1400	23.0	19.0	7.5	7.3	4.0	70.0	75.7	8.7	3854.1	5167	4733
103	900503	1800	22.0	19.5	7.4	7.8	4.0	70.0	72.8	8.9	3918.2	4660	4210
104	900503	2200	19.5	19.0	7.4	8.2	4.0	.	72.1	9.1	3983.2	4786	5123
105	900504	200	17.0	18.5	7.4	8.1	5.0	.	.	9.2	4016.1	.	.
106	900504	600	15.0	18.5	7.4	8.0	5.0	70.0	70.9	9.3	4049.1	4882	5068
107	900504	1000	16.0	18.5	7.4	7.3	5.0	75.0	69.3	9.3	4049.1	4793	4878
108	900504	1400	22.0	19.0	7.4	7.8	5.0	70.0	70.9	9.3	4049.1	4521	4311
109	900504	1800	23.0	19.0	7.6	7.9	5.0	70.0	73.1	9.4	4082.0	4663	4001
110	900504	2200	21.0	19.5	7.0	8.3	.	.	81.4	9.4	4082.0	4748	4868
111	900505	200	21.5	20.0	7.3	.	5.0	.	77.6	9.5	4114.9	5989	5197
112	900505	600	22.0	19.0	.	7.2	7.0	80.0	70.9	9.2	4016.1	4772	4499
113	900505	1000	23.0	19.5	7.3	8.2	5.0	80.0	73.3	8.9	3918.2	4787	4381
114	900505	1400	23.0	19.5	7.3	8.2	5.0	80.0	78.1	8.8	3886.1	4641	4290
115	900505	1800	23.0	20.0	7.4	7.9	.	70.0	72.6	8.7	3854.1	4860	4766
116	900505	2200	20.0	20.0	7.3	8.4	5.0	.	73.6	8.7	3854.1	4593	4335
117	900506	200	15.5	18.0	7.6	8.2	.	.	74.3	8.7	3854.1	5187	4529
118	900506	600	13.0	18.0	7.6	7.0	4.0	60.0	69.9	8.7	3854.1	5019	4758
119	900506	1000	18.0	19.0	7.4	7.4	4.0	60.0	64.1	8.7	3854.1	4823	4344
120	900506	1400	20.0	19.5	7.4	8.0	4.0	75.0	78.1	8.7	3854.1	4702	4333
121	900506	1800	19.5	19.0	7.5	8.2	4.0	70.0	80.5	8.7	3854.1	5086	4582
122	900506	2200	15.0	19.0	7.6	8.7	4.0	.	82.4	8.7	3854.1	5100	4583
123	900507	200	14.0	19.0	7.6	8.2	4.0	.	74.1	8.7	3854.1	4819	4495
124	900507	600	14.0	18.0	7.5	7.4	2.0	70.0	75.9	8.6	3822.0	4716	4443
125	900507	1000	18.0	18.5	7.7	8.2	3.0	80.0	82.4	8.6	3822.0	4819	4934
126	900507	1400	20.0	19.5	7.6	8.5	4.0	80.0	70.9	8.3	3725.7	4802	4300
127	900507	1800	20.0	20.0	7.5	8.7	3.0	80.0	70.6	8.1	3661.6	4688	4193
128	900507	2200	17.0	19.5	7.6	8.9	4.0	.	68.8	8.0	3629.5	4570	4686

Table A-4. Continued.

PAGE	DATE	TIME	ATEMP	WTEMP	PH	DO	TDS	SECCHI	WVEL	RSTAGE	XSECT	SREVS	OREVS
129	900508	200	14.0	19.5	7.5	8.8	3.0	.	68.4	8.0	3629.5	4892	4748
130	900508	600	12.0	19.0	7.5	8.0	.	70.0	73.3	8.3	3725.7	4772	4338
131	900508	1000	16.5	19.0	7.6	7.9	.	65.0	71.8	8.4	3757.8	4442	4525
132	900508	1400	24.0	19.5	7.5	7.9	4.0	70.0	72.8	8.5	3789.9	4601	4218
133	900508	1800	23.0	20.0	7.6	8.3	4.0	75.0	84.3	8.7	3854.1	5143	4777
134	900508	2200	17.0	20.0	7.6	9.0	4.0	.	87.4	9.0	3950.3	5335	4712
135	900509	200	7.7	19.5	7.7	8.7	4.0	.	83.7	9.1	3983.2	5464	4935
136	900509	600	15.0	20.0	7.6	7.9	5.0	60.0	78.4	9.2	4016.1	5244	5043
137	900509	1000	19.0	20.0	7.6	7.3	4.0	60.0	86.4	9.2	4016.1	5366	5164
138	900509	1400	23.0	20.5	7.5	8.3	4.0	80.0	87.4	9.3	4049.1	5318	6179
139	900509	1800	23.0	20.5	7.5	8.2	4.0	80.0	84.0	9.3	4049.1	4918	5108
140	900509	2200	20.0	20.5	7.4	8.2	4.0	.	85.0	9.3	4049.1	5071	4991
141	900510	200	19.0	20.0	7.4	8.3	4.0	.	77.9	9.4	4082.0	5418	5429
142	900510	600	18.5	20.0	7.5	7.4	4.0	65.0	75.7	9.3	4049.1	5304	4859
143	900510	1000	19.0	20.0	.	.	.	60.0	76.5	9.4	4082.0	5547	5062
144	900510	1400	23.0	20.5	7.3	8.1	4.0	80.0	85.7	9.4	4082.0	4272	5909
145	900510	1800	22.0	20.5	7.3	8.1	4.0	75.0	84.0	9.4	4082.0	5315	.
146	900510	2200	18.0	18.5	7.4	7.5	.	.	90.0	9.5	4114.9	5252	4789
147	900511	200	14.0	18.5	7.1	8.2	5.0	.	86.4	9.5	4114.9	5063	5105
148	900511	600	15.0	18.0	7.1	8.0	4.0	55.0	69.9	9.5	4114.9	5342	5193
149	900511	1000	16.0	19.0	7.1	7.5	4.0	50.0	81.1	9.5	4114.9	5268	5226
150	900511	1400	20.0	19.0	7.2	8.0	4.0	80.0	83.7	9.5	4114.9	5102	4922
151	900511	1800	19.0	19.0	7.4	8.2	4.0	75.0	85.7	9.5	4114.9	4985	5012
152	900511	2200	18.0	20.0	7.9	8.8	6.0	.	93.2	10.0	4279.5	5504	5124
153	900512	200	13.0	18.5	8.0	8.4	5.0	.	84.7	10.6	4485.2	6417	5909
154	900512	600	13.0	18.5	7.4	8.3	4.0	65.0	86.7	11.3	4730.5	5935	5631
155	900512	1000	18.0	19.0	7.0	8.3	4.0	55.0	83.7	11.4	4766.6	6409	5916
156	900512	1400	18.0	20.0	7.1	7.1	5.0	55.0	84.7	11.8	4910.9	6481	6113
157	900512	1800	21.0	19.5	7.3	8.2	4.0	65.0	96.1	12.0	4983.1	6195	6023
158	900512	2200	17.0	18.0	7.7	8.0	4.0	.	79.0	12.2	5056.9	6369	6177
159	900513	200	18.0	19.0	.	8.1	5.0	.	88.5	12.2	5056.9	6029	6037
160	900513	600	17.0	18.0	7.3	7.3	4.0	70.0	81.4	12.3	5093.7	6113	5929
161	900513	1000	23.0	19.5	7.1	7.1	4.0	65.0	74.3	12.4	5130.6	5900	5711

Table A-4. Continued.

PAGE	DATE	TIME	ATEMP	WTEMP	PH	DO	TDS	SECCHI	WVEL	RSTAGE	XSECT	SREVS	OREVS
162	900513	1400	24.0	19.5	7.3	7.5	4.0	65.0	81.8	12.4	5130.6	5633	5720
163	900513	1800	21.0	19.5	7.6	7.8	4.0	75.0	83.3	12.4	5130.6	5631	5540
164	900513	2200	17.0	19.5	7.0	7.4	4.0	70.0	82.1	12.5	5167.5	4877	5193
165	900514	200	19.0	20.0	7.1	8.0	4.0	.	92.8	12.5	5167.5	5455	5211
166	900514	600	17.0	19.0	6.8	7.4	4.0	65.0	81.4	12.6	5204.4	5730	6119
167	900514	1000	22.0	20.0	7.3	8.0	4.0	70.0	86.0	12.6	5204.4	5811	5445
168	900514	1400	21.0	20.0	7.1	8.0	4.0	75.0	90.0	12.6	5204.4	6198	5620
169	900514	1800	22.0	20.5	7.2	8.1	4.0	.	80.8	12.7	5241.3	5760	6038
170	900514	2200	18.0	20.0	7.1	7.3	4.0	.	92.0	13.2	5427.8	6141	6604
171	900515	200	15.0	20.0	7.0	7.6	4.0	.	107.2	13.5	5541.7	6281	5808
172	900515	600	13.0	19.0	7.1	7.4	4.0	60.0	93.6	14.1	5770.3	6535	6678
173	900515	1000	21.0	19.5	7.3	8.3	4.0	65.0	88.5	14.4	5886.9	6360	6464
174	900515	1400	21.0	20.0	7.3	8.4	4.0	70.0	103.1	14.5	5925.7	6522	6165
175	900515	1800	25.0	20.0	7.4	8.2	4.0	70.0	105.1	14.6	5964.5	6230	6326
176	900515	2200	20.0	20.5	7.6	7.9	4.0	.	104.6	14.7	6003.4	6800	6158
177	900516	200	19.0	20.5	7.5	8.2	4.0	.	104.1	14.8	6042.2	6005	6137
178	900516	600	19.0	20.0	7.5	7.5	4.0	65.0	98.8	14.9	6081.1	6475	6247
179	900516	1000	22.0	20.5	7.5	7.0	4.0	70.0	101.1	15.0	6119.9	6248	6283
180	900516	1400	25.0	20.5	7.4	8.2	4.0	75.0	105.1	15.0	6119.9	6012	5917
181	900516	1800	25.0	21.0	7.4	8.4	4.0	75.0	96.5	15.0	6119.9	5609	5641
182	900516	2200	24.0	21.0	7.5	7.4	4.0	.	105.6	15.0	6119.9	5852	6605
183	900517	200	22.0	21.0	7.4	7.6	4.0	.	100.6	15.0	6119.9	5905	6106
184	900517	600	20.5	21.0	7.8	7.2	4.0	65.0	108.3	15.1	6159.4	6493	5965
185	900517	1000	24.0	21.0	7.7	7.0	4.0	60.0	101.6	15.1	6159.4	6209	6148
186	900517	1400	26.0	21.0	7.6	7.4	4.0	75.0	101.6	15.1	6159.4	6100	5927
187	900517	1800	27.0	21.0	7.2	7.5	3.0	70.0	101.1	15.1	6159.4	5997	6000
188	900517	2200	20.0	21.0	7.5	7.1	4.0	.	100.6	15.0	6119.9	6145	6100
189	900518	200	18.0	21.0	7.2	7.4	4.0	.	104.1	15.0	6119.9	6124	6085
190	900518	600	17.0	19.0	7.5	6.4	4.0	70.0	98.3	15.0	6119.9	6531	6856
191	900518	1000	21.0	20.0	7.5	6.0	4.0	75.0	98.3	15.0	6119.9	6176	6238
192	900518	1400	24.0	20.0	7.6	6.0	3.0	65.0	102.6	15.1	6159.4	6963	6800
193	900518	1800	24.0	20.5	7.4	6.4	4.0	80.0	97.9	15.1	6159.4	6131	5836
194	900518	2200	17.0	20.0	7.8	6.2	4.0	.	99.7	15.1	6159.4	6700	6156

Table A-4. Continued.

PAGE	DATE	TIME	ATEMP	WTEMP	PH	DO	TDS	SECCHI	WVEL	RSTAGE	XSECT	SREVS	OREVS
195	900519	200	18.0	20.0	7.2	6.0	4.0	.	104.1	15.1	6159.4	6010	6123
196	900519	600	17.0	20.0	7.2	7.0	5.0	70.0	86.4	15.1	6159.4	5791	6045
197	900519	1000	19.0	20.0	7.4	7.0	4.0	80.0	87.1	15.1	6159.4	5917	5823
198	900519	1400	22.0	21.0	7.2	7.5	4.0	85.0	95.7	15.2	6198.9	6024	5860
199	900519	1800	23.0	21.0	7.2	7.3	4.0	75.0	94.0	15.2	6198.9	6011	5837
200	900519	2200	20.0	21.5	7.2	7.3	5.0	.	95.7	15.1	6159.4	5863	5747
201	900520	200	21.0	21.0	8.1	7.0	4.0	.	94.0	15.0	6119.9	5832	6040
202	900520	600	20.0	20.0	8.1	7.2	4.0	75.0	73.1	13.4	5503.7	5058	4309
203	900520	1000	22.0	21.0	7.8	7.2	4.0	70.0	78.1	12.7	5241.3	4905	4691
204	900520	1400	25.5	21.5	7.8	7.2	4.0	70.0	74.6	12.3	5093.7	4606	4139
205	900520	1800	24.0	22.0	7.8	7.2	4.0	60.0	79.0	11.7	4874.9	4985	4226
206	900520	2200	21.0	22.0	7.8	7.2	4.0	.	75.9	11.3	4730.5	5085	4602
207	900521	200	21.0	22.0	7.7	7.6	5.0	.	75.4	11.0	4622.3	4918	4026
208	900521	600	19.0	21.0	8.0	6.3	4.0	60.0	81.8	10.5	4450.9	4754	4764
209	900521	1000	22.0	22.0	8.0	6.4	4.0	60.0	87.1	10.4	4416.6	4934	4057
210	900521	1400	23.0	22.0	7.4	6.9	4.0	75.0	76.5	10.2	4348.1	4311	4202
211	900521	1800	25.0	22.0	7.9	7.2	4.0	70.0	85.7	10.0	4279.5	4531	3999
212	900521	2200	20.5	22.0	8.1	6.4	3.0	.	75.4	9.9	4246.6	4818	4199
213	900522	200	17.0	22.0	7.6	8.0	5.0	.	70.9	9.7	4180.7	5049	4715
214	900522	600	14.0	20.0	8.3	7.0	4.0	70.0	75.4	9.8	4213.7	5030	4346
215	900522	1000	14.0	20.0	8.1	8.0	4.0	65.0	73.1	9.8	4213.7	4517	4177
216	900522	1400	15.0	20.0	7.9	8.1	4.0	70.0	74.6	9.8	4213.7	4012	4226
217	900522	1800	14.0	21.0	7.7	7.8	4.0	70.0	72.3	9.7	4180.7	5411	5117
218	900522	2200	11.0	20.0	7.4	6.4	4.0	.	70.6	9.8	4213.7	5150	4271
219	900523	200	11.0	20.0	7.6	7.9	4.0	.	73.8	9.8	4213.7	4940	5123
220	900523	600	10.0	20.0	7.6	7.2	4.0	70.0	78.7	9.8	4213.7	4700	4186
221	900523	1000	18.0	20.0	7.4	7.0	4.0	65.0	75.1	9.8	4213.7	5070	3993
222	900523	1400	20.0	20.5	7.4	7.2	4.0	70.0	74.3	9.8	4213.7	4173	4307
223	900523	1800	23.0	21.0	7.5	7.8	4.0	70.0	73.8	9.8	4213.7	4816	4976
224	900523	2200	13.0	21.0	7.8	7.5	4.0	.	73.3	9.8	4213.7	4920	4282
225	900524	200	12.0	21.0	7.7	7.6	4.0	.	81.1	9.8	4213.7	5274	4899
226	900524	600	14.0	20.0	7.3	7.2	3.0	70.0	67.5	9.8	4213.7	4855	4283
227	900524	1000	22.0	20.0	7.4	7.2	4.0	75.0	75.7	9.8	4213.7	4563	4438

Table A-4. Continued.

PAGE	DATE	TIME	ATEMP	WTEMP	PH	DO	TDS	SECCHI	WVEL	RSTAGE	XSECT	SREVS	OREVS
228	900524	1400	23.0	21.0	7.5	7.4	4.0	75.0	77.9	9.8	4213.7	4914	4686
229	900524	1800	21.0	21.0	7.5	7.0	4.0	70.0	74.6	9.7	4180.7	5070	4819
230	900524	2200	16.0	21.0	7.5	6.5	4.0	.	74.1	9.7	4180.7	4701	3980
231	900525	200	14.0	21.0	7.5	6.7	4.0	.	74.3	9.7	4180.7	5062	4578
232	900525	600	14.0	21.0	7.6	7.3	4.0	70.0	71.8	9.7	4180.7	4672	4614
233	900525	1000	22.0	21.0	7.2	7.0	4.0	75.0	75.9	9.6	4147.8	4728	3645
234	900525	1400	22.0	21.0	7.1	7.0	4.0	75.0	77.6	9.6	4147.8	4651	4484
235	900525	1800	19.0	21.0	7.7	7.2	4.0	70.0	77.3	9.6	4147.8	4434	4513
236	900525	2200	18.0	21.0	7.5	7.0	4.0	.	69.3	9.5	4114.9	4200	3660
237	900526	200	19.0	21.0	7.4	7.0	4.0	.	80.8	9.5	4114.9	5055	4699
238	900526	600	18.0	20.5	7.6	6.5	4.0	70.0	72.1	9.5	4114.9	4808	4137
239	900526	1000	23.0	20.5	7.1	7.0	4.0	70.0	79.3	9.6	4147.8	5100	3948
240	900526	1400	24.0	21.0	7.3	7.2	4.0	75.0	87.1	10.1	4313.8	5161	5419
241	900526	1800	24.0	21.0	7.0	8.1	4.0	70.0	88.2	10.8	4553.7	5012	4988
242	900526	2200	22.0	21.0	7.4	7.5	4.0	.	85.7	11.5	4802.7	6063	5181
243	900527	200	20.0	21.0	7.0	7.7	5.0	.	88.5	12.1	5020.0	5412	5223
244	900527	600	19.0	21.0	7.1	7.3	4.0	.	92.4	12.3	5093.7	5866	5650
245	900527	1000	18.0	20.5	7.2	7.5	4.0	45.0	88.5	12.6	5204.4	6021	5372
246	900527	1400	20.0	21.0	7.5	7.0	3.0	45.0	80.8	12.7	5241.3	5253	4925
247	900527	1800	18.0	21.0	7.4	7.5	3.0	50.0	84.3	12.8	5278.1	5497	5599
248	900527	2200	17.0	21.0	7.4	7.0	3.0	.	83.7	12.8	5278.1	5588	5277
249	900528	200	16.0	20.5	7.3	7.3	4.0	.	88.9	12.8	5278.1	5532	4968
250	900528	600	15.0	20.5	7.6	7.2	3.0	65.0	95.3	13.2	5427.8	6171	6260
251	900528	1000	15.0	20.5	7.5	7.0	3.0	65.0	108.3	13.2	5427.8	6694	6275
252	900528	1400	17.0	20.5	7.4	7.4	3.0	65.0	107.2	14.9	6081.1	5633	5427
253	900528	1800	17.5	20.5	7.4	7.9	4.0	65.0	117.2	16.7	6795.3	6957	6872
254	900528	2200	18.0	20.5	7.4	6.5	3.0	.	116.0	17.2	7002.5	6893	6074
255	900529	200	17.0	20.5	7.2	7.4	4.0	.	113.5	17.4	7089.4	6801	6893
256	900529	600	19.0	20.0	7.5	7.5	3.0	60.0	125.5	17.8	7263.3	7577	8262
257	900529	1000	18.0	20.0	7.5	7.2	3.0	60.0	116.6	18.1	7395.2	7884	6970
258	900529	1400	19.0	20.0	7.2	7.4	4.0	55.0	112.3	18.3	7484.9	7595	6770
259	900529	1800	19.0	20.0	7.2	7.4	4.0	60.0	111.7	18.4	7529.8	6707	6532
260	900529	2200	18.0	20.0	7.6	8.0	3.0	.	124.0	18.4	7529.8	7027	6214

Table A-4. Continued.

PAGE	DATE	TIME	ATEMP	WTEMP	PH	DO	TDS	SECCHI	WVEL	RSTAGE	XSECT	SREVS	OREVS
261	900530	200	17.0	20.0	7.0	8.0	4.0	.	115.3	18.5	7574.7	6624	6432
262	900530	600	14.0	20.0	7.5	7.0	3.0	65.0	110.5	18.4	7529.8	7168	6574
263	900530	1000	17.5	20.0	7.3	7.2	4.0	65.0	112.3	18.4	7529.8	7002	6340
264	900530	1400	21.0	20.0	7.5	7.4	3.0	70.0	112.3	18.4	7529.8	6922	6919
265	900530	1800	21.0	20.5	7.4	7.2	4.0	70.0	114.7	18.4	7529.8	6708	6623
266	900530	2200	16.5	20.0	7.5	7.3	4.0	.	104.1	18.4	7529.8	6800	6636
267	900531	200	16.0	20.0	7.5	7.5	4.0	.	102.1	18.4	7529.8	6547	6789
268	900531	600	15.0	20.0	7.6	7.5	4.0	70.0	107.2	18.5	7574.7	7224	7055
269	900531	1000	18.0	20.5	7.5	7.3	4.0	70.0	107.8	18.5	7574.7	7052	6656
270	900531	1400	22.0	20.5	7.6	7.4	4.0	75.0	109.4	18.5	7574.7	6767	6566
271	900531	1800	24.0	20.5	7.2	7.3	4.0	75.0	102.1	18.5	7574.7	7187	6321
272	900531	2200	18.0	20.5	7.4	7.2	4.0	.	104.6	18.5	7574.7	6773	6273
273	900601	200	17.0	20.5	7.3	8.0	4.0	.	112.3	18.5	7574.7	6746	7062
274	900601	600	15.0	20.0	7.5	7.5	4.0	70.0	102.6	18.5	7574.7	6742	6806
275	900601	1000	21.0	20.5	7.5	7.3	4.0	70.0	108.3	18.5	7574.7	6772	6503
276	900601	1400	25.0	20.5	7.4	7.5	4.0	75.0	105.1	18.4	7529.8	6500	6744
277	900601	1800	25.0	20.5	7.4	7.5	4.0	75.0	105.6	18.4	7529.8	6742	6432
278	900601	2200	20.0	21.0	7.4	7.8	4.0	.	105.1	18.4	7529.8	6541	6559
279	900602	200	18.0	21.0	7.3	7.4	5.0	.	105.1	18.4	7529.8	6835	6650
280	900602	600	19.5	21.0	7.8	7.3	4.0	70.0	105.1	18.2	7440.1	6893	6662
281	900602	1000	25.0	21.0	7.7	7.2	4.0	70.0	109.4	18.2	7440.1	5931	6480
282	900602	1400	25.0	21.5	7.2	7.3	4.0	80.0	101.6	18.2	7440.1	6459	6428
283	900602	1800	25.0	21.0	7.3	7.1	4.0	80.0	109.4	18.3	7484.9	6359	6640
284	900602	2200	21.5	21.0	7.5	7.0	3.0	.	100.6	18.0	7350.3	4907	6678
285	900603	200	21.0	21.0	7.8	7.6	4.0	.	108.9	18.3	7484.9	6499	6756
286	900603	600	19.0	21.0	7.6	7.3	4.0	65.0	106.1	18.2	7440.1	6896	6301
287	900603	1000	24.0	21.0	7.6	7.2	4.0	65.0	99.7	18.2	7440.1	6380	6196
288	900603	1400	26.0	21.0	7.6	7.4	4.0	80.0	102.1	18.2	7440.1	6201	6012
289	900603	1800	25.0	21.0	7.2	7.5	4.0	.	.	18.2	7440.1	.	.
290	900603	2200	25.0	21.0	7.7	7.0	4.0	.	.	18.2	7440.1	.	.
291	900604	200	20.0	21.0	7.4	7.2	5.0	.	107.2	18.2	7440.1	6325	6392
292	900604	600	20.5	21.0	7.4	7.0	3.0	60.0	102.1	18.3	7484.9	6495	6189
293	900604	1000	25.0	21.0	7.4	6.0	3.0	60.0	106.7	18.3	7484.9	6610	5994

Table A-4. Continued.

PAGE	DATE	TIME	ATEMP	WTEMP	PH	DO	TDS	SECCHI	WVEL	RSTAGE	XSECT	SREVS	OREVS
294	900604	1400	29.0	21.0	7.5	7.1	4.0	80.0	105.6	18.1	7395.2	6023	6331
295	900604	1800	27.0	21.0	7.5	7.3	3.0	80.0	106.7	18.1	7395.2	6202	6327
296	900604	2200	20.0	21.5	7.3	7.3	4.0	.	111.1	18.1	7395.2	6381	6744
297	900605	200	18.0	21.5	7.4	7.5	4.0	.	106.1	18.1	7395.2	6409	6740
298	900605	600	14.0	21.5	7.5	7.5	4.0	60.0	104.6	18.2	7440.1	5665	6241
299	900605	1000	15.0	21.5	7.5	7.0	4.0	70.0	103.6	18.2	7440.1	6514	6080
300	900605	1400	21.0	21.5	7.2	7.3	4.0	80.0	107.8	18.2	7440.1	6422	6355
301	900605	1800	20.0	21.5	7.5	7.4	4.0	80.0	108.3	18.2	7440.1	7410	6814
302	900605	2200	15.0	21.5	7.4	7.0	4.0	.	110.0	18.2	7440.1	6476	6498
303	900606	200	12.0	21.5	7.2	7.2	4.0	.	105.1	18.2	7440.1	6269	6282
304	900606	600	14.0	21.0	7.4	7.3	4.0	70.0	108.3	18.3	7484.9	6362	7612
305	900606	1000	23.5	21.5	7.3	7.2	4.0	70.0	101.6	18.4	7529.8	6437	5856
306	900606	1400	24.0	21.5	7.8	7.2	4.0	70.0	116.6	18.3	7484.9	6302	6220
307	900606	1800	22.0	22.0	7.6	7.0	3.0	75.0	111.7	18.3	7484.9	6244	6161
308	900606	2200	20.5	22.0	7.4	7.3	4.0	.	99.2	18.3	7484.9	6470	6958
309	900607	200	20.0	22.0	7.5	8.0	4.0	.	103.1	18.3	7484.9	6578	6447
310	900607	600	21.0	21.5	7.5	7.4	4.0	70.0	107.2	18.4	7529.8	6439	6501
311	900607	1000	23.0	21.5	7.5	7.5	4.0	70.0	102.6	18.4	7529.8	6542	6200
312	900607	1400	25.0	22.0	7.4	7.0	4.0	80.0	107.2	18.4	7529.8	6255	6177
313	900607	1800	27.0	22.0	7.5	7.2	4.0	80.0	106.1	18.4	7529.8	6241	6405
314	900607	2200	22.0	22.0	7.5	7.0	4.0	.	106.1	18.4	7529.8	6457	6287
315	900608	200	21.0	22.0	7.4	7.6	4.0	.	88.9	17.8	7263.3	5801	5867
316	900608	600	21.0	22.0	7.4	7.2	3.0	80.0	102.1	17.7	7219.9	6294	6256
317	900608	1000	25.5	22.0	7.4	7.0	4.0	80.0	107.8	17.9	7306.8	6146	7026
318	900608	1400	28.0	22.0	7.6	7.0	4.0	85.0	104.6	18.0	7350.3	5963	6012
319	900608	1800	30.0	22.5	7.4	6.8	4.0	85.0	105.1	18.1	7395.2	6152	6010
320	900608	2200	25.0	22.5	7.2	7.2	4.0	.	106.7	18.2	7440.1	6343	6411
321	900609	200	23.0	22.5	7.4	7.5	4.0	.	104.6	18.3	7484.9	6412	6285
322	900609	600	22.0	23.0	7.4	7.0	4.0	80.0	111.1	18.4	7529.8	6607	6426
323	900609	1000	26.0	23.0	7.3	7.2	4.0	80.0	107.8	18.4	7529.8	6543	6349
324	900609	1400	29.0	23.0	7.3	7.0	4.0	85.0	102.6	18.4	7529.8	5958	5925
325	900609	1800	31.0	23.5	7.5	7.0	4.0	90.0	103.6	18.4	7529.8	6122	5987
326	900609	2200	24.0	23.5	7.2	7.7	4.0	.	106.7	18.4	7529.8	6512	6321

Table A-4. Continued.

PAGE	DATE	TIME	ATEMP	WTEMP	PH	DO	TDS	SECCHI	WVEL	RSTAGE	XSECT	SREVS	OREVS
327	900610	200	22.0	23.0	7.1	7.5	4.0	.	112.9	18.4	7529.8	6613	6191
328	900610	600	22.0	23.0	7.5	7.0	4.0	85.0	107.2	18.5	7574.7	6358	6557
329	900610	1000	22.5	23.0	7.5	7.2	4.0	80.0	113.5	18.5	7574.7	6765	7064
330	900610	1400	25.0	23.0	7.3	7.0	4.0	90.0	108.3	18.5	7574.7	6295	6421
331	900610	1800	26.0	23.0	7.3	7.0	4.0	90.0	106.7	18.5	7574.7	6565	6101
332	900610	2200	21.0	23.0	6.9	7.0	4.0	.	107.8	18.5	7574.7	6702	6887
333	900611	200	18.0	23.0	7.1	7.4	4.0	.	108.3	18.5	7574.7	6184	6198
334	900611	600	18.0	23.0	7.3	7.4	4.0	80.0	106.7	18.5	7574.7	6106	6262
335	900611	1000	22.0	23.0	7.4	7.3	4.0	80.0	106.7	18.5	7574.7	6317	7261
336	900611	1400	24.0	23.0	7.4	6.5	4.0	80.0	111.7	18.5	7574.7	6687	6561
337	900611	1800	24.0	23.0	7.5	7.0	4.0	85.0	107.2	18.5	7574.7	6263	6527
338	900611	2200	21.0	23.0	7.3	7.2	4.0	.	112.3	18.5	7574.7	7381	7015
339	900612	200	18.0	23.0	7.4	7.2	4.0	.	107.2	18.5	7574.7	7212	7199
340	900612	600	18.0	23.0	7.3	7.4	4.0	85.0	106.1	18.4	7529.8	6574	6687
341	900612	1000	19.0	23.0	7.5	7.0	4.0	80.0	105.1	18.4	7529.8	6279	5650
342	900612	1400	23.0	23.0	7.4	7.0	4.0	90.0	105.1	18.4	7529.8	5999	5969
343	900612	1800	24.0	23.0	7.4	7.0	4.0	85.0	107.2	18.4	7529.8	6213	6233
344	900612	2200	17.0	23.0	7.2	6.5	4.0	.	110.5	18.4	7529.8	6365	6128
345	900613	200	16.0	23.0	7.3	7.0	4.0	.	108.9	18.4	7529.8	6370	6158
346	900613	600	14.0	23.0	7.4	7.3	4.0	85.0	106.7	18.4	7529.8	6635	5993
347	900613	1000	23.0	23.0	7.3	7.0	4.0	85.0	110.0	18.4	7529.8	6220	6052
348	900613	1400	25.0	23.0	7.3	7.0	4.0	85.0	104.1	18.4	7529.8	6345	6021
349	900613	1800	24.0	23.0	7.2	6.9	4.0	85.0	106.1	18.4	7529.8	6258	6137
350	900613	2200	18.0	23.0	7.3	7.0	4.0	.	118.5	18.4	7529.8	6138	5749
351	900614	200	19.0	23.0	7.5	7.4	4.0	.	110.5	18.4	7529.8	6314	6068
352	900614	600	18.0	23.0	7.3	6.5	4.0	85.0	108.3	18.4	7529.8	6454	6265
353	900614	1000	21.0	23.0	7.4	6.5	4.0	85.0	110.0	18.4	7529.8	6265	6193
354	900614	1400	29.0	23.0	7.4	6.6	4.0	85.0	110.5	18.4	7529.8	6200	6336
355	900614	1800	29.0	23.0	7.3	7.0	4.0	90.0	108.9	18.4	7529.8	6026	5963
356	900614	2200	22.0	23.0	7.2	6.9	4.0	.	110.0	18.4	7529.8	5666	5609
357	900615	200	21.0	23.0	7.0	6.4	4.0	.	104.1	18.4	7529.8	5578	5674
358	900615	600	18.5	23.0	7.4	6.5	4.0	80.0	108.3	18.4	7529.8	6258	6218

Table A-5. Striped bass egg enumeration and stage of development data collected at Barnhill's Landing, Roanoke River, North Carolina, from 16 April to 15 June 1990.

PAGE	DATE	TIME	ASURF	BSURF	AOBL	BOBL	ASVIA	BSVIA	AOVIA	BOVIA	ST1	ST2	ST3	ST4
1	900416	1800	0	0	0	0	.	.	.	.	.	.	.	.
2	900416	2200	0	0	0	0	.	.	.	.	.	.	.	.
3	900417	200	0	0	0	0	.	.	.	.	.	.	.	.
4	900417	600	.	.	.	.	.	.	.	.	.	.	.	.
5	900417	1000	0	0	0	0	.	.	.	.	.	.	.	.
6	900417	1400	0	0	0	0	.	.	.	.	.	.	.	.
7	900417	1800	0	0	0	0	.	.	.	.	.	.	.	.
8	900417	2200	0	0	0	0	.	.	.	.	.	.	.	.
9	900418	200	0	0	0	0	.	.	.	.	.	.	.	.
10	900418	600	0	0	0	0	.	.	.	.	.	.	.	.
11	900418	1000	0	0	0	0	.	.	.	.	.	.	.	.
12	900418	1400	0	0	0	0	.	.	.	.	.	.	.	.
13	900418	1800	0	0	0	0	.	.	.	.	.	.	.	.
14	900418	2200	0	0	0	0	.	.	.	.	.	.	.	.
15	900419	200	.	.	.	.	.	.	.	.	.	.	.	.
16	900419	600	0	0	0	0	.	.	.	.	.	.	.	.
17	900419	1000	0	0	0	0	.	.	.	.	.	.	.	.
18	900419	1400	0	0	0	0	.	.	.	.	.	.	.	.
19	900419	1800	0	0	0	0	.	.	.	.	.	.	.	.
20	900419	2200	0	0	0	0	.	.	.	.	.	.	.	.
21	900420	200	0	0	0	0	.	.	.	.	.	.	.	.
22	900420	600	0	0	0	0	.	.	.	.	.	.	.	.
23	900420	1000	0	0	0	0	.	.	.	.	.	.	.	.
24	900420	1400	0	0	0	0	.	.	.	.	.	.	.	.
25	900420	1800	0	0	0	0	.	.	.	.	.	.	.	.
26	900420	2200	0	0	0	0	.	.	.	.	.	.	.	.
27	900421	200	0	0	0	0	.	.	.	.	.	.	.	.
28	900421	600	0	0	0	0	.	.	.	.	.	.	.	.
29	900421	1000	0	0	0	0	.	.	.	.	.	.	.	.
30	900421	1400	0	0	0	0	.	.	.	.	.	.	.	.

Table A-5. Continued.

PAGE	DATE	TIME	ASURF	BSURF	AOBL	BOBL	ASVIA	BSVIA	AOVIA	BOVIA	ST1	ST2	ST3	ST4
31	900421	1800	0	0	0	0	.	.	.	.	.	.	.	.
32	900421	2200	0	0	0	0	.	.	.	.	.	.	.	.
33	900422	200	0	0	0	0	.	.	.	.	.	.	.	.
34	900422	600	0	0	0	0	.	.	.	.	.	.	.	.
35	900422	1000	0	0	0	0	.	.	.	.	.	.	.	.
36	900422	1400	0	0	0	0	.	.	.	.	.	.	.	.
37	900422	1800	0	0	0	0	.	.	.	.	.	.	.	.
38	900422	2200	0	0	0	0	.	.	.	.	.	.	.	.
39	900423	200	0	0	0	0	.	.	.	.	.	.	.	.
40	900423	600	.	.	.	.	.	.	.	.	.	.	.	.
41	900423	1000	0	0	0	0	.	.	.	.	.	.	.	.
42	900423	1400	0	0	0	0	.	.	.	.	.	.	.	.
43	900423	1800	0	0	0	0	.	.	.	.	.	.	.	.
44	900423	2200	0	0	0	0	.	.	.	.	.	.	.	.
45	900424	200	0	0	0	0	.	.	.	.	.	.	.	.
46	900424	600	0	0	0	0	.	.	.	.	.	.	.	.
47	900424	1000	0	0	0	0	.	.	.	.	.	.	.	.
48	900424	1400	0	0	0	0	.	.	.	.	.	.	.	.
49	900424	1800	0	0	0	0	.	.	.	.	.	.	.	.
50	900424	2200	1	0	1	0	0	0	0	0	.	.	.	.
51	900425	200	1	2	1	1	0	0	0	0	.	.	.	.
52	900425	600	17	19	20	17	3	0	1	2	6	0	0	0
53	900425	1000	2	0	1	0	2	0	1	0	3	0	0	0
54	900425	1400	0	1	5	0	0	1	3	0	4	0	0	0
55	900425	1800	0	0	0	0	.	.	.	.	.	.	.	.
56	900425	2200	15	16	34	20	6	3	6	8	23	0	0	0
57	900426	200	4	5	1	6	3	2	0	2	7	0	0	0
58	900426	600	6	2	5	4	1	2	2	1	6	0	0	0
59	900426	1000	1	0	0	1	0	0	0	1	1	0	0	0
60	900426	1400	1	0	0	0	0	0	0	0	.	.	.	.
61	900426	1800	0	0	2	1	0	0	2	0	2	0	0	0
62	900426	2200	7	1	2	2	4	1	2	0	6	0	0	0
63	900427	200	10	18	75	26	7	15	26	11	5	54	0	0

Table A-5. Continued.

PAGE	DATE	TIME	ASURF	BSURF	AOBL	BOBL	ASVIA	BSVIA	AOVIA	BOVIA	ST1	ST2	ST3	ST4
64	900427	600	6	10	12	13	1	0	3	1	3	2	0	0
65	900427	1000	2	4	7	9	0	0	2	1	3	0	0	0
66	900427	1400	0	1	3	0	0	0	0	0	.	.	.	.
67	900427	1800	1	0	2	1	0	0	0	0	.	.	.	.
68	900427	2200	5	12	4	8	1	2	2	3	.	.	.	.
69	900428	200	.	.	.	.	.	.	.	.	.	.	.	.
70	900428	600	9	5	18	6	7	5	13	3	28	.	.	.
71	900428	1000	2	0	1	0	1	0	1	0	2	0	0	0
72	900428	1400	0	0	0	0	.	.	.	.	.	0	0	0
73	900428	1800	0	0	0	0	.	.	.	.	.	.	.	.
74	900428	2200	3	9	1	7	2	6	1	3	12	0	0	0
75	900429	200	.	.	.	.	.	.	.	.	.	.	.	.
76	900429	600	13	16	12	26	9	9	7	14	37	2	0	0
77	900429	1000	0	0	1	0	0	0	1	0	1	0	0	0
78	900429	1400	0	0	0	0	.	.	.	.	.	.	.	.
79	900429	1800	0	0	2	0	0	0	2	0	1	1	0	0
80	900429	2200	0	0	0	0	.	.	.	.	.	.	.	.
81	900430	200	8	26	13	31	5	18	6	12	41	0	0	0
82	900430	600	6	13	23	22	1	5	15	11	25	7	0	0
83	900430	1000	0	1	3	3	0	0	2	1	2	1	0	0
84	900430	1400	0	1	3	0	0	1	2	0	2	1	0	0
85	900430	1800	0	0	0	0	.	.	.	.	.	.	.	.
86	900430	2200	4	7	2	0	2	3	0	0	5	0	0	0
87	900501	200	18	15	33	32	9	.	14	12	45	0	0	0
88	900501	600	10	4	11	19	5	4	1	5	12	3	0	0
89	900501	1000	0	0	0	3	0	0	0	3	3	0	0	0
90	900501	1400	0	1	4	0	0	1	1	0	2	0	0	0
91	900501	1800	2	3	3	1	2	2	3	0	4	2	1	0
92	900501	2200	.	.	.	.	.	.	.	.	.	.	.	.
93	900502	200	17	28	21	28	11	19	14	14	57	1	0	0
94	900502	600	36	38	71	52	23	22	46	31	65	57	0	0
95	900502	1000	39	18	53	54	25	12	23	36	31	65	0	0
96	900502	1400	13	17	22	9	9	12	12	4	22	15	0	0

Table A-5. Continued.

PAGE	DATE	TIME	ASURF	BSURF	AOBL	BOBL	ASVIA	BSVIA	AOVIA	BOVIA	ST1	ST2	ST3	ST4
97	900502	1800	5	7	12	10	2	3	6	4	8	7	0	0
98	900502	2200	5	13	10	15	2	6	5	6	15	4	0	0
99	900503	200	42	75	73	41	20	46	43	19	92	36	0	0
100	900503	600	53	48	45	56	31	22	28	25	90	16	0	0
101	900503	1000	1	1	4	4	1	1	3	3	6	2	0	0
102	900503	1400	2	4	4	3	2	2	3	3	10	0	0	0
103	900503	1800	2	0	1	2	1	0	1	1	3	0	0	0
104	900503	2200	7	22	11	3	3	10	9	2	24	0	0	0
105	900504	200	.	.	.	.	.	.	.	.	.	.	.	.
106	900504	600	26	1	22	32	17	0	17	19	53	0	0	0
107	900504	1000	9	7	12	18	3	3	9	14	29	0	0	0
108	900504	1400	5	2	4	6	2	1	2	4	9	0	0	0
109	900504	1800	4	5	12	9	1	2	4	4	11	0	0	0
110	900504	2200	4	10	9	3	3	5	6	3	17	0	0	0
111	900505	200	3	0	5	1	1	0	3	1	5	0	0	0
112	900505	600	21	11	15	18	10	8	9	16	43	0	0	0
113	900505	1000	12	8	10	17	6	5	8	12	27	4	0	0
114	900505	1400	4	5	7	6	3	3	6	2	13	1	0	0
115	900505	1800	1	3	0	1	1	3	0	0	4	0	0	0
116	900505	2200	4	9	3	4	2	1	1	1	5	0	0	0
117	900506	200	56	11	46	10	30	8	26	10	74	0	0	0
118	900506	600	75	21	169	37	42	12	95	24	106	67	0	0
119	900506	1000	16	25	19	11	6	10	13	2	29	2	0	0
120	900506	1400	26	26	25	28	15	16	6	16	49	3	1	0
121	900506	1800	7	9	6	6	3	4	4	3	13	1	0	0
122	900506	2200	8	2	18	18	5	2	9	13	27	2	0	0
123	900507	200	64	13	101	28	39	12	78	18	142	5	0	0
124	900507	600	222	199	338	284	145	148	273	217	277	141	0	0
125	900507	1000	188	119	162	125	85	77	88	81	123	35	0	0
126	900507	1400	17	33	22	22	13	9	18	7	47	0	0	0
127	900507	1800	13	17	20	29	5	11	16	20	50	2	0	0
128	900507	2200	1	2	5	2	0	0	3	2	5	0	0	0
129	900508	200	14	22	5	11	8	8	3	6	20	5	0	0

Table A-5. Continued.

PAGE	DATE	TIME	ASURF	BSURF	AOBL	BOBL	ASVIA	BSVIA	AOVIA	BOVIA	ST1	ST2	ST3	ST4
130	900508	600	43	15	51	40	33	9	25	33	80	20	0	0
131	900508	1000	21	15	29	11	10	13	24	7	54	0	0	0
132	900508	1400	10	14	17	8	4	9	11	4	19	9	0	0
133	900508	1800	2	5	5	9	2	2	4	5	11	2	0	0
134	900508	2200	14	18	16	5	8	5	8	2	18	5	0	0
135	900509	200	20	18	22	20	13	12	15	16	49	7	0	0
136	900509	600	129	106	124	73	79	80	89	48	48	248	0	0
137	900509	1000	31	6	30	9	17	5	16	7	35	10	0	0
138	900509	1400	19	15	28	16	15	9	17	13	39	14	1	0
139	900509	1800	10	6	15	9	4	3	10	6	18	5	0	0
140	900509	2200	22	15	10	23	10	11	6	17	42	2	0	0
141	900510	200	342	143	287	63	213	73	210	51	69	55	0	0
142	900510	600	336	228	246	175	221	150	176	113	0	278	0	0
143	900510	1000	5	9	18	10	3	7	12	9	16	15	0	0
144	900510	1400	9	8	22	19	1	1	9	3	14	0	0	0
145	900510	1800	4	3	.	.	1	1	.	.	2	0	0	0
146	900510	2200	15	3	20	2	12	3	13	0	22	6	0	0
147	900511	200	48	38	92	60	33	23	51	32	115	24	0	0
148	900511	600	17	5	12	14	14	4	9	10	14	23	0	0
149	900511	1000	7	5	13	5	5	2	9	3	16	3	0	0
150	900511	1400	4	2	8	7	2	2	5	3	10	2	0	0
151	900511	1800	10	4	9	2	6	2	5	2	12	3	0	0
152	900511	2200	18	8	11	13	13	4	6	10	30	2	1	0
153	900512	200	40	23	39	26	28	14	19	19	76	4	0	0
154	900512	600	11	4	15	9	6	0	7	3	16	0	0	0
155	900512	1000	1	0	1	0	1	0	1	0	2	0	0	0
156	900512	1400	0	0	0	0	0	0	0	0	.	.	.	.
157	900512	1800	2	3	3	4	1	1	2	2	6	0	0	0
158	900512	2200	1	1	0	0	0	0	0	0	.	.	.	.
159	900513	200	8	2	36	7	5	2	30	6	43	0	0	0
160	900513	600	9	27	25	31	7	23	16	21	67	0	0	0
161	900513	1000	2	3	8	2	1	1	6	2	10	0	0	0
162	900513	1400	2	3	6	4	1	2	2	3	8	0	0	0

Table A-5. Continued.

PAGE	DATE	TIME	ASURF	BSURF	AOBL	BOBL	ASVIA	BSVIA	AOVIA	BOVIA	ST1	ST2	ST3	ST4
163	900513	1800	6	5	9	7	3	3	4	3	13	0	0	0
164	900513	2200	3	5	1	0	2	3	1	0	6	0	0	0
165	900514	200	2	3	3	1	0	2	3	1	6	0	0	0
166	900514	600	28	23	71	27	17	16	48	17	95	3	0	0
167	900514	1000	11	8	25	6	9	6	18	1	32	2	0	0
168	900514	1400	2	6	2	1	1	3	2	1	6	1	0	0
169	900514	1800	5	4	9	8	4	2	7	4	17	0	0	0
170	900514	2200	6	1	2	1	5	1	2	0	6	2	0	0
171	900515	200	13	8	6	13	11	4	1	8	24	0	0	0
172	900515	600	112	30	124	28	65	23	95	21	204	0	0	0
173	900515	1000	4	10	18	8	2	4	13	4	23	0	0	0
174	900515	1400	5	5	10	20	4	0	6	11	21	0	0	0
175	900515	1800	1	4	3	4	0	1	2	2	5	0	0	0
176	900515	2200	2	0	0	0	2	0	0	0	2	0	0	0
177	900516	200	3	1	0	2	1	0	0	1	2	0	0	0
178	900516	600	16	8	20	10	12	6	14	3	17	0	0	0
179	900516	1000	0	1	0	0	0	0	0	0	0	.	.	.
180	900516	1400	0	0	0	0	.	.	.	.	.	.	.	.
181	900516	1800	2	1	3	1	2	0	3	1	6	0	0	0
182	900516	2200	3	2	1	3	2	1	0	1	4	0	0	0
183	900517	200	5	3	4	9	2	1	4	5	12	0	0	0
184	900517	600	16	46	95	52	7	25	54	26	72	40	0	0
185	900517	1000	9	7	9	0	3	6	5	0	13	1	0	0
186	900517	1400	3	2	7	3	1	2	3	3	8	1	0	0
187	900517	1800	11	8	12	16	2	5	5	6	18	0	0	0
188	900517	2200	4	7	28	5	3	6	23	5	35	2	0	0
189	900518	200	54	33	134	44	17	11	48	19	74	21	0	0
190	900518	600	13	11	19	14	8	6	13	7	30	4	0	0
191	900518	1000	0	3	2	1	0	3	0	1	4	0	0	0
192	900518	1400	4	1	3	1	4	0	2	0	6	0	0	0
193	900518	1800	3	1	4	5	2	0	3	3	8	0	0	0
194	900518	2200	5	1	1	1	2	1	1	1	5	0	0	0
195	900519	200	8	6	12	9	4	4	8	7	20	3	0	0

Table A-5. Continued.

PAGE	DATE	TIME	ASURF	BSURF	AOBL	BOBL	ASVIA	BSVIA	AOVIA	BOVIA	ST1	ST2	ST3	ST4
196	900519	600	10	12	26	19	5	8	15	12	40	0	0	0
197	900519	1000	6	7	8	10	3	4	4	5	16	0	0	0
198	900519	1400	3	1	0	5	1	0	0	1	2	0	0	0
199	900519	1800	1	0	2	1	1	0	1	0	2	0	0	0
200	900519	2200	1	1	0	0	1	0	0	0	1	0	0	0
201	900520	200	0	3	5	0	0	1	4	0	5	0	0	0
202	900520	600	2	0	2	6	1	0	2	3	1	5	0	0
203	900520	1000	1	0	0	0	1	0	0	0	1	0	0	0
204	900520	1400	3	2	7	7	3	1	3	3	8	2	0	0
205	900520	1800	0	1	1	1	0	1	1	1	1	2	0	0
206	900520	2200	5	0	4	2	4	0	3	1	5	3	0	0
207	900521	200	30	56	101	40	13	30	51	11	14	91	0	0
208	900521	600	23	34	63	36	17	23	40	29	28	81	0	0
209	900521	1000	12	5	10	24	12	3	4	20	21	18	0	0
210	900521	1400	12	5	16	11	7	4	12	8	15	16	0	0
211	900521	1800	0	0	1	0	0	0	1	0	0	1	0	0
212	900521	2200	2	3	3	4	0	3	2	4	1	8	0	0
213	900522	200	25	13	29	25	15	9	19	20	45	17	0	1
214	900522	600	5	1	10	6	3	1	5	4	8	5	0	0
215	900522	1000	0	0	1	0	0	0	1	0	0	1	0	0
216	900522	1400	0	0	0	0	.	.	.	.	.	.	.	.
217	900522	1800	13	18	19	15	10	9	10	12	26	15	0	0
218	900522	2200	5	4	10	5	2	4	6	4	2	14	0	0
219	900523	200	23	5	9	5	2	3	3	2	5	3	2	0
220	900523	600	0	0	0	0	.	.	.	.	.	.	.	.
221	900523	1000	0	1	2	0	0	0	0	0	.	.	.	.
222	900523	1400	0	0	0	0	.	.	.	.	.	.	.	.
223	900523	1800	0	0	0	0	.	.	.	.	.	.	.	.
224	900523	2200	0	0	0	0	.	.	.	.	.	.	.	.
225	900524	200	1	2	3	2	0	0	3	0	3	0	0	0
226	900524	600	1	1	1	2	1	1	0	2	4	0	0	0
227	900524	1000	1	0	0	3	1	0	0	3	4	0	0	0
228	900524	1400	1	2	13	5	1	1	3	2	5	2	0	0

Table A-5. Continued.

PAGE	DATE	TIME	ASURF	BSURF	AOBL	BOBL	ASVIA	BSVIA	AOVIA	BOVIA	ST1	ST2	ST3	ST4
229	900524	1800	1	3	3	6	0	1	2	2	5	0	0	0
230	900524	2200	0	0	0	0	0	0	0	0	.	.	.	.
231	900525	200	3	2	13	4	2	1	6	2	11	0	0	0
232	900525	600	0	2	0	4	0	2	0	3	0	5	0	0
233	900525	1000	0	2	2	4	0	2	2	3	5	2	0	0
234	900525	1400	2	2	0	0	1	2	0	0	3	0	0	0
235	900525	1800	0	0	0	0	0	0	0	0	.	.	.	.
236	900525	2200	2	0	6	1	2	0	3	0	5	0	0	0
237	900526	200	7	18	9	13	3	7	3	2	15	0	0	0
238	900526	600	3	6	5	3	1	4	3	2	4	6	0	0
239	900526	1000	4	1	15	11	2	0	6	8	16	0	0	0
240	900526	1400	0	0	0	1	0	0	0	0	.	.	.	.
241	900526	1800	0	0	0	0	0	0	0	0	.	.	.	.
242	900526	2200	0	0	2	2	0	0	1	1	4	0	0	0
243	900527	200	2	1	5	7	1	0	3	2	6	0	0	0
244	900527	600	5	1	5	2	0	1	3	0	4	0	0	0
245	900527	1000	0	1	1	0	0	1	1	0	2	0	0	0
246	900527	1400	0	0	1	2	0	0	1	2	3	0	0	0
247	900527	1800	2	4	4	1	1	1	2	0	4	0	0	0
248	900527	2200	2	7	4	2	2	6	4	1	10	3	0	0
249	900528	200	5	3	2	5	2	0	0	3	5	0	0	0
250	900528	600	0	0	1	0	0	0	0	0	.	.	.	.
251	900528	1000	1	0	2	0	1	0	0	0	1	0	0	0
252	900528	1400	0	0	0	0	.	.	.	.	.	.	.	.
253	900528	1800	1	1	0	0	0	1	0	0	1	0	0	0
254	900528	2200	0	2	1	0	0	2	0	0	0	2	0	0
255	900529	200	0	1	3	6	0	1	0	0	1	0	0	0
256	900529	600	0	0	2	0	0	0	1	0	0	1	0	0
257	900529	1000	1	0	2	0	0	0	1	0	1	0	0	0
258	900529	1400	0	0	0	0	.	.	.	.	.	.	.	.
259	900529	1800	0	0	0	0	.	.	.	.	.	.	.	.
260	900529	2200	0	0	0	0	.	.	.	.	.	.	.	.
261	900530	200	0	0	0	0	.	.	.	.	.	.	.	.

Table A-5. Continued.

PAGE	DATE	TIME	ASURF	BSURF	AOBL	BOBL	ASVIA	BSVIA	AOVIA	BOVIA	ST1	ST2	ST3	ST4
262	900530	600	0	0	0	0	0	0	0	0	.	.	.	.
263	900530	1000	0	0	0	0	0	0	0	0	.	.	.	.
264	900530	1400	0	0	0	0	0	0	0	0	.	.	.	.
265	900530	1800	0	0	0	0	0	0	0	0	.	.	.	.
266	900530	2200	0	0	0	0	0	0	0	0	.	.	.	.
267	900531	200	0	0	0	1	0	0	0	0	.	.	.	.
268	900531	600	0	0	2	0	0	0	1	0	1	0	0	0
269	900531	1000	0	0	0	2	0	0	0	1	1	0	0	0
270	900531	1400	1	0	1	1	0	0	0	1	1	0	0	0
271	900531	1800	1	0	0	0	0	0	0	0	.	.	.	.
272	900531	2200	0	1	1	5	0	0	1	3	4	0	0	0
273	900601	200	1	4	4	3	0	0	2	0	2	0	0	0
274	900601	600	4	0	2	3	3	0	0	1	4	0	0	0
275	900601	1000	0	3	0	0	0	1	0	0	0	1	0	0
276	900601	1400	0	0	1	0	0	0	0	0	.	.	.	.
277	900601	1800	0	0	0	0	0	0	0	0	.	.	.	.
278	900601	2200	0	1	3	0	0	0	2	0	2	0	0	0
279	900602	200	3	3	22	1	1	2	6	0	9	0	0	0
280	900602	600	0	3	2	1	0	2	0	0	0	2	0	0
281	900602	1000	1	0	0	0	0	0	0	0	.	.	.	.
282	900602	1400	1	1	0	0	1	0	0	0	1	0	0	0
283	900602	1800	4	2	4	1	3	2	1	0	6	0	0	0
284	900602	2200	0	0	0	2	0	0	0	2	2	0	0	0
285	900603	200	1	0	2	2	1	0	2	1	4	0	0	0
286	900603	600	1	0	2	3	1	0	1	1	0	3	0	0
287	900603	1000	1	0	1	0	0	0	0	0	.	.	.	.
288	900603	1400	0	0	1	0	0	0	0	0	.	.	.	.
289	900603	1800	.	.	.	.	.	.	.	.	.	.	.	.
290	900603	2200	.	.	.	.	.	.	.	.	.	.	.	.
291	900604	200	2	1	1	2	1	0	0	1	2	0	0	0
292	900604	600	0	0	0	3	0	0	0	1	1	0	0	0
293	900604	1000	0	0	0	0	0	0	0	0	.	.	.	.
294	900604	1400	0	0	0	0	0	0	0	0	.	.	.	.

Table A-5. Continued.

PAGE	DATE	TIME	ASURF	BSURF	AOBL	BOBL	ASVIA	BSVIA	AOVIA	BOVIA	ST1	ST2	ST3	ST4
295	900604	1800	0	0	0	0	0	0	0	0	.	.	.	.
296	900604	2200	0	0	0	0	.	.	.	.	.	.	.	.
297	900605	200	0	3	3	3	0	2	0	1	3	0	0	0
298	900605	600	3	1	2	0	2	1	0	0	3	0	0	0
299	900605	1000	0	0	0	0	.	.	.	.	.	.	.	.
300	900605	1400	0	0	0	0	0	0	0	0	.	.	.	.
301	900605	1800	6	0	2	4	1	0	0	0	1	0	0	0
302	900605	2200	0	0	2	0	0	0	2	0	2	0	0	0
303	900606	200	0	1	1	1	0	1	0	0	1	0	0	0
304	900606	600	1	1	1	0	1	1	0	0	2	0	0	0
305	900606	1000	0	0	0	0	0	0	0	0	.	.	.	.
306	900606	1400	0	0	0	0	0	0	0	0	.	.	.	.
307	900606	1800	0	0	1	1	0	0	0	0	.	.	.	.
308	900606	2200	1	0	1	0	1	0	1	0	2	0	0	0
309	900607	200	0	2	2	1	0	0	1	1	1	1	0	0
310	900607	600	0	0	0	0	0	0	0	0	.	.	.	.
311	900607	1000	0	0	1	2	0	0	0	0	.	.	.	.
312	900607	1400	0	0	1	0	0	0	0	0	.	.	.	.
313	900607	1800	0	0	0	0	.	.	.	.	.	.	.	.
314	900607	2200	0	0	2	1	0	0	1	1	2	0	0	0
315	900608	200	0	0	0	2	0	0	0	0	.	.	.	.
316	900608	600	0	0	2	0	0	0	0	0	.	.	.	.
317	900608	1000	0	0	0	0	0	0	0	0	.	.	.	.
318	900608	1400	0	0	0	0	.	.	.	.	.	.	.	.
319	900608	1800	0	0	0	0	.	.	.	.	.	.	.	.
320	900608	2200	0	0	0	0	.	.	.	.	.	.	.	.
321	900609	200	0	0	0	0	.	.	.	.	.	.	.	.
322	900609	600	1	0	0	0	1	0	0	0	1	0	0	0
323	900609	1000	0	0	0	1	0	0	0	0	.	.	.	.
324	900609	1400	0	1	0	1	0	1	0	1	1	1	0	0
325	900609	1800	0	0	0	0	.	.	.	.	.	.	.	.
326	900609	2200	0	1	0	0	0	0	0	0	.	.	.	.
327	900610	200	0	2	2	0	0	0	1	0	0	1	0	0

Table A-5. Continued.

PAGE	DATE	TIME	ASURF	BSURF	AOBL	BOBL	ASVIA	BSVIA	AOVIA	BOVIA	ST1	ST2	ST3	ST4
328	900610	600	0	0	1	0	0	0	0	0	.	.	.	.
329	900610	1000	0	0	3	0	0	0	3	0	1	2	0	0
330	900610	1400	0	0	0	0	.	.	.	.	.	.	.	.
331	900610	1800	0	0	0	0	0	0	0	0	.	.	.	.
332	900610	2200	0	0	0	1	0	0	0	1	1	0	0	0
333	900611	200	0	0	0	0	.	.	.	.	.	.	.	.
334	900611	600	0	0	1	0	0	0	0	0	.	.	.	.
335	900611	1000	1	0	0	1	0	0	0	0	.	.	.	.
336	900611	1400	0	0	0	0	0	0	0	0	.	.	.	.
337	900611	1800	0	0	1	0	0	0	0	0	.	.	.	.
338	900611	2200	0	1	0	0	0	1	0	0	0	1	0	0
339	900612	200	0	0	0	0	.	.	.	.	.	.	.	.
340	900612	600	0	0	0	0	.	.	.	.	.	.	.	.
341	900612	1000	0	0	0	0	.	.	.	.	.	.	.	.
342	900612	1400	0	0	0	0	.	.	.	.	.	.	.	.
343	900612	1800	0	0	0	0	.	.	.	.	.	.	.	.
344	900612	2200	0	3	0	0	0	1	0	0	1	0	0	0
345	900613	200	0	0	1	0	0	0	0	0	.	.	.	.
346	900613	600	0	0	0	0	0	0	0	0	.	.	.	.
347	900613	1000	0	0	0	0	0	0	0	0	.	.	.	.
348	900613	1400	0	0	0	0	.	.	.	.	.	.	.	.
349	900613	1800	0	0	0	0	.	.	.	.	.	.	.	.
350	900613	2200	0	0	0	0	0	0	0	0	.	.	.	.
351	900614	200	0	0	0	0	.	.	.	.	.	.	.	.
352	900614	600	0	0	0	0	0	0	0	0	.	.	.	.
353	900614	1000	0	0	0	0	0	0	0	0	.	.	.	.
354	900614	1400	0	0	0	0	.	.	.	.	.	.	.	.
355	900614	1800	0	0	0	0	.	.	.	.	.	.	.	.
356	900614	2200	0	0	0	0	.	.	.	.	.	.	.	.
357	900615	200	0	0	0	0	.	.	.	.	.	.	.	.
358	900615	600	0	0	0	0	0	0	0	0	.	.	.	.

Table A-6. Summary of total egg catches in surface nets for the striped bass egg study, Barnhill's Landing, Roanoke River, North Carolina in 1990.

Day	Date	0200	0600	1000	1400	1800	2200	Total
0	900416	.	.	.	.	0	0	0
1	900417	0	.	0	0	0	0	0
2	900418	0	0	0	0	0	0	0
3	900419	.	0	0	0	0	0	0
4	900420	0	0	0	0	0	0	0
5	900421	0	0	0	0	0	0	0
6	900422	0	0	0	0	0	0	0
7	900423	0	.	0	0	0	0	0
8	900424	0	0	0	0	0	1	1
9	900425	3	36	2	1	0	31	73
10	900426	9	8	1	1	0	8	27
11	900427	28	16	6	1	1	17	69
12	900428	.	14	2	0	0	12	28
13	900429	.	29	0	0	0	0	29
14	900430	34	19	1	1	0	11	66
15	900501	33	14	0	1	5	.	53
16	900502	45	74	57	30	12	18	236
17	900503	117	101	2	6	2	29	257
18	900504	.	27	16	7	9	14	73
19	900505	3	32	20	9	4	13	81
20	900506	67	96	41	52	16	10	282
21	900507	77	421	307	50	30	3	888
22	900508	36	58	36	24	7	32	193
23	900509	38	235	37	34	16	37	397
24	900510	485	564	14	17	7	18	1105
25	900511	86	22	12	6	14	26	166
26	900512	63	15	1	0	5	2	86
27	900513	10	36	5	5	11	8	75
28	900514	5	51	19	8	9	7	99
29	900515	21	142	14	10	5	2	194
30	900516	4	24	1	0	3	5	37
31	900517	8	62	16	5	19	11	121
32	900518	87	24	3	5	4	6	129
33	900519	14	22	13	4	1	2	56
34	900520	3	2	1	5	1	5	17
35	900521	86	57	17	17	0	5	182
36	900522	38	6	0	0	31	9	84
37	900523	28	0	1	0	0	0	29
38	900524	3	2	1	3	4	0	13
39	900525	5	2	2	4	0	2	15
40	900526	25	9	5	0	0	0	39
41	900527	3	6	1	0	6	9	25
42	900528	8	0	1	0	2	2	13
43	900529	1	0	1	0	0	0	2
44	900530	0	0	0	0	0	0	0

Table A-6. Eggs in surface nets, 1990, continued.

Day	Date	0200	0600	1000	1400	1800	2200	Total
45	900531	0	0	0	1	1	1	3
46	900601	5	4	3	0	0	1	13
47	900602	6	3	1	2	6	0	18
48	900603	1	1	1	0	.	.	3
49	900604	3	0	0	0	0	0	3
50	900605	3	4	0	0	6	0	13
51	900606	1	2	0	0	0	1	4
52	900607	2	0	0	0	0	0	2
53	900608	0	0	0	0	0	0	0
54	900609	0	1	0	1	0	1	3
55	900610	2	0	0	0	0	0	2
56	900611	0	0	1	0	0	1	2
57	900612	0	0	0	0	0	3	3
58	900613	0	0	0	0	0	0	0
59	900614	0	0	0	0	0	0	0
60	900615	0	0	.	.	.	.	0

Table A-7. Summary of total egg catches in oblique nets for the striped bass egg study, Barnhill's Landing, Roanoke River, North Carolina in 1990.

Day	Date	0200	0600	1000	1400	1800	2200	Total
0	900416	.	.	.	.	0	0	0
1	900417	0	.	0	0	0	0	0
2	900418	0	0	0	0	0	0	0
3	900419	.	0	0	0	0	0	0
4	900420	0	0	0	0	0	0	0
5	900421	0	0	0	0	0	0	0
6	900422	0	0	0	0	0	0	0
7	900423	0	.	0	0	0	0	0
8	900424	0	0	0	0	0	1	1
9	900425	2	37	1	5	0	54	99
10	900426	7	9	1	0	3	4	24
11	900427	101	25	16	3	3	12	160
12	900428	.	24	1	0	0	8	33
13	900429	.	38	1	0	2	0	41
14	900430	44	45	6	3	0	2	100
15	900501	65	30	3	4	4	.	106
16	900502	49	123	107	31	22	25	357
17	900503	114	101	8	7	3	14	247
18	900504	.	54	30	10	21	12	127
19	900505	6	33	27	13	1	7	87
20	900506	56	206	30	53	12	36	393
21	900507	129	622	287	44	49	7	1138
22	900508	16	91	40	25	14	21	207
23	900509	42	197	39	44	24	33	379
24	900510	350	421	28	41	.	22	862
25	900511	152	26	18	15	11	24	246
26	900512	65	24	1	0	7	0	97
27	900513	43	56	10	10	16	1	136
28	900514	4	98	31	3	17	3	156
29	900515	19	152	26	30	7	0	234
30	900516	2	30	0	0	4	4	40
31	900517	13	147	9	10	28	33	240
32	900518	178	33	3	4	9	2	229
33	900519	21	45	18	5	3	0	92
34	900520	5	8	0	14	2	6	35
35	900521	141	99	34	27	1	7	309
36	900522	54	16	1	0	34	15	120
37	900523	14	0	2	0	0	0	16
38	900524	5	3	3	18	9	0	38
39	900525	17	4	6	0	0	7	34
40	900526	22	8	26	1	0	4	61
41	900527	12	7	1	3	5	6	34
42	900528	7	1	2	0	0	1	11
43	900529	9	2	2	0	0	0	13
44	900530	0	0	0	0	0	0	0
45	900531	1	2	2	2	0	6	13

Table A-7. Eggs in oblique nets, 1990, continued.

Day	Date	0200	0600	1000	1400	1800	2200	Total
46	900601	7	5	0	1	0	3	16
47	900602	23	3	0	0	5	2	33
48	900603	4	5	1	1	.	.	11
49	900604	3	3	0	0	0	0	6
50	900605	6	2	0	0	6	2	16
51	900606	2	1	0	0	2	1	6
52	900607	3	0	3	1	0	3	10
53	900608	2	2	0	0	0	0	4
54	900609	0	0	1	1	0	0	2
55	900610	2	1	3	0	0	1	7
56	900611	0	1	1	0	1	0	3
57	900612	0	0	0	0	0	0	0
58	900613	1	0	0	0	0	0	1
59	900614	0	0	0	0	0	0	0
60	900615	0	0	.	.	.	.	0

Table A-8. Summary of total egg catches in all nets for the striped bass egg study, Barnhill's Landing, Roanoke River, North Carolina in 1990.

Day	Date	0200	0600	1000	1400	1800	2200	Total
0	900416	.	.	.	.	0	0	0
1	900417	0	.	0	0	0	0	0
2	900418	0	0	0	0	0	0	0
3	900419	.	0	0	0	0	0	0
4	900420	0	0	0	0	0	0	0
5	900421	0	0	0	0	0	0	0
6	900422	0	0	0	0	0	0	0
7	900423	0	.	0	0	0	0	0
8	900424	0	0	0	0	0	2	2
9	900425	5	73	3	6	0	85	172
10	900426	16	17	2	1	3	12	51
11	900427	129	41	22	4	4	29	229
12	900428	.	38	3	0	0	20	61
13	900429	.	67	1	0	2	0	70
14	900430	78	64	7	4	0	13	166
15	900501	98	44	3	5	9	.	159
16	900502	94	197	164	61	34	43	593
17	900503	231	202	10	13	5	43	504
18	900504	.	81	46	17	30	26	200
19	900505	9	65	47	22	5	20	168
20	900506	123	302	71	105	28	46	675
21	900507	206	1043	594	94	79	10	2026
22	900508	52	149	76	49	21	53	400
23	900509	80	432	76	78	40	70	776
24	900510	835	985	42	58	7	40	1967
25	900511	238	48	30	21	25	50	412
26	900512	128	39	2	0	12	2	183
27	900513	53	92	15	15	27	9	211
28	900514	9	149	50	11	26	10	255
29	900515	40	294	40	40	12	2	428
30	900516	6	54	1	0	7	9	77
31	900517	21	209	25	15	47	44	361
32	900518	265	57	6	9	13	8	358
33	900519	35	67	31	9	4	2	148
34	900520	8	10	1	19	3	11	52
35	900521	227	156	51	44	1	12	491
36	900522	92	22	1	0	65	24	204
37	900523	42	0	3	0	0	0	45
38	900524	8	5	4	21	13	0	51
39	900525	22	6	8	4	0	9	49
40	900526	47	17	31	1	0	4	100
41	900527	15	13	2	3	11	15	59
42	900528	15	1	3	0	2	3	24
43	900529	10	2	3	0	0	0	15
44	900530	0	0	0	0	0	0	0
45	900531	1	2	2	3	1	7	16

Table A-8. Eggs in all nets, 1990, continued.

Day	Date	0200	0600	1000	1400	1800	2200	Total
46	900601	12	9	3	1	0	4	29
47	900602	29	6	1	2	11	2	51
48	900603	5	6	2	1	.	.	14
49	900604	6	3	0	0	0	0	9
50	900605	9	6	0	0	12	2	29
51	900606	3	3	0	0	2	2	10
52	900607	5	0	3	1	0	3	12
53	900608	2	2	0	0	0	0	4
54	900609	0	1	1	2	0	1	5
55	900610	4	1	3	0	0	1	9
56	900611	0	1	2	0	1	1	5
57	900612	0	0	0	0	0	3	3
58	900613	1	0	0	0	0	0	1
59	900614	0	0	0	0	0	0	0
60	900615	0	0	.	.	.	.	0

Table A-9. Normal and observed rainfall (inches) for the Roanoke River basin downstream of Kerr Reservoir (RM 178.7), and basinwide, for April-June 1982-1992 (U.S. Army Corps of Engineers data).

	Below Kerr Dam						Basinwide					
	Normal			Observed			Normal			Observed		
Year	Apr	May	Jun	Apr	May	Jun	Apr	May	Jun	Apr	May	Jun
1963	3.37	4.02	3.91	1.55	2.83	2.59						
1964	3.26	4.02	3.91	2.20	1.30	2.45						
1965	3.26	3.77	3.78	2.04	1.98	8.30						
1966	3.16	3.62	4.16	1.49	6.38	3.55						
1967	3.03	3.84	4.11	1.88	3.24	2.39						
1968	2.95	3.79	3.99	3.21	5.20	3.05						
1969	2.95	3.79	3.99	3.05	3.24	4.12						
1970	2.95	3.79	3.99	4.09	2.36	3.12						
1971	2.95	3.79	3.99	2.57	6.36	3.41						
1972	2.95	3.79	3.99	2.32	5.03	4.52						
1973	2.95	3.79	3.99	4.62	4.53	5.95						
1974	2.95	3.79	3.99	2.56	5.68	2.65						
1975	2.95	3.79	3.99	2.23	3.23	2.27						
1976	2.95	3.79	3.99	0.85	3.73	4.39						
1977	2.95	3.79	3.99	2.66	5.44	3.69						
1978	2.90	4.08	3.87	4.94	4.85	5.60						
1979	2.98	4.11	3.94	4.30	6.09	5.87						
1980	2.98	4.11	3.94	3.15	2.85	2.84						
1981	2.98	4.11	3.94	1.41	4.96	3.10						
1982	2.98	4.11	3.94	3.04	2.56	4.83						
1983	2.98	4.11	3.97	5.99[A]	3.99	2.48						
1984	2.98	4.11	3.97	4.59	6.83	2.49						
1985	3.13	4.19	3.88	1.13	3.03	3.32						
1986	3.13	4.19	3.88	1.40	1.98	0.32[B]						
1987	3.13	4.19	3.88	5.53	2.21	3.44						
1988	3.01	4.09	3.75	4.67	3.87	3.68						
1989	3.01	4.09	3.75	6.41	5.16	8.41	3.36	3.89	3.84	4.02	5.76	7.95
1990	3.22	4.06	3.87	3.37	5.83	2.34	3.40	3.87	3.83	3.51	7.55	1.76
1991	3.22	4.06	3.87	2.62	1.46	2.86	3.40	3.87	3.83	2.94	3.08	2.68

[A] Maximum observed April rainfall since 1952.

[B] Record low observed June rainfall.