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Abundance and Viability of Striped Bass Eggs Spawned in the Roanoke River, North Carolina, in 1988

ALBEMARLE - PAMLICO ESTUARINE STUDY

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ALBEMARLE-PAMLICO

ABUNDANCE AND VIABILITY OF STRIPED BASS EGGS SPAWNED IN THE ROANOKE RIVER, NORTH CAROLINA, IN 1988

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ABSTRACT

Sampling to estimate production and viability of striped bass eggs was conducted at Pollock's Ferry on the Roanoke River, North Carolina, from 10 April to 7 June 1988. Samples were taken by towing paired nets at the surface for five minutes every four hours for 60 days in the manner established and used by W.W. Hassler since 1959. A total of 20,144 eggs were collected in surface nets: first eggs appeared in samples on 12 April and continued sporadically until 2 June, when the last eggs were collected. Estimated striped bass egg production in the Roanoke River for 1988 was 2,082,130,728. The major portion of eggs was collected in one large peak (11-12 May) and three minor peaks (15-16 May, 20 May, and 24-25 May). With the exception of 1986, egg production in 1988 was the highest estimate since 1975. Viability for eggs in 1988 was estimated at 89%, the highest estimate since 1972. Primary egg production was observed after water temperatures reached 18 C. The majority (71.8%) of the eggs collected ranged between 20 and 28 hours old. Nearly 13% were between 10 and 18 hours old, and 14% were 30 to 38 hours old. Fewer than one percent were less than 10 hours old. About 79% of the eggs were collected at water temperatures between 18 and 21.9 C; greatest viability was at 20 C and higher. Nearly all eggs (99.5%) were collected at water velocities between 60 and 99.9 cm/second. Approximately 85% of all eggs were collected in water with dissolved oxygen values ranging between 6.0 and 7.9 mg/L. Only eight percent of the eggs were collected in waters with pH values less than 7.0. Relative steadiness of water discharge from the Roanoke Rapids Dam during spawning season is believed responsible for stable water quality during the period.

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1. The estimated number of striped bass eggs produced in the Roanoke River for 1988 was 2,082,130,728 from a total of 20,144 eggs collected in surface nets during the period 10 April to 7 June. Whether spawning was initiated prior to this date was undetermined.

2. In 1988, the major portion of eggs were observed in one large peak and three minor peaks: 11-12 May, 15-16 May, 20 May, and 24-25 May.

3. With the exception of 1986, this represented the greatest production estimate since 1975.

4. Major egg production was observed after water temperatures reached 18 ^{o}C.

5. Viability of striped bass eggs for 1988 was estimated at 89%, the highest viability estimate since 1972.

6. The majority (71.8%) of the eggs passing Pollocks Ferry were between 20 and 28 hours old. Nearly 13% were between 10 and 18 hours old, and 14% were 30 to 38 hours old. Less than one percent were less than 10 hours old.

7. Most eggs (79%) were collected at water temperatures between 18 and 21.9^{o}C.

8. Greatest egg viability was observed at 20^{o}C or higher.

9. Nearly all eggs (99.5%) were collected at water velocities between 60 and 99.9 cm/second.

10. About 85% of all eggs were collected in water with dissolved oxygen values ranging between 6.0 and 7.9 mg/L.

11. Only 8% of the eggs were collected in waters with pH values less than 7.0.

12. Discharge of waters from Roanoke Rapids Reservoir was relatively steady compared to the historical record, remaining at a base of about 6,000 cfs and changing to 9,500 cfs by increments of 1,500 cfs per hour during peak hydroelectric demand.

A. 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. 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. 1986), 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. The information gathered by these researchers spans nearly 30 years of complete records and is well-known as the best data base on striped bass spawning activity in North America. These daily records have been an extremely 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 regimen and water quality for the Roanoke River watershed. The retirement of Dr. Hassler in 1987 from actively pursuing his studies threatened to end this valuable data base; however, 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 summarizes the information obtained during the 1988 striped bass spawning season.

The manner in which water is released from dams on this watershed, and the subsequent physiological and behavioral effects on spawning striped bass, has been scrutinized closely at various times since construction of John H. Kerr Reservoir in 1952. This concern 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 lawsuit between the State of North Carolina and the City of Virginia Beach concerning the interbasin transfer of water for municipal use; the effort by the Federal government to establish a 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 problem of how the flow regime is managed by the system of reservoirs located in the Piedmont region of the watershed.

In 1988, an ad hoc group was formed to investigate the improvement of Roanoke River water flows 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 by Manooch and Rulifson (1989).

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 original agreement, 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 6,000 cfs (cubic feet per second) can increase to 12,000 cfs within two hours, and then to 24,000 cfs within four hours. These sudden changes in the flow regime result in dramatic changes in water depth on the spawning grounds within a several-hour period. Although these sudden and dramatic changes in flow are well-known, no studies have been conducted to determine how spawning is affected by this surge of water.

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 radical changes in the flow regime); and 3) to correlate the intensity of striped bass spawning (as measured by egg production) with water releases from the reservoir at Roanoke Rapids, North Carolina. Only objectives 1 and 3 are addressed in this report. Objective 2 will require an additional two years of studies to ascertain the relationships among the physical parameters of volume, water velocity, river stage, and rate of net filtration.

B. STUDY SITE DESCRIPTION

The Roanoke River is a major coastal stream originating on the eastern slopes of 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 km2), making it the largest basin of any North Carolina estuary (Giese et al. 1979). 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: in Virginia, Smith Mountain Lake, Philpott Lake, Leesville Lake, John H. Kerr Reservoir, and Lake Gaston; and Lake Gaston and Roanoke Rapids Lake in North Carolina. Of these, the Roanoke Rapids Reservoir located at River Mile (RM) 137 is most important to the lower river and Albemarle Sound; approximately 87% of the flow to the coastal watershed is provided by its discharge (Giese et al. 1979). Average annual discharge of the river at Weldon, North Carolina (USGS gage), is about 8,500 cfs. The watershed itself contributes approximately 50% of the freshwater input to Albemarle Sound.

The primary spawning ground for Albemarle striped bass is located in the Roanoke River between Halifax (RM 120) and Weldon (RM 130), North Carolina. The historical spawning grounds farther upstream were blocked by construction of the Roanoke Rapids Dam at RM 137 in 1955 (McCoy 1959). Spawning activity begins in late April and is completed by mid-June

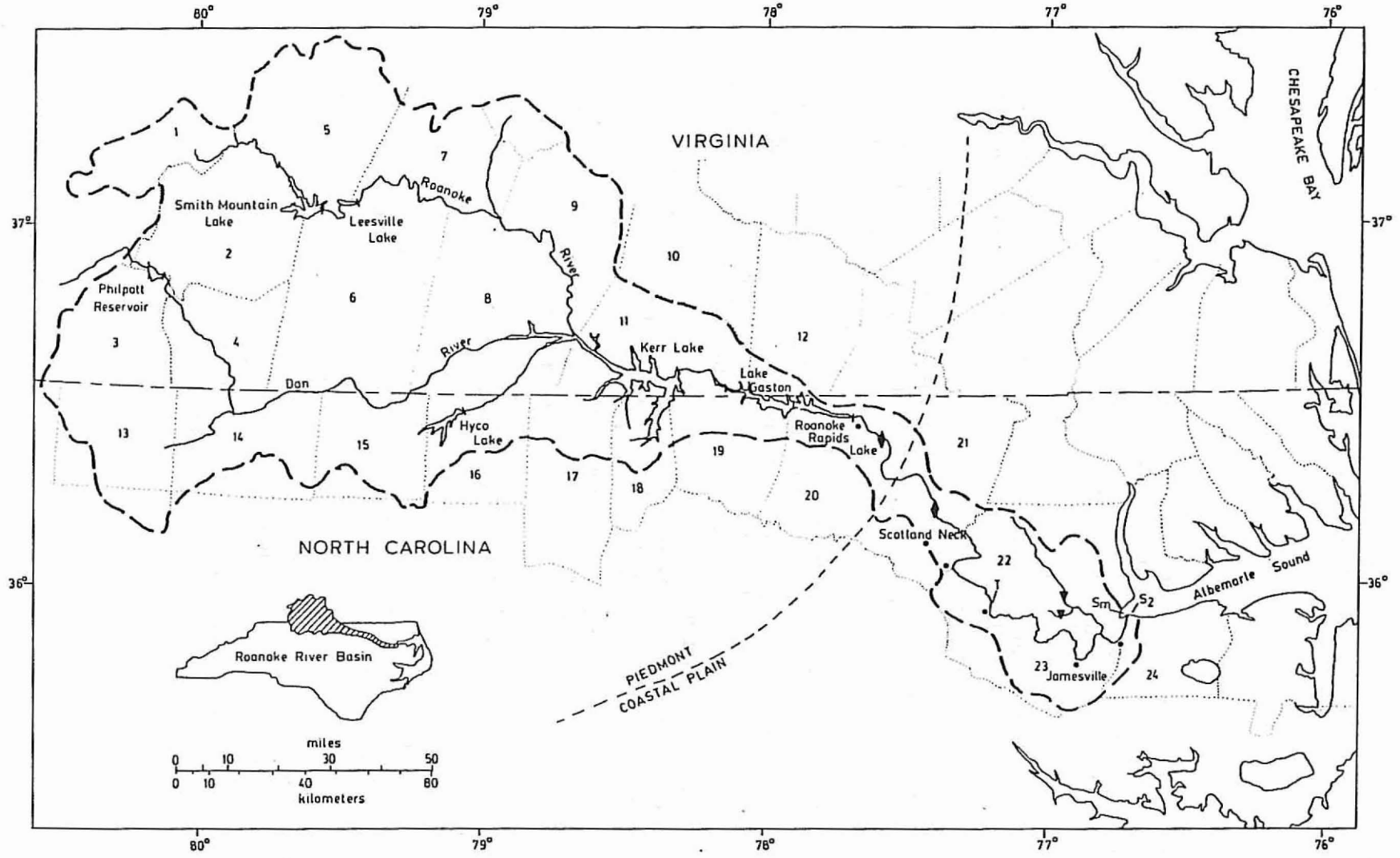


Figure 1. Roanoke River watershed depicting the six existing impoundments: Philpott, Smith Mountain, Leesville, Hyco, Kerr, Gaston, and Roanoke Rapids. Dashed line indicates approximate location of the fall line. Diamonds = USGS water quality and gaging stations; inverted triangle = USGS water quality 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 (after Giese et al. 1979). Counties within the Roanoke watershed are enumerated. See Appendix for county listing.

(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 into the historical nursery grounds of western Albemarle Sound (Rulifson et al. 1988).

C. METHODS

Initially, the field station was established on 10 April at the Pollocks Ferry Hunting Club near the town of Scotland Neck, North Carolina (Figure 1). On 20 May, the field station was moved to the Wildlife Resources Commission access ramp adjacent to the NC Hwy. 258 bridge between the towns of Scotland Neck and Rich Square. Field efforts were terminated on 7 June 1988.

The procedures for field sampling and sample workup were identical to those used by W.W. Hassler to ensure compatibility of the data sets. The tables and figures presented in my study are similar to Hassler's for purpose of comparison.

Sampling for striped bass eggs was just downstream of the Caledonia State Prison Farm in a straight section of the river adjacent to the Pollocks Ferry Hunting Club and slightly below the power lines, approximately 24 miles below Weldon at RM 105 and about 15 miles below Halifax (Figure 2). Eggs were collected in a manner similar to that described by Dr. Hassler's annual reports and by Kornegay and Mullis (1984). Samples were taken six times daily at four-hour intervals (0200, 0600, 1000, 1400, 1800, and 2200 hours) by towing paired 10-inch diameter nets constructed of 500-um nitex mesh (6:1 tail-to-mouth ratio) from a small aluminum boat. A solid cup attached to the tail of each net was used to retain collected eggs. Two tows of five-minute duration were made: the first tow six inches below the surface (Hassler's method), and the second tow in an oblique manner from the bottom to the surface. This procedure allowed comparisons of egg density at the surface with the abundance of eggs throughout the water column. 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. On several occasions during peak collection, eggs were subsampled to determine percent viability and developmental stage. Viability was determined using the criteria established by Hassler. Each egg was examined to determine the status of the embryo, yolk and oil globules, and perivitellene space. Eggs were examined under a dissecting microscope and staged using the criteria established by Bonn et al. (1976). Stage of development was based on an assumed water temperature of 17^{o}C; eggs spawned at temperatures greater than 17^{o}C will develop faster and hatch earlier. Stage 1 included eggs less than 10 hours old. Stage 2 eggs were those 10 to 18 hours old. Stage 3 eggs were 20 to 28 hours old, and Stage 4 eggs were 30 to 38 hours old. Stage 5 were eggs 40 hours and older, and newly-hatched larvae.

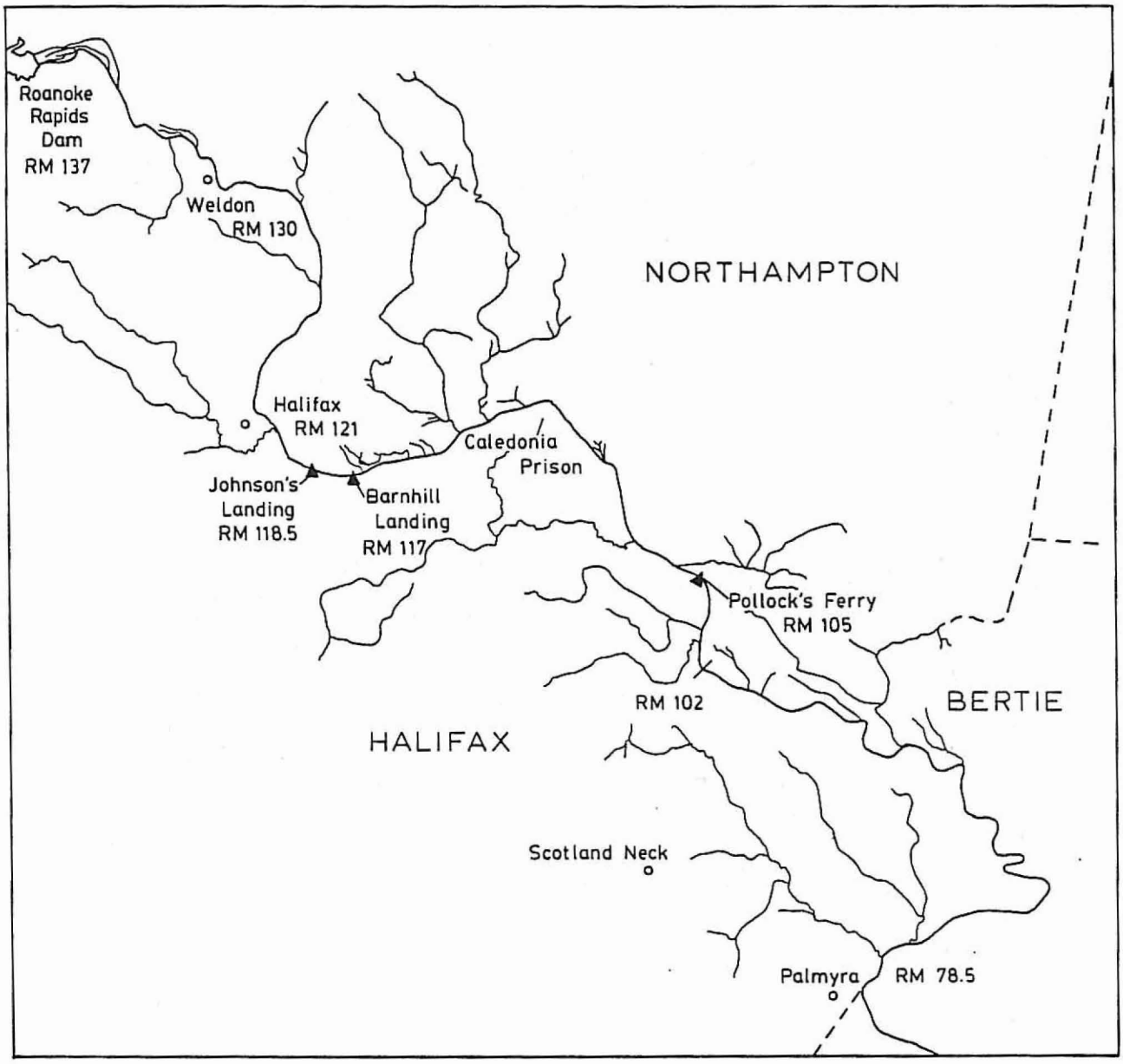


Figure 2. Roanoke River watershed downstream of Roanoke Rapids Reservoir showing the historical sampling stations for striped bass eggs: Palmyra (1959-60), Halifax (1961-74), Barnhill's Landing (1975-1981), Johnson's Landing (1982-87), and Pollocks Ferry (1988).

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

$$N = 514.29\,XY,$$

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 square feet of river area to the mouth opening of the 10-inch diameter egg net (0.56 square feet, 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.

D. RESULTS

Approximately 90% of the scheduled sampling trips were completed in 1988. The remaining trips were incomplete or were not attempted due to unfavorable weather and equipment failure.

D. 1. Egg Production and Viability

Using Hassler's methodology, the estimated number of striped bass eggs produced in 1988 was 2,082,130,728 from a total of 20,144 eggs collected in surface nets. Sampling was initiated on 10 April, and eggs were first collected in surface nets at Pollocks Ferry Hunting Club on 12 April 1988 (Table 1). Whether spawning was initiated prior to this date is unknown. Spawning activity continued at a low level until 11 May, which was the major spawning peak of the season representing 31% of the total eggs produced (Figure 3). From 11 May through 24 May, the major portion of eggs were produced in one large peak and three minor peaks: 11-12 May, 15-16 May, 20 May, and 24-25 May (Figure 4), after which less than 2% of the total egg production occurred (Table 1, Figure 3). No eggs were collected in surface nets after 2 June, and sampling was terminated on 7 June. The estimate of total egg production for 1988 was the seventh highest for the period of record (starting in 1959) and, with the exception of 1986, represented the greatest production estimate since 1975 (Table 2). Major egg production was observed just after water temperatures reached 18^{o}C (Figure 5).

Overall viability of striped bass eggs for 1988 was estimated at 89% for the season, ranking tenth for the period of record but representing the best viability estimate since 1972 (Table 2). Eggs collected in April and early May had low viability, but the percentage increased dramatically during peak spawning activity (Table 3). Viability declined late in the spawning season.

A total of 9,557 eggs were examined throughout the season to determine stage of development. The majority of the eggs (71.8%, or 6,865 eggs) were between 20 and 28 hours old. Fewer than one percent of the eggs (64) were less than 10 hours old. Nearly 13% (1,237) exhibited development of between 10 and 18 hours, and 14% (1,385) were staged at 30 to 38 hours of development. Only six eggs were over 40 hours old.

Table 1. Striped bass spawning in the Roanoke River, NC, as estimated from samples collected at Pollocks Ferry Hunting Club, 1988.

Date	Number samples	Average river stage	Area of river x-section	Average no. eggs per net	Est. no. eggs per day	Percent-age of total	Cum. per-centage of spawning
880410	4	5.4	1,448	0.00	0	0.00	0.00
880411	6	.	1,500	0.00	0	0.00	0.00
880412	11	.	2,500	1.27	1,636,377	0.08	0.08
880413	6	.	2,500	0.17	214,287	0.01	0.09
880414	12	11.6	2,821	0.00	0	0.00	0.09
880415	10	10.3	2,511	0.40	516,594	0.02	0.11
880416	12	.	2,500	0.00	0	0.00	0.11
880417	6	.	2,500	0.00	0	0.00	0.11
880418	12	8.7	2,158	0.08	92,486	0.00	0.12
880419	8	.	2,400	0.13	154,287	0.01	0.13
880420	4	10.0	2,400	0.25	308,574	0.01	0.14
880421	8	9.8	2,408	0.00	0	0.00	0.14
880422	12	10.3	2,518	0.00	0	0.00	0.14
880423	12	10.1	2,477	0.25	318,464	0.02	0.16
880424	12	9.5	2,340	0.00	0	0.00	0.16
880425	12	8.6	2,137	0.00	0	0.00	0.16
880426	12	8.7	2,162	0.33	370,609	0.02	0.17
880427	12	8.5	2,104	0.00	0	0.00	0.17
880428	12	8.6	2,231	0.08	95,608	0.00	0.18
880429	12	8.6	2,132	0.00	0	0.00	0.18
880430	12	8.2	2,171	0.17	186,092	0.01	0.19
880501	12	8.0	2,042	0.08	87,536	0.00	0.19
880502	12	7.9	1,987	1.17	1,192,130	0.06	0.25
880503	12	7.9	1,987	0.00	0	0.00	0.25
880504	10	8.7	2,165	0.00	0	0.00	0.25
880505	12	11.1	2,715	0.17	232,703	0.01	0.26
880506	12	11.2	2,636	0.00	0	0.00	0.26
880507	12	9.9	2,431	0.08	104,200	0.01	0.26
880508	12	8.8	2,189	0.17	187,590	0.01	0.27

Table 1. (Continued)

Date	Number samples	Average river stage	Area of river x-section	Average no. eggs per net	Est. no. eggs per day	Percent-age of total	Cum. per-centage of spawning
880509	12	8.6	2,132	4.08	4,476,257	0.21	0.49
880510	12	9.6	2,367	10.00	12,171,701	0.58	1.07
880511	12	9.8	2,401	534.00	659,310,883	31.67	32.74
880512	12	9.6	2,371	114.08	139,088,625	6.68	39.42
880513	12	9.4	2,325	28.67	34,275,217	1.65	41.06
880514	12	8.5	2,114	31.33	34,073,941	1.64	42.70
880515	12	9.0	2,223	271.67	310,524,573	14.91	57.61
880516	12	9.7	2,382	117.58	144,048,175	6.92	64.53
880517	10	10.4	2,536	14.00	18,258,776	0.88	65.41
880518	12	10.1	2,469	37.42	47,518,707	2.28	67.69
880519	12	8.8	2,185	26.08	29,308,223	1.41	69.10
880520	10	9.6	2,372	214.70	261,889,562	12.58	81.68
880521	10	9.7	2,395	14.80	18,227,240	0.88	82.55
880522	10	9.3	2,295	31.10	36,700,154	1.76	84.32
880523	12	9.3	2,291	71.33	84,033,609	4.04	88.35
880524	12	9.5	2,348	169.42	204,547,643	9.82	98.18
880525	10	9.8	2,418	4.50	5,595,110	0.27	98.44
880526	12	9.1	2,257	15.00	17,408,202	0.84	99.28
880527	12	9.0	2,238	0.67	767,229	0.04	99.32
880528	10	9.0	2,236	2.10	2,414,403	0.12	99.43
880529	10	8.2	2,044	7.40	7,779,097	0.37	99.81
880530	8	7.9	1,978	0.25	254,358	0.01	99.82
880531	10	8.6	2,152	1.40	1,549,367	0.07	99.89
880601	10	13.1	3,199	1.10	1,809,565	0.09	99.98
880602	10	10.6	2,609	0.30	402,572	0.02	100.00
880603	10	7.6	1,923	0.00	0	0.00	100.00
880604	10	7.8	1,971	0.00	0	0.00	100.00
880605	10	5.4	1,449	0.00	0	0.00	100.00
880606	12	3.5	1,052	0.00	0	0.00	100.00
880607	6	10.1	2,489	0.00	0	0.00	100.00

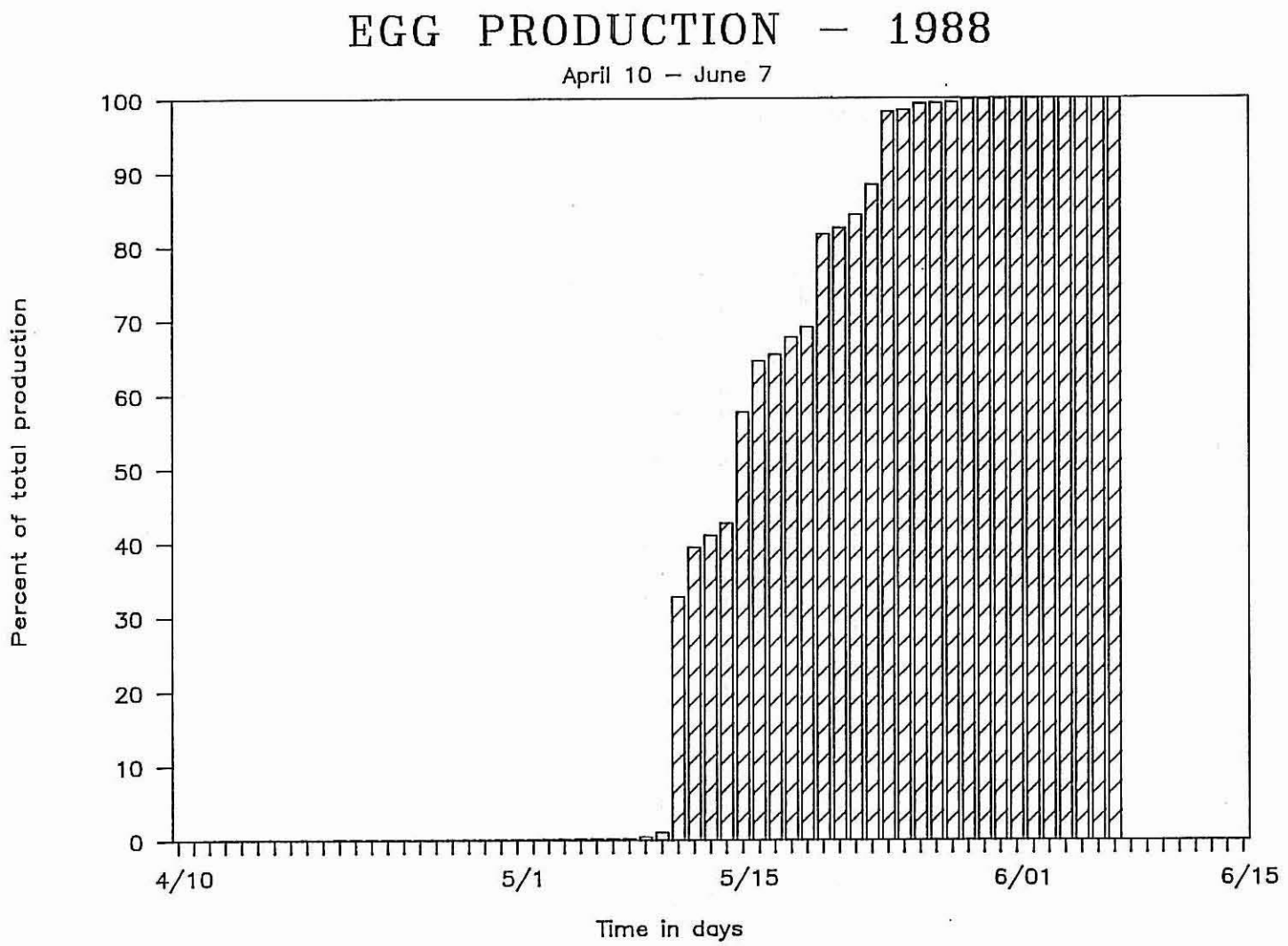


Figure 3. Estimated production of striped bass eggs in the Roanoke River based on samples collected at Pollocks Ferry, NC, in 1988, presented as percentage of total production.

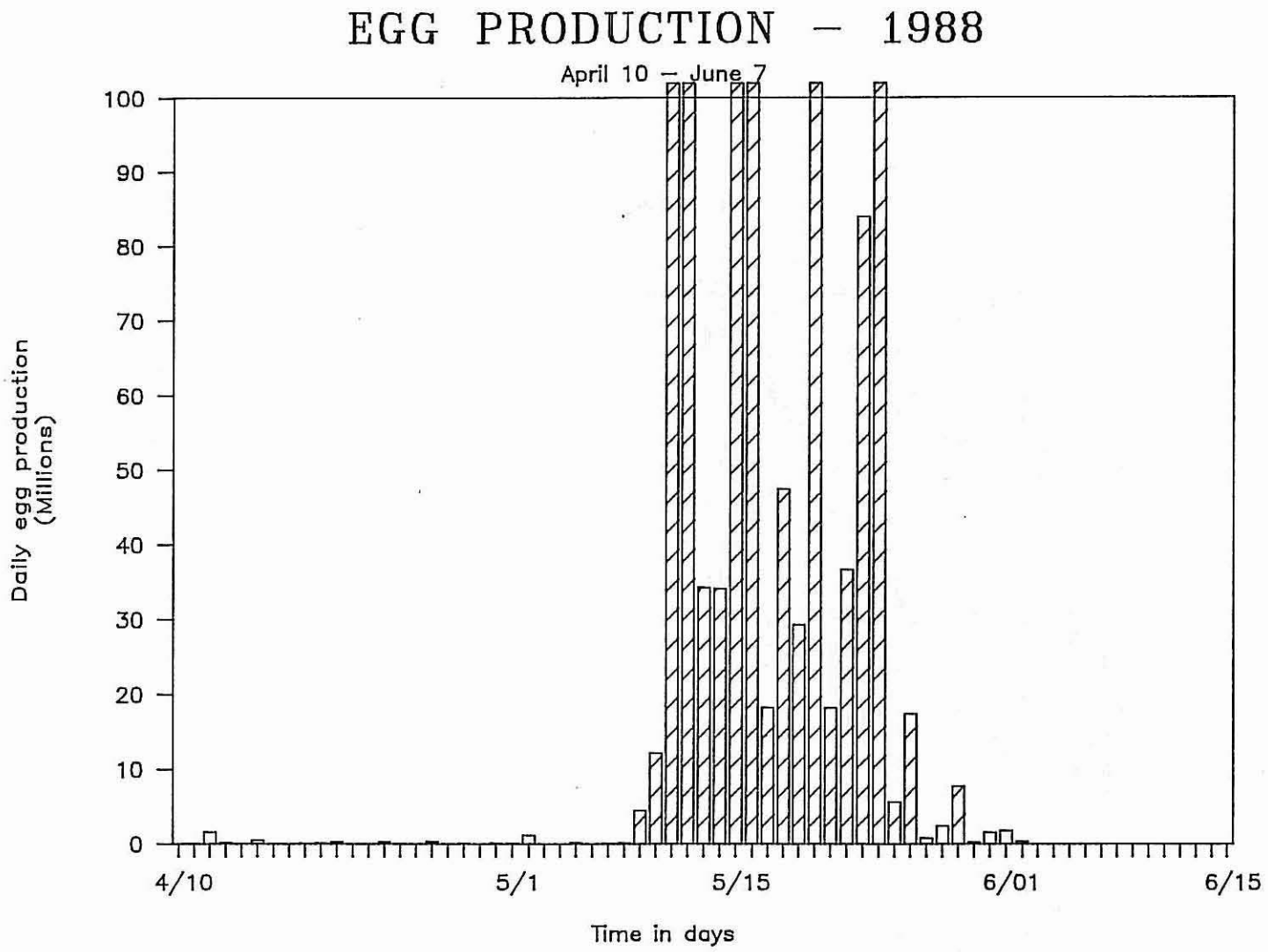


Figure 4. Estimated daily production of striped bass eggs in the Roanoke River based on samples collected at Pollocks Ferry, NC, in 1988.

Table 2. Estimated number of striped bass eggs spawned in the Roanoke River, NC, 1959-1987 (Hassler data), and 1988 (this study). Years with no dates for the sampling period indicates no records available.

Year	Sampling period	Number of eggs	Egg viability (%)	Site of egg collection
1959		300,000,000*	92.88	Palmyra (RM 78.5)
1960	23 Apr-8 Jun	740,000,000*	92.88	Palmyra
1961		2,065,232,519	79.74	Halifax (RM 121)
1962		1,088,076,294	86.22	Halifax
1963	18 Apr-8 Jun**	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		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		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-11 Jun	1,352,611,202	33.29	Johnson's Landing
1984	9 May-9 Jun	703,879,559	22.73	Johnson's Landing
1985	25 Apr-23 May	600,562,645	72.21	Johnson's Landing
1986		2,279,071,483	51.10	Johnson's Landing
1987		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)

* Partial season data only
** Sampling interrupted from 21 April to 1 May due to a fish kill caused by accidental waste spill and minimal water level.

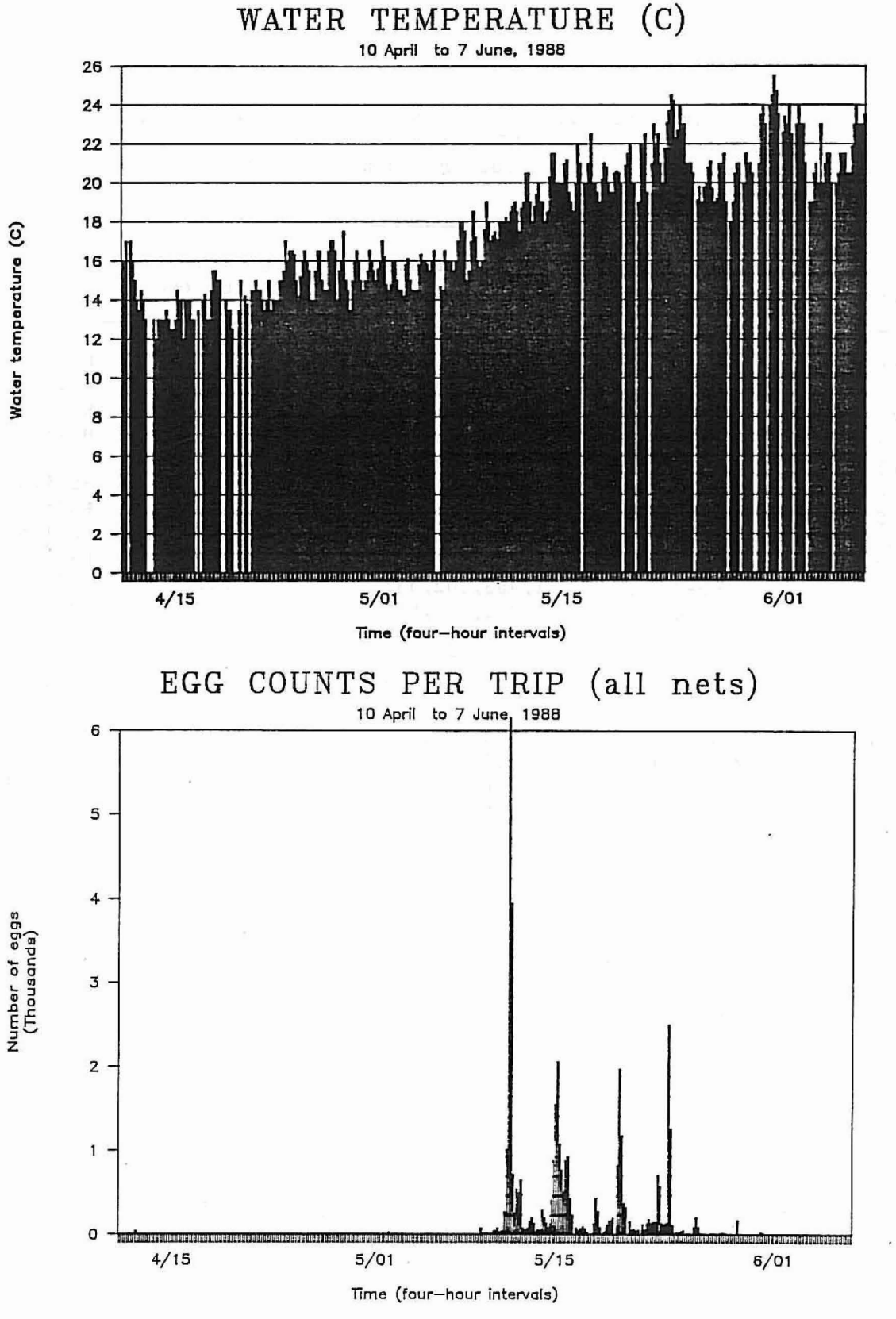


Figure 5. Number of striped bass eggs collected in all nets during each trip, and corresponding water temperatures (oC), at Pollocks Ferry, NC, in 1988.

Table 3. Daily viability of striped bass eggs in the Roanoke River at Pollocks Ferry, NC, in 1988.

Date	Number of samples	Number of non-viable eggs	Number viable eggs	Percentage viable eggs
880410	4	0	0	0.00
880411	6	0	0	0.00
880412	11	8	6	42.86
880413	6	1	0	0.00
880414	12	0	0	0.00
880415	10	4	0	0.00
880416	12	0	0	0.00
880417	6	0	0	0.00
880418	12	1	0	0.00
880419	8	0	1	100.00
880420	4	1	0	0.00
880421	8	0	0	0.00
880422	12	0	0	0.00
880423	12	2	1	33.33
880424	12	0	0	0.00
880425	12	0	0	0.00
880426	12	4	0	0.00
880427	12	0	0	0.00
880428	12	0	1	100.00
880429	12	0	0	0.00
880430	12	2	0	0.00
880501	12	1	0	0.00
880502	12	13	1	7.14
880503	12	0	0	0.00
880504	10	0	0	0.00
880505	12	2	0	0.00
880506	12	0	0	0.00
880507	12	1	0	0.00
880508	12	2	0	0.00
880509	12	24	25	51.02
880510	12	48	72	60.00
880511	12	3,526	2,882	44.98
880512	12	394	975	71.22
880513	12	43	301	87.50
880514	12	49	327	86.97
880515	12	222	3,038	93.19
880516	12	124	1,287	91.21
880517	10	15	125	89.29
880518	12	21	428	95.32
880519	12	40	273	87.22
880520	10	792	1,355	63.11

Table 3. (continued)

Date	Number of samples	Number of non-viable eggs	Number viable eggs	Percentage viable eggs
880521	10	23	125	84.46
880522	10	35	276	88.75
880523	12	65	791	92.41
880524	12	138	1,895	93.21
880525	10	2	43	95.56
880526	12	7	173	96.11
880527	12	2	6	75.00
880528	10	4	17	80.95
880529	10	6	68	91.89
880530	8	2	0	0.00
880531	10	5	9	64.29
880601	10	5	6	54.55
880602	10	0	3	100.00
880603	10	0	0	0.00
880604	10	0	0	0.00
880605	10	0	0	0.00
880606	12	0	0	0.00
880607	6	0	0	0.00

Table 4. Striped bass egg viability at Pollocks Ferry, Roanoke River, NC, 1988, as related to temperature.

Temperature range (° C)	Number non-viable eggs	Number viable eggs	Percentage viable eggs	Percent of all eggs collected
not recorded	0	0	0.00	0.000
12.0-13.9	7	6	46.15	0.065
14.0-15.9	12	2	14.29	0.069
16.0-17.9	242	106	30.46	1.728
18.0-19.9	3,842	4,730	55.18	42.554
20.0-21.9	1,269	6,009	82.56	36.130
22.0-23.9	188	2,969	94.04	15.672
24.0-25.9	74	688	90.29	3.783
Totals	5,634	14,510		100.0000

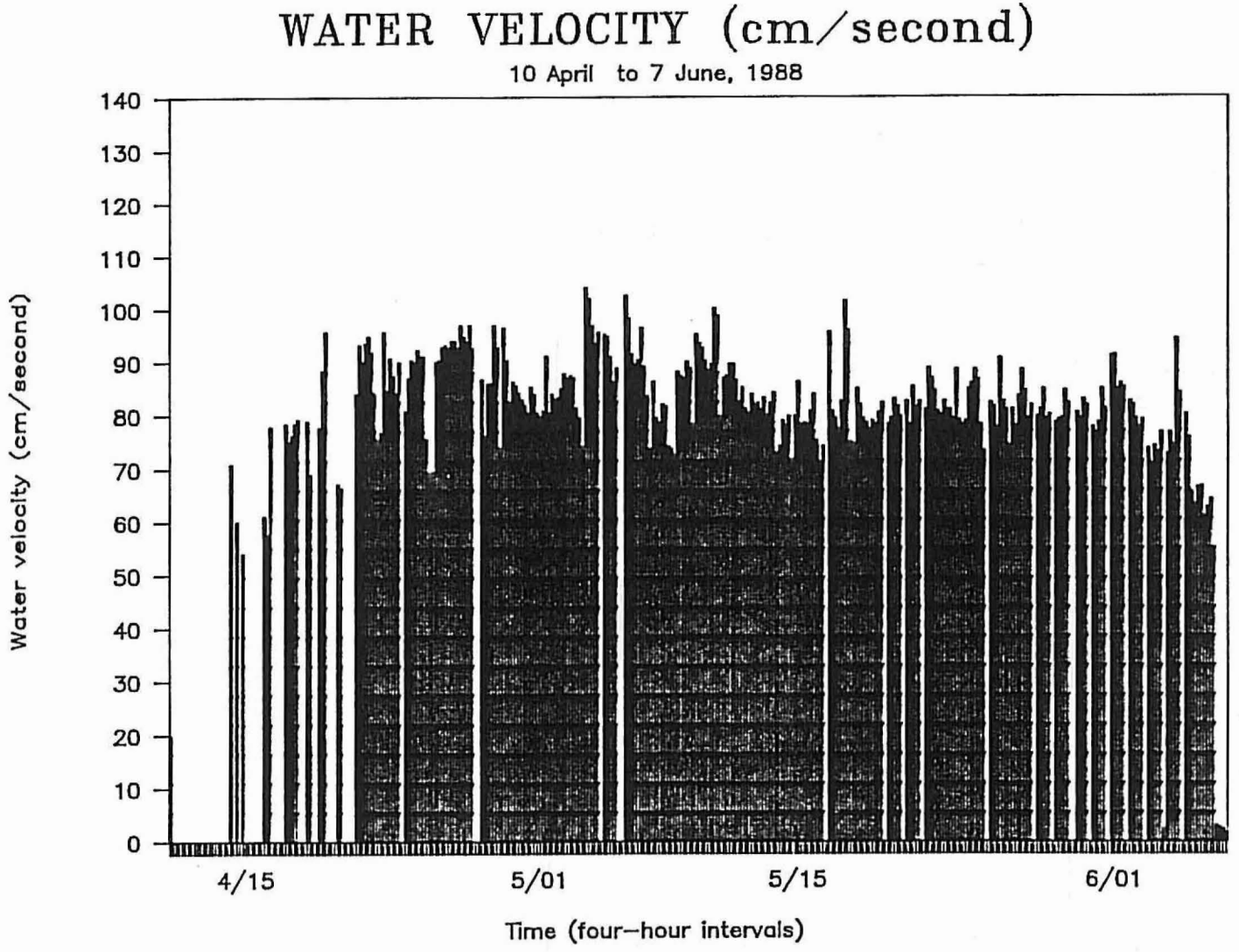


Figure 6. Surface water velocity of the Roanoke River at Pollocks Ferry, NC, for the period 10 April to 7 June 1988. Unfilled bars indicate no information available.

Table 5. Striped bass egg viability at Pollocks Ferry, Roanoke River, NC, 1988, as related to water velocity.

Water velocities (cm/second)	Number non-viable eggs	Number viable eggs	Percentage viable eggs	Percent of all eggs collected
not recorded	18	13	41.94	0.154
40.0-59.9	0	0	0.00	0.000
60.0-79.9	491	5,595	91.93	30.212
80.0-99.9	5,119	8,854	63.37	69.366
100.0-119.9	6	48	88.89	0.268
120.0-139.9	0	0	0.00	0.000
Totals	5,634	14,510		100.000

Most eggs (79%) were collected at water temperatures ranging between 18 and 21.9°C (Table 4). An additional 16% of eggs were collected at temperatures of 22.0 to 23.9°C. Greatest viability was observed at temperatures of 20.0°C and higher (Table 4).

Surface water velocities at Pollocks Ferry in 1988 never deviated more than about 40 cm/second during the study (Figure 6), resulting in essentially all eggs (99.5%) collected at velocities between 60.0 and 99.9 cm/second (Table 5). Although most eggs were caught in a range between 80.0 and 99.9 cm/second, greatest viability was evident at the lower range of water velocities (Table 5).

The relatively small variability in water velocities and slower speeds reflected the manner in which water was released from the Roanoke Rapids Reservoir during spawning activity. In January and February, U.S. Geological Survey (USGS) records indicated on-demand hydroelectric generation by Virginia Power Company (Figure 7). A shortage of water in March curtailed on-demand water release. In mid-April, minimal flows were supplemented by water from reservoir storage to provide 6,000 cfs (cubic feet per second) during spawning activity. From mid-April through the end of May, Virginia Power Company regulated on-demand water release to stay between approximately 5,800 and 10,000 cfs. This cyclical pattern of peak power generation resulted in river height fluctuations of four feet at the sampling station (Figure 8).

Turbidity of the water column as measured by secchi visibility and total dissolved solids did not fluctuate greatly, probably reflecting the relative stability of water velocities. Secchi visibility of surface waters primarily was between 80 and 100 cm during the study, but water clarity on occasion was over 110 cm (Figure 9). Total dissolved solids mostly varied between 3 and 5 uS (Figure 10).

Temporal patterns of abundance for the entire spawning season revealed lowest numbers at 2200 hours and 0200 hours. About 63% of the eggs were caught from 1000 hours to 1800 hours (Table 6). Pollocks Ferry Hunting Club (RM 105) is approximately 25 miles downstream from Weldon (RM 130). Unfortunately, no documentation is available indicating the section of the river serving as the primary spawning area for striped bass in 1988.

Levels of dissolved oxygen in Roanoke River waters remained above 5.0 mg/L throughout the study, but a general decrease was evident between April and June (Figure 11). Most (85%) of striped bass eggs were collected in waters containing dissolved oxygen levels ranging from 6.0 to 7.9 mg/L (Table 7).

Acidity of the waters at Pollocks Ferry remained near 7.0 throughout much of the study (Figure 12). Approximately 67% of striped bass eggs were collected in waters with pH values of 7.00 to 7.24 (Table 8). Only eight percent of the eggs were caught at pH values less than 7.0.

D. 2. Vertical Heterogeneity

During each sampling trip, paired-net egg samples were taken both at the surface and in an oblique manner for five-minute periods so that potential bias in the vertical distribution of eggs could be quantified. Egg production for each sampling period 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 in the oblique nets during the five-minute tow.

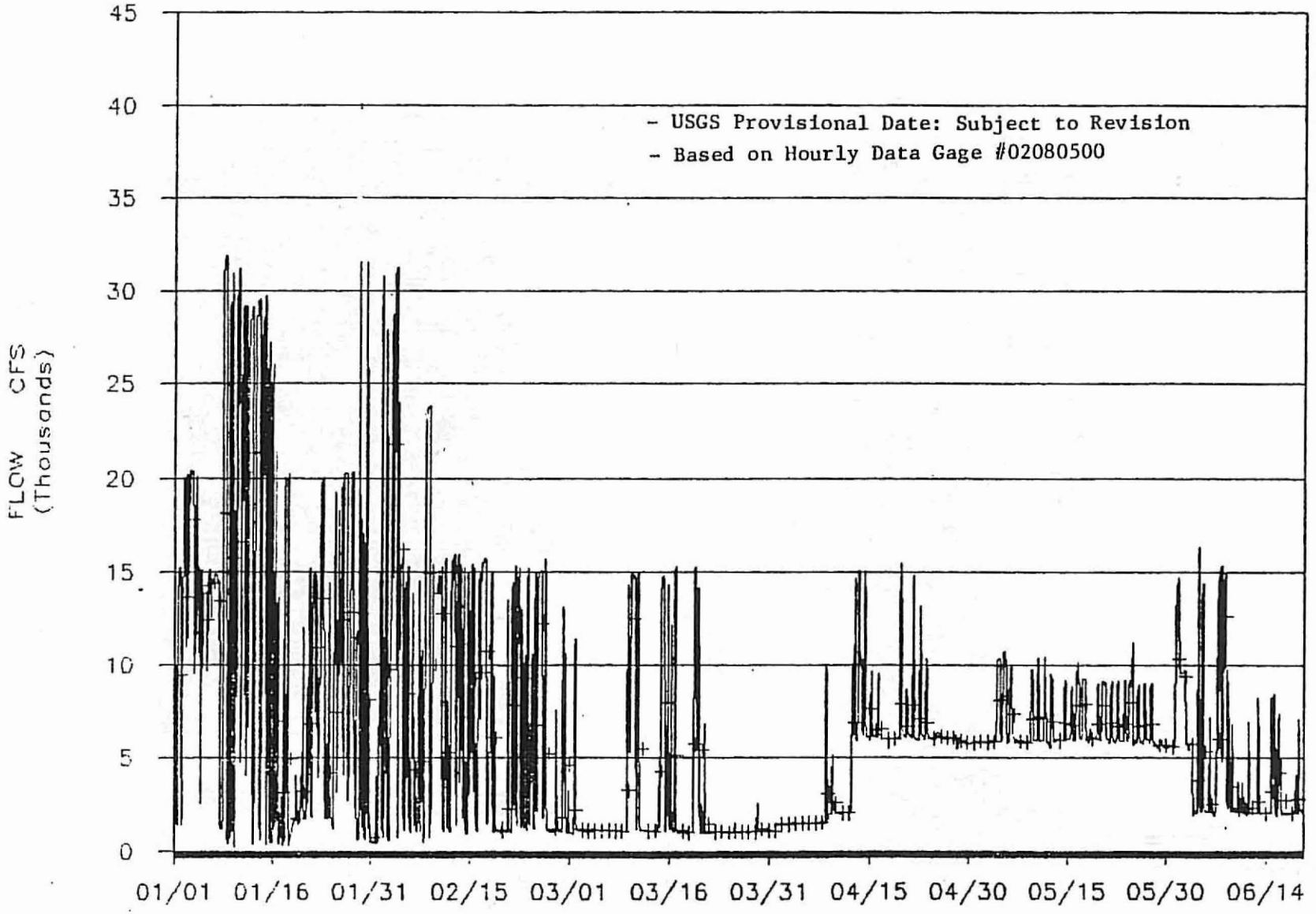


Figure 7. Roanoke River flow (cfs) downstream of the Roanoke Rapids Dam recorded hourly from 1 January through 15 June 1988 showing effects of hydropower generation, and flow augmentation releases (5,800 cfs) for striped bass spawning activity (mid-April through May).

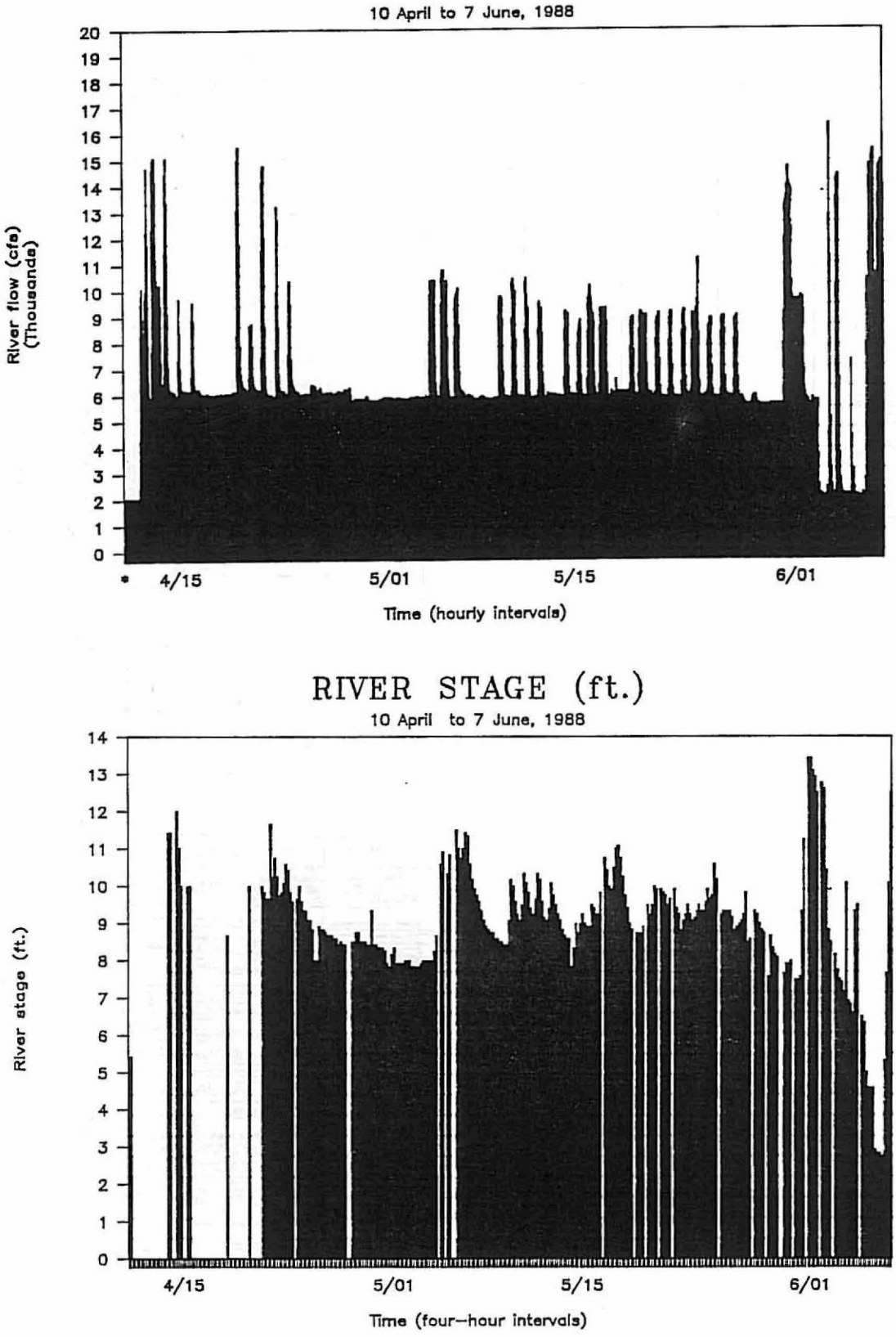


Figure 8. Hourly flow of the Roanoke River (cfs) below the Roanoke Rapids Dam (USGS gage) and relative change in river stage (ft.) at Pollocks Ferry, NC, for the period 10 April to 7 June 1988. Unfilled bars indicate no information available.

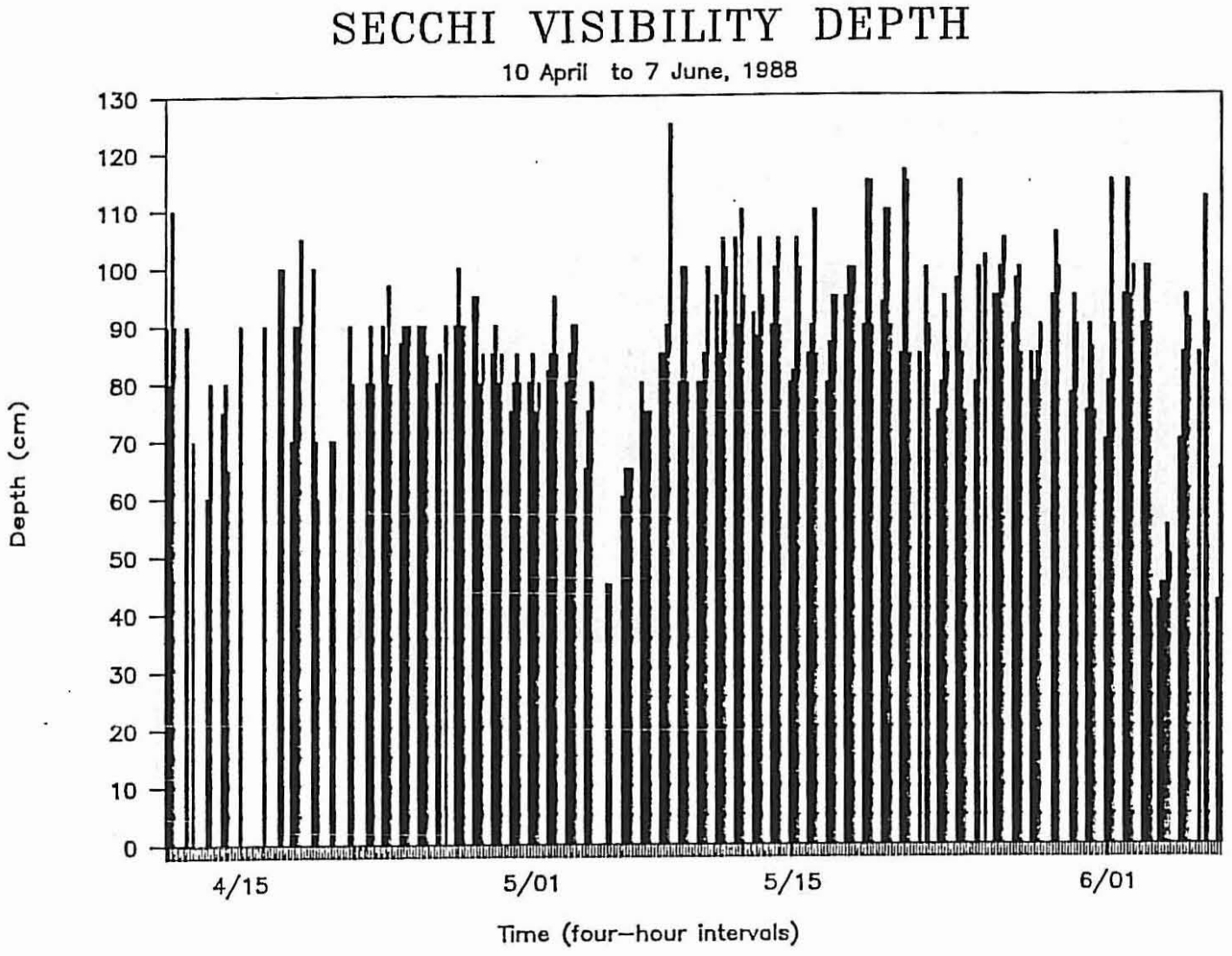


Figure 9. Depth (cm) of Secchi disk visibility in the Roanoke River at Pollocks Ferry, NC, for the period 10 April to 7 June 1988. Unfilled bars indicate no information available.

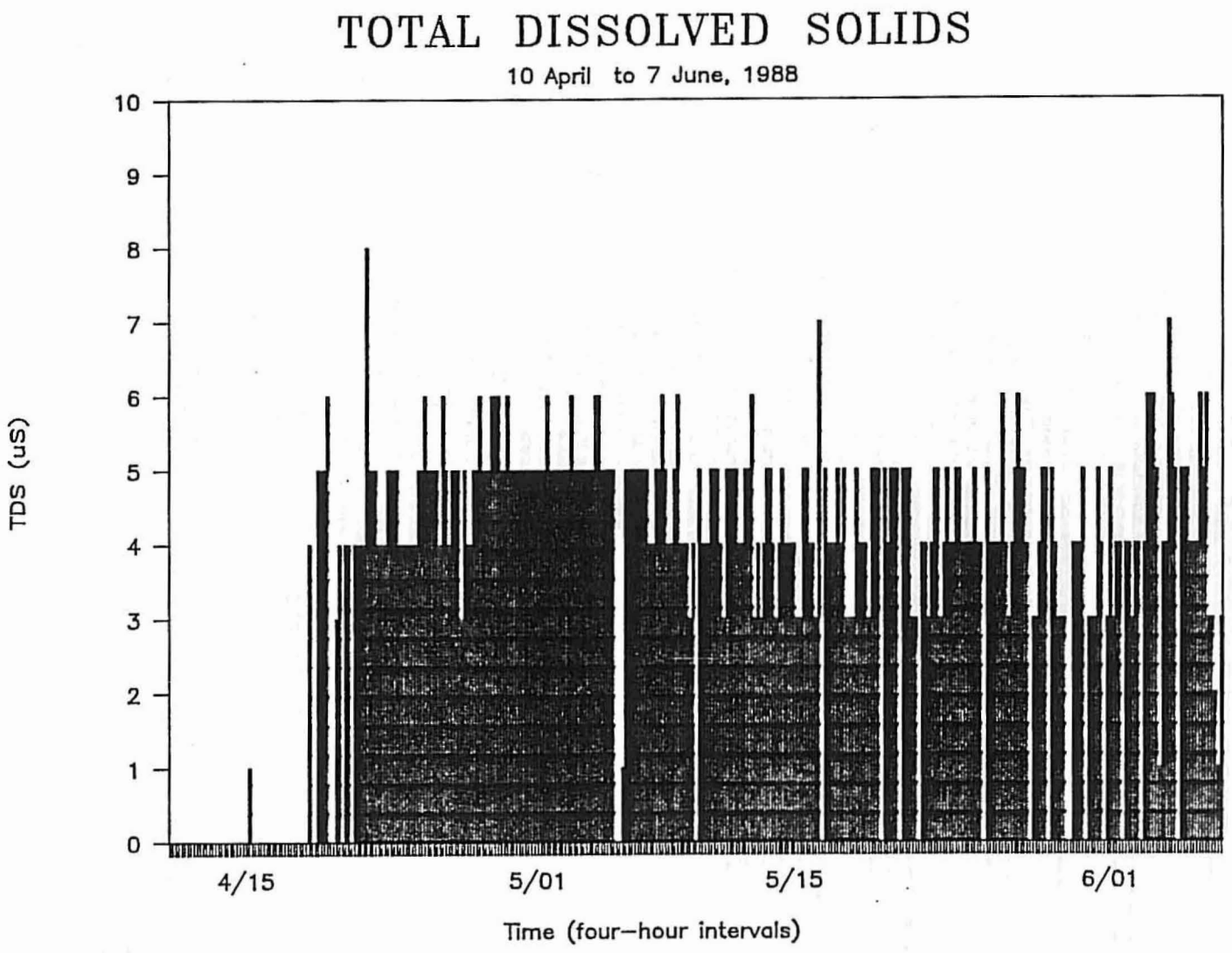


Figure 10. Levels of total dissolved solids (uS) measured in the Roanoke River at Pollocks Ferry, NC, during the period 10 April to 7 June 1988. Unfilled bars indicate no information available.

Table 6. Striped bass egg viability at Pollocks Ferry, Roanoke River, NC, 1988, as related to time of day.

Time of collection	Number non-viable eggs	Number viable eggs	Percentage viable eggs	Percent of all eggs collected
0200	277	685	71.21	4.776
0600	251	2,826	91.84	15.275
1000	1,028	2,698	72.41	18.497
1400	549	3,204	85.37	18.631
1800	2,233	3,250	59.27	27.219
2200	1,296	1,847	58.77	15.603
Totals	5,634	14,510		100.000

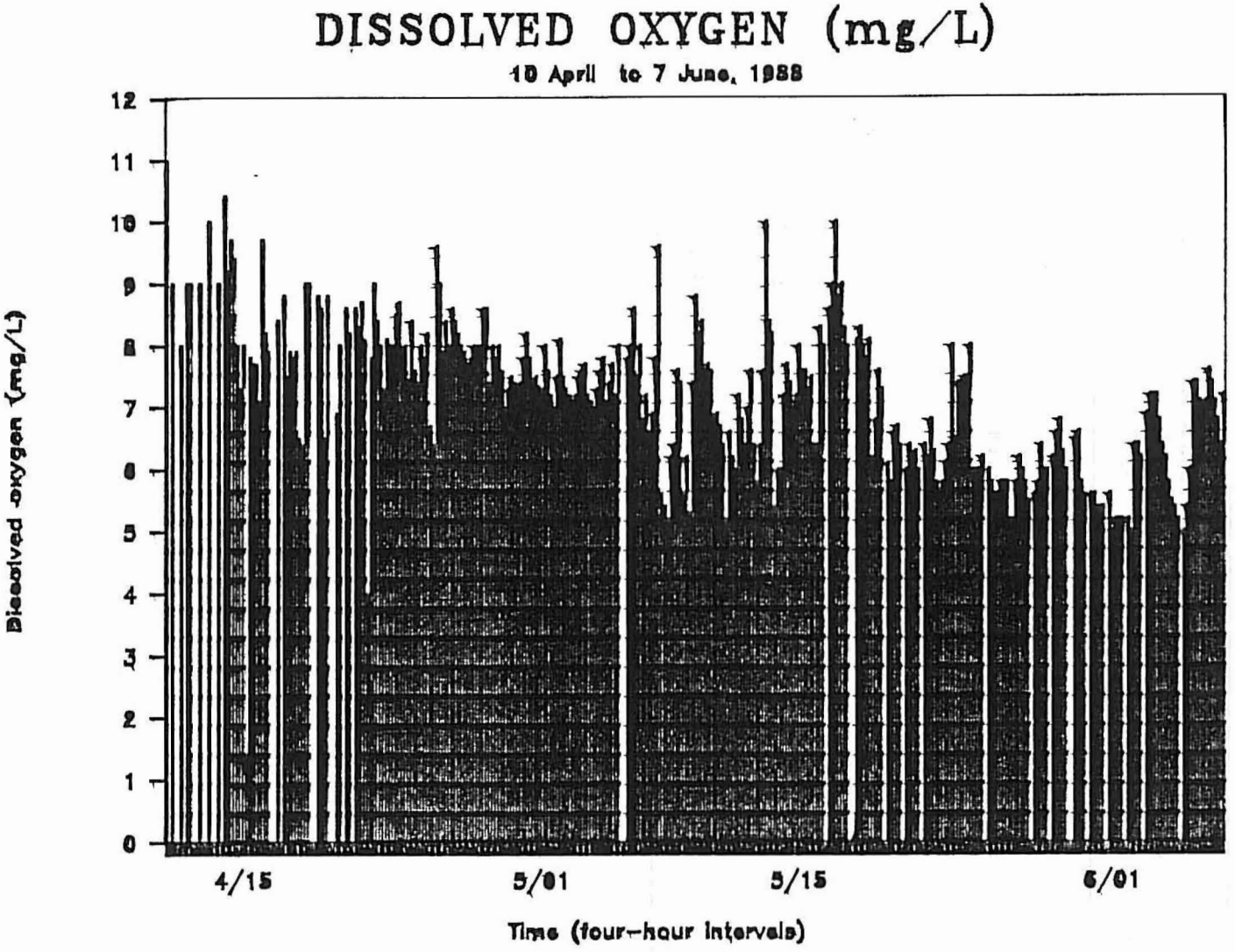


Figure 11. Levels of dissolved oxygen (mg/L) measured in the Roanoke River at Pollocks Ferry, NC, during the period 10 April to 7 June 1988. Unfilled bars indicate no information available.

Table 7. Striped bass egg viability at Pollocks Ferry, Roanoke River, NC, 1988, as related to dissolved oxygen.

Dissolved oxygen (m/L)	Number non-viable eggs	Number viable eggs	Percentage viable eggs	Percent of all eggs collected
not recorded	3	59	95.16	0.308
4.0-4.9	0	0	0.00	0.000
5.0-5.9	827	459	35.69	6.384
6.0-6.9	3,890	6,778	63.54	52.959
7.0-7.9	760	5,602	88.05	31.583
8.0-8.9	124	1,440	92.07	7.764
9.0-9.9	11	48	81.36	0.293
10.0-10.9	19	124	86.71	0.710
11.0-11.9	0	0	0.00	0.000
Totals	5,634	14,510		100.000

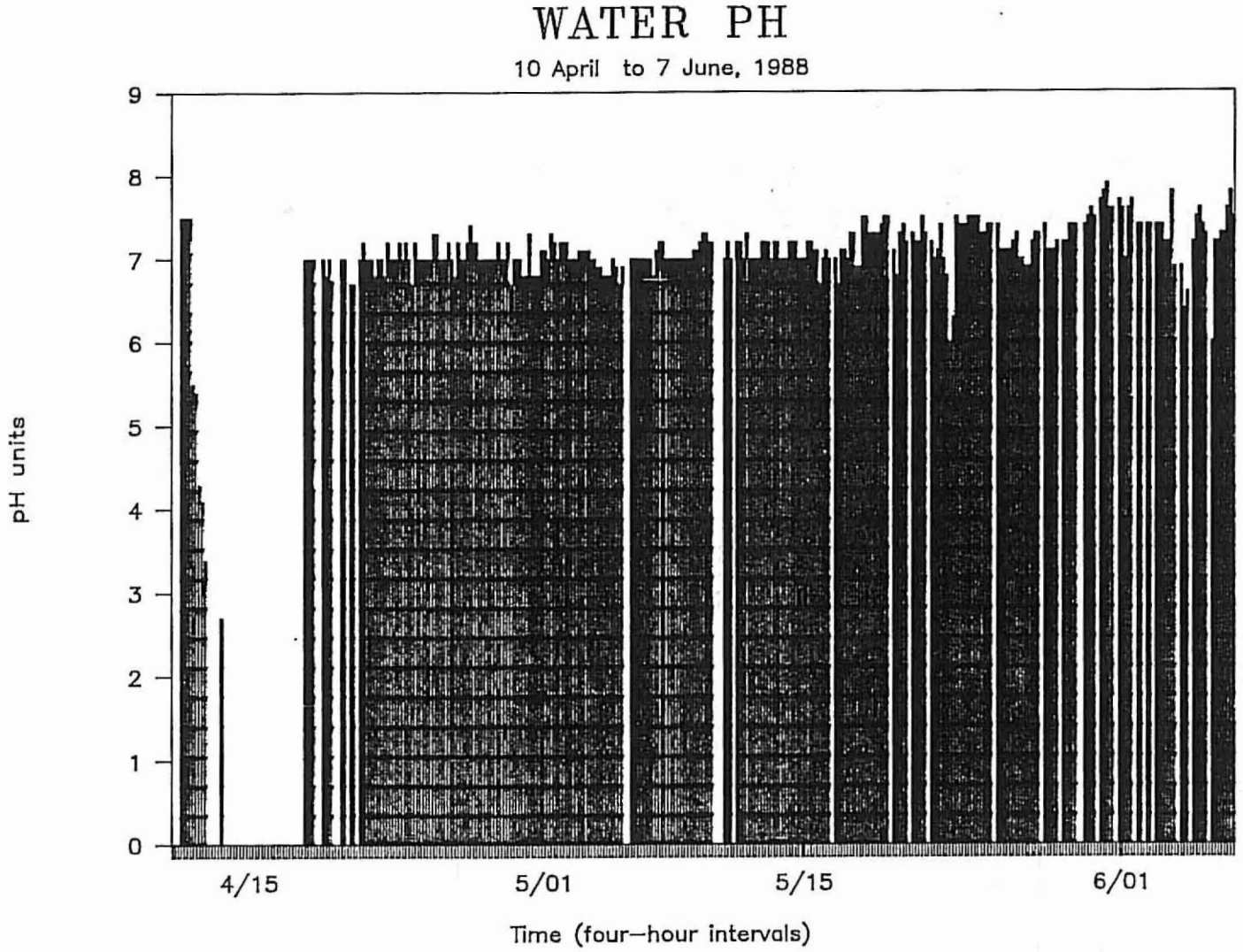


Figure 12. Levels of pH measured in the Roanoke River at Pollocks Ferry, NC, during the period 10 April to 7 June 1988. Unfilled bars indicate no information available.

Table 8. Striped bass egg viability at Pollocks Ferry, Roanoke River, NC, 1988, as related to pH.

Range of pH values	Number non-viable eggs	Number viable eggs	Percentage viable eggs	Percent of all eggs collected
not recorded	304	226	42.64	2.631
5.50-5.74	0	0	0.00	0.000
6.00-6.24	8	38	82.61	0.228
6.25-6.49	15	339	95.76	1.757
6.50-6.74	34	383	91.85	2.070
6.75-6.99	711	114	13.82	4.096
7.00-7.24	4,188	9,298	68.95	66.948
7.25-7.49	179	1,522	89.48	8.444
7.50-7.74	191	2,586	93.12	13.786
7.75-7.99	4	4	50.00	0.040
8.0 or more	0	0	0.00	0.000
Totals	5,634	14,510		100.000

Table 9. Raw data and instantaneous egg production estimates for striped bass at Pollocks Ferry, Roanoke River, NC, 1988. Combined production is the average of all 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
880410	1211	0	0	0	0	5.4	1,448	0	0	0
	1342	0	0	0	0	5.4	1,448	0	0	0
880411	1406	0	0	0	0	.	1,500	0	0	0
	1800	0	0	0	0	.	1,500	0	0	0
	2205	0	0	0	0	.	1,500	0	0	0
880412	200	2	0	7	6	.	2,500	4,464	29,018	16,741
	600	1	0	0	0	.	2,500	2,232	0	1,116
	1014	0	0	0	0	.	2,500	0	0	0
	1408	5	6	15	17	.	2,500	24,554	71,429	47,991
	1800	0	0	0	0	.	2,500	0	0	0
	2200	.	0	0	0	.	2,500	.	0	0
880413	200	0	0	0	0	.	2,500	0	0	0
	600	.	.	.	.	.	2,500	.	.	.
	1000	.	.	.	.	.	2,500	.	.	.
	1400	0	0	1	0	.	2,500	0	2,232	1,116
	1830	.	.	.	.	.	2,500	.	.	.
	2200	1	0	0	0	.	2,500	2,232	0	1,116
880414	200	0	0	0	0	.	.	.	.	.
	600	0	0	0	0	11.4	2,773	0	0	0
	1000	0	0	2	0	11.4	2,773	0	4,952	2,476
	1405	0	0	0	0	.	.	.	.	.
	1820	0	0	0	0	.	.	.	.	.
	2200	0	0	0	0	12.0	2,917	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
880415	200	0	0	0	0	11.0	2,682	0	0	0
	600	0	0	0	0	10.0	2,454	0	0	0
	1000	0	0	0	0	.	.	.	.	.
	1417	0	0	0	0	.	.	.	.	.
	1800	.	.	.	.	10.0	2,454	.	.	.
	2200	4	0	1	2	10.0	2,454	8,765	6,574	7,670
880416	200	0	0	0	0	.	2,500	0	0	0
	600	0	0	0	0	.	2,500	0	0	0
	1000	0	0	0	0	.	2,500	0	0	0
	1400	0	0	0	0	.	2,500	0	0	0
	1800	0	0	0	0	.	2,500	0	0	0
	2200	0	0	0	0	.	2,500	0	0	0
880417	200	.	.	.	.	.	2,500	.	.	.
	600	.	.	.	.	.	2,500	.	.	.
	1000	.	.	.	.	.	2,500	.	.	.
	1400	0	0	0	0	.	2,500	0	0	0
	1800	0	0	0	0	.	2,500	0	0	0
	2200	0	0	0	0	.	2,500	0	0	0
880418	200	0	0	0	0	.	2,158	0	0	0
	600	0	0	0	0	.	2,158	0	0	0
	1007	1	0	0	0	.	2,158	1,927	0	963
	1405	0	0	0	0	.	2,158	0	0	0
	1815	0	0	0	0	8.7	2,158	0	0	0
	2200	0	0	0	0	.	2,158	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
880419	200	.	.	.	.	.	2,400	.	.	.
	600	.	.	.	.	.	2,400	.	.	.
	1000	0	0	0	0	.	2,400	0	0	0
	1400	0	1	0	0	.	2,400	2,143	0	1,071
	1800	0	0	0	0	.	2,400	0	0	0
	2200	0	0	0	0	.	2,400	0	0	0
880420	200	.	.	.	.	.	2,400	.	.	.
	600	.	.	.	.	.	2,400	.	.	.
	1013	0	0	1	0	10.0	2,400	0	2,143	1,071
	1434	0	1	0	0	.	2,400	2,143	0	1,071
	1800	.	.	.	.	.	2,400	.	.	.
	2200	.	.	.	.	.	2,400	.	.	.
880421	200	.	.	.	.	.	.	.	.	.
	600	.	.	.	.	.	.	.	.	.
	1000	0	0	0	1	10.0	2,454	0	2,191	1,096
	1400	0	0	1	0	9.8	2,409	0	2,151	1,075
	1800	0	0	0	0	9.7	2,385	0	0	0
	2200	0	0	0	0	9.7	2,385	0	0	0
880422	200	0	0	0	0	9.7	2,385	0	0	0
	600	0	0	0	0	11.3	2,749	0	0	0
	1000	0	0	0	0	10.8	2,636	0	0	0
	1400	0	0	0	0	10.3	2,522	0	0	0
	1800	0	0	0	0	9.8	2,409	0	0	0
	2200	0	0	0	0	9.8	2,409	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
880423	200	0	0	0	0	10.1	2,476	0	0	0
	600	0	0	0	0	10.6	2,591	0	0	0
	1000	0	0	0	1	10.4	2,545	0	2,273	1,136
	1400	0	3	0	2	9.8	2,409	6,452	4,301	5,377
	1800	0	0	0	0	9.6	2,363	0	0	0
	2200	0	0	0	0	.	.	.	.	.
880424	200	0	0	0	0	9.7	2,385	0	0	0
	600	0	0	0	1	10.0	2,454	0	2,191	1,096
	1000	0	0	0	0	9.6	2,363	0	0	0
	1400	0	0	0	0	9.3	2,294	0	0	0
	1800	0	0	0	1	9.3	2,294	0	2,048	1,024
	2200	0	0	0	0	9.1	2,249	0	0	0
880425	200	0	0	0	1	9.1	2,249	0	2,008	1,004
	600	0	0	0	0	8.8	2,181	0	0	0
	1005	0	0	0	0	8.0	2,005	0	0	0
	1356	0	0	0	0	8.0	2,005	0	0	0
	1800	0	0	0	0	8.9	2,203	0	0	0
	2200	0	0	0	0	8.8	2,181	0	0	0
880426	200	0	0	0	0	8.8	2,181	0	0	0
	600	0	0	0	0	8.8	2,181	0	0	0
	1000	0	0	0	0	8.7	2,158	0	0	0
	1400	0	0	0	0	8.7	2,158	0	0	0
	1800	0	0	0	0	8.7	2,158	0	0	0
	2200	3	1	1	0	8.6	2,136	7,627	1,907	4,767

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
880427	200	0	0	0	0	8.6	2,136	0	0	0
	600	0	0	0	0	8.4	2,090	0	0	0
	1000	0	0	0	0	8.5	2,112	0	0	0
	1400	0	0	0	0	8.4	2,090	0	0	0
	1800	0	0	0	0	8.4	2,090	0	0	0
	2200	0	0	0	0	.	.	.	.	.
880428	200	0	0	0	0	.	.	.	.	.
	600	0	0	0	2	8.5	2,112	0	3,772	1,886
	1000	1	0	1	3	8.5	2,112	1,886	7,544	4,715
	1400	0	0	0	0	8.8	2,409	0	0	0
	1800	0	0	0	0	8.8	2,409	0	0	0
	2200	0	0	0	0	8.5	2,112	0	0	0
880429	200	0	0	0	0	8.5	2,112	0	0	0
	600	0	0	0	0	8.5	2,112	0	0	0
	1000	0	0	0	0	8.4	2,090	0	0	0
	1400	0	0	0	0	8.4	2,090	0	0	0
	1800	0	0	0	0	9.3	2,294	0	0	0
	2200	0	0	0	0	8.4	2,090	0	0	0
880430	200	0	0	0	0	8.4	2,090	0	0	0
	600	0	0	0	0	8.3	2,294	0	0	0
	1000	0	0	0	0	8.3	2,294	0	0	0
	1400	0	0	0	0	8.3	2,294	0	0	0
	1800	1	1	1	0	8.3	2,069	3,695	1,848	2,772
	2200	0	0	0	0	7.9	1,984	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
880501	200	0	0	0	0	7.8	1,962	0	0	0
	600	0	0	0	0	8.2	2,047	0	0	0
	1000	0	0	0	0	8.3	2,294	0	0	0
	1400	1	0	0	0	7.9	1,984	1,771	0	886
	1800	0	0	0	0	7.9	1,984	0	0	0
	2200	0	0	0	0	7.9	1,984	0	0	0
880502	200	0	0	0	0	7.9	1,984	0	0	0
	600	0	0	0	0	8.0	2,005	0	0	0
	1000	9	5	5	3	8.0	2,005	25,057	14,319	19,688
	1400	0	0	0	0	8.0	2,005	0	0	0
	1800	0	0	0	0	7.8	1,962	0	0	0
	2200	0	0	0	0	7.8	1,962	0	0	0
880503	200	0	0	0	0	7.8	1,962	0	0	0
	600	0	0	1	0	7.8	1,962	0	1,752	876
	1000	0	0	0	0	7.9	1,984	0	0	0
	1400	0	0	0	0	8.0	2,005	0	0	0
	1800	0	0	0	0	8.0	2,005	0	0	0
	2200	0	0	0	0	8.0	2,005	0	0	0
880504	200	0	0	0	0	8.0	2,005	0	0	0
	600	0	0	0	0	8.0	2,005	0	0	0
	1000	0	0	0	0	8.3	2,069	0	0	0
	1400	0	0	0	0	8.7	2,158	0	0	0
	1800	.	.	.	.	.	.	.	.	.
	2200	0	0	0	0	10.6	2,591	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
880505	200	0	0	0	0	10.9	2,658	0	0	0
	600	0	0	0	0	.	.	.	.	.
	1000	0	2	0	0	10.3	2,522	4,503	0	2,252
	1400	0	0	0	1	10.8	2,636	0	2,354	1,177
	1800	0	0	0	0	11.6	2,818	0	0	0
	2200	0	0	0	0	12.1	2,939	0	0	0
880506	200	0	0	0	0	11.5	2,295	0	0	0
	600	0	0	0	0	11.0	2,682	0	0	0
	1000	0	0	0	0	10.8	2,636	0	0	0
	1400	0	0	0	0	11.0	2,682	0	0	0
	1800	0	0	0	0	11.4	2,773	0	0	0
	2200	0	0	0	0	11.3	2,749	0	0	0
880507	200	0	0	0	0	10.6	2,591	0	0	0
	600	0	0	0	0	10.2	2,500	0	0	0
	1000	0	0	0	0	9.9	2,431	0	0	0
	1400	0	0	0	0	9.8	2,409	0	0	0
	1800	0	0	0	0	9.6	2,363	0	0	0
	2200	1	0	1	0	9.3	2,294	2,048	2,048	2,048
880508	200	0	0	0	0	9.1	2,249	0	0	0
	600	0	0	0	0	8.9	2,203	0	0	0
	1000	0	1	0	0	8.8	2,181	1,947	0	974
	1400	0	1	0	1	8.8	2,181	1,947	1,947	1,947
	1800	0	0	0	0	8.8	2,181	0	0	0
	2200	0	0	0	0	8.6	2,136	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
880509	200	0	0	0	0	8.6	2,136	0	0	0
	600	0	0	0	0	8.5	2,112	0	0	0
	1000	0	0	1	2	8.5	2,112	0	5,658	2,829
	1400	28	15	17	15	8.4	2,090	80,249	59,720	69,984
	1800	2	1	2	8	8.4	2,090	5,599	18,662	12,131
	2200	2	1	2	7	9.1	2,249	6,023	18,070	12,047
880510	200	2	4	5	6	10.2	2,500	13,392	24,552	18,972
	600	0	0	0	0	10.0	2,454	0	0	0
	1000	0	4	2	3	9.6	2,363	8,440	10,550	9,495
	1400	17	12	12	3	9.3	2,294	59,406	30,727	45,067
	1800	11	23	6	9	9.1	2,249	68,264	30,117	49,190
	2200	25	22	17	15	9.5	2,340	98,188	66,851	82,520
880511	200	7	4	8	7	10.3	2,522	24,768	33,774	29,271
	600	13	14	11	10	10.1	2,476	59,697	46,431	53,064
	1000	84	53	65	68	9.8	2,409	294,648	286,045	290,346
	1400	233	171	310	303	9.4	2,318	836,063	1,268,581	1,052,322
	1800	1,819	1,867	1,994	1,873	9.3	2,294	7,550,704	7,921,479	7,736,092
	2200	1,147	996	1,098	709	9.7	2,385	4,564,015	3,848,425	4,206,220
880512	200	193	118	214	190	10.3	2,522	700,250	909,649	804,949
	600	22	99	113	26	10.2	2,500	270,068	310,243	290,155
	1000	186	147	141	67	9.6	2,363	702,660	438,899	570,779
	1400	136	139	145	79	9.2	2,272	557,931	454,460	506,195
	1800	174	120	170	183	9.1	2,249	590,284	708,742	649,513
	2200	16	19	25	16	9.4	2,318	72,431	84,848	78,640

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
880513	200	20	15	12	11	10.1	2,476	77,384	50,853	64,118
	600	19	23	24	14	9.8	2,409	90,330	81,727	86,029
	1000	60	31	43	28	9.5	2,340	190,109	148,327	169,218
	1400	57	40	58	43	9.3	2,294	198,703	206,897	202,800
	1800	36	27	32	35	9.1	2,249	126,489	134,520	130,505
	2200	7	9	8	12	8.8	2,181	31,160	38,950	35,055
880514	200	11	10	22	18	8.7	2,158	40,457	77,061	58,759
	600	23	14	6	10	8.6	2,136	70,554	30,510	50,532
	1000	66	57	81	87	8.6	2,136	234,546	320,355	277,450
	1400	53	29	59	53	7.8	1,962	143,632	196,180	169,906
	1800	41	41	27	30	8.3	2,069	151,510	105,318	128,414
	2200	21	10	33	25	9.0	2,227	61,632	115,311	88,472
880515	200	91	93	109	114	8.8	2,181	358,340	434,292	396,316
	600	215	208	223	237	9.0	2,227	840,977	914,537	877,757
	1000	345	231	562	418	9.3	2,294	1,179,926	2,007,512	1,593,719
	1400	568	549	482	468	9.0	2,227	2,220,735	1,888,718	2,054,727
	1800	276	273	325	205	8.9	2,203	1,079,961	1,042,586	1,061,273
	2200	200	211	184	180	8.9	2,203	808,496	716,040	762,268
880516	200	105	135	135	138	9.5	2,340	501,386	570,326	535,856
	600	170	219	242	251	9.4	2,318	805,021	1,020,246	912,634
	1000	226	214	256	234	9.3	2,295	901,528	1,003,975	952,752
	1400	101	74	127	131	9.3	2,295	358,562	528,623	443,593
	1800	94	51	66	17	9.8	2,409	311,854	178,509	245,181
	2200	.	.	.	.	.	.	.	.	.
	200	13	9	27	28	10.8	2,636	51,786	129,466	90,626

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
880517	600	14	12	21	7	10.4	2,545	59,087	63,632	61,360
	1000	24	22	12	19	10.0	2,454	100,802	67,932	84,367
	1400	30	9	33	27	9.9	2,431	84,644	130,221	107,433
	1800	15	7	15	31	10.5	2,567	50,429	105,443	77,936
	2200	6	1	6	11	11.0	2,682	16,762	40,707	28,735
880518	200	0	0	0	0	11.1	2,704	0	0	0
	600	2	0	0	0	10.8	2,636	4,708	0	2,354
	1000	41	17	36	41	10.3	2,522	130,593	173,374	151,983
	1400	122	81	109	127	9.8	2,409	436,595	507,568	472,082
	1800	58	79	64	77	9.4	2,319	283,639	291,920	287,780
	2200	24	25	18	17	9.0	2,227	97,418	69,584	83,501
880519	200	0	0	0	0	8.8	2,181	0	0	0
	600	10	8	7	9	.	2,181	35,052	31,157	33,104
	1000	33	36	23	30	8.8	2,181	134,377	103,217	118,797
	1400	27	31	61	49	8.8	2,181	112,955	214,225	163,590
	1800	29	35	36	75	8.8	2,181	124,640	216,172	170,406
	2200	42	62	53	41	8.9	2,203	204,583	184,911	194,747
880520	200	.	.	.	.	.	.	.	.	.
	600	222	236	220	152	9.5	2,340	956,811	777,148	866,979
	1000	363	334	655	626	9.3	2,294	1,427,792	2,624,105	2,025,949
	1400	324	335	257	264	9.5	2,340	1,376,721	1,088,425	1,232,573
	1800	90	94	91	96	10.0	2,454	403,206	409,780	406,493
	2200	72	77	83	89	9.9	2,431	323,383	373,301	348,342

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
880521	200	.	.	.	.	.	.	.	.	.
	600	33	37	40	44	9.9	2,431	151,925	182,310	167,117
	1000	4	7	33	16	9.8	2,409	23,658	105,385	64,521
	1400	7	24	13	21	9.8	2,409	66,672	73,124	69,898
	1800	8	7	14	18	9.5	2,340	31,337	66,851	49,094
	2200	11	10	15	19	9.7	2,385	44,724	72,411	58,568
880522	200	.	.	.	.	.	.	.	.	.
	600	21	43	23	39	9.9	2,431	138,903	134,562	136,732
	1000	3	5	18	38	9.4	2,318	16,556	115,890	66,223
	1400	32	37	46	25	9.3	2,294	141,345	145,442	143,394
	1800	54	59	31	37	8.8	2,181	220,067	132,430	176,249
	2200	26	31	43	39	9.1	2,249	114,443	164,637	139,540
880523	200	29	36	47	43	9.3	2,294	133,151	184,363	158,757
	600	10	36	59	49	9.5	2,340	96,099	225,624	160,861
	1000	190	164	185	176	9.3	2,294	725,163	739,502	732,332
	1400	107	164	148	158	9.1	2,249	544,105	614,377	579,241
	1800	33	36	31	39	9.2	2,272	139,990	142,019	141,004
	2200	23	28	34	39	9.3	2,294	104,473	149,539	127,006
880524	200	30	32	36	44	9.5	2,318	128,307	165,557	146,932
	600	664	620	628	591	9.3	2,294	2,630,251	2,497,099	2,563,675
	1000	320	300	314	329	9.3	2,294	1,270,059	1,317,174	1,293,616
	1400	25	29	22	34	9.6	2,363	113,945	118,165	116,055
	1800	3	3	.	.	9.9	2,431	13,022	.	13,022
	2200	3	4	7	9	9.7	2,385	14,908	34,076	24,492

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
880525	200	1	2	5	7	9.8	2,409	6,452	25,809	16,130
	600	7	6	13	8	10.6	2,591	30,073	48,579	39,326
	1000	14	13	11	10	10.2	2,500	60,263	46,871	53,567
	1400	.	.	.	.	.	.	.	.	.
	1800	0	1	0	2	9.3	2,294	2,048	4,097	3,073
	2200	1	0	0	2	9.3	2,294	2,048	4,097	3,073
880526	200	0	0	0	0	9.3	2,294	0	0	0
	600	23	19	20	27	9.3	2,294	86,036	96,279	91,157
	1000	41	53	54	53	9.3	2,294	192,557	219,188	205,872
	1400	21	20	19	27	9.2	2,272	83,182	93,327	88,254
	1800	2	1	1	2	8.8	2,181	5,842	5,842	5,842
	2200	0	0	0	0	8.9	2,203	0	0	0
880527	200	0	0	0	0	9.0	2,227	0	0	0
	600	0	0	0	0	9.1	2,249	0	0	0
	1000	0	0	0	0	9.3	2,294	0	0	0
	1400	4	3	2	2	9.8	2,409	15,055	8,603	11,829
	1800	0	0	1	1	8.5	2,112	0	3,772	1,886
	2200	0	1	0	0	8.6	2,136	1,907	0	953
880528	200	.	.	.	.	.	.	.	.	.
	600	0	7	0	8	9.3	2,294	14,339	16,388	15,364
	1000	7	3	3	5	9.3	2,294	20,485	16,388	18,436
	1400	3	1	4	1	9.0	2,227	7,952	9,941	8,947
	1800	0	0	0	0	8.8	2,181	0	0	0
	2200	0	0	0	0	8.8	2,181	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
880529	200	.	.	.	.	.	.	.	.	.
	600	0	0	0	0	7.6	1,919	0	0	0
	1000	0	0	0	0	8.7	2,158	0	0	0
	1400	41	30	47	54	8.3	2,069	131,185	186,616	158,900
	1800	1	2	0	1	8.2	2,047	5,484	1,828	3,656
	2200	0	0	0	0	8.1	2,027	0	0	0
880530	200	.	.	.	.	.	.	.	.	.
	600	.	.	.	.	.	.	.	.	.
	1000	0	2	0	0	7.7	1,941	3,466	0	1,733
	1400	0	0	0	0	7.9	1,984	0	0	0
	1800	0	0	0	0	7.9	1,984	0	0	0
	2200	0	0	0	0	8.0	2,005	0	0	0
880531	200	.	.	.	.	.	.	.	.	.
	600	2	1	0	1	7.5	1,898	5,085	1,695	3,390
	1000	3	0	19	0	7.5	1,898	5,085	32,203	18,644
	1400	3	2	2	3	7.6	1,919	8,567	8,567	8,567
	1800	2	1	1	0	9.3	2,294	6,145	2,048	4,097
	2200	0	0	0	0	11.3	2,749	0	0	0
880601	200	.	.	.	.	.	.	.	.	.
	600	2	2	1	1	13.4	3,290	11,751	5,876	8,813
	1000	1	0	0	1	13.4	3,290	2,938	2,938	2,938
	1400	1	0	0	0	13.1	3,209	2,865	0	1,432
	1800	2	3	0	1	12.9	3,155	14,087	2,817	8,452
	2200	0	0	0	0	12.5	3,049	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
880602	200	.	.	.	.	.	.	.	.	.
	600	0	0	0	0	12.8	3,130	0	0	0
	1000	1	2	6	0	12.6	3,077	8,242	16,484	12,363
	1400	0	0	0	0	10.4	2,545	0	0	0
	1800	0	0	0	0	8.8	2,181	0	0	0
	2200	0	0	0	0	8.5	2,112	0	0	0
880603	200	.	.	.	.	.	.	.	.	.
	600	0	0	0	0	8.2	2,047	0	0	0
	1000	0	0	0	0	7.8	1,962	0	0	0
	1400	0	0	0	0	7.5	1,898	0	0	0
	1800	0	0	0	0	7.4	1,876	0	0	0
	2200	0	0	0	0	7.2	1,834	0	0	0
880604	600	0	0	0	0	6.9	1,770	0	0	0
	1000	0	0	0	0	6.8	1,748	0	0	0
	1400	0	0	0	0	6.6	1,705	0	0	0
	1800	0	0	0	0	9.3	2,294	0	0	0
	2200	0	0	0	0	9.5	2,340	0	0	0
880605	200	.	.	.	.	.	.	.	.	.
	600	0	0	0	0	6.5	1,684	0	0	0
	1000	0	0	0	0	6.3	1,642	0	0	0
	1400	0	0	0	0	5.0	1,363	0	0	0
	1800	0	0	0	0	4.6	1,277	0	0	0
	2200	0	0	0	0	4.6	1,277	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
880606	200	0	0	0	0	4.6	1,277	0	0	0
	600	0	0	0	0	2.9	917	0	0	0
	1000	0	0	0	0	2.8	896	0	0	0
	1400	0	0	0	0	2.8	896	0	0	0
	1800	0	0	0	0	2.8	896	0	0	0
	2200	0	0	0	0	5.3	1,428	0	0	0
880607	600	.	.	.	.	.	.	.	.	.
	200	0	0	0	0	7.7	1,941	0	0	0
	600	0	0	0	0	10.1	2,476	0	0	0
	1000	0	0	0	0	12.5	3,051	0	0	0

Immediately evident from Table 9 is that egg production estimates for surface and oblique samples are not similar, especially during the period prior to peak spawning activity. Between 10 April and 9 May, there were 30 trips in which eggs were caught; in 18 cases eggs were collected in surface nets and in 22 cases were eggs found in oblique nets. Yet in only 33% (10) of the cases were eggs caught in both surface and oblique tows. This vertical heterogeneity phenomenon disappears during peak spawning activity (Table 9).

Egg production estimates for each sampling period in 1988 did not vary significantly ($p>0.05$) between surface and oblique tows, although in several cases differences in the estimations were quite large. The most dramatic example occurred for samples collected at 1000 hours on 20 May (Table 9). Surface and oblique egg production estimates differed by 1.2 million. Yet considering that the level of significant digits in these numbers is in the millions, this seemingly large discrepancy becomes minor.

D. 3. Comparison of Calculation Methods

Egg production estimates for each sampling period were extrapolated to daily production estimates by two methods. The first method, designated the "Hassler Method", used the formula described earlier: the method uses the average number of eggs collected from all samples in the 24-hour period (12) and the average cross-sectional area of the river during the same period. The Hassler method could also be referred to as the "lumping method." The second method of determining daily egg production was termed the "Trip Method." In this case, the instantaneous egg production value (obtained by the average of the replicate samples and the cross-sectional area of the river for that sample) was entered into the equation. The trip method could also be termed the "splitting method" of data analysis.

Comparing daily estimates of striped bass egg production using Hassler's Method indicates some differences in estimation using surface samples, oblique samples, or all samples combined (Table 10). The differences shown in Table 9 were magnified greatly in daily egg production estimates (Table 10). The greatest discrepancy was observed on 20 May, when daily egg production estimates between the two strata differed by 47 million eggs. However, total striped bass egg production for 1988 estimated by surface and obliques tows differed by 194 million eggs, which is about 9.3% of the Hassler surface estimate. Overall, the difference in egg production estimated by surface and oblique strata and using Hassler's Method of estimation was not significant ($p>0.05$) in 1988.

Similar results were obtained using the Trip Method of estimating egg production. The largest difference in daily egg production estimates between the two strata occurred on 20 May, in which 45 million more eggs were estimated from oblique samples compared to surface samples. Using the Trip Method of estimation, total egg production in 1988 differed by 222 million eggs (10.8% of surface estimates) between surface and bottom samples.

Comparing the two methods directly, estimates of egg production by the two strata suggest little real difference (Table 10). Striped bass egg production using surface samples only and calculated by the Trip Method estimated 32 million eggs less than Hassler's Method, representing a difference of only 1.5% at the surface. For eggs collected in oblique tows, the Trip Method differed from the Hassler Method by approximately 34 million eggs (again only about 1.5% of the total oblique estimate).

Table 10. Daily egg production of striped bass at Pollocks Ferry, Roanoke River, NC, 1988, estimated by two methods and two depths.

Date	No. 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)
880410	8	0	0	0	0	0	0
880411	12	0	0	0	0	0	0
880412	23	1,800,015	4,821,469	3,160,741	1,636,377	4,821,469	3,298,164
880413	12	214,287	214,287	214,287	214,287	214,287	214,287
880414	24	0	475,358	237,679	0	241,802	120,901
880415	20	841,481	631,111	736,296	516,594	387,446	452,020
880416	24	0	0	0	0	0	0
880417	12	0	0	0	0	0	0
880418	24	92,486	0	46,243	92,486	0	46,243
880419	16	154,287	0	77,143	154,287	0	77,143
880420	8	308,574	308,574	308,574	308,574	308,574	308,574
880421	16	0	312,630	156,315	0	309,638	154,819
880422	24	0	0	0	0	0	0
880423	24	371,647	378,667	375,157	318,464	318,464	318,464
880424	24	0	203,513	101,757	0	200,576	100,288
880425	24	0	96,374	48,187	0	91,597	45,799
880426	24	366,123	91,531	228,827	370,609	92,652	231,631
880427	24	0	0	0	0	0	0
880428	24	108,628	651,770	380,199	95,608	573,649	334,629
880429	24	0	0	0	0	0	0
880430	24	177,379	88,689	133,034	186,092	93,046	139,569
880501	24	85,021	0	42,510	87,536	0	43,768
880502	24	1,202,770	687,297	945,034	1,192,130	681,217	936,674
880503	24	0	84,078	42,039	0	85,152	42,576
880504	20	0	0	0	0	0	0
880505	24	259,387	135,587	197,487	232,703	116,351	174,527
880506	24	0	0	0	0	0	0
880507	24	98,328	98,328	98,328	104,200	104,200	104,200
880508	24	186,962	93,481	140,221	187,590	93,795	140,693
880509	24	4,409,835	4,901,325	4,655,580	4,476,257	4,933,018	4,704,638
880510	24	11,889,232	7,814,332	9,851,782	12,171,701	7,911,606	10,041,654

Table 10. (Continued)

Date	No. 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)
880511	24	639,840,378	643,432,775	641,636,576	659,310,883	664,249,541	661,780,212
880512	24	138,895,063	139,529,530	139,212,297	139,088,625	139,088,625	139,088,625
880513	24	34,280,699	31,741,392	33,011,045	34,275,217	31,883,923	33,079,570
880514	24	33,712,130	40,547,601	37,129,865	34,073,941	40,870,605	37,472,273
880515	24	311,447,493	336,179,776	323,813,634	310,524,573	334,052,049	322,288,311
880516	24	140,647,815	164,696,384	152,672,099	144,048,175	168,651,725	156,349,950
880517	20	17,955,443	23,497,283	20,726,363	18,258,776	23,736,409	20,997,593
880518	24	45,742,131	50,037,876	47,890,003	47,518,707	51,752,000	49,635,354
880519	24	29,357,387	35,985,111	32,671,249	29,308,223	35,956,414	32,632,318
880520	20	258,506,022	303,713,517	281,109,770	261,889,562	308,973,572	285,431,567
880521	20	18,335,153	28,804,941	23,570,047	18,227,240	28,695,587	23,461,414
880522	20	36,363,996	39,914,906	38,139,451	36,700,154	40,004,348	38,352,251
880523	24	83,663,763	98,661,171	91,162,467	84,033,609	98,955,465	91,494,537
880524	22	200,185,278	238,009,308	199,575,718	204,547,643	243,163,179	222,100,160
880525	20	5,811,030	7,456,562	6,633,796	5,595,110	7,211,475	6,403,293
880526	24	17,645,834	19,902,663	18,774,249	17,408,202	19,632,584	18,520,393
880527	24	814,177	593,988	704,082	767,229	575,422	671,326
880528	20	2,463,958	2,460,482	2,462,220	2,414,403	2,414,403	2,414,403
880529	20	7,872,216	10,854,440	9,363,328	7,779,097	10,722,539	9,250,818
880530	16	249,572	0	124,786	254,358	0	127,179
880531	20	1,433,234	2,564,034	1,998,634	1,549,367	2,877,395	2,213,381
880601	20	1,822,500	669,930	1,246,215	1,809,565	658,024	1,233,795
880602	20	474,757	949,513	712,135	402,572	805,144	603,858
880603	20	0	0	0	0	0	0
880604	20	0	0	0	0	0	0
880605	20	0	0	0	0	0	0
880606	24	0	0	0	0	0	0
880607	12	0	0	0	0	0	0
Total production		2,050,086,470	2,242,291,582	2,126,517,450	2,082,130,728	2,276,508,968	2,177,633,838

E. DISCUSSION

The 1988 striped bass spawning season was one of the earliest on record all along the eastern seaboard due to warm spring temperatures and drier than normal conditions. Spawning in the Roanoke River was also quite early relative to the historical records of Dr. Hassler. Water temperatures were approaching 18 C on 10 April, and eggs were present in samples collected on 12 April. Major spawning activity probably would have ensued except for the sudden decrease in water temperatures as a result of the release of augmentation flows by the U.S. Army Corps of Engineers. Water needed for this release was not available in reservoir storage. Additional water became available as a result of rainfall to the watershed upstream of Kerr Reservoir. Observed rainfall for March 1988 was only 1.63 inches (42.8% of normal) but increased to 4.67 inches in April (155% of normal). May rainfall (3.87 inches) and June rainfall (3.68 inches) were approximately normal for the period. The rather stable river flows in May resulted in water temperatures rising steadily to produce peak spawning in mid-May. All observed water quality factors changed little throughout the spawning period, suggesting that steady flows serve to stabilize water quality and provide favorable conditions for egg development and survival.

Steady river flow patterns in 1988 could also reduce differences in egg production estimates between surface and oblique samples, and between the two estimating methods. Waters discharged from Roanoke Rapids Reservoir during spawning activity remained at a base of approximately 6,000 cfs (augmentation flow required by the cooperative agreement) and increased to 9,500 cfs by increments of 1,500 cfs during peak hydroelectric demand. These actions by Virginia Power Company resulted in water velocities remaining between 60 and 100 cm/second and the river remained within the banks for the entire spawning period. Completion of the scheduled 1989 study should provide additional information on the influence of changes in river flow on egg production estimates.

REFERENCES

Bonn, E.W., W.M. Bailey, J.D. Bayless, K.E. Erickson, and R.E. Stevens. 1976. Guidelines for striped bass culture. American Fisheries Society, Bethesda, Maryland, USA.

Cheek, R.P. 1961. Quantitative aspects of striped bass, *Roccus saxatilis* (Walbaum), spawning in the Roanoke River, North Carolina. M.S. Thesis, North Carolina State University, Raleigh. 99 p.

Fish, F.F. 1959. Report of the steering committee for Roanoke River studies, 1955-58. U.S. Public Health Service, Raleigh, NC. 279 p.

Giese, G.L., H.B. Wilder, and G.G. Parker, Jr. 1979. Hydrology of major estuaries and sounds in North Carolina. U.S. Geological Survey, Water Resources Investigations 79-46. 175 p.

Hassler, W.W., N.L. Hill, and J.T. Brown. 1981. The status and abundance of striped bass in the Roanoke River and Albemarle Sound, North Carolina 1956-1980. North Carolina Department of Natural Resources and Community Development, Division of Marine Fisheries, Special Scientific Report No. 38.

Hassler, W.W., B.B. Brandt, J.T. Brown, and P.R. Cheek. 1961. Status of the striped bass in the Roanoke River, North Carolina, for 1960. Department of Zoology, North Carolina State University, Raleigh, Mimeo Report. 38 p. + Appendices.

Hassler, W.W., W.L. Trent, and W.E. Gray. 1963. The status and abundance of the striped bass in the Roanoke River, North Carolina, for 1963. Department of Zoology, North Carolina State University, Raleigh, Mimeo Report. 43 p. + Appendices.

Hassler, W.W., W.L. Trent, and B.M. Florence. 1965. The status and abundance of the striped bass in the Roanoke River, North Carolina, for 1964. Department of Zoology, North Carolina State University, Raleigh, Mimeo Report. 45 p. + Appendices.

Hassler, W.W., W.L. Trent, and B.M. Florence. 1966. The status and abundance of the striped bass in the Roanoke River, North Carolina, for 1965. Department of Zoology, North Carolina State University, Raleigh, Mimeo Report. 53 p. + Appendices.

Hassler, W.W., W.T. Hogarth, and H.L. Liner, III. 1967. The status and abundance of the striped bass in the Roanoke River, North Carolina, for 1966. Department of Zoology, North Carolina State University, Raleigh, Mimeo Report. 53 p. + Appendices.

Hassler, W.W., W.T. Hogarth, H.L. Liner, III and H.S. Millsaps. 1968. The status and abundance of the striped bass in the Roanoke River, North Carolina, for 1967. Department of Zoology, North Carolina State University, Raleigh, Mimeo Report. 72 p. + Appendices.

Hassler, W.W., W.T. Hogarth, C.R. Stroud, Jr., and H.S. Millsaps. 1969. The status and abundance of the striped bass in the Roanoke River, North Carolina, for 1968. Department of Zoology, North Carolina State University, Raleigh, Mimeo Report. 71 p. + Appendices.

Hassler, W.W., and W.T. Hogarth. 1970. The status, abundance, and exploitation of striped bass in the Roanoke River and Albemarle Sound, North Carolina, and the spawning of striped bass in the Tar River, North Carolina. Department of Zoology, North Carolina State University, Raleigh, Mimeo Report. 64 p. + Appendices.

Hassler, W.W., W.T. Hogarth, and C.S. Manooch. 1971. The status, abundance, and exploitation of striped bass in the Roanoke River and Albemarle Sound, North Carolina, 1970. Department of Zoology, North Carolina State University, Raleigh, Mimeo Report. 82 p. + Appendices.

Hassler, W.W., W.T. Hogarth, C.S. Manooch, and N.L. Hill. 1973. The status, abundance, and exploitation of striped bass in the Roanoke River and Albemarle Sound, North Carolina, 1972. Department of Zoology, North Carolina State University, Raleigh, Mimeo Report. 75 p. + Appendices.

Hassler, W.W., and N.L. Hill. 1975. The status, abundance, and exploitation of striped bass in the Roanoke River and Albemarle Sound, North Carolina, 1973. Department of Zoology, North Carolina State University, Raleigh, Mimeo Report. 64 p. + Appendices.

Hassler, W.W., and N.L. Hill. 1976. The status, abundance, and exploitation of striped bass in the Roanoke River and Albemarle Sound, North Carolina, 1974. Department of Zoology, North Carolina State University, Raleigh, Mimeo Report. 80 p. + Appendices.

Hassler, W.W., and N.L. Hill. 1976. The status, abundance, and exploitation of striped bass in the Roanoke River and Albemarle Sound, North Carolina, 1975. Department of Zoology, North Carolina State University, Raleigh, Mimeo Report. 87 p. + Appendices.

Hassler, W.W., and N.L. Hill. 1978. The status, abundance, and exploitation of striped bass in the Roanoke River and Albemarle Sound, North Carolina, 1976. Department of Zoology, North Carolina State University, Raleigh, Mimeo Report. 117 p. + Appendices.

Hassler, W.W., and N.L. Hill. 1979. The status, abundance, and exploitation of striped bass in the Roanoke River and Albemarle Sound, North Carolina, 1977. Department of Zoology, North Carolina State University, Raleigh, Mimeo Report. 118 p. + Appendices.

Hassler, W.W., and N.L. Hill. 1980. The status, abundance, and exploitation of striped bass in the Roanoke River and Albemarle Sound, North Carolina, 1979. Department of Zoology, North Carolina State University, Raleigh, Mimeo Report. 82 p.

Hassler, W.W., L.G. Luempert, and J.W. Mabry. 1982. The status, abundance, and exploitation of striped bass in the Roanoke River and Albemarle Sound, North Carolina, 1981. Department of Zoology, North Carolina State University, Raleigh, Mimeo Report, 55 p. + Appendices.

Hassler, W.W., and S.D. Taylor. 1984. The status, abundance, and exploitation of striped bass in the Roanoke River and Albemarle Sound, North Carolina, 1982 and 1983. Department of Zoology, North Carolina State University, Raleigh, Mimeo Report. 67 p. + Appendices.

Hassler, W.W., and S.D. Taylor. 1986. The status, abundance, and exploitation of striped bass in the Roanoke River and Albemarle Sound, North Carolina, 1985. Department of Zoology, North Carolina State University, Raleigh, Mimeo Report. 47 p. + Appendices.

Johnson, J.C., P. Fricke, M. Hepburn, J. Sabella, W. Still, and C.R. Hayes. 1986. Recreational fishing in the sounds of North Carolina: a socioeconomic analysis. Volume I. UNC Sea Grant Publication UNC-SG-86-12.

Kornegay, J.W. and A.W. Mullis. 1984. Investigations into the decline in egg viability and juvenile survival of Albemarle Sound striped bass (*Morone* (*saxatilis*). Final Report on Project F-22, Study VIII. North Carolina Wildlife Resources Commission, Raleigh, NC, 13 p.

Manooch, C.S., III and R.A. Rulifson (eds.). 1989. Roanoke River Water Flow Committee Report: A recommended water flow regime for the Roanoke River, North Carolina, to benefit anadromous striped bass and other below-dam resources and users. NOAA Technical Memorandum NMFS-SEFC-216.

McCoy, E.G. 1959. Quantitative sampling of striped bass, *Roccus saxatilis* (Walbaum), eggs in the Roanoke River, North Carolina. M.S. Thesis, North Carolina State University, Raleigh, NC, 136 p.

Rulifson, R.A., J.E. Cooper, and D.W. Stanley. 1988. Striped bass and the food chain: cause for concern? American Water Resources Association Technical Publication Series TPS-88-1, pp. 177-187.

Rulifson, R.A., D.W. Stanley, and J.E. Cooper. 1986. Food and feeding of young striped bass in Roanoke River and western Albemarle Sound, North Carolina: 1984-1985. North Carolina Department of Natural Resources and Community Development, Division of Marine Fisheries, Completion Report for AFS-24.

SAS Institute. 1985. SAS User's Guide: Statistics, Version 5 Edition. SAS Institute, Inc., Cary, NC 584 p.

USDOI and USDOC (U.S. Department of the Interior and U.S. Department of Commerce). 1986. Emergency striped bass research study. 1985 Annual Report. Washington, District of Columbia, USA.

APPENDIX

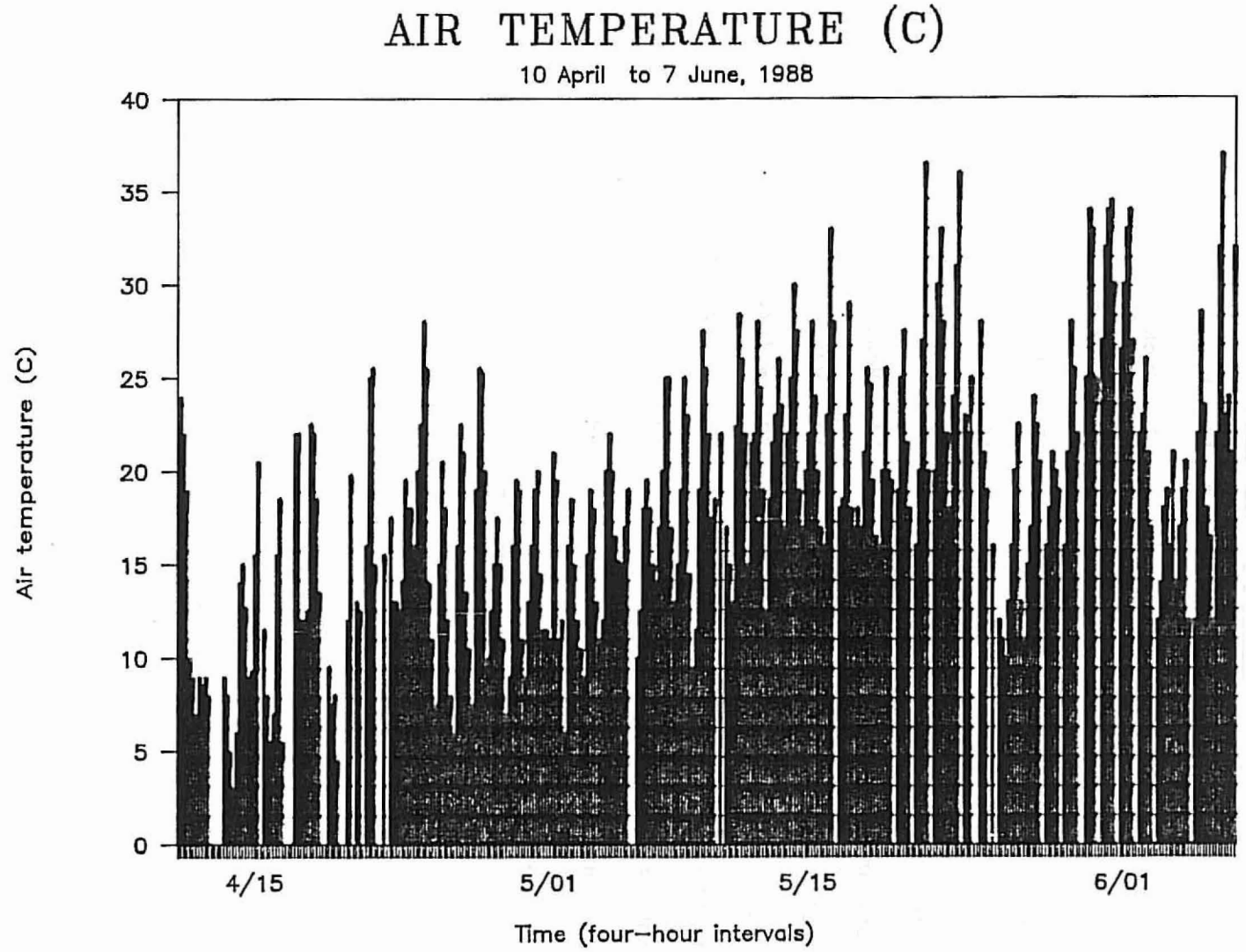


Figure A-1. Air temperature recorded at Pollocks Ferry on the Roanoke River, NC, from 10 April to 7 June 1988. Unfilled bars indicate no information available.

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

1-12 (Virginia)	13-24 (North Carolina)
1. Roanoke	13. Stokes
2. Franklin	14. Rockingham
3. Patrick	15. Caswell
4. Henry	16. Person
5. Bedford	17. Granvill
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 colleagues (1959-1987), and this study (1988).

Location	River Mile	Latitude	Longitude
Halifax	120	77o35'5"E	36o20'6"N
Johnson's Landing	118.5	77o18'23"E	36o33'20"N
Barnhill's Landing	117	77o18'23"E	36o32'15"N
Pollock's Ferry	105	77o24'30"E	36o15'30"N
Palmyra	78.5	77o19'30"E	36o4'32"N

Code Listing for Appendix Tables A-3 and A-4.

Variable name	Description
OBS	record number.
PAGE	page number of original field sheet.
DATE	YY/MM/DD.
TIME	military time.
ATEMP	air temperature in degrees Celcius.
WTEMP	surface water temperature in degrees Celcius.
PH	pH of surface water.
DO	dissolved oxygen (mg/L) in surface waters.
TDS	total dissolved solids.
SECCHI	secchi disk visibility (cm).
WVEL	surface water velocity (cm/second).
RSTEN	river stage (relative measurement, in feet and tenths).
XSECT	cross-sectional area of river (square feet).
SREVS	surface flowmeter reading (for five-minute period).
OREVS	oblique flowmeter reading (for five-minute period).
ASURF	number of eggs in surface net A.
ASOBL	number of eggs in oblique net A.
BSURF	number of eggs in surface net B.
BOBL	number of eggs in oblique net B.
ASVIA	number of viable eggs in surface net A.
AOVIA	number of viable eggs in oblique net A.
BSVIA	number of viable eggs in surface net B.
AOVIA	number of viable eggs in oblique net B.
ST1	number of eggs less than 10 hours old.
ST2	number of eggs 10-18 hours old.
ST3	number of eggs 20-28 hours old.
ST4	number of eggs 30-38 hours old.
HATCH	number of striped bass larvae.

Table A-3. Water quality data collected at Pollocks Ferry, Roanoke River, NC, from 10 April to 7 June 1988.

OBS	PAGE	DATE	TIME	ATEMP	WTEMP	PH	DO	TDS	SECCHI	WVEL	RSTEN	XSECT	SREVS	OREVS
1	1	880410	1211	20.0	15.5	.	11.0	.	90	.	5.4	1448.4	2713	2152
2	2	880410	1342	24.0	16.0	.	.	.	80	.	5.4	1448.4	2602	3225
3	3	880411	1406	22.0	17.0	.	9.0	.	110	.	.	.	2842	1899
4	4	880411	1800	19.0	.	7.5	.	.	90	.	.	.	2600	2050
5	5	880411	2205	10.0	17.0	7.5	.	.	.	.	.	.	2859	2801
6	6	880412	200	9.0	16.0	7.5	8.0	.	.	.	.	.	1679	1529
7	7	880412	600	7.0	15.0	7.5	.	.	.	.	.	.	2134	633
8	8	880412	1014	9.0	14.0	5.5	9.0	.	90	.	.	.	2600	2056
9	9	880412	1408	8.5	13.5	5.4	9.0	.	.	.	.	.	3882	3984
10	10	880412	1800	9.0	14.5	4.3	.	.	70	.	.	.	3553	3634
11	11	880412	2200	8.0	14.0	4.1	.	.	.	.	.	.	4337	3144
12	12	880413	200	.	13.0	3.4	9.0	.	.	.	.	.	5054	4337
13	13	880413	600	.	.	.	.	.	.	.	.	.	.	.
14	14	880413	1000	.	.	.	.	.	.	.	.	.	.	.
15	15	880413	1400	.	.	.	10.0	.	60	.	.	.	.	.
16	16	880413	1830	9.0	13.0	.	.	.	80	.	.	.	.	.
17	17	880413	2200	8.0	12.0	2.7	.	.	.	.	.	.	.	.
18	18	880414	200	5.0	13.0	.	9.0	.	.	.	.	.	.	.
19	19	880414	600	3.0	13.0	.	.	.	.	.	11.4	2772.9	.	.
20	20	880414	1000	6.0	13.0	.	10.4	.	75	.	11.4	2772.9	4720	4252
21	21	880414	1405	14.0	13.0	.	9.2	.	80	71	.	.	5426	4782
22	22	880414	1820	15.0	13.5	.	9.7	.	65	.	.	.	4169	4145
23	23	880414	2200	12.7	13.0	.	9.4	.	.	60	12.0	2917.2	4294	3572
24	24	880415	200	9.0	12.5	.	8.0	.	.	.	11.0	2681.9	4781	4189
25	25	880415	600	9.3	12.5	.	7.3	.	.	54	10.0	2454.3	4354	4121
26	26	880415	1000	15.5	13.0	.	8.0	.	90	.	.	.	3247	3037
27	27	880415	1417	20.5	14.5	9.0	1.4	.	.	.	.	.	.	3776
28	28	880415	1800	.	14.0	.	7.8	.	.	.	10.0	2454.3	.	.
29	29	880415	2200	11.5	14.0	.	7.7	.	.	.	10.0	2454.3	3208	3363
30	30	880416	200	8.0	12.0	.	7.7	.	.	.	.	.	3282	2746
31	31	880416	600	5.5	14.0	.	7.1	.	.	.	.	.	2960	2266
32	32	880416	1000	7.0	14.0	.	9.7	.	.	61	.	.	3126	3254

Table A-3. (Continued)

OBS	PAGE	DATE	TIME	ATEMP	WTEMP	PH	DO	TDS	SECCHI	WVEL	RSTEN	XSECT	SREVS	OREVS
33	33	880416	1400	15.5	14.0	.	8.2	.	.	58	.	.	3194	3250
34	34	880416	1800	18.5	13.0	.	7.9	.	90	78	.	.	4094	3670
35	35	880416	2200	5.5	13.0	.	.	.	.	.	.	.	3813	3796
36	36	880417	200	.	.	.	.	.	.	.	.	.	.	.
37	37	880417	600	.	13.5	.	8.4	.	.	.	.	.	.	.
38	38	880417	1000	.	.	.	.	.	.	.	.	.	.	.
39	39	880417	1400	22.0	14.0	.	8.8	.	100	78	.	.	4126	3808
40	40	880417	1800	22.0	14.3	.	7.5	.	100	75	.	.	4000	3265
41	41	880417	2200	12.0	13.0	.	7.9	.	.	76	.	.	.	3326
42	42	880418	200	12.0	13.0	.	7.8	.	.	78	.	.	3053	2241
43	43	880418	600	12.5	14.5	.	7.9	.	70	79	.	.	3840	4086
44	44	880418	1007	22.5	15.5	7.0	6.5	.	90	.	.	.	4174	4117
45	45	880418	1405	22.0	15.5	7.0	6.4	.	90	.	.	.	4370	3512
46	46	880418	1815	18.5	15.0	7.0	9.0	.	105	79	8.7	2157.7	3905	3859
47	47	880418	2200	13.5	15.0	7.0	9.0	4	.	69	.	.	4159	2639
48	48	880419	200	.	.	.	.	.	.	.	.	.	.	.
49	49	880419	600	.	.	.	.	.	.	.	.	.	.	.
50	50	880419	1000	9.5	14.0	7.0	8.8	5	100	78	.	.	4277	4324
51	51	880419	1400	7.5	13.5	6.8	8.6	5	70	88	.	.	4522	4470
52	52	880419	1800	8.0	13.5	7.0	6.5	5	60	96	.	.	4507	5029
53	53	880419	2200	4.5	12.5	6.8	8.8	6	.	.	.	.	4915	4823
54	54	880420	200	.	.	.	.	.	.	.	.	.	.	.
55	55	880420	600	.	.	.	.	.	.	.	.	.	.	.
56	56.0	880420	1013	12.0	13.5	7.0	6.9	3	70	67	10.0	2454.3	3482	4700
57	57.0	880420	1434	19.8	15.0	7.0	8.0	4	70	66	.	.	4432	5558
58	58.0	880420	1800	.	.	.	.	.	.	.	.	.	.	.
59	59.0	880420	2200	13.0	14.2	6.7	8.6	4	.	.	.	.	.	.
60	60.0	880421	200	12.5	13.8	6.7	8.2	4	.	.	.	.	.	.
61	61.0	880421	600	.	.	.	.	.	.	.	.	.	.	.
62	62.0	880421	1000	16.0	14.5	7.0	8.6	4	90	84	10.0	2454.3	4483	4140
63	63.0	880421	1400	25.0	14.5	7.2	8.3	4	80	93	9.8	2408.8	4393	4381
64	64.0	880421	1800	25.5	15.0	7.0	8.7	4	.	90	9.7	2385.0	4431	4521
65	65.0	880421	2200	15.0	14.5	7.0	8.1	4	.	94	9.7	2385.0	4709	4724

Table A-3. (Continued)

OBS	PAGE	DATE	TIME	ATEMP	WTEMP	PH	DO	TDS	SECCHI	WVEL	RSTEN	XSECT	SREVS	OREVS
66	66.0	880422	200	.	14.5	7.0	4.0	8	.	95	9.7	2385.0	5080	4952
67	67.0	880422	600	.	14.0	6.8	7.8	5	.	92	11.3	2749.4	4851	4968
68	68.0	880422	1000	15.5	13.5	7.0	9.0	5	80	84	10.8	2636.4	3511	3224
69	69.0	880422	1400	19.0	14.0	7.0	8.4	5	90	76	10.3	2521.8	.	3421
70	70.0	880422	1800	17.5	15.0	6.8	8.0	4	80	77	9.8	2408.8	3926	2633
71	71.0	880422	2200	13.0	13.5	7.2	7.3	4	.	96	9.8	2408.8	3495	4047
72	72.0	880423	200	13.0	14.0	7.0	8.1	4	.	85	10.1	2476.3	4286	4160
73	73.0	880423	600	12.5	14.0	7.0	8.0	5	90	91	10.6	2590.9	4196	4089
74	74.0	880423	1000	14.1	14.0	7.0	8.0	5	85	87	10.4	2545.3	4589	4521
75	76.0	880423	1400	19.5	15.0	7.2	8.5	5	97	84	9.8	2408.8	4215	4269
76	77.0	880423	1800	18.0	15.0	7.0	8.7	5	80	90	9.6	2363.3	4359	4487
77	78.0	880423	2200	18.0	15.5	7.2	7.9	4	.	.	.	.	3869	3480
78	79.0	880424	200	16.0	17.0	7.0	8.0	4	.	81	9.7	2385.3	4210	4025
79	80.0	880424	600	20.0	16.0	6.7	7.5	4	87	87	10.0	2454.3	4123	4212
80	81.0	880424	1000	22.5	16.5	7.2	8.4	4	90	90	9.6	2363.3	4379	4402
81	81.1	880424	1400	28.0	16.5	7.0	7.6	4	90	90	9.3	2294.3	2367	4598
82	81.2	880424	1800	25.5	16.3	7.0	7.4	4	90	92	9.3	2294.3	4524	2737
83	81.3	880424	2200	14.0	15.0	7.0	8.0	5	.	91	9.1	2248.7	4249	3746
84	81.4	880425	200	11.0	14.2	7.0	7.8	5	.	91	9.1	2248.7	4103	2873
85	81.5	880425	600	7.5	15.2	7.0	8.2	6	90	76	8.8	2181.2	4091	3834
86	82.0	880425	1005	15.0	16.0	7.3	6.7	5	90	69	8.0	2004.6	4206	3465
87	83.0	880425	1356	20.5	16.5	7.3	6.4	5	90	69	8.0	2004.6	3826	4510
88	84.0	880425	1800	18.0	16.0	7.0	9.6	5	85	90	8.9	2203.2	.	4089
89	85.0	880425	2200	12.0	15.5	7.0	9.0	5	.	90	8.8	2181.2	.	.
90	86.0	880426	200	8.0	14.0	7.0	7.9	4	.	93	8.8	2181.2	.	.
91	87.0	880426	600	6.0	14.0	7.2	8.4	6	80	93	8.8	2181.2	.	.
92	88.0	880426	1000	16.0	15.5	7.0	8.0	5	85	93	8.7	2157.7	.	.
93	89.0	880426	1400	22.5	16.5	6.8	8.6	4	.	94	8.7	2157.7	.	.
94	90.0	880426	1800	21.0	16.5	7.2	8.4	5	90	94	8.7	2157.7	7846	6669
95	91.0	880426	2200	13.5	15.0	7.0	8.2	5	.	93	8.6	2135.7	8058	6610
96	92.0	880427	200	10.5	14.5	7.0	8.0	5	.	97	8.6	2135.7	.	3350
97	93.0	880427	600	7.5	14.5	7.2	7.9	3	90	95	8.4	2090.2	7803	4282
98	94.0	880427	1000	19.0	16.5	7.4	7.7	5	100	94	8.5	2112.2	7924	7917

Table A-3. (Continued)

OBS	PAGE	DATE	TIME	ATEMP	WTEMP	PH	DO	TDS	SECCHI	WVEL	RSTEN	XSECT	SREVS	OREVS
99	95.0	880427	1400	25.5	17.0	7.2	7.8	4	90	97	8.4	2090.2	.	.
100	96.0	880427	1800	25.3	17.0	7.2	8.0	4	90	93	8.4	2090.2	8502	7684
101	97.0	880427	2200	20.0	16.5	7.0	8.0	5	.	.	.	.	.	.
102	98.0	880428	200	10.0	14.0	7.0	8.0	5	.	.	.	.	.	.
103	99.0	880428	600	12.5	15.5	7.0	8.6	6	95	87	8.5	2112.2	7869	4642
104	100.0	880428	1000	15.0	16.0	7.0	8.6	5	95	76	8.5	2112.2	9059	8437
105	101.0	880428	1400	17.5	17.5	7.0	7.4	5	80	86	8.8	2408.8	7557	5659
106	102.0	880428	1800	15.0	15.0	7.0	8.0	5	85	86	8.8	2408.8	7515	8102
107	103.0	880428	2200	11.0	14.5	7.2	7.8	6	.	97	8.5	2112.2	8711	5758
108	104.0	880429	200	7.0	13.5	7.0	8.0	6	.	93	8.5	2112.2	.	.
109	105.0	880429	600	9.0	15.0	7.0	7.6	6	85	74	8.5	2112.2	.	.
110	106.0	880429	1000	16.0	16.0	7.2	7.0	5	90	97	8.4	2090.2	4989	5140
111	107	880429	1400	19.5	16.5	6.7	7.3	5.00	80	90	8.4	2090.2	5564	3842
112	108	880429	1800	19.0	16.0	7.0	7.5	6.00	85	83	9.3	2294.3	1563	5899
113	109	880429	2200	11.0	15.0	7.0	7.4	5.00	.	86	8.4	2090.2	7282	6425
114	110	880430	200	9.0	14.5	7.0	7.3	5.00	.	86	8.4	2090.2	3579	165
115	111	880430	600	13.0	15.0	6.8	7.4	5.00	75	84	8.3	2294.3	3600	3582
116	112	880430	1000	16.0	15.5	6.8	7.8	5.00	80	83	8.3	2294.3	2441	4011
117	113	880430	1400	19.0	16.5	7.3	8.2	5.00	85	82	8.3	2294.3	5898	5970
118	114	880430	1800	20.0	16.0	6.8	7.8	5.00	80	81	8.3	2069.4	6532	6586
119	115	880430	2200	14.5	15.5	6.8	7.4	5.00	.	85	7.9	1983.8	8282	5075
120	116	880501	200	11.5	15.0	6.8	7.5	5.00	.	84	7.8	1961.8	8970	4092
121	117	880501	600	11.5	15.6	7.1	7.4	5.00	80	81	8.2	2047.4	8136	5923
122	118	880501	1000	11.0	16.0	7.1	7.3	5.00	85	80	8.3	2294.3	8697	7260
123	119	880501	1400	21.0	17.0	7.0	8.0	5.00	75	81	7.9	1983.8	8223	6380
124	120	880501	1800	19.5	16.2	7.3	7.6	5.00	80	91	7.9	1983.8	9009	7055
125	121	880501	2200	11.0	14.8	7.2	7.2	6.00	.	81	7.9	1983.8	8035	4920
126	122	880502	200	12.0	14.5	7.0	7.0	5.00	.	84	7.9	1983.8	.	7218
127	123	880502	600	6.0	14.8	7.2	7.5	5.00	82	83	8.0	2004.6	8143	4593
128	124	880502	1000	16.0	16.0	7.2	8.1	5.00	85	83	8.0	2004.6	8119	7408
129	125	880502	1400	18.5	16.0	7.2	7.5	5.00	95	85	8.0	2004.6	8820	8477
130	126	880502	1800	15.0	15.0	7.0	7.3	5.00	85	88	7.8	1961.8	7951	7983
131	127	880502	2200	12.0	14.5	7.0	7.2	5.00	.	87	7.8	1961.8	2599	7510

Table A-3. (Continued)

OBS	PAGE	DATE	TIME	ATEMP	WTEMP	PH	DO	TDS	SECCHI	WVEL	RSTEN	XSECT	SREVS	OREVS
132	128	880503	200	10.5	14.5	7.0	7.1	5.00	.	87	7.8	1961.8	5882	5811
133	129	880503	600	9.0	14.2	7.1	7.2	6.00	80	87	7.8	1961.8	8520	8539
134	130	880503	1000	15.5	15.8	7.1	7.5	5.00	85	81	7.9	1983.8	8351	6002
135	131	880503	1400	19.0	16.1	7.1	7.6	5.00	90	80	8.0	2004.6	8716	6890
136	132	880503	1800	18.0	15.0	7.1	7.7	5.00	90	74	8.0	2004.6	7556	5467
137	133	880503	2200	13.0	14.5	7.0	7.2	5.00	.	104	8.0	2004.6	8740	8273
138	134	880504	200	11.0	14.5	7.0	7.1	5.00	.	102	8.0	2004.6	8050	8098
139	135	880504	600	12.0	14.5	6.9	7.0	5.00	65	97	8.0	2004.6	7950	7902
140	136	880504	1000	20.0	15.8	6.9	7.3	5.00	75	94	8.3	2069.4	7559	7496
141	137	880504	1400	22.0	16.3	6.8	7.6	6.00	80	96	8.7	2157.7	4609	7510
142	138	880504	1800	20.0	16.0	6.8	7.8	6.00	.	.	.	.	.	.
143	139	880504	2200	16.5	16.0	6.8	7.1	5.00	.	95	10.6	2590.9	10339	10630
144	140	880505	200	15.2	15.8	7.0	7.4	5.00	.	95	10.9	2658.4	9050	8902
145	141	880505	600	15.0	15.5	6.9	7.7	5.00	.	91	.	.	7981	8119
146	142	880505	1000	17.0	16.0	6.7	7.2	5.00	45	86	10.3	2521.8	8315	8384
147	143	880505	1400	19.0	16.5	6.9	8.0	5.00	45	89	10.8	2636.4	9248	9422
148	143	880505	1800	16.5	16.0	.	7.8	.	50	93	11.6	2818.4	10299	9771
149	143	880505	2200	16.0	15.2	7.0	8.5	5.00	.	116	12.1	2939.2	9967	9091
150	144	880506	200	10.0	14.7	7.0	7.8	1.25	.	103	11.5	2294.9	7727	7750
151	145	880506	600	12.5	14.5	7.0	8.0	5.00	60	98	11.0	2681.9	8539	8896
152	146	880506	1000	18.0	16.5	7.0	8.6	5.00	65	92	10.8	2636.4	8440	7947
153	147	880506	1400	19.5	16.0	7.0	7.5	5.00	65	90	11.0	2681.9	9636	8581
154	148	880506	1800	18.0	16.0	7.0	8.0	5.00	65	90	11.4	2772.9	8123	9022
155	149	880506	2200	15.0	16.0	7.0	6.8	5.00	.	97	11.3	2749.4	9120	8326
156	150	880507	200	14.0	15.5	7.0	7.2	5.00	.	89	10.6	2590.9	8558	7684
157	151	880507	600	17.0	16.0	6.8	6.6	5.00	80	84	10.2	2499.8	7091	7459
158	152	880507	1000	20.0	17.0	7.1	6.9	5.00	75	74	9.9	2430.8	7218	7300
159	153	880507	1400	25.0	18.0	7.2	7.8	4.00	75	86	9.8	2408.8	7742	6543
160	154	880507	1800	25.0	18.0	7.2	9.6	4.00	75	80	9.6	2363.3	8082	7374
161	155	880507	2200	17.0	17.5	7.0	5.6	5.00	.	79	9.3	2294.3	6758	6477
162	156	880508	200	13.0	15.0	7.0	5.4	5.00	.	82	9.1	2248.7	7597	6703
163	157	880508	600	15.0	15.5	7.0	5.2	6.00	85	82	8.9	2203.2	7212	7531
164	158	880508	1000	19.0	17.0	7.0	6.2	5.00	85	74	8.8	2181.2	7273	.

Table A-3. (Continued)

OBS	PAGE	DATE	TIME	ATEMP	WTEMP	PH	DO	TDS	SECCHI	WVEL	RSTEN	XSECT	SREVS	OREVS
165	159	880508	1400	25.0	18.5	7.0	6.4	4.00	90	74	8.8	2181.2	8337	8033
166	160	880508	1800	23.0	17.2	7.0	7.6	4	125	73	8.8	2181.2	10749	.
167	161	880508	2200	14.5	16.0	7.0	7.4	5	.	88	8.6	2135.7	8182	6679
168	162	880509	200	9.5	15.7	7.0	5.6	6	.	87	8.6	2135.7	3093	7277
169	163	880509	600	11.5	16.0	7.0	6.2	4	80	87	8.5	2112.2	8729	7052
170	164	880509	1000	19.0	17.6	7.1	5.3	4	100	90	8.5	2112.2	6591	6785
171	165	880509	1400	27.5	19.0	7.1	7.4	4	100	89	8.4	2090.2	6697	7665
172	166	880509	1800	25.5	18.0	7.2	8.8	3	80	78	8.4	2090.2	7828	8085
173	167	880509	2200	22.0	17.0	7.3	8.2	4	.	95	9.1	2248.7	9642	10143
174	168	880510	200	17.5	17.3	7.3	8.4	.	.	94	10.2	2499.8	10635	9555
175	169	880510	600	18.5	17.5	7.2	7.6	5	80	93	10.0	2454.3	9014	8566
176	170	880510	1000	.	17.1	7.2	7.7	4	80	90	9.6	2363.3	6413	7939
177	171	880510	1400	22.0	18.0	.	7.6	4	85	89	9.3	2294.3	7798	8331
178	172	880510	1800	.	18.0	.	6.8	4	100	90	9.1	2248.7	8848	8260
179	173	880510	2200	17.0	18.0	.	6.9	5	.	100	9.5	2339.8	9175	5296
180	174	880511	200	15.0	18.2	7.0	6.7	5	.	.	10.3	2521.8	9998	9399
181	175	880511	600	13.0	18.0	7.2	6.4	5	95	80	10.1	2476.3	8188	7642
182	176	880511	1000	22.4	18.5	7.0	5.2	4	85	87	9.8	2408.8	8765	7925
183	177	880511	1400	28.4	18.8	.	6.6	3	105	87	9.4	2317.8	8480	7448
184	178	880511	1800	26.0	19.0	7.2	6.2	5	100	90	9.3	2294.3	7532	7412
185	179	880511	2200	22.0	18.5	7.2	6.0	5	.	90	9.7	2385.3	9289	8403
186	180	880512	200	15.0	17.5	7.0	7.2	5	.	87	10.3	2521.8	9189	8099
187	181	880512	600	21.5	18.7	7.3	6.8	5	105	83	10.2	2499.8	7102	8702
188	182	880512	1000	22.0	19.0	7.0	6.4	4	90	85	9.6	2363.3	8757	8178
189	183	880512	1400	28.0	20.5	7.0	7.0	4	110	81	9.2	2272.3	7623	7363
190	184	880512	1800	24.5	20.5	7.0	7.6	5	95	81	9.1	2248.7	7576	6694
191	185	880512	2200	19.0	19.0	7.0	6.4	5	.	84	9.4	2317.8	9072	8820
192	186	880513	200	12.5	18.0	7.2	5.8	6	.	82	10.1	2476.3	9522	8602
193	187	880513	600	18.5	18.8	7.2	6.4	3	92	82	9.8	2408.8	8040	7470
194	188	880513	1000	21.5	19.4	7.2	7.6	4	88	81	9.5	2339.8	8671	7336
195	188	880513	1400	23.0	20.0	7.0	10.0	3	105	83	9.3	2294.3	7454	7321
196	189	880513	1800	26.0	19.0	7.2	8.4	4	95	80	9.1	2248.7	7793	6356
197	190	880513	2200	23.5	19.0	7.2	8.2	5	.	82	8.8	2181.2	6513	4843

Table A-3. (Continued)

OBS	PAGE	DATE	TIME	ATEMP	WTEMP	PH	DO	TDS	SECCHI	WVEL	RSTEN	XSECT	SREVS	OREVS
198	191	880514	200	17.0	18.0	7.0	5.4	5	.	84	8.7	2157.7	7265	6885
199	192	880514	600	22.0	18.5	7.0	6.0	4	90	73	8.6	2135.7	7370	4911
200	193	880514	1000	25.0	20.4	7.0	6.0	3	100	74	8.6	2135.7	8059	7231
201	194	880514	1400	30.0	21.5	7.2	7.2	4	105	79	7.8	1961.8	8024	7218
202	195	880514	1800	27.5	21.5	7.2	7.7	5	90	78	8.3	2069.4	8114	9426
203	196	880514	2200	19.0	20.0	7.2	7.4	4	.	80	9.0	2226.7	7743	7806
204	197	880515	200	17.0	20.0	7.0	7.0	4	.	72	8.8	2181.2	8614	8429
205	198	880515	600	20.0	20.0	7.0	7.2	4	80	80	9.0	2226.7	7887	7197
206	199	880515	1000	22.0	20.0	7.0	8.0	4	82	86	9.3	2294.3	7726	7261
207	200	880515	1400	28.0	21.0	7.2	7.6	3	105	78	9.0	2226.7	6695	6042
208	201	880515	1800	24.0	21.2	7.2	7.6	3	100	79	8.9	2203.2	6493	6991
209	202	880515	2200	20.0	19.5	7.1	7.3	5	.	78	8.9	2203.2	7445	6907
210	203	880516	200	17.0	19.0	7.1	7.5	5	.	81	9.5	2339.8	8589	8967
211	204	880516	600	16.0	18.5	6.7	6.4	4	85	84	9.4	2317.8	7969	8164
212	205	880516	1000	23.0	20.0	7.0	6.4	4	90	75	9.3	2294.8	7133	7122
213	206	880516	1400	33.0	22.0	7.1	8.3	3	110	71	9.3	2294.8	9034	8729
214	207	880516	1800	28.0	21.0	7.0	8.0	7	85	74	9.8	2408.8	8470	7926
215	208	880516	2200	.	.	.	.	.	.	.	.	.	.	.
216	209	880516	200	18.0	20.0	7.0	8.6	5	.	96	10.8	2636.4	8998	8992
217	210	880517	600	18.5	20.0	6.7	9.0	4	80	81	10.4	2545.3	7610	6871
218	211	880517	1000	23.0	21.0	7.1	10.0	4	87	80	10.0	2454.3	8147	6417
219	212	880517	1400	29.0	22.5	7.1	8.8	4	95	78	9.9	2430.8	8728	8886
220	213	880517	1800	18.0	20.0	7.0	9.0	5	95	83	10.5	2567.3	8357	8221
221	214	880517	2200	17.0	20.0	7.3	8.3	4	.	102	11.0	2681.9	8174	8674
222	215	880518	200	18.0	19.5	7.3	8.0	5	.	96	11.1	2703.9	7826	7742
223	216	880518	600	17.0	19.0	6.9	.	3	95	75	10.8	2636.4	7291	6887
224	217	880518	1000	21.0	20.2	6.9	.	3	100	75	10.3	2521.8	7729	7213
225	218	880518	1400	25.5	21.0	7.5	8.1	3	100	85	9.8	2408.8	8068	9158
226	219	880518	1800	24.7	20.8	7.5	8.3	5	100	82	9.4	2318.8	7323	6736
227	220	880518	2200	19.5	20.0	7.3	8.0	4	.	80	9.0	2226.7	6805	6845
228	221	880519	200	16.5	19.5	7.3	7.8	4	.	79	8.8	2181.2	7450	7590
229	222	880519	600	16.0	19.5	7.3	8.1	4	90	78	.	.	7989	8250
230	223	880519	1000	20.0	20.5	7.3	6.2	3	115	79	8.8	2181.2	7245	6890

Table A-3. (Continued)

OBS	PAGE	DATE	TIME	ATEMP	WTEMP	PH	DO	TDS	SECCHI	WVEL	RSTEN	XSECT	SREVS	OREVS
231	224	880519	1400	25.5	20.6	7.4	6.8	5	115	78	8.8	2181.2	7411	6216
232	225	880519	1800	20.0	20.5	7.5	7.6	5	90	81	8.8	2181.2	8077	7423
233	226	880519	2200	19.5	20.0	7.5	7.3	5	.	82	8.9	2203.2	9198	7163
234	227	880520	200	.	.	.	.	.	.	.	.	.	.	.
235	228	880520	600	19.0	20.9	7.1	6.1	5	94	78	9.5	2339.8	6759	6683
236	229	880520	1000	25.0	21.5	6.8	5.8	4	110	80	9.3	2294.3	7349	7492
237	230	880520	1400	27.5	22.0	7.3	6.6	5	110	83	9.5	2339.8	7848	7805
238	231	880520	1800	21.5	20.0	7.4	6.7	5	90	82	10.0	2454.3	9101	8271
239	232	880520	2200	18.0	20.0	7.2	6.4	5	.	80	9.9	2430.8	8992	7738
240	233	880521	200	.	.	.	.	.	.	.	.	.	.	.
241	234	880521	600	16.0	19.0	7.3	6.0	5	85	83	9.9	2430.8	8153	8383
242	235	880521	1000	20.0	22.0	7.2	6.4	5	117	78	9.8	2408.8	8583	6342
243	236	880521	1400	27.0	22.0	7.2	6.2	5	115	85	9.8	2408.8	8005	8834
244	237	880521	1800	36.5	22.5	7.5	6.3	3	85	82	9.5	2339.8	8323	7709
245	238	880521	2200	20.0	19.5	7.3	6.0	3	.	83	9.7	2385.3	8883	7938
246	239	880522	200	.	.	.	.	.	.	.	.	.	.	.
247	240	880522	600	20.0	21.0	7.2	6.4	4	85	81	9.9	2430.8	8445	9459
248	241	880522	1000	30.0	23.0	7.0	6.2	4	.	89	9.4	2317.8	9493	8915
249	242	880522	1400	33.0	22.0	7.1	6.8	3	100	87	9.3	2294.3	8550	7269
250	243	880522	1800	28.0	22.5	7.4	6.3	4	90	85	8.8	2181.2	8547	13774
251	244	880522	2200	22.0	21.0	7.0	5.8	5	.	81	9.1	2248.7	7571	7697
252	245	880523	200	18.0	20.0	6.8	5.6	5	.	80	9.3	2294.3	7533	7484
253	246	880523	600	24.0	21.8	6.0	5.8	3	75	83	9.5	2339.8	7608	7643
254	247	880523	1000	31.0	23.1	6.3	6.1	4	80	81	9.3	2294.3	7627	7815
255	248	880523	1400	36.0	23.7	7.5	6.4	5	95	81	9.1	2248.7	7611	7629
256	249	880523	1800	.	24.5	7.4	8.0	4	85	80	9.2	2272.3	8119	7134
257	250	880523	2200	23.0	24.2	7.4	6.5	4	.	89	9.3	2294.3	8154	8210
258	251	880524	200	22.0	22.3	7.4	7.4	5	.	79	9.5	2317.8	7277	7623
259	252	880524	600	25.0	22.7	7.5	7.4	5	98	78	9.3	2294.3	9697	8819
260	253	880524	1000	.	24.0	7.5	7.5	4	115	79	9.3	2294.3	8788	7722
261	254	880524	1400	.	23.0	7.5	7.5	4	85	85	9.6	2363.3	10571	10496
262	255	880524	1800	28.0	23.0	7.5	8.0	4	75	86	9.9	2430.8	4291	.
263	256	880524	2200	21.0	21.0	7.3	6.0	4	.	89	9.7	2385.3	9011	8422

Table A-3. (Continued)

OBS	PAGE	DATE	TIME	ATEMP	WTEMP	PH	DO	TDS	SECCHI	WVEL	RSTEN	XSECT	SREVS	OREVS
264	257	880525	200	19.0	21.0	7.3	6.0	5	.	87	9.8	2408.8	9384	7387
265	258	880525	600	.	21.0	7.4	6.0	4	80	78	10.6	2590.9	8075	8334
266	259	880525	1000	16.0	20.5	7.4	6.2	4	100	74	10.2	2499.8	8421	7761
267	260	880525	1400	.	.	.	.	.	.	.	.	.	.	.
268	261	880525	1800	12.0	19.1	7.4	6.0	5	102	82	9.3	2294.3	8057	9379
269	262	880525	2200	11.0	19.8	7.1	5.8	4	.	82	9.3	2294.3	7764	8514
270	263	880526	200	10.0	19.0	7.1	5.6	4	.	78	9.3	2294.3	8568	8077
271	264	880526	600	13.0	19.8	7.1	5.6	4	95	91	9.3	2294.3	7960	8932
272	265	880526	1000	16.0	20.0	7.1	5.8	4	95	83	9.3	2294.3	4238	7438
273	266	880526	1400	20.0	20.8	7.2	5.8	6	100	81	9.2	2272.3	8355	9125
274	267	880526	1800	22.5	21.1	7.3	5.8	4	105	75	8.8	2181.2	9179	8694
275	268	880526	2200	13.0	19.7	7.0	5.2	3	.	81	8.9	2203.2	9023	9048
276	269	880527	200	11.0	19.0	7.0	5.2	4	.	78	9.0	2226.7	9005	9052
277	270	880527	600	15.0	19.2	6.9	5.8	5	90	84	9.1	2248.7	9042	9110
278	271	880527	1000	17.0	21.0	6.9	6.2	6	98	89	9.3	2294.3	10238	10091
279	272	880527	1400	24.0	21.0	7.2	6.0	5	100	85	9.8	2408.8	10140	8526
280	273	880527	1800	22.5	21.5	7.3	5.8	5	85	80	8.5	2112.2	8791	8219
281	274	880527	2200	20.5	19.0	7.3	5.5	4	.	82	8.6	2135.7	8458	8639
282	275	880528	200	.	.	.	.	.	.	.	.	.	.	.
283	276	880528	600	16.0	18.0	7.4	5.6	3	85	80	9.3	2294.3	9378	8392
284	277	880528	1000	18.0	19.0	7.1	5.8	3	80	81	9.3	2294.3	7092	7417
285	278	880528	1400	21.0	20.5	7.1	6.4	4	85	85	9.0	2226.7	7712	6493
286	279	880528	1800	20.0	21.0	7.1	6.0	5	90	80	8.8	2181.2	7666	7687
287	280	880528	2200	19.0	21.0	7.2	6.0	5	.	80	8.8	2181.2	7886	7211
288	281	880529	200	.	.	.	.	.	.	.	.	.	.	.
289	281	880529	600	16.0	20.0	7.2	6.2	5	.	79	7.6	1919.1	6526	7471
290	282	880529	1000	21.0	21.5	7.2	6.6	4	95	79	8.7	2157.7	7032	6944
291	283	880529	1400	28.0	21.0	7.4	6.8	3	106	80	8.3	2069.4	7268	6983
292	284	880529	1800	25.5	21.0	7.4	6.3	3	100	85	8.2	2047.4	8801	7827
293	285	880529	2200	22.0	20.5	7.4	6.0	3	.	82	8.1	2026.6	7507	7329
294	286	880530	200	.	.	.	.	.	.	.	.	.	.	.
295	287	880530	600	.	.	.	.	.	.	.	.	.	.	.
296	288	880530	1000	25.0	21.0	7.4	6.5	4	78	81	7.7	1941.1	8513	9011

Table A-3. (Continued)

OBS	PAGE	DATE	TIME	ATEMP	WTEMP	PH	DO	TDS	SECCHI	WVEL	RSTEN	XSECT	SREVS	OREVS
297	289	880530	1400	34.0	23.5	7.5	6.6	4	95	80	7.9	1983.8	8557	8903
298	290	880530	1800	33.0	24.0	7.6	5.8	4	90	83	7.9	1983.8	7954	8268
299	291	880530	2200	25.0	23.0	7.5	5.6	5	.	82	8.0	2004.6	8659	7954
300	292	880531	200	.	.	.	.	.	.	.	.	.	.	.
301	293	880531	600	27.0	24.0	7.7	5.6	3	75	78	7.5	1898.3	.	.
302	294	880531	1000	32.0	24.5	7.8	5.6	3	90	77	7.5	1898.3	7538	8115
303	295	880531	1400	34.0	25.5	7.9	5.4	3	86	79	7.6	1919.1	8949	8250
304	296	880531	1800	34.5	24.7	7.6	5.4	5	75	85	9.3	2294.3	11564	11772
305	297	880531	2200	30.1	23.5	7.6	5.4	4	.	81	11.3	2749.4	9511	10138
306	298	880601	200	.	.	.	.	.	.	.	.	.	.	.
307	299	880601	600	26.5	22.6	7.7	5.6	3	70	91	13.4	3290.3	10273	10470
308	300	880601	1000	30.0	23.4	7.6	5.0	5	80	91	13.4	3290.3	9376	9227
309	301	880601	1400	33.0	23.0	7.0	5.2	3	115	85	13.1	3208.7	9833	9226
310	302	880601	1800	34.0	24.0	7.6	5.2	4	90	86	12.9	3155.4	6187	8653
311	303	880601	2200	27.0	22.5	7.7	5.2	4	.	85	12.5	3048.8	7926	8951
312	304	880602	200	.	.	.	.	.	.	.	.	.	.	.
313	305	880602	600	22.0	23.0	7.4	5.2	4	95	83	12.8	3130.4	8391	8619
314	306	880602	1000	23.0	24.0	7.4	5.0	4	115	82	12.6	3077.1	8399	8434
315	307	880602	1400	26.0	23.0	.	6.4	3	95	80	10.4	2545.3	7513	6847
316	308	880602	1800	21.0	23.0	7.4	6.4	4	100	78	8.8	2181.2	8761	7525
317	309	880602	2200	17.0	21.0	7.4	6.2	4	.	79	8.5	2112.2	6370	4645
318	310	880603	200	.	.	.	.	.	.	.	.	.	.	.
319	311	880603	600	12.0	19.0	7.4	6.9	4	90	74	8.2	2047.4	6455	6605
320	312	880603	1000	14.0	19.0	7.4	7.2	6	100	71	7.8	1961.8	6560	6608
321	313	880603	1400	18.0	20.5	7.4	7.2	6	100	74	7.5	1898.3	7357	7511
322	314	880603	1800	19.0	21.0	7.2	7.2	6	90	73	7.4	1876.3	8057	7608
323	315	880603	2200	16.0	20.0	7.2	6.8	5	.	77	7.2	1833.5	7305	8751
324	316	880607	600	.	.	.	.	.	.	.	.	.	.	.
325	317	880604	600	14.0	20.0	6.9	6.2	4	45	73	6.9	1769.9	7712	8606
326	318	880604	1000	17.0	21.0	.	5.8	4	45	77	6.8	1747.9	8986	7569
327	319	880604	1400	19.0	21.5	6.9	5.5	7	55	75	6.6	1705.1	8862	8848
328	320	880604	1800	20.5	21.5	6.4	5.4	6	50	94	9.3	2294.3	10645	10534
329	321	880604	2200	12.0	20.0	6.6	5.2	5	.	84	9.5	2339.8	7628	8469

Table A-3. (Continued)

OBS	PAGE	DATE	TIME	ATEMP	WTEMP	PH	DO	TDS	SECCHI	WVEL	RSTEN	XSECT	SREVS	OREVS
330	322	880605	200	.	.	.	.	.	.	.	.	.	.	.
331	323	880605	600	12.0	20.0	7.2	5.0	5	70	80	6.5	1684.3	7820	7447
332	324	880605	1000	22.0	20.5	7.5	5.4	5	85	76	6.3	1641.5	5881	5522
333	325	880605	1400	28.5	21.5	7.6	6.0	5	95	66	5.0	1362.8	6379	5372
334	326	880605	1800	23.5	21.5	7.4	7.4	4	91	64	4.6	1277.4	6262	6624
335	327	880605	2200	18.0	21.5	7.3	7.4	4	.	66	4.6	1277.4	5604	5691
336	328	880606	200	16.5	20.5	.	7.1	4	.	67	4.6	1277.4	5732	5790
337	329	880606	600	12.0	20.5	6.0	7.0	6	85	61	2.9	917.3	6930	3638
338	330	880606	1000	22.0	21.9	7.2	7.1	5	.	63	2.8	896.3	4744	5221
339	331	880606	1400	32.0	23.0	7.2	7.6	6	112	64	2.8	896.3	5687	5603
340	332	880606	1800	37.0	24.0	7.3	7.4	3	90	55	2.8	896.3	3992	2911
341	333	880606	2200	23.0	23.0	7.3	7.1	3	.	70	5.3	1427.6	6389	6017
342	334	880607	200	24.0	23.0	7.6	6.8	2	.	80	7.7	1941.1	6057	6213
343	335	880607	600	21.0	23.0	7.8	6.4	1	42	90	10.1	2476.3	9140	8965
344	336	880607	1000	32.0	23.5	7.5	7.2	3	65	126	12.5	3050.8	11692	13453

Table A-4. Striped bass egg enumeration and stage of development data collected at Pollocks Ferry, Roanoke River, NC, from 10 April to 7 June 1988.

OBS	PAGE	DATE	TIME	ASURF	AOBL	BSURF	BOBL	ASVIA	AOVIA	BSVIA	BOVIA	ST1	ST2	ST3	ST4	HATCH
1	1	880410	1211	0	0	0	0	0	0	0	0	0	0	0	0	0
2	2	880410	1342	0	0	0	0	0	0	0	0	0	0	0	0	0
3	3	880411	1406	0	0	0	0	0	0	0	0	0	0	0	0	0
4	4	880411	1800	0	0	0	0	0	0	0	0	0	0	0	0	0
5	5	880411	2205	0	0	0	0	0	0	0	0	0	0	0	0	0
6	6	880412	200	2	7	0	6	0	3	0	4	0	1	6	0	0
7	7	880412	600	1	0	0	0	1	0	0	0	1	0	0	0	0
8	8	880412	1014	0	0	0	0	0	0	0	0	0	0	0	0	0
9	9	880412	1408	5	15	6	17	4	0	1	3	2	4	2	0	0
10	10	880412	1800	0	0	0	0	0	0	0	0	0	0	0	0	0
11	11	880412	2200	.	0	0	0	0	0	0	0	0	0	0	0	0
12	12	880413	200	0	0	0	0	0	0	0	0	0	0	0	0	0
13	13	880413	600	.	.	.	.	.	.	.	.	.	.	.	.	.
14	14	880413	1000	.	.	.	.	.	.	.	.	.	.	.	.	.
15	15	880413	1400	0	1	0	0	0	0	0	0	0	0	0	0	0
16	16	880413	1830	.	.	.	.	.	.	.	.	.	.	.	.	.
17	17	880413	2200	1	0	0	0	0	0	0	0	0	0	0	0	0
18	18	880414	200	0	0	0	0	0	0	0	0	0	0	0	0	0
19	19	880414	600	0	0	0	0	0	0	0	0	0	0	0	0	0
20	20	880414	1000	0	2	0	0	0	1	0	0	1	0	0	0	0
21	21	880414	1405	0	0	0	0	0	0	0	0	0	0	0	0	0
22	22	880414	1820	0	0	0	0	0	0	0	0	0	0	0	0	0
23	23	880414	2200	0	0	0	0	0	0	0	0	0	0	0	0	0
24	24	880415	200	0	0	0	0	0	0	0	0	0	0	0	0	0
25	25	880415	600	0	0	0	0	0	0	0	0	0	0	0	0	0
26	26	880415	1000	0	0	0	0	0	0	0	0	0	0	0	0	0
27	27	880415	1417	0	0	0	0	0	0	0	0	0	0	0	0	0
28	28	880415	1800	.	.	.	.	.	.	.	.	.	.	.	.	.
29	29	880415	2200	4	1	0	2	0	0	0	0	0	0	0	0	0
30	30	880416	200	0	0	0	0	0	0	0	0	0	0	0	0	0
31	31	880416	600	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A-4. (Continued)

OBS	PAGE	DATE	TIME	ASURF	AOBL	BSURF	BOBL	ASVIA	AOVIA	BSVIA	BOVIA	ST1	ST2	ST3	ST4	HATCH
32	32	880416	1000	0	0	0	0	0	0	0	0	0	0	0	0	0
33	33	880416	1400	0	0	0	0	0	0	0	0	0	0	0	0	0
34	34	880416	1800	0	0	0	0	0	0	0	0	0	0	0	0	0
35	35	880416	2200	0	0	0	0	0	0	0	0	0	0	0	0	0
36	36	880417	200	.	.	.	.	.	.	.	.	.	.	.	.	.
37	37	880417	600	.	.	.	.	.	.	.	.	.	.	.	.	.
38	38	880417	1000	.	.	.	.	.	.	.	.	.	.	.	.	.
39	39	880417	1400	0	0	0	0	0	0	0	0	0	0	0	0	0
40	40	880417	1800	0	0	0	0	0	0	0	0	0	0	0	0	0
41	41	880417	2200	0	0	0	0	0	0	0	0	0	0	0	0	0
42	42	880418	200	0	0	0	0	0	0	0	0	0	0	0	0	0
43	43	880418	600	0	0	0	0	0	0	0	0	0	0	0	0	0
44	44	880418	1007	1	0	0	0	0	0	0	0	0	0	0	0	0
45	45	880418	1405	0	0	0	0	0	0	0	0	0	0	0	0	0
46	46	880418	1815	0	0	0	0	0	0	0	0	0	0	0	0	0
47	47	880418	2200	0	0	0	0	0	0	0	0	0	0	0	0	0
48	48	880419	200	.	.	.	.	.	.	.	.	.	.	.	.	.
49	49	880419	600	.	.	.	.	.	.	.	.	.	.	.	.	.
50	50	880419	1000	0	0	0	0	0	0	0	0	0	0	0	0	0
51	51	880419	1400	0	0	1	0	0	0	1	0	1	0	0	0	0
52	52	880419	1800	0	0	0	0	0	0	0	0	0	0	0	0	0
53	53	880419	2200	0	0	0	0	0	0	0	0	0	0	0	0	0
54	54	880420	200	.	.	.	.	.	.	.	.	.	.	.	.	.
55	55	880420	600	.	.	.	.	.	.	.	.	.	.	.	.	.
56	56.0	880420	1013	0	1	0	0	0	0	0	0	0	0	0	0	0
57	57.0	880420	1434	0	0	1	0	0	0	0	0	0	0	0	0	0
58	58.0	880420	1800	.	.	.	.	.	.	.	.	.	.	.	.	.
59	59.0	880420	2200	.	.	.	.	.	.	.	.	.	.	.	.	.
60	60.0	880421	200	.	.	.	.	.	.	.	.	.	.	.	.	.
61	61.0	880421	600	.	.	.	.	.	.	.	.	.	.	.	.	.
62	62.0	880421	1000	0	0	0	1	0	0	0	0	0	0	0	0	0
63	63.0	880421	1400	0	1	0	0	0	0	0	0	0	0	0	0	0
64	64.0	880421	1800	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A-4. (Continued)

OBS	PAGE	DATE	TIME	ASURF	AOBL	BSURF	BOBL	ASVIA	AOVIA	BSVIA	BOVIA	ST1	ST2	ST3	ST4	HATCH
65	65.0	880421	2200	0	0	0	0	0	0	0	0	0	0	0	0	0
66	66.0	880422	200	0	0	0	0	0	0	0	0	0	0	0	0	0
67	67.0	880422	600	0	0	0	0	0	0	0	0	0	0	0	0	0
68	68.0	880422	1000	0	0	0	0	0	0	0	0	0	0	0	0	0
69	69.0	880422	1400	0	0	0	0	0	0	0	0	0	0	0	0	0
70	70.0	880422	1800	0	0	0	0	0	0	0	0	0	0	0	0	0
71	71.0	880422	2200	0	0	0	0	0	0	0	0	0	0	0	0	0
72	72.0	880423	200	0	0	0	0	0	0	0	0	0	0	0	0	0
73	73.0	880423	600	0	0	0	0	0	0	0	0	0	0	0	0	0
74	74.0	880423	1000	0	0	0	1	0	0	0	0	0	0	0	0	0
75	76.0	880423	1400	0	0	3	2	0	0	1	0	1	0	0	0	0
76	77.0	880423	1800	0	0	0	0	0	0	0	0	0	0	0	0	0
77	78.0	880423	2200	0	0	0	0	0	0	0	0	0	0	0	0	0
78	79.0	880424	200	0	0	0	0	0	0	0	0	0	0	0	0	0
79	80.0	880424	600	0	0	0	1	0	0	0	0	0	0	0	0	0
80	81.0	880424	1000	0	0	0	0	0	0	0	0	0	0	0	0	0
81	81.1	880424	1400	0	0	0	0	0	0	0	0	0	0	0	0	0
82	81.2	880424	1800	0	0	0	1	0	0	0	0	0	0	0	0	0
83	81.3	880424	2200	0	0	0	0	0	0	0	0	0	0	0	0	0
84	81.4	880425	200	0	0	0	1	0	0	0	0	0	0	0	0	0
85	81.5	880425	600	0	0	0	0	0	0	0	0	0	0	0	0	0
86	82.0	880425	1005	0	0	0	0	0	0	0	0	0	0	0	0	0
87	83.0	880425	1356	0	0	0	0	0	0	0	0	0	0	0	0	0
88	84.0	880425	1800	0	0	0	0	0	0	0	0	0	0	0	0	0
89	85.0	880425	2200	0	0	0	0	0	0	0	0	0	0	0	0	0
90	86.0	880426	200	0	0	0	0	0	0	0	0	0	0	0	0	0
91	87.0	880426	600	0	0	0	0	0	0	0	0	0	0	0	0	0
92	88.0	880426	1000	0	0	0	0	0	0	0	0	0	0	0	0	0
93	89.0	880426	1400	0	0	0	0	0	0	0	0	0	0	0	0	0
94	90.0	880426	1800	0	0	0	0	0	0	0	0	0	0	0	0	0
95	91.0	880426	2200	3	1	1	0	0	0	0	0	0	0	0	0	0
96	92.0	880427	200	0	0	0	0	0	0	0	0	0	0	0	0	0
97	93.0	880427	600	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A-4. (Continued)

OBS	PAGE	DATE	TIME	ASURF	AOBL	BSURF	BOBL	ASVIA	AOVIA	BSVIA	BOVIA	ST1	ST2	ST3	ST4	HATCH
98	94.0	880427	1000	0	0	0	0	0	0	0	0	0	0	0	0	0
99	95.0	880427	1400	0	0	0	0	0	0	0	0	0	0	0	0	0
100	96.0	880427	1800	0	0	0	0	0	0	0	0	0	0	0	0	0
101	97.0	880427	2200	0	0	0	0	0	0	0	0	0	0	0	0	0
102	98.0	880428	200	0	0	0	0	0	0	0	0	0	0	0	0	0
103	99.0	880428	600	0	0	0	2	0	0	0	1	1	0	0	0	0
104	100.0	880428	1000	1	1	0	3	1	0	0	0	1	0	0	0	0
105	101.0	880428	1400	0	0	0	0	0	0	0	0	0	0	0	0	0
106	102.0	880428	1800	0	0	0	0	0	0	0	0	0	0	0	0	0
107	103.0	880428	2200	0	0	0	0	0	0	0	0	0	0	0	0	0
108	104.0	880429	200	0	0	0	0	0	0	0	0	0	0	0	0	0
109	105.0	880429	600	0	0	0	0	0	0	0	0	0	0	0	0	0
110	106.0	880429	1000	0	0	0	0	0	0	0	0	0	0	0	0	0
111	107	880429	1400	0	0	0	0	0	0	0	0	0	0	0	0	0
112	108	880429	1800	0	0	0	0	0	0	0	0	0	0	0	0	0
113	109	880429	2200	0	0	0	0	0	0	0	0	0	0	0	0	0
114	110	880430	200	0	0	0	0	0	0	0	0	0	0	0	0	0
115	111	880430	600	0	0	0	0	0	0	0	0	0	0	0	0	0
116	112	880430	1000	0	0	0	0	0	0	0	0	0	0	0	0	0
117	113	880430	1400	0	0	0	0	0	0	0	0	0	0	0	0	0
118	114	880430	1800	1	1	1	0	0	0	0	0	0	0	0	0	0
119	115	880430	2200	0	0	0	0	0	0	0	0	0	0	0	0	0
120	116	880501	200	0	0	0	0	0	0	0	0	0	0	0	0	0
121	117	880501	600	0	0	0	0	0	0	0	0	0	0	0	0	0
122	118	880501	1000	0	0	0	0	0	0	0	0	0	0	0	0	0
123	119	880501	1400	1	0	0	0	0	0	0	0	0	0	0	0	0
124	120	880501	1800	0	0	0	0	0	0	0	0	0	0	0	0	0
125	121	880501	2200	0	0	0	0	0	0	0	0	0	0	0	0	0
126	122	880502	200	0	0	0	0	0	0	0	0	0	0	0	0	0
127	123	880502	600	0	0	0	0	0	0	0	0	0	0	0	0	0
128	124	880502	1000	9	5	5	3	0	0	1	0	0	1	0	0	0
129	125	880502	1400	0	0	0	0	0	0	0	0	0	0	0	0	0
130	126	880502	1800	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A-4. (Continued)

OBS	PAGE	DATE	TIME	ASURF	AOBL	BSURF	BOBL	ASVIA	AOVIA	BSVIA	BOVIA	ST1	ST2	ST3	ST4	HATCH
131	127	880502	2200	0	0	0	0	0	0	0	0	0	0	0	0	0
132	128	880503	200	0	0	0	0	0	0	0	0	0	0	0	0	0
133	129	880503	600	0	1	0	0	0	0	0	0	0	0	0	0	0
134	130	880503	1000	0	0	0	0	0	0	0	0	0	0	0	0	0
135	131	880503	1400	0	0	0	0	0	0	0	0	0	0	0	0	0
136	132	880503	1800	0	0	0	0	0	0	0	0	0	0	0	0	0
137	133	880503	2200	0	0	0	0	0	0	0	0	0	0	0	0	0
138	134	880504	200	0	0	0	0	0	0	0	0	0	0	0	0	0
139	135	880504	600	0	0	0	0	0	0	0	0	0	0	0	0	0
140	136	880504	1000	0	0	0	0	0	0	0	0	0	0	0	0	0
141	137	880504	1400	0	0	0	0	0	0	0	0	0	0	0	0	0
142	138	880504	1800	.	.	.	.	.	.	.	.	.	.	.	.	.
143	139	880504	2200	0	0	0	0	0	0	0	0	0	0	0	0	0
144	140	880505	200	0	0	0	0	0	0	0	0	0	0	0	0	0
145	141	880505	600	0	0	0	0	0	0	0	0	0	0	0	0	0
146	142	880505	1000	0	0	2	0	0	0	0	0	0	0	0	0	0
147	143	880505	1400	0	0	0	1	0	0	0	0	0	0	0	0	0
148	143	880505	1800	0	0	0	0	0	0	0	0	0	0	0	0	0
149	143	880505	2200	0	0	0	0	0	0	0	0	0	0	0	0	0
150	144	880506	200	0	0	0	0	0	0	0	0	0	0	0	0	0
151	145	880506	600	0	0	0	0	0	0	0	0	0	0	0	0	0
152	146	880506	1000	0	0	0	0	0	0	0	0	0	0	0	0	0
153	147	880506	1400	0	0	0	0	0	0	0	0	0	0	0	0	0
154	148	880506	1800	0	0	0	0	0	0	0	0	0	0	0	0	0
155	149	880506	2200	0	0	0	0	0	0	0	0	0	0	0	0	0
156	150	880507	200	0	0	0	0	0	0	0	0	0	0	0	0	0
157	151	880507	600	0	0	0	0	0	0	0	0	0	0	0	0	0
158	152	880507	1000	0	0	0	0	0	0	0	0	0	0	0	0	0
159	153	880507	1400	0	0	0	0	0	0	0	0	0	0	0	0	0
160	154	880507	1800	0	0	0	0	0	0	0	0	0	0	0	0	0
161	155	880507	2200	1	1	0	0	0	0	0	0	0	0	0	0	0
162	156	880508	200	0	0	0	0	0	0	0	0	0	0	0	0	0
163	157	880508	600	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A-4. (Continued)

OBS	PAGE	DATE	TIME	ASURF	AOBL	BSURF	BOBL	ASVIA	AOVIA	BSVIA	BOVIA	ST1	ST2	ST3	ST4	HATCH
164	158	880508	1000	0	0	1	0	0	0	0	0	0	0	0	0	0
165	159	880508	1400	0	0	1	1	0	0	0	0	0	0	0	0	0
166	160	880508	1800	0	0	0	0	0	0	0	0	0	0	0	0	0
167	161	880508	2200	0	0	0	0	0	0	0	0	0	0	0	0	0
168	162	880509	200	0	0	0	0	0	0	0	0	0	0	0	0	0
169	163	880509	600	0	0	0	0	0	0	0	0	0	0	0	0	0
170	164	880509	1000	0	1	0	2	0	0	0	0	0	0	0	0	0
171	165	880509	1400	28	17	15	15	16	10	5	7	0	2	14	0	0
172	166	880509	1800	2	2	1	8	2	1	0	7	0	0	7	0	0
173	167	880509	2200	2	2	1	7	2	1	0	6	0	0	6	0	0
174	168	880510	200	2	5	4	6	2	4	2	3	0	3	0	0	0
175	169	880510	600	0	0	0	0	0	0	0	0	0	0	0	0	0
176	170	880510	1000	0	2	4	3	0	0	0	1	0	1	0	0	0
177	171	880510	1400	17	12	12	3	5	3	4	1	6	7	0	0	0
178	172	880510	1800	11	6	23	9	2	3	15	1	1	20	0	0	0
179	173	880510	2200	25	17	22	15	22	15	20	14	1	60	0	0	0
180	174	880511	200	7	8	4	7	4	6	3	3	0	16	0	0	0
181	175	880511	600	13	11	14	10	11	7	10	8	3	33	0	0	0
182	176	880511	1000	84	65	53	68	44	23	22	48	20	72	0	0	0
183	177	880511	1400	233	310	171	303	153	.	.	242	10	70	73	0	0
184	178	880511	1800	1819	1994	1867	1873	1639	1654	.	.	0	0	821	818	0
185	179	880511	2200	1147	1098	996	709	996	.	.	600	0	60	420	120	0
186	180	880512	200	193	214	118	190	.	187	98	164	0	8	83	7	0
187	181	880512	600	22	113	99	26	.	96	74	21	0	0	74	0	0
188	182	880512	1000	186	141	147	67	167	111	124	54	0	18	149	0	0
189	183	880512	1400	136	145	139	79	125	127	115	59	0	8	131	0	0
190	184	880512	1800	174	170	120	183	150	160	97	164	0	49	115	0	0
191	185	880512	2200	16	25	19	16	12	21	13	13	0	0	12	0	0
192	186	880513	200	20	12	15	11	17	10	11	11	0	12	3	0	0
193	187	880513	600	19	24	23	14	18	24	18	13	0	11	8	0	0
194	188	880513	1000	60	43	31	28	56	32	27	25	0	54	2	0	0
195	188	880513	1400	57	58	40	43	50	57	35	38	0	0	34	0	0
196	189	880513	1800	36	32	27	35	32	30	22	33	0	0	32	0	0

Table A-4. (Continued)

OBS	PAGE	DATE	TIME	ASURF	AOBL	BSURF	BOBL	ASVIA	AOVIA	BSVIA	BOVIA	ST1	ST2	ST3	ST4	HATCH
197	190	880513	2200	7	8	9	12	6	8	9	12	0	0	12	0	0
198	191	880514	200	11	22	10	18	11	20	10	16	1	15	0	0	0
199	192	880514	600	23	6	14	10	20	6	13	9	8	1	0	0	0
200	193	880514	1000	66	81	57	87	61	76	54	79	0	5	56	0	0
201	194	880514	1400	53	59	29	53	40	55	23	32	0	11	21	0	0
202	195	880514	1800	41	27	41	30	37	27	37	30	0	3	34	0	0
203	196	880514	2200	21	33	10	25	14	30	7	9	0	0	30	0	0
204	197	880515	200	91	109	93	114	85	100	84	105	0	0	85	0	0
205	198	880515	600	215	223	208	237	202	210	191	215	0	27	175	0	0
206	199	880515	1000	345	562	231	418	332	522	222	369	0	0	332	0	0
207	200	880515	1400	568	482	549	468	528	452	512	435	0	0	471	41	0
208	201	880515	1800	276	325	273	205	256	305	261	187	0	0	187	0	0
209	202	880515	2200	200	184	211	180	180	151	185	162	0	112	73	0	0
210	203	880516	200	105	135	135	138	99	124	127	130	0	79	14	0	6
211	204	880516	600	170	242	219	251	150	228	211	216	0	169	42	0	0
212	205	880516	1000	226	256	214	234	214	238	179	201	0	61	118	22	0
213	206	880516	1400	101	127	74	131	92	112	66	117	0	12	105	0	0
214	207	880516	1800	94	66	51	17	84	53	45	13	0	0	11	55	0
215	208	880516	2200	.	.	.	.	.	.	.	.	.	.	.	.	.
216	209	880516	200	13	27	9	28	11	25	9	26	0	0	26	0	0
217	210	880517	600	14	21	12	7	12	16	10	4	0	0	14	2	0
218	211	880517	1000	24	12	22	19	22	12	17	17	0	0	22	0	0
219	212	880517	1400	30	33	9	27	28	30	9	20	0	0	30	0	0
220	213	880517	1800	15	15	7	31	15	15	6	27	0	1	14	0	0
221	214	880517	2200	6 p	6	1	11	5	6	1	11	0	0	11	0	0
222	215	880518	200	0	0	0	0	0	0	0	0	0	0	0	0	0
223	216	880518	600	2	0	0	0	0	0	0	0	0	0	0	0	0
224	217	880518	1000	41	36	17	41	41	36	7	38	0	34	11	0	0
225	218	880518	1400	122	109	81	127	120	105	79	123	0	0	122	0	0
226	219	880518	1800	58	64	79	77	55	63	74	75	0	0	58	0	0
227	220	880518	2200	24	18	25	17	20	16	22	14	0	0	18	2	0
228	221	880519	200	0	0	0	0	0	0	0	0	0	0	0	0	0
229	222	880519	600	10	7	8	9	7	6	7	8	0	7	0	0	0

Table A-4. (Continued)

OBS	PAGE	DATE	TIME	ASURF	AOBL	BSURF	BOBL	ASVIA	AOVIA	BSVIA	BOVIA	ST1	ST2	ST3	ST4	HATCH
230	223	880519	1000	33	23	36	30	30	21	21	27	0	21	9	0	0
231	224	880519	1400	27	61	31	49	27	59	30	49	0	35	14	0	0
232	225	880519	1800	29	36	35	75	27	30	32	71	0	30	2	0	0
233	226	880519	2200	42	53	62	41	37	49	55	35	0	0	35	0	0
234	227	880520	200	.	.	.	.	.	.	.	.	.	.	.	.	.
235	228	880520	600	222	220	236	152	207	206	221	127	0	52	155	0	0
236	229	880520	1000	363	655	334	626	.	.	.	.	.	.	.	.	.
237	230	880520	1400	324	257	335	264	311	240	325	249	0	33	278	0	0
238	231	880520	1800	90	91	94	96	79	88	82	89	.	.	.	.	.
239	232	880520	2200	72	83	77	89	63	73	67	78	0	0	73	0	0
240	233	880521	200	.	.	.	.	.	.	.	.	.	.	.	.	.
241	234	880521	600	33	40	37	44	28	34	31	37	0	7	30	0	0
242	235	880521	1000	4	33	7	16	3	25	5	10	0	0	33	0	0
243	236	880521	1400	7	13	24	21	7	11	23	17	0	0	21	0	0
244	237	880521	1800	8	14	7	18	7	8	6	14	0	0	8	0	0
245	238	880521	2200	11	15	10	19	8	10	7	14	0	0	19	0	0
246	239	880522	200	.	.	.	.	.	.	.	.	.	.	.	.	.
247	240	880522	600	21	23	43	39	20	21	41	34	0	0	34	0	0
248	241	880522	1000	3	18	5	38	2	15	3	30	0	0	15	0	0
249	242	880522	1400	32	46	37	25	28	41	29	16	0	0	16	0	0
250	243	880522	1800	54	31	59	37	52	23	56	30	0	0	30	0	0
251	244	880522	2200	26	43	31	39	21	36	24	33	0	0	24	0	0
252	245	880523	200	29	47	36	43	25	42	30	39	0	0	42	0	0
253	246	880523	600	10	59	36	49	8	51	30	43	0	3	40	0	0
254	247	880523	1000	190	185	164	176	187	182	152	169	0	0	187	0	0
255	248	880523	1400	107	148	164	158	98	145	150	128	0	0	98	0	0
256	249	880523	1800	33	31	36	39	32	29	35	38	0	0	20	15	0
257	250	880523	2200	23	34	28	39	20	29	24	35	0	0	22	1	0
258	251	880524	200	30	36	32	44	26	32	28	38	0	0	19	13	0
259	252	880524	600	664	628	620	591	628	603	592	561	0	0	589	29	0
260	253	880524	1000	320	314	300	329	289	285	273	293	0	0	64	225	0
261	254	880524	1400	25	22	29	34	23	20	26	29	0	0	720	16	0
262	255	880524	1800	3	.	3	.	2	.	2	.	0	0	2	0	0

Table A-4. (Continued)

OBS	PAGE	DATE	TIME	ASURF	AOBL	BSURF	BOBL	ASVIA	AOVIA	BSVIA	BOVIA	ST1	ST2	ST3	ST4	HATCH
263	256	880524	2200	3	7	4	9	3	7	3	8	0	0	3	0	0
264	257	880525	200	1	5	2	7	1	4	2	6	0	0	4	0	0
265	258	880525	600	7	13	6	8	7	10	6	6	0	0	7	0	0
266	259	880525	1000	14	11	13	10	14	9	12	9	0	1	11	0	0
267	260	880525	1400	.	.	.	.	.	.	.	.	.	.	.	.	.
268	261	880525	1800	0	0	1	2	0	0	1	2	0	0	2	0	0
269	262	880525	2200	1	0	0	2	0	0	0	0	0	0	0	0	0
270	263	880526	200	0	0	0	0	0	0	0	0	0	0	0	0	0
271	264	880526	600	23	20	19	27	22	20	19	27	0	0	26	0	0
272	265	880526	1000	41	54	53	53	41	53	52	52	0	0	41	0	0
273	266	880526	1400	21	19	20	27	21	19	17	26	0	0	17	0	0
274	267	880526	1800	2	1	1	2	0	0	1	0	0	0	0	0	0
275	268	880526	2200	0	0	0	0	0	0	0	0	0	0	0	0	0
276	269	880527	200	0	0	0	0	0	0	0	0	0	0	0	0	0
277	270	880527	600	0	0	0	0	0	0	0	0	0	0	0	0	0
278	271	880527	1000	0	0	0	0	0	0	0	0	0	0	0	0	0
279	272	880527	1400	4	2	3	2	2	2	3	0	0	3	0	0	0
280	273	880527	1800	0	1	0	1	0	1	0	0	0	0	1	0	0
281	274	880527	2200	0	0	1	0	0	.	1	.	0	0	1	0	0
282	275	880528	200	.	.	.	.	.	.	.	.	.	.	.	.	.
283	276	880528	600	0	0	7	8	0	0	6	6	6	0	0	0	0
284	277	880528	1000	7	3	3	5	5	2	3	4	0	3	1	0	0
285	278	880528	1400	3	4	1	1	2	3	1	1	0	0	2	0	0
286	279	880528	1800	0	0	0	0	0	0	0	0	0	0	0	0	0
287	280	880528	2200	0	0	0	0	0	0	0	0	0	0	0	0	0
288	281	880529	200	.	.	.	.	.	.	.	.	.	.	.	.	.
289	281	880529	600	0	0	0	0	0	0	0	0	0	0	0	0	0
290	282	880529	1000	0	0	0	0	0	0	0	0	0	0	0	0	0
291	283	880529	1400	41	47	30	54	39	43	27	51	0	0	51	0	0
292	284	880529	1800	1	0	2	1	1	0	1	1	0	0	1	0	0
293	285	880529	2200	0	0	0	0	0	0	0	0	0	0	0	0	0
294	286	880530	200	.	.	.	.	.	.	.	.	.	.	.	.	.
295	287	880530	600	.	.	.	.	.	.	.	.	.	.	.	.	.

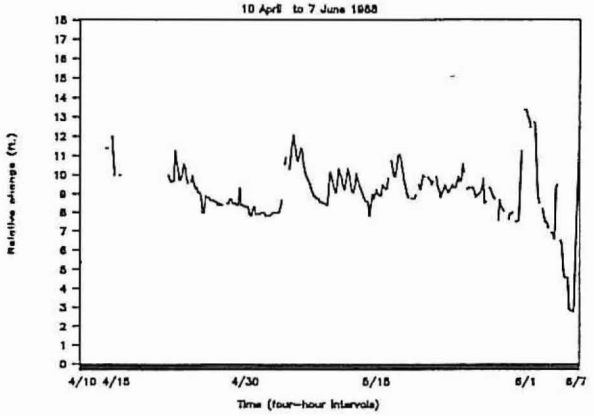
Table A-4. (Continued)

OBS	PAGE	DATE	TIME	ASURF	AOBL	BSURF	BOBL	ASVIA	AOVIA	BSVIA	BOVIA	ST1	ST2	ST3	ST4	HATCH
296	288	880530	1000	0	0	2	0	0	0	0	0	.	.	.	.	.
297	289	880530	1400	0	0	0	0	0	0	0	0	.	.	.	.	.
298	290	880530	1800.	0	0	0	0	0	0	0	0	.	.	.	.	.
299	291	880530	2200	0	0	0	0	0	0	0	0	.	.	.	.	.
300	292	880531	200	.	.	.	.	.	.	.	.	.	.	.	.	.
301	293	880531	600	2	0	1	1	2	0	1	0	0	0	2	0	0
302	294	880531	1000	3	19	0	0	2	19	0	0	0	0	0	19	0
303	295	880531	1400	3	2	2	3	2	1	0	2	0	0	2	0	0
304	296	880531	1800	2	1	1	0	2	0	0	0	0	0	2	0	0
305	297	880531	2200	0	0	0	0	0	0	0	0	0	0	0	0	0
306	298	880601	200	.	.	.	.	.	.	.	.	.	.	.	.	.
307	299	880601	600	2	1	2	1	2	1	0	1	0	2	0	0	0
308	300	880601	1000	1	0	0	1	0	0	0	1	0	0	1	0	0
309	301	880601	1400	1	0	0	0	1	0	0	0	0	0	1	0	0
310	302	880601	1800	2	0	3	1	1	0	2	1	0	0	1	0	0
311	303	880601	2200	0	0	0	0	0	0	0	0	0	0	0	0	0
312	304	880602	200	.	.	.	.	.	.	.	.	.	.	.	.	.
313	305	880602	600	0	0	0	0	0	0	0	0	0	0	0	0	0
314	306	880602	1000	1	6	2	0	1	5	2	0	0	0	5	0	0
315	307	880602	1400	0	0	0	0	0	0	0	0	0	0	0	0	0
316	308	880602	1800	0	0	0	0	0	0	0	0	0	0	0	0	0
317	309	880602	2200	0	0	0	0	0	0	0	0	0	0	0	0	0
318	310	880603	200	.	.	.	.	.	.	.	.	.	.	.	.	.
319	311	880603	600	0	0	0	0	0	0	0	0	0	0	0	0	0
320	312	880603	1000	0	0	0	0	0	0	0	0	0	0	0	0	0
321	313	880603	1400	0	0	0	0	0	0	0	0	.	.	.	.	.
322	314	880603	1800	0	0	0	0	0	0	0	0	.	.	.	.	.
323	315	880603	2200	0	0	0	0	0	0	0	0	0	0	0	0	0
324	316	880607	600	.	.	.	.	.	.	.	.	.	.	.	.	.
325	317	880604	600	0	0	0	0	0	0	0	0	.	.	.	.	.
326	318	880604	1000	0	0	0	0	0	0	0	0	.	.	.	.	.
327	319	880604	1400	0	0	0	0	0	0	0	0	.	.	.	.	.
328	320	880604	1800	0	0	0	0	0	0	0	0	.	.	.	.	.

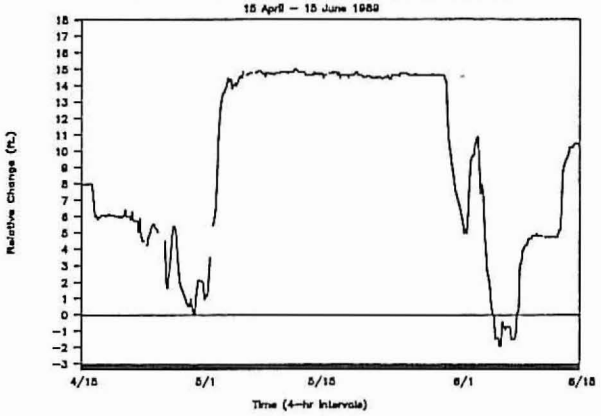
Table A-4. (Continued)

OBS	PAGE	DATE	TIME	ASURF	AOBL	BSURF	BOBL	ASVIA	AOVIA	BSVIA	BOVIA	ST1	ST2	ST3	ST4	HATCH
329	321	880604	2200	0	0	0	0	0	0	0	0	.	.	.	.	.
330	322	880605	200	.	.	.	.	.	.	.	.	.	.	.	.	.
331	323	880605	600	0	0	0	0	0	0	0	0	.	.	.	.	.
332	324	880605	1000	0	0	0	0	0	0	0	0	0	0	0	0	0
333	325	880605	1400	0	0	0	0	0	0	0	0	0	0	0	0	0
334	326	880605	1800	0	0	0	0	0	0	0	0	.	.	.	.	.
335	327	880605	2200	0	0	0	0	0	0	0	0	.	.	.	.	.
336	328	880606	200	0	0	0	0	0	0	0	0	.	.	.	.	.
337	329	880606	600	0	0	0	0	0	0	0	0	.	.	.	.	.
338	330	880606	1000	0	0	0	0	0	0	0	0	.	.	.	.	.
339	331	880606	1400	0	0	0	0	0	0	0	0	.	.	.	.	.
340	332	880606	1800	0	0	0	0	0	0	0	0	.	.	.	.	.
341	333	880606	2200	0	0	0	0	0	0	0	0	.	.	.	.	.
342	334	880607	200	0	0	0	0	0	0	0	0	.	.	.	.	.
343	335	880607	600	0	0	0	0	0	0	0	0	.	.	.	.	.
344	336	880607	1000	0	0	0	0	0	0	0	0	.	.	.	.	.

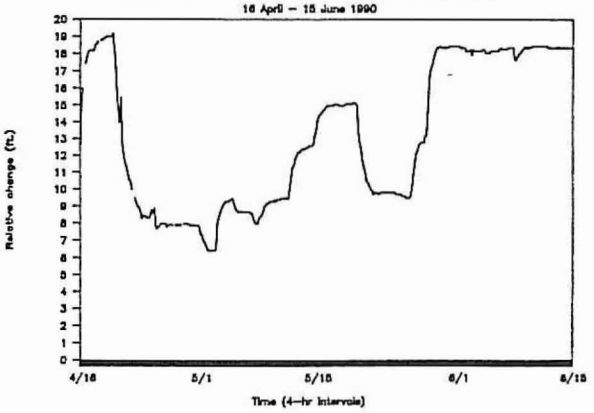
RIVER STAGE AT POLLOCK'S FERRY



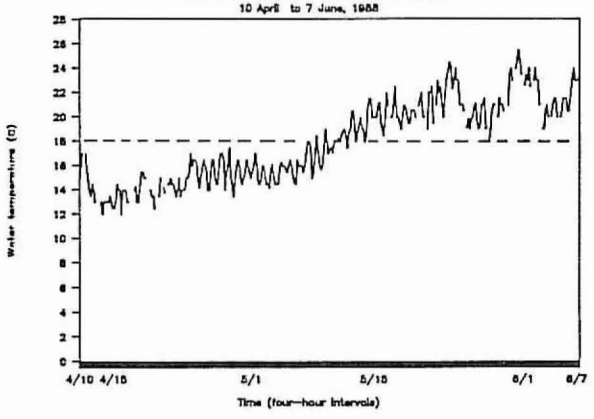
RIVER STAGE AT BARNHILL'S LANDING



RIVER STAGE AT BARNHILL'S LANDING



WATER TEMPERATURE (C)



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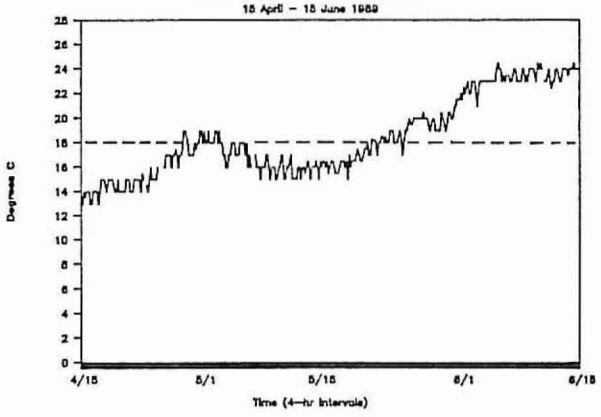
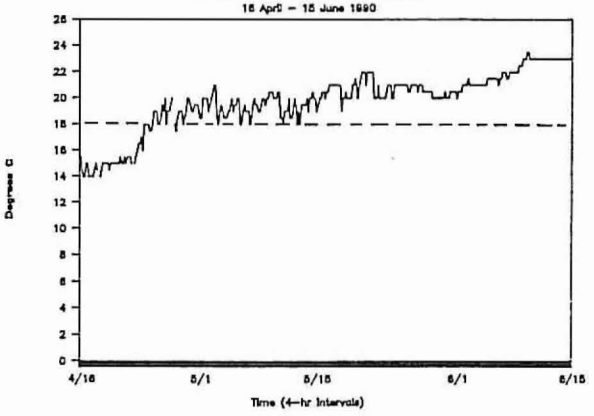
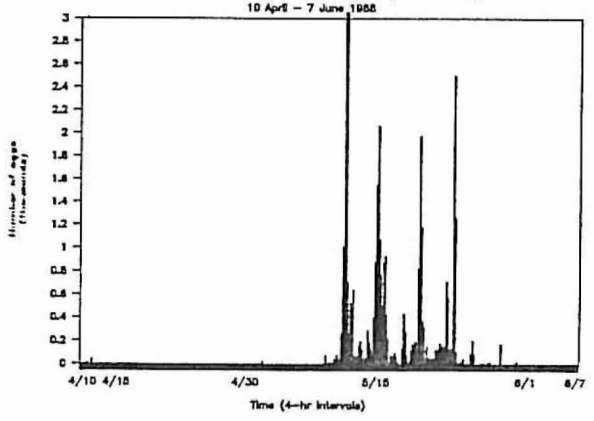


WATER TEMPERATURE



TOTAL EGGS PER TRIP (all nets)



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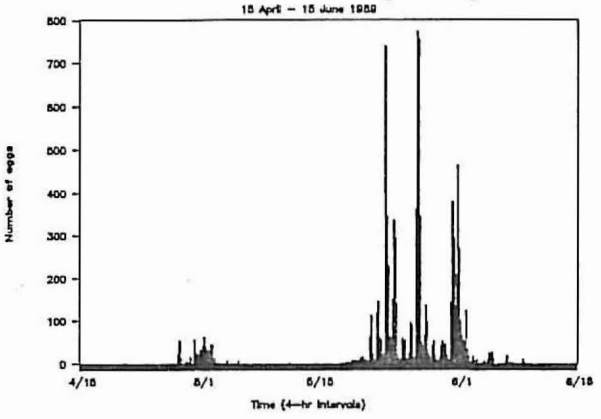
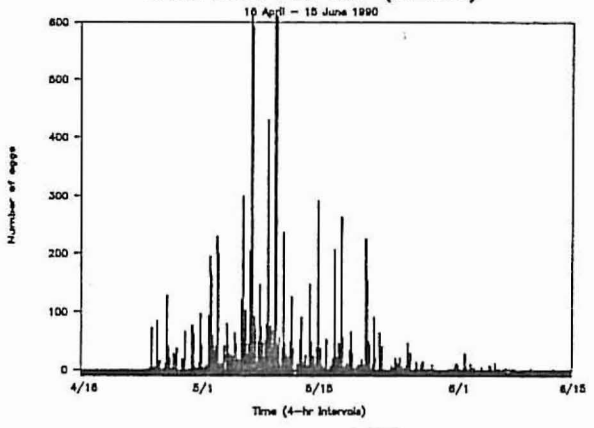


TOTAL EGGS PER TRIP (all nets)



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