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Abundance, Density and Composition of Ichthyoplankton of the Connecticut River Near Vernon, Vermont

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ABUNDANCE AND COMPOSITION OF ICHTHYOPLANKTON OF THE CONNECTICUT RIVER NEAR VERNON, VERMONT

ABSTRACT

Ichthyoplankton sampling was conducted from 1982-1989 at discrete depths at established stations in the Connecticut River near Vernon, Vermont. Nearly 37,000 ichthyoplankton representing at least 14 taxa were captured. White perch and minnow larvae represented about 95 percent of the ichthyoplankton. Yellow perch and walleye prolarvae appeared only during a short time period in May, while white perch usually appeared in mid-May and were routinely observed at appreciable densities throughout June and early-July. Minnow larvae were abundant during most of the summer. White perch were most frequently captured in the middle and bottom strata in the water column while the minnow larvae were most often encountered in the near-surface samples. At the Vermont Yankee intake, ichthyoplankton densities were low for the important game fish species indicating that entrainment rates did not result in appreciable harm to the fish community during the study.

INTRODUCTION

Investigations of fishes in the Connecticut River near Vernon, Vermont, conducted as part of the Vermont Yankee Nuclear Power Corporation studies, began in 1968 (Aquatec et seqq. 1972). Initially, biological studies conducted as part of these annual investigations concentrated on the juvenile and adult life stages of the resident fish community, characterizing species composition and fish growth.

In 1974, investigations of ichthyoplankton in Vernon pool were initiated as part of the evaluation of the Vermont Yankee's Phase Testing Program. The sampling during 1974-1977 concentrated on intake ichthyoplankton sampling. Larval fish collected during these studies were enumerated and intake densities reported by Binkerd et al. (1978). The taxonomy of the larval fishes was not conducted.

In 1982, an intensive investigation of ichthyoplankton was undertaken at the intake and at various locations in the Connecticut River, both upstream and downstream of Vernon Dam (Binkerd et al. 1983).

These studies evaluated the composition of ichthyoplankton in Vernon pool and the techniques for collecting and characterizing the larval fish community. These studies have continued since 1982 using the developed techniques of the 1982 study. The objective of this bulletin is to examine the information obtained during the annual ichthyoplankton monitoring for trends in larval fish distribution and the relationship between this distribution and Vermont Yankee's summer operation.

METHODS

The larval fish study area included stations in the Vernon pool and the upper Turners Falls pool (Figure 32.1). Each station was sampled along predetermined transects at multiple depths using one-half meter conical Nitex nylon plankton nets. The mesh size was 363 microns, providing a 46 percent open area in the net body. Typically, a 114 millimeter (mm) diameter straining bucket covered with mesh (either stainless steel or Nitex) with nominal 369 micron mesh or smaller. Flow through the nets was determined with an Inter-ocean Systems Model 313 recording flow meter.

The nets were deployed at various depths (usually surface, and 6 and 12 feet below the surface) and pushed through the water by boat (Figure 32.2). At the completion of sampling at a station, the two samplers on the boat quickly retrieved the three nets, pulling the two nets from the depth to the surface. The time of sampling of each net was recorded to the nearest second. At stations that were too shallow to permit sampling at three depths (such as Station 4-VT and Station 4-NH) only those nets which could be set (i.e., surface and/or six feet deep) were deployed. In 1982, a diurnal study was conducted (Binkerd et al. 1983) and day/night differences were not detected. As a result, ichthyoplankton collection was routinely conducted from 8:00 a.m. to 5:00 p.m. during the 1983-1989 studies.

The sampling effort at different locations varied during the monitoring effort (Table 32.1). In 1982, an intensive investigation of ichthyoplankton at the intake structure and at various locations in the river was undertaken. Sampling was conducted in both the lower and middle section (as far upstream as Station 8 in Brattleboro, Vermont), of Vernon pool and downstream of Vernon Dam. Ichthyoplankton were collected at various depths during 1982-1985 at the Vermont Yankee intake structure using a variety of gear. This sampling effort included deployment of a one-half meter net in the intake, pumping water from in front of the intake through a net and pushing one-half meter nets through the water column in the river in front of the intake. Binkerd et al. (1983) summarized the evaluation of various equipment used in 1982.

Since 1986, larval fish sampling has focused on sampling at various depths in front of the Vermont Yankee plant using one-half meter nets. During the eight years of sampling, 1982-1989, over 1,800 samples have been collected with a one-half meter net, while 63 seine samples using a 500 micron mesh have been obtained.

All retrieved nets were washed immediately and the contents preserved in five percent formalin. Ichthyoplankton were later separated from debris in the laboratory using a dissecting microscope at ten magnification. Larval fish were identified to the lowest feasible taxonomic level with the aid of published larval keys: Norden (1961), Mansueti and Hardy (1967), Lippson and Moran (1974), Hogue and Buchanan (1976), Jones et al. (1978), Wang and Kernehan (1979), and Auer (1982).

RESULTS

Species Composition

Nearly 37,000 ichthyoplankton representing 14 fish taxa were collected during the eight years of study (Table 32.2). About 90 percent (33,200 fish) of the ichthyoplankton were captured in the Vernon pool while 10 percent (3,400 fish) were captured in the Turners

Falls pool. Differences in the total number of ichthyoplankton captured in Vernon and Turners Falls pools were primarily the result of the significantly higher sampling effort in Vernon pool. Minnows and white perch were the most abundant ichthyoplankton, representing about 95 percent of the ichthyoplankton collected. Sunfishes, suckers, yellow perch, and walleye were collected consistently, but usually in low numbers.

There was a distinct pattern of seasonal succession of ichthyoplankton observed during the spring to early summer. The yellow perch were typically the earliest fish larvae captured during the beginning of sampling in early to mid-May (Table 32.3). The walleye were the next species to appear and were captured as prolarvae during a two week period, 15 May through 28 May. The suckers appeared during late-May. White perch were collected beginning in mid-May and peaked during late-May and early-June. The minnows were collected beginning in early-June and were the principal ichthyoplankton component during late-June and July.

Percidae

Yellow perch and walleye prolarvae were each only collected during a two to three week time interval, indicating that these two species spawn during a relatively narrow time frame. Both species were captured infrequently during sampling at the Vermont Yankee intake and throughout the river stations.

Walleye densities were very low and more than 90 percent of the larval walleye were captured annually during the last two weeks in May (Table 32.4). Densities of walleye appear to be highest in the mid-depth strata while surface and near bottom samples contained fewer walleye larvae.

Since the walleye are an important game species, the order of magnitude of entrainment was examined further. Using an estimated density of 0.05 per cubic meter occurring during 15 May through 28 May, based upon data presented in Table 32.4, and assuming a maximum intake flow of 800 cubic feet of water per second, a magnitude of walleye entrainment was conservatively estimated at 1.4 million larvae per year. To put this figure into perspective, the fecundity of walleye have been reported to range from 60,000 to 600,000 eggs per female; therefore, between 3 and 23 female walleyes would be needed annually to provide 1.4 million eggs.

White Perch

The white perch represented more than one-third of all ichthyoplankton collected near Vernon, Vermont. These larval fish typically appeared in low densities as early as mid-May, with higher densities being observed beginning in late-May (i.e., densities greater than two fish per ten cubic meters of water sampled) and continuing through June (Figure 32.3). White perch prolarvae were routinely captured in July suggesting that this species does not spawn during a short time period like the Percidae, but the spawning period was protracted, mid-May through mid-July.

White perch larval densities were typically higher in the mid-depth strata and in the bottom strata than in the surface strata (Figure 32.4). Overall densities at various depths at Stations 4 and 5 were comparable with densities observed near the Vermont Yankee intake.

Minnows

Several taxonomic groups of minnows were observed during the study. One minnow group which was probably a Notropis sp., was abundant in samples and these individuals generally dominated the larval minnow densities in the summer time samples. Other minnow taxa

identified included the carp (Cyprinus carpio), golden shiner (Notemogonous crysoleucas), and the silvery minnow (Hybognathus regius). Because the taxonomy of minnow larvae was variable due to the number of minnow species present and the absence of keys to definitively identify all minnow species, the minnow data were grouped at the family level (Cyprinidae).

Minnow larvae began appearing consistently in early-June (Figure 32.5). The density of minnows increased rapidly during June and by late-June densities greater than one larvae per cubic meter of surface water was common. Minnow larvae density remained relatively high through July (and August in 1982) and dominated the ichthyoplankton community during the late summer.

The distribution patterns of minnow ichthyoplankton in the water column was distinct and nearly the opposite of that observed for the white perch. Minnow larvae were most abundant in the surface water samples, while only a few larvae were captured in the mid-strata and bottom (Figure 32.4). Minnow densities near the Vermont Yankee intake were usually less than 0.6 larvae per cubic meter. These densities were typically less than densities observed at Stations 4 and 5 during the same weekly time period.

Minnows were also found to be abundant in shallow, slow-moving, near-shore areas. Seine sampling conducted at Station 3 for American shad (Alosa sapidissima) frequently captured large number of minnow larvae. These high concentrations of minnow larvae were also observed in shallow areas of the Vernon pool, particularly in shallow areas at Station 5-NH. In one seine sample collected at this site, the density of minnow larvae was estimated to be approximately 3,000 larvae per cubic meter of water.

The operation of Vermont Yankee will result in fish being entrained in the circulating water cooling system. The densities of the abundant taxa were relatively low in the intake water and were comparable to densities observed in river samples. Shallow shoreline

areas were generally productive and contained higher densities of ichthyoplankton than mid-river areas. Because of the low densities in the intake samples observed during the eight year sampling program, the effect of entrainment on walleye and other game species, such as smallmouth bass, was determined to be minimal. This conclusion is also supported by the adult and juvenile fish studies conducted during the same time period. The evaluation of ichthyoplankton near Vernon, Vermont indicates that the entrainment of ichthyoplankton through Vermont Yankee's circulating water cooling system did not result in appreciable harm to the fish community during the study.

ACKNOWLEDGMENT

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Table 32.1 Ichthyoplankton sampling effort, number of one-half meter net samples, 1982-1989.

	Depth (ft.)	Year 1982	1983	1984	1985	1986	1987	1988	1989
Station 2									
	<5		8	27	5				
	5-10								
	>10								
Stebbin Island									
	<5				10	6	2	3	
	5-10								
	>10								
Station 3									
	<5	45	28	54	10	7	3	3	
	5-10	18						2	
	>10	9						2	
Station 4									
	<5	98	29	18	10	21	11	2	
	5-10	40	12	18	10	16	6	2	
	>10						2		
VY Boat Launch									
	<5						6		
	5-10						6		
	>10						6		
VY Intake									
	<5	2			1	10	44	12	11
	5-10	37		17	7	10	21	11	11
	>10	127		32	12	3		10	11
Station 5									
	<5	176	64	84	45	33	12	3	
	5-10	123	36	46	43	33	12	3	
	>10	96							
Other Locations		58					15		
Annual Total		829	177	296	153	139	146	53	33

Table 32.2 Relative abundance of ichthyoplankton collected near Vernon, 1982-1989. Vernon fish were obtained from 1,584 samples while Turners Falls fish represented 242 samples.

	Vernon Pool		Turners Falls Pool	
	(No.)	(%)	(No.)	(%)
Clupeidae	2	<0.1	1	<0.1
American shad	15	<0.1	2	0.1
Blueback herring	7	<0.1		
Cyprinidae	4,018	12.1	288	8.5
Common carp	41	0.1	25	0.7
Golden shiner	20	<0.1	3	0.1
Notropis spp.	15,020	45.2	1,828	53.8
Catostomidae	87	0.3	7	0.2
White sucker	541	1.6	23	0.7
White perch	12,348	37.2	1,057	31.1
Centrarchidae	7	<0.1	1	<0.1
Rock bass	1	<0.1		
Lepomis spp.	434	1.3	120	3.5
Smallmouth bass	2	<0.1		
Percidae	11	<0.1		
Tessellated darter	13	<0.1	1	<0.1
Yellow perch	339	1.0	28	0.8
Walleye	225	0.7	9	0.3
Indeterminate	95	0.3	5	0.1
Total	33,226		3,398	

Table 32.3 Earliest and latest dates of capture of ichthyoplankton for four fish species, 1982-1989.

	Date of Capture							
	Smallmouth Bass		White Perch		Walleye		Yellow Perch	
Year	Earliest	Latest	Earliest	Latest	Earliest	Latest	Earliest	Latest
1982	26 Jun	30 Jun	17 May	21 Jul	17 May	09 Jun	11 May	10 Jun
1983	22 Jun	23 Jun	20 May	06 Jul	16 May	23 May	12 May	02 Jun
1984			18 May	11 Jul	14 May	08 Jun	07 May	08 Jun
1985			16 May	11 Jul	14 May	21 May	03 May	21 May
1986			14 May	08 Jul	14 May	20 May	14 May	29 May
1987			14 May	09 Jun			04 May	26 May
1988			16 May	13 Jul			10 May	23 Jun
1989			23 May	14 Jul			12 May	19 May

Table 32.4 Density of walleye larvae collected near the Vermont Yankee circulating water intake structure from 15 May through 28 May, 1982-1989.

Year	Week	Sampling Depth <5 Feet Number/m^3	5 to <10 Feet Number/m^3	>10 Feet Number/m^3
1982	15-21 May			0.013
	22-28 May	0	0	0
1983	15-21 May[1]			
	22-28 May[1]			
1984	15-21 May		0.011	0.010
	22-28 May		0.279	0.126
1985	15-21 May		0.011	0
	22-28 May	0.020	0.110	0.021
1986	15-21 May	0.034	0.243	
	22-28 May	0	0	
1987	15-21 May	0	0	
	22-28 May	0	0	
1988	15-21 May	0	0	0
	22-28 May	0	0	0
1989	15-21 May	0	0	0
	22-28 May	0	0	0

[1] Vermont Yankee was shutdown for routine maintenance, mid-March through late-June.

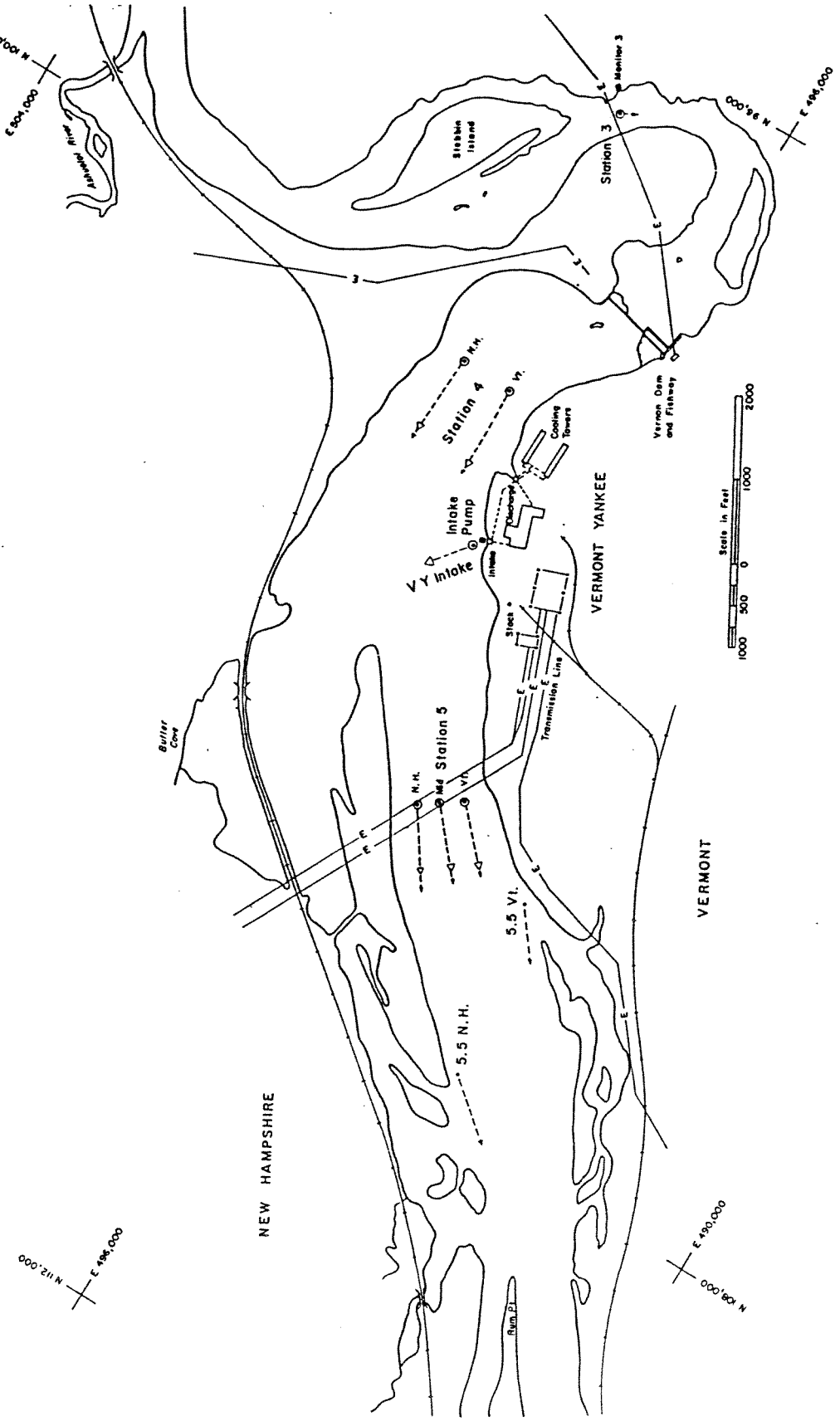

Figure 32.1 Generalized ichthyoplankton sampling locations in Connecticut River near Vernon, Vermont.

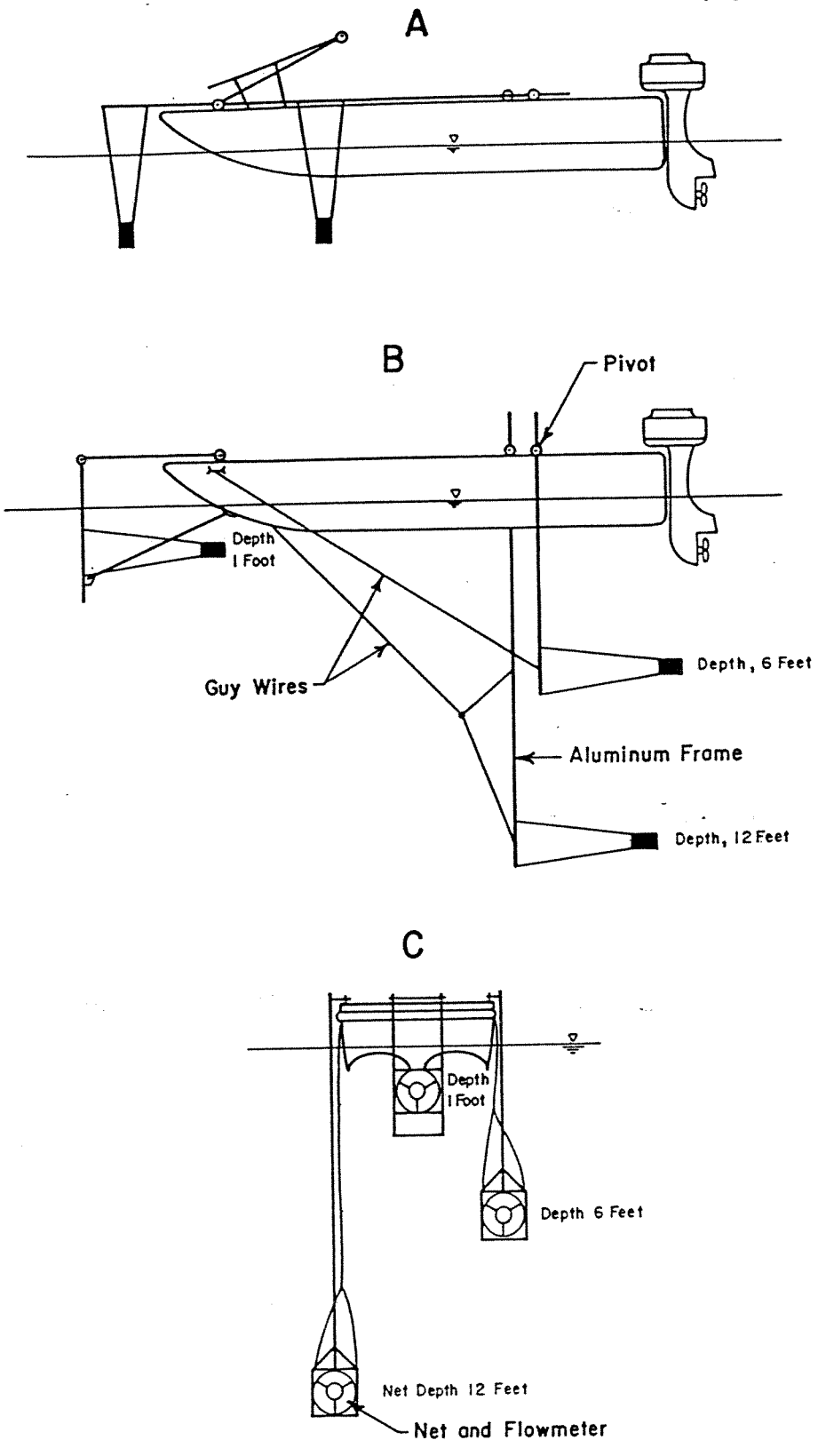

Figure 32.2 Side and front view of the three net sampling apparatus used to sample ichthyoplankton from a boat.

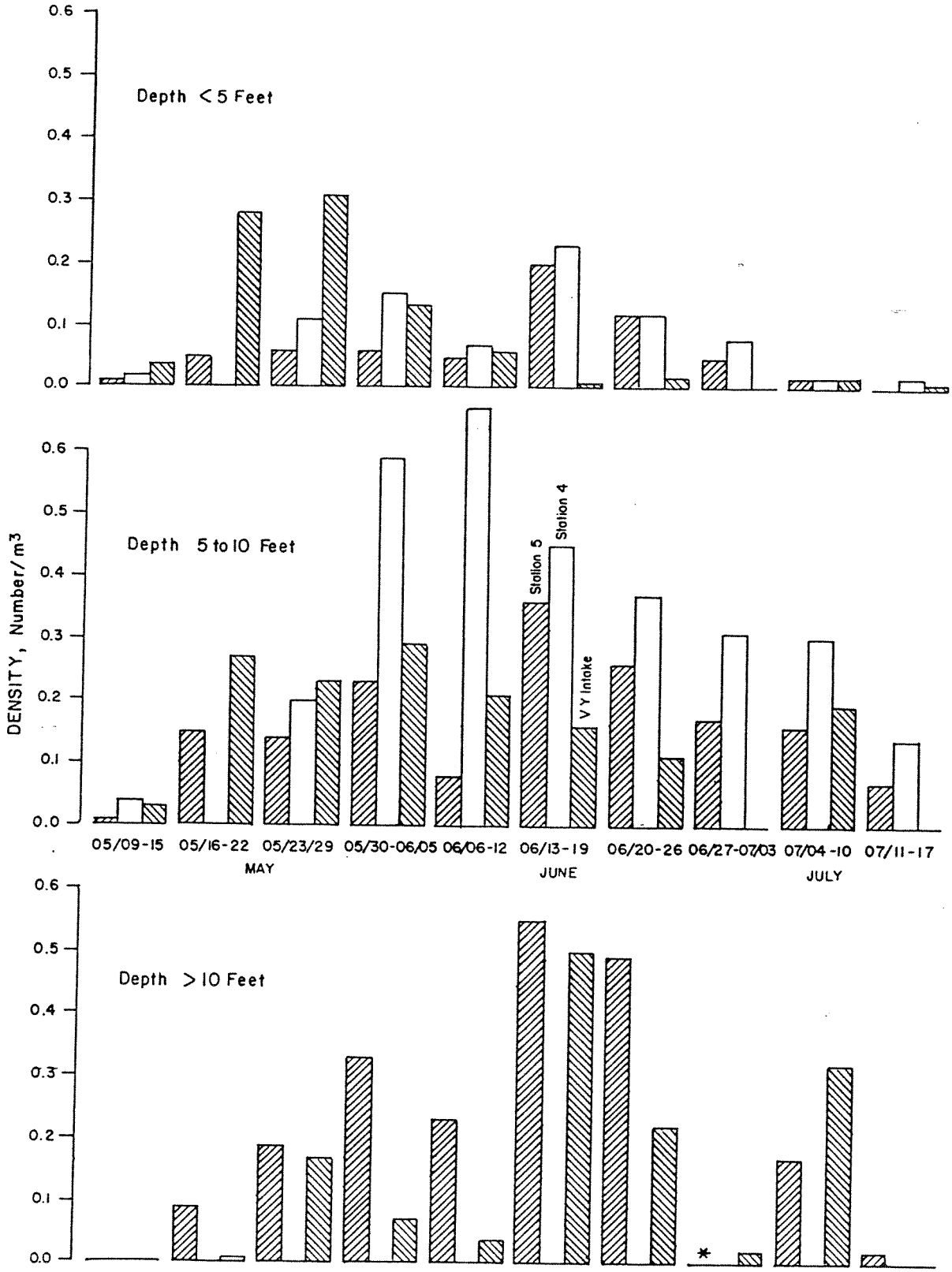

Figure 32.3 Average white perch ichthyoplankton density weekly, 1982-1989

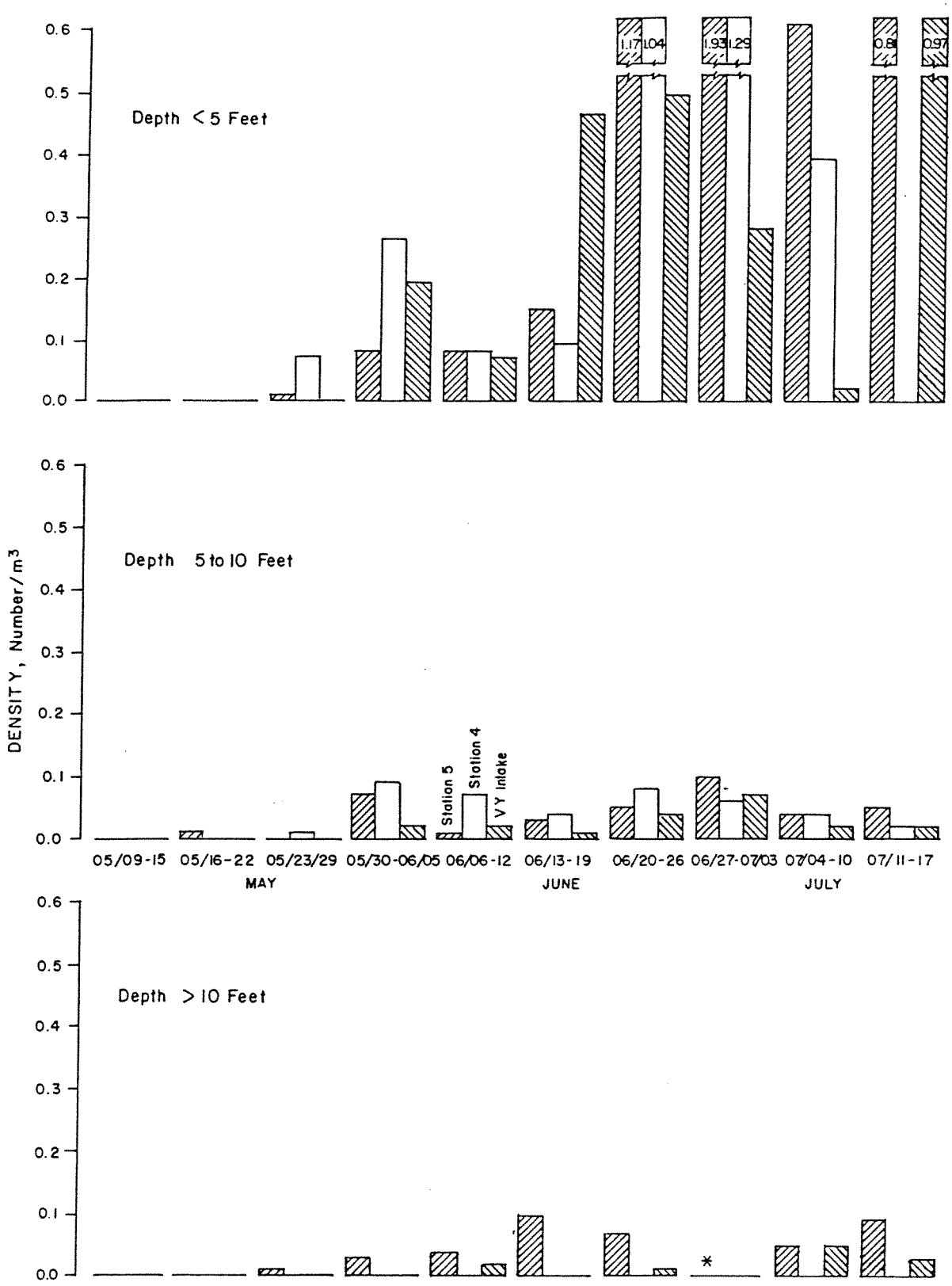

Figure 32.4 Average minnow ichthyoplankton density weekly, 1982 - 1989