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Thermal plume entrainment of ichthyoplankton at the VEPCO Surry Nuclear Power Station : progress report, October 1975

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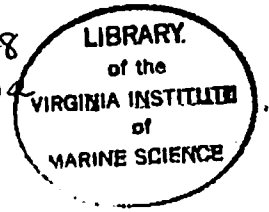
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Thermal Plume Entrainment of Ichthyoplankton
at the VEPCO Surry Nuclear Power Station
Progress Report - October 1975

OCT 29 1975

by

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and

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Introduction

Plume entrainment studies at Vepco Nuclear Power Plant located near Surry, Virginia were initiated in August, 1975 by the Ichthyology department of Virginia Institute of Marine Science. The program was undertaken to define the amount and kinds of fish eggs and larvae that are present in the Cobham Bay area of the James River and become entrained by the heated effluent.

The discharge canal has vertical and horizontal constrictions at the discharge point and was designed to promote rapid mixing of the heated effluent and existing river waters. This was to insure that only a small portion of the river water would be heated to any appreciable degree. Pelagic fish eggs and larvae in the water adjacent to the discharge would be swept into the mixing zone. Larvae and eggs would not be able to overcome the turbulence in the mixing zone and thus would become entrained in the plume.

Species lists and abundance of eggs, larvae, and juvenile fishes captured within and near the thermal plume of Vepco-Surry during August and September sampling periods are presented in this report.

Materials and Methods

Preliminary gear evaluation studies made for the plant entrainment study were reviewed^{1/} and the 0.5 meter bongo unit

^{1/} See Ichthyoplankton Entrainment Study, Progress Report - July 1975.

was selected as the sampling gear for the plume study. The apparatus was equipped with 0.5 meter diameter conical nitex nets of 505 micron mesh. GSI flowmeters were used to record volume of water sampled. A bridle (Figure 1), made with 0.25 inch braided nylon rope was attached to the frame to allow towing behind the boat. The bongo apparatus provided 2 replicate samples for each tow.

Oblique tows of 5 minute duration are made with 3 steps in depth per tow (bottom, midwater, and surface). The nets are fished at each depth for approximately 1 minute and 40 seconds. The boat is run at 900 RPM during tows except in the discharge canal where it is stationary. Sampling sites are 1) discharge canal at the roadway bridge, 2) plume area where temperatures exceeded ambient river temperature by 5 C, and 3) river area where ambient river temperatures existed (Figure 2). Two tows each are made in the thermal plume area and ambient river water area. One tow is made in the discharge canal. Temperature, salinity, and dissolved oxygen readings are taken in the discharge canal, at the end of tow #1 in the heated water plume, and at the end of tow #3 in ambient river waters. Data are taken from surface, midwater, and bottom depths; if water is less than 4 meters deep, then only surface and bottom data are recorded.

Samples are preserved in labelled glass jars with approximately 5% formalin and returned to the laboratory for sorting,

enumeration, and identification. Data are stored in log sheet form and are being prepared as punch cards for ADP. Specimens are stored in vials with 5% buffered formalin for future reference or further study.

Vessels and operators are furnished by VEPCO. Two project personnel are required to conduct the sampling program each trip.

Sampling is conducted during low slack tide or as near to it as possible. A small quantity of fluorescein dye is placed in the heated water just outside of the discharge canal groin to mark the path of the plume into the river. Samples taken in the plume closely follow the path of the dye.

The first sample run was conducted on August 13, 1975, and sampling continued on a weekly basis through August. Two sets of samples were taken during September. When possible, the plume and plant entrainment programs are conducted on the same dates. The sampling schedules for these two programs are given in Table 1. Intensity of sampling reflects the anticipated periods of greatest density of fish eggs and larvae and the seasonal maxima of ambient river water temperatures.

Results and Discussion

This program will show the abundance and kinds of young fishes that are being entrained by the heated water plume from Vepco Surry. Station 1 in the discharge provides documentation of the organisms present in the heated water from the plant. Stations 3 and 4 in an area of ambient water temperature provide documentation of the organisms present in the river proper.

Stations 1 and 2 in the plume provide the data for organisms present after mixing has occurred. Comparison of catches from the three locations provides information on the kinds and abundance of organisms that are entrained into the plume from existing river waters.

Sampling at low slack tide assures that the position of the plume would be similar during all sampling runs, thereby reducing total sampling time per site visit and providing a relatively fixed position and water depth for sampling. At low slack tide the plume usually flows straight out from the discharge canal groin and then bends slightly upriver (Figure 2), apparently due to an eddying effect in this portion of the river. The plume's position does vary slightly due to environmental conditions (i.e., recent rainfall or wind conditions) that affect river flow at any given sampling period.

Fishes captured in the samples were mostly larval and post-larval forms though some juveniles were present. The numbers of organisms captured were quite low (Table 2) presumably since the height of the spawning season (spring and early summer) had passed. The density of individuals captured per tow did not reach one per cubic meter of water strained during sampling periods (Table 3).

Variability of catches among stations and between replicate tows was great. Due to the low densities and high variability in catches reported herein, conclusions as to the extent of plume entrainment at Vepco Surry can not be reached at this

time, nor could statistically valid tests be performed on the data set.

Species captured during August and September were predominately the naked goby, Gobisoma bosci and bay anchovy, Anchoa mitchilli (Table 2). Other species were present in only small numbers. The abundance of gobies in the plume tended to be higher than that in the discharge canal. The August 13 sample was an exception, having twice as many gobies present in the discharge canal as in the plume. The trend of finding higher numbers in the plume does not lead to the conclusion that they are being entrained from ambient river water. Very few gobies have been found in the latter samples.

Bay anchovy were present in all but two collections (September 23 when catches were quite low). Highest numbers were captured during the month of August and catches decreased noticeably in September. On August 13, catches of anchovy remained fairly constant at all sampling sites but variability between replicate samples was high. On August 21, highest numbers were captured in the discharge canal and catches in the plume were the smallest. August 26 samples produced highest numbers at the ambient river station with lowest numbers in the discharge canal indicating that some anchovies may have been swept into the mixing zone. On September 11, highest catches were in the plume with the discharge canal and the existing river sites having very low numbers.

Additional species captured during the sampling to date include tidewater silverside; Menidia beryllina; Atlantic silverside, Menidia menidia; Blueback herring, Alosa aestivalis; and Atlantic croaker, Micropogon undulatus. Eggs of Dorosoma species were found in the discharge canal on August 13.

Dissolved oxygen, salinity, and temperature data from all stations are presented in Table 4.

Few conclusions can be deduced from the existing data. The high degree of variability in the data and small number of samples to date do not reveal substantive trends and preclude meaningful analysis by statistical tests. As sampling continues and a larger volume of data is compiled, more thorough analysis will be performed. These data will be presented in later reports.

Figure 1. 0.5 meter bongo net showing rope bridle.

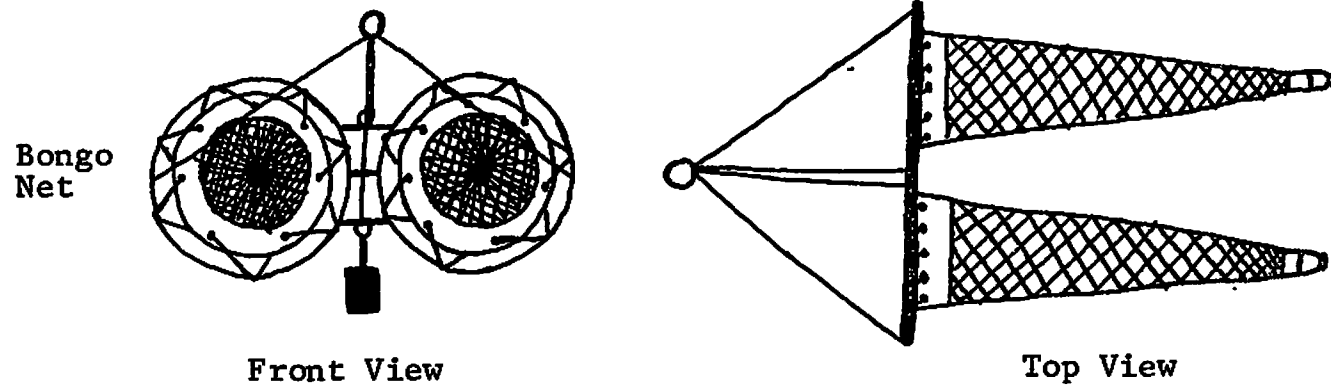


Figure 2. James River in vicinity of Surry Nuclear Power Station showing location of plume entrainment samples.

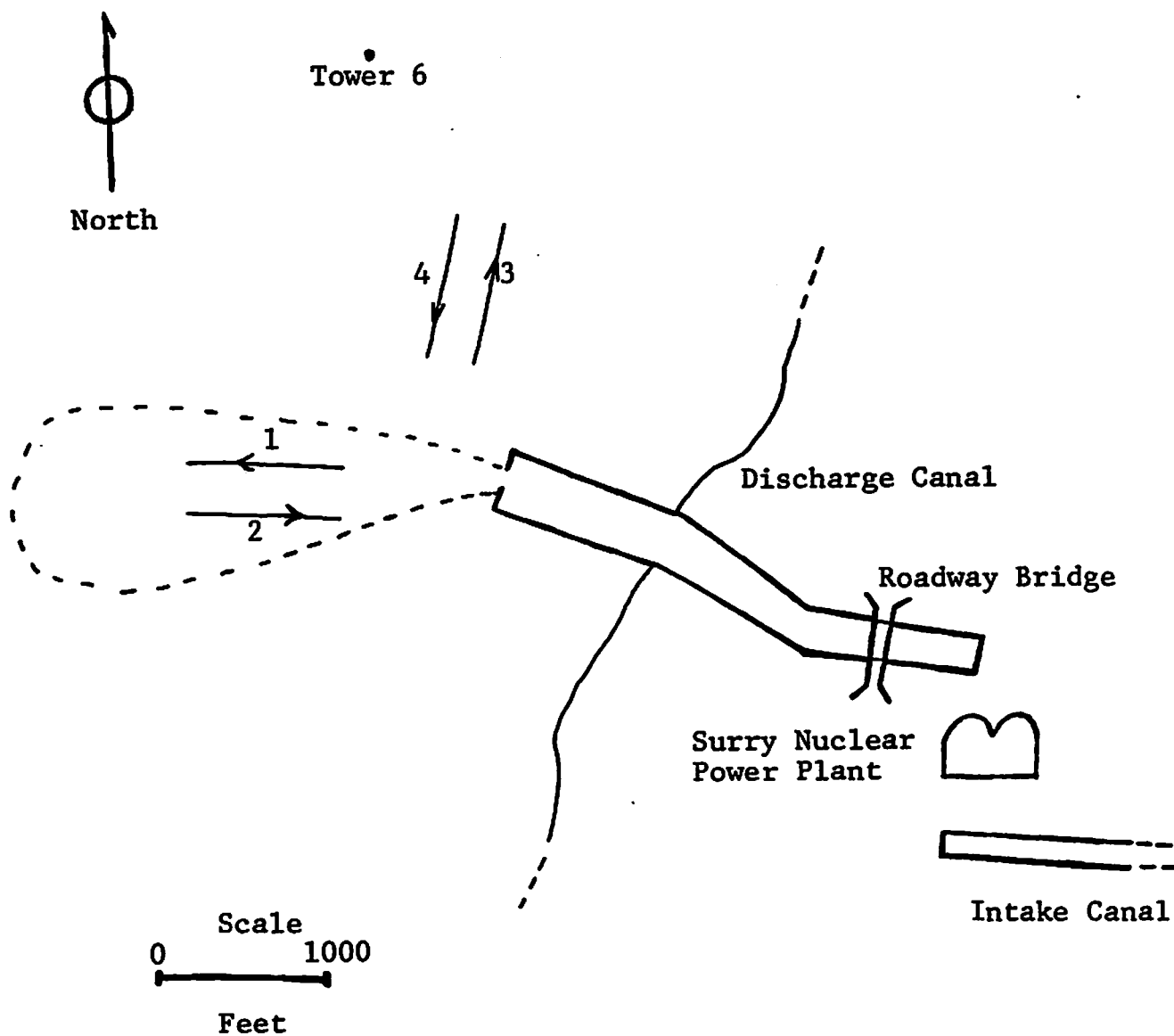


Table 1. Ichthyoplankton sampling schedule for Plant and Plume entrainment studies at VEPCO Surry Nuclear Power Station (Aug. 1975 through June 1976).

Study	1975					1976					
	<u>Aug.</u>	<u>Sept.</u>	<u>Oct.</u>	<u>Nov.</u>	<u>Dec.</u>	<u>Jan.</u>	<u>Feb.</u>	<u>Mar.</u>	<u>Apr.</u>	<u>May</u>	<u>June</u>
Plant Entrainment	X	X	X	X	X	X	X	XX	XX XX	XX XX	XX
Plume* Entrainment	XXX	XX	X	XX	XX	X	X	XX	XX XX	XX XX	XX

* begun 13 Aug. 1975

Table 2. Species and number of individuals caught during plume entrainment stations during August and September, 1975.

Species	Date	Discharge Canal		+Tow 1		+Tow 2		+Tow 3		+Tow 4	
		Left	Right	Left	Right	Left	Right	Left	Right	Left	Right
Gobisoma bosci	13 Aug.	16	23	9	12	6	3	7	3	10	14
Anchoa mitchilli		6	5	10	2	5	5	8	3	2	1
Alosa aestivalis			1								
Menidia beryllina					1	1				1	
Dorosoma species			6 (eggs)								
Gobisoma bosci	21 Aug.	6	6	12	10	13	16	9	6	1	3
Anchoa mitchilli		15	22	14	6	7	9	9	18	18	13
Menidia beryllina						1	1				
Unidentified*		2	2	1							
Gobisoma bosci	26 Aug.	3	3	1	1	1					
Anchoa mitchilli				4	6	4	5	13	15	18	19
Menidia beryllina						1					
Menidia menidia										1	
Gobisoma bosci	11 Sept.			2		6	4	1	1		1
Anchoa mitchilli			2	9	11	5	6	2	3	3	
Gobisoma bosci	23 Sept.			2		1		1			
Anchoa mitchilli					2			3			2
Micropogon undulatus						1					

+ Tows 1 and 2 made in the $\Delta T=5^\circ$ plume; Tows 3 and 4 made outside the plume.

* Unidentified fish; injured beyond positive identification.

Table 3. Species and calculated number of individuals per 100 cubic meters of water during plume entrainment stations during August and September, 1975 .

Species	Date	Discharge Canal		Tow 1		Tow 2		Tow 3		Tow 4	
		Left	Right	Left	Right	Left	Right	Left	Right	Left	Right
Gobisoma bosci	13 Aug.	52	76	21	28	12	5	17	7	53	44
Anchoa mitchilli		19	16	23	5	10	9	19	7	11	3
Alosa aestivalis			3								
Menidia beryllina					2	2			2		
Dorosoma species			19(eggs)								
Gobisoma bosci	21 Aug.	16	16	21	21	22	33	18	13	2	7
Anchoa mitchilli		39	60	25	13	12	18	18	38	36	30
Menidia beryllina						2	2				
Unidentified*		5	5	2							
Gobisoma bosci	26 Aug.			2	2	2					
Anchoa mitchilli		8	8	8	13	7	10	22	33	30	36
Menidia beryllina						2					
Menidia menidia										2	
Gobisoma bosci	11 Sept.			2		11	8	2	2		3
Anchoa mitchilli			4	11	14	9	12	4	7	8	
Gobisoma bosci	23 Sept.			4		2		2			
Anchoa mitchilli					4			6			4
Micropogon undulatus						2					

* Unidentified fish; injured beyond positive identification.

Table 4. Dissolved oxygen, salinity, and temperature data for plume entrainment stations during August and September

Date	<u>Dissolved Oxygen</u>								
	Discharge Canal			$\Delta T = 5^\circ$ Plume			Ambient River Water		
	<u>Surface</u>	<u>Midwater</u>	<u>Bottom</u>	<u>Surface</u>	<u>Midwater</u>	<u>Bottom</u>	<u>Surface</u>	<u>Midwater</u>	<u>Bottom</u>
13 Aug. 1975	6.5	6.3	6.6	6.3	6.8	6.5	6.3	6.9	6.1
21 Aug. 1975	5.9	6.0	6.5	6.1	*--	6.0	6.0	--	6.3
26 Aug. 1975	6.5	6.6	6.2	6.4	6.3	6.6	7.6	--	6.8
11 Sept. 1975	7.2	6.8	7.7	7.7	7.2	7.3	7.3	--	7.6
23 Sept. 1975	7.0	6.8	7.2	7.0	7.1	7.1	7.2	--	7.1
	<u>Salinity</u>								
13 Aug. 1975	4.3	4.2	4.2	3.2	3.0	2.8	3.1	3.1	3.1
21 Aug. 1975	4.6	4.7	4.6	4.0	--	3.9	1.1	--	2.3
26 Aug. 1975	5.1	5.0	5.1	4.4	4.4	4.3	1.6	--	2.6
11 Sept. 1975	3.3	3.2	3.3	2.2	2.3	2.3	1.5	--	1.6
23 Sept. 1975	2.9	3.0	3.0	2.5	2.3	1.8	1.8	--	1.7
	<u>Temperature</u>								
13 Aug. 1975	37.0	37.0	36.5	35.0	34.0	33.5	33.5	33.0	32.5
21 Aug. 1975	36.5	35.5	35.5	33.5	--	33.0	29.4	--	30.1
26 Aug. 1975	37.0	35.6	34.0	35.0	35.0	34.0	31.5	--	32.0
11 Sept. 1975	34.0	33.5	33.5	30.0	28.5	28.5	26.7	--	26.7
23 Sept. 1975	31.0	31.0	31.0	28.0	27.5	26.5	+25.0	--	25.0

* Midwater samples not taken due to shallow water.

+ Temperature at beginning of final tow was 23.5°.