50-247

Redirect - Rebuttal Testimony of

Dr. C. P. Goodyear

Susceptibility of Larvae to the Intake of I.P. 2

TTTRAN

February 22, 1973

References:

(1) Testimony of Dr. John P. Lawler (5 February 1973): "Mathematical Model Used by the Staff to Estimate the Effect of Indian Point Units 1 and 2 Entrainment on Hudson River Striped Bass."

(2) Testimony of Dr. Gerald J. Lauer (5 February 1973): "The Temperature Tolerance of Striped Bass Eggs and Larvae Relative to Their Seasonal Occurrence and Expected Indian Point Plant Discharge Temperatures"

(3) Testimony of Dr. John P. Lawler (30 October 1972): "Effect of Entrainment and Impingement at Indian Point on the Population of the Hudson River Striped Bass"

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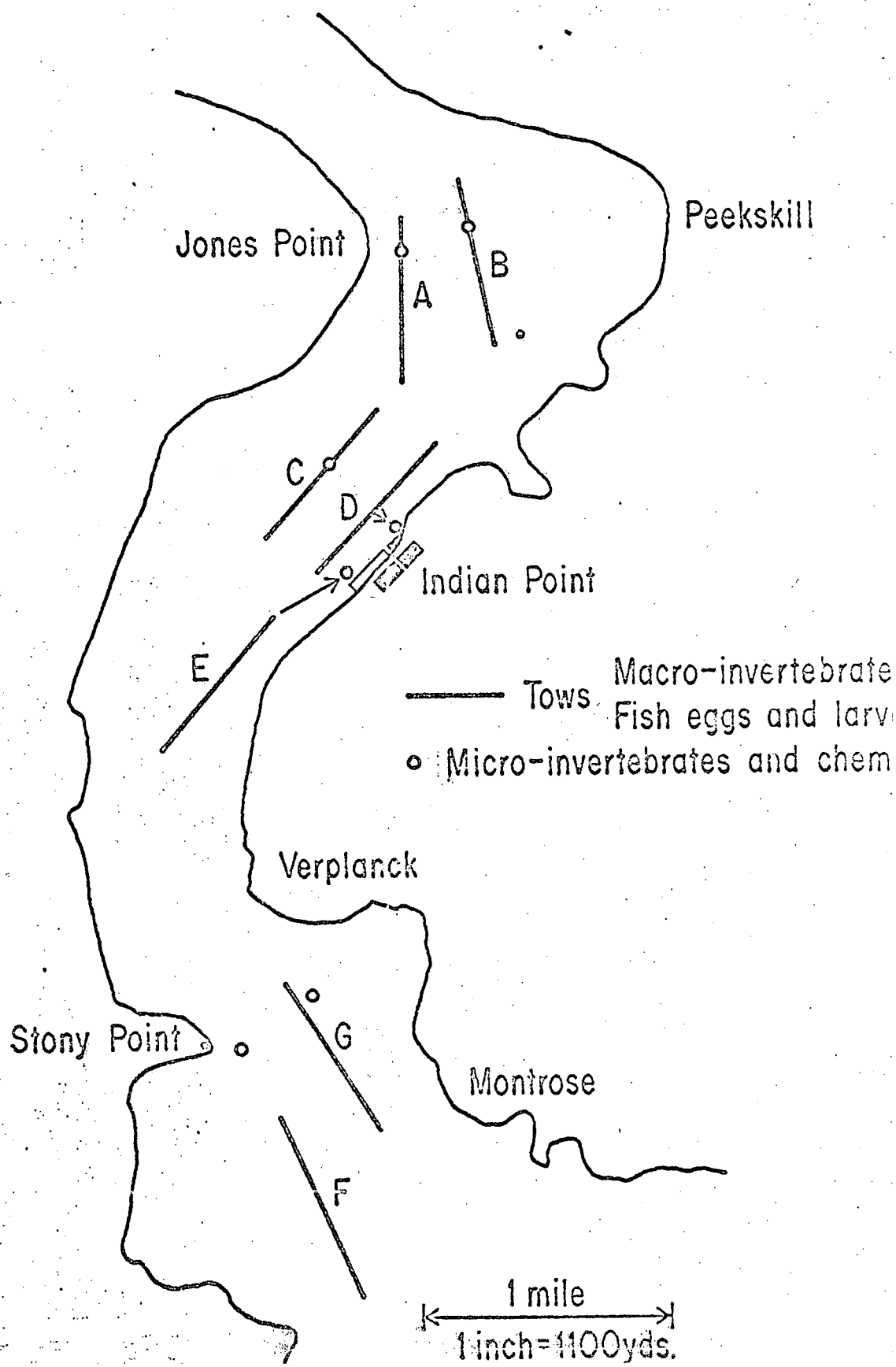
Susceptibility of Larvae to the Intake of I.P. 2

In rebuttal to the Staff model, Dr. Lawler asserts (Ref. 1, pp. 18, 20) that the Staff is in error in using the sectional-averaged concentration to describe the concentration of organisms which will be removed by power plant operation. On first examination, the Staff believed that the most reasonable approach was to utilize a concentration in intake water which was equal to the average concentration in the adjoining cross-section of the river. After studying the available information and the alternatives in some detail, the Staff is convinced that this approach is still the most reasonable.

The Applicant's consultants have asserted that there will be a deviation from the average concentration as a result of 1) the plant withdrawing from the surface water, 2) larvae and early juveniles being able to avoid the intake, and 3) the plant depleting the concentration of organisms in the section of the river adjacent to the plant. The conceptual framework for these assumptions is developed in Dr. Lawler's October 30 testimony where he evaluated each of the factors based on data from sampling in the river (See generally, Reference 3, pp. 48 et. seq.). However, the staff believes that the values which were used by the applicant to estimate the various parameters included values for numerator and denominator of various ratios which were not significantly different. As a consequence, the Staff believes that the value for each of the parameters which were estimated should be taken as unity.

New York University
1971 Hudson River Sampling Stations



It is further believed that the Applicant bases his assertion that the average concentration withdrawn by I.P. will be different than the cross-sectional concentration on an erroneous concept of the relationship of the origin of the cooling water to the distribution of early larval and juvenile fishes within the water column. This relationship and the reasons for the staff belief are described below.

To support his position Dr. Lawler presented evidence from the NYU study with the assertion that it demonstrated a difference in the distribution of larvae from point to point in the river. In particular, he sought to show that the distribution of larvae in the river would minimize the entrainment potential at I.P. However Dr. Lauer, who was responsible for the data, noted that there was probably no real differences among the stations (Fig. 1) which were sampled (T7081-7083).

Furthermore, an analysis of Dr. Lauer's data, which were gathered in conjunction with sampling the intake and discharge structures at I.P. Unit 1 during 1972, indicate that the average concentrations in the intake water and in the discharge canal were not significantly different and were probably not different from the average concentrations in the river. The analysis further showed that there was no consistent difference between the day and night concentrations in the water withdrawn by the plant. These data are not consistent with the thesis propounded by Dr. Lawler and by Dr. Lauer. However, they are consistent with the analysis made by the Staff before the issuance of the FES and as amplified as follows.

Staff Position

It is the Staff's position that the normal concentration of organisms which might be expected to be withdrawn by Indian Point Units 1 and 2 will be essentially the same as the average cross-sectional concentration in the

estuary. This is contrary to the Applicant's assertions that the power plant will withdraw water from the upper layer rather than from the zone from top to bottom within the estuary. The disagreement is understandable. The Applicant has conceptualized the power plant's withdrawal of water as being related to the cross-section of the Hudson River presented in Fig. 2. This figure uses an exaggerated vertical scale. However one can more easily discern the staff's position by observing the slope of the bottom relative to the intake drawn to scale as is presented in Fig. 3. The differences in these views can be illustrated by use of actual data, as follows:

Data on vertical and lateral variation in distribution of larval and juvenile striped bass were obtained both in the Hudson River Fisheries Investigations and in the Raytheon Co. studies. However, data from the 1968 Hudson River Fisheries Investigations were far more extensive and detailed than any other set of ichthyoplankton data gathered before or since in the Hudson River. Therefore, these data were selected by the Staff for analysis.

The sampling stations utilized in this study are presented in Fig. 4. Each vertical line represents a vertical transect within the water column. There was a sample at the surface and a sample at each 15-foot depth interval to the bottom for each horizontal location. This series of data is summarized in Appendix 6 of the Hudson River Fisheries Investigation which is included hereafter. It is evident from the data presented in Appendix 6 that the collections were extensive. In fact, there were over 5,000 individual collections taken during the period represented. These 5,000 collections sampled over 13 million cubic feet of water, from which some 12,000 eggs and 19,000 striped bass larvae were obtained.

In order to determine the importance of lateral variation in average concentration, the Staff calculated mean vertical and horizontal concentrations

"Figure 2"

Sheet 1
9-13-'55

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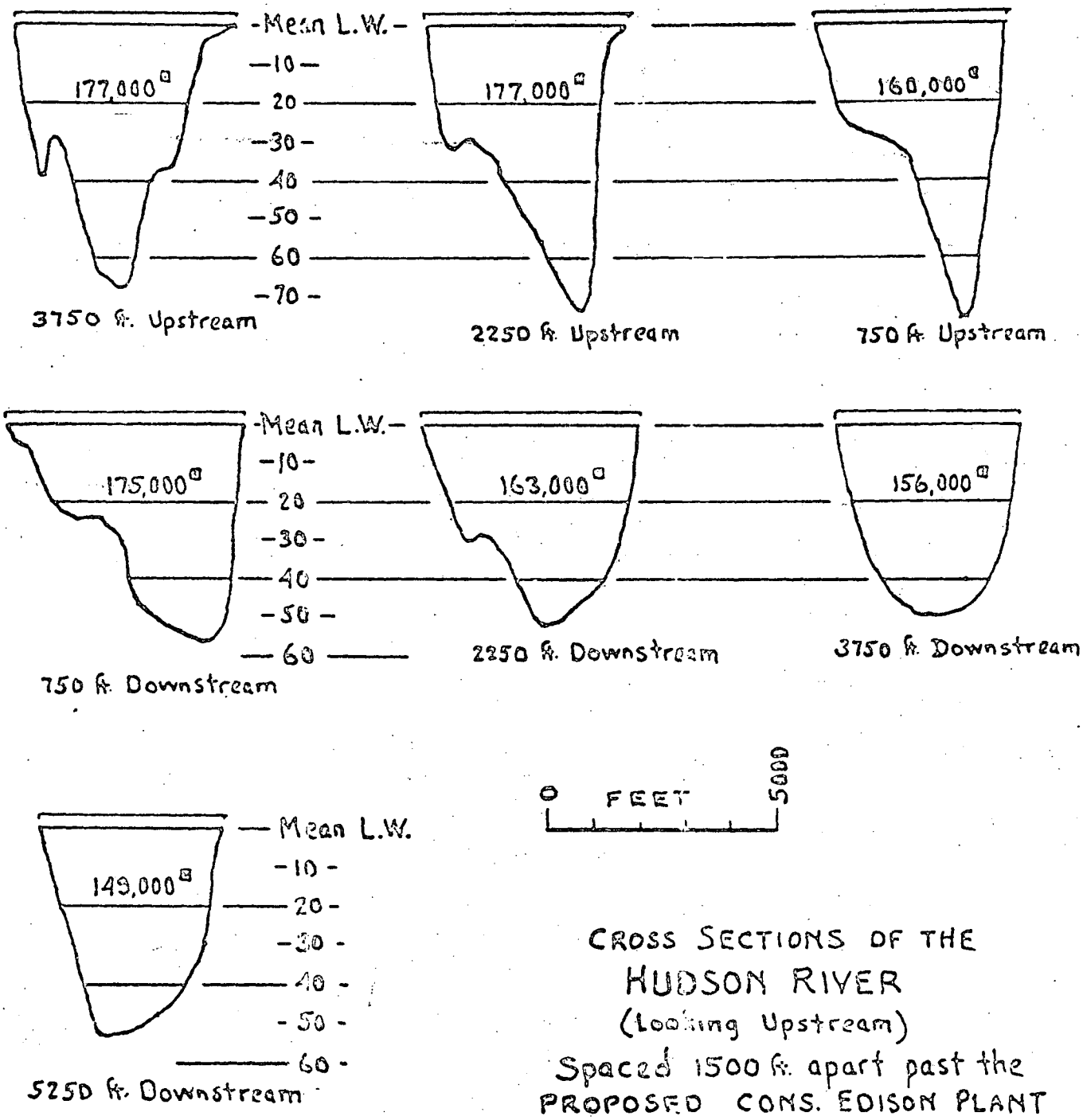
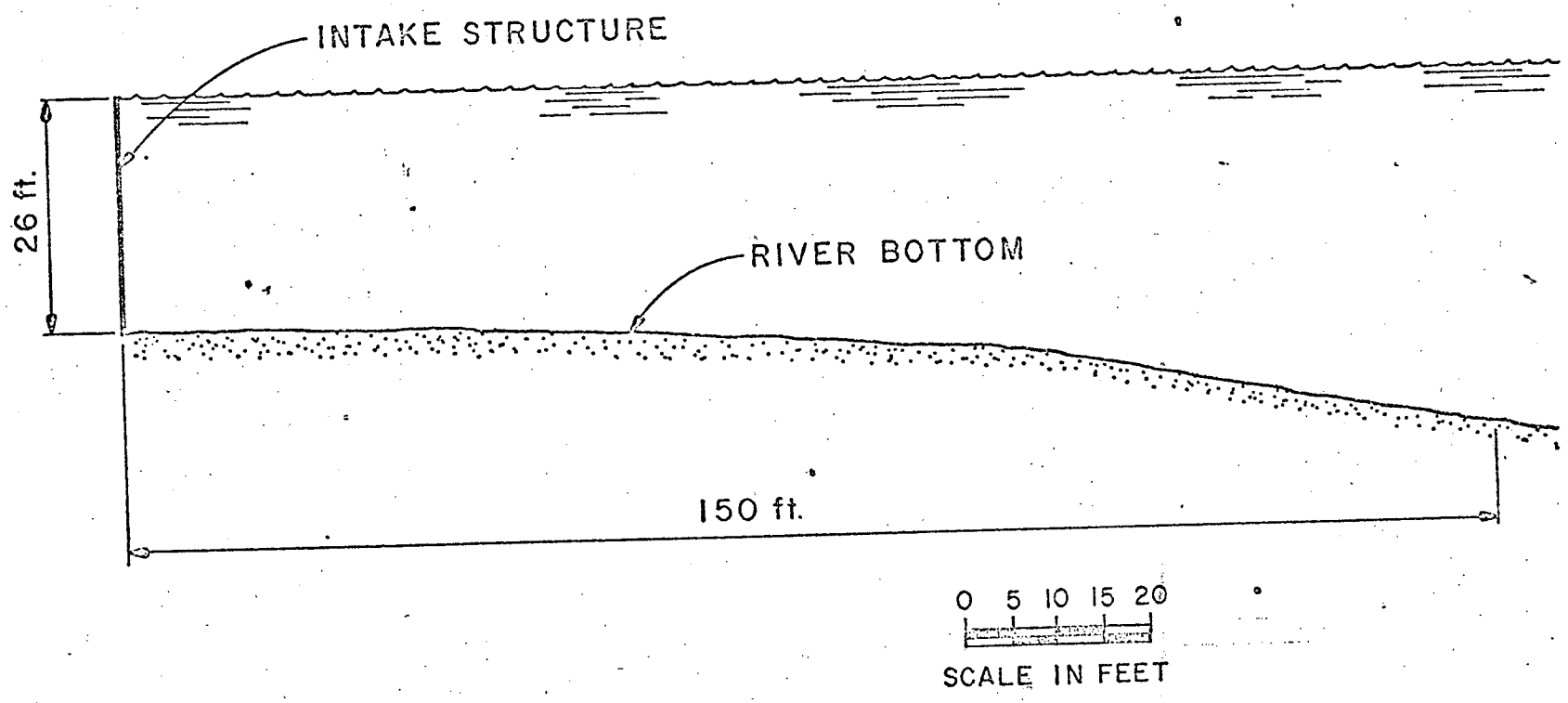


CROSS SECTIONS OF THE
HUDSON RIVER
(Looking Upstream)
Spaced 1500 ft. apart past the
PROPOSED CONS. EDISON PLANT
BELOW PEEKSKILL



HUDSON RIVER BOTTOM CONTOUR ADJACENT TO INDIAN POINT INTAKE

Figure 3

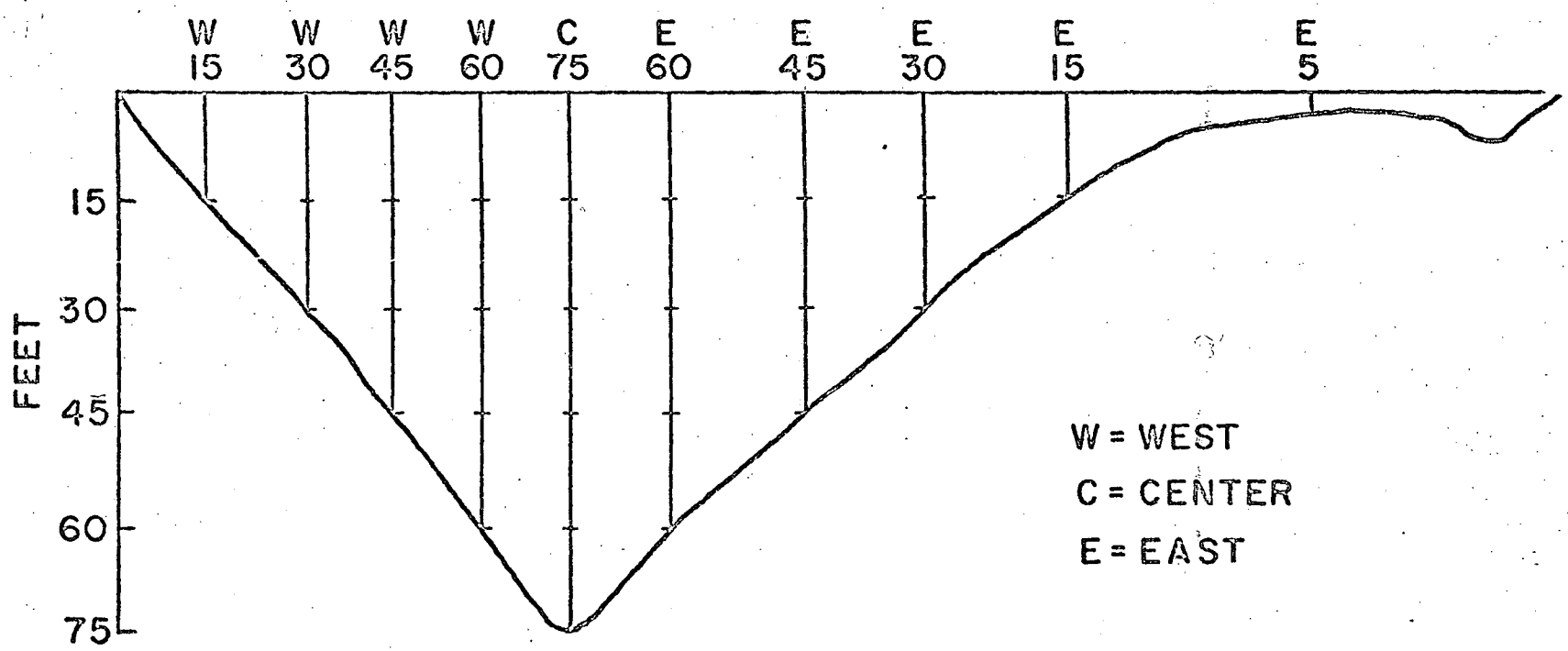


Figure 2.- Cross section of the Hudson River at Cornwall, New York, showing sampled sites and stations.

FIGURE 4

by averaging vertical concentrations for day and night for each lateral station sampled. These data were presented in Table A-V-13 of the FES which is reproduced here (Table 1). The result of this comparison indicates that the lateral variation in mean vertical concentration does not demonstrate a reduced concentration in shallow areas near shore.

A comparison of vertical variation, which represents the susceptibility of these organisms to transport via density-induced flows, shows that the deeper water in the river is characterized by a higher concentration of larvae (Table 2). Thus, the lower layer flow in saline-intruded reaches could be expected to transport a greater proportion of larvae per unit volume of water transported upstream than the upper layer flows would transport downstream. This concept is consistent with the modeling techniques which were used by the Staff in evaluating the impact of the I.P. power plant on the Hudson River. And at the same time, these data were ignored by the Applicant's consultants in evaluating the applicability of their transport model for the transport of striped bass larvae and early juveniles.

These data on vertical and horizontal distribution indicate that "top" and "bottom" for a fish larvae refer to points in the water column however shallow or deep that column may be. These orientations do not always correspond to the division of the center channel into upper and lower layers with respect to net flows. Withdrawal of water from the upper flow layer also includes organisms at the "bottom" in a shallow zone.

Based on these data as analyzed and on the fact that the Applicant has supplied insufficient data to support its contentions, the Staff concludes that the most reasonable approach to estimating vulnerability of organisms to the intake is to assume that the concentration which will be withdrawn will be representative of the sectional-average concentration, and the F_2 factors

TABLE 1

Table A-V-13. Lateral distribution of larval striped bass for a 12-week period at Cornwall in 1968

(average concentration of larvae per 15-ft interval)

Period[a]	W 15	W 30	W 45	W 60	C 75	E 60	E 45	E 30	E 15	E 5	Mean concentration of larvae (number per 1000 ft³)	Standard error
4/28–5/4												
D	0.06	0.067	0.13	0.034	0.01	0.05	0.035	0.097	0.04	0.0	0.052	0.012
N	0.315	0.02	0.098	0.264	0.042	0.188	0.085	0.137	0.03	0.0	0.118	0.034
5/5–5/11												
D	0.03	0.027	0.102	0.04	0.03	0.052	0.09	0.0	0.15	0.0	0.079	0.015
N	0.0	0.0	0.0	0.11	0.608	0.0	0.0	0.08	0.0	0.0	0.080	0.060
5/12–5/18												
D	0.26	0.54	0.79	0.878	1.57	1.48	1.837	1.95	3.535	2.96	1.58	0.331
N		2.13	1.30	1.008	0.64	1.26	1.235	1.237		1.06	1.234	0.149
5/19–5/25												
D	1.13	2.653	4.05	3.752	4.11	3.296	2.478	3.33	2.325	1.77	2.889	0.313
N	2.11		4.133	5.07	3.242	2.054	4.062	1.693	3.01	3.00	3.153	0.372
5/26–6/1												
D	0.945	4.523	4.468	3.172	1.825	3.542	2.43	4.913	1.705	0.81	2.833	0.478
N	3.445	23.483	7.22	7.818	7.242	2.494	4.213	4.70	3.375	2.81	6.68	1.967
6/2–6/8												
D	0.29	0.75	0.783	0.488	1.112	0.65	1.037	0.71	1.2	1.23	0.825	0.090
N	0.18	0.577	0.997	0.756	0.812	1.032	0.66	0.923	0.995	1.05	0.795	0.086
6/9–6/15												
D	6.975	6.477	6.175	5.945	5.737	3.674	4.382	4.46	2.65	1.23	4.771	0.308
N	7.835	24.197	6.61	4.57	2.185	2.336	1.018	4.13	5.725	2.80	6.141	2.116
6/16–6/22												
D	2.975	3.56	1.882	1.592	1.363	0.752	1.417	1.793	1.765	0.95	1.805	0.638
N	2.28	2.993	0.702	0.526	0.99	1.444	1.83	4.817	3.385	3.58	2.255	0.447
6/23–6/29												
D	0.49	0.763	0.478	0.644	0.322	0.864	0.59	0.653	1.09	0.70	0.659	0.139
N		0.62	1.118	0.262	0.622	1.12	0.938	1.943	1.13	1.13	0.987	0.157
6/30–7/6												
D	0.04	0.07	0.0	0.028	0.0	0.04	0.072	0.227	0.155	0.54	0.117	0.055
N	0.0	0.07	0.115	0.394	0.095	0.0	0.478	0.037	0.0	0.0	0.119	0.063
7/7–7/13												
D									1.48	0.44	0.96	0.520
N									1.055	0.22	0.638	0.417
7/14–7/20												
D	0.18	0.11	0.435	0.0	0.0	0.518	0.048	1.107	0.34	0.0	0.274	0.109
N			0.0		0.177	1.056	0.35	0.533	0.485	2.83	0.776	0.365
$\overline{D}$	1.216	1.785	1.754	1.507	1.462	1.356	1.311	1.749	1.37	0.886	1.440	0.088
$\overline{N}$	2.021	6.010	2.027	2.078	1.514	1.180	1.352	1.839	1.745	1.540	2.131	0.441

[a]D = day; N = night.

Table 2 MEAN CONCENTRATION OF LARVAE AT CORNWALL IN 1968 AVERAGED OVER DEPTH ACROSS ALL SAMPLE LOCATIONS, EXPRESSED AS NUMBER PER 1000 ft^3

Week	Depth (ft)	Day Total	Day Av	Night Total	Night Av	Weighted Av Day and Night
4/28-5/4	0	0.07	0.007	0.83	0.083	0.039
	15	0.31	0.034	1.00	0.111	0.066
	30	0.81	0.116	0.42	0.06	0.093
	45	0.45	0.09	0.52	0.104	0.096
	60	0.19	0.063	0.76	0.253	0.143
	75	0.0	0.0	0.0	0.0	0.0
5/5-5/11	0	0.0	0.0	0.14	0.014	0.006
	15	0.41	0.045	0.12	0.013	0.032
	30	0.45	0.064	0.40	0.057	0.061
	45	0.58	0.097	0.12	0.024	0.067
	60	0.41	0.137	0.31	0.103	0.123
	75	0.0	0.0	3.35	3.35	1.362
5/12-5/18	0	4.47	0.447	13.09	0.131	0.322
	15	9.19	1.021	5.47	0.781	0.926
	30	11.40	1.629	7.51	1.073	1.409
	45	14.02	2.804	5.91	1.182	2.164
	60	6.97	2.323	4.49	1.50	1.998
	75	3.69	3.69	0.38	0.38	2.385
5/19-5/25	0	3.81	0.381	39.24	3.924	1.733
	15	10.66	1.184	19.72	2.191	1.566
	30	27.73	3.961	8.09	1.348	2.957
	45	33.28	6.56	20.57	4.114	5.615
	60	21.55	7.183	16.10	5.367	6.477
	75	15.61	15.61	6.21	6.21	11.995
5/26-6/1	0	3.97	0.397	50.04	5.004	2.110
	15	13.32	1.48	54.53	6.059	3.184
	30	37.60	5.371	68.04	9.72	6.992
	45	24.68	4.936	37.81	7.562	5.916
	60	23.38	7.793	19.14	6.38	7.274
	75	3.58	3.58	12.17	12.17	6.776
6/2-6/9	0	1.79	0.179	7.10	0.710	0.371
	15	4.90	0.544	7.27	0.808	0.639
	30	5.96	0.851	4.73	0.676	0.788
	45	9.19	1.838	7.04	1.408	1.682
	60	4.18	1.393	2.35	0.783	1.172
	75	2.24	2.24	0.88	0.88	1.748

Table A-V-15 (continued)

Week	Depth (ft)	Day Total	Day Av	Night Total	Night Av	Weighted Av Day and Night
6/9-6/15	0	17.10	0.171	32.24	3.224	1.242
	15	40.81	4.534	47.28	5.253	4.780
	30	57.89	8.27	69.49	9.927	8.840
	45	33.33	6.666	27.6	5.52	6.255
	60	21.16	7.053	14.91	4.97	6.313
	75	7.79	7.79	6.12	6.12	7.194
6/16-6/22	0	6.10	0.610	26.87	2.687	1.32
	15	16.88	1.875	16.30	1.811	1.86
	30	20.95	2.993	10.23	1.461	2.47
	45	9.79	1.958	7.37	1.474	1.79
	60	4.19	1.397	2.83	0.943	1.24
	75	1.75	1.75	0.66	0.66	1.38
6/23-6/29	0	3.21	0.321	16.86	1.686	0.78
	15	9.54	1.06	5.14	0.643	0.92
	30	3.76	0.537	4.19	0.599	0.56
	45	3.71	0.742	2.89	0.578	0.68
	60	1.54	0.513	1.14	0.38	0.47
	75	0.09	0.09	0.0	0.0	0.60
6/30-7/6	0	0.62	0.062	1.92	0.192	0.11
	15	0.82	0.091	0.33	0.037	0.07
	30	0.83	0.119	0.49	0.07	0.10
	45	0.18	0.036	0.52	0.104	0.06
	60	0.0	0.0	1.97	0.65	0.22
	75	0.0	0.0	0.0	0.0	0.0
7/14-7/20	0	0.40	0.04	4.14	0.591	0.24
	15	1.95	0.217	7.40	0.925	0.47
	30	3.51	0.501	1.32	0.264	0.42
	45	1.02	0.204	1.21	0.303	0.24
	60	2.33	0.582	0.0	0.0	0.37
	75	0.0	0.0	0.37	0.37	0.13

should be taken as unity.

Appendix 6

Weekly abundance of striped bass larvae by day and night per sampling station in the Hudson River at Cornwall in 1968.

Number of larvae per 1000 ft³
Days: 4/28-5/4/68

Depth (ft)	West 15	West 30	West 45	West 60	Center 75	East 60	East 45	East 30	East 15	East 5
0	0.00	0.04	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15	0.12	0.02	0.03	0.00	0.06	0.00	0.00	0.00	0.08	
30		0.14	0.09	0.10	0.00	0.05	0.14	0.29		
45			0.37	0.03	0.00	0.05	0.00			
60				0.04	0.00	0.15				
75					0.00					

Night: 4/28-5/4/68

Depth (ft)	West 15	West 30	West 45	West 60	Center 75	East 60	East 45	East 30	East 15	East 5
0	0.08	0.00	0.00	0.20	0.00	0.08	0.00	0.41	0.06	0.00
15	0.55	0.06	0.39	0.00	0.00	0.00	0.00	0.00	0.00	
30		0.00	0.00	0.20	0.13	0.00	0.09	0.00		
45			0.00	0.32	0.12	0.00	0.08			
60				0.60	0.00	0.16				
75					0.00					

Number of larvae per 1000 ft³
Day: 5/5-5/11/68

Depth (ft)	West 15	West 30	West 45	West 60	Center 75	East 60	East 45	East 30	East 15	East 5
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15	0.06	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.30	
30		0.08	0.11	0.00	0.00	0.00	0.26	0.00		
45			0.30	0.00	0.12	0.11	0.05	0.00		
60				0.20	0.06	0.15				
75					0.00					

Night: 5/5-5/11/68

Depth (ft)	West 15	West 30	West 45	West 60	Center 75	East 60	East 45	East 30	East 15	East 5
0	0.00	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.00	0.00
15	0.00	0.00	0.00	0.12	0.00	0.00	0.00	0.00	0.00	
30		0.00	0.00	0.00	0.16	0.00	0.00	0.24		
45			0.00	0.12	0.00	0.00	0.00			
60				0.31	0.00	0.00				
75					3.35					

Number of larvae per 1000 ft³
Day: 5/12-5/18/68

Depth (ft)	West 15	West 30	West 45	West 60	Center 75	East 60	East 45	East 30	East 15	East 5
0	0.12	0.12	0.00	0.10	0.37	0.26	0.08	0.33	0.13	2.96
15	0.40	0.14	0.18	0.16	0.28	0.07	0.48	0.54	6.94	
30		1.36	1.09	0.82	0.40	1.58	1.17	4.98		
45			1.89	1.11	3.07	2.33	5.62			
60				2.20	1.61	3.16				
75					3.69					

Night: 5/12-5/18/68

Depth (ft)	West 15	West 30	West 45	West 60	Center 75	East 60	East 45	East 30	East 15	East 5
0	0.00	2.65	1.99	0.80	1.66	1.36	2.24	0.96	0.37	1.06
15	—	1.09	0.57	1.24	0.43	0.13	0.87	1.14	—	
30		2.65	0.65	0.96	0.57	0.63	0.39	1.61		
45			1.99	1.24	0.24	1.00	1.44			
60				0.80	0.56	3.13				
75					0.38					

Appendix 6 (Continued)

Number of larvae per 1000 ft³
Day: 5/19-5/25/68

Depth (ft)	West 15	West 30	West 45	West 60	Center 75	East 60	East 45	East 30	East 15	East 5
0	0.34	0.06	0.07	0.63	0.00	0.17	0.44	0.09	0.24	1.77
15	1.92	0.90	0.38	0.44	0.82	0.21	0.49	1.09	4.41	
30		7.00	1.85	2.64	1.15	2.70	3.58	8.81		
45			13.90	5.77	4.14	4.07	5.40			
60				9.28	2.94	9.33				
75					15.61					

Night: 5/19-5/25/68

0	1.57	1.76	3.98	7.39	3.39	3.36	9.80	1.30	3.69	3.00
15	2.65	2.00	2.03	3.88	1.94	0.70	2.13	2.06	2.33	
30			2.93	0.78	1.29	0.77	0.60	1.72		
45			7.59	5.08	2.97	1.21	3.72			
60				8.22	3.65	4.23				
75					6.21					

Number of larvae per 1000 ft³
Day: 5/26-6/1/68

Depth (ft)	West 15	West 30	West 45	West 60	Center 75	East 60	East 45	East 30	East 15	East 5
0	0.27	0.70	0.41	0.20	0.15	0.54	0.15	0.27	0.47	0.81
15	1.62	1.38	1.60	0.23	0.14	0.28	0.48	4.65	2.94	
30		11.49	6.59	1.41	1.08	2.47	4.74	9.82		
45			9.27	3.74	2.12	5.20	4.35			
60				10.28	3.88	9.22				
75					3.58					

Night: 5/26-6/1/68

0	3.63	18.60	5.04	6.11	5.61	1.70	1.87	1.84	2.84	2.81
15	3.26	19.55	6.17	6.11	2.15	2.43	3.70	7.25	3.91	
30		32.30	5.49	8.76	10.24	2.01	4.23	5.01		
45			12.18	9.28	7.62	1.68	7.05			
60				8.83	5.66	4.65				
75					12.17					

Number of larvae per 1000 ft³
Day: 6/2-6/8/68

Depth (ft)	West 15	West 30	West 45	West 60	Center 75	East 60	East 45	East 30	East 15	East 5
0	0.00	0.05	0.05	0.14	0.05	0.08	0.04	0.11	0.04	1.23
15	0.58	0.45	0.13	0.36	0.00	0.27	0.34	0.41	2.36	
30		1.75	0.78	0.14	0.60	0.92	0.16	1.61		
45			2.17	0.55	1.87	0.99	3.61			
60				1.25	1.91	0.99				
75					2.24					

Night: 6/2-6/8/68

0	0.19	0.20	0.67	1.00	0.77	0.85	0.70	1.15	0.52	1.05
15	0.17	1.00	0.66	0.63	0.41	1.64	0.43	0.86	1.47	
30		0.53	0.98	0.80	0.16	1.07	0.43	0.76		
45			1.68	0.76	2.34	1.18	1.08			
60				0.59	0.31	1.45				
75					0.88					

Appendix 6 (Continued)

Number of larvae per 1000 ft³
Day: 6/9-6/15/68

Depth (ft)	West 15	West 30	West 45	West 60	Center 75	East 60	East 45	East 30	East 15	East 5
0	3.45	1.77	1.24	1.49	1.81	0.29	2.61	2.11	1.10	1.23
15	10.50	6.31	2.40	3.85	5.45	1.06	4.17	2.87	4.20	
30		11.35	9.99	8.94	9.29	3.77	6.15	8.40		
45			11.07	5.50	4.24	7.92	4.60			
60				9.99	5.84	5.33				
75					7.79					

Night: 6/9-6/15/68

0	2.91	6.84	2.93	3.57	3.21	1.86	1.48	3.94	2.70	2.80
15	12.76	12.03	0.54	4.48	0.00	0.32	0.34	3.47	8.75	
30		53.72	6.46	0.76	0.38	1.57	1.62	4.98		
45			16.51	3.50	1.99	4.97	0.63			
60				10.54	1.41	2.96				
75					6.12					

Number of larvae per 1000 ft³
Day: 6/16-6/22/68

Depth (ft)	West 15	West 30	West 45	West 60	Center 75	East 60	East 45	East 30	East 15	East 5
0	0.77	0.29	1.72	0.41	0.47	0.62	0.52	0.28	0.07	0.95
15	5.18	1.64	1.60	1.22	1.78	0.30	0.92	0.78	3.46	
30		8.75	1.87	0.62	2.12	1.14	2.13	4.32		
45			2.34	3.07	1.44	0.84	2.10			
60				2.71	0.62	0.86				
75					1.75					

Night: 6/16-6/22/68

0	0.45	3.60	1.57	0.00	3.43	3.17	0.94	6.55	3.58	3.58
15	4.11	1.36	0.20	1.43	0.52	0.40	0.53	4.56	3.19	
30		4.02	0.10	0.44	0.37	0.68	1.28	3.34		
45			0.94	0.76	0.41	0.69	4.57			
60				0.00	0.55	2.28				
75					0.66					

Number of larvae per 1000 ft³
Day: 6/23-6/29/68

Depth (ft)	West 15	West 30	West 45	West 60	Center 75	East 60	East 45	East 30	East 15	East 5
0	0.82	0.14	0.24	0.50	0.13	0.08	0.00	0.00	0.60	0.70
15	0.16	1.22	1.57	1.31	0.85	0.98	1.40	0.47	1.58	
30		0.93	0.10	0.14	0.24	0.29	0.57	1.49		
45			0.00	0.32	0.30	2.70	0.39			
60				0.95	0.32	0.27				
75					0.09					

Night: 6/23-6/29/68

0	0.28	0.96	1.58	1.08	0.51	4.02	2.69	3.61	1.00	1.13
15	—	0.55	1.68	0.23	0.15	0.58	0.69	0.00	1.26	
30		0.35	0.96	0.00	0.29	0.00	0.37	2.22		
45			0.25	0.00	2.09	0.55	0.00			
60				0.00	0.69	0.45				
75					0.00					