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A FIELD EVALUATION OF THE EFFECTS OF HEATED DISCHARGES ON FISH DISTRIBUTION[1]

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ABSTRACT. Studies were conducted to determine the distribution of fish in the New and East Rivers in relation to thermal discharges from Appalachian Power Company's fossil fuel plant at Glen Lyn, Virginia. Over 15,300 specimens representing 41 species were collected with seines, electrogear and rotenone at six sampling locations from February, 1973 to October 1973. Sampling frequency was designed to evaluate the effects of ambient temperature upon preferred temperature. Diversity indices were calculated for each location. There was a slight decrease in the diversity indices for those stations located in the thermal discharge. Condition coefficients calculated for *Notropis albeolus* Jordan, *Notropis rubellus* Aqassiz, *Notropis spilopterus* Cope, *Ictalurus punctatus* Rafinesque, and *Etheostoma blennioides* Rafinesque were found to be significantly (p = .05) lower in the thermal discharge for all species tested except *E. blennioides.* Temperatures were plotted against frequency of capture to determine a particular species temperature selection from field data and indicated that: (1) Some species avoided high temperatures (i.e., *Campostoma anomalum* Rafinesque). (2) Some species were attracted to high temperatures (i.e., *Ictalurus punctatus).* (3) Some species distribution was not effected by temperatures (i.e., *Notropis spilopterus).*
(KEY TERMS: thermal; fish thermal responses; thermal effects on fish distribution; thermal effects on fish condition factors; fish thermal preference; avoidance; field study of thermal effects on fish distribution)

INTRODUCTION

The United States presently uses approximately 40 per cent of its available fresh water for industrial cooling (as projected by Woodward, 1957). The major portion of this water is presently used by the steam electric – generation industry (Clark, 1969; Mihursky, 1969).

The seasonal distribution of sportfish in thermal plumes of steam-electric power plants is characterized by summer movement away and winter attraction to the plumes (Alabaster, 1963; Trembly, 1965). Movement of sportfishes into thermal discharges has been reported by Naylor (1965); Allen Boydstun, and Garcia (1970); Landry and Strawn (1973); and Fairbanks, Collins and Sides (1971). Warm water, current, and abundance of

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forage fish are reasons for the attraction of sport fishes into heated areas during colder months (Mihursky, 1969; Drew and Tilton, 1970; Barkley and Perrin, 1972). Landry and Strawn (1973) reported movement of fishes out of a thermal plume during periods of seasonal high temperatures.

Laboratory studies which demonstrate the effect of temperature on fish are numerous (Doudoroff, 1938; Fisher and Elson, 1950; Fry, 1947; Brett, 1952; Garside and Tait, 1958; Meldrim and Gift, 1971 and others). For a comprehensive series of references see Raney and Menzel (1969). Field studies to evaluate the impact of thermal discharges on the distribution of fish in rivers are rare (Ferguson, 1958). Those studies which used field data were mostly limited to lake or reservoir studies in which temperature varies with depth (Fry, 1937; Dendy, 1948; Kennedy, 1941).

This study used field data on fish distribution to evaluate the impact of a thermal discharge on the fishes of the New River and East River at Appalachian Power Company's (APCO) fossil fuel plant, Glen Lyn, Virginia (figure 1). The effects of the heated discharge on several fish species were evaluated by comparison of distributional data from within the thermal plume with data collected outside of the plume.

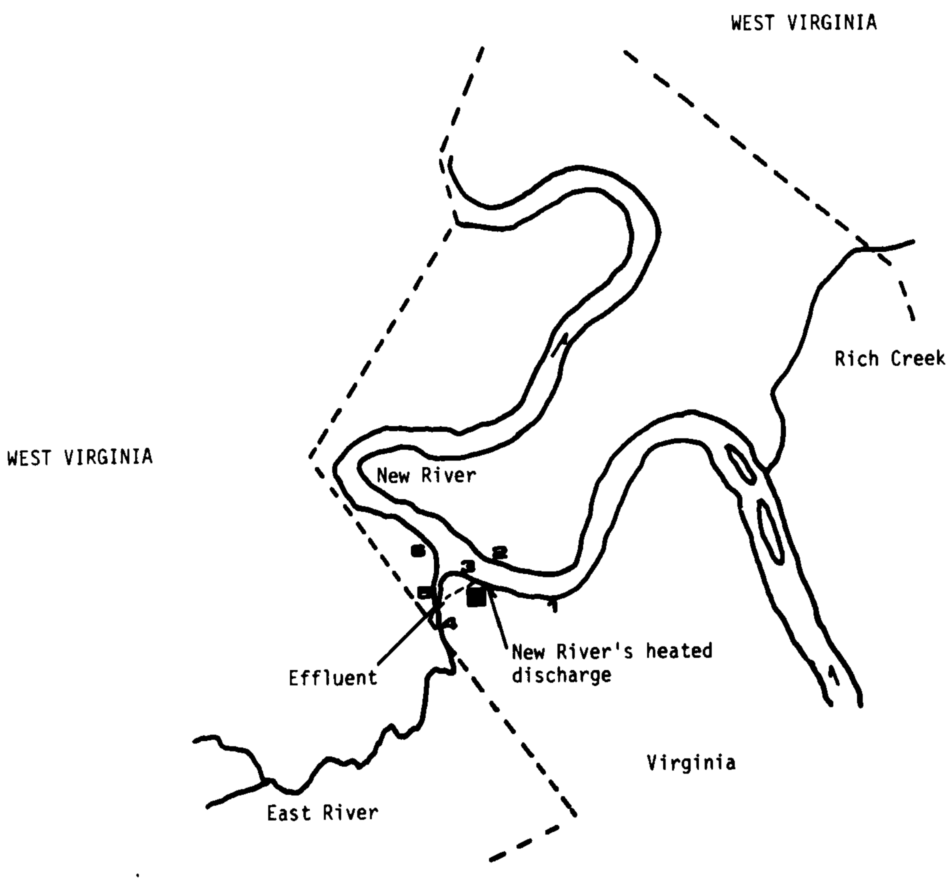

Figure 1. Map of the New River in vicinity of the Glen Lyn Lower Plant, showing collection stations in reference to the heated waste discharges.

DESCRIPTION OF STUDY AREA

Heated waste water (i.e. above ambient temperature) entered the New River from two APCO discharges at Glen Lyn. One unit discharged 85,000 gal/min directly into the New River approximately 50 yards above the Rt. 460 bridge. The second unit discharged 121,600 gal/min, via a 300 feet long effluent channel, into the East River (a tributary of the New River) upstream from its confluence with the New River, and 30,400 gal/min into the New River. Water from both units remained along the left bank of the New River.

The New River varied in flow from a high of 82,800 cfs recorded in May to a low of 1375 cfs recorded in September, 1973. Flow data were not available for the East River. Field sampling stations, all in Giles County, Virginia, are shown on figure 1. Stations were selected for accessibility, proximity to heated discharges, substrate composition, and presence of riffles and pools. The substrate at all locations consisted of silt, gravel, rubble, and rocks.

Station 1

Location: Left bank of the New River, 2.5 road miles east of the Rt. 460 bridge, Glen Lyn, Virginia.
Shoreline: Deciduous trees
Aquatic vegetation: *Justicia, Elodea*

Station 2

Location: Right bank of the New River, 2.5 miles east of the Rt. 460 bridge, Glen Lyn, Virginia.
Shoreline: Grass, shrubs
Aquatic vegetation: *Justicia, Elodea*

Station 3

Location: Left bank of the New River, 300 yards downstream from the Rt. 460 bridge, Glen Lyn, Virginia. Downstream of unit 6's discharge, and upstream of the East River confluence.
Shoreline: Deciduous trees
Aquatic vegetation: *Justicia, Elodea, Potamogeton*

Station 4

Location: East River at West Virginia – Virginia State Line. Upstream of thermal discharge.
Shoreline: Deciduous trees
Aquatic vegetation: *Justicia, Vallisneria*

Station 5

Location: Right bank of East River directly below thermal discharge.
Shoreline: Deciduous trees
Aquatic vegetation: *Elodea*

Station 6

Location: Left bank of New River directly below influent of the East River.
Shoreline: Deciduous trees
Aquatic vegetation: *Justicia, Elodea, Vallisneria*

Stations 1 and 2 (New River) and Station 4 (East River) were not exposed to thermal discharges and were, therefore, selected an ambient temperature reference sites.

MATERIALS AND METHODS

Fishes were collected with electroshocker, seine, and rotenone from February – October, 1973. Rotenone was used in conjunction with a block net to sample both pool and riffle habitats at each locality (Hocutt *et al.,* 1973). The results from all methods of collection were used to calculate per cent species composition and a diversity index (d; Wilhm and Doris, 1968) for each station. However, only the results from rotenone collections were used to determine a fish's temperature response because it was felt that rotenone was the most quantitative method. Temperatures were recorded in °F with a Taylor hand thermometer.

Diversity indices for collections from all stations were calculated (Wilhm and Doris, 1968). In a companion study Hocutt *et al* (manuscript with editor) collected fishes in the main channel New River using the same rotenone techniques. Confidence limits ($p = .05$, $df = 5$) for the diversity index were calculated using the diversity indices of Stations 1, 2, 4, and diversity indices calculated by Hocutt *et al* (manuscript with editor) for three additional upstream stations near Pearisburg, Virginia. The diversity indices for the areas exposed to a heated discharge were then compared to the mean diversity index. The per cent species composition of the ten most abundant species at each station was determined. An estimate of temperature preference and upper temperature avoidance for six of the more abundant species was made. Diversity indices of collections obtained with rotenone were also calculated at two degree temperature intervals. These were plotted against temperatures to determine the temperature at which the fish community had the highest diversity index.

The abundance of six species captured with rotenone was plotted against temperature. The total abundance at a particular temperature was then divided by the number of collections made at that temperature.

Condition coefficients were calculated using the formula $K = W/L^3$, where K was the coefficient of condition, W was the weight in grams, and L was the fork length of the specimen. The higher the condition factor (K) the more "healthy" the fish (Nikolsky, 1963). This factor was used by Nikolsky (1963) to determine the difference in condition between specimens of the same species captured in different habitats. The condition factors of five species collected at reference stations were compared to condition factors of the same species collected from stations located in the thermal discharges. The students t-test was used to compare condition coefficients of each species collected from the heated plume for the same species collected from the ambient waters.

RESULTS AND DISCUSSION

A total of 15,361 specimens represented by 41 species were captured from February - October, 1973. Data from these collections were summarized by station in table 1. Stations 1, 2 and 4 were represented by 30, 31, and 35 species of fishes respectively. Stations 3, 5, 6, within the influence of the heated discharges, had 22, 34, and 21 species of fish.

TABLE 1. Number of specimens of each species captured at Stations 1 – 6 from February – October, 1973

Familes and species	Station Numbers 1	2	3	4	5	6
Clupeidae						
Alosa pseudoharengus Alewife	15	5				
Cyprinidae						
Campostoma anomalum Stoneroller	335	133	3	1,599	32	10
Cyprinus carpio Carp				1		
Exoglossum maxillingua Cutlips minnow	2	1		1	2	
Nocomis leptocephalus Bluehead chub	13	19	1	45	32	4
Nocomis platyrhynchus Bigmouth chub	16	9	1	17		
Notemigonus crysoleucas Golden shiner				1	1	
Notropis albeolus White shiner	31	48	3	404	80	
Notropis ardens Rosefin shiner	2	4	4	8	30	
Notropis cornutus Common shiner				4		
Notropis galacturus Whitetail shiner	43	10	10	19	38	2
Notropis hudsonius Spottail shiner	57	181	8	105	24	20
Notropis photogenis Silver shiner	89			5	3	
Notropis procne Comely shiner					1	
Notropis rubellus Rosyface shiner	112	107	24	111	107	8
Notropis spilopterus Spotfin shiner	716	598	348	986	1,090	111
Notropis straminens Sand Shiner					1	
Notropis telescopus	3	3	1	22	28	1

TABLE 1. Number of specimens of each species captured at Stations 1 – 6 from February – October, 1973 (con't)

Familes and species	Station Number 1	2	3	4	5	6
Telescope shiner						
Notropis volucellus	391	528	209	68	58	33
Mimic shiner						
Pimephales notatus	823	272	19	786	138	48
Bluntnose minnow						
Pimephales promelas				7	5	
Fathead minnow						
Rhinichthys atratulus	4	20		54	2	4
Blacknose dace						
Rhinichthys cataractae		12		2		
Longnose dace						
Semotilus atromaculatus	1	2		37	1	1
Creek chub						
Catostomidae						
Catostomus commersoni				238	20	
White sucker						
Hypentelium nigricans	157	17	9	76	19	18
Northern hog sucker						
Ictaluridae						
Ictalurus punctatus	51	60	405	3	421	69
Channel catfish						
Pylodictis olivaris	63	305	87	8	47	10
Flathead catfish						
Cottidae						
Cottus carolinae	65	123		51	4	
Banded sculpin						
Centrarchidae						
Ambloplites rupestris	66	24	17	47	36	2
Rock bass						
Lepomis auritus	32	16	13	53	24	1
Redbreast sunfish						
Lepomis cyanellus		1		1		
Green sunfish						
Lepomis gibbosus	1					
Pumpkinseed						
Lepomis macrochirus	39	10	2	1	15	1
Bluegill						
Micropterus dolomieui	43	68	22	11	11	4
Smallmouth bass						
Micropterus punctulatus	19	24	9		11	
Spotted bass						
Percidae						
Etheostoma blennioides	135	176	80	118	84	11
Greenside darter						
Etheostoma flabellare		1		63	1	

TABLE 1. Number of specimens of each species captured at Stations 1 – 6 from February – October, 1973 (con't)

Familes and Species	Station Number 1	2	3	4	5	6
Fantail darter *Percina crassa roanoka*	71	78	42	1	48	17
Piedmont darter *Percina maculata*				1		
Blackside darter *Percina oxyrhyncha*	11	1			6	5
Sharpnose darter						
Total Number of Specimens						
Total Number of Specimens	3,434	2,856	1,317	4,953	2,421	380
Total Number of Species	30	31	22	35	34	21
Number of Collections	7	12	6	10	15	5
Diversity Index	3.5465	3.6352	2.8535	3.1339	3.0483	3.2822

*The authorities are those which accompany the scientific names listed in the American Fisheries Society, Special Publication No. 6, (Bailey, 1970), from which all scientific and common names were taken.

Community Structure

Diversity indices were used to estimate community health. Areas with a high diversity are considered to be more "healthy" than those with low diversity (Patrick, 1949). The mean diversity index calculated from data of all reference sites was 3.40 with 95 per cent confidence limits (df = 5) of 3.21 (lower) and 3.59 (upper). Indices for Station 3 (2.85) and Station 5 (3.13) fall outside and that for Station 6 within the confidence limits.

The ten most abundant species by per cent composition for each station are summarized (table 2). This suggests the channel catfish (*Ictalurus punctatus,* Rafinesque) was attracted to localities which received a thermal discharge. The stone roller (*Campostoma anomalum,* Rafinesque) and the sculpin (*Cottus carolinae,* Gill) avoided the thermal discharge. The data also suggested that the distribution of the spotfin shiner (*Notropis spilopterus,* Cope) and the greenside darter (*Etheostoma blennioides,* Rafinesque) were not affected by the presence of the thermal discharges.

Diversity may decrease with an absence of species or with a redundance of a few species (Wilhm and Doris, 1968). The low diversity of Stations 3 and 5 was probably caused by the attraction of large numbers of channel catfish, rather than by a reduction in the number of species. The presence of large numbers of channel catfish was reflected by both the per cent compostion (table 2) and a high redundance coefficient ($r = 0.41$).

Several authors have used species diversity at stressed and unstressed areas to indicate changes in community condition (Copeland, 1961; Grimes and Mountain, 1971; Mihursky and McErlean, 1971). Diversity is high in healthy communities, but decreases with pollution stress (Grimes and Mountain, 1971; Wilhm and Doris, 1968). The

TABLE 2. Per cent composition of the ten most abundant species collected at stations 1 – 6 for all collections made between February – October, 1973.

Stations	Reference			Heated Areas		
Species	1	2	3	4	5	6
Campostoma anomalum	10.3	4.6	32.3	--	--	2.6
Notropis albeolus	--	--	8.2	--	3.3	--
Notropis galacturus	--	--	--	--	1.6	--
Notropis hudsonius	--	6.3	2.1	--	--	5.3
Notropis rubellus	3.5	3.8	2.2	--	4.4	--
Notropis photogenis	2.6	--	--	--	--	--
Notropis spilopterus	20.9	20.9	19.9	26.4	45.0	29.2
Notropis volucellus	11.4	18.5	1.4	15.9	2.4	8.7
Pimephales notatus	24.0	9.5	15.9	1.4	5.7	12.6
Catostonus commersoni	--	--	4.8	--	--	--
Hypentellium nigricans	4.6	--	1.5	--	--	4.8
Pylodictus olivaris	--	10.7	--	6.6	1.9	2.6
Ictalurus punctatus	--	--	--	30.7	17.4	18.2
Ambloplites rupestris	1.9	--	--	1.3	--	--
Micropterus dolomieui	--	--	--	1.7	--	--
Etheostoma blennioides	3.9	6.7	2.4	6.1	3.5	2.9
Percina crassa roanoka	2.1	2.7	--	3.2	2.0	4.5
Cottus carolinae	--	4.3	--	--	--	--

*-- Indicates that species was not among the ten most abundant fish for that station.

comparison of diversity indices of affected versus unaffected areas is a useful biological tool in analyzing community "health." However, a diversity index based on a compilation of yearly data might not detect a difference in community structure caused by a heated discharge. Although the temperature at those stations located within the thermal plume will always be higher than the temperature at the reference stations, the temperature of the heated discharge will at some time correspond with the temperature preferendum of all species present. In order to overcome this problem, diversity indices and per cent composition were evaluated in relation to temperature, regardless of the site of capture. Figure 2 illustrates diversity indices plotted against temperature for all rotenone collections made in the study. Diversity indices increased with temperature from 2.78 at 69°F to a maximum of 3.3 at 84°F. As temperatures continued to increase above 84°F, diversity decreased to a minimum of 2.3 at 95°F. A decreased diversity index with increased temperatures was also demonstrated by Grimes and Mountain (1971), and Hatch (1973). The decrease in diversity at elevated temperatures in this study was probably caused by two major factors: (1) An increase in abundance of thermophilic organisms such as the channel catfish and spotfin shiner, and (2) An absence of thermophobic fishes such as the stone roller (*Campostoma anomalum*) and the sculpin (*Cottus carolinae*).

Of particular interest is the presence of the sharpnose darter (*Percina oxyrhyncha*, Hubbs and Raney) in water exceeding 94°F. The sharpnose darter was listed as a possible rare and endangered species by the United States Department of the Interior (1973). This species was collected ten yards below the heated discharge pipe both times rotenone was used at Station 5.

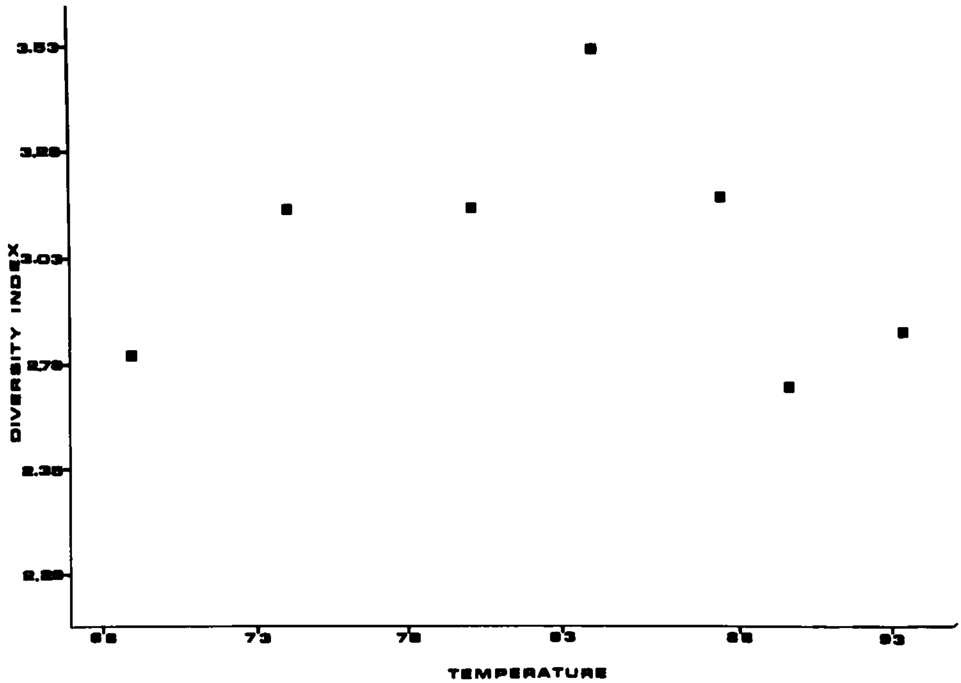

Figure 2. The relationship of diversity indicies to temperature (°F) for fish collected with rotenone from June-September, 1973.

Temperature Selection

Temperature preference and avoidance of fish are dependent upon the thermal history of the organism (Fry, 1947; Meldrim and Gift, 1971). Therefore, a fish's response to temperature in this study was unique to both the particular species and the temperature regime of the New River and East River.

The number of specimens of each species collected at two degree temperature intervals by rotenone is summarized in table 3. Figures 3–8 plot the number of specimens captured versus temperature for six species. Table 4 lists the percent composition of the five most abundant fishes for two degree temperature intervals. The above tables and figures were used to evaluate the effect of temperature on the most abundant species collected.

Stoneroller *(Campostoma anomalum)*. Figure 3 indicates the stoneroller preferred a temperature range from 67–80°F, but suggests an ability to acclimate to temperatures as high as 95°F.

Rosyface shiner *(Notropis rubellus,* Agassiz*)*. The rosyface shiner decreased linearly in abundance as temperature increased from 68 to 80°F, followed by an abrupt decrease at temperatures above 80°F. These data suggested that the rosyface shiner avoided temperatures above 80°F.

TABLE 3. Number of specimens of each species captured by rotenone at 2°F temperature intervals* from February – October 1973

Number of Collections Temperature Range	1 68 – 69	1 74 – 75	4 80 – 81	1 84 – 85	1 86 – 87	1 88 – 89	1 90 – 91	1 92 – 93	1 94 – 95
Alosa pseudoharengus			17	1					
Campostoma anomalum	1,025	512	464	15	13	10			3
Cyprinus carpio		1							
Exoglossum maxillingua	1		2						
Nocomis leptocephalus	44		32	14	16		1	4	
Nocomis platyrhynchus		17	23						
Notemigonus crysoleucas				1					
Notropis albeolus	164	145	23		17		2		7
Notropis ardens		4	4		2		1		
Notropis cornutus	2	2							
Notropis galacturus	4	3	24			1	4		16
Notropis hudsonius	11	93	179	1		12			13
Notropis photogenis	2	3	69						1
Notropis procne									
Notropis rubellus	33	27	42		2	2	1	6	9
Notropis spilopterus	323	27	843	36	29	58	97		403
Notropis telescopus	5	4	1		7		1	1	14
Pimephales notatus	312	419	640	4	6	39	3		17
Pimephales promelas	2								
Rhinichthys atratulus	16	33	24	1				4	
Rhinichthys cataractae	1		12						
Semotilus atromaculatus	15	20	3	1				1	
Catostomus commersoni	123	95		7	2				
Hypentelium nigricans	32	38	155	3	2	15	6	2	3
Ictalurus punctatus		3	115	3		61	18	3	789
Pylodictus olivaris		8	368	1		10			132
Cottus carolinae kanawhae	49		186	3					
Ambloplites rupestris	22	25	75	1	1	5		46	
Lepomis auritus	5	48	32	2	1	1	4		28
Lepomis cyanellus	1		1						
Lepomis gibbosus			1						
Lepomis macrochirus	1		20			1	2		14
Micropterus dolomieui	10	1	74		1		4	2	22
Micropterus punctulatus		16	7			1		12	
Etheostoma blennioides	75	34	285	7	1	8	35	7	103
Etheostoma flabellare	44	17	1		1				
Percina crassa roanoka			124	4		7	22	5	55
Percina maculata	1								
Percina oxyrhyncha			11	4					2
Total Number of Specimens	2,325	1,637	4,538	120	109	241	406	48	1,700
Total Number of Species	28	25	33	21	16	15	18	12	20
Diversity Index	2.81	3.14	3.38	3.53	3.19	3.02	2.38	3.20	2.42

*No rotenone collections were made at those temperature intervals not found in the table

TABLE 4. Per cent composition of the total catch of five species of fish captured with rotenone at 2°F temperature intervals.*

Temperature Range	68-69	74-75	80-81	84-85	86-87	88-89	90-91	92-93	94-95
Species:									
Campostoma anomalum	44.09	31.28	10.22	12.50	11.93	4.15	---	---	0.42
Notropis rubellus	1.42	1.65	0.93	---	1.83	0.83	0.25	12.50	0.90
Notropis spilopterus	13.89	1.65	17.47	30.00	26.60	24.06	23.89	14.12	30.49
Hypentelium nigricans	1.38	2.32	3.41	2.50	1.83	6.22	1.48	4.17	0.43
Ictalurus punctatus	---	0.18	2.40	2.50	---	25.31	4.43	6.25	54.90

*No rotenone collections were made at those temperature intervals not found in the table.

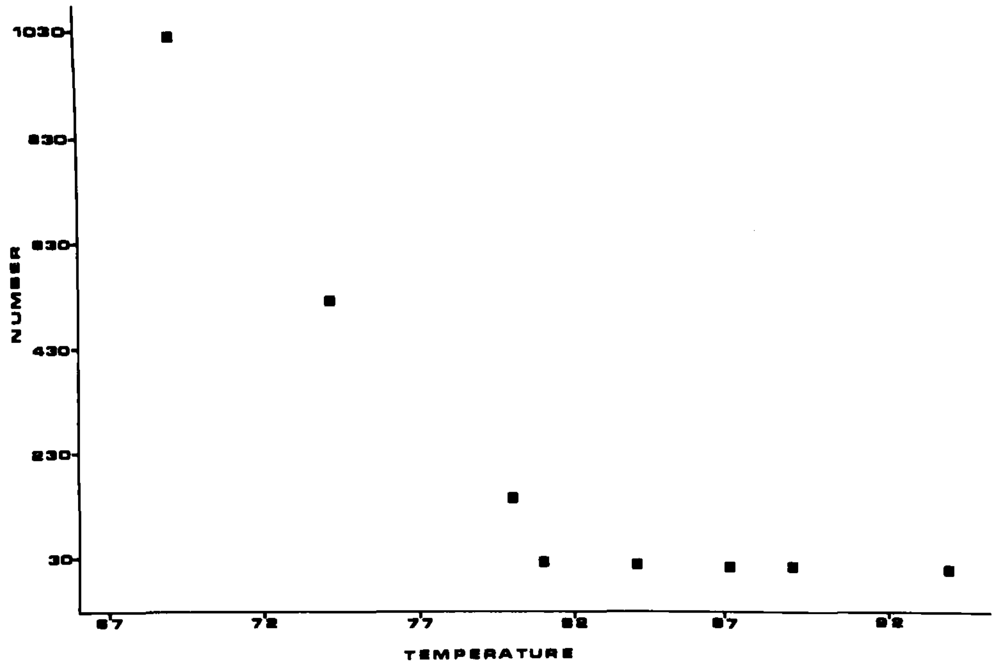

Figure 3. The relationship of the number of specimens (corrected for sampling effort) of stoneroller *(Campostoma anomalum)* to temperature (°F) from June-September, 1973.

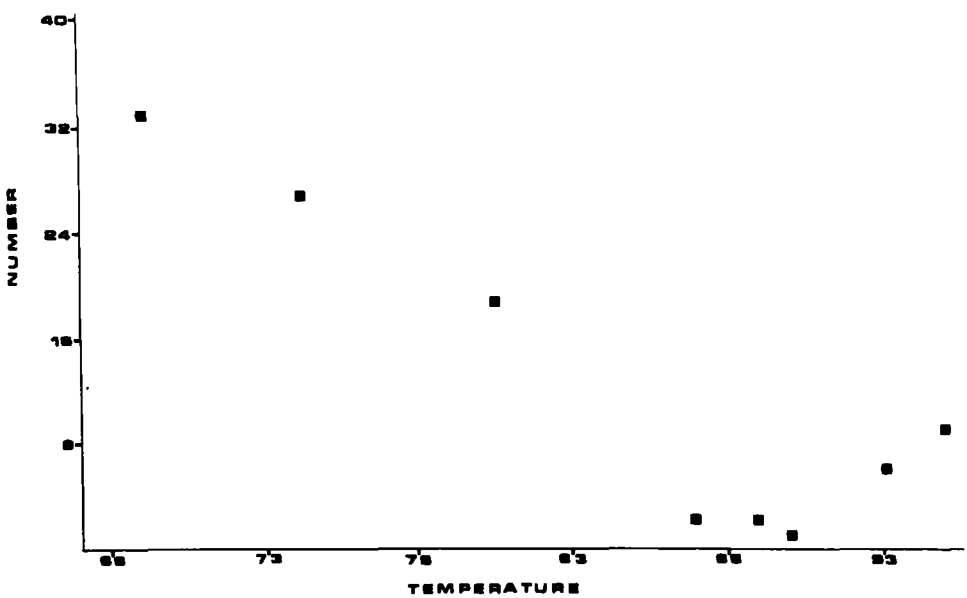

Figure 4. The relationship of the number of specimens (corrected for sampling effort) of rosyface shiner *(Notropis rubellus)* to temperature (°F) from June-September, 1973.

Spotfin shiner *(Notropis spilopterus).* The plot of number of species captured versus temperature for the spotfin shiner showed a scattered distribution (figure 5). The spotfin shiner was the second most abundant fish at 68–69°F and at 94–95°F. It was the most abundant fish from 80–93°F (table 4). This suggested that the spotfin shiner was thermally adaptable.

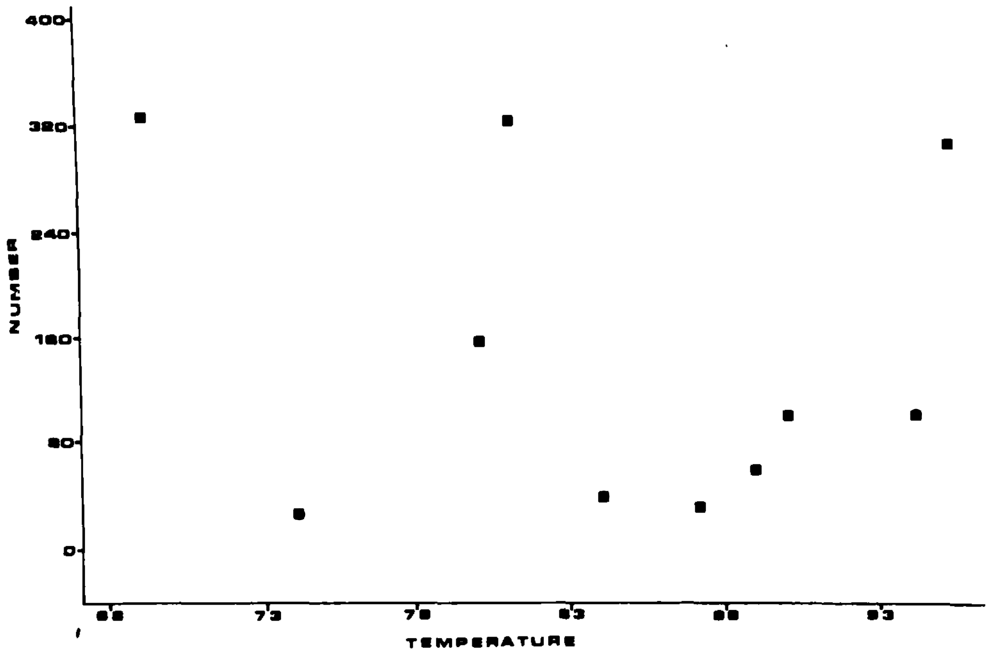

Figure 5. The relationship of the number of specimens (corrected for sampling effort) of spotfin shiner *(Notropis spilopterus)* to temperature (°F) from June-September, 1973.

Bluntnose minnow *(Pimephales notatus,* Rafinesque *).* Figure 6 indicates that the temperature preferendum of the bluntnose minnow ranged from 73 to 85°F. However, data from table 4 showed that the bluntnose minnow acclimated to elevated temperatures under field conditions.

Northern hog sucker *(Hypentelium nigricans,* Lesueur*).* The frequency distribution of the northern hog sucker indicates a preference of 69–80°F (figure 7). The northern hog sucker was similar to many species in this study in that it appeared to acclimate to water above 92°F (figure 7).

Channel catfish *(Ictalurus punctatus).* The frequency distribution of channel catfish was unique. It was relatively constant from 74 to 90°. It appeared to congregate in water at temperatures above 90°F (figure 8). The channel catfish was the most abundant species only at the 94–95°F temperature interval where it comprised 54% of the total catch.

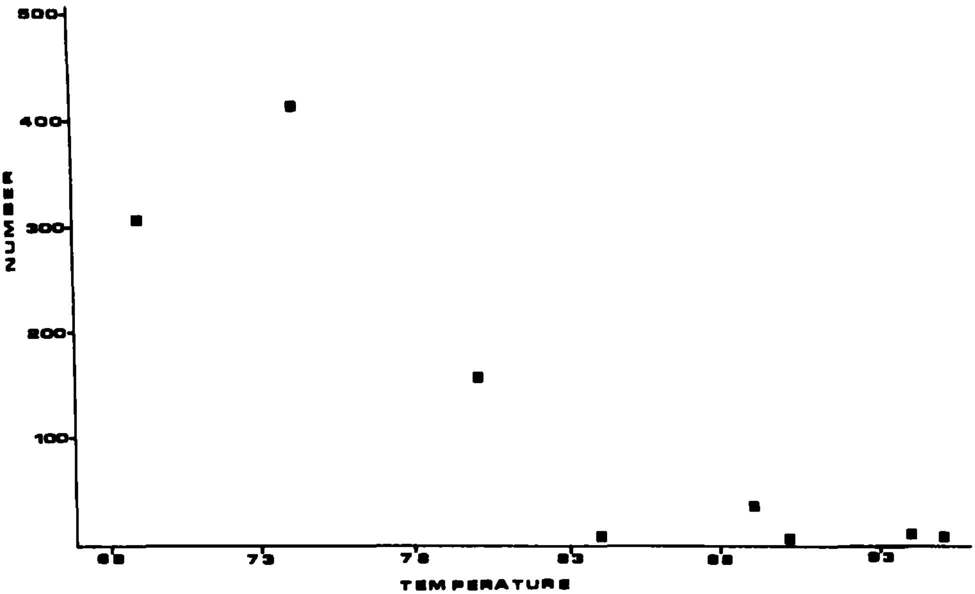

Figure 6. The relationship of the number of specimens (corrected for sampling effort) of Bluntnose minnow *(Pimephales notatus)* to temperature (°F) from June-September, 1973.

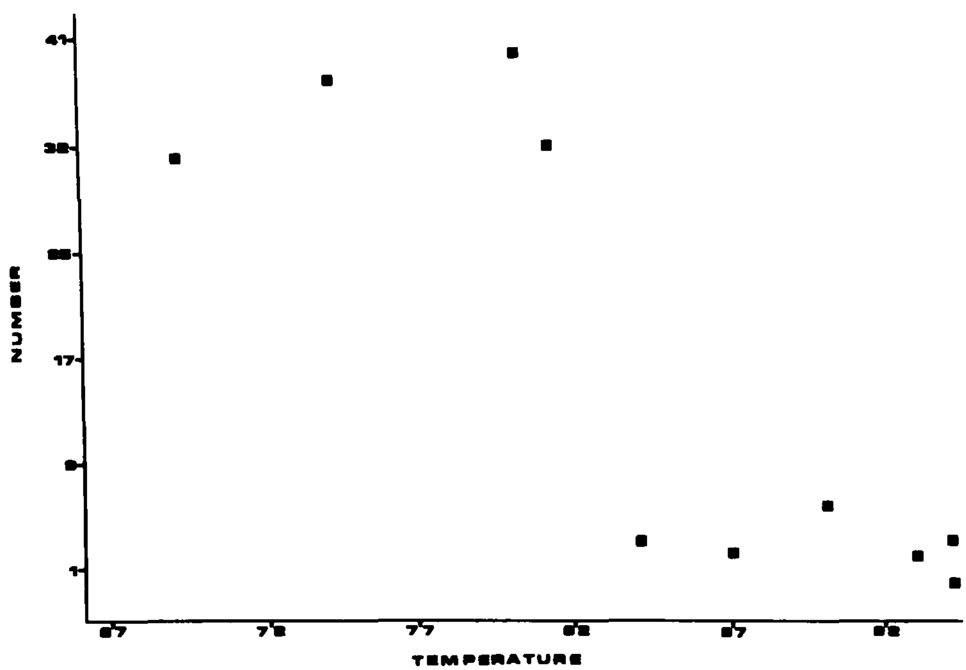

Figure 7. The relationship of the number of specimens (corrected for sampling effort) of Northern hogsucker *(Hypentelium nigricans)* to temperature (°F) from June-September, 1973.

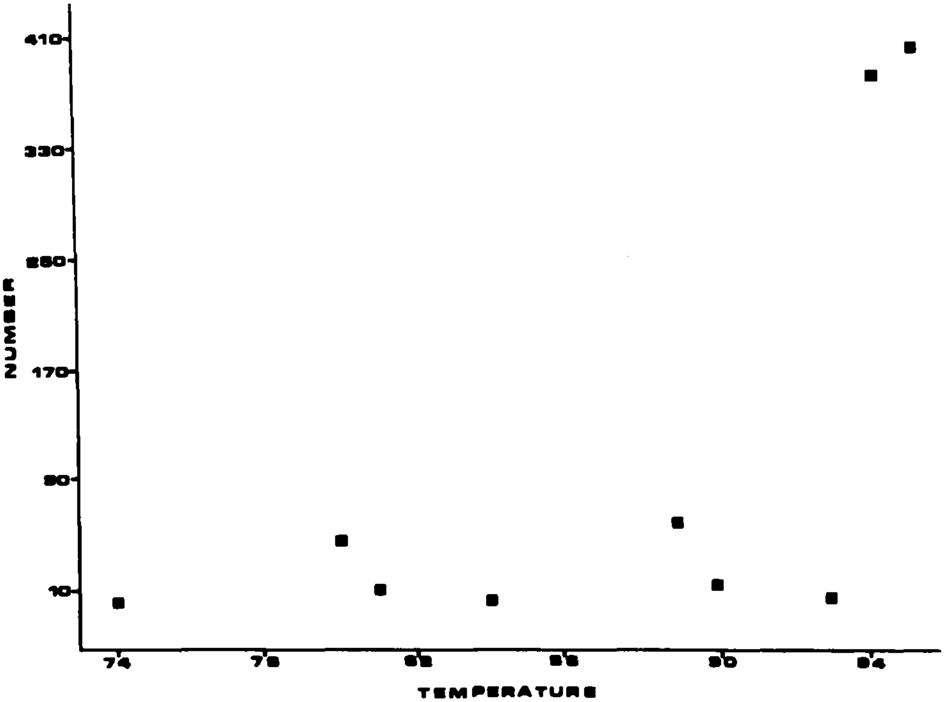

Figure 8. The relationship of the number of specimens (corrected for sampling effort) of channel catfish *(Ictalurus punctatus)* to temperature (°F) from June-September, 1973.

Condition Factors

Condition coefficients of the following fish captured in the heated discharge were significantly lower than those calculated for the same species captured at ambient river temperatures: white shiner *(Notropis albeolus,* Jordan), spotfin shiner *(Notropis spilopterus),* channel catfish *(Ictalurus punctatus),* flathead catfish *(Pylodictis olivaris,* Rafinesque) (table 5). Condition factor decreases if there is a lack of food or an increase in metabolic rate. The warmer water of the heated discharge probably increased metabolic rate and therefore maintenance requirements (Brown, 1957), which resulted in a decrease in the condition coefficients. The greenside darter's condition coefficient did not differ significantly between the heated discharge and the ambient areas. There are two possible explanations why the condition factors of the greenside darter were not significantly different: (1) a higher variance for the condition coefficients calculated at Station 3; and (2) the greenside darter spends most of its life on the stream bottom (Fahy, 1954). Therefore an increase in temperature may not significantly increase its maintenance requirements.

TABLE 5. Comparison of Condition Factors of Five Species of Fish Captured in Thermally Influenced and Ambient Areas Near Glen Lyn, Virginia

Species	Station Number	Date of Collection	Condition Factor	No. of Specimens	Variance	Results of Student's t-test (.05 level)
Notropis albeolus	5*	2 June 1973	1.00	38	.01	significant
Notropis albeolus	4	2 June 1973	1.16	42	.03	
Notropis spilopterus	5*	2 June 1973	1.13	193	.01	significant
Notropis spilopterus	4	2 June 1973	1.26	113	.04	
Notropis spilopterus	3*	3 September 1973	1.12	58	.01	significant
Notropis spilopterus	1	4 September 1973	1.27	211	.01	
Ictalurus punctatus	3*	3 September 1973	1.18	40	.01	significant
Ictalurus punctatus	1	4 September 1973	1.23	180	.01	
Pylodictus olivaris	3*	3 September 1973	1.11	87	.01	significant
Pylodictus olivaris	2	3 September 1973	1.38	66	.01	
Etheostoma blennioides	3*	10 July 1973	1.82	35	1.40	non-significant
Etheostoma blennioides	2	11 July 1973	1.86	125	.04	

*Indicates station which was influenced by the heated waste discharge.

CONCLUSIONS

1. Comparison of diversity indices by station from February – October indicated that community structure as determined by diversity indices was stable throughout the study area. Lower diversity indices at two stations were very probably caused by an increased abundance of thermally adapted fish rather than a decrease in number of species present since the spectrum of preferred temperatures for all species studied were available at each station sometime during the study.

2. A comparison of the diversity index with temperature intervals showed that above 80–87°F diversity index values decreased with an increase in temperature.

3. The stoneroller and the rosy face shiner selected temperatures below 80°F, while the bluntnose minnow showed a preference for 73–85°F water. The spotfish shiner showed no definite temperature preference. The channel catfish congregated in waters exceeding 92°F. All of the species studied, regardless of their selected temperature were able to acclimate to temperatures as high as 95°F. A species response to the thermal discharges was regarded to be dependent on acclimation to thermal regime of the New and East River.

4. Condition factors of fishes captured in the thermal plume are significantly lower (p = .05) than the condition factors of fishes collected at ambient temperatures for all species tested except the greenside darter. Life history of the greenside darter reported by Fahy (1954) indicated that an increase in temperature may not result in an increase in maintenance requirements.

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