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FILE

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by

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Abstract

Spot from the York and Elizabeth Rivers were taken in 1983, 1984, and 1985. The length to weight ratio was used to find the equation for Condition Index (K). Condition Indices for the two populations were found and plotted against temperature. Regression lines were plotted for each group. From 6 to 19 degrees, the Condition Index of the two populations rises at similar rates. From 19 degrees on, the Elizabeth River Condition Index rises steadily while the York K drops down to approach the levels of winter.

Introduction

The Elizabeth River, which flows into the James River just west of Norfolk, is a subestuary of the Chesapeake Bay. It "is likely the most polluted estuary in Virginia (Huggett, Bender and Unger, 1984)." Numerous military and civilian plants are the main sources for the pollution. In one notable case, a fire in a creosote plant in the late 1940's left wastes which are still visible today. Polynuclear aromatic hydrocarbons (PAH's), one of the results of the fire, are now at toxic levels (Huggett, Bender and Unger, 1984). Spot (Leiostomus xanthurus), Atlantic silverside (Menidia menidia), Atlantic menhaden (Brevoortis tyrannus), bay anchovy (Anchoa mitchilli) and hogchoker (Trinectes maculatus) are normal residents of the Elizabeth.

This study compares the general health of young of the year spot from the Elizabeth and York Rivers as quantified by their Condition Index (K) in order to dramatize the effects of pollution. Condition Index is a coefficient that depicts the degree of "plumpness" or health of a fish (Moyle & Cech, 1988). Spot were chosen for two reasons, 1) the data were available, and 2) spot have been shown to be susceptible to Elizabeth River pollutants (VIMS, 1988).

Methods & Materials

Spot were taken using a thirty foot semi-balloon otter trawl in both the York and Elizabeth Rivers. The sampling was conducted in connection with another project from May to January in 1984, 1985, and 1986. I used thirty-two different samples for my project. A typical sample had about twenty fish (Warriner, unpublished data). Fork lengths ranged from 80 to 130 centimeters.

Because of the nature of the experiment for which these fish were initially used, many were kept in an aquarium for some length of time. All the aquariums used York River water. The longest time in captivity was twenty-eight days.

I used the original investigators' notebooks containing length and weight data on spot, hogchoker, and summer flounder. I entered the data on spot from the York and the Elizabeth into the VIMS Prime. Using the SSPS-X graphics program, I plotted length against weight on a logarithmic scale. The Condition Index is found from the relation $K = W/L^3$

where K = Condition Index

W = Weight (g)

L = Length (mm)

The cubic relation is a general perciform (perch shaped) fit. To find the actual coefficient the equation is $K = W/L^b$ where b is the slope of a regression line of W vs. L (Royce, 1972; Moyle and Cech, 1988) In the case of spot b is equal to 3.2.

Using the equation for K, I computed the Condition Index for each fish and the mean and standard deviation for each sample. The mean values were regressed against water temperature on the date of capture. I then plotted the 95% confidence intervals for each regression line to determine the significance of the differences between the two.

Results

Spot in the Elizabeth and York Rivers were found to have similar Condition Indices from 6 to 22 degrees Celsius (Figure 2). At 21 degrees the regression lines intersect. From 21 to 30 degrees the York regression line drops to almost the same level as it started with at 6 degrees. Over the same interval, the Elizabeth River line continues to increase. At the 30 degree mark the two line are separated by almost one unit of condition index.

The York River samples increased over the domain of 6 to 19 degrees Celsius. From 19 to 30 degrees, the line decreased at approximately the same rate as it had increased. The global maximum and minimum were at 19 and 6 degrees respectively, with values of 4.95 and 4.24 for K.

The Elizabeth River regression line increased steadily throughout the entire temperature domain. At 6 degrees the value of K was 4.36 and at 30 degrees K was 5.20.

Discussion

There were a large range of values for K in both the Elizabeth and the York River samples. In the case of the Elizabeth River, the range of the 95% confidence interval was $\pm$ .73, about 15% of a typical value. For the York the range of 95% confidence was $\pm$ .45, or about 10% of a typical value. With 16 samples per river available, a single outlying point could significantly change the shape of the regression line. For example, I removed one point from each river because they were outside the 95% confidence interval, and my results changed from having a slightly higher York index in the low temperatures, to an obviously higher Elizabeth index in the upper temperature range.

A second consideration with my data was the lack of reliable temperature. My source for temperatures was not the same as my source for length and weight data. I used records of river surveys from the same time period, but the dates did not always coincide with the capture dates. I had to use proxy data, a common practice in retrospective analyses. I interpolated the temperatures for the capture dates using the actual temperatures and a chart of pier temperatures in the York River. I assumed that the change in temperature would follow the same general pattern whether the data came from the VIMS pier or the bottom of the Elizabeth River. This assumption is generally valid, but the data obtained are certainly not as accurate as actual measurements would have been; especially when there were intervals as long as two months between the measurement date and the capture date. In addition, I did not obtain any temperatures for 1986, so seventeen of my fifty samples had to be rejected.

The final consideration with the procedure was the treatment of the fish upon capture. Rather than being measured and weighed immediately, the fish were kept in aquariums for varied lengths of time, the longest being twenty-eight days. The aquariums were filled with running York River water. Therefore any effect that the Elizabeth River could have had on the Condition Indices was probably lessened.

Interpretation and Analysis

Normally when compared to temperature, the K for cold blooded creatures like the spot shows the following seasonal pattern: Fish are thinnest in cold temperatures, reach maximum plumpness in spring and fall temperatures, and drop down to almost as thin as they are in winter during the hottest part of the summer (Lagler, Bardach and Miller, 1962). Spot in the York River follow this normal pattern (Figure 2).

The drop during the winter is probably due to the loss of food sources. During the spring and fall the fish achieved a balance between the available food supply and their metabolic rate. The drop in the summer is likely due to several sources. The food supply of the fish could be adversely affected by the hot temperatures, and not as available. The hot temperature also speeds up the metabolism of fish. The metabolism, and consequently the food needs, of the spot doubles with every 10 degree increase in temperature. The available food sources probably cannot keep up with the increased metabolic needs of the fish (Lagler, Bardach and Miller, 1962).

The Elizabeth River regression line followed an atypical pattern for condition index vs. temperature graphs. Rather than getting thinner in the hottest months, Elizabeth River spot continue to "plump up" at virtually the same rate as they do during the spring and fall. I speculate that this anomaly is an indirect result of the pollution in the Elizabeth River. Knowing that the metabolic rate of fish doubles for every increase of 10 degrees (Lagler, Bardach and Miller, 1962), I deduce that the food supply must increase at an even greater rate for the Condition Index to keep rising. Polychaetes (Spionids, Nephthyids, and Maldinids), a primary food source for spot, could be more resistant to the combination of Elizabeth River pollution and high temperatures than competing benthic taxa (Diaz, personal communication). In the absence of competition, these Polychaetes would thrive, and consequently, so would the spot.

Assuming that my speculations are correct, the actual effects of the Elizabeth River environment are clear. As the summer continues, the fish consume more and more food, and consequently more and more pollution enters their systems. One should see an increase in the symptoms characteristic of PAH pollution (i.e. skin lesions, finrot, and cataracts) (VIMS 1988) as temperatures increase. Therefore, while the increase in Condition Index seems to show an improvement in the health of the fish, it can also be seen as a warning sign for an imminent decrease.

Conclusions

1. The Condition Index vs. Temperature comparison of York River spot follows a normal, seasonal pattern.

2. The Condition Index vs. Temperature comparison of Elizabeth River spot follows a pattern of increasing K throughout the temperature range.

3. The increase in Condition Index in the Elizabeth River at high temperatures may be due to an increase in available food supplies.

4. The increase in forage may be due to the elimination of competing benthic taxa in the Elizabeth River as a result of reduced water quality.

Literature Cited

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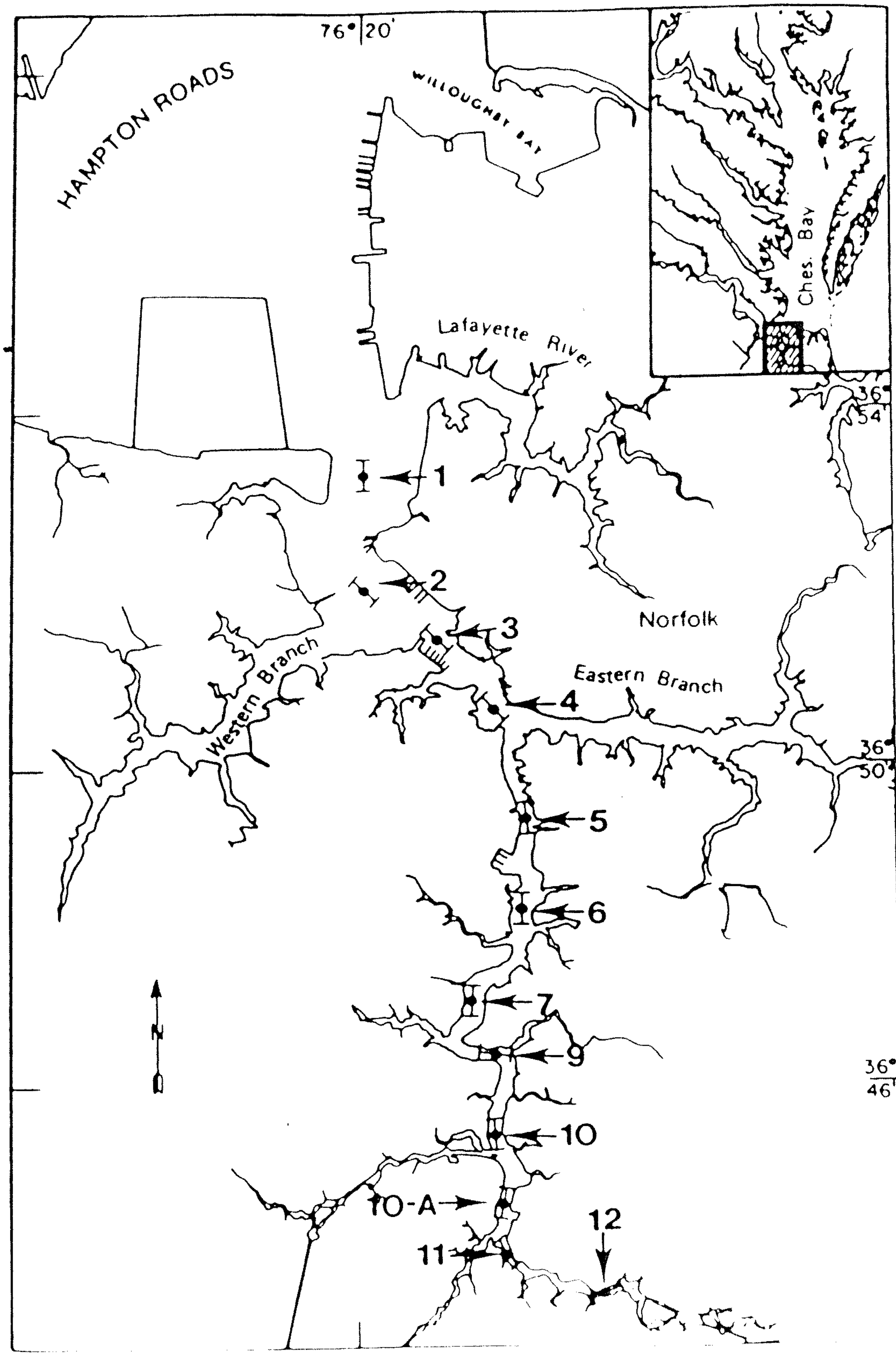
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HAMPTON ROADS
WILLOUGHBY BAY
Lafayette River
Norfolk
Western Branch
Eastern Branch
Ches. Bay
36° 54'
36° 50'
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CONDITION INDEX (K)
SPOT (Leiostomus xanthurus)

IN THE YORK AND ELIZABETH RIVERS, VA.

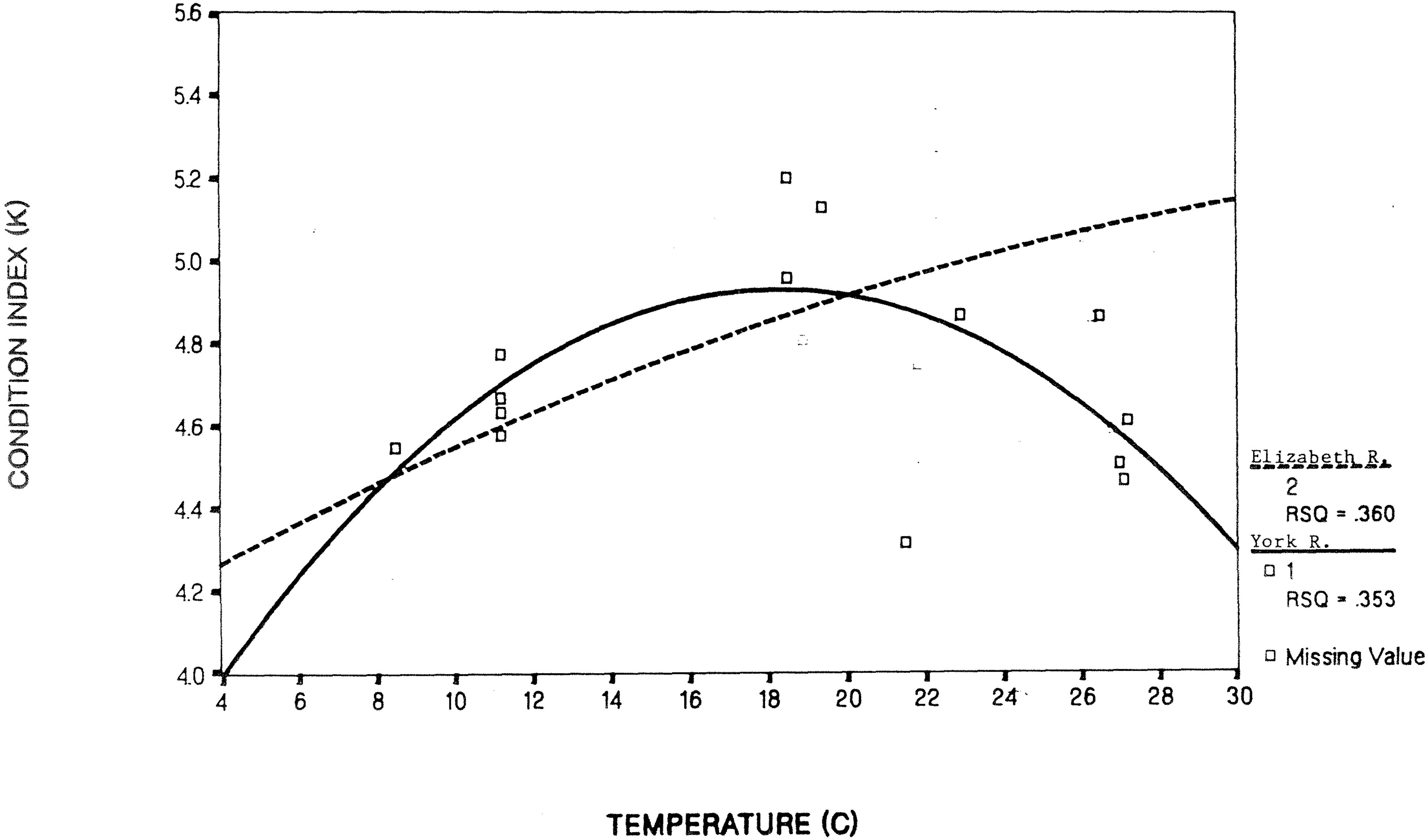

Figure 2