PROJECT OBJECTIVES:

1. To determine the feasibility of using the heated water discharged by electric power stations to increase the efficiency of shellfish production.
2. To obtain data on the growth and quality of growth of oysters as affected by increased water temperature.

ACHIEVEMENT OF OBJECTIVES:

We have achieved the objectives of this project as outlined above. It has been demonstrated conclusively that the heated effluent from a fossil fuel power plant on the north shore of Long Island Sound can stimulate and accelerate the growth, gonadal development and shell deposition of oysters.

RESEARCH PROCEDURES USED:

The oysters *Crassostrea virginica* used in this study were yearlings obtained from a commercial bed in Norwalk Harbor, Connecticut. The oysters were maintained in two plastic coated cages. One cage of oysters was suspended in the discharge canal of the Connecticut Light and Power fossil fuel power plant at Norwalk, Connecticut on June 1, 1971. The other cage of seed oysters, which served as the control was suspended near the intake of the plant on the same day. Monthly samples of 30 oysters from each group were taken commencing in June 1971 and continuing to October 1972. Water samples were also taken for chlorophyll analysis. Water temperature measurements made daily at midnight and noon were obtained from the plant's
own temperature recordings. Oxygen concentrations were determined with a YSI Model 54 oxygen meter. In the laboratory the meat and shell of 20 oysters from each sample were weighed after carefully blotting with a paper towel. The oysters were then combined in groups of two or three and homogenized in water (50 ml/gm). The homogenate was frozen and thawed three times, centrifuged, and the supernatant poured off and saved for protein and carbohydrate determinations. Protein concentration was determined according to the method of Lowry et al. (1951). Bovine serum albumin was used as the standard protein. Total carbohydrate concentration was determined spectrophotometrically using the reaction of phenol and sulfuric acid as described by Dubois et al. (1956). Glucose was used as the carbohydrate standard.

The remaining ten oysters from each sample were fixed in Davidson's fixative. A section was cut from the center of the stomach perpendicular to the anterior-posterior line, processed by standard histological methods, sectioned at 7μ, and stained with hematoxylin and eosin. The amount of chlorophyll was used to estimate the relative amount of phytoplankton in the discharge and intake channel. For each determination one liter of water was filtered with a Millipore filter (0.45μ) and the chlorophyll extracted in acetone according to the method of Strictland and Parsons (1965). The absorbance was measured at 665 nm with a Beckman Acta II spectrophotometer using 1 cm cuvettes.

RESULTS OR CONCLUSIONS:
Yearling oysters suspended in trays in the heated effluent and also near the intake to a power plant were sampled monthly for 17 months and their protein and carbohydrate content, condition index and extent of gonadal development determined. During the winter and spring months (December to May), the oysters in the heated effluent averaged 56, 109 and 22% higher in protein and carbohydrate concentration and condition index than the
control oysters. However, during the summer months (June to September), the control oysters attained levels of protein, carbohydrate and condition index that were similar to that of the warm water grown oysters. Examinations of histological sections revealed that gonadal development of the oysters in the heated effluent was four months in advance of that of the controls but spawning took place only one month earlier (June) than that of the control oysters. In addition to the biochemical and gonadal effects, the oysters in the heated effluent produced shells that were significantly heavier for a given shell dimension product (Length X Width X Height) than the controls (P < 0.05).

The elevated temperature (14-19°C) in the discharge channel during the winter and spring allowed the oysters there to feed while the control oysters in the ambient temperature (2-7°C) remained relatively inactive. The abundance of phytoplankton during this period will no doubt dictate how great an advantage will accrue to the oysters. During the summer the temperature in the effluent (ca. 30°C) apparently exceeded the optimum for the growth of oysters. It was shown that the growth period of oysters held in the heated effluent could be extended to 9 months as compared with the normal 6-month growing season for the control oysters. We, therefore, conclude that it is feasible to use the heated effluent to increase the efficiency of shellfish production. However, detailed engineering design of such a shellfish culture system as well as the evaluation of sanitary conditions of shellfish grown in the effluent are still to be investigated.

REFERENCES:

Protein measurement with the Folin phenol reagent. J. Biol. Chem. 
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LIST OF PUBLICATIONS:
Ruddy, G.M., S.Y. Feng and G.S. Campbell 197-. The effect of prolonged 
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development and shell deposition of the American oyster, Crassostrea 
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Physiology.

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ABSTRACT:
The oysters in the heated effluent consistently showed higher levels 
of protein, carbohydrate and condition index than that of the control 
oysters during the winter and spring months. The rapid growth of oysters 
in the discharge canal during this period appeared to be associated with 
optimum temperatures (14-19°C) and the presence of a very large spring 
phytoplankton bloom which due to the low ambient temperatures (2-7°C), 
was not utilized by the control oysters in the intake canal. During the 
summer months, the control oysters attained levels of protein, carbohydrate 
and condition index that were similar to that of the warm-water grown 
oysters.
The development of the gonads of the oysters in the heated effluent occurred four months earlier than in the controls, but spawning took place only one month earlier. The warm-water grown oysters produced thicker shells than the control oysters.

KEYWORDS:
Oyster; Crassostrea virgirica; Fossil Power Plant; Temperature Effect; Prolonged Exposure; Protein; Carbohydrate; Condition Index; Gonadal Development; Shell Deposition.