BEFORE THE UNITED STATES

ATOMIC ENERGY COMMISSION

In the Matter of Consolidated Edison Company of New York, Inc. (Indian Point Station, Unit No. 2)	)))))	Docket No. 50-247

TESTIMONY OF

JOHN R. CLARK

ON

CUMULATIVE EFFECTS OF
HUDSON RIVER POWER
PLANTS AND OTHER MATTERS

DATED: MARCH 30, 1973

I. EFFECTS OF HIGHER TEMPERATURES FROM MULTIPLE PLANTS ON HUDSON.

This testimony is concerned with the effect on the aquatic biota of the Hudson of the increased water temperatures predicted by Siman-Tov in testimony dated February 8, 1973, "Preliminary Study of Expected Temperature Distribution in the Hudson River as a result of Operation of Danskammer, Roseton, Indian Point Units 1 and 2, Lovett and Bowline Power Stations."

Siman-Tov concludes that the five power stations have a heat loading potential sufficient to raise the temperature of the water mass of the Hudson estuary over 80 miles of its length - about 35 miles of it would be heated by 4°F to 6°F under the conditions described in the testimony (Siman-Tov, Fig. 6). This increase in temperature would have a significant adverse impact on the ecology of the estuary. An increment of up to 6°F in the estuary temperature is sufficient to alter substantially many of Con Edison's major contentions about survival of entrained organisms and the resilience of the estuary biota vis-a-vis Indian Point heat discharge. For purposes of exposition in the discussion below, I have used temperatures of 3°F (without Indian Point, Siman-Tov Fig. 5) and 6°F (with Indian Point, Siman-Tov Fig. 6) to illustrate probable effects.

An increase of 3° or 6°F would push the temperature of the Hudson estuary well into the 80's (see attached figure 1, from Lauer, Environmental Report Supplement, App. J.). The ecological effect would be unfavorable in many respects. For example, the natural estuary ambient temperatures during the peak of abundance of embryonic stages of striped bass in the vicinity of Indian Point (about June 1st - Clark, Test. of 10/30/72) is about 63-64°F (figure 1). Striped bass embryos and larvae (of the South Carolina stock in laboratory conditions) are still within their safe temperature during long term exposure (180 minutes) to water at 64°F (figure 2). Even at the late end of the embryonic period (June 10-15th) with temperatures of 68°F, the embryos are safe. But an increase of 6°F in the Hudson temperature in early June - historically the time of peak spawning of striped bass would be 70°F - is sufficient to expose the embryos in the estuary to a brief period of lethal temperatures during the gastrula stage. From this time to the virtual end of spawning in mid-June, the embryos are exposed to natural temperatures that are increasing rapidly to 68°. With an added 3°F or 6°F, temperatures would increase to 71°F or 74°F - sufficient to guarantee lethal exposure for several hours at the gastrula stage and (for survivors) again just after hatching. Consequently, substantial numbers of embryos at large in the estuary would be exposed to lethal temperatures. Of course, virtually all of those entrained into the plant cooling system would be killed (see next section).

In the heated portion of the Hudson, the fish might spawn earlier in response to the increased temperature, thus lessening the damage, but we do not know if this would happen. Certainly, those above the heated section would be expected to spawn on their natural schedule and such of their embryos as might drift into the heated water would suffer the exposure outlined above. Those spawned ahead of schedule may be out of place with the seasonal abundance of larval food, and thus malnutrition might reduce survival.

Temperatures in the 80's must be considered stressful to striped bass. Siman-Tov shows that estuary temperatures would reach the low to mid-80's in summer - up to 83.3 with Roseton and Bowline and 85.7°F with Indian Point 1 and 2 on line. Chadwick noted loss of equilibrium at "temperatures over 85°F" (Lauer, Test. of 2/20/73), indicating major stress which, if continued, would certainly lead to death. The incremental 3° or 6°F can be expected to have similarly serious impacts on embryonic and larval stages of many other species that spawn in the Hudson estuary.

One must expect that an increase of 3° or 6°F in the Hudson estuary, pushing temperatures into the 80's, would have generally unfavorable ecological effects in the summer when much of the biota would be existing beyond any reasonable optimum temperature condition for growth and reproduction. The adverse effect of high, but still sub-lethal, temperatures on growth of fish is shown in figure 3, from the work of J.R. Brett with sockeye salmon reviewed by C.Coutant (CRC Crit. Rev. in Env. Contr., Vol. 1, Issue 3: Fig. 12). Coutant states:

> "Starved fish progressively lose weight at a rate that increases with temperature rise. At the opposite extreme, excess ration yields a growth response with a marked thermal optimum that decreases either side to low growth rate at low temperatures, and weight loss as temperature approaches the lethal level. Limitations in available food displaces toward lower temperatures both the optimum (or mode of the curve) and the temperature at which growth ceases and weight is lost."

In discussing the broader effects of temperature increase, Coutant states, ". . . there are several processes that could be contributing to imbalances of production and consumption" and mentions elimination or reduction of herbivores and inedibility of the prominent algal species as shown in figure 4 from Coutant (designed by J. Teal). One would certainly expect a strong shift in the phytoplankton community toward blue-green algae which, as Coutant mentions, are considered by many biologists to be an inferior base to the food chain, compared to green algae and diatoms that are more abundant at lower temperatures. The blue-greens already make up about 25% of the phytoplankton in the estuary (Lauer, Test. of 10/30/72).

A significant increase in blue-greens at the expense of greens and diatoms - expected with the incremental 3°F or 6°F - would be expected to interfere markedly with the food chain by reducing the food supply of the herbivores. With estuary natural temperatures near 80°F in summer, the blue-greens are repressed; however, as temperatures are increased into the mid-80's, and beyond, the blue-greens begin to dominate. From Coutant (particularly Figure 9), one might expect the critical point for rapid increase in blue-greens to occur where they comprise about 25% of the phytoplankton as, for example, they did in the Hudson in August and September of 1971 at temperatures in the range of 76-80.5°F (Lauer, Test. of 10/30/72).

Effects of Passage of Organisms Through Indian Point 2.

Lauer's data for entrainment sampling of *Morone* larvae indicate that mortality increases with discharge temperature (Lauer,Test. of January, 1973). In July, with discharge temperature of 94°F, only 1 of 38 *Morone* larvae survived passage through the plant and discharge canal (Clark test. of 2/12/73) a mortality of 98.4% when weighted by differences in cu. meters of water sampled (calculated from Lauer, table 1: intake $13.5m^3$, discharge $21.8m^3$=.62) - a virtually complete kill. With an incremental 3° to 6°F, discharge temperatures of 94°F or higher would be common throughout the summer, increasing the probability of a virtual 100% mortality of larvae entrained in the plant.

Phytoplankton metabolism was often reduced in Lauer's experiments (Lauer, Test.of 10/30/72; tests on phytoplankton from the cooling system, table 1) when discharge temperatures exceeded 88°F. The frequency and intensity of the reductions would be greater and occur over a longer span of time with a 3° or 6°F incremental estuary temperature.

The incremental 3° or 6°F temperature would be expected to have a significant effect on entrainment survival of copepods. It would appear from Lauer's testimony (10/30/72) that significant mortality of copepods could be predicted at discharge temperatures above 93°F, which would be infrequent without the 3° or 6°F incremental temperature, but which could be expected from mid-July to late August at 3°F incremental, and from early July through early September at 6°F incremental. Lauer (Test. of 10/30/72) concludes that "sizable percent mortalities of <u>Neomysis</u> (an important food for striped bass and other species) may occur in the discharge canal when temperature exceeds 90°F." The mortality during this time would be increased because of the incremental 3°F or 6°F. Also, the time span over which the "sizable percent mortalities" of Neomysis occur would be increased by 1 to 1-1/2 months extending the total effect in time and in severity.

Through synergy, the higher estuary temperature caused by the incremental 3°F or 6°F would also increase the adversity of oxygen reduction (reduced affinity of hemoglobin for oxygen, increased metabolism) chlorine toxicity (increases speed of reaction) and other impacts within the cooling system.

EQUILIBRIUM SURFACE TEMPERATURE
&
RIVER AMBIENT TEMPERATURE
HUDSON RIVER NEAR INDIAN POINT

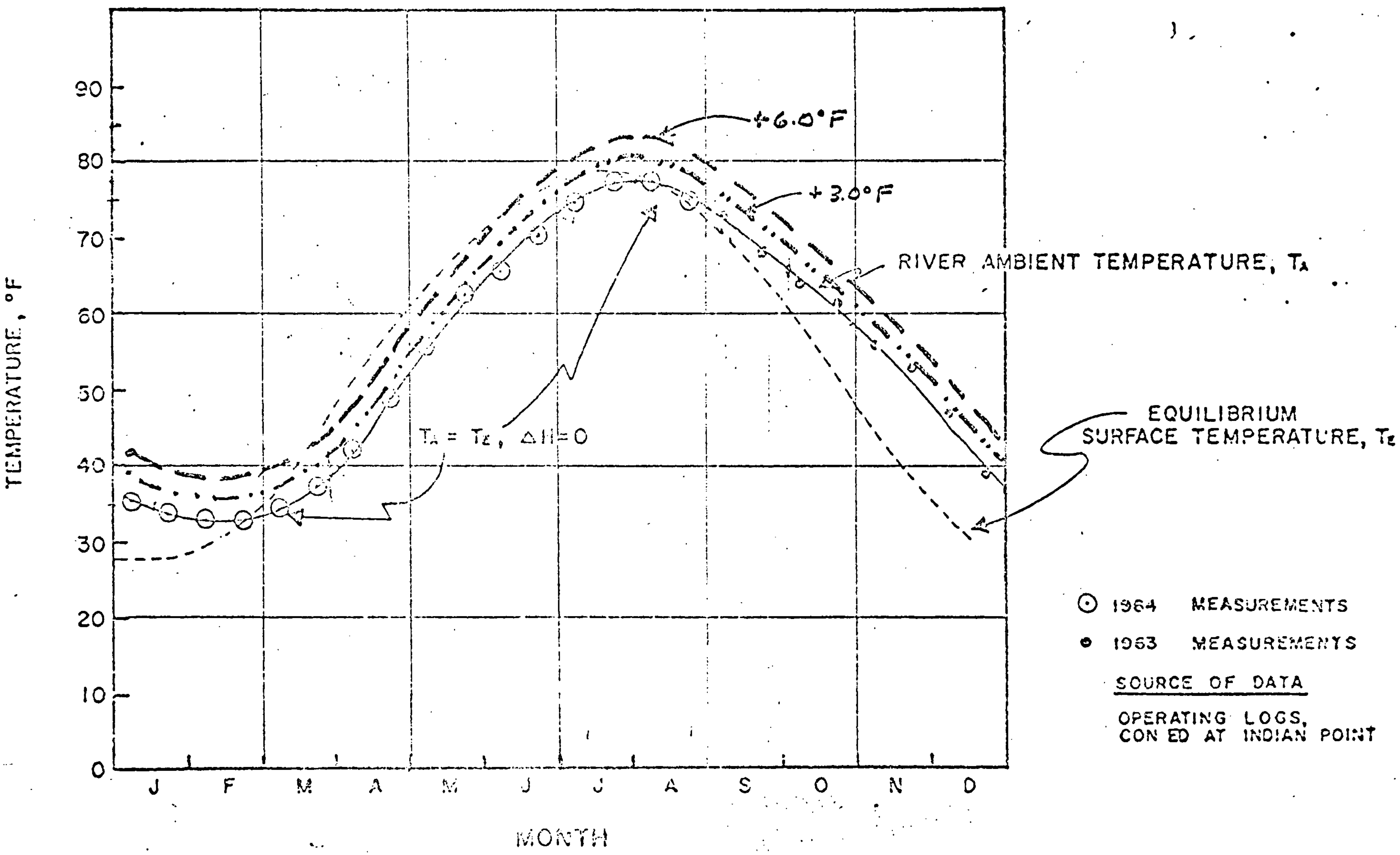

FIGURE 1

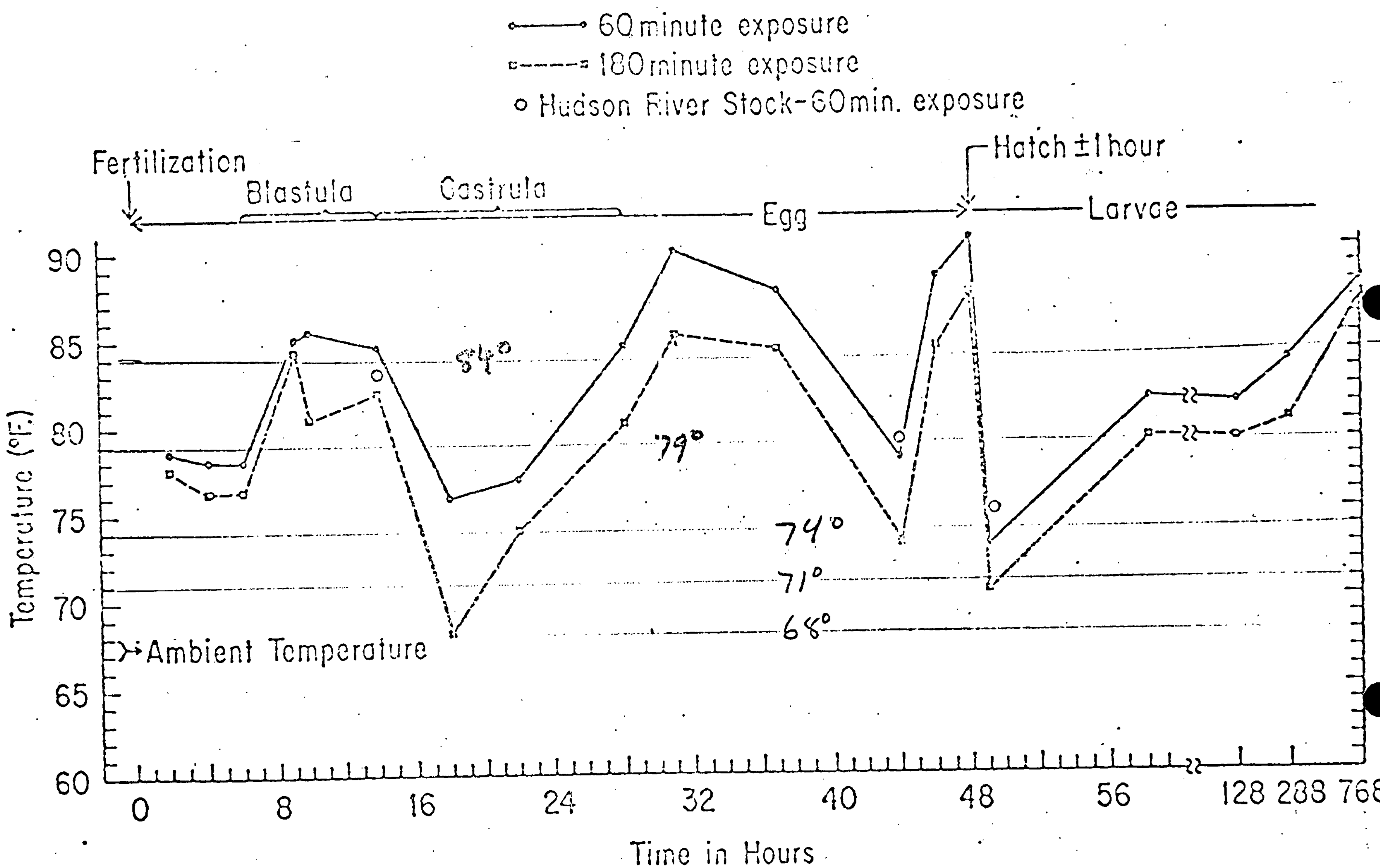

Figure 2 Maximum Safe Temperature[1] for Striped Bass Eggs and Larvae from Monks Corner, S. C. Hatchery Stock (from Lauer testimony of Feb. 1973).

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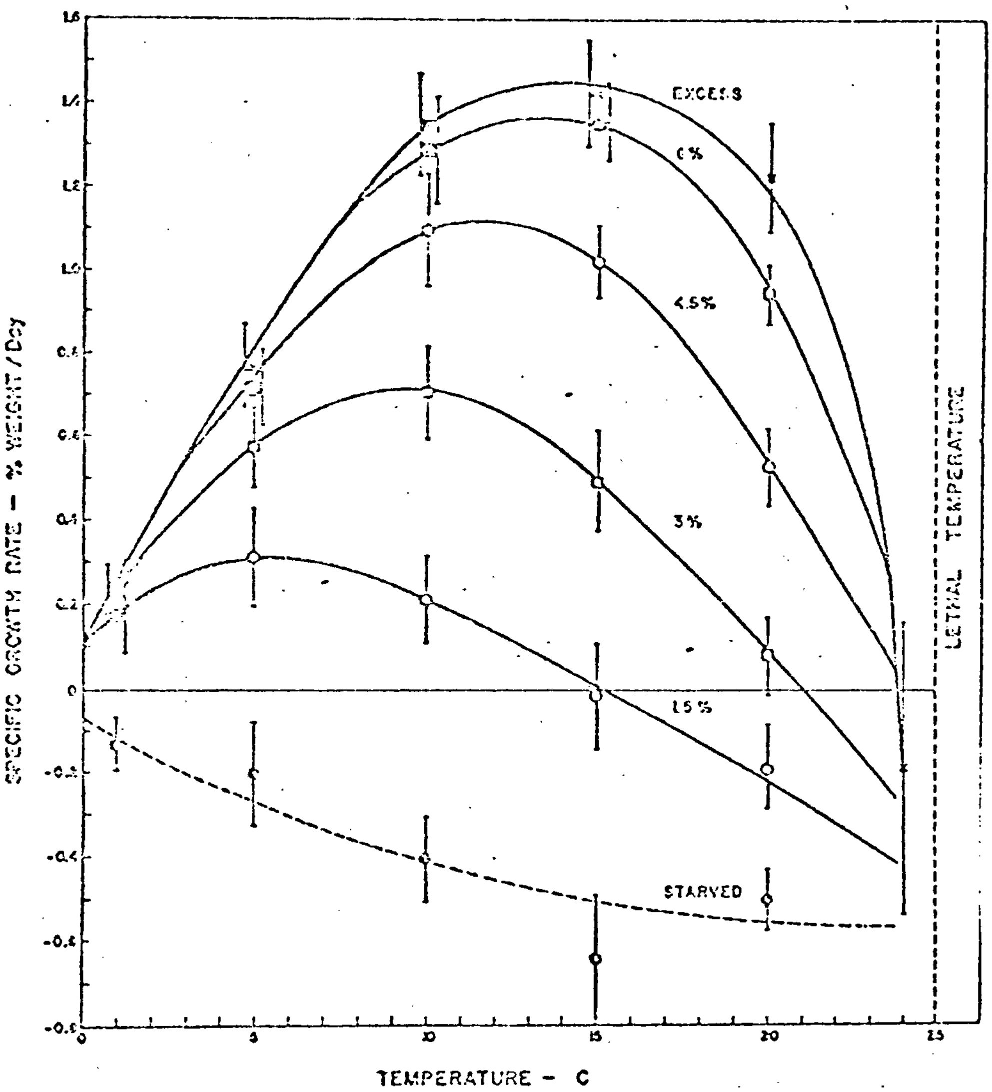
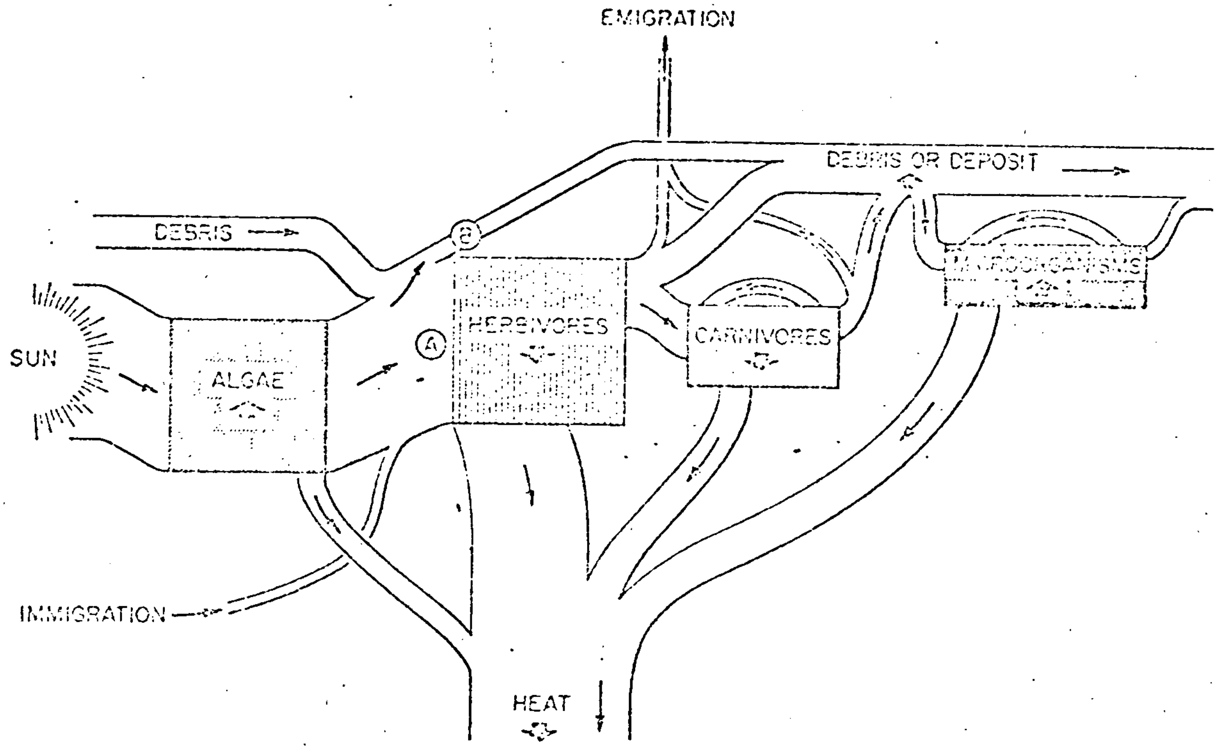
[1] Safe temperature is the maximum temperature of exposure which did not result in increased mortality or abnormal development compared to controls.

FIG. 3



Combined effects of ration (% of body weight per day) and temperature on growth rates (±2 SE) of 7- to 12-month-old sockeye salmon.[128]

FIG. 4



Pattern of energy flow through a stream ecosystem." Small arrows indicate direction of energy flow; large arrows indicate increase (up) or decrease (down) of a component at abnormally high temperatures.

II. COMMENTS ON "ELECTROPHORETIC DETERMINATION OF POPULATIONS OF STRIPED BASS, *MORONE SAXATILIS*, IN THE UPPER CHESAPEAKE BAY," BY MORGAN, KOO AND KRANTZ.

I have reviewed the subject paper from the American Fisheries Society transactions (TR. 9869-71) and find that it is not likely to be applicable to the problem of determining the source of fish in a coastal stock. This method is useful in describing similarities or differences in particular populations but is not the type of analysis that can be used to determine the percentage composition of a stock of fish in terms of spawning centers of origin.

This paper did not define a "Chesapeake type" of fish; to the contrary, the authors found differences in protein characteristics of the fish among various spawning rivers in the northern part of the bay. The investigators found substantial differences in fish collected in the same place on different days and they also found differences between the ages and the sexes of the fish. They commented:

> "We were disappointed in finding so many of the proteins related to the age, sex and day of collection for the striped bass."

They found some of the Chesapeake river fish to be the same as others and some to differ. The variations were not systematic. They did not present tests to show if the results could be duplicated in one or more following years. Nor did they look at any stocks outside the Chesapeake. Thus, there is no showing from the paper that there is a likelihood that sampling of the mid-Atlantic coastal striped bass population will allow a determination of the proportion of that population which is contributed by the Chesapeake, the Hudson or other spawning centers.

III. COUTANT SAFETY FACTOR

I wish to clarify my response to Dr. Geyer's questions about the Coutant 3.5°F safety factor during my testimony on March 7, 1973. According to my notes, Mr. Chadwick reported at the February Entrainment and Impingement Workshop at Johns Hopkins in reference to upper lethal temperatures that 86°F was the maximum "safe" temperature for striped bass, based on L.D. 50 experiments. Furthermore, loss of equilibrium was noted by Chadwick at 85°F. If one adjusts the 86°F L.D. 50 by the Coutant safety factor - 3.5°F (2°C) - the maximum safe temperature is 82.5°F. If one assumes that the loss-of-equilibrium syndrome at 85°F is indicative of an irreversible condition leading to 50% death of the larvae and one assigns this as the L.D. 50, then the maximum allowable temperature after deducting the 3.5°F is 81.5°F. Using either the 81.5°F or the 82.5°F maximum, one finds that the Indian Point discharge temperature with a 14°F delta T exceeds this maximum throughout the summer season, starting in mid-June. If, as predicted by Mr. Siman-Tov's analysis, the temperature of the Hudson in the stretch of the river near Indian Point is raised 6°F by accumulated heat loading of the plants along the estuary, lethal discharge temperatures would begin in late May and extend until early October.