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

Place - Croton-on-Hudson, New York

Date - 4 December 1972

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MR. KARMAN: That is our direct evidence, Mr. Chairman.

CHAIRMAN JENSCH: Very well. It is almost the time for our recess. Shall we proceed with the Hudson River Fisherman's Association or would you prefer after recess?

MR. MACBETH: I think this can be done rather briefly. We have three documents to offer in evidence. The first is testimony of John Clark dated July 14, 1972, on certain effects of once-through cooling systems on Indian Point and the Hudson Estuary. The second is the testimony of Dr. ERic Aynsley, dated October 30th, 1972, on laternatives to once-through cooling on Indian Point Unit No. 2, and the third is testimony of John Clark, dated October 30, 1972, on the effects of Indian Point Units 1 and 2 on the Hudson River aquatic life.

The -- the Clark testimony of July and the Aynsley testimony of October 30th have previously been served on the parties and the Board. Theree were a few inadvertent omissions from the Clark testimony of October 30 and in light of stipulation reached by the Applicant on impingement of fish, some refinement and modification of the figures on the fish impingement -- rather than produce an errata sheet, I thought it was simpler to redo the appropriate pages. I have done that and I present that testimony. It is

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essentially the same testimony filed on October 30th as incorporated and I have marked under the date, final, simply to distinguish it from the earlier testimony from there, should there be any confusion.

Neither witness is here at the present time but the parties have stipulated they agree that if here, they would adopt this testimony as their own and I would move to have the three pieces of testimony incorporated in the transcript as if read.

CHAIRMAN JENSCH: Any objection from the Applicant?

MR. TROSTEN: No objection. I would ask Mr. Macbeth to identify the pages -- the revised pages.

MR. MACBETH: Yes. If I could do it later I could identify the pages so it is clear to everyone. I don't have the numbers on the top of my head.

CHAIRMAN JENSCH: Excuse me. Does that conclude your statement, Applicant?

CHAIRMAN JENSCH: Yes, sir.

MR. MARTIN: No objection.

MR. KARMAN: No objection.

CHAIRMAN JENSCH: The request of counsel for Hudson River Fishermen's Association is granted and the statements from witnesses Clark and Aynsley may be physically incorporated in the transcript as if orally presented and shall constitute evidence on behalf of the Hudson

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River Fishermen's ASsociation.

(The documents follow.)

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MR. MACBETH: One final matter. A stipulation was entered into between the Applicant and the Hudson River Fishermen's Association and the Environmental Defense Fund involving some of the facts on fish impingement and dated and signed October 30th, 1972. Copies of that stipulation have been served on the parties and the Board and I would simply offer to put that in the record at this point as well. I have copies which I will give the reporter.

CHAIRMAN JENSCH: Any objection?

Applicant? Hudson River -- New York Atomic Energy?

MR.MARTIN: No objection.

MR. TROSTEN: No objection.

MR. KARMAN: No objection.

CHAIRMAN JENSCH: The request will be granted and it may be physically incorporated in the transcript as if read.

(The document to be furnished.)

eak6

MR. MACBETH: One final matter. A stipulation was entered into between the Applicant and the Hudson River Fishermen's Association and the Environmental Defense Fund involving some of the facts on fish impingement and dated and signed October 30th, 1972. Copies of that stipulation have been served on the parties and the Board and I would simply offer to put that in the record at this point as well. I have copies which I will give the reporter.

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Applicant? Hudson River -- New York Atomic Energy?

MR. MARTIN: No objection.

MR. TROSTEN: No objection.

MR. KARMAN: No objection.

CHAIRMAN JENSCH: The request will be granted and it may be physically incorporated in the transcript as if read.

(The document to be furnished.)

BEFORE THE UNITED STATES

ATOMIC ENERGY COMMISSION

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

TESTIMONY OF JOHN CLARK

ON

CERTAIN EFFECTS OF ONCE-THROUGH COOLING SYSTEMS OF INDIAN POINT UNITS NOS. 1 & 2 ON HUDSON ESTUARY FISHES AND THEIR ENVIRONMENT

July 14, 1972

The operation of Indian Point Units Nos. 1 and 2 with once-through cooling will have extensive adverse effects on the fish and fisheries of the Hudson Estuary. These effects include direct killing of a large quantity of Hudson fishes, disabling others, interfering with their life cycles, and disrupting their environment and their sustenance. Here I deal principally with the effect on fish and their life cycles of the heated effluent; with the way in which chemical contamination of the cooling water will effect fish; and with the interference with the food chain, the lower forms that make up the food supply of the fishes.

Type of Effect on Fishes

A high megawattage nuclear power plant such as Indian Point No. 2 operating with once-through cooling withdraws large quantities from its source and returns the water substantially heated,often with the addition of chemical contaminants. Such operation has a variety of direct and indirect effects on fishes. The direct killing of masses of fish by steam generating plants on the screens and within the cooling system is well documented and is the subject of other testimony. In addition there are the external effects of the plants on fishes, effects that occur outside the plant in the estuary. The most significant external adverse impacts on fish and fisheries may occur at the non-lethal level; that is, they would function to reduce the size and vigor of natural populations without causing immediate or visible kills. Occasionally there are direct and immediate kills, for example, cold-shock kills caused by abrupt plant shutdown in winter time when fishes resident in the plume area are rapidly impacted with cold ambient water.

Before discussing the variety of external effects that I expect will result from operation of the Indian Point plants, it is appropriate to review some ecological life cycle functions of fishes.

Types of Critical Functions and Areas

In siting and operating a power plant it is essential to select a location and a mode of operation that will add the least impact on aquatic life and on the aquatic environment. In reference to fish life, the key to minimizing adverse impacts is to identify critical life functions and avoid interference with these.

Fishes perform regular seasonal rhythms of critical life functions going into different behavior modes and migrating to different parts of their general habitat. This has the effect of making them especially vulnerable to interference at certain times of the year and in certain places.

It is absolutely essential to avoid siting power plants in these areas of critical function. If, due to inadequate knowledge and planning or other factors, a plant is constructed in one of these areas it is mandatory that the utility design into the plant the maximum safeguards necessary to reduce adverse impacts to the negligible point. The technology exists to accomplish this goal through choice of appropriate operating systems.

Critical Areas for Hudson Fishes

The following are the five basic critical functions of key Hudson River fish species and the areas involved with each function:

1. Breeding* -- breeding areas
2. Culture of young -- nursery areas
3. Nourishment -- feeding areas
4. Migration -- migratory pathways
5. "Hibernation" -- wintering areas

Those functions performed in the Hudson must be protected. This requires extreme care in the selection of power plant sites and modes of operation. In Table 1, I have indicated the areas of critical functions for each important Hudson species of fish (as recognized in Appendix II-3 of the AEC draft detailed impact statement for Indian Point No. 2, April 13, 1972).

Often the critical areas are very restricted in size compared to the whole range of the population of a species, yet its survival in high abundance throughout its range depends upon conditions in these critical areas. It is quite possible to deplete severely a population of fish by disrupting its breeding area or its nursery area or by interfering with its movement along a migration pathway.

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*Spawning and larval development

TABLE 1

PRIMARY PLACE OF CRITICAL FUNCTIONS

SPECIES	BREEDING AREA	NURSERY AREA	FEEDING AREA[1] ADULT	WINTER AREA	MIGRATION
Alewife	HF	HF	O	O	OH
Anchovy (bay)	HE	HE	HG	HE*	HE*
Bluefish	O	HE	O	O	OH[3]
Eel[4]	O	HE and HF	HE and HF	HE and HF	OH
Herring (bl. back)	HF	HF	O	O	OH
Menhaden	O	HE	O	O	OH[3]
Shad (Amer)	HF	HF	O	O	OH
Smelt	HF	HE	O	O and H*	OH
Striped Bass	HF	HE	O	HE[2]	OH
Sturgeon (Amer & Sht. nose)	HE	HE*	O	HE[2]	OH
Tomcod	HE	HE	O*	HE	OH
White perch	HF	HE	HE	HE	HE

[1]Adolescents may feed as adults or juveniles.
[2]Some larger adults may winter in offshore ocean areas.
[3]Migration does not involve adults.
[4]In river females recorded primarily in fresh, males in estuarine waters.

General Notes:

*Definitive data lacking.

HF - Fresh water areas of Hudson. Upper part of Hudson is fresh-water with variable southern boundary.

HE - Estuarine areas of Hudson. Estuarine part of Hudson has variable northern and southern boundaries; from Tappan Zee or Haverstraw Bay north to about Cornwall. This is the area heavily impacted by Indian Point operations.

OH - Migrates along Hudson pathways on way to sea or return.

O - Oceanic areas including open sea, bays, sounds and lower Hudson.

This is especially true where a power plant is located on a narrow reach of a tidal river or estuary, through which the fish must, for example, migrate to a breeding area, a nursery area, or a wintering area or which is itself a critical area.

From Table 1 it can be seen that for all 12 species identified there are major critical areas in the Hudson, and that all but two must traverse the Hudson on migrations to the ocean and return. With this background it is then necessary to determine any adverse impact of the particular plant site on these critical areas and their relevant functions. The Indian Point plants are situated on a relatively narrow reach of the Hudson and also in an area which is critical to the life functions of various fishes. Controls on plant regulation must be considered in this context. In order to provide sufficient protection these controls must be based upon the "worst case" predictions of adverse impact. In discussing these impacts the striped bass, the most important sport and commercial fish in the Hudson, is used as the primary example.

Hudson striped bass feed and make their adolescent and adult growth primarily in the sea --- open ocean, bays, estuaries, ranging long distances from the Hudson in search of food.

Many return in winter to live in a near-dormant stage in the Hudson, where the young are found in the channels suspended in the mid-depths, mostly between 20 and 30 feet, and the adults are found in greatest abundance suspended four to eight feet off bottom along the slopes where the Hudson is 30-45 feet deep. On Cruise D-68-2 of the R.V. Dolphin (March 6-8, 1968) we found the maximum concentration of adults in upper Haverstraw Bay and the maximum concentration of juveniles north of the bay in the vicinity of Indian Point. Both adults and juveniles were in a state of metabolic reduction or semi-hibernation, had low response levels, and showed no sign of active feeding. Concentrated near Indian Point in this semi-dormant condition they are particularly defenseless and vulnerable to impacts from the plants.

As water temperatures reach the mid-40's, striped bass become active again. In spring, the mature males and females move upriver past Indian Point to spawn farther upriver, and migrate back downriver after spawning, to live and feed in the ocean during summer and fall. Therefore, twice in their spawning migration most striped bass pass Indian Point and are exposed there to any negative impacts of the plant. Another group of striped bass appears out of the sea in spring and ascends the Hudson to spawn (having wintered to the south). This group is also subject to the impact of Indian Point on its spawning run.

Most striped bass migrate to areas above Indian Point for spawning, but the main nursery areas are below Indian Point, and thus most young fish have to pass the constricted Indian Point site on their way from spawning to nursery areas. Because of tidal action and salinity-induced circulation, each fish may be swept back and forth in front of the plant ten, twenty, or more times while it is in its planktonic or pelagic stage.

The eggs are semi-buoyant and drift with the tide. After hatching and living several weeks of planktonic and pelagic life, drifting about the estuary with the tides, the young striped bass appear to seek out the bottom in the shallower parts of the estuary. Here, while feeding along the shallow bottom during late summer and fall, they are not so vulnerable to the plants. At this time the adults and advanced adolescents are safely out to sea feeding .

It is not feasible here to examine each species and describe its critical areas in relation to the Indian Point site. However, Table 1 provides the basic information on critical areas for the identified 12 important Hudson species.

External Impacts of the Indian Point Plants

I shall discuss below the external impacts involved with thermal and chemical effects. In general, the discussion relates to combined operations of Indian Point Nos. 1 and 2. The additional plants in the area - Lovett, Danskammer, Roseton and Bowline Point - will, of course, heighten the effects.

Thermal Effects

There is little precise and comprehensive data which allows one to relate volume withdrawal, ΔT, position of the heated plume, ambient water temperature and fish behavior over periods of time in such a manner that it is useful for predicting the effect of the Indian Point No. 1 and 2 thermal plume on the critical functions of Hudson fishes in a precise, quantitative manner. In these circumstances, estimates and opinions must be based on the experience and indirect sources of information which are available. For example, the recent work of J.S. Meldrim and J. J. Gift (Ichthyological Associates, Bulletin No. 7, November, 1971) presents the conclusion that juvenile white perch, living in water of temperatures anywhere in a range from 35° F. to 75° F., always prefer a higher temperature generally than that of the water they are in. When given a free choice then, juvenile fish in the experimental tanks always moved toward temperatures that were 5 to 8° higher. Limited tests with striped bass juveniles indicated that they too choose higher temperatures when given a choice -- perhaps 9°F higher on average. Since different sizes of fish react differently, these experiments with juveniles do not indicate how adults react.

In "thermal shock" studies reported by the same authors, obvious thermal stress was shown for both white perch and striped bass, beginning with $\Delta T = 10°F$ and becoming pronounced at $\Delta T = 15°F$. This indicates that the lives of juveniles of both species are controlled quite closely by temperatures. The relationships are summarized in Figure 1. If we assume the tank experiments to be a reasonable imitation of nature, it would appear that juveniles are attracted always to temperatures somewhat higher than environmental ambient -- usually from $\Delta T = 5°F$ to $9°F$. They appear to be repelled by temperatures higher than $\Delta T = 10°F$.This is the point where the experiments showed thermal stress beginning, stress was far worse at $\Delta T = 15°F$ and there were heat deaths among the juvenile striped bass.

It is apparent why fish would avoid stressful and lethal temperatures just below the stress level, no matter how high the ambient temperature.

Assuming that the experimental results give a true picture, the Indian Point plume would normally attract all juvenile fishes within its influence -- probably to the outermost edge of the gradient where $\Delta T = 0.1°F$. Water of $\Delta T = 0.1\ °F - 1.0\ °F$ higher than ambient would extend over hundreds of acres of the Hudson, attracting juvenile fish toward the plant. These fish would move up the gradient seeking their preferred temperature, which would bring the fish into the region near the discharge point where the high ΔT's are to be found.

Therefore, temperature working alone must inevitably draw juvenile Hudson fish toward the plant where they are (1) susceptible to being entrained with the cooling water and drawn into the plant and, 2) where they are subject to the most intense of adverse external plant effects. The heated effluent itself must <u>at all times</u> tend to concentrate juvenile fish in the part of the plume with higher temperatures, the part close to the plant where concentrations of chemicals are highest, where oxygen may be reduced, and where the food supply (of lower organisms) is most disrupted by adverse internal and external plant effects. But heat in the Hudson does not work as it does in experimental tanks -- in nature other influences are at work which could at times override the thermal attraction.

Experience at Indian Point No. 1 shows that juvenile fish are indeed attracted by heated plume -- especially in winter -- as indicated by the history of massive fish kills at Indian Point 1 and 2 which is detailed in other testimony. There are no data from the Meldrim and Gift experiments to explain why there should be a stronger attraction in winter than spring, summer or fall. The explanation may lie in differential vulnerability to screen impingement, which could affect the kill rate or in a variation of distribution, or responsivity of the fish populations.

An environmental explanation of the increased attraction of juvenile fish to Indian Point in wintertime is that in coldest weather the heated plume does not rise but actually sinks downward. In theory this occurs to some extent whenever the Hudson temperature is below 39°F but is most pronounced in the lower 30's. This is because water becomes less dense from 39°F down to freezing and therefore when heated becomes more dense and when returned to the river will sink through the less dense colder water.

A sunken plume cannot be cooled by evaporation and so the heat tends to remain longer and spread throughout more of the Hudson. Because it sinks it also brings the attractant force of the plume into deeper water where it reaches fish that may be down below the surface. Therefore, low river temperatures in the winter, juvenile striped bass and other species that are in deep waters are reached by the sunken plume from Indian Point 1 and attracted and brought to plant-side. The maximum attractant effect would occur from January to mid-March (see ambient temperatures in Figure 1).

At other times of the year the Indian Point heated water rises and tends to spread out over the estuary where it would attract mostly the fishes living nearer the surface. In summer, for example, this attraction might include the pelagic young stages of fish that were born in the spring, like herrings, white perch and striped bass.

These various responses of juvenile fish have been observed in relation to the plume for Indian Point No. 1, a small plant. The heated discharge of Indian Points 1 and 2 will be four times the amount of Indian Point No. 1 alone. This more massive plume will serve to attract more juvenile fish to plantside than has occurred with only Indian Point No. 1 in operation.

The responses of adult fish to heat have not been studied in relation to Indian Point. The Meldrim and Gift experiments showed that the smaller juveniles reacted differently to heat than the larger ones. Likewise adults may be expected to react at different levels than juveniles.

Chemicals Effects

The effluent plume carries with it not only added heat but a variety of chemical contaminants released on various schedules. It appears chlorine will be released in high enough concentration to have significant adverse effects at the non-lethel level. Chlorine and various of its compounds are poisonous to many forms of fish life when in concentrations above 0.5ppm, has extended adverse effects on life down to 0.01 ppm, and causes avoidance reactions at levels down to 0.001 ppm. and perhaps lower.

The concentrations of chemicals, such as chlorine, in the Hudson will be correlated with plume temperatures as shown in the hypothetical diagram of figure 3 (which represents an arbitrary set of conditions and is not to scale for any of the parameters). If the juvenile fish of the Hudson are attracted by the heated effluent as shown by the Meldrim and Gift experiments, they will be drawn into the hotter area of the plume where they would find preferred temperatures of $\Delta T = 5 - 9°F$ and the maximum and most adverse concentrations of chemicals such as chlorine. Juvenile fishes holding to their preferred temperatures for long periods of time would get frequent higher doses of chlorine, enough, in my opinion, to have adverse effects on them. The same would hold true for oxygen reductions or any other effects.

Another possibility, of course, is that the repelling effect of even the low concentrations spread across the Hudson could override the attracting effect of temperature and block the fish from entering the central plume area where the deleterious concentrations occur and thus spare them entry into the danger area.

However, if the repelling effects occur, for example, at times when chlorine of 0.001 ppm or greater occurs over the whole area of the channel, the migrations of fish upriver or downriver would be interfered with. Unfortunately, at Indian Point, the channel in which fish normally migrate is adjacent to the plant, as shown in figure 4. This means that the maximum adverse external impacts will be in the channel area, and since the fish migrate near the surface (approximately 20 feet) they would be exposed to the maximum impact when there is a rising jet with river ambient over 39° F, i.e., most of the migration period. Whether fish are attracted by the ΔT and detoured from their normal migrations, or blocked by repelling effect of chemicals, the effect will be greatest in the upper part of the channel water where they migrate.

Synergistic Effects

This is a field where virtually no work has been reported in relation to the environmental impacts of the Indian Point plants. One cannot assume, that any of the factors such as temperature or various chemicals work alone, that each can be looked at singly. They have to be examined together to see if synergism is present. For example, the effects of toxicants may become pronounced at high temperatures or lower oxygen concentrations, one chemical may increase the toxicity of another. Insofar as adverse effects on the critical functions of Hudson River fish are concerned, we can expect synergism to compound them.

Trophic Effects

Hudson fish have a variety of diets but each depends on some level or part of a complex food chain, or web. The basis of most of the food web is phytoplankton converted by zooplankton. These plankton forms are subject to internal and external adverse effects of the Indian Point plants. They will be entrained with the cooling water and subject to damage from pressure changes, temperature increase, changes in gas concentrations (oxygen, nitrogen, carbon dioxide, etc.), turbulence, mechanical shock as they are impinged against pipes and chambers within the cooling system, and the effects of chemical releases. The damage may result in immediate death or in extended adverse neurologic or physiologic effects. A high proportion of many species will be killed outright during summer when the maximum adverse effects are present and synergy is at its highest.

Unfortunately, the loss will be greatest for certain zooplankton species that make up the primary diets of juvenile striped bass, white perch, and other Hudson River fish. These zooplankton have a long generative interval, reproducing only 2 or 3 cycles per year. These include the major items in striped bass and white perch juvenile diets: Gammarus and Neomysis. Once killed, the replacement of these species requires considerable time; it is not virtually instantaneous as it is for smaller, simpler plankton forms.

Like the planktonic fish larvae, these zooplankton are moved back and forth with the tides; they drift downstream at the upper levels and are recirculated back upstream in the lower levels by density-induced currents so that they pass repeatedly by the Indian Point and so are repeatedly subject to death with the plant and to other adverse internal and external effects. The damage to the food supply is greatest in the warm season, when the fish are in their larval and early juvenile stag their larval and early juvenile stages and must feed heavily on zooplankton.

Review of Effects on Critical Functions

We have seen that operation of Indian Point Plants No.1 & 2 with once-through cooling will have adverse impacts on each of the critical functions of Hudson fish. Only the most stringent controls on these plants can prevent extensive damage to the fish and to the Hudson and coastal fisheries. Below, I have summarized these effects leaving aside the kills of fish on the screens or within the plant's cooling systems:

Breeding. The Hudson, from Haverstraw Bay north, is the breeding area for many species of diadromous and resident fish. The Indian Point plants are located in such a way as to do significant damage to breeding activities of the majority of these species.

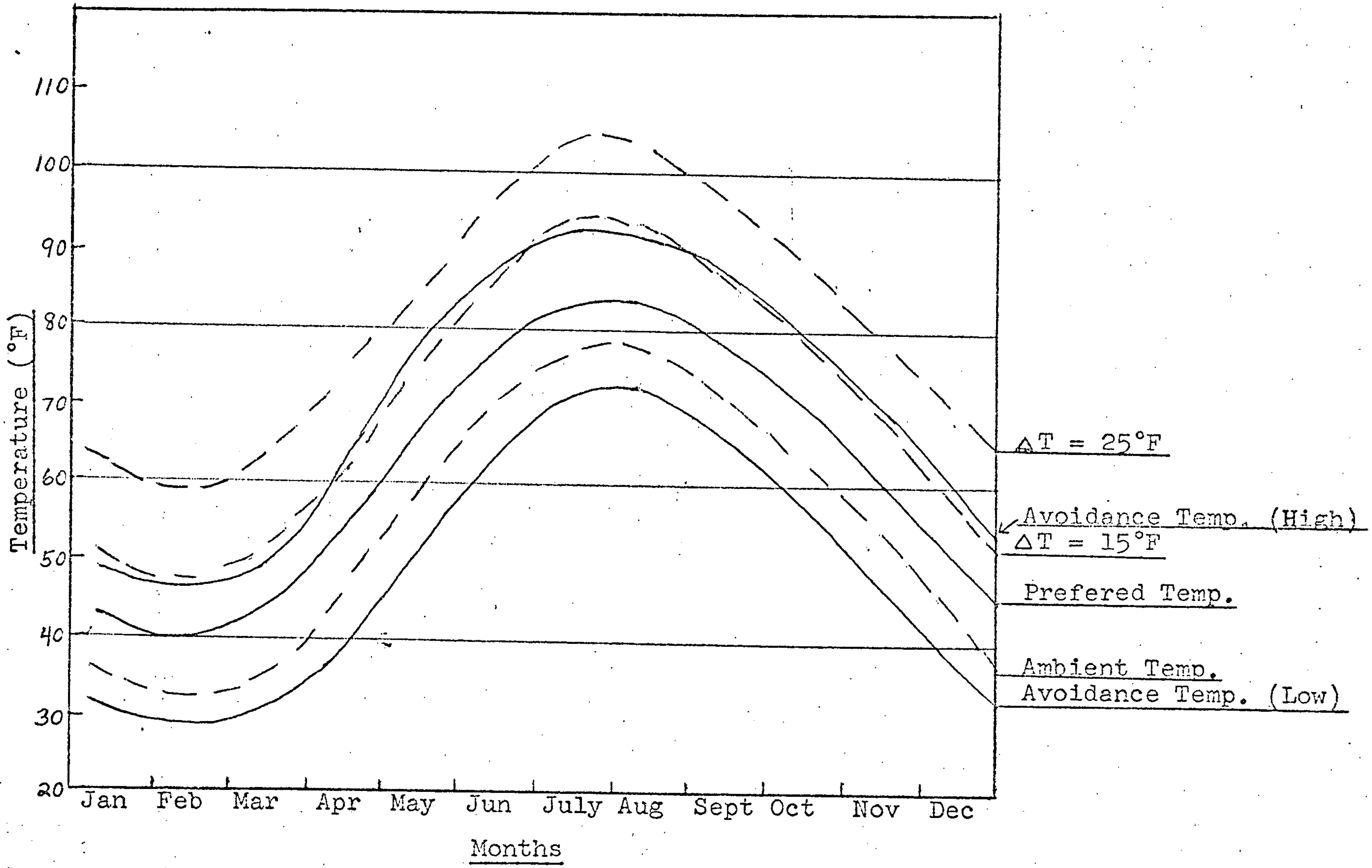
Culture of Young. The Indian Point plant is located in the nursery areas of many of the important Hudson species, including striped bass, where its maximum adverse impacts are operant.

Feeding. Many species of the Hudson are anadromous and do their heavy feeding in oceanic areas, thus the Indian Point plants would not interfere with adult feeding. However, important feeding areas of the larval and juvenile stages are located in the vicinity of Indian Point where adverse impacts would be operant.

Migration. Most of the important species migrate past Indian Point as juveniles or adults as they pass to and from feeding areas, wintereing areas, and nursery areas. Migration occurs in the channel adjacent to the plant and in its upper layers where the heaviest adverse impacts prevail. Interference of the migration patterns to and from the spawning grounds can be expected.

Wintering. Many important species winter over in high concentration in the lower Hudson ----in fact the Indian Point area is one of the greatest wintering areas for fish along the northeast coast. The Indian Point plants are situated so that where they will do significant damage to the wintering juvenile fish.

Figure 1. Seasonal summary of thermal effects on juvenile fishes.



Preference - avoidance data from Icthy. Assoc. Bull. No.7, Nov. 1971

Figure 3. Hypothetical (non-scale) diagram of relation between thermal and chemical outputs (example: chlorine) near the water surface and channel location (rising plume, spring to fall).

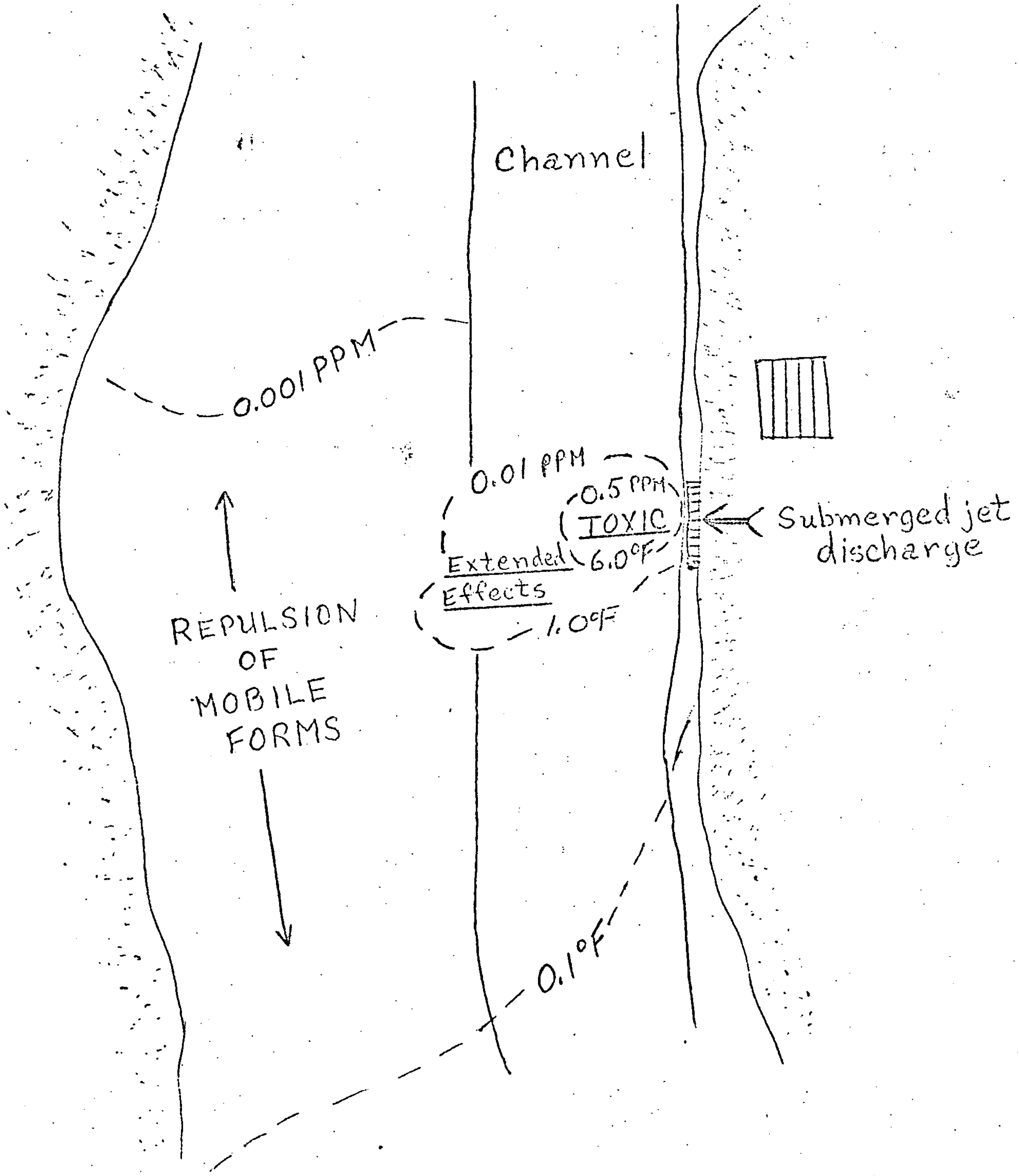
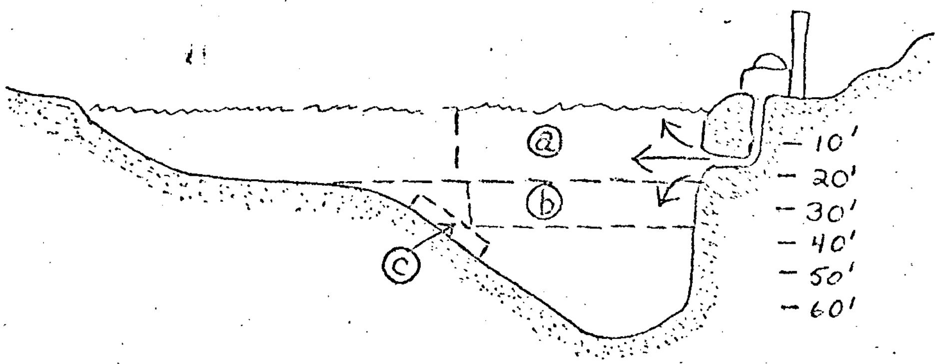


Figure 4. Profile of Hudson Estuary at Indian Point showing areas involved with critical functions of Hudson fishes.



a = Migration pathway

b = Juvenile wintering area

c = Adult and adolescent wintering area

BEFORE THE UNITED STATES

ATOMIC ENERGY COMMISSION

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

Testimony of

John R. Clark

on

Effects of Indian Point Units 1 & 2
on Hudson River Aquatic Life

October 30, 1972
(Final)

we have more scientific data concerning their life history than we have for other species, therefore the striped bass serves as a good example for the probable impact on fish life which will occur with operation of Indian Point No. 2, as it is now designed, and of other power plants to come.

The anadromous striped bass is the most important, economically, of the species that spawn in the Hudson and perhaps the most valuable of all Atlantic fishes. It supports intense recreational and commercial fisheries.

The recreational fishery provides the highest revenues and also supports substantial public participation. The most recent published survey of Atlantic sport fisheries is for the year 1965 (10). It shows that, in 1965, 613,000 persons fished for striped bass in the Middle and North Atlantic states (Maine to Cape Hatteras, N. Carolina) and caught 15,982,000 striped bass weighing 55,340,000 pounds. The next in the series of quintiennial surveys - for 1970 - is not yet published; however, advance figures available from the Department of Commerce (31) show that even though sport fishing increased to 783,000 fisherman, the catch of striped bass declined in number caught to 14,166,000 fish, although the weight increased to 73,106,000 pounds. This trend - a catch of fewer fish of a higher average weight - is diagnostic of a fishery wherein the production of young may have been undermined and which may be following the pattern indicated by the Staff in the Final

Environmental Statement. (22, p V-57).

The Department of Commerce (31) estimates the worth of the striped bass sport fishery of the North and Middle Atlantic states at $59,000,000 for 1970. This is based upon the following for the North and Middle Atlantic:

Total value of Salt Water Fishing	=	$417 million
Total pounds of Salt Water fish	=	514 million
Total pounds of Striped Bass Caught	=	73 million
Percentage of Striped Bass to Total	=	14.2 per cent
Value of striped bass (.142 x 417)	=	59 million

This value is understated, in my opinion. It calculates to only 81¢ per pound, the average for all types of salt-water sport fishes. In reality, striped bass is a highly prized fish, and fishermen pay considerably more to pursue and capture them than they do for the bulk of salt water species. Salt water fishing expert Mark Sosin (40) concludes that the minimum value of striped bass is $2.00 per pound, raising the worth of the sport fishery of the North and Middle Atlantic to a minimum of $146 million per year.

In addition, the commercial fishery for 1970 in the Middle and North Atlantic (Delaware to Maine) produced 3,057,000 pounds, according to the Department of Commerce (41) and the fishermen received $795,000 for this catch. The retail value is a minimum of three times this amount, or about $2,400,000.

These figures are all the reliable information available on striped bass catches and the only basis for estimating the worth of the fishery. To improve the estimate on the sport fishery for the purpose of this testimony, it is desirable to confine the estimates to the area of the coast north of the Chesapeake Bay. To eliminate the Maryland, Virginia and North Carolina catches and refine the estimate more nearly to the segment of the coast supported substantially by the Hudson breeding grounds (22), one may estimate that one half the sport catch is influenced by the Hudson - the value would then be about $73 million. Adding the commercial value for the catch north of Maryland - $2.4 million - the total value of the Hudson-supported striped bass fishery would be roughly $75.4 million annually.

These fisheries depend exclusively upon riverine-estuarine breeding areas. Striped bass spawn only in certain river-estuary systems, never in the open sea. There are no breeding rivers north of the Hudson and the nearest significant ones to the south are in the Chesapeake Bay, the Delaware being too polluted to support a significant nursery ground. In tagging studies, we have shown that Hudson-bred striped bass furnish a significant proportion of the Atlantic Coast striped bass fishery (5). Safeguarding the breeding of striped bass in the Hudson is necessary to ensure the future of the species in these areas.

Striped Bass Breeding

Striped bass breed in the part of the Hudson that extends north from the Tappan Zee (7). The heaviest spawning occurs from the Indian Point sector* of the Hudson north to the Saugerties sector (1). Striped bass spawn once a year and most spawning takes place during a month's period, from about May 15 to June 15; the peak occurs in late May and early June (1).

The eggs are released free into the water. They are semi-buoyant and drift with the flow of the tides. The eggs hatch out in about 2 days releasing yolk-sac larvae into the water at a size of about 1/10th inch (3 mm) (1). The yolk-sac larvae are planktonic; that is, they drift passively with the water flow. Within two weeks they grow to .25 to .30 inches (6 or 7 mm), absorb the yolk-sac (6), and then begin to feed on zooplankton (small planktonic life) performing diurnal migrations in pursuit of the plankters. At this point, they are in the post larval stage during which they remain planktonic. Six or seven weeks after hatching they reach 1 inch (38 mm) or slightly more (1) and transform to the juvenile stage. In this stage they take on a more typical striped bass appearance.

From various studies of striped bass one can deduce the following pattern for the next 2 or 3 months of juvenile life. They apparently lead a somewhat pelagic life foraging

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* Throughout this testimony the Hudson River sectors referred to are those used by Carlson-McCann. (1).

at various depths. Their diet expands to include bottom life, such as amphipod crustaceans. At an age of 4 to 5 months after hatching, when they have reached an average size of 3 to 3-1/2 inches in length, they may be considered more bottom oriented than pelagic, except in the winter when they appear to remain at mid-water in a somewhat comatose state (1, 6, 7, 4).

Adverse Impact on Striped Bass

In this first year of life, each brood of striped bass is exposed to a predictable risk from the power plants that draw water from the Hudson for the cooling of their steam condensers. During the first few months the larvae and young fish are entrained with the water pumped into the plants, during entrainment they are subject to lethal conditions of thermal impact, mechanical damage, exposure to toxic chemicals, pressure changes and other possible effects such as reduction of dissolved oxygen. During their third and fourth months the striped bass gradually become large enough to be stopped by the 3/8" mesh screens (1). Those that are impinged on the mesh suffocate and die.

In order to predict the effect upon the striped bass population of any one of the power plants that draw cooling water from the Hudson breeding areas, it is necessary to consider the risk to each one of the stages in the cycle of the species' first year of life. I have made an analysis of the risk to striped bass, using data furnished by Con Edison and other relevant data. Because of limitations on the extent and usefulness of the data at hand, the analysis includes a number of approximations, based upon interpretive judgments. Certainly it will benefit from refinement whenever in the future the data become available to make this possible. For now, the analysis provides a needed comprehensive view of the potential effects of the Indian Point power plants on striped bass populations of the Hudson.

ANALYSIS OF REMOVALS

The Indian Point plants are located so as to have a maximum potential adverse effect on the striped bass populations. This can be seen in Figure 1 which shows the location of various electrical generating plants and the distribution of young striped bass throughout the Hudson. Specifically, the Indian Point plants are situated in areas of maximum density of all three phases of young striped bass: eggs, larvae, and juveniles. Also they are situated so as to intercept a substantial proportion of larvae and juveniles as they move to the nursery areas.

This analysis is concerned with potential damage to the first year class populations of the striped bass by depletion and death caused by Indian Point Units No. 1 and 2. I have attempted to estimate the potential damage at each major life stage; first, in terms of the actual number that would be exposed to death at Indian Point and, second, in terms of the proportion of the total population affected during each life stage.

Derivation of Population Estimates

In making this analysis it was necessary first to construct a relevant model of the survival or population curve for a typical year's brood of striped bass so that the population size could be estimated at any point in the year. The baseline data used were those for striped

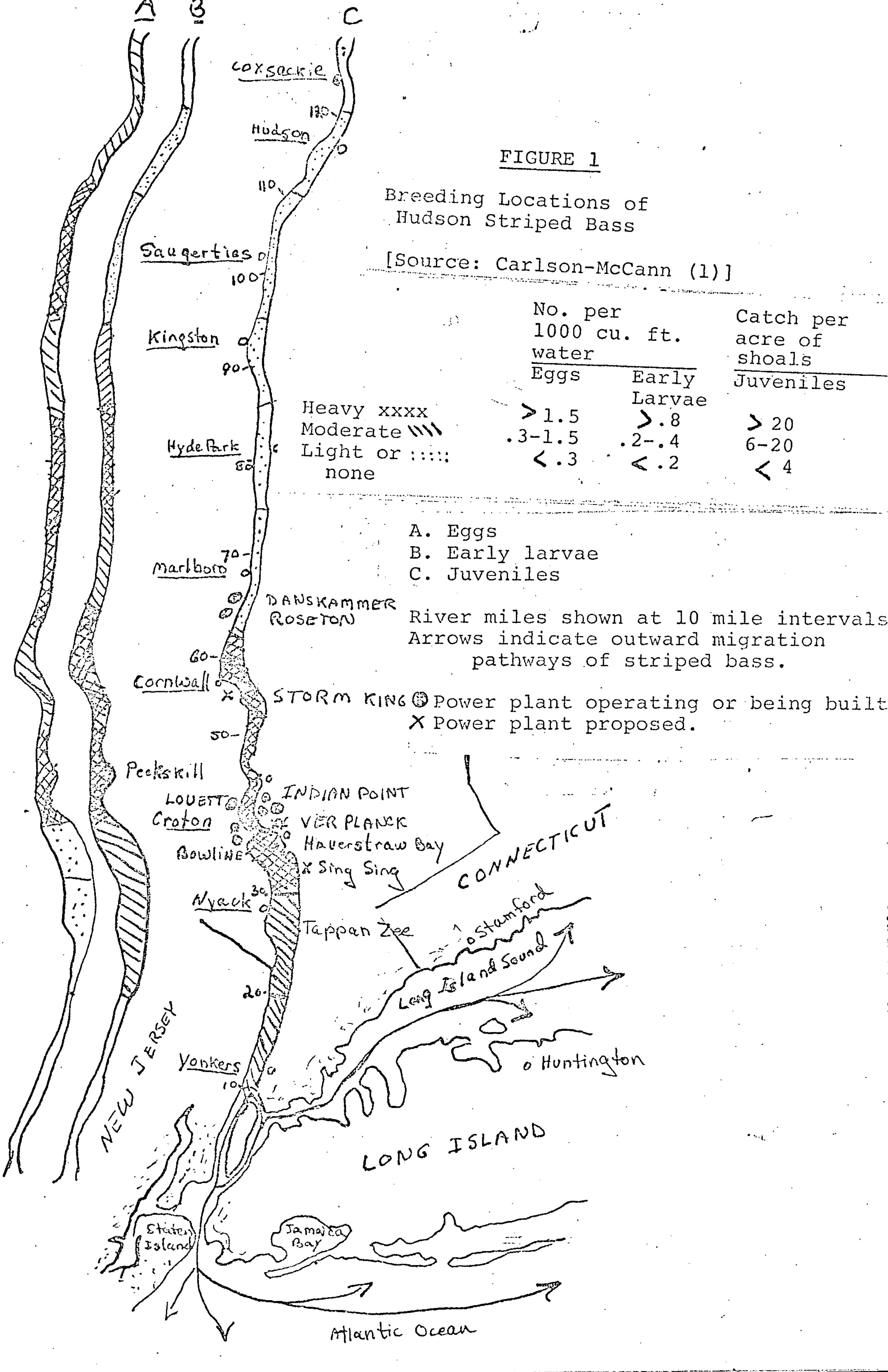

FIGURE 1

Breeding Locations of Hudson Striped Bass

[Source: Carlson-McCann (1)]

	No. per 1000 cu. ft. water		Catch per acre of shoals
	Eggs	Early Larvae	Juveniles
Heavy xxxx	> 1.5	> .8	> 20
Moderate \\\\	.3-1.5	.2-.4	6-20
Light or :::: none	< .3	< .2	< 4

A. Eggs
B. Early larvae
C. Juveniles

River miles shown at 10 mile intervals
Arrows indicate outward migration pathways of striped bass.

⊛ Power plant operating or being built
X Power plant proposed.

bass generated in 1966 and 1967 as reported in the "Hudson River Fishery Investigations 1965-1968" by Frank T. Carlson and James A. McCann (1).* The Carlson-McCann data vary widely in their suitability for quantitative analysis, but they provide the only opportunity to make some baseline approximations of striped bass populations in the various early life stages. I was guided in derivation of the population model by studies of Pearcy (2) on the survival of winter flounder in the estuary of the Mystic River, Connecticut.

The approximate population curve for young striped bass in the Hudson estuary is shown in Figure 2A. Basepoints for fitting the Hudson population model were estimates of the average mid-point population for each stage derived from the Carlson-McCann data for 1966 and 1967 (1). In these two years sampling of young striped bass was conducted throughout most of the estuary and tidal fresh waters of the Hudson using methods designed to be quantitative (1). The curve follows Pearcy's description "...a concave form of decreasing mortality rates with age." (2, p. 31).

The steep rate of pupulation reduction at the youngest stages is due to a very high mortality during the first few weeks of life. This is typical of estuarine species that spawn great masses of eggs each year. For instance, a female striped bass aged five years and weighing 8 pounds, sheds a half million eggs (3).

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* 1968 data were used to aid in interpreting the baseline data.

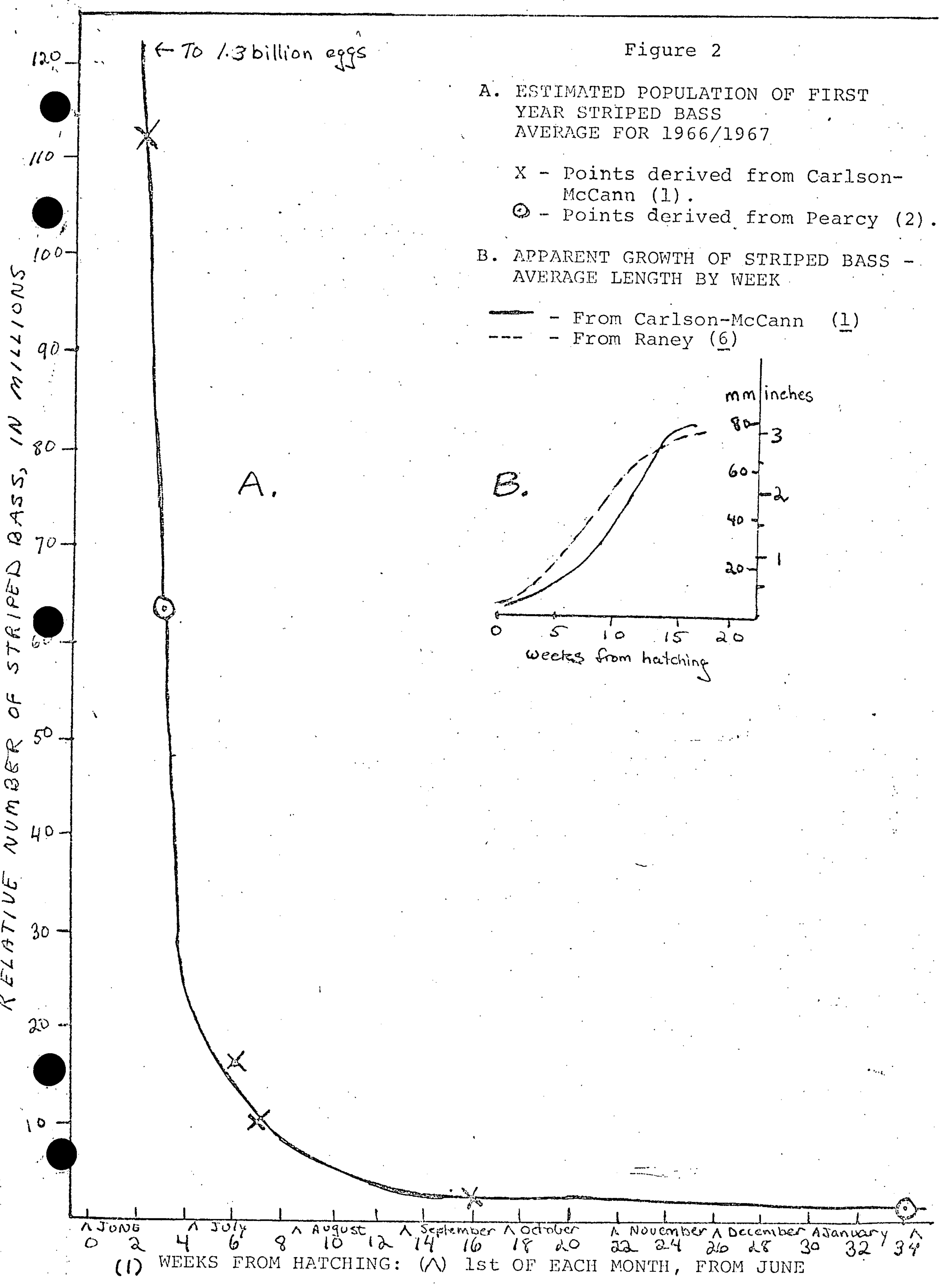

Figure 2

A. ESTIMATED POPULATION OF FIRST YEAR STRIPED BASS AVERAGE FOR 1966/1967

X - Points derived from Carlson-McCann (1).
⊙ - Points derived from Pearcy (2).

B. APPARENT GROWTH OF STRIPED BASS - AVERAGE LENGTH BY WEEK

——— - From Carlson-McCann (1)
- - - - From Raney (6)

Estimates were made for various stages throughout the first year of life of the striped bass. The stages were chosen partly on the basis of natural life history factors and partly on the basis of sampling methodology and effectiveness. Although absolute numbers are assigned to the population curve, they must be considered relative values because the sampling errors are believed to have the effect of minimizing the population size; i.e., the apparent population would be less than the actual population.

Stage I - Eggs

The distribution and characteristics of striped bass eggs are such that quantitative sampling of them is very difficult (1). Their life is short, hatching out of the egg occurs about two days after spawning. They have a slight negative buoyancy and tend to remain near the bottom where they avoid capture by conventional plankton sampling equipment.

One can estimate a standing crop of eggs for the Hudson estuary from the Carlson-McCann 1966-1967 sampling and, by adjusting for the period of an average generation, one can estimate the total production of the estuary. This derivation, shown in Table 1, results in an estimate of 1.3 billion at the median point or half-life of the egg. Whatever sampling incompleteness existed in the Carlson-McCann study would tend to make this a minimum estimate. It appears that there may have been serious deficiencies in the sampling techniques. For example, in 1967 such fine mesh was used that the plankton nets clogged up and

TABLE 1 - An Estimate of Average Annual Egg Production of Striped Bass in the Hudson Estuary, 1966 and 1967.

River Sector	Length of River Sector[1]	Cubic Feet of Water[2] (in billions)	Average Number of Striped Bass Eggs Per 1000 Cubic Feet[3]	Average Standing Crop for Season (in millions)	Average Number of days of Spawning[4]	Number of Generations[5]	Production of Fertilized Eggs[6] (in millions)
Coxsackie	22.5	4.15	0.30	1.2	10	5	6
Saugerties	19.3	7.17	1.30	9.3	34	17	158
Kingston	10.2	6.50	0.51	3.3	28	14	46
Hyde Park	11.3	7.10	1.86	13.2	34	17	225
Marlboro	12.2	8.20	1.80	14.8	28	14	207
Cronwall	11.8	9.64	1.40	13.5	48	24	324
Peekskill	11.0	9.00	2.87	25.8	24.5	12	310
Croton	20.0	23.35	0.18	4.2	20	10	42
Total				85.3			1,318

1. From Table 21, Carlson-McCann (1).
2. Cross-Section from Table 21, Carlson-McCann (1) times length of sector.
3. Weekly abundance from Table 21, Carlson-McCann (1) average for 1966 and 1967.
4. From Carlson-McCann (1) Appendix 2-1, 3-1.
5. Number of days spawning divided by 2 (average length of embryonic life).
6. Standing crop times number of generations. Figures are rounded to nearest whole number, indicating confidence level of data.

failed to pass sufficient water through to collect eggs efficiently (1 , p. 12). The average catch of eggs in 1967 was 1/5 of that in 1966 (0.46 compared to 2.08 per 1000 cu.ft.) for the whole Hudson. At the Peekskill Sector (used to represent Indian Point) the difference was far greater: the 1967 average catch was only 1/16 of that for 1966 (0.34 compared to 5.39 per 1000 cu. ft.). If the population of eggs for the whole river was estimated from the 1966 data alone it would be over 2 billion.

Alternately, one can estimate the egg crop from Carlson-McCann's 1968 data. In the 1968 data Carlson-McCann give predictions of a daily withdrawal of 463,000 planktonic eggs by the proposed Storm King plant for an eleven week period, or a seasonal total of 35.6 million.* Carlson-McCann estimated this to be 0.6% of the fertilized planktonic eggs produced, and thus the total produced in 1968 would be about 6 billion. However, a basic error in the procedures used by Carlson-McCann** led to an underestimate of the percentage (0.6%) which caused an overestimate of the total produced. Therefore, in my opinion, 6 billion, based on the Carlson-McCann sampling, is an overestimate.

Account must also be taken of the fact that the total number of eggs initially spawned is expected to be much greater than the

*Slide rule accuracy throughout this testimony.

**The tidal influence was not considered. Since the organisms do not pass the plant once but are carried back and forth past it a number of times, this resulted in underestimating the time of exposure of eggs and larvae to pumping by the plant.

number of fertilized eggs produced because a substantial proportion is not successfully fertilized and these sink to the bottom and die.

Possible sources of error notwithstanding, I consider the estimate of 1.3 billion viable fertilized eggs to be as good as is now possible and necessary for deriving a population estimate.

Stage II - Early Larvae

The early larvae stage extends from the hatching of the egg until the yolk is absorbed and the larvae begin to feed on zooplankton. During this interval the larvae grow from an average of 3.1 mm in total length at hatching to about 6 mm at the time of yolk absorption (1, 6).

The adequacy and uniformity of the Carlson-McCann larval fish data are affected by sampling deficiencies and by gear changes during the course of the three-year program, 1966-1968. Nevertheless, these are the best data available for estimating larval populations.

Because the lengths of larvae sampled are not given by Carlson-McCann for 1966-1967, the base years for derivation of the population curve, the stage or development for the larvae that were caught is not apparent. However, comparison of the 1966-1967 data (1, figures 7 & 8) with the 1968 data (1, figure 9) and examination of the lengths of larvae taken in 1968 (1, table 1) indicate that the method and the nets used in much of the 1966-1967 plankton sampling were such that the catch was preponderately of the smaller yolk larvae. The 1968 data indicate that the larvae caught would range from 3-7 mm and average between 5 and 6 mm in the time of greatest larval occurence, May 20-June 15, (1, figure 9, table 1).

In June of 1966 the early larvae were undersampled, apparently because the mesh was oversized (1, p. 12). Following this a standard .012 x .020 in. mesh was used until July 1967, when larger meshes were used in order to lower water resistance and to take the larger post larvae more efficiently (1, p. 12). This last change appears to have succeeded (although lengths are not given). The average of the two years (1966 & 1967) may be used as an acceptable approximation of the average density of larvae in the Hudson during the period of their early existance. But the sampling in these two years is in no way representative of the density of the later larvae which avoid capture because they escape small mesh plankton nets.

To make an estimate of the average population of early larvae produced in the Hudson in 1966-1967, I found it necessary to estimate the number produced in the estuary during each week of the breeding season. This was accomplished by estimating the proportion of each week's standing crop of early larvae that was produced in that week and recruited to the existing population.

The standing crop for each week for each sector was calculated from the data in Carlson-McCann (1, app. 2-2, 3-2) and a total was drawn for the entire Hudson for each week of the larval recruitment season in 1966 and 1967, i.e., the period when new yolk larvae are added to the population from breeding activities. The recruitment season extends from the first significant occurence of yolk larvae in the samples in mid-May until one week after the last significant occurence of young yolk larvae in mid-June. The first occurence for 1966 and 1967 is the time of the initial catch of larvae in each year (week of May 15 in 1966, May 14 in 1967). Estimating the time of last occurence is more difficult. Significant spawning ended in the two years during the weeks of June 5-11 and June 4-10. Therefore, significant additions of yolk larvae should end two weeks later because the yolk stage, 3-6 mm, lasts for no more than 2 weeks. Therefore, the last week of larval recruitment should be June 19-26 and June 18-25 in the two years. This cannot be directly substantiated in the 1966 and 1967 catches because larval sizes are not given, but the 1968 data for Cornwall (1, table 1) show that the average size of larvae (gear 1, mesh 2) begins to increase from mid to late June and often exceeds 8 mm. (.32 inches) by June 23-29. This indirectly confirms the choice of June 19-26 and June 18-25 as the periods of last significant recruitment of larvae in 1966 and 1967.

The estimated average numbers produced and recruited to the Hudson populations each week for 1966 and 1967 are given in Table 2. The total, 112 million, is plotted in Figure 2 as a base point representing the population of early larvae at two weeks from hatching, the median point of the 28-day period of substantial larvae production, June 1-28.

According to Pearcy's model, the reduction in population that corresponds to a larval length of 8 mm is 43.3 percent, or

The lower Hudson is an arm of the sea, a long tidal slough running from Troy to the Atlantic Ocean. In the last 60 miles, from Newburgh to the sea, river water mixes with ocean water in gradually increasing proportions. This is the rich part of the Hudson, the estuarine sector. It is a productive breeding area for fishes, not only for resident species like white perch but also for migratory oceanic species like striped bass, shad, and herring. The oceanic fishes are anadromous species, meaning that the adults come up the Hudson to spawn and after spawning, return to the sea. The young grow up in the Hudson; when they are safely through early life, they migrate to the sea, leaving the sanctuary of the Hudson to spread out onto coastal fishing grounds.

It is unfortunate that Con Edison has chosen the Indian Point area to locate a number of nuclear power plants because this site is in the middle of the breeding and nursery zones for the Hudson striped bass (4)* Many other species also breed in this same area. The plants are destructive to the young stages of these fish and endanger the continuance of the entire fishery served by the Hudson. The plants pose a general ecological threat to the immediate areas where they are located.

Striped Bass Fishery

Striped bass are the most important Hudson fish and

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* Throughout this testimony references in parenthesis are to the numbered list of references provided at the end of the testimony.

TABLE 2 - The Number of Striped Bass Early Larvae Produced Each Week and Recruited to the Hudson Estuary (population average for 1966-1967)

Week of Production of Larvae[1]	Standing Crop, Number of Larvae in Hudson[2] (in millions)	Number Remaining from Previous Weeks' Recruitments[3]	Number of New Recruit Produced in Week (in million
May 5 - 21	0.1	-	0.1
May 22 - 28	2.4	.1	2.3
May 29 - June 4	7.7	2.0	5.8
June 5 - 11	37.6	4.7	32.9
June 12 - 18	80.1	23.9	56.2
June 19 - 25	63.2	49.4	14.8
TOTAL			112.1

1. In 1966; one day earlier for each week in 1967.

2. Calculated by multiplying the average density of larvae for each week, for each sector, (1, Appendix 2,3) by the volume of water in the sector (Table 1, Col. 2).

3. Calculated by assuming a reduction to 2/3 in the first week following recruitment, to 1/3 in the second, and to nil in the third (from net escapement and changes in distribution (1)).

62.5 million remaining of 112 million, at an age of about 3 weeks (see figure 2B). This value is used as a baseline point in fitting the population curve.

Stage III - Later larvae and pre-juveniles

This stage extends from the end of the yolk stage through the larval and pre-juvenile stages during which the striped bass develops the essential features of the adult form and ceases its planktonic existence. The endpoint of this stage is reached at the size of 1 1/2 inches which corresponds to an age of 10 1/2 weeks (figure 2B). During most of this period the fish are difficult to sample, being large enough to escape capture by the plankton nets and not large enough nor distributed so as to be captured efficiently by the trawls used by Carlson-McCann. In 1968, when sampling was confined to the Cornwall sector, more intensive development of sampling gear was conducted and a progression of mesh sizes was used throughout the season (1, table 1). These results show more accurately the natural rate of decline in population and are useful in estimating the density of the later larvae and pre-juvenile fish (1, App. 4) based on the density of the early larvae.

At Cornwall in 1968 the peak of abundance of yolk larvae was 12.19 per 1,000 cubic feet during the week of June 9-15 (average size of fish was 5 - 6 mm). By the week of June 30-July 6 catches reached a low of 0.37 per 1000 cubic feet, apparently because the larvae drifted out of the sampling area. Then in the week of July 7-13 abundance increased nearly fivefold to 1.74 per 1000 cubic feet (average size of fish was 11 mm). It is likely that this represents the measure of their true abundance in the Hudson; the increase may have been caused by the penetration of the salt front up the estuary to Cornwall, bringing the later larvae and pre-juvenile fish with it. In any event, between June 9-15 and July 7-13 there was a decline from 12.19 to 1.74 fish per 1000 cubic feet, a reduction of 85.7% in the four weeks following the peak of yolk density. There was a further reduction to 1.08 fish per 1000 cubic feet, or 91.1%, in the course of the next week, July 14-20.

If the 1966-1967 population of 112 million is reduced by these amounts, the population size remaining at the end of the 6th and 7th weeks following hatching is 16.0 and 10.0 million. These points are used in deriving the population curve (Figure 2A).

Stage IV - Early juveniles

The juvenile stage begins at the time the striped bass ceases its planktonic mode, becomes pelagic and finally bottom oriented at about 1 1/2 inches (38 mm) in length and extends throughout the first year of life. It appears that the early juvenile stage is a period of fast growth and within the 28 days of this stage (August 13-Sept 9) the young stripers will almost double their length, from 1 1/2 to nearly 3 inches (38-76 mm) as reflected in Figure 2B. (1, table 24).

The Cornwall sector is the only one with reliable data for this life stage and I have estimated the population for the whole Hudson from this sector. The population of pelagic early juveniles can be estimated from sampling in 1967 at the Cornwall sector (1, table 16) with bottom and surface trawls. The average density of early juveniles in the Cornwall sector is 0.60 per 1000 cu. ft. of water, as computed in Table 3. Since there are 9.64 billion cu. ft. of water in the sector, there is an estimated average population of about 0.6 million early juveniles at Cornwall in the summer period.

The data for 1966 are less complete but an average catch of 13.5 fish per bottom trawl tow in 1966 (1, table 15) compares closely enough to the 12.2 per bottom tow in 1967 to indicate that the 1967 data represents an acceptable average for both years.

I have used for reference the 1968 sampling data for bottom trawls (1, table 11). I have assumed that the distribution of young throughout the Hudson in 1966-1967 was generally similar to that of 1968. From Table 4 it can be seen that the population of juveniles in the Cornwall sector was about 25 percent of the whole Hudson in 1968 based on the bottom trawl sampling. Therefore, on the assumption that the same proportionate distribution applies to 1966-1967, the population of early juveniles would be about 2.4 million for the whole Hudson. This point is used in deriving the population curve and is plotted at 16 weeks, the median point of the interval 11 1/2-20 1/2 weeks from hatching (Figure 2A).

TABLE 3 - Striped Bass Catch in Trawls at Cornwall, 1967

WEEK	Bottom Trawl, Number per tow	Surface Trawl, Number per tow
Aug. 13 - 19	15.4	1.3
Aug. 20 - 26	8.3	2.8
Aug. 27 - Sept. 2	15.7	133.8
Sept. 3 - 9	7.0	0.5
Sept. 10 - 16	28.0	0.8
Sept. 16 - 23	1.9	0.3
Sept. 24 - 31	3.5	0.0
Oct. 1 - 7	1.4	2.2
Oct. 8 - 14	28.7	0.7
TOTAL	109.9	142.4
AVG. per tow	12.2	15.8
EST. Amount of Water Sampled Per Tow (in thousands of cubic feet)	300.0	200.0
AVG. Number per 1000 cubic feet	.041	.079
AVG. for both gears	.060	

Source: 1, Table 16

TABLE 4 - Computation of the Proportion of Early Juveniles at the Cornwall Sector, in Trawl Sampling - 1968.

	Number of Fish per tow[1]	% of Water Volume in Hudson at Sector	Index of Relative Abundance[2]
Saugerties	0.2	9.2	2
Kingston	0.5	8.3	4
Hyde Park	1.7	9.2	16
Marlboro	4.2	10.5	44
Cornwall	48.5	12.3	597
Peekskill	47.4	11.5	545
Croton-Nyack	37.4	30.0	1120
Yonkers	8.2	9.0	74
TOTAL			2402
Cornwall as a percentage of total.			24.8%

1 Source: (1) Table 11

2 Fish/tow X percent of water volume at station. Figures are rounded to nearest whole number, indicating confidence level of data.

Stage V - Later juveniles

I was not able to establish the population of later juveniles from the Carlson-McCann data because sampling was not conducted in late fall or winter. However, Pearcy (2, p. 57) indicated that of the fish which survive to become juveniles, 41% would survive through ten months of juvenile life. At this rate, 75% of the 2.4 million striped bass population at the 16th week would survive to the 34th week, leaving a population of 1.8 million in mid-February. No other estimate is possible with the data at hand.

Estimation of Removals

The purpose of this part of the analysis is to estimate the number of striped bass removed from the Hudson by Indian Point Units No. 1 and 2, i.e., the numbers of each stage which would be withdrawn from the Hudson along with the condenser cooling water and either killed on the protective screens or carried through the screens into the plant where they are exposed to lethal conditions.

For eggs (Stage I) and early larvae (Stage II) this estimate was made by simply taking the average number of fish per unit of water (1000 cubic ft.) from plankton net data for the sector representing Indian Point in 1966-1967 (Peekskill stations) for the breeding season and multiplying it by the number of ...

units of water pumped during the season. This estimate of the quantity removed can be expressed as a percentage of the whole population as it is determined from the population curve (Figure 2A).

For later larvae and pre-juvenile fish (Stage III) the computation was similar except that the number of fish per unit of water was based on the rate of population reduction from early larvae (Stage II) to larval and pre-juvenile fish (Stage III), per unit of water. For early juvenile fish (Stage IV) the same general procedure was followed. Estimates of the number of juveniles per unit of water were obtained from the Carlson-McCann trawl data for 1967 (1, table 16). Only those of prescreenable size were included; the larger, screenable sizes are made up mostly of later juveniles (Stage V).

For later juvenile fish (Stage V), estimates were made separately for each month, using Con Edison reports of fish kills for Indian Point 1 and making suitable adjustments.

Separate estimates were given for each of the assigned stages in the first year of life of the striped bass. Taken together, the estimates span the period from spawning (peak about May 29-30) and the emergence of early larvae to the end of the first year of life (May 28 of the following year). They cover the period when the species is most vulnerable to the operations of power plants at Indian Point using once through cooling. Estimates of the number of fish subject to removal by the plants are made for each stage. The eggs are treated separately. The larval and juvenile stages are treated sequentially by stage. The stage assignments are as follows:

Life Stage	Assigned Dates	Length of Period	Median Date
I	5/17 - 6/11	24 1/2 days	6/1
II	6/1 - 6/28	28 days	6/16
III	6/29 - 8/12	45 days	7/21
IV	8/13 - 9/9	28 days	8/27
V	9/10 - 5/28	261 days	1/21

Stage I - Eggs

The egg stage would be the least affected by power plant operation at Indian Point. Their exposure time would be brief because egg deposition occurs over a long stretch of the Hudson above Indian Point and because the life of the eggs is only two days.

The Table 1 the average density of eggs at the Indian Point sector (Peekskill stations) for 1966-1967 was estimated at an average of 2.87 per 1000 cu. ft. of water (5.39 and 0.34 per 1000 cu. ft. in 1966 and 1967) from the Carlson-McCann data for a spawning period averaging 24 1/2 days - 3 weeks in 1966 and 4 weeks in 1967 at Peekskill (1, App. 2-9, 3-9). In this 3 1/2 weeks, 5.45 billion cu. ft. of water would be pumped into the Indian Point No. 1 and 2 plants at a planned rate of 1,157,000 gallons per minute (8, p. 2.3.2-3). Consequently, the removal by the plant operations would be 15.6 million eggs per year based on the average density for the 1966 and 1967 spawnings.

Stage II - Early larvae

The estimates of removal of early larvae (Stage II) were made following the same general procedure as outlined for eggs. This stage is comprised of young larvae taken in the plankton nets, which appear, because of the nature of the sampling, to be mostly yolk larvae. One cannot be more specific because Carlson-McCann give no size data for larvae sampled in 1966 and 1967. However, the size data are given for Cornwall sampling in 1968 (1, table 1) which indicate that the larvae catch was made up of yolk larvae (averaging 5-7 mm) and some small post-larvae (averaging 8-9 mm) through to the end of June when the larvae become very scarce. The larvae then reappear in greater abundance at a larger size (about 12 mm) in July. The same scarcity and reappearance shows in the 1967 data for Peekskill but not in the 1966 data (when the finer mesh used in the net greatly reduced its efficiency for catching larger larvae). I have used this low point in abundance to mark the end of the early larvae phase (Stage II). This seemed appropriate because spawning terminates in mid-June so there can be no further additions of yolk larvae, because there is a temporary diminution at this point, and because the 1966 sampling failed to take significant numbers of larvae past this point. Thus I have used the period from first appearance of larvae (June 1) at Peekskill to the temporary low point (June 28th) for the period of removal by the plants at Indian Point of the early larvae, those effectively sampled by the plankton nets in 1966-1967.

In this 28-day period the average density of the early larvae can be deduced to be 0.92 per 1000 cu. ft. of water from the Carlson-McCann data, as shown in Table 5. Since the Indian Point 1 and 2 plants would pump 6.2 billion cu. ft. of water in the 28 days, there would be 5.7 million larvae removed by the plants in one season, or 5.1% of the median population of 112 million.

Stage III - Later larvae and pre-juveniles

The later larvae and pre-juvenile stage begins during a sampling hiatus in the Carlson-McCann data. The period involved is 45 days, including weeks 5 to 10 1/2 (June 29 - August 12) as previously mentioned. In order to estimate the densities of the later larvae and pre-juvenile fish (Stage III) that would be subject to removal by Indian Point Units No. 1 and 2 during this period, I have used the population curve (Figure 2A) to estimate the survival density at the mid-point of the period, 7 3/4 weeks. The median population of early larvae (112 million) corresponds to the time of peak density of larvae at Peekskill in mid-June --2.36 and 1.51 per 1000 cu. ft. for 1966 and 1967 (1, App. 2-9, 3-9) or an average of 1.93 per 1000 cu. ft. The survival indicated at week 7 3/4 is 8.5% corresponding to a density of 0.16 fish per 1000 cu. ft. of water.

The Indian Point No. 1 and 2 plants would pump 10.0 billion cu. ft. in the 45 days of the period removing 1.6 million larvae.

This is 16.7% of the 9.5 million population at the 7 3/4 week median.

During this period the fish grow from less than 0.5 inch (6 mm) to about 1 3/4 inches (45 mm). Near the end of the period a small proportion are large enough to be caught on the intake screens. They die there but are prevented from entering the plant (1, table 24). These fish are not treated separately.

Table 5 - Calculation of Average Larvae Densities for June 1 - June 28 from Plankton Net Samples 1966-1967

Sampling Week[1]	Average of Larvae Densities, Number per 1000 cubic feet[2]
May 28 - June 3	.06
June 4 - 10	.44
June 11 - 17	1.77
June 18 - 24	1.20
June 25 - July 1	.40
Weighted Average[3]	.92

Source: 1, appendix 2-9, 3-9

1 For 1967; 1966 is one day later each week.
2 Average of weekly averages for 1966 and 1967.
3 Based on 3 days of week 1, 7 days each of weeks 2-4, and 4 days week 5.

Stage IV - Early juveniles

The early juvenile stage is assigned to a period of 28 days, from August 13 - September 9. This is a period of fast growth (Figure 2B) during which the juveniles increase from about 1 3/4" (45 mm) to about 3 inches (76 mm), a size large enough for nearly all to be impinged on the intake screens (1, table 24). The juveniles become less pelagic at this time and more bottom oriented. This stage, then, carries them through the transition from mostly pre-screenable to fully screenable and from a more pelagic life to a more bottom oriented life. It is assumed that once they abandon the pelagic life habit they are no longer uniformly distributed through the water and subject to simple entrainment in the plant cooling water. Therefore, over this period I have reduced entrainment from nearly 50% to nil, as well as their passability by the intake screens (1, table 24).

Estimates of the number of early juveniles (Stage IV) subject to removal can be made from the quantitative trawl sampling conducted in 1967; the weekly results are listed in Table 3. Following the data and the procedure developed in Table 3, but for only the four weeks from August 13 to September 3 we find an average density of 0.11 fish per 1000 cu. ft. of water. This is an even higher density than later larvae and pre-juveniles (Stage III) owing to peculiarly high catches in one week, particularly by the surface trawl. Nevertheless, the data are presented as valid by Carlson-McCann and since one can only assume that chance variation is the cause, I have no reason to discard this one high estimate in drawing a monthly average. However, it does make a week by week analysis unreasonable.

The total of water withdrawn by Indian Point Units 1 and 2 in the 28-day period is 6.2 billion gallons. The total number of fish in this amount of water would be 0.68 million ($0.11 \times 6.2 \times 10^9 / 10^3$). The change from pelagic to bottom oriented mode is reflected in a linear reduction from full vulnerability to removal by entrainment on the first day, to nil on the last day. The average would be 50%, resulting in a total for the 28-day period of 0.34 million. The size of the fish results in 77.5% being screened at the intake (average for the weeks August 11 - September 7; 1, table 24). Reducing the 0.34 million by 77.5% leaves a total of 0.077 million subject to withdrawal into the plant.

In addition, from the data in Table 6 it can be estimated that in the 28-day period (August 13 - September 9), a total of203,000 fish of all species would be impinged on the screens.

If 5% of these were striped bass than 0.010 million of the species would be impinged. Added to the 0.077 million above, the total for the period becomes 0.087 million -- 2.5% of 3.5 million, the average relative population for the period.

Stage V - Later juveniles

This stage comprises the remainder of the first year of life of the striped bass following hatching, 261 days from September 10th to May 28th. The fish are assumed to be bottom oriented, nektonic, and fully screenable. Their vulnerability to eradication by the plants is affected by behavioral characteristics, most of which are, presently, quite unpredictable.

The number of striped bass that would be killed on the screens by Indian Point Units 1 and 2 can be projected from the records of fish kills at Indian Point No. 1 that are available from 1965 to 1972 (8, App. S, and stipulation to this Hearing, October 30, 1972; 45). These records are not continuous over the 7 years, nor are they complete for the intervals of sampling. They appear to show trends of change in the natural abundance or vulnerability of the species which comprise the screen kill over the years, and reflect variations in the seasonal pattern of occurence. In addition, there were a number of changes in the plant which may have affected screen kill patterns and a number of uncertainties and changes in the procedure for counting the fish killed on the screens. For these reasons it has been difficult to find a basis to use the Indian Point No. 1 screen kill experience to predict the effects of Indian Point No. 2 on a once-through cooling basis. Fortunately there is an unbroken 12-month period during which fish counts were made in each month -- April 1966 to March 1967 -- which coincides most closely with the period during which the larval and early juvenile data were available from Carlson and McCann (1) for our analysis of stages I to IV.

Table 6 Estimation of average daily and monthly screen kills for Indian Point Units Nos. 1 and 2 for all species combined and for striped bass (based on 1966 and 1967 data).

Month	Unit No. 1 kill/day - all species (in thousands of fish)[1]	Units Nos. 1 & 2 kill/day - all species (in thousands of fish)[2]	All Species kill per month (in thousands of fish)	Striped Bass kill per month (in thousands of fish)[3]
January	7.2	54.0	1670	84
February	4.3	32.2	900	45
March	4.4	33.0	1020	51
April	0.5	3.8	120	6
May	0.7	5.2	160	8
June	0.6	4.5	140	7
July	1.6	12.0	370	18
August	1.0	7.5	230	12
September	0.9	6.8	204	10
October	1.3	9.8	300	15
November	1.4	10.8	310	16
December	4.6	34.5	1070	54
T O T A L S			6494	326

[1] Source: Reference 42

[2] Unit No. 1 kills x 7.5 Derivation: 0.25 (missed periods) + 0.25 (missed fish) + 1.0 (I.P. 1) = 1.50 x 5 (adjustment from I.P. 1 to I.P. 2 screen kill level = 7.5

[3] All species x .05. Derivation: There is no data for 1966-67 so an approximation was made based upon data for other years. The various estimates of striped bass kill range from: .01-.13 of total species kill. We chose a figure of .05 as representative of the average case. A figure of .10, representing a worst case would increase the kill of striped bass to about 650,000. Example sources are as follows:

Source	Period	Ratio (striped bass/all species)
Raytheon (42)	Nov 6-Jan 11 '69/70	.11
NY DEC (42)	Jan 11-Mar 5 '70	.10
	Mar 6-June 18 '70	.01
Con Ed (45)	Apr. '70	.13
Lauer (37)		.03
Con Ed (47)		.04

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Lauer (37)		.03
Con [illegible] (47)		.04

It is agreed that the records do not represent the total daily fish kill, but only part of it; and that they understate the yearly screen mortality.

One source of underestimation arose from the sampling methods used; i.e. the incomplete method of collecting the fish from a sluice after they were cleaned by a water jet from the traveling screens which resulted in a substantial number washing away without being counted. The amount so lost is estimated at 25% by Con Edison. Secondly, --- fish counting was not carried out continuously; i.e., for all wash periods of the day and all days of the week. Typically, fish counting rarely has been done on weekends. To account for this incompleteness I added 25% to account for the amount of fish not included because of sampling periods missed. Together, the two sources of error are corrected by increasing the raw daily average kill of all species by 50%; as shown in Table 6. This is only an approximation but there does not appear to be a better basis for arriving at the kill for Indian Point No. 1 in 1966-67, and obtaining an estimate of the total potential screen kill had Indian Point No. 2 been operating in the manner during this period.

Specific data for Indian Point No. 2 are available from pre-operation tests conducted in 1971 and 1972 during which no powere was produced but the pumps were operated. The test series of February 4th to 10th, 1971, when the pumps were operated continuously for 3 out of 6 bays, gave the following results:

Bay	Operation	All species. average kill Per bay	Reported in 1,000's For 6 bays
26	Full flow (140,000 gpm)	4.0	24.0
23	Reduced flow (105,000 gpm)	3.7	22.2
22	Reduced flow (105,000 gpm)	3.1	18.5
Average for 22 & 23	Reduced flow (105,000 gpm)	3.4	20.4

The reduced flow rate is most appropriate for estimating kills because Con Edison intends to operate Indian Point No. 2 at reduced flow in the winter period (Indian Point No. 1 is apparently operating now at reduced flow). Because there are no concurrent records for Indian Point No. 1 for this time, I compared the average rate of 20.4 thousand for Indian Point No. 2 to the average daily 1966-67, February kill of 6,450 for Indian Point No. 1 (Table 6). The Indian Point No. 2 kill of 20.4 thousand is 3.2 times the February daily average for Indian Point No. 1.

The 1972 tests included a combination of different pumps for various portions of the day from Jan. 11 to Feb. 26 (42). The average total kill per day (adjusted for a 24-hour day and 6 pump operation at full flow) for 10 days when fish kill counts were made was 97,068. At a nominal reduced flow of 105,000 gpm, the estimated count would be ($105/140 \times 97 \times 10^3$) 75,000 fish killed per day in full operation on once-through cooling with reduced flow for all pumps of 105,000 gpm. This is approximately 11.6 times the Indian Point No. 1 kill of 6,450 per day for February.

On the other hand recent data on the screen kills at Indian Point 1, particularly with reduced flows of water through the screens, indicate that, either because of changes in plant operation, natural conditions or reduced populations of fish in the Hudson, the rate of kills has, fallen somewhat below the 1966-1967 figures (42). In these, circumstances it is appropriate to estimate the increased kills due to the operation of Indian Point 2 on a conservative basis.

A very conservative estimate, reflecting both 1971 and 1972 reduced flow results, would be four times Unite No. 1 kill for Unit No. 2, or five times Unit No. 1 for the kill by both plants. Thus the total 1966-67 screen kill is estimated to have been 6.5 million fish of all species with operation of both Indian Point No. 1 and No. 2 (Table 6). Of this total, 326,000 are striped bass. By seasons, the 1966-67 kill of striped bass was as follows:

Season	No. of fish killed
September - November	41,000
December-February	183,000
March-May	65,000
June-August	37,000

During the later juvenile period (Stage V) (September 10 to May 28) the kill would have been 0.3 million (September 10 - November 30; 38,000; December 1 - February 28: 183,000; March 1 - May 28: 64,000 or 18.6% of the 'virgin' population of 1.9 million (at the median point, mid-January).

It is not possible to determine how accurately these figures will predict the screen kills of later juveniles by the combined operation of Indian Point No.s 1 and 2, but in the absence of any recent data on all phases of the first year's life history of striped bass, I believe this analysis of 1966 and 1967 data is the best available.

Older Fish

Striped bass appear to be vulnerable to Indian Point power plant operations principally in their first year of life. Screen kill records available from Con Edison for Indian Point No. 1 show that kills of striped bass of one year of age and older have been infrequent in recent years and consequently we have not included them in the analysis.

Effect of Winter Conditions

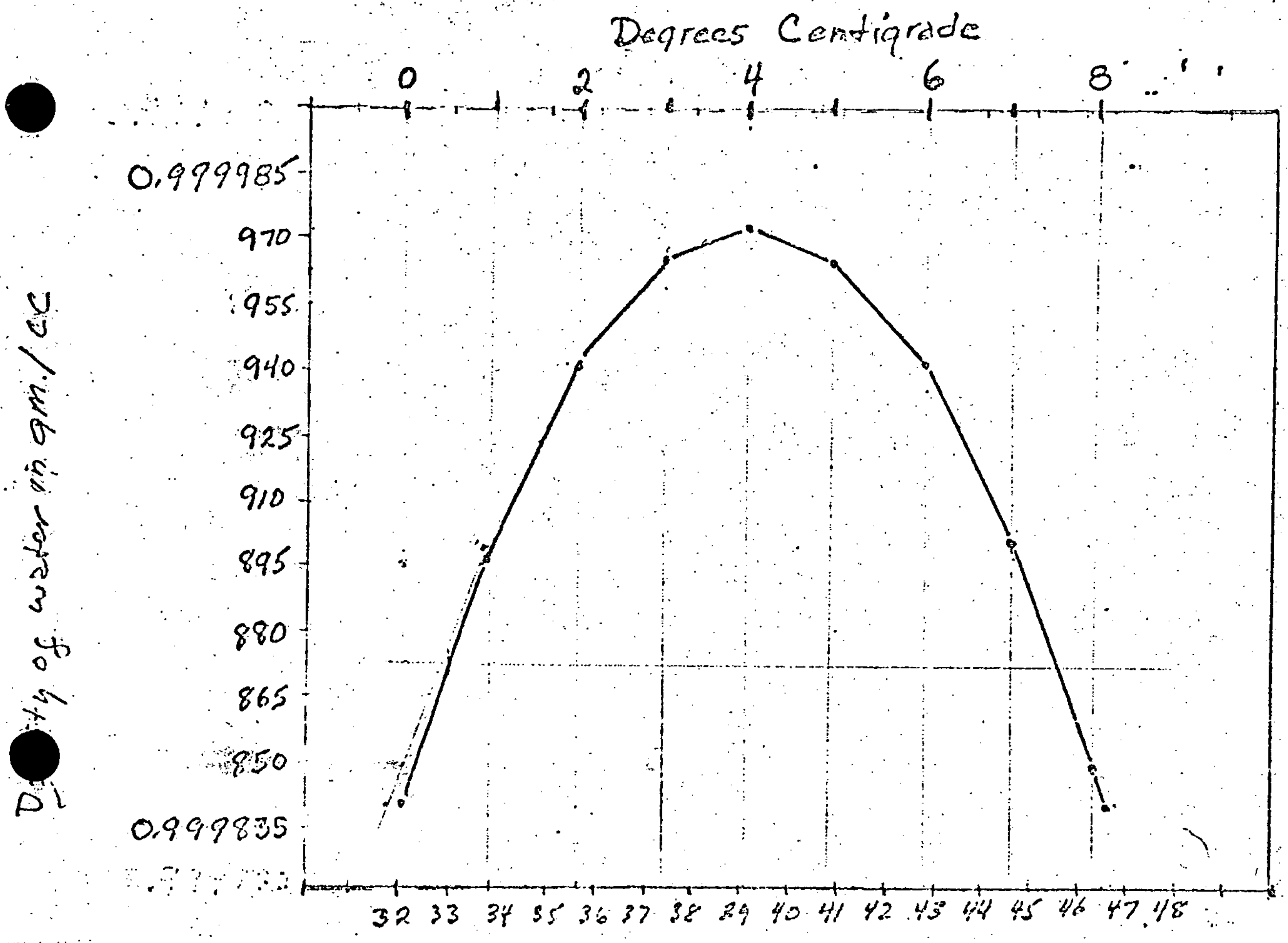
Over 70% of the fish kill on the screens occurs from December to March (4.7 out of 6.5 million; table 6). This shows that impinged species are particularly vulnerable in the cold season. Two major reasons for this are, first, the reduced physiological state of the fish and second, the winter pattern of the effluent plume.

On a research cruise of the R.V. Dolphin to the Hudson estuary in early March 1968, we brought many live striped bass up in nets and kept them in a tank on board for tagging and study purposes. I observed that these fish were in a very lethargic state in the tank and when released again into the river. This lethargy is probably from their existing in a state of semi-hiberation (17) (19) during winter when there is a considerable saving of energy to the fish by reducing metabolism and activity. In this state of lethargy they are probably more readily entrained by the intake plume and less capable of exerting themselves to escape impingement upon the screens.

In winter the heated effluent plume does not remain bouyant; to the contrary, it tends to sink beneath the surface and to spread toward the bottom when the water temperature goes below 39.2°F. (17) (18). Once beneath the surface the plume does not lose heat quickly as it does at the surface and thus its influence is spread more widely and persists a great deal longer.

Some basic information is given in Figures 3A-D on water densities in relation to temperature. These facts set forth the basic premise but they are based upon pure (distilled) water. To make specific predictions for the Hudson Estuary one would need to compute values from the actual densities of the estuary water and its variations with depth, season, etc. However, if one assumes homogenous density, one would expect plume sinkage to start sometime after mid-December and extend through until sometime in late March. The reactions of fish of various species to the sinking plume can be expected to be most complex - the number of behavioral variables is large.

Studies have not been made of the subsurface dispersal of the heated effluent in winter at Indian Point, but it is most probable that the sinking plume in winter serves as a far more effective attractor of fish than the floating plume of summer. One would expect the subsurface heated water plume to be swept back and forth with the tides in front of the plant and to lose temperature as it becomes diluted with river water. The plume might sink only to the pyncnocline and spread out horizontally, depending upon relative densities and temperatures of the upper and lower layers. One may expect salinity stratification during winter, ranging from extreme to gradual. During the Dolphin cruise (March 6-8, 1968) we observed rather great stratification; for example, in the Indian Point area surface salinity was 1.4 ppt while bottom salinity was 6.0 ppt.



Degrees fahrenheit

°C	°F	DENSITY (+0.999)
0	32.0	841
1		900
2	35.6	941
3		965
4	39.2	973
5		965
6	42.8	941
7		902
8	46.4	849
(8.13)	(46.6)	(841)

Amb. Temp. °F	Max T. for sinkage
32	46-1/2
33	45-1/2
34	44-1/2
35	43-1/2
36	42-1/2
37	41-1/2
38	40-1/2
39	39-1/2

River Ambient Month	°F
Nov. 1	58
Dec. 1	48
15	42
Jan. 1	37
15	35
Feb. 1	33
15	33
Mar. 1	33
15	36
Apr. 1	39
15	45

Figure 3. A. Density curve (pure water). B. Density table (pure water). C. Maximum temperature for plume sinkage. D. Seasonal river ambient temperatures.

It is also at the level of the pyncnocline that the juvenile fish have been found located in a horizontal stratum. Because of the probable occurance of the heated water at the pyncnocline where juvenile fish would be concentrated, the attractant force of the plume would be maximized. E. C. Raney (19) concludes that the fish can sense the presence of the plume anywhere the temperature is a minimum 0.1°F above ambient as a practical working figure (although fish are capable of sensing temperature differences as low as about 0.5°F (20)). The 0.1°F delta T edge of the sunken plume could often extend a great enough distance from the plant so as to reach the areas of high winter concentration of juvenile fish and to attract them along the temperature gradient to higher temperatures near the source of the effluent. According to experimental results, white perch at an ambient temperature of 34°F would prefer and be attracted to higher temperatures up to 42° or 43°F, a delta T of 8 or 9°F. (21) (19). The higher delta T's would be found only near the plant site in all probability. On the flood tide, fish resident in the warm parts of the plume would often be swept upstream in front of the intakes where they would be most susceptible to entrainment and to death by suffocation on the screens.

Also, one might expect those fish resident in the plume in winter to be suddenly driven into adjoining cold water when chlorine added to the cooling water reaches the plume (1 hour per day, 6 days a week (22)). For example, salmonid fish are repulsed by chlorine concentrations as low as 0.001 mg/l (23). Fish may be driven out of the plume toward the intake and be drawn onto the screens. They would be especially vulnerable to impingement because of the stress of cold shock caused by their sudden movement from the plume to colder water and they could be impinged before they have a chance to recover from the shock. It is even possible that fish would be killed directly by cold shock if driven very suddenly from a high plume temperature to a much lower ambient temperature. (24). If killed in this manner they would sink and there would be no visible evidence of the kill. (24)

IMPACT ON POPULATIONS

The extent of the removals by entrainment and impingement indicates that operation of Indian Point plants No. 1 and No. 2 with once-through cooling would have a serious adverse impact on the striped bass populations of the Hudson. There are some possible mitigating factors that must be considered but none that offer any certainty of significant reduction of the adverse impact.

Proportion of the Population Removed

To approximate the total removals from the population of first year striped bass by the Indian Point plants, one may accumulate the losses of the various early life stages. I have added the removals in sequential order and the loss for each stage is based on the population remaining after the loss for the preceding stage is subtracted. This procedure is necessary if one assumes that all fish entrained and carried into the plant are killed. The results are shown in Table 7. Egg removals are not included because they are so small a portion of the whole population. The estimates are based primarily on 1966 and 1967 data.

The effect of full time operation of Indian Point No. 2 slong with Indian Point No. 1, with both using once-through cooling, would be to remove from the Hudson 39 percent of the striped bass in their first year of life, from early larvae through to advanced juveniles. This estimate of removals is based upon year round operation of the plants. It is clear that the plant will be off line at times, but any reduction because of partial operation, "down" time" for maintenance, and so forth, would depend upon the time of year involved. For example, if the plant were not operated in May the reduction in removals would be low, if it were not operated in July or January the reduction would be great. On average, an allowance of 15% or 10% non-operating days would reduce the removals to a total of approximately 33 to 35 percent of the Hudson population.

There are a number of factors that could increase the proportion of the kill beyond this moderate estimate; e.g., if the proportion of striped bass in the total screen kill were higher than 5%, as it was during late 1969 and early 1970, or if Indian Point No. 2 killed more than 4 times as many fish as Indian Point No. 1, as it did in the February 1972 tests (42), or if persistent screen problems block the intake screens and increase the velocity of flow, as it did in the winter of 1970.

TABLE 7 - Removals of striped bass by Indian Point Units Nos. 1 and 2 at various stages in the first year of life.

		STRIPED BASS SUBJECT TO REMOVAL INDIAN POINT No.1 & 2				
LIFE HISTORY STAGE AND LENGTH OF STAGE	Original Population (Median)	Unadjusted fish removed (millions)	Adjusted population (millions)[1]	Adjusted removal (millions)[1]	Percent of population (millions)	Remaining population (millions)
II EARLY LARVAE 28 DAYS	112	5.7	112	5.7	5.1	106.3
III LATER LARVAE 45 DAYS	9.5	1.6	9.0	1.5	16.7	7.5
IV EARLY JUVENILES 28 DAYS	3.5	0.09	2.7	0.07	2.6	2.63
V LATER JUVENILES 261 DAYS	1.9	0.30	1.4	0.25	17.8	1.15

PERCENTAGE OF ORIGINAL POPULATION REMAINING AT END OF FIRST YEAR: 61%

1. Adjusted at each stage for removals at the prior stage.

Mortality of Removals

For screenable sizes (generally above 2 inches or 51 mm) it is accepted that virtually all fish are dead or mortally injured as they come off the traveling screens at Indian Point No. 1. Indian Point No. 2 is fitted with the same type of screens and therefore the effect of screen impingement should be just as lethal.

For the smaller pre-screenable striped bass, larvae and juveniles that are entrained, there is a serious absence of data. There are no useful studies of the effects on pre-screenable stages of striped bass of passage through Indian Point No. 1 or No. 2. However, there are studies by Barton C. Marcy that show the effects on white perch, a very closely related species (11). This work, done at the Connecticut Yankee plant at Haddam Neck on the Connecticut River, shows clearly that white perch yolk larvae are all killed by passage through the plant; at least when temperatures are elevated to 83°F. (28.2°C) or higher at the discharge. This temperature condition would be reached in the cooling water of Indian Point No. 2 in early June and remain until early October, the period when Hudson ambient temperatures exceed 68°F. Marcy got a complete kill at 83°F but tried no lower temperatures. Therefore, it is quite possible that a complete kill, or virtually complete kill, would occur at even lower temperatures.

It is valid to assume that striped bass would be affected in the same manner as white perch because they are such closely related species. Consequently one must assume that beginning in early June, a lethal condition for them would exist in the Indian Point No. 2 cooling system. Since the peak of striped bass early larvae abundance occurs in June in the Hudson, those entrained in the cooling water would be exposed to the conditions of the Marcy experiment and would die (See Marcy experimental Set A for June 30th. (11)).

Marcy stated that the majority of the dead larvae and juveniles emerging from the plant were "mangled" and this condition "was more apparent in larger specimens." Thus for the species Marcy studied, the damage apparently was even greater for stages following the yolk larvae; thus later larval and prescreenable juvenile stages can be expected to suffer heavy mechanical damage and death. It is probable that virtually all of the striped bass entrained and carried through the plant will be killed - from early larvae to pre-screenable juveniles. Those that might escape immediate death from the plant impact will still be endangered from the various after effects of the impact, such as susceptibility to predation, (25)(26). In one experiment, for example, whitefish fry were shown to be far more vulnerable to predation after only a one-minute thermal shock, (24).

In summarizing the vulnerability effect, Barber states: "The increase in predation from shock may be one of the more significant impacts of the waste heat discharge. This shock may not only result from temperature but also from physical damage during passage through a plant's cooling system or while entrained or from sub-lethal doses of biocides." (24)

In determining the potential impact of plant removals on striped bass stocks one must assume that all fish withdrawn by the plant are killed, including those entrained in the cooling water and carried through the plant as well as those impinged upon the screens. There is no proof that any significant number will escape death.

Compensatory Effects, Predation, and Competition

One cannot be certain of the type of relation that may exist between the quantity of striped bass and other species steadily removed from the Hudson and the size and vigor of the steady state population of striped bass. The number of variables involved in a natural estuarine habitat are so great as to have prevented anyone from completing a really comprehensive analysis of this type. However, there is a background of knowledge, mostly fresh water, from which certain relationships are drawn and held to be true by many fishery researchers.

The principle of overcrowding is generally accepted by fresh water fishery experts. It is quite demonstrable that if too many fish are crowded into a pond or small lake, the result is that individual fish become stunted from a shortage of food and do not reach a size desirable to fishermen (12).

No applicable experimental results demonstrating overcrowding in a natural estuary are known to me. Estuaries are known to be very productive and a standing crop of 100 pounds or more of fishes per acre would not be unexpected (9) From McHugh (39) an estimate of 250 pounds of fishes per acre can be estimated for the Chesapeake. Productive fresh water ponds, lakes and reservoirs also hold more than 100 pounds of fish per acre (12). Certainly, any typical estuary holding far less than 100 pounds per acre of fishes could not be considered overcrowded. It has been estimated that the Hudson estuary in the vicinity of Indian Point (Haverstraw Bay to the Bear Mountain Bridge) holds only 19.5 pounds per acre. Of this amount, 10.3 pounds per acre are white perch, the most abundant demersal species there (13). Striped bass are estimated at 1.9 pounds per acre. These low standing crops, certainly indicate that the Hudson near Indian Point is not overcrowded with demersal species for an estuary considered at one time to be as productive as the richest of fresh water lakes (14). However, these standing crop estimates (13) do not have a firm foundation and could be seriously in error.

The trawl catches of Carlson-McCann (1) also appear to suggest that overcrowding does not exist in the lower Hudson. The various samplings reported show that standing crops rarely exceeded 200 or 300 small fishes per acre, weighing altogether not more than 5-10 pounds. Striped bass were found to occur at about 25-30 per acre in the vicinity of Indian Point (1, Table 11) - a standing crop of less than 1/2 pound per acre. Again, the sampling base of the estimates is very shaky and one can use the data only with the greatest reservation.

Nevertheless, from the information at hand one gains the impression that the Hudson estuary is carrying less than its natural capacity of demersal fishes, rather than more. If this is so, there should be no shortage of food for the young striped nor serious competition for food with other species, such as white perch. Consequently, it appears that there would be no beneficial compensatory effect from thinning populations by killing fish at Indian Point. Still, the removal of millions of fish that striped bass feed upon - such as white perch - would reduce the available food supply to the striped bass. A shortage of forage fishes certainly would be a detriment to the striped bass of the Hudson, both the young that are resident there and the older ones that spawn there and then feed heavily before leaving for the sea. The recorded kills for Indian Point No. 1 are made up in large part of white perch, a species that striped bass are known to feed upon in the Chesapeake Bay, particularly in the late spring and early summer (15). (There have been no detailed studies of feeding habits reported for Hudson striped bass older than 1 year.)

One might also wish to examine the special situation of the early life stages to find if there are signs of any self correction mechanism which would balance the losses of eggs, larvae, and juveniles. Striped bass, for example, spawn masses of eggs, most of which are not fertilized or perish from one cause or another before hatching. After hatching there is, of course, a high incidence of mortality throughout the juvenile stage (Figure 2). One might assume that with this high level of natural mortality, it should not matter if a significant proportion are killed by power plants because they would die anyway, owing to, a limitation of food or other causes.

I have examined this matter in some detail and find that there is no reason whatsoever to believe that any balancing factors will compensate for the removals at Indian Point of larval or juvenile striped bass or white perch. That is, populations of these fishes will, in my opinion, be reduced in direct proportion to the mortality imposed by the plant, as concluded by the AEC Staff (22). I have independantly reached this opinion based on studies in other waters, as reviewed below.

Sommani (27) studied the striped bass of the San Francisco Bay estuary and found: "A close relationship between the abundance of the 1.5 inch fry and the number of 3-year-old fish . . ." This . . . "suggests that year class strength is determined before the fish reach a size of 1.5 inches." Sommani's findings are shown in Figure 4.

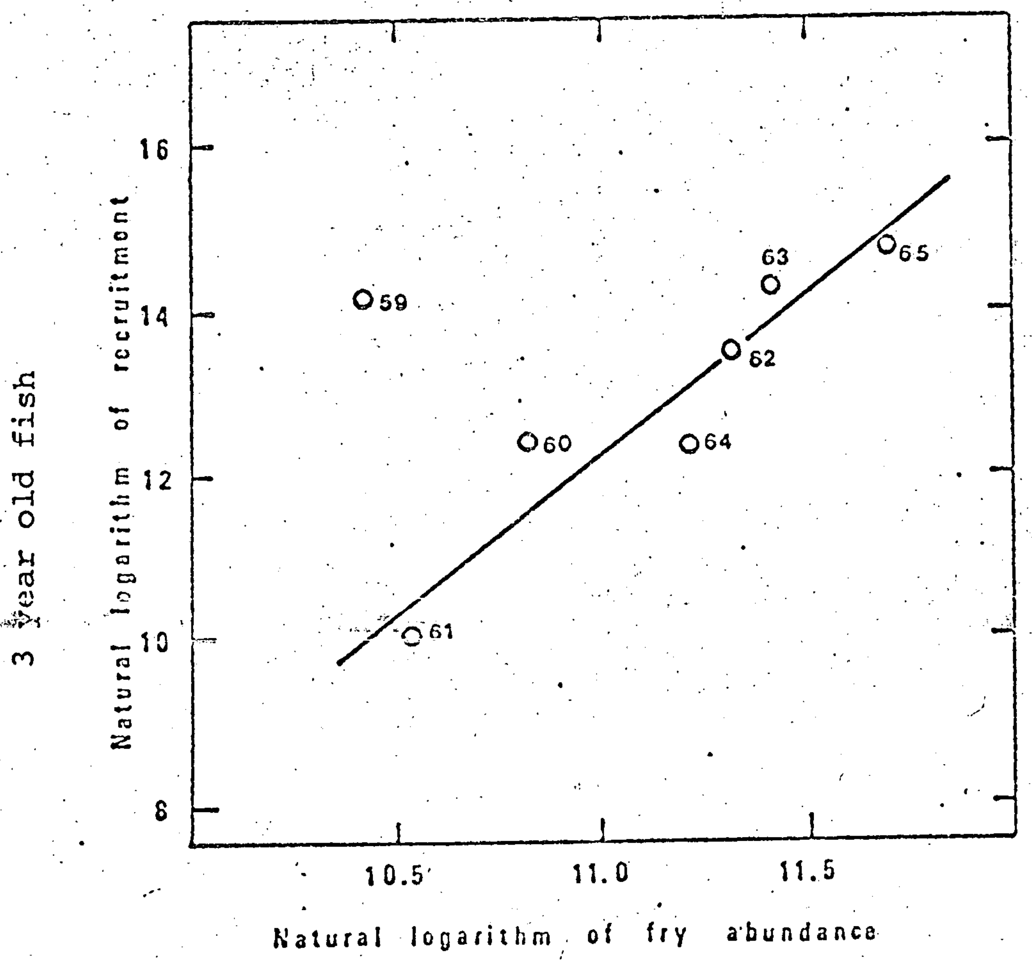


Figure 4. Relationship between logarithm of recruitment and logarithm of fry abundance during 1959 to 1965. The 1959 data were omitted when the relationship was calculated. (San Francisco Bay striped bass. Source: ref. 27)

Turner and Chadwick (28) studying the same striped bass stock (San Joaquin - Sacramento estuary) found a correlation of r=-0.9 between abundance of the young bass and the percent of the water pumped from the estuary by the Tracy Pumping Plant.

These two factors together indicate that: first, the abundance of juveniles (about 1.5 inches) is controlled directly by removals from the estuary - high removals resulting in low abundance of juveniles - and; second, since the stock of older fish three years later is a direct function of the number of juveniles, it follows that the fishery depends directly on the protection of the young from removal from the river.

In addition, Chadwick (29) has found no indication of any density control on the survival of striped bass in the San Joaquin-Sacramento estuary. In the Chesapeake Bay, Hollis (33) found a relationship between young juveniles and the fishable stock sufficiently exact to predict catches of the commercial fishery. Striped bass is a 'year-class' species, varying in order of magnitude in density from poor to good years (30)(33)(32), thus eliminating any idea that the population is held to a particular level by density-dependent factors.

Furthermore, there is no evidence whatsoever that growth of Hudson striped bass or white perch is reduced because of an over abundance of fish in the Hudson. The average growth of striped bass to the end of the first 15 weeks of life (about 3 inches) is essentially the same for the Hudson (1)(7) as for the

Chesapeake (15) (30) and the San Joaquin-Sacramento estuary (35) stocks, and is higher than for the Albemarle Sound (36) stock.

The Hollis data (33) on year classes (catch-haul index) supplemented by length data (supplied by Ray Scott, State of Maryland) is given below:

Year	Length in late Summer (inches)	Year Class Size Index
1958	3.1	18.1
1959	3.2	1.3
1960	3.3	6.8
1961	3.4	14.9
1962	3.0	12.2
1963	2.9	4.0
1964	2.6	23.5
1965	3.2	7.4
1966	2.7	12.4
1967	2.5	7.8
1968	2.9	7.2
1969	2.6	10.2

From these data it can be seen that the largest year classes grow, on the average, as well as the smaller year classes, thus showing positively that there is no density effect on growth of Chesapeake striped bass.

White perch grow to about the same size at the end of the first year in the Hudson (37) as in the Delaware (38) and the Chesapeake Bay (34). At age three the Hudson stock is about equal in size or a bit larger (140 mm) (37) than the Chesapeake (138 mm) (34) or Delaware (135 mm) (38) stocks (some problem was encountered in converting lengths measured in different ways). The indications are that white perch grow as well in the Hudson as in other areas for the first three years of life. Consequently, there appears to be no density effect on growth for the Hudson white perch.

My general conclusion is that the direct relation between the abundance of young striped bass and the abundance of the fishable stock is not mitigated by density-dependent effects. This is confirmed by the AEC Staff's Final Environmental Statement (22) showing a direct reduction of the striped bass fishery caused by reduction of breeding potential in the Hudson.

Nor is there any reason whatsoever to believe that reduction in populations of white perch or any other species of Hudson Estuary fishes would be offset by density dependent factors.

OTHER SPECIES

Screen kill records of Consolidated Edison show clearly that white perch, tomcod, herrings, anchovy, and other important species are killed in great numbers on the Indian Point No. 1 screens. Much higher kills would occur on the Indian Point No. 2 screens, probably increasing the total kill of these species at the Indian Point site each year by a factor of 5 or greater, as previously shown for striped bass. The kill of species other than striped bass is estimated at 6.2 million fish per year (Table 6).

Although I have not made quantitative estimates of the effects on other Hudson fishes, it is clear that planktonic and pelagic pre-screenable stages of the other species would be exposed to risks from entrainment and death in the Indian Point No. 2 cooling system similar to those for striped bass. The breeding periods of such important species as white perch, anchovy, and herring, also occur from May to July and their planktonic early life stages would be vulnerable to withdrawal in this period.

Thus, the populations of other valuable species can be expected to suffer serious adverse effects from Indian Point No. 1 and 2 alone. With Roseton, and Bowline Point also operating with once-through cooling, the combined effect could be disastrous to much of the fish life of the Hudson.

ADDITIONAL POWER PLANTS

The adverse effects on the striped bass populations of removals at Indian Point will be far more serious in combination with the effects of other power plants being built on the lower Hudson. Certainly the total number of striped bass and other species removed and killed will increase greatly. With Roseton and Bowline Point operating the remaining population would drop to less than 45 percent of the original population (44). With the proposed Verplanck, Sing Sing, and Storm King plants, the numbers remaining would fall to a nearly negligible proportion of the original population and the resource would be gravely endangered.

DURATION OF EFFECTS

I have shown that removing and killing larvae and juvenile striped bass will cause a proportionate direct reduction in the fishery; that is, if 39 percent of a year's brood are killed, that year class will join the fishery depleted by 39 percent of its potential size. In a few years, the new, reduced-size, year classes will make up most of the fishery stock and the size of the total fishery would fall by 39 percent - a corresponding decrease would occur in catches. This would be the initial status after about 4 or 5 years. 39% reduction from direct kill of the young.

Then a further reduction is expected because the breeding stock would also be reduced by 39 percent and less larvae would be produced in each breeding season. This would lead to accelerated reduction of greater than 39 percent and in time could lead to extreme depletion. These effects are shown by Jensen to be sufficiently adverse to lead to the complete extermination of a stock (brook trout) in a fresh water situation when 50 percent of a year class are exterminated in their first year (43). Serious consequences from this secondary, or feedback, affect could result after 4 or 5 years of operation of Indian Point No. 2 with once-through cooling, such that the fishery would suffer massive long-term losses. Even operation of the once-through cooling system through two spawning seasons will have long-term detrimental effects on the fishery through reduction of catch and breeding stock. The total size of the fishery might possibly be restored over time through a combination of natural and management means, but the lower fish population will be a real and irreversible loss so long as it lasts.

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MR. KARMAN: May I have just one moment, Mr. Chairman? I believe after the errata list will be read off, to make sure the record is complete, I believe that I neglected to request of my panel of witnesses whether they adopt the Final Environmental Statement as corrected as their testimony in this proceeding.

WITNESS KNIGHTON: I do.

WITNESS COUTANT: I do.

WITNESS SIMAN-TOV: I do.

WITNESS CARTER: I do.

WITNESS OESTMANN: I do.

WITNESS GOODYEAR: I do.

WITNESS YEE: I do.

MR. KARMAN: Thank you.

CHAIRMAN JENSCH: At this time, let's recess to reconvene in this room at 2:50.

(Recess.)

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CHAIRMAN JENSCH: Please come to order.

The procedures that we considered at our November 22nd conference contemplated that in order to provide schedules for the Staff witnesses, the Staff witnesses would be cross-examined first. Which party would desire to proceed with the cross-examination first?

MR. TROSTEN: Applicant will proceed.

CHAIRMAN JENSCH: Would you proceed, please.

MR. TROSTEN: We would like to cross-examine Dr. Phillip Goodyear first, Mr. Chairman.

CHAIRMAN JENSCH: If you feel it would be more convenient to have him at the witness stand --

MR. KARMAN: Mr. Chairman, we would prefer, if possible -- this is a team effort and has been with respect to the environmental statement. Dr. Coutant is here, and he worked with Dr. Goodyear on this. I think it probably would be more practical if we can work from the panel. If it doesn't work out, we can swing it the other way.

CHAIRMAN JENSCH: Is this a compromise -- why not have Dr. Goodyear and Dr. Coutant both go to the stand?

MR. KARMAN: We -- if we can add Mr. Siman-Tov, we would have no objection.

CHAIRMAN JENSCH: I thought the people could hear better.

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MR. KARMAN: If the three can go up, that would be fine.

CHAIRMAN JENSCH: It will be understood if any of the witnesses desire to have conferences with the other persons at the Staff table, they should feel free to invite the participation of the other Staff personnel.

Proceed, Applicant, please.

MR. TROSTEN: Thank you, Mr. Chairman.

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MR. TROSTEN: Dr. Goodyear, am I correct in understanding that you were responsible principally for the sections of the Final Environmental Statement dealing with biological impact?

WITNESS GOODYEAR: Yes.

MR. TROSTEN: Dr. Goodyear, I think I have your qualifications here. Did you graduate from college in 1966, is that correct?

WITNESS GOODYEAR: Yes.

MR. TROSTEN: And you received your PhD from Mississippi State University in 1969, is that correct?

WITNESS GOODYEAR: Yes.

MR. TROSTEN: Could you tell me what was the subject of your PhD thesis?

WITNESS GOODYEAR: The subject was -- the dissertation was entitled Vision and Learning in Mosquitofish.

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MR. TROSTEN: So the mosquitofish was the subject of the thesis?

WITNESS GOODYEAR: Right.

MR. TROSTEN: Is the mosquitofish a native to the Hudson River?

WITNESS GOODYEAR: No.

MR. TROSTEN: Is it an estuarian -- excuse me. Well, what is its habitat?

WITNESS GOODYEAR: It is a fresh water form. It does go into estuaries. Presently it is distributed very widely throughout the U.S. and abroad it's been introduced to control mosquitoes.

MR. TROSTEN: Do you find it in the middle Atlantic states north of the Chesapeake Bay?

WITNESS GOODYEAR: I am not certain. It may well occur there.

MR. TROSTEN: Is it an anadromous fish?

WITNESS GOODYEAR: No.

MR. TROSTEN: How large would you say it grows?

WITNESS GOODYEAR: Oh, about two inches. That would be average.

MR. TROSTEN: How large would you say a striped bass grows, average size fish?

WITNESS GOODYEAR: Most of the striped bass that are taken in the Chesapeake only make it to a pound or two

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in weight. On the Atlantic coast, they grow larger than that. This is a problem whether you are trying to say what is the largest fish or the average.

MR. TROSTEN: I just meant some of the fish that are taken in the Hudson River by the commercial fishermen. Arent they up to --

WITNESS GOODYEAR: 50 pounds or so.

MR. TROSTEN: How large would a fish like that be?

WITNESS GOODYEAR: In length?

MR. TROSTEN: In length, yes.

WITNESS GOODYEAR: 28 inches, 30.

MR. TROSTEN: Now the mosquitofish, does it lay eggs?

WITNESS GOODYEAR: No.

MR. TROSTEN: In other words, it hatches its -- the young are hatched inside the female fish and born alive, is that right?

WITNESS GOODYEAR: Yes.

MR. TROSTEN: Now the striped bass lays eggs, is that correct?

WITNESS GOODYEAR: Yes.

MR. TROSTEN: I am sorry. I do not recall whether the title of the scientific papers you had published were contained in your biography. What were the titles of those papers?

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WITNESS GOODYEAR: I would have to look at the list. There are like 20 papers dealing with a variety of subjects. I have a single copy of the list of my publications with me.

MR. TROSTEN: Would you mind bringing that? Do you have a list with you?

WITNESS GOODYEAR: Not right here.

MR. TROSTEN: Would you mind having someone bring it to you so I could hear what the list is?

WITNESS GOODYEAR: I probably could find it much faster.

MR. TROSTEN: All right. Thank you.

CHAIRMAN JENSCH: While there is a pause, I wonder if I could understand the relevancy of some of the inquiry. Is it your contention that the disciplines of fish studies are different or that because the fish are different, the studies should be different?

MR. TROSTEN: It is certainly our view, Mr. Chairman, that the disciplines, or rather the expertise involved in studying different species of fish or different types of fish are different, yes. This is the basic purpose. I am inquiring as to the background the witness had with regard to the fish in question, particularly with regard to the striped bass, which is the subject of the Staff's model.

CHAIRMAN JENSCH: Very well. Thank you.

WITNESS GOODYEAR: The first publication that I -- actually the first two publications I was a party to were both abstracts of papers that were presented in meetings at the Mississippi Academy of Science. 1963, I reported on preliminary study for parasitic trematode.

MR. TROSTEN: I am sorry. I didn't understand that.

WITNESS GOODYEAR: It is -- well, a preliminary study of a parasitic trematode.

MR. TROSTEN: What is a trematode?

WITNESS GOODYEAR: It is a -- it is a small -- it is a --

MR. TROSTEN: Is it a fish?

WITNESS GOODYEAR: No. It is an invertebrate flatworm.

MR. TROSTEN: Thank you very much.

WITNESS GOODYEAR: All right.

These -- again back to the titles. Preliminary study of a parasitic trematode found in the Trichiurus lepturus from the Mississippi and Chandeleur Sounds.

CHAIRMAN JENSCH: Excuse me. May I interrupt a moment? Mr. Reporter, feel free to ask questions.

(Laughter.)

WITNESS GOODYEAR: The second was in 1965, entitled "Some Serological Studies with the genus Peromyscus," at the Mississippi Academy of Science.

MR. TROSTEN: I don't want to string this out too much, but could you give me an idea of an animal we are talking about?

WITNESS GOODYEAR: A small mammal now.

MR. TROSTEN: Living in water or living on land?

WITNESS GOODYEAR: This was a terrestrial mammal.

MR. TROSTEN: Okay.

WITNESS GOODYEAR: The third was 1966, distribution of gars on the Mississippi Coast, General Journal of Mississippi Academy of Science.

1967, feeding habits of three species of gars, Lepisosteus, along the Mississippi Gulf Coast, the Trans. American Fishery Society.

MR. TROSTEN: What kind of a fish is the gar? Is it a fresh water fish?

WITNESS GOODYEAR: It is primarily a fresh water fish, but it does live in brackish water habitats. This was a terrestrian environment here. The food habits differ somewhat between fresh and terrestrian environments.

MR. TROSTEN: Is that an anadromous fish?

WITNESS GOODYEAR: That's a difficult question to answer. Within the boundaries of the location that I was studying, you could call it an anadromous fish. It did not spawn in salt water. However, for the most part, the gars are strictly fresh water.

MR. TROSTEN: But on the basis of your study, it is not very easy to tell that, is that right, whether it is or is not an anadromous fish?

WITNESS GOODYEAR: Well, it is not -- in the classical sense it is not an anadromous fish.

MR. TROSTEN: I see.

WITNESS GOODYEAR: It does not require salt water for a portion of its existence.

MR. TROSTEN: I see.

WITNESS GOODYEAR: The next in 1967, the pathway of endrin entry in black bullheads, Ictalurus melas, Copeia.

MR. TROSTEN: Is that a fresh water fish?

WITNESS GOODYEAR: Yes. Then my master's thesis, Gambusia affinis. PhD, learning and orientation, vision and learning in the orientation of mosquitofish, Gambusia affinis, and sun-compass orientation, published in Animal Behavior, 1969.

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MR. TROSTEN: What type of organism is that?

WITNESS GOODYEAR: That is a topminnow, very much like many of the forms that are found in the Hudson. It is a Cyprino dontid fish.

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MR. TROSTEN: Go ahead, Doctor.

WITNESS GOODYEAR: Orientation of bullfrogs during metamorphosis, Copeia.

Herpetologica -- I might mention that some of these have other authors as well.

MR. TROSTEN: Yes.

WITNESS GOODYEAR: In 1971, somatic and dry matter and protein in gravid females of several amphibian species.

1971, nutritive quality of food in the ecological systems, hydrobiology.

1971, protein content in common reptiles and amphibians.

'72, simple technique for detecting effects of toxicants or other stresses on a predator-prey interaction. Transactions American Fisherman's Society.

1972, relationships between primary productivity and mosquitofish production in large microcosms. Oceanography.

1972, elemental composition of largemouth bass, Micropterus salmoides, Transaction American Fishery Society.

MR. TROSTEN: Is that the fresh water variety of bass?

WITNESS GOODYEAR: Yes.

In 1972, I assisted in the thermal effects, annual literative review, Journal of Water Pollution Control Federation, and 1972, I have one article that's now in press, the learned orientation in the predator avoidance behavior of mosquitofish behavior. That may be in 1973 also. I am not sure.

MR. TROSTEN: Yes.

WITNESS GOODYEAR: And those are the -- the primary publications. I have a few reports, too, of the same nature.

MR. TROSTEN: If I remember the list correctly, your master's thesis and your doctoral thesis and two of the papers that you have written since receiving your PhD were on the mosquitofish. Is that correct?

WITNESS GOODYEAR: Would you repeat?

MR. TROSTEN: If I remember the list correctly, both your master's degree and your doctor's degree related to your work with mosquitofish?

WITNESS GOODYEAR: Yes.

MR. TROSTEN: And two of the papers that you have done since you received your PhD dealt with mosquitofish?

WITNESS GOODYEAR: Yes. Three, actually.

MR. TROSTEN: Excuse me?

WITNESS GOODYEAR: Three.

MR. TROSTEN: I beg your pardon.

I didn't hear any of those papers that dealt with the striped bass. Did I miss one?

WITNESS GOODYEAR: No.

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MR. TROSTEN: How many of those papers that you listed -- excuse me. Let me rephrase that. With respect to how many of those papers were you the senior author?

WITNESS GOODYEAR: One moment. Fourteen.

MR. TROSTEN: You were the senior author of fourteen of those papers? All right.

Withregard to the others that -- with respect to which you were not the senior author, what was the role that you had in the preparation of these papers?

MR. KARMAN: Mr. Chairman, aren't we going a little too far on this? We have some 20-odd publications or 20 and Dr. Goodyear has said he has been the senior man on fourteen, I think we are really stretching this a little beyond the scope of testing qualifications for the witness. I am not sure how far down the road we can go with this.

CHAIRMAN JENSCH: Could you in your response indicate your relevancy situation? As I understand it, you feel that if a man hadn't studies striped bass, he is not qualified to talk about striped bass, is that your view?

MR. TROSTEN: No, I am not saying that, Mr. Chairman. I think that to say that the only person who could talk about striped bass was a man who had spent his life studying it would be to unduly restrict the field.

Obviously, I certianly would never put that position forth. But I do think that in an area such as the one we

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are discussing in this hearing, where so much frankly, Mr. Chairman, depends on expert opinion because the data are not that conclusive and it is a matter of interpretation of data, that it is important to determine the background of an individual so that one can have a better feel for his ability to sponsor the sort of testimony that he is sponsoring. I don't want to string this out and it will move along quickly if I am just allowed to proceed.

CHAIRMAN JENSCH: Proceed.

WITNESS GOODYEAR: Would you repeat the question again?

MR. TROSTEN: What was your role with regard to the other papers, Dr. Goodyear?

WITNESS GOODYEAR: Do you want each one?

MR. TROSTEN: No, just a general statement.

WITNESS GOODYEAR: For most of the other papers, I either was responsible for the work in its entirety or as a shared responsibility for the development of them.

MR. TROSTEN: All right. That is fine. Thank you.

Dr. Goodyear, when did you last inspect the Indian Point Nuclear Power Plant?

WITNESS GOODYEAR: A little over a year ago.

MR. TROSTEN: And did you -- were you there prior to that visit that you just described?

WITNESS GOODYEAR: No.

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MR. TROSTEN: In other words, you have been to the Indian Point Nuclear Power plant once?

WITNESS GOODYEAR: Well, once where an inspection was carried out. I have been there one other time.

MR. TROSTEN: All right. With regard to that one time when an inspection was carried out, what did you inspect?

WITNESS GOODYEAR: The intake structures, canal discharge structures.

MR. TROSTEN: How long would you say you were there?

WITNESS GOODYEAR: Several hours.

MR. TROSTEN: And you were then looking at the intake structures and the discharge structures? In other words, you walked along the dock, is that basically what you did?

WITNESS GOODYEAR: Basically.

MR. TROSTEN: Right. Were the intakes in operation at the time?

WITNESS GOODYEAR: Yes.

MR. TROSTEN: Have you yourself performed sampling of eggs and larvae of fishes in the Hudson River?

WITNESS GOODYEAR: No.

MR. TROSTEN: Have you performed sampling of zooplankton in the Hudson River?

WITNESS GOODYEAR: No.

MR. TROSTEN: Phytoplankton?

WITNESS GOODYEAR: No.

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MR. TROSTEN: Have you performed sampling of eggs or larvae of fishes in some other river?

WITNESS GOODYEAR: I have participated with -- no, not in rivers. I have participated in sampling in lakes.

MR. TROSTEN: Have you yourself performed the sampling of phytoplankton in other bodies of water besides the Hudson River?

WITNESS GOODYEAR: Could you explain what you mean by sampling?

MR. TROSTEN: The actual collection of phyto-plankton samples in a river.

WITNESS GOODYEAR: For abundance estimates?

MR. TROSTEN: Or species composition estimates.

WITNESS GOODYEAR: No.

MR. TROSTEN: Have you done that type of sampling for zooplankton?

WITNESS GOODYEAR: No.

MR. TROSTEN: Have you yourself engaged in a tagging study of the striped bass?

WITNESS GOODYEAR: No.

MR. TROSTEN: Have you engaged in another type of field study of the striped bass?

WITNESS GOODYEAR: No.

MR. TROSTEN: Have you engaged in a study involving the migration of anadromous fish?

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WITNESS GOODYEAR: Would you explain by -- what you mean by study. I have studied data in the literature very extensively.

MR. TROSTEN: I mean a field study.

WITNESS GOODYEAR: No.

MR. TROSTEN: Have you ever been on a field trip on the Hudson River?

WITNESS GOODYEAR: No.

MR. TROSTEN: Have you ever performed a population dynamics study of the striped bass?

WITNESS GOODYEAR: No.

MR. TROSTEN: Have you ever performed a population dynamics study of another fish?

WITNESS GOODYEAR: Yes.

MR. TROSTEN: Which fish?

WITNESS GOODYEAR: Mosquitofish.

MR. TROSTEN: Have you ever performed a population dynamics study of anadromous fish?

WITNESS GOODYEAR: No.

CHAIRMAN JENSCH: What is a population dynamics study?

MR. TROSTEN: It is a study involving the factors that would affect a population of fishes, factors that might cause a population to expand or be depressed, the sort of pressures for example, that a fishery might place on a fish

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population. These are the sort of studies that are often done for fresh water ponds and streams in order to determine what sort of fishing limits might be placed or they are done in connection with commercial fisheries to see how the fisheries should be managed.

CHAIRMAN JENSCH: Thank you. Do you accept that definition?

MR. TROSTEN: Did I correctly describe it?

WITNESS GOODYEAR: Generally speaking, you did. I would like to make it clear that I am interpreting your questions as field studies.

MR. TROSTEN: That is what I meant.

And however, I would like to expand my question with regard to -- you are not saying that you performed a theoretical study of the striped bass other than the one that is reflected in the Final Environmental Statement of population dynamics study, are you?

WITNESS GOODYEAR: Other than that, no.

MR. TROSTEN: That is right.

Do I understand from your responses to my questions that you have never performed a population dynamics study, either a field study or a theoretical study of another estuarian fish other than -- well mosquitofish you indicated lives in a marsh. I guess that has a slight favor of an estuary to it.

WITNESS GOODYEAR: Would you repeat that, please?

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MR. TROSTEN: Have you ever performed a population dynamics study either a field study or a theoretical study of an estuarian fish?

WITNESS GOODYEAR: Not for the total population dynamics of the fish. I have been involved in portions. The studies conducted on gar provide a fairly substantial portion of population dynamics.

MR. TROSTEN: That is a fresh water fish, is that right?

WITNESS GOODYEAR: In an estuarian environment.

MR. TROSTEN: I see.

Now, I understand that you were the principal sponsor of the portions of the Final Environmental Statement dealing with biological impact, is that correct?

WITNESS GOODYEAR: I am -- I was the one that compiled the information, yes.

MR. TROSTEN: Well, did you have assistance in preparing portions of the statement?

WITNESS GOODYEAR: Would you please --

MR. TROSTEN: Well, let's take Section 5. Section 5 has a section D which begins on page V-7 called, "Biological Impact of Station Operation of Units 1 and 2" and it runs through -- oh, about page V-73, from V-7 to V-73. Did you prepare that section? Taking this as an example?

WITNESS GOODYEAR: I prepared the -- most of the

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information included here. There were other people who assisted in providing some input information and some of the write-ups have been augmented by people.

MR. TROSTEN: But in other words, I can cross-examine you with regard to this portion of it and if you need -- if there is a particular questions, you will turn to something else, is that correct.

WITNESS GOODYEAR: Yes.

MR. TROSTEN: All right. You have assistance. Who were the people who assisted you in preparing Chapter 5, Section D, the pages I have just indicated.

WITNESS GOODYEAR: Dr. Coutant.

MR. TROSTEN: Which part did Dr. Coutant help you with?

MR. KARMAN: I am not quite certain we have to so clearly define every line that has been included in this Environmental Statement. Dr. Goodyear has indicated as had I when we introduced this evidence that this was an effort of the Regulatory Staff and its consultants. Dr. Goodyear has indicated that he is prepared to respond to every part of this matter in consultation, with the other witnesses present here. I think if we are going to get to which secretary gave him certain figures, I think we are going to go way,way off base.

CHAIRMAN JENSCH: I think that as Staff counsel points

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out, the question is for -- to what extent will this witness assume responsibility for these statements. If he says I will take responsibility for this section, he gets the questions.

MR. KARMAN: He has. I don't think we should develop any further than that.

MR. TROSTEN: I am not trying to develop, Mr. Chairman. I assume the answer is quite simple. The two people with Dr. Goodyear are Dr. Coutant and Dr. Siman-Tov. I suppose that is the answer, of course.

CHAIRMAN JENSCH: Yes. To the extent they can pick out portions or contributions. I suppose it is somewhat difficult to quantify.

(Laughter.)

MR. TROSTEN: I merely wanted to find out who were the people who assisted and I will be able to address my question more appropriately.

CHAIRMAN JENSCH: I think the objection of Staff counsel is sustained if he can't pick it out line by line.

MR. TROSTEN: Mr. Chairman, may I rephrase my question and ask about the areas?

CHAIRMAN JENSCH: Proceed, yes.

MR. TROSTEN: Would you please tell me, Dr. Goodyear, which areas you had assistance in and from whom?

WITNESS GOODYEAR: Most of the material that is in

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here reflects consultation while the analysis was going on.

MR. TROSTEN: For example, did you have assistance from Dr. Coutant in the matter of the effect of elevated temperatures on phytoplankton? Did he help you in that area?

WITNESS GOODYEAR: Yes.

MR. TROSTEN: Did Dr. Siman-Tov --

WITNESS SIMAN-TOV: Mr. Siman-Tov.

MR. TROSTEN: Did he help you with regard to the Hudson River hydrodynamic aspects?

WITNESS GOODYEAR: Yes.

MR. TROSTEN: Were there other aspects that you care to tell me you had help on?

WITNESS GOODYEAR: Well again, what I am saying is that I am primarily responsible for this.

MR. TROSTEN: All right. Okay. I just wanted to be clear because I didn't want to bother asking you a question and then having to turn to Dr. Coutant and trying to remember what my question was.

Okay. Now, when -- you joined the Staff at Oak Ridge National Laboratory in 1970, is that correct? Or was it 1969?

WITNESS GOODYEAR: 1971.

MR. TROSTEN: I am sorry. What has been the scope of your duties since you joined the Staff at Oak Ridge National Laboratory?

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WITNESS GOODYEAR: For the most part, analyzing information such as is in here.

(Indicating.)

MR. TROSTEN: Have you been assigned just to the Indian Point Project since you joined in 1971?

WITNESS GOODYEAR: This has been my principal responsibility, yes.

MR. TROSTEN: All right. In other words, you spent most of your work on the Indian Point Project and you had not worked on other projects simultaneously?

WITNESS GOODYEAR: I had worked on other projects.

MR. KARMAN: Mr. Chairman, we are going too far. I don't understand Mr. Trosten's point. Dr. Goodyear has indicated he has spent most of his time on the Indian POint Project. Whether he spent two hours a week on some unrelated matter, I think that is really not pertinent to the examination. We have a long row to hoe and I think we are just going down blind allies.

CHAIRMAN JENSCH: Well, I think this is part of foundation to the extent to which he worked. If he just joined the AEC in 1971 and we are almost done with 1972, but if he is responsible for a project that is ranging in cost possibly from 60 million to 190 million, I think he probably is going to take this row hoeing in some detail.

Objection overruled. Proceed.

MR. KARMAN: In addition, I think the recordought ak 12

to indicate that Dr. Goodyear, as is Dr. Coutant and Mr. Siman-Tov are not employees of the Atomic Energy Commission.

CHAIRMAN JENSCH: Yes. That should be noted and established in the record. I presume it is Union Carbide?

MR. KARMAN: Yes.

MR. TROSTEN: What training or experience have you had in the field of statistics? I didn't hear anything mentioned in your resume. Did I miss it?

WITNESS GOODYEAR: No special training.

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MR. TROSTEN: Excuse me. I was distracted. You were starting to tell me about the other project you had worked on.

WITNESS GOODYEAR: Doing some thermal effects research as well as the input into this document. These involve principally the population dynamics of a large-mouth bass population in a reservoir with a thermal effluent.

MR. TROSTEN: In what, sir?

WITNESS GOODYEAR: In a reservoir that receives a thermal effluent.

I have also participated in aiding other -- preparation of other impact statements, other staff.

MR. TROSTEN: What special training do you have in the field of mathematics, Dr. Goodyear?

WITNESS GOODYEAR: None.

MR. TROSTEN: What special training do you have in the modeling of biological systems?

WITNESS GOODYEAR: Would you please -- I am not certain what you mean by special in this case.

MR. TROSTEN: What I mean is we have here in the record a mathematical model developed by the Atomic Energy Commission Staff, developed by you. I wanted to know whether you had special training in the development of such mathematical models? Had you developed a mathematical model like this for other fish?

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Let's take a specific question.

WITNESS GOODYEAR: No. However, I would like to point out that I have had special assistance from people who are modelers within our division.

MR. TROSTEN: All right. Now, did Dr. Coutant help you with that model? Of the striped bass?

WITNESS GOODYEAR: Not from the standpoint of the model itself with input to it.

MR. TROSTEN: Did Mr. Siman-Tov help you with regard to that model?

WITNESS GOODYEAR: Would you now please clarify which model you are speaking of?

MR. TROSTEN: I assume Mr. Siman-Tov probably had a considerable input in your model which is described in Appendix 5-2, but did he help you with the model which is described in Appendix 5-3, which is the mathematical model of the impact of the plant on striped bass?

WITNESS GOODYEAR: Not to the same degree, no.

MR. TROSTEN: But he consulted with you?

WITNESS GOODYEAR: I consulted with him.

MR. TROSTEN: Was there someone else you haven't identified yet who consulted with you in a significant way on the development of the mathematical model for the striped bass which is in the Final Environmental Statement?

WITNESS GOODYEAR: Several other people have, yes.

MR. TROSTEN: Who were those people?

WITNESS GOODYEAR: Dr. Charles Hall.

MR. TROSTEN: Who is Dr. Charles Hall?

WITNESS GOODYEAR: I am sorry.

MR. TROSTEN: Who is Dr. Charles Hall? Who is he? Does he work for Brookhaven National Laboratory?

WITNESS GOODYEAR: Not presently, no. Well, he may be still -- I think he's half-time Cornell and half-time Brookhaven.

MR. TROSTEN: I see. Who else helped you with that mathematical model?

WITNESS GOODYEAR: Just a moment.

(Witnesses consulting.)

WITNESS GOODYEAR: I received considerable assistance from programmers in our math division.

MR. TROSTEN: By programmers, you mean that these are men whom after you have developed the computer program, they translate this into the computer language, is that right? Is that what you mean by a programmer?

WITNESS GOODYEAR: In this case they are in the math division. The assistance was from the math division. It involved more than just translating my program into a language to be solved in the computer because much of the information, I cross-checked with them to make sure methodology is correct.

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MR. TROSTEN: Did they actually --

CHAIRMAN JENSCH: Excuse me. Had you finished?

WITNESS GOODYEAR: Yes.

MR. TROSTEN: I beg your pardon, Doctor.

Did they actually develop the mathematical model or portions of it? The theory, in other words, the equations that later were translated into computer language.

WITNESS GOODYEAR: The equations that have been used are largely my own. They were checked, cross-checked with several other modelers -- with several modelers to see if they were legitimate or not.

MR. TROSTEN: Do you know if any of those modelers had ever developed a computer -- a mathematical model involving the population dynamics of a fish?

WITNESS GOODYEAR: I don't know.

MR. TROSTEN: Do you know what Dr. Hall's background is? Is he a biologist?

WITNESS GOODYEAR: He is a biologist, yes.

MR. TROSTEN: Do you know if he has had any special training in the modeling of the population dynamics of a fish?

WITNESS GOODYEAR: Just a moment.

(Witnesses conferring.)

CHAIRMAN JENSCH: While there is a pause, I wonder if I could understand the question.

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What is the special training? Are you really saying what is his training and you can determine whether it is special or not? I mean -- special training may mean something to a graduate student and to an undergraduate or a Ph.D.

MR. TROSTEN: Excuse me. I will rephrase the question: Do you know if Dr. Hall has ever developed a mathematical model for the life cycle of a fish?

WITNESS COUTANT: If I might answer that, Dr. Hall did have his Ph.D. training in systems analysis and modeling at the University of North Carolina and part of his thesis training was the development of such models, and I believe he's -- excuse me, his thesis research involved such a preparation.

MR. TROSTEN: Of mathematical models?

WITNESS COUTANT: Of a mathematical model for a fish population, right.

MR. TROSTEN: All right.

Have you any special training in computer programming, Dr. Goodyear?

WITNESS GOODYEAR: What do you mean by special training?

MR. TROSTEN: Would you describe the training that you have in computer programming?

WITNESS GOODYEAR: I do not have any formal training

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in computer programming. I have been -- if you can include training, on-the-job-type training with assistance from programmers and modelers, then the answer is yes. I have had it.

MR. TROSTEN: Would you say that the on-the-job training you have described was principally the training that you have had since joining the Oak Ridge National Laboratory?

WITNESS GOODYEAR: Principally yes.

MR. TROSTEN: In other words, the on-the-job training you have had has been principally in the development of a mathematical model which is the subject of the Final Environmental Statement?

WITNESS GOODYEAR: It is related to it, yes.

MR. TROSTEN: But is that the principal on-the-job training that you have?

WITNESS GOODYEAR: The principal training is in the development of a mathematical model for striped bass. The model that is used in the Final Statement is a much simplified version of it.

MR. TROSTEN: But am I correct in understanding that the principal training which you described as on-the-job training was developed in connection with the preparation of the model which is the subject of the Final Environmental Statement?

WITNESS GOODYEAR: I am sorry. What do you mean by

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subject of the Environmental Statement?

MR. TROSTEN: Well, there is a model presented in the Final Environmental Statement.

WITNESS GOODYEAR: Yes.

MR. TROSTEN: The preparation of that model required programming on the computer. I asked you if you had had any -- I asked you what your training was in the programming of a computer and you said that you had had on-the-job training. I wanted to know if the on-the-job training that you just described was the training that you received when you were working on this model?

WITNESS GOODYEAR: Working on striped bass models, yes.

CHAIRMAN JENSCH: Was that in the plural, striped bass models?

MR. TROSTEN: Striped bass.

CHAIRMAN JENSCH: Was that your answer, included more than one model?

WITNESS GOODYEAR: Yes.

CHAIRMAN JENSCH: Thank you. Proceed.

WITNESS COUTANT: If I might amplify, we do have a research program at the laboratory that involves population dynamics modeling and Dr. Goodyear has a part of the research work in that programming. This program involves other models in addition to the particular model which was used for the impact statement before us. So I think it is unfair to suggest that the only on-the-job training is with respect to this particular model. He is working with other models and considerably more generous are his models.

MR. TROSTEN: I didn't mean to be unfair. I was just trying to inquire about it.

Now what special training do you have in the specialty of hydrology, Dr. Goodyear?

WITNESS GOODYEAR: None.

MR. TROSTEN: What special training do you have with regard to -- excuse me. I shouldn't use that phrase. I will stop.

What is the training that you have, either professional training or experiential training, with regard to factors controlling phytoplankton growth, you, Dr. Goodyear?

WITNESS GOODYEAR: Factors controlling phytoplankton growth?

MR. TROSTEN: Factors controlling phytoplankton growth.

WITNESS GOODYEAR: Well, virtually all of the biological training that I have had is oriented around factors controlling not only phytoplankton, but other forms of life as well.

MR. TROSTEN: In other words, you are a biologist and graduate biologist, and hence you have a general -- you have the understanding of a biologist of factors which control phytoplankton growth? But apart from that, was any of your work specifically devoted to the subject of factors controlling phytoplankton growth?

Let me be as specific as I can. There are sections in here, in Appendix 5-1, for example, that deal with the factors that control phytoplankton growth and diversity. I wnated to know if you had performed any special studies in your professional career that dealt with those very subjects?

WITNESS GOODYEAR: Yes, I have.

MR. TROSTEN: Would you describe them?

WITNESS GOODYEAR: Let me collect my thoughts for a second.

One of -- again there are so many different things that control population.

MR. TROSTEN: Yes.

WITNESS GOODYEAR: I have worked with phytoplankton for a particular controlling factor and related that to secondary production.

MR. TROSTEN: Which factor was this, Dr. Goodyear?

WITNESS GOODYEAR: This is nutrient input.

MR. TROSTEN: The effect of nutrient input on subsequent phytoplankton production?

WITNESS GOODYEAR: Subsequent phytoplankton production

10mil and production by consumers.

MR. TROSTEN: You did not work specifically on the effect of heat on phytoplankton production?

WITNESS GOODYEAR: No, I did not.

MR. TROSTEN: Did you work on the effect of chemicals on subsequent phytoplankton production?

12 WITNESS GOODYEAR: I have assisted in studies

13 of that. I have not done them specifically myself.

MR. TROSTEN: All right.

Which -- have you performed studies yourself to determine the effects of temperature elevation on species composition of phytoplankton?

WITNESS GOODYEAR: No.

MR. TROSTEN: Have you performed studies yourself to determine the generation time of phytoplankton relative to temperature effects?

WITNESS GOODYEAR: We are still talking field studies?

MR. TROSTEN: Yes, sir.

WITNESS GOODYEAR: No.

MR. TROSTEN: Have you performed studies yourself on the effects of temperature elevation on species composition and abundance of zooplankton?

WITNESS GOODYEAR: No.

MR. TROSTEN: The same question excepting chemical,

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substitute chemicals for temperature elevation.

WITNESS GOODYEAR: For zooplankton?

MR. TROSTEN: Yes.

WITNESS GOODYEAR: No.

MR. TROSTEN: Dr. Goodyear, do you think that it is important in discussing the impact of the proposed operation of a facility to make clear whether the supporting evidence is based on theoretical laboratory, theoretical laboratory that is, or ~~on sight~~ on-site or field studies?

WITNESS GOODYEAR: To distinguish between them?

MR. TROSTEN: Yes. In other words, do you think, when you are making a study, do you think it is important to make it clear whether the supporting evidence whereby -- from which you are drawing your conclusions, is based on theoretical or laboratory or ~~on sight~~ on-site or field studies? Cou' you say would you agree?

WITNESS GOODYEAR: Yes.

MR. TROSTEN: You would? Fine.

Do you agree that generally each site must be evaluated individually in order to determine the environmental impact of the proposed operation of a power plant?

WITNESS GOODYEAR: Yes.

MR. TROSTEN: And do you believe that this is the most appropriate way in which you can decide what the optimum balance of costs and benefits is, that is looking at the individual site?

WITNESS GOODYEAR: Yes.

MR. TROSTEN: Now do you agree that generally speaking the data collected in on-site studies are valuable in determining the environmental impact of power operations?

WITNESS GOODYEAR: Yes.

MR. TROSTEN: Thank you.

Now if data were available from on-site studies of Indian Point concerning the environmental impact of that plant, would you want to consider those data in reaching your judgment about the environmental impact of that plant?

WITNESS GOODYEAR: Yes.

MR. TROSTEN: Now, Dr. Goodyear, I want to show you a list of documents which is -- this list is attached to a letter dated November 18, 1972, to Chairman Jensch and the list consists of the documents and the portions of the record in the Indian Point 2 proceeding on which Con Edison plans to rely for a full term, full power operating license.

MR. KARMAN: Does the witness have a copy of that?

MR. TROSTEN: I am going to give it to him in just a moment. Thank you, Mr. Karman.

Let me show you the list now.

(Handing list to witness.)

CHAIRMAN JENSCH: I wonder if you would go ahead with your questions and perhaps we can take a recess after you have stated the question and he can look at that list.

MR. TROSTEN: I would like to have you look at the list, at the first break, Dr. Goodyear, and I would like you to tell the Board and us whether you have personally reviewed and evaluated each of these documents and the portions of the transcript that are also identified on that piece of paper you have, with the exception of the ones that are dated October 30, which were offered in evidence today prior to the time your work on the Final Environmental Statement was concluded. Would you do that?

CHAIRMAN JENSCH: You don't have to answer that right away. If you would like to take a recess to consider it, I see there are three or four or five pages there.

WITNESS GOODYEAR: Yes.

CHAIRMAN JENSCH: Would you like to answer now? We can take a recess.

MR. TROSTEN: We can go to another subject.

CHAIRMAN JENSCH: All right. If you can defer that and give us your answer later.

Proceed, Applicant.

MR. TROSTEN: Thank you.

WITNESS GOODYEAR: Before we go on, the question was for which of these documents were reviewed before I completed --

MR. TROSTEN: Your work on the Final Environmental Statement. There is a list of documents. Perhaps I can help you a little bit, Dr. Goodyear. On ~~that~~ those list is a list of all the principal documents the Applicant intends to rely on. Some of that list consists of documents that we offered in evidence today. I am excluding that from the question. I am asking you with regard to all the documents except those that we put in evidence today, but including the ones that were attached to our comments on the draft ~~detail~~ detailed statement, did you look at all of those and personally review and evaluate those documents before your work on the Final Environmental Statement was concluded?

I will proceed, Mr. Chairman.

CHAIRMAN JENSCH: Proceed, yes.

MR. TROSTEN: Did you review and evaluate the testimony of Dr. Lauer of New York University and Dr. Lawler, dated April 5th, 1972? You have the two documents in mind I am thinking about?

WITNESS GOODYEAR: The striped bass model.

MR. TROSTEN: And the effects of temperature and the effects of chemical discharges on biota.

WITNESS GOODYEAR: Yes.

MR. TROSTEN: Those are Dr. Lauer's two documents.

Did you review those three documents prior to the time your work on the draft environmental statement was finished?

CHAIRMAN JENSCH: Perhaps he would have to take a look at the documents. If you have them available, he can review those during a recess, too.

MR. TROSTEN: Yes. I will show them to you.

CHAIRMAN JENSCH: If you can give them to him at the break, he can review them.

Please proceed with another question.

If you desire to have the answers now, we will take a break.

MR. TROSTEN: If we can take a minute, Mr. Chairman.

MR. KARMAN: I would just as soon have the witness to be able to sit down during a recess.

CHAIRMAN JENSCH: Do you have another question like this that will have document review?

MR. TROSTEN: I'll go on. We can get back.

CHAIRMAN JENSCH: All right. All right.

MR. TROSTEN: Dr. Goodyear, have you had an opportunity to review Dr. Lauer's October 30th testimony which concerns the work performed by New York University on the effects of Indian Point plant operations on Hudson River biota?

WITNESS GOODYEAR: Not in detail.

MR. TROSTEN: All right. Well, if you have reviewed

16mil it in detail and if it contained any material that caused you to alter any of the conclusions which you expressed in the Final Environmental Statement, would you so advise the Board?

CHAIRMAN JENSCH: Let him take a look at that document, too, also, on the recess.

MR. TROSTEN: Would you look at all these documents, Dr. Goodyear, and we will go on from there.

CHAIRMAN JENSCH: All right. Let us take a -- if this is convenient, how long would you like to take, 15, 20 minutes?

Dr Goodyear ~~MR. TROSTEN~~: I --

MR. KARMAN: I understand the question, Mr. Chairman.

CHAIRMAN JENSCH: All right. Let us take -- at this time, let us recess, to reconvene in this room at 4:10.

(Recess.)

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CHAIRMAN JENSCH: Please come to order.

Will the witnesses please resume the stand?

Staff counsel, did you have a statement?

MR. KARMAN: Yes, Mr. Chairman. After examining the rather lengthy list of documents which the Applicant stated he wanted Dr. Goodyear or the -- and/or the other two witnesses to look at, so much paper has been proliferated during the course of this proceeding that Dr. Goodyear requested of me, and I certainly concurred in that opinion, that we would appreciate it if we could look over all of those statements during the course of the evening and that tomorrow morning we can definitively say.

We feel in all likelihood we have looked at every one of them, but Dr. Goodyear does not want to at this time indicate, because so much has been seen by him that he just wants to make sure that the item in question is the one that he had looked at.

MR. TROSTEN: Mr. Chairman, I think it is an extremely good idea that Dr. Goodyear have an adequate opportunity to review these documents so he can be sure that he has seen them and has taken them into account. I think the Staff counsel's suggestion is very well taken.

CHAIRMAN JENSCH: We will try to make a provision for that. I think it means that the evening time will be needed by the witness.

Before we recessed, or during the recess, I inquired of Applicant's counsel did you have more questions that involve documentary review?

MR. TROSTEN: Not really.

CHAIRMAN JENSCH: Do you want to proceed with other questions?

MR. TROSTEN: Yes, I will proceed.

CHAIRMAN JENSCH: Proceed.

MR. TROSTEN: Dr. Goodyear, I would like to move to another topic.

Basically what I would like to discuss with you now are the effects of entrainment and elevated temperatures and chemical discharges on aquatic biota, just so we are all talking about the same things.

I have a general question I would like to ask you first. Would you say that all power plants have the same effect on entrained organisms?

WITNESS GOODYEAR: Would you explain "effect"?

MR. TROSTEN: Well, for example, take the effect of elevated temperatures on an entrained organism, an organism might be affected in a certain way, for example, photosynthesis might be inhibited in phytoplankton by a certain temperature. And so taking that as an example, would you say that all power plants have the same effects, citing this one example, on entrained organisms?

WITNESS GOODYEAR: Basically, yes.

MR. TROSTEN: They all have the same effect?

WITNESS GOODYEAR: All of them that use -- within a -- each power plant will have its own specific attributes.

MR. TROSTEN: That's what I meant. In other words, each plant, by its design and operating characteristics, would have its own specific attributes which would have to be considered, don't you agree?

WITNESS GOODYEAR: Yes, the ambient, the environment, all types of organisms would have to be considered.

MR. TROSTEN: All power plants do not have the same effects on organisms, each power plant would have to be looked at to determine its effect on the entrained organism?

WITNESS GOODYEAR: Right.

MR. TROSTEN: Right.

Now what are some of the factors which can vary the effect of a power plant upon entrained organisms? You started to mention some.

WITNESS GOODYEAR: Well, of course, the temperature of the condensers.

MR. TROSTEN: Right.

WITNESS GOODYEAR: I need to make sure we are talking about the same thing. When you say an effect upon aquatic organisms, are you talking about effects on

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individual organisms?

MR. TROSTEN: Yes. I am referring to the effects on the individual organisms as they pass through the cooling system of the plant.

WITNESS GOODYEAR: All right. The chemical environment they are exposed to; the temperature environment they are exposed to; and the amount of turbulence, change of pressure.

MR. TROSTEN: Now would you say that the residence time is important?

WITNESS GOODYEAR: Residence time is important in establishing the actual exposure.

MR. TROSTEN: Yes.

WITNESS GOODYEAR: Not only to chemicals, but temperature as well.

MR. TROSTEN: In other words, if the residence time were very short, this might have a much lesser effect than if the residence time were relatively long? It might, I say?

WITNESS GOODYEAR: Yes.

MR. TROSTEN: All right.

Now it is also important, of course, that you address yourself to the type of organism that's entrained, right?

WITNESS GOODYEAR: Yes.

MR. TROSTEN: That's the most important thing, isn't it?

WITNESS GOODYEAR: Yes.

MR. TROSTEN: All right.

Now what happens to an animal organism that is either killed or injured as the result of entrainment through a power plant? What might happen, let's put it that way?

WITNESS GOODYEAR: Well, there's several alternative things that could happen. The organism could actually decompose without being consumed by some other -- in other words, it could be an effect of decomposition.

MR. TROSTEN: Let's take, for example, a mackerel invertebrate zooplankton-like vertebrae? What would happen to that?

WITNESS GOODYEAR: He could either decompose or it could be consumed by another organism.

MR. TROSTEN: In other words, when the individual gammarus came out of the discharge canal, it might, if it were dead, sink to the bottom and decompose or if there were a fish there which ate gammarus, it might be eaten by the fish?

WITNESS GOODYEAR: Yes.

MR. TROSTEN: Did you want to add something, Dr. Coutant?

WITNESS COUTANT: Just a comment that it could be broken by mechanical damage so it came out as parts rather than the whole.

MR. TROSTEN: Right. Thank you.

Now -- and, in fact, the -- one reason fishermen like to go to the outfall of power plants is because they think fish are there and are perhaps feeding. That's one reason why they might go there. I am not suggesting that is the reason, but perhaps that's the reason.

WITNESS GOODYEAR: Is that a question?

MR. TROSTEN: Yes.

WITNESS GOODYEAR: I don't really know.

MR. TROSTEN: So you said then the individual organism that goes through the plant, in this case a consumer organism such as the zooplankton, could serve as food for a higher trophic level, is that correct, if it were entrained and killed?

WITNESS GOODYEAR: Yes.

MR. TROSTEN: And if it were entrained and injured for example, if it were stunned, it could also serve as food for a higher trophic level?

WITNESS GOODYEAR: Yes.

MR. TROSTEN: Now is it possible that particular organisms which are entrained in a particular plant will suffer no adverse effects? I say it is possible this might happen?

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WITNESS GOODYEAR: Yes.

MR. TROSTEN: Could this be true for phytoplankton?

WITNESS GOODYEAR: Under some circumstances, yes.

MR. TROSTEN: Could it be true for zooplankton?

WITNESS GOODYEAR: Under some circumstances.

MR. TROSTEN: How about fish eggs?

WITNESS GOODYEAR: (No response.)

MR. TROSTEN: Is it possible a fish egg might not be injured?

WITNESS GOODYEAR: Well, it is certainly possible.

MR. TROSTEN: How about larva?

WITNESS GOODYEAR: Again it is possible.

MR. TROSTEN: Right. Okay.

Now is it possible that although individual organisms might be killed or injured by entrainment at a power plant, that this would have no significant impact on the populations of those organisms?

WITNESS GOODYEAR: Yes.

MR. TROSTEN: Just to take an example, I guess I understand your answer, but supposing only a small percentage of the total number of organisms present in the area were killed or injured. Would that have a minor effect on the populations in the river?

WITNESS GOODYEAR: That would depend upon the organism itself.

MR. TROSTEN: But under certain circumstances it might have a minor effect?

WITNESS GOODYEAR: Yes.

MR. TROSTEN: Suppose, for example, only that a relatively large number of organisms in the immediate area were killed or injured, but that the organisms were very widely distributed over the river. In that circumstance, might there be a minor impact on the total population?

WITNESS GOODYEAR: There could be.

MR. TROSTEN: There might be only a minor impact?

WITNESS GOODYEAR: Yes.

MR. TROSTEN: Right.

Now suppose you have an organism that has a very high mortality rate, normally so that a very large percentage of the organisms would die very quickly anyway. They are dying, you know, being born and dying very quickly. Now if a number of those organisms were killed by entrainment in a power plant, might that have only a minor impact on the overall populations of those organisms?

CHAIRMAN JENSCH: Excuse me, could you tell me something about time factors involved? Are you talking about a minute or two, or two months, or two years?

MR. TROSTEN: I am talking about a -- well, to take this example, Mr. Chairman: Supposing you had a population

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that's present in the area during the summertime and this population has a very short generation time. The animals are being born, dying very, very quickly; and I am asking Dr. Goodyear if under these circumstances, if the power plant were operating on a river during that period of time and a number of these organisms were being killed, but these were organisms that were being born and were dying very, very quickly, now might the impact on the population of those organisms be very small because of the reason I have just given you?

WITNESS GOODYEAR: It would really -- the answer depends upon whether or not the mortality that you have seen, the natural rate of die-off, depends upon what causes that natural rate of die-off.

MR. TROSTEN: Right. It would depend, for example, if this were strictly an additive process, maybe it would have a significant impact; but if it were not a strictly additive process, then it would not have a major impact. Is that right?

WITNESS GOODYEAR: Right.

MR. TROSTEN: Now I have asked you a series of questions about circumstances that might exist where organisms were being entrained in a power plant, and they were being killed, but under these circumstances the result was having a relatively minor impact on the population, and you have indicated that there might be circumstances like this that would exist. Now I am going to ask you, is it possible that any one of these circumstances or all of these circumstances exist at Indian Point? Is it possible?

WITNESS GOODYEAR: For some species.

MR. TROSTEN: It is possible?

WITNESS GOODYEAR: For some species, but not all of them.

MR. TROSTEN: Okay.

Now --

CHAIRMAN JENSCH: Excuse me. Is that a speculative question or -- would it be foundation that that does occur?

MR. TROSTEN: I was merely asking him for a general statement of principle.

CHAIRMAN JENSCH: Are you going to be able to supply evidence that that is a condition?

MR. TROSTEN: Yes, we will supply a foundation.

CHAIRMAN JENSCH: Very well. Thank you.

Proceed.

MR. TROSTEN: Now turning to page 5-22 in the Final Environmental Statement, I wanted to ask you a question that is suggested by that page. If an organism did not passively float in the Hudson River, and if its distribution were not uniform in the Hudson River, would the rate of entrainment of that organism not be simply proportional to the flow through the condensers? If either or both of those conditions existed, let me repeat the conditions for you.

WITNESS GOODYEAR: Please.

MR. TROSTEN: I ask you to assume a situation where an organism didn't passively float in the Hudson River and/or its distribution wasn't uniform in the Hudson River. In other words, there were more on the east bank than the west bank or vice versa. Under those circumstances, isn't it true that the rate of entrainment of such an organism would not be simply proportional to the flow through the condensers, of water through the condensers?

WITNESS GOODYEAR: The problem that I am having is with rate of entrainment.

MR. TROSTEN: There is a statement that appears on this page, and I'll read it to you. You say -- you talk about the biological consequences of power plant operation with once-through cooling. Are you the author of the statement?

WITNESS GOODYEAR: Yes.

MR. TROSTEN: All right. You say the importance of such predation, you are likening power plant operation to predation, is related to the rate at which organisms are consumed and for passive and nearly passive organisms, consumption rates are similar in magnitude to the rate at which the water is used.

Now I am asking you if an organism did not passively float in the Hudson River, or if its distribution was not uniform across the river cross section, is it not true that the rate of entrainment of that organism would not be simply proportional to the flow of water through the condensers?

WITNESS GOODYEAR: Again the rate -- it would have to be proportional to the rate of water withdrawal. However, we have got two factors we have got to look at. One is the magnitude and the other is the fraction.

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MR. TROSTEN: Excuse me --

CHAIRMAN JENSCH: Let him finish. Go ahead.

MR. TROSTEN: I am sorry. I just felt my question -- I didn't think I was making my question clear.

CHAIRMAN JENSCH: I thought he was in the middle of an answer.

WITNESS GOODYEAR: Yes, the magnitude of withdrawal is going to depend upon -- or the magnitude of the mortality for those organisms is going to be proportional to the water that is withdrawn, but it will not necessarily be a fraction. Your point is that -- as I understand it is -- that you could have a proportional difference from the depth of distribution.

MR. TROSTEN: I think we are passing each other like ships inthe night on this. Let me try again.

If you take an organism which lived on the west bank of the Hudson River, only lived on the west bank of the Hudson River. Now there is water flowing back and forth in front of the Indian Point plant. Now the rate of consumption of that organism which was living on the west bank of the Hudson River wouldn't simply be proportional to the rate at which the water from the east bank or the water from the Hudson flowed through the condensers because it never got to the east bank, isn't that correct?

WITNESS GOODYEAR: This is true.

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MR. TROSTEN: That is all I was really getting at.

WITNESS GOODYEAR: My point that I was trying to make clear is that it is still the fact that you have a variation across the river doesn't affect the proportion -- the magnitude of the entrainment that is still going to be a function of the withdrawal of water.

MR. TROSTEN: Let's think about that for a minute. Let's say that you had an organism that didn't live only on the west bank of the Hudson River but it lived in a portion of the Hudson River, it lived in the lower center of the Hudson River, shall we say?

That is really the only place where it lived in any substantial numbers.

Now, all of the water that goes through the plant doesn't come from the lower center of the Hudson River. So, therefore, the rate at which that organism that lived in the bottom of the Hudson River in the center wouldn't just be simply proportional to the rate of flow of the Hudson River water through the condensers, would it?

WITNESS GOODYEAR: Again, we have the same problem. You are saying the proportion of the Hudson River water going through the condensers?

MR. TROSTEN: Well --

WITNESS GOODYEAR: See --

MR. TROSTEN: I guess m y knowledge of hydraulics, I guess, is too faulty to make this point clear, but really all I am talking about here is the rate at which the organism is withdrawn from the river. Now, perhaps if you coulddistinguish between the terms magnitude of withdrawal, proportional to flow, and the rate of consumption, it might help me and might help the record.

WITNESS GOODYEAR: The distinction I am making is that the magnitude would be in numbers of individuals and the rate would be a proportion taken per unit time or proportion of something, would be a ratio of what is withdrawn and what is there.

MR. TROSTEN: Well, I will have to think about this a little bit further. Let me just ask you one question which I think expresses my question and I think you probably have already answered it. If an organism were uniformly distributed throughout the river so that it -- at any point in the river, its distribution were the same as at any other point in the river, then it would seem to me as a layman if the plant were withdrawing water from the river, that the numbers of organisms that would be withdrawn relative to the total number of organisms in a segment, say, of the river would be proportional to the amount of water that was withdrawn by the plant relative to the amount of water in the segment, so that you could tell how many -- what percentage of the organisms were being withdrawn by simply taking the amount of flow through the plant, multiplying it by the time the

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water was going through the plant, and then computing the volume of water into segments, say an 11-mile segment of the Hudson River.

But if an organism were not uniformly distributed throughout the segment, then the amount of organisms that would be withdrawn, cannot be computed in that very simply way. Would you agree with that?

WITNESS GOODYEAR: Yes.

MR. TROSTEN: Okay. That was really the only question. I will have to think about the other thing you said and see if I can understand it.

Now taking that simple case, if an organism were not uniformly distributed throughout the 11-mile segment, shall we say, of the river, wouldn't you have to consider what its biological characteristics were in order to determine its real, real world susceptibility to withdrawal? In other words, instead of simply computing the amount of water going through the plant and figuring out how many gallons of water there are in that submatter, wouldn't you have to study that organism and decide, for example, whether it lived on the west bank?

WITNESS GOODYEAR: Yes.

MR. TROSTEN: Okay. Thank you. Now on page 5-22, you refer to certain fish species and invertebrate species being susceptible to entrainment. For example, you refer to bacteria, planktonic algae, many invertebrate species, on the bottom of the page there. Do some of the ak5

invertebrate species that are found at Indian Point exhibit non-homogenous distribution in the vertical water column?

WITNESS GOODYEAR: Yes.

MR. TROSTEN: How about the eggs and larvae of striped bass? Do they exhibit non-homogenous distribution in the vertical water column?

WITNESS GOODYEAR: Yes.

MR. TROSTEN: Might this not influence their susceptibility to entrainment?

WITNESS GOODYEAR: Yes.

MR. TROSTEN: Could it reduce their susceptibility to entrainment? Could it?

WITNESS GOODYEAR: Certainly.

MR. TROSTEN: Now, I would like to turn for a moment to a discussion of phytoplankton. Now in the discussion of producers that you have that appears in Appendix V-1, you are the author of Appendix V-1, is that correct?

CHAIRMAN JENSCH: What was the reference, please?

MR. TROSTEN: Appendix 5-1 of the Final Environmental Statement, Mr. Chairman. It appears starting on page AV-1.

CHAIRMAN JENSCH: Thank you.

WITNESS GOODYEAR: Yes, this is a compilation of information gathered from various sources.

MR. TROSTEN: I notice it says on the bottom -- there is an asterisk and says manuscript by C. P. Goodyear, Oak Ridge National Laboratory. You are the author of this?

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WITNESS GOODYEAR: I put it together, yes.

MR. TROSTEN: Thank you.

Now, is it correct that the information which is available from other power plants which is cited in your Appendix V-1, indicates that photosynthesis of phytoplankton may be stimulated in the winter and spring and fall and during some parts of the summer of any particular year?

WITNESS GOODYEAR: Yes.

MR. TROSTEN: And is it correct that those of the references which you cite which also indicated studies of the large size receiving water populations have indicated no effects of entrainment on the receiving water populations of phytoplankton?

WITNESS GOODYEAR: I have to reflect on that a moment.

MR. TROSTEN: You want to take a look at it? The pages I am referring to are pages -- they start on pages V-2 and runs through page A-55.

CHAIRMAN JENSCH: You may take the time to read that if you want to freshen your recollection on it.

MR. TROSTEN: Mr. Chairman, I am sorry. I didn't reall think of this as being a document request. It is just a page here

MR. KARMAN: Did you say AV-2 to A-55?

MR. TROSTEN: Why don't we go on? Why don't you consider that question Dr. Goodyear and we can talk about this tomorrow, too.

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CHAIRMAN JENSCH: Very well.

Will Staff counsel make a note of that?

Thank you, proceed.

MR. TROSTEN: Just a moment, Mr. Chairman.

All right. Now, when you are thinking about that question -- you have the geustion. Thatis the only question I want you to look at. The one reflected in the record.

Now going back now to page V-33 of the Final Environmental Statement, you say on that page that significant changes in species population and composition could occur in the phytoplankton community as a result of plant operation.

You see where you say that?

(No response.)

MR. TROSTEN: Now, that is a statement that in this particular case I gather refers to the Indian POint plant and it is not just a general statement that says that in some power plants such and such an event might take place.

Or is that really what you meant?

Did you really mean that is something that might happen in some power plants?

WITNESS GOODYEAR: No. Would you point out the location?

MR. TROSTEN: I am sorry. The first sentence of the paragraph under Item 2, the very first sentence.

WITNESS GOODYEAR: Now, what was your question?

MR. TROSTEN: My question was did you mean the

Indian Point plant?

WITNESS GOODYEAR: Yes.

MR. TROSTEN: Now, is the foundation for that statement the basis upon which you drew that conclusion contained in pages A-52 through A-55, the pages I just referred you to?

CHAIRMAN JENSCH: Well, perhaps -- I was going to say is this something you would want to review in order to seek a foundation for your statement on V-33?

MR. TROSTEN: Isn't it true, Dr. Goodyear, that what you have done here is you have prepared the manuscript that appears in Appendix A-51 which is a study of -- literature survey of temperature effects on phytoplankton and it is on the basis of that literature survey that you formulated this conclusion, isn't that right?

WITNE_S GOODYEAR: Not entirely, no.

MR. TROSTEN: Is there other bases?

WITNESS GOODYEAR: There is bases within the Section 2, producers.

MR. TROSTEN: In other words, there may be statements in here as well?

WITNESS GOODYEAR: Yes.

MR. TROSTEN: Okay. Fine.

Isn't it true that with one exception the references cited on pages A-52 through A-55 -- and I think this is also true of the references cited on pageV-33 through

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V-35 deal with periphyton growth. Of course, I am not referring to the references that appear on page V-34 to the Applicant's field studies which definitely deal with phytoplankton, but I am refering to the literature surveys that you got referred to on page AV-52 through A-55 and any other literature survey on page V-33 through V-35?

WITNESS GOODYEAR: Most of the work has been done on periphyton.

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MR. TROSTEN: I am talking about the specific references you cite here; don't they deal, with one exception, with periphyton?

WITNESS GOODYEAR: I am not sure how many exceptions there are. The basic work has been done with periphyton.

MR. TROSTEN: Would you look at it tonight and let me know whether there are any references besides one that deals with -- I am sorry. Would you let me know whether all the references but one deal with periphyton that are cited in here?

WITNESS GOODYEAR: Certainly.

MR. TROSTEN: Okay. Thank you.

CHAIRMAN JENSCH: I think as we go on in response to the question from Applicant's counsel during the recess as to how late we go, the more documentary review questions we have, the less time we are going to extend this session this evening, if that is agreeable with the parties. As you keep adding documentary review, we bring it back 15 minutes or so. We are going to stop pretty soon here.

(Laughter.)

Proceed.

It is all right. All your documentary questions that you can give him. I want to afford him enough time to do the review.

MR. TROSTEN: Yes. All right.

I'll continue in accordance with the Chairman's

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suggestion to pose a question to you and that is were the periphyton that are the subject of these literature reviews, and I am sure Dr. Coutant could help you with this very quickly, weren't they exposed for a much longer period of time than would be the exposure of phytoplankton at Indian Point in the plant and than in the plume?

For example, Dr. Trembley's study, isn't it true the periphyton there were exposed for a much longer period of time than was the exposure of the phytoplankton in the Indian Point plant and plume?

WITNESS GOODYEAR: Certainly. I don't want to make a broad statement about everything that is in here.

MR. TROSTEN: You certainly think before you check it, that that was the case?

WITNESS GOODYEAR: Yes.

MR. MACBETH: Could the Applicant's counsel identify what he means by much longer period of time?

MR. TROSTEN: Much longer in terms of hours versus days or maybe longer than that. Hours as compared with days or weeks.

CHAIRMAN JENSCH: Very well. Proceed.

MR. TROSTEN: Now were those plants, that is the periphyton that I am referring you to, not exposed to the elevated temperatures for a period of time several times in excess of their generation rate, wouldn't you say

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that is true?

WITNESS GOODYEAR: Yes.

MR. TROSTEN: All right. Now if periphyton were exposed to elevated temperatures for a period of time considerably in excess of their generation rate, that is the time necessary to produce a new generation as I understand that term, wouldn't this allow a shift in species to manifest itself?

WITNESS GOODYEAR: Certainly.

MR. TROSTEN: Now in the case of planktonic algae, the phytoplankton which you are describing on page 5-33 through 5-35, aren't they exposed to the elevated temperatures at Indian Point for a much shorter period of time than their generation time?

WITNESS GOODYEAR: By what -- you have to -- the answer to that depends on what elevated temperature -- 15 degree delta T for a much shorter period, yes.

MR. TROSTEN: Let's think about it in statements. The generation time of phytoplankton of the type we are talking about under optimum conditions could be three times a day; would you say that is probably right, under laboratory conditions, the generation time of the phytoplankton we are talking about could be three times a day?

WITNESS GOODYEAR: Could be, yes.

MR. TROSTEN: But in the case of Indian Point, their generation time, that is the generation time of these phyto-plankton would be considerably less than that because the Hudson River is so turbid that the phyto-synthetically active zone is only at the surface and therefore the generation time of the phytoplankton as a whole would be considerably longer than the optimum rate of three times a day; so therefore we can think of the generation time as being considerably longer than three times a day?

WITNESS GOODYEAR: Yes.

MR. TROSTEN: All right. Now taking that as the basis for the question, we now look at the time that these phytoplankton are exposed to elevated temperatures. Now they are exposed to the elevated temperatures at Indian Point for up to a couple of hours, shall we say, or up to a few hours, right? Wouldn't you say that's correct?

WITNESS GOODYEAR: For several hours.

MR. TROSTEN: For several hours, okay.

So therefore the exposure of the phytoplankton at Indian Point, that is several hours, is much less than the length of the generation time of these phytoplankton which is considerably more than eight hours, isn't that correct?

WITNESS GOODYEAR: For the cells that are in the plume.

MR. TROSTEN: That is what I am talking about, the cells that are entrained and in the plume.

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WITNESS GOODYEAR: For the particular cells, the generation time, the time for them to reproduce themselves, would not necessarily be the same as the generation time for the average throughout the water colony. Obviously the ones close to the bottom are not reproducing.

MR. TROSTEN: Right.

WITNESS GOODYEAR: So I couldn't -- I don't believe I could answer whether the generation time would necessarily be a lot different than the exposure time in the plume.

MR. TROSTEN: Let me ask --

CHAIRMAN JENSCH: Now let him finish. I know you don't mean to interrupt. I think he wants to add a little more. Go ahead, Doctor.

MR. TROSTEN: Please prevent me from interrupting you, Doctor.

(Laughter.)

What were you saying?

WITNESS GOODYEAR: The cells that are in the plume or that are on the surface, naturally don't have the same generation time as the cells that are in deep water.

MR. TROSTEN: Right.

WITNESS GOODYEAR: And the average throughout the water column is much different, actually would be much longer generation than those cells which are on the surface and exposed to the plume.

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MR. TROSTEN: Right. I certainly can understand that, I think.

Now, but even under optimum laboratory conditions, the generation time of the phytoplankton that we are talking about is eight hours a day, approximately, isn't that correct?

WITNESS GOODYEAR: Depending on the species, that range.

MR. TROSTEN: Well, on page 2-31 -- 2-31 -- I think it is 2-31. This is where I got the idea -- you indicate that the generation time is longer than three times a day. I had the impression that the generation time for the particular species we are talking about here, the times you examined in your report, under optimum laboratory conditions is about three times a day, do you think that's correct?

WITNESS GOODYEAR: Yes.

CHAIRMAN JENSCH: Could you give us the reference?

MR. TROSTEN: Page 2-31. I am drawing a reference from what Dr. Goodyear said, but I thought I understood it.

CHAIRMAN JENSCH: Yes, yes. Thank you very much. Proceed.

MR. TROSTEN: Would you agree that basically the generation time of the phytoplankton we are talking about, you and I are discussing here, is probably about eight hours a day under optimum laboratory conditions?

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WITNESS GOODYEAR: Something on that order.

MR. TROSTEN: All right. Now isn't it -- isn't that longer than the generation time that the phytoplankton cells would -- isn't that generation time longer than the time that the phytoplankton cells that are entrained in the plant and then appear in the plume briefly would be subjected to these elevated temperatures? In other words, you said a moment ago that the time of exposure of these cells that are entrained and go into the plume is up to several hours, but not as much as eight hours. You know it might be two or three and a half hours. But not up to two or three times that, like eight hours.

WITNESS GOODYEAR: Again, it depends upon where you cut off the elevated temperature.

WITNESS SIMAN-TOV: We generate the temperature 15 degrees or 8 degrees.

MR. TROSTEN: Let's say 15 degrees.

WITNESS GOODYEAR: Will be much less.

MR. TROSTEN: Let's say 7.5 degrees.

WITNESS GOODYEAR: Still.

MR. TROSTEN: Still much less.

Let's say 3.25 degrees, half of the 7.5 degrees. That would be pretty small, too, wouldn5t it?

WITNESS SIMAN-TOV: That might decrease.

MR. TROSTEN: Could that be maybe a few hours, Mr.

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Siman-Tov?

WITNESS SIMAN-TOV: It might come to closer than a few hours. It depends really --

MR. TROSTEN: That might begin to approach --

WITNESS SIMAN-TOV: Two days.

MR. TROSTEN: Somewhere from maybe two to eight hours?

WITNESS SIMAN-TOV: Yes.

MR. TROSTEN: Okay. Now how long -- let's see. Okay. I guess we have established that the generation time is about eight hours and under some circumstances if you got down to as little as 3.25 degrees, the exposure might begin to approach eight hours from the bottom end. It would be somewhere from two to eight hours. Okay.

Now what are the elevated temperatures that are expected to be in the plume from Indian Point 2 during the hottest part of the year? I am talking about July or August.

Now I am talking now about the hottest part of the plume, not the part that sees the entrained water just as it comes gushing out of the submerged discharge, but out in the river, once a certain amount of mixing has taken place?

MR. MACBETH: Mr. Chairman, can this question be clarified somewhat? I find it hard to understand just how

9mil much mixing Applicant's counsel is talking about in this hypothetical?

MR. TROSTEN: Let me try to rephrase the question.

CHAIRMAN JENSCH: Proceed.

MR. TROSTEN: It is true, isn't it, Mr. Siman-Tov, that the part of the plume that would see a 15 degree rise in temperature is very small?

WITNESS SIMAN-TOV: Right.

MR. TROSTEN: And it is also true that the part of the plume that would see a 7.5 degree rise in temperature is very small?

WITNESS SIMAN-TOV: Depends on what you call small.

MR. TROSTEN: All right. Are you in a position to tell me now, not how small the part of the plume is that sees the 7.5 degree temperature, but to tell me how long it would see the 7.5 degree rise in temperature?

WITNESS SIMAN-TOV: Long in time?

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MR. TROSTEN: Yes, long in time.

WITNESS SIMAN-TOV: In the plume it it means I am considering outside of the discharge point.

MR. TROSTEN: Just outside.

WITNESS SIMAN-TOV: Might be a matter of a minute.

MR. TROSTEN: A minute or two?

WITNESS SIMAN-TOV: Or two.

MR. TROSTEN: Okay. Can you tell me how long in time the plume would see a discharge rise of 3.25 degrees Fahrenheit?

WITNESS SIMAN-TOV: It's more difficult to say. As I said before, it comes close to day.

MR. TROSTEN: Close to a day?

WITNESS SIMAN-TOV: I would say about a half day or something like that, just as an estimate.

MR. TROSTEN: All right. Now in making this statement, I assume that you are basing your estimate on the more conservative. You are not basing this on the Applicant's jet diffusion coefficient of -- what it ought to be?

WITNESS SIMAN-TOV: Right.

MR. TROSTEN. On pages ~~A-V-2 through A/55,~~ A-U-2 through A-U-52 through A-U-55 those are the pages I referred you to before, where are the results of the New York University studies performed under Dr. Lauer's direction reflected? Can you show me where they are reflected on those pages?

MR. KARMAN: What studies are we talking about and when?

MR. TROSTEN: The studies performed by New New York University that are reflected in the testimony ~~of~~ [Of] Dr. Lauer dated April 5 and October 30.

MR, KARMAN: Obviously they would not be in the October 30.

MR. TROSTEN: All right. The April 5.

WITNESS SIMAN-TOV: Which pages did you say?

MR. TROSTEN: Page A-52 [A-V-52 through] [A 55] through ~~A-56~~ [A-V-56] the other reference I wanted to ask you about was page A-513 through ~~A-518.~~ A-V-18

CHAIRMAN JENSCH: That is 15 minutes off the anticipated recess for this evening. Proceed.

(Laughter.)

MR. TROSTEN: Would you look at that and let me know where the results of the New York University's studies are reflected on those pages?

All right. I will make a note of that.

CHAIRMAN JENSCH: Proceed.

MR. TROSTEN: We will get back to that when you have had a chance to study that.

Now let's think about the matter of -- in addition of photosynthesis and phytoplankton that are submitted to elevated temperatures. Now supposing that carbon 14 uptake capability by phytoplankton were reduced by -- as a result

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of the subjection of the organism to higher temperatures. Is there proof that this capability will not restore itself in time?

WITNESS GOODYEAR: Proof that it will not.

MR. TROSTEN: That it will not. In other words, as I understand it, it has been demonstrated that carbon 14 uptake capability of phytoplankton can be inhibited by certain influences like elevated temperature and as I understand the fact, and please correct me if I am wrong, this is a measure that is used by biologists in determining whether possible damage may be occurring to such a producer. Now, what I am asking you is this: Is there proof that if carbon 14 uptake is inhibited as a result of exposure to elevated temperatures, that after a period of time the capability of the organism to photosynthesize, will not restore itself?

WITNESS GOODYEAR: In some cases I think it has been shown they do restore themselves.

MR. TROSTEN: In other words, if phytoplankton were exposed to elevated temperatures,as a result their photosynthesis activity were inhibited, it is possible after a period of time they would start to photosynthesize in the normal way again and they would go on about their business doing whatever phytoplanktondo?

WITNESS GOODYEAR: Yes.

MR. TROSTEN: Okay.

(Laughter.)

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MR. TROSTEN: Now, when you -- on page V-33 when you estimate a reduction of 17 percent of phytoplankton productivity at Indian Point resulting from a complete reproductive kill of the entrained phytoplankton, is that estimate of 17 percent reduction in productivity, based on 100 percent kill of all the phytoplankton that are actually going through the plant annually?

WITNESS GOODYEAR: As it says, it is a maximum possible consequence.

MR. TROSTEN: In other words, this -- let me see --

MR. KARMAN: What page?

MR. TROSTEN: V-33. My understanding of that statement is that you estimated that 17 percent of the phytoplankton that are in a segment of the river at around Indian Point, 17 percent of the productivity of the phytoplankton in the river around Indian Point might be eliminated if 100 percent of the phytoplankton that went through the plant were killed? That is they were dead, they couldn't photosynthesize.

WITNESS GOODYEAR: Right.

MR. TROSTEN: Is there empirical evidence from plant studies at Indian Point that such a 100 percent kill will actually occur in Indian Point?

WITNESS GOODYEAR: No.

MR. TROSTEN: And do not the NYU studies that are the subject of Dr. Lauer's April 5th testimony -- and I won't ask you about the October 30th yet -- demonstrated that this is not so, that 100 percent kill does not occur.

WITNESS GOODYEAR: That is right.

MR. TROSTEN: In other words, the situation you are talking about, the Staff estimate of 17 percent reduction of phytoplankton productivity describes a situation that has been shown not to exist at Indian Point? It is just a hypothetical estimate of what might happen but it is not an estimate of what actually has happened or could happen?

WITNESS GOODYEAR: This estimate as you put it is an upper boundary.

CHAIRMAN JENSCH: Let him go ahead, please. I think he is going to tell you more about it.

Go ahead.

WITNESS GOODYEAR: It is an upper estimate of direct plant entrainment losses, but it does not reflect entrainment in the plume, any losses which might occur in the plume.

The number of 17 percent was based on that yearly average withdrawal.

MR. TROSTEN: But what you are saying as I understand it is it is an upper estimate that describes a situation that might possibly occur whereas the evidence indicates that this couldn't occur because the temperatures aren't there and so forth.

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WITNESS GOODYEAR: Again, if you can extrapolate Unit 1 to 2.

MR. TROSTEN: Right.

WITNESS GOODYEAR: Then you would expect that this would not occur.

MR. TROSTEN: Right. So if the -- if you have the situation, the design, that the operating conditions of Unit 2 indicate would be produced, then you wouldnot get this situation? This is merely an upper bound situation, something that would occur if you killed everything that went through the plant but the evidence has shown that you don't kill everything that goes through the plant?

WITNESS GOODYEAR: Yes.

MR. TROSTEN: Okay. Now, in addition in Appendix V-1, you state for most algae species ~~studeid~~ studied to date, lethal temperatures range from 91.5 degrees Fahrenheit with the majority of lethal temperatures being 101.5 degrees Fahrenheit.

WITNESS SIMAN TOV: What page?

MR. TROSTEN: AV-4, it is thenext to the last paragraph and says lethal temperature of the algae varies with the species. For most of the algal species to date, the lethal temperature is in a range from 91.5 degrees Fahrenheit to 113 degrees Fahrenheit with the majority being 111 degrees Fahrenheit. Is that a correct statement?

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WITNESS GOODYEAR: For lethal in the sense of direct mortality from the temperature.

MR. TROSTEN: Will such a temperature of 111 degrees Fahrenheit ever occur at Indian Point Units 1 in the discharge canal?

WITNESS GOODYEAR: No.

MR. TROSTEN: Will it ever occur in the plume?

WITNESS GOODYEAR: No.

MR. TROSTEN: All rgiht. So that the majority of lethal temperatures that are the subject of this statement will never occur in either the discharge canal or the plume in Indian Point?

WITNESS GOODYEAR: This is true.

MR. TROSTEN: Okay.

CHAIRMAN JENSCH: Was your last question related to Indian Point 2 or Indian Point 1?

MR. TROSTEN: Both of them or either of them separately.

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CHAIRMAN JENSCH: Thank you.

Proceed.

MR. TROSTEN: Okay.

WITNESS GOODYEAR: Would you repeat that again?

MR. TROSTEN: I said is it correct that you will not see 111 degrees Fahrenheit in the discharge canal or the plume when the Indian Point 2 plant is operating or the Indian Point 1 or the two of them operating?

WITNESS GOODYEAR: This is true.

MR. TROSTEN: Okay.

Now will you see 91.5 degrees in the plume when the Indian Point 2 is operating?

WITNESS GOODYEAR: On the surface?

MR. TROSTEN: At the surface, yes.

WITNESS GOODYEAR: Not for an extended period of time.

MR. TROSTEN: In other words, now, you have indicated, Mr. Siman-Tov, that you expect the surface discharge criteria of 90 degrees is going to be met. Isn't it correct you won't see 91.5 degrees at the surface?

WITNESS SIMAN-TOV: According to my knowledge.

WITNESS GOODYEAR: I would assume that.

MR. TROSTEN: All right. Now will you see it at any other point other than the surface, 91.5 degrees?

WITNESS GOODYEAR: In the canal.

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MR. TROSTEN: You might see it in the canal?

WITNESS GOODYEAR: Yes.

MR. TROSTEN: But not in the plume?

WITNESS GOODYEAR: Not on the surface, no.

MR. TROSTEN: Well, you might see it somewhere between the point of discharge on the surface at the -- in these fractional instants when the cold water is mixing with the hot water, but it is really just seconds, isn't it? For seconds, you might see 91.5 degrees?

WITNESS GOODYEAR: Yes.

MR. TROSTEN: Okay. In the case of the discharge canal, you say you will see 91.5 degrees. Now you would see 91.5 degrees if you assume a 14.5 degree roughly Delta T across the condensers only in the situation -- excuse me a minute. Just a moment. Let me collect my thoughts.

Let me rephrase that question. You would see 91.5 degrees in the discharge canal in the situation where you had -- you added 14.5 degrees to say 79 degrees, and you would get 93.5 degrees in the discharge canal. That's a situation where you might see 91.5 degrees in the discharge canal, is that correct?

WITNESS SIMAN-TOV: I would like to add here this is a minimum possible. Although the upper possibility is 80 degrees in-take plus a 14.8 for intake.

MR. TROSTEN: All right. Now that -- the 80 degrees, the temperature in the discharge canal that you just postulated would only be seen in a situation where you did in fact have an 80 degree intake temperature and you did also have a 14.8 degree Delta T?

WITNESS SIMAN-TOV: Whatever the intake is.

MR. TROSTEN: There is disagreement between the Staff and the Applicant as to whether you will see 80 degrees in the intake structure, is that correct?

WITNESS SIMAN-TOV: I assume so.

MR. TROSTEN: The Applicant's evidence doesn't agree with the Staff's conclusion. You will see 80 degrees. In fact, the Applicant says you won't see more than 79 degrees at the intake temperature. Is that correct?

WITNESS SIMAN-TOV: That's what you say, yes.

MR. TROSTEN: If you did see 80 degrees, if you were right and we were wrong about this, you wouldn't see 80 degrees at the intake temperature very often, would you, probably?

WITNESS SIMAN-TOV: You would see it every tidal movement in the situation.

MR. TROSTEN: You said you would or you might?

WITNESS SIMAN-TOV: You will.

MR. TROSTEN: You will?

WITNESS SIMAN-TOV: Well, it depends on which flows and what time of the year and so on. We are talking

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about maximum upper limit.

MR. TROSTEN: So in other words, there are situations where you might see it?

WITNESS SIMAN-TOV: Sure. Sure.

MR. TROSTEN: Okay. All right.

May I stop for a moment, Mr. Chairman?

CHAIRMAN JENSCH: Surely.

MR. TROSTEN: Now let's turn to page 5-36. Do you know whether the seasonal fluctuations which are depicted on page 5-36, Figure 5-4, which is entitled phytoplankton abundance at Indian Point are more or less severe than those which occur elsewhere in the Hudson River?

By the way, before you answer that question, this figure that is reproduced on page 5-36 is taken from studies by New York University provided to the Staff, isn't that correct?

WITNESS GOODYEAR: Yes.

MR. TROSTEN: Do you know whether the seasonal fluctuations that are depicted on that figure are more or less severe than those which occur elsewhere in the Hudson River?

WITNESS GOODYEAR: Not for certain. The other sampling locations, I'd have to check the data to make sure, but as I remember my original analysis, they are quite similar.

MR. TROSTEN: You think they are quite similar to what appears in other parts of the Hudson River?

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WITNESS GOODYEAR: Yes.

MR. TROSTEN: Now if it were shown to you that the seasonal fluctuations that appear on Figure 5-4 on page 5-36 are essentially the same as the seasonal fluctuations that appear in other parts of the river where Indian Point isn't, might that affect your conclusion as to whether the operations of the Indian Point plant were causing fluctuations, seasonal fluctuations?

WITNESS GOODYEAR: No.

MR. TROSTEN: It wouldn't change your --

WITNESS GOODYEAR: No.

MR. TROSTEN: In other words, if -- I am a little puzzled by your answer, Dr. Goodyear. You say on the bottom of page 5-34, going over to the top of page 5-35, that present data indicate that fluctuations predicted in the preceding discussion, and you are talking about fluctuations in seasonal abundance -- excuse me -- in species composition, that such fluctuations may already be occurring as the result of natural cycles which perhaps are augmented by the operation of the Indian Point Unit No. 1 and the Lovett Plant. Now we can agree that they may be occurring as the result of natural cycles, but you then go on to say which perhaps are augmented by the operation of Indian Point Unit No. 1 and the Lovett Plant. Now the question I asked you before was this: If you could -- if there were data that could be brought to your attention that would indicate that the same or essentially the same seasonal fluctuations occur in parts of the river that are completely beyond the influence of the Indian Point plant, might it alter your conclusion that perhaps the seasonal fluctuations are being augmented by the operation of Indian Point Unit No. 1 and the Lovett Plant?

WITNESS GOODYEAR: If there were a careful analysis to show the lack of an incremental addition, then that -- the augmentation could be dropped. However, the type of response that is presented here is not a normal response, but it is one which largely is dependent upon temperature, especially for changes in the composition.

MR. TROSTEN: Now if I understand what you have said, it comes down to this: that you are looking at a figure that shows what is essentially a normal seasonal abundance, and will you accept for the purposes of our discussion that this is indeed a seasonal abundance which is rather typical of what appears elsewhere in the river? I guess you would agree with that, wouldn't you?

WITNESS GOODYEAR: Yes.

MR. TROSTEN: Then you are saying that perhaps this -- these fluctuations are being augmented by the operation of the Indian Point 1 plant and the Lovett plant, correct?

But you are not saying that as a result of anything you say in this figure, you are saying that perhaps this is occurring simply on the basis of the general analysis and discussion that you present elsewhere. You are not saying this on the basis of this figure?

WITNESS GOODYEAR: All right.

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MR. TROSTEN: Just pursuing this for just another minute, this diagram, this graph, rather, depicts phyto-plankton abundance at Indian Point in 1970, isn't that correct?

WITNESS GOODYEAR: Yes.

MR. TROSTEN: Now was the Indian Point -- yes, it says 1970. Now was the Indian Point 1 plant operating in 1970?

WITNESS GOODYEAR: No.

MR. TROSTEN: All right. Now let's go on to Appendix -- well, let me just wrap this up.

When you say that this seasonal fluctuation might be augmented by Indian Point 1 plant operation and you are citing 1970 figures, you are actually citing a seasonal fluctuation that took place at a time the plant wasn't operating?

WITNESS GOODYEAR: Yes.

MR. TROSTEN: Now let's turn to Appendix A.5-2.

You say on the bottom of this page that changes in phytoplankton abundance as a result of heated -- I am sorry. You say there is a shift to heat tolerant blue-green algae when water temperature exceeds about 86 degrees Fahrenheit, is that correct? Have you found the place there? It is on the bottom of the page.

WITNESS GOODYEAR: Which page?

MR. TROSTEN: A.5-2.

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It is also -- it is also stated in the third sentence, at least the point is made in the third sentence under heading 2, producers.

WITNESS GOODYEAR: What was the question?

MR. TROSTEN: I haven't stated the question yet. Doesn't the blue-green form begin to dominate when the temperature reaches about 95 degrees Fahrenheit? I am contrasting the data shown on -- I am sorry. I am contrasting the population shift shown on figure A.5-1 with the general statement that you made on the bottom of page A.5-2 that there is a shift to heat tolerant blue-green algae when the water temperature exceeds about 86 degrees Fahrenheit.

WITNESS GOODYEAR: Yes.

MR. TROSTEN: So is there discontinuity there between that figure and what you said?

WITNESS GOODYEAR: Well, if you look at the figure you will see it has a temperature -- as the temperature moves up from 85 degrees, the proportion of the total algal population changes.

MR. TROSTEN: Yes. It begins to change. You can see those curves intersecting there. But isn't it true the blue-greens begin to dominate the greens between 95 and 105 as opposed to around 86? Isn't that true?

WITNESS GOODYEAR: Yes.

MR. TROSTEN: So isn't it true that the shift to the heat tolerant blue-green algae occurs above 95 degrees rather than around 86 degrees as you suggested on the bottom of page A.5-2?

WITNESS GOODYEAR: The shift begins --

MR. TROSTEN: Well, you see --

CHAIRMAN JENSCH: Let him finish. I know you don't mean to interrupt. But I think he carefully phrases his answer. Will you proceed?

MR. TROSTEN: Mr. Chairman, while Dr. Goodyear is thinking about this, I apparently have misquoted him, really. I guess I misread what he said. I will quote what appears on the bottom of page A.5-2. You state that reports of field studies of the biota associated with discharge canals of power plants, where the water temperature is still essentially as high as it was when it left the condensers of noted dominance of the periphyton community by heat tolerant blue-green algae when water temperatures exceed about 86 degrees Fahrenheit.

That was the sentence I was calling for.

WITNESS GOODYEAR: Yes. You are wondering about the discrepancy between --

MR. TROSTEN: That's right.

WITNESS GOODYEAR: This plot which has been reproduced many different times in many different publications is specific for one particular situation. The scales actually

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don't precisely overlap in different locations. In other words, the 95 -- you are speaking of dominance by the blue-greens at 95 degrees. There are situations where it comes on at lesser temperatures than that.

MR. TROSTEN: In other words, you are saying that this plot doesn't represent every possible situation and that there might be a situation where dominance occurred below 96 degrees as this plot indicates, is that what you are saying?

WITNESS GOODYEAR: Yes.

MR. TROSTEN: Okay. Would you say that this plot accurately portrays many situations or maybe even most situations?

WITNESS GOODYEAR: In a general form.

MR. TROSTEN: In a general form?

WITNESS GOODYEAR: You notice the height of those scales for dominance are not labelled.

MR. TROSTEN: Right. Well, would you say that this plot does show dominance even though it -- well, on the side of it, I note -- it's been called to my attention that it says relative number of organisms and as I understand this -- the graph or chart -- I never can tell which it is -- anyway, as I understand it, blue-greens begin to dominate greens about ninety -- above 95 degrees, is that generally the way you read it?

WITNESS GOODYEAR: That is one common --

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CHAIRMAN JENSCH: Did you want to go on with something? You said that is one comment, but your opinion is something else?

WITNESS GOODYEAR: This is a relative situation which is not necessarily directly -- the scales cannot be directly examined for the Indian Point situation.

WITNESS COUTANT: Could I amplify just a bit? This is a graph that I have used in publications. It's been used by a number of authors in the past and if you become familiar with the study on which it is based, the precise quantitative nature is somewhat lacking. So I think it is really not appropriate for us to assign specific values to specific degrees of temperature on that figure, but only qualitative impression of the dominance of one type of algae after another.

MR. TROSTEN: I think that is a very important point, Dr. Coutant, and I think you have to -- I agree you certainly have to bear that in mind with regard to this graph. When you say -- would you say that same sort of observation you just made perhaps ought to be applied to the general observation about 86 degrees Fahrenheit that appears on the bottom of page A.5-2, that is that these studies -- the precise quantitative data upon which that statement was based are not necessarily subject to the interpretation that the dominance occurs at 86 degrees?

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WITNESS COUTANT: Yes, I think that is true. That is why the several numbers are given this study.

MR. TROSTEN: Let's turn to the ones we studied, Dr. Coutant, and isn't it true the dominance occurred in that case when the temperature exceeded 94.1 degrees Fahrenheit?

WITNESS COUTANT: At the time the data were collected for that particular sample, 94.1 was the temperature recorded by using field thermometers at the site.

MR. TROSTEN: Okay. Right.

Now let's think about the Buck study of Connecticut Yankee that is reported on page A.5-4 in the second paragraph, third line of the second paragraph.

Now, Dr. Coutant, did not that power plant -- I am sorry. Did not the study reported by Buck in that particular study involve discharges that exceeded 100 degrees Fahrenheit? Am I correct about that?

WITNESS COUTANT: I have forgotten the exact numbers, but that could be correct.

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MR. TROSTEN: Will you ever see 100 degrees Fahrenheit in the discharge canal at Indian Point 1 and 2?

WITNESS COUTANT: No.

MR. TROSTEN: Will you ever see the plume?

WITNESS COUTANT: No.

MR. TROSTEN: Okay. Now on page A5-4, you refer to the Beer and Pipe's report, is that correct?

WITNESS COUTANT: (No response.)

MR. TROSTEN: It is in the second paragraph.

WITNESS GOODYEAR: I was on down the page a ways.

MR. TROSTEN: Now, Dr. Goodyear, did you prepare that discussion of the -- that paragraph that has the discussion of the Beer and Pipe's report?

WITNESS GOODYEAR: Most of this material, as you might have gathered was -- as I cited earlier -- was adapted from Dr. Coutant's review.

MR. TROSTEN: Well, did you write that, the part -- the particular part where you said -- I am sorry -- similar changes in species composition of plankton in cooling water were reported by Beer and Pipes. I am asking you the question to know to whom to direct my question.

WITNESS GOODYEAR: I would really have to look and see the rough copy to tell you.

(Laughter.)

MR. TROSTEN: Let me try it with you. Did you read the entire Beer and Pipes' report, Dr. Goodyear? Do

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you remember whether you did?

WITNESS GOODYEAR: I don't remember.

MR. TROSTEN: Okay. Are you aware from your recollection of reading that report that there was no sampling of the phytoplankton in the inlet to this plant in connection with that study?

WITNESS GOODYEAR: Again I would have to review the amount of notes on it.

MR. TROSTEN: You did not, I take it from your response, contact the authors of this report to investigate the extent to which they sampled the intake. Is that correct?

WITNESS GOODYEAR: No. Yes, that's correct.

MR. TROSTEN: And you did not go back to the base data yourself to determine whether that had been done?

WITNESS GOODYEAR: No.

MR. TROSTEN: Thank you.

I would like to turn now to another subject, Mr. Chairman, of zooplankton, effects of the plant on zooplankton.

(Board conference.)

CHAIRMAN JENSCH: Proceed.

MR. TROSTEN: On page 5-38, is it correct, Dr. Goodyear, that neomysis distribution can vary from year to year, depending on the salt front?

WITNESS GOODYEAR: Yes.

MR. TROSTEN: Might this mean in some years the distribution of neomysis might be significantly different than appears in the data you refer to on page 5-38?

WITNESS GOODYEAR: Yes.

MR. TROSTEN: Is it true that large numbers of neomysis have been found over stretches of the river considerably above and below Indian Point, for example, from Newburgh to Yonkers?

WITNESS GOODYEAR: Yes. However, I have not yet seen a longitudinal profile for one particular interval of time which would indicate whether or not the distribution was the high concentrations at other locations, consisted of the same base group of individuals which is present at Indian Point on occasion.

MR. TROSTEN: All right. But this doesn't mean, though, that these organisms are not widely distributed across the river?

WITNESS GOODYEAR: They certainly are.

MR. TROSTEN: Yes. Okay.

Well, do you agree with the following statement? "The principal food of the young of the year striped bass in the Hudson River appears to be the small arthropoda shrimp gammarus crustaceous." Do you agree with that statement?

WITNESS GOODYEAR: Young of the year up to within a certain size range. The very early forms are eating micro-

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crustaceans rather than gammarus. There is not a great deal of information on the young of the year and the old of the young of the year.

MR. TROSTEN: So you would say when they reach the size stage where they are eating the mackerel invertebrates that the principal food would appear to be gammarus, is that right?

WITNESS GOODYEAR: From the limited data.

MR. TROSTEN: I ask you this: This is a conclusion that has been drawn by John Clark, one of the witnesses for the Hudson River Fishermen's Association -- if it were true, if Mr. Clark's conclusion were correct, and I gathered you agree generally with Mr. Clark's conclusion in this respect, Would this lessen the significance of any impact that the Indian Point 1 and 2 plant might have on the neomysis population? In other words, if the principal food of the young of the year is gammarus, then if the Indian Point plant were having some type of an impact on the neomysis population, it would not be having an impact on the principal food. Would you agree with that sentence, that statement?

WITNESS GOODYEAR: For the striped bass?

MR. TROSTEN: Yes.

WITNESS GOODYEAR: Yes.

MR. TROSTEN: All right. Thank you.

On page 5-37 you state that if --

CHAIRMAN JENSCH: May I interrupt a moment? Was your -- may I ask the witness, was your answer to indicate that it was limited to striped bass, but another fish -- when other fish were involved, it would be a different effect as to what they would be eating?

WITNESS GOODYEAR: If another species were eating the neomysis, depending upon them very heavily, then it would affect that species.

CHAIRMAN JENSCH: The loss of the neomysis would affect the species?

WITNESS GOODYEAR: Yes.

CHAIRMAN JENSCH: But you understood the Applicant's question to be related solely to striped bass?

WITNESS GOODYEAR: Yes. That was the indication.

CHAIRMAN JENSCH: Thank you. Excuse me for interrupting. Proceed.

MR. TROSTEN: On page 5-37, Dr. Goodyear, you state in the second sentence under item B, "If high entrainment mortality of zooplankton occurs"-- and I am paraphrasing what you said --"certain results will follow."

You see where I am?

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WITNESS GOODYEAR: Yes.

MR. TROSTEN: If high entrainment mortality did not occur as a result of Indian Point operations, then your conclusions would not apply, is that not correct?

WITNESS GOODYEAR: Which conclusions?

MR. TROSTEN: Well, your introduction to your discussion says if high entrainment mortality is encountered, and then you go on to discuss a series of things that might happen. I am simply asking you if high entrainment mortality did not occur, then the rest of your discussion would not apply, is that right?

WITNESS GOODYEAR: Not entirely, no.

MR. TROSTEN: Well --

WITNESS GOODYEAR: Many of the entrainment mortality -- things can happen to the population which result from less than -- less severe of an impact than the mortality itself, population --

MR. TROSTEN: Yes.

WITNESS GOODYEAR: The conclusion -- I am not sure exactly which conclusion you were speaking of when you --

MR. TROSTEN: Well, let's -- go ahead.

WITNESS GOODYEAR: When you made your question.

MR. TROSTEN: Let's take a specific one. Let's take the sentence in which that quotation appears. If high entrainment mortality is encountered, selection for heat

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tolerant microcrustaceans with short turnover populations will result.

Now if high mortality did not occur, I am correct in assuming that turnovers might not result or there would be no basis for saying it would result, is that correct? In other words --

WITNESS GOODYEAR: Well, it wouldn't be as severe.

MR. TROSTEN: Well, let me ask you --

WITNESS GOODYEAR: Pressures would not be as strong.

MR. TROSTEN: Let's say zero mortality occurred. Then there would be no basis for saying selection for heat tolerant microcrustaceans with short turnover populations would result, would there?

WITNESS GOODYEAR: If there were no alterations of reproductive capabilities.

MR. TROSTEN: Let's assume there was zero mortality and no discernible effect on reproductive capabilities.

WITNESS GOODYEAR: Yes.

MR. TROSTEN: We could go down each of the points being made on page 5-37 and 5-39 and ask the same sort of questions and you would agree that if you had either zero mortality or very low mortality, that you would have to alter any of the observations or conclusions that you made in here, to take into account the extent to which mortality was not occurring; and of course, you would add to that, well you would also have to consider whether they were being affected other than by being killed. But you see the point I am making, do you not?

WITNESS GOODYEAR: Yes.

MR. TROSTEN: All of these conclusions in here would have to be analyzed to determine the extent to which mortality really does occur and the extent to which injury really does occur in this plant?

WITNESS GOODYEAR: The thing would have to be analyzed, the degree to which the reproductive capacity is disabled. Obviously if he is killed, then there is no question; but if he is not killed, there is still the capacity for the plant to reduce the reproductive capability. If it works -- if it were eliminated, then as far as population is concerned, that organism might as well not exist.

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MR. TROSTEN: Let me try it again. If it could be shown that there was no mortality of organisms that were entrained in this facility, and if it could be shown that there was no inhibition of reproductive capability, then you could just sort of take out this section on zooplankton because there would be nothing really to worry about?

WITNESS GOODYEAR: Yes.

MR. TROSTEN: If it could be shown that there is some degree of entrainment mortality and some degree of reproductivity inhibitions but not 100 percent killed and not 100 percent inhibition of reproduction, then it would affect in some way the conclusions that you have drawn here, is that correct? You might want to modify your conclusions in here, you ~~knew~~ know that?

WITNESS GOODYEAR: Yes.

MR. TROSTEN: Right. Now, you would also agree that even if damage were shown to entrained organisms, that this doesn't necessarily mean that population damage will occur, isn't that correct?

WITNESS GOODYEAR: This is true.

MR. TROSTEN: Okay. Now, I guess this kind of gets back to the questions we have asked you before and maybe you will want to think about this over night, too, Dr. Goodyear, but with respect to page V-37, your general discussion of the influences of plant operation on zooplankton community, have

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have you studied Dr. Lauer's testimony of April 5th and October 30th concerning temperature tolerance of microinvertebrate zooplankton and the survival of these organisms in the intake and discharge canal samples?

MR. KARMAN: May I have that question read back?

(The reporter read the record as requested.)

MR. KARMAN: All right. I understand.

Did you think that you should want to examine that with the other references?

WITNESS GOODYEAR: I believe I would rather do that.

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CHAIRMAN JENSCH: I think we have just about given him enough for tonight, don't you think? Leave him enough time for the game and he can work on the answers to the questions.

(Laughter.)

Let me ask Dr. Goodyear: Have you ever been on the stand before?

WITNESS GOODYEAR: Once.

CHAIRMAN JENSCH: The reason I asked you is this: I know Applicant's counsel wants to give you all the time that you need for an answer, but as you have observed, he has a very carefully prepared cross-examination, and sometimes he wants to move along with it. I know he doesn't want to interrupt you. But you should feel that if you have something further to answer, that you suggest that to him. He wants you to give the answer. I have had the impression that some of your answers here were partial. You would be -- as if you were somewhat hesitant. In this business, hesitancy gets lost, and so I suggest that if you have something further to give, Applicant's counsel wants your answer. But you have got to tell him something more to tell him. That will assist him in his questioning.

Will you do that?

WITNESS GOODYEAR: I understand.

MR. TROSTEN: I very much appreciate the

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Chairman's suggestion, and I apologize to both the Board and the witness.

CHAIRMAN JENSCH: I think sometimes the pauses have indicated that he was complete in his answer, but I have had the impression otherwise that in some cases he was not. I don't think there is any occasion for you to apologize. I think it is a lack of understanding by the witness as to what he should do to fully present his answers.

Any other matter we can consider before we recess?

I think we should give the witness an opportunity to confer with his associates on these matters. It looks like it is quite comprehensive.

Is this an agreeable time to recess?

What time do you suggest in the morning?

MR. TROSTEN: May we convene at 9:00, Mr. Chairman, or earlier, if the Chair wishes.

(Laughter.)

CHAIRMAN JENSCH: I think I heard you the first time.

(Laughter.)

At this time let's recess and reconvene in this room tomorrow morning at 9:00 o'clock.

(Whereupon, at 5:40 p.m., the hearing was adjourned, to reconvene at 9:00 a.m., December 5, 1972.)

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