50-247

Redirect - Rebuttal Testimony of

Dr. C. P. Goodyear

Compensation in Striped Bass Populations

February 22, 1973

Reference:

(1) Testimony of Dr. John P. Lawler (5 April 1972): "The Effect of Entrainment at Indian Point on the Population of the Hudson River Striped Bass"

(2) Testimony of Dr. John P. Lawler (30 October 1972): "Effect of Entrainment and Impingement at Indian Point on the Population of the Hudson Raiver Striped Bass"

(3) Testimony of Dr. John P. Lawler (5 February 1973): "Contribution of the Hudson River to kthe Middle Atlantic Striped Bass Fishery"

(4) Testimony of Dr. John P. Lawler (5 February 1973): "Mathematical Model Used by the Staff to Estimate the Effect of Indian Point Units 1 and 2 Entrainment on Hudson River Striped Bass"

Compensation in Striped Bass Populations

In his rebuttal testimony concerning the mathematical model used by the staff to estimate entrainment of striped bass (Reference 4), Dr. Lawler correctly stated that the Applicant's model includes a compensatory mechanism, i.e. variation of survival according to the size of the striped bass population, whereas the Staff's model does not. He later asserts in his concluding remarks that the compensatory process should be incorporated into the Staff model.

The staff has evaluated the importance of the compensatory process in relationship to striped bass production on the East Coast and has concluded that compensation as such is not operative in striped bass larval populations. Considerable discussion concerning this topic is presented in the FES, Chap. 5, pp.54-56. In summary, it is the staff's position that there is no reason to conclude that there will be any compensatory increase in survival or growth within the striped bass population as a result of increasing mortality within the larval population such as would occur with the operation of I.P. 2.

There is no evidence that compensation of this type is operative within striped bass populations on the East Coast. There are several reasons for this conclusion. For instance, the strong predominance of year classes suggests that the buffering capacity within the population is limited and that recruitment is not limited by the resources available to the population. Furthermore, the age structure of the population is such that the greatest proportion of the exploitation of the bass by the commercial and sport fishery consists of members of the population which are below reproductive size, and hence are removed from the population before they are able to contribute to it reproductively.

The most important indication that the striped bass population of the East Coast is not regulated by mortality rates operating within the larval or juvenile stages is the recent 40-year increase in the striped bass population along the Atlantic coast, in the Chesapeake, mid-Atlantic, and along New England. There is no indication that this increase has reached the limiting capacity of the environment. Furthermore, this increase is apparently a direct response to decreased mortality rate as a result of the implementation of fishing laws, which regulate the types of gear and the minimum size of fish which can be taken by the fishery.

It is the Staff's belief that the recruitment rate is dependent primarily on the reproductive activity of mature individuals. The activities of the fishery, and of the laws which regulate it, determine the numbers of young fish that survive to reproduce. In this connection, there has been no evidence produced by the Applicant or any of its consultants which either supports their position or refutes the position of the Staff.

The Applicant's position in regard to their view of compensation is dependent upon the assumption that the population of striped bass is at equilibrium in the Hudson River. This point is amply demonstrated in the following quotation on p. 25, parag. 3, of Dr. Lawler's Oct. 30 testimony:

> Whether we are close or far from the theoretical ultimate saturation that might be reached under the best of conditions is beside the point. We are only interested in saying that before a specific new influence enters the river, the river is probably not in a state in which significant departure from a balanced population exists.

The general approach that Dr. Lawler assumes concerning compensation can be seen in the following quotation from p. 22 of his Oct. 30 testimony:

> Quantitative accounting for compensation in biological systems is simply a recognition that, as in other physical systems, first order kinetics cannot be employed to describe survival kinetics over the whole range of population. This recognition requires that rather than using the simple first order decay function exclusively to describe natural survival behavior, a more complex expression must be employed.
>
> This expression should reduce to the first order function over the range of populations where such is appropriate, but should also recognize the tendency of the system to compensate itself when driven substatially beyond this range in either the direction of increased populations or in the direction of decreased populations. This is the concept of homeostasis or 'biofeedback', that is, that a living system tends to self-stabilizing.

Whereas this approach has a very real theoretical foundation, its applicability to any form of life must be established before its use for any purpose of prediction for a population of interest. This has not been done by the Applicant nor has it been attempted by the Applicant for the case of striped bass. The only theoretical foundation which has been presented by the Applicant is referred to on p. 19 of Dr. Lawler's Oct. 30 testimony:

> The notion of compensation has been introduced in our early testimony (1) wherein it is shown that, rather than simply being a possibility, compensation must occur in the type of biological system under consideration in this study.

In this paragraph, Dr. Lawler asserts that, based on the previous study, it has been shown that compensation must in fact occur within the larval community to control the population of striped bass in the Hudson River. The logic behind this comment is presented on p. 53 of Dr. Lawler's April 5 testimony:

> Comparison of this result to that shown in Figure 8 is excellent support for the position that compensation is not a question of "perhaps it occurs," but rather "it must occur."

The two figures in question are reproduced herein for comparison to the growth of striped bass populations on the Atlantic coast since 1930 (See figs. 1 and 2 hereafter). Note that the population growth curve represents the condition which Dr. Lawler asserts cannot occur. The reason for this situation is not the fault in the logic of Dr. Lawler, but instead is a situation which commonly results when there is substantial mortality in the adult population as a result of high fishing intensity by a major commercial or sport fishery. In such situations, the compensatory capabilities of the population are strongly reduced or overshadowed, at least insofar as increasing the reproduction capability within the population or by increasing the changes of survival within the early stages of development.

This situation is not restricted to striped bass populations alone. Other examples, including the menhaden fishery in New York and the sardine fishery on the West coast, as well as the shad fishery in the Hudson River could serve as other examples. For instance, McHugh in a recent publication, commented as follows:

Figure 1

ADULT STRIPED BASS POPULATION
HUDSON RIVER

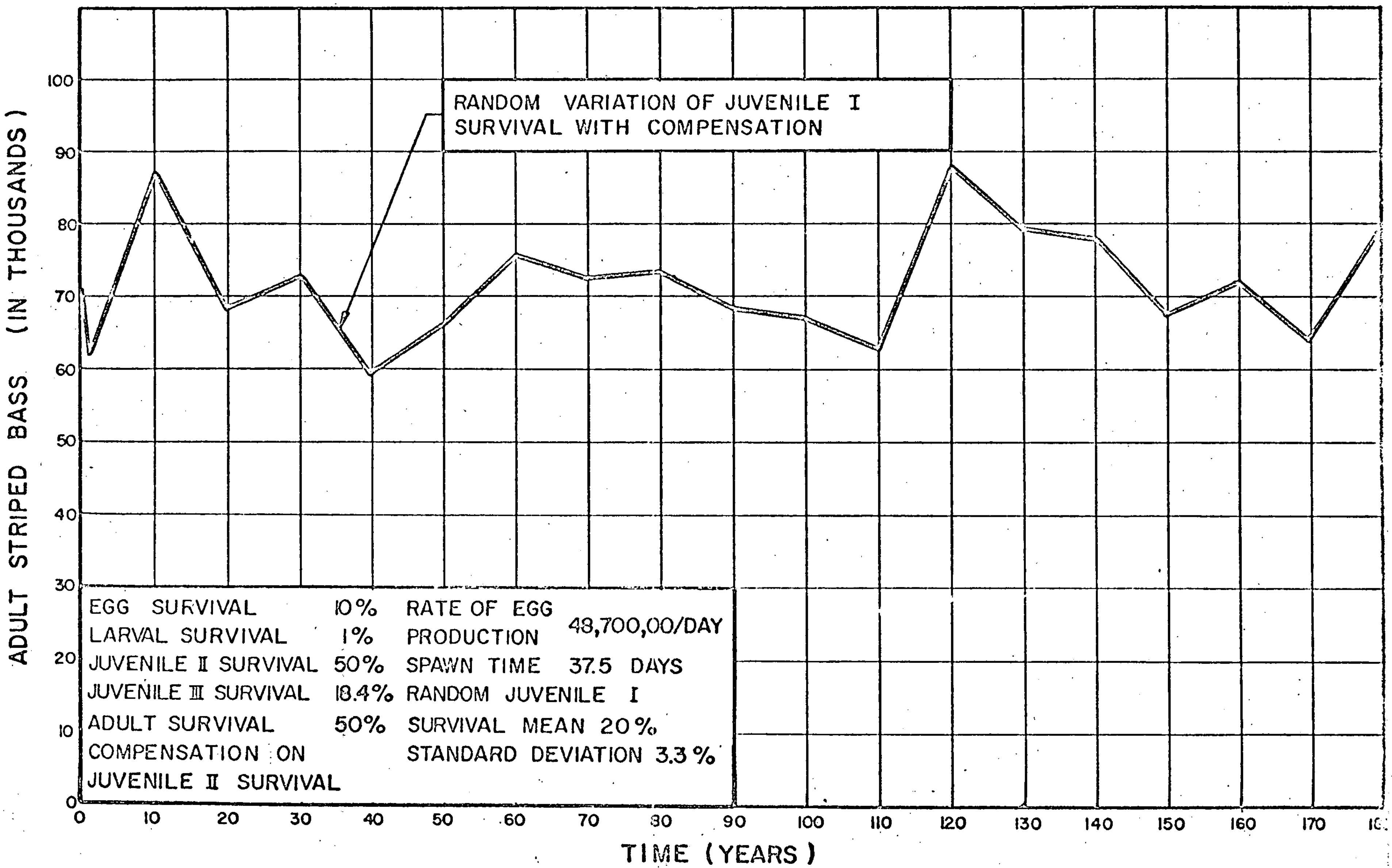
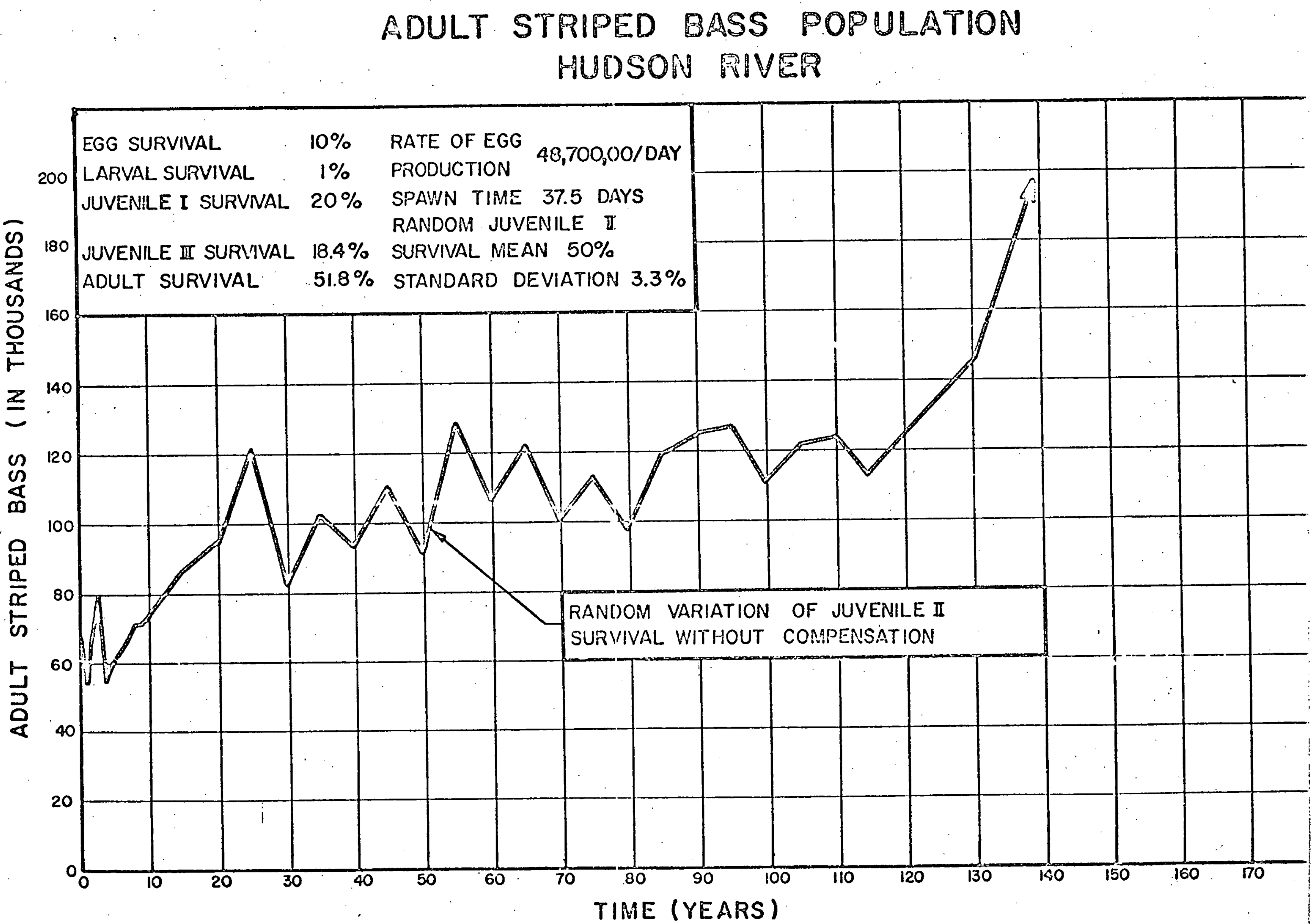


Figure 2



ADULT STRIPED BASS POPULATION
HUDSON RIVER
EGG SURVIVAL 10%
LARVAL SURVIVAL 1%
JUVENILE I SURVIVAL 20%
JUVENILE III SURVIVAL 18.4%
ADULT SURVIVAL 51.8%
RATE OF EGG PRODUCTION 48,700,00/DAY
SPAWN TIME 37.5 DAYS
RANDOM JUVENILE II SURVIVAL MEAN 50%
STANDARD DEVIATION 3.3%
RANDOM VARIATION OF JUVENILE II SURVIVAL WITHOUT COMPENSATION
ADULT STRIPED BASS (IN THOUSANDS)
TIME (YEARS)
0
20
40
60
80
100
120
140
160
180
200
10
30
50
70
90
110
130
150
170

Figure 3

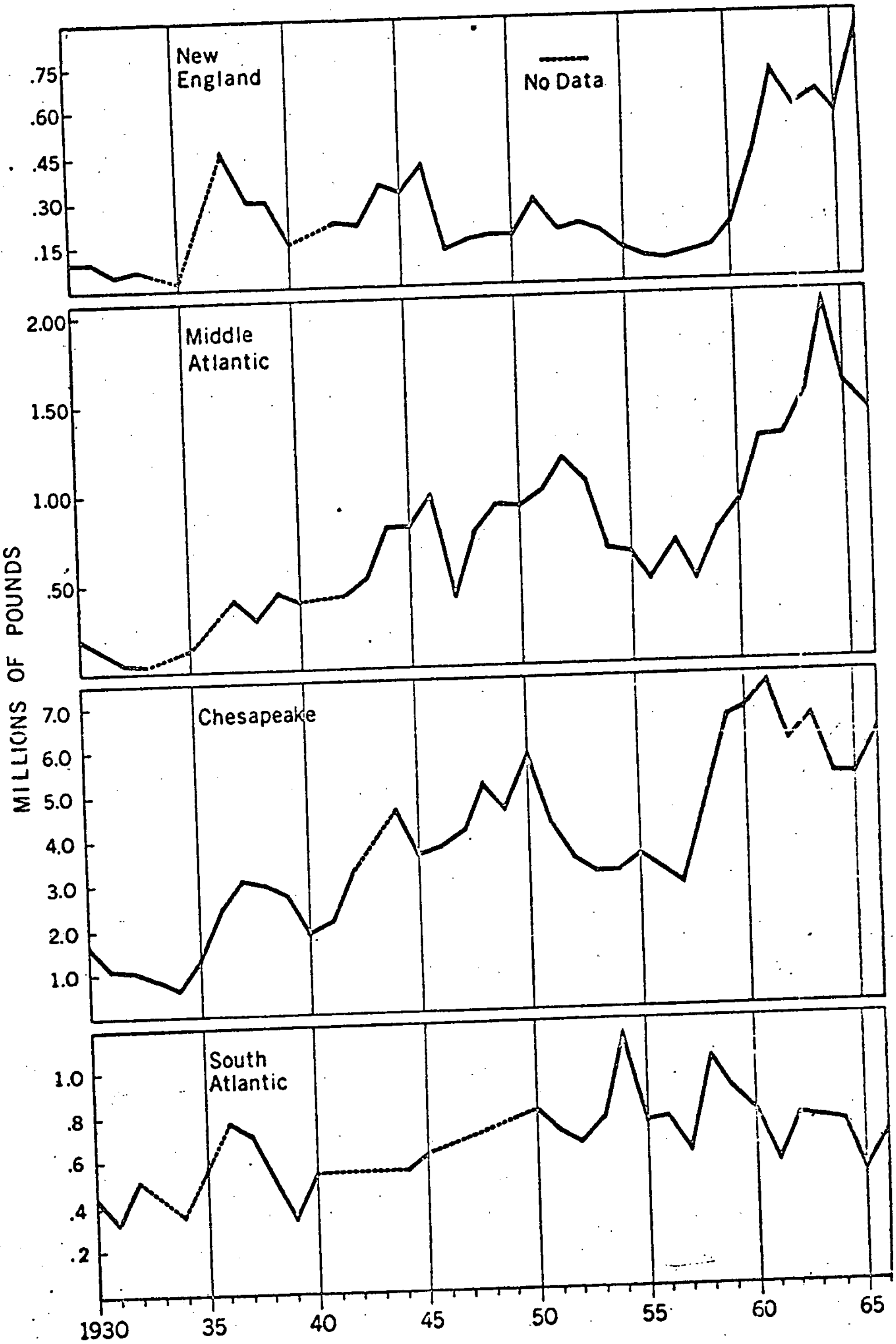


Fig. 2. Striped bass landings, by region.

p. 588. . . There is no reasonable room for doubt that the principal cause of the decline in the Atlantic menhaden fishery was overfishing, as has been established for the Pacific sardine fishery (Murphy, 1966). It would have been prudent, for want of better information, to manage the menhaden fishery in the light of the extensive historical and scientific knowledge of the sardine resource, but for various reasons this was not done . . . Although it is virtually certain that overfishing was the primary cause of the decline of both fisheries, the tendency of both resources to fluctuate widely in abundance from natural causes was an important contributing factor, which made overfishing inevitable.

p. 589 . . . Menhaden caught north of Chesapeake Bay usually are large, mature fish, most of which have had an opportunity to spawn at least once. It is probable that if menhaden fisheries had not developed south of the Delaware River, the northern fisheries could have continued forever. It is certain that the abrupt decline in New York waters would have been slowed, if not prevented altogether . . . The intense menhaden fishery in Chesapeake Bay, which now takes almost exclusively immature fish in their first and second years of life, reduces the life expectancy so greatly that few fish live long enough to migrate farther north. Thus, the collapse of the menhaden fishery in New York waters, like the early collapse of the sardine fishery in northern California and higher latitudes, was caused not so much by local overfishing, but by overfishing by other fleets in the waters of other States to the southward.

p. 593 . . . The phenomenon of the rise and fall of the shad fishery in the Hudson River from 1924 to 1953 has been analyzed in some detail by Burdick (1954). He concluded that overfishing from 1941 to 1951 was responsible for the decline, which first became noticeable in 1946. He found no evidence that water pollution had any different effect on the shad stocks of the river during the period of rising catches than during the period after 1945. The overfishing was caused, according to Burdick, by the increased demand for fishery products during the war which led to relaxation of the fishing regulations (substantial shortening of the weekly closed season).[1]

(1) McHugh, "Marine Fisheries of New York State," in Fishery Bulletin, 70:3, 1972, pp. 585-610.

The Staff feels that the same type of situation is operant within the striped bass population, particularly in the region around New York which is primarily served by reproduction in the Hudson River.

Furthermore, it is noted that the only information by witnessses for the Applicant concerning the manner in which striped bass populations are controlled is presented by Dr. Lawler in his comments on the origin of the stock of the mid-Atlantic striped bass fishery (p. 9-11). On the bottom of p. 9, Dr. Lawler presents a possible explanation of a dramatic increase in striped bass from 1934. This hypothesis was presented by Pearson who was quoted by Dr. Lawler:

> A possible explanation of the dramatic increase in striped bass is presented by Pearson (6) who states the following:
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> > "It is surprising to note that after an extended period of lean years the catch of striped bass in Maryland waters increased from 332,000 pounds in 1934 to 928,000 pounds in 1935. This increase of nearly threefold cannot be definitely explained in the absence of field observations but a likely cause for the greater abundance of fish is suggested. In 1932 the use of the purse seine was forbidden in Maryland. This type of net had accounted for about 24 percent of the annual catch for several years prior to 1931. Although the catch remained low from 1932 to 1934, it is significant that the striped bass do not generally attain commercial size until their third summer. Hence, fish which were spawned in 1933 did not appear in the catch until 1935. It might be assumed that enough adult striped bass 3 years old or older were spared by the abolition of the purse-seine fishery in 1932 to aid greatly in spawning production in the spring of 1933. Many fish spawned in 1933 undoubtedly reached the commercial catch during 1935. If such a condition actually occurred then a heavy production of young also occurred in 1934, making possible a large commercial catch in 1936. Field repots again indicate that the striped bass was as abundant in 1936 as in 1935, and that most catches were composed of small fish."

Pearson's work was published in 1938 and apparently he did not have available to him the records for commercial catches made after 1935. Table 1 indicates that Pearson's deduction was correct; striped bass were again plentiful in the Chesapeake in 1936. It is of interest to note that while fishing improved in the Chesapeake in 1935, three years after the end of purse seining, the records also show an improvement in fishing in the Middle Atlantic in 1937. This is consistent with the idea that these fish originated in Chesapeake Bay since members of a year class would first appear in the commercial catches near their spawning area and then in the following years in areas further away as the fish grow older and undertake more extensive migrations. If this is indeed the correct explanation then this is a strong indication that fish of Chesapeake Bay origin are directly responsible for the abundance of striped bass along the entire coast, since an alteration in the fishery in that region directly affected the level of abundance of striped bass in the North and Middle Atlantic regions. It is also apparent that despite the high level of exploitation by both commercial and sports fishermen the population of striped bass, as reflected by commercial fishery statistics, has been increasing for over thirty years. There is no indication from more recent fishery statistics that this trend has not contimued to the present.

In essence, the thesis which Pearson was presenting was that the increase in abundance in fish in the commercial catch which occurred in the mid-30's was principally the result of increased reproduction in the striped bass population which resulted from a decreased fishing intensity. Dr. Lawler concludes that Pearson's deduction was correct.

Through this discussion, cause of the upward trend is directly related to increased reproductive effort of fish spared by the fishery. This thesis, as presented by Dr. Lawler, does not confirm but rather is in direct conflict with the assumptions inherent in the Applicant's Hudson River striped bass model. The Applicant's model utilizes a compensatory process operant within the larval community. Were a compensatory process of the type postulated in Dr. Lawler's Hudson River model to be operant in the larval community, it would not have been possible for an increased survivorship in the adult striped bass to increase the stock in the Atlantic coast through reproductive processes.

In summary, it is the Staff's position that the applicant's formulation of compensation is erroneous, and from a computational standpoint it should not be used for predictive purposes. The equations which are used to solve for mortality rate within the larval community are descriptive and can only be utilized for descriptive reference to a population identical to that for which the data were gathered. Any extrapolation of those functions presented to solve mortality rates to future populations and future conditions in the Hudson River is unfounded. This is because the mechanisms through which any compensation or any density-dependent mortality or growth may be exhibited have not been established either conceptually or from a data base related to the striped bass population existing in the Hudson River. It is the Staff's position that the utilization of the compensatory mechanism as designed by the Applicant is not a realistic feature of his model and should be eliminated for any predictions of future striped bass populations resulting from reproduction in the Hudson River.