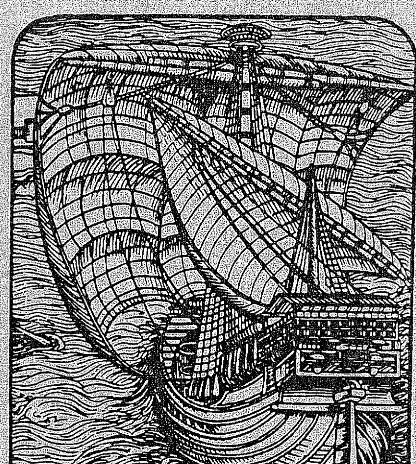
PROCEEDINGS OF THE LIONEL A. WALFORD MEMORIAL CONVOCATIONS

1979 - 1981



JUNE 1982

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OF THE

LIONEL A. WALFORD

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A. L. Pacheco, Editor

Sandy Hook Laboratory
Northeast Fisheries Center
National Marine Fisheries Service
National Oceanic and Atmospheric Administration
U. S. Department of Commerce

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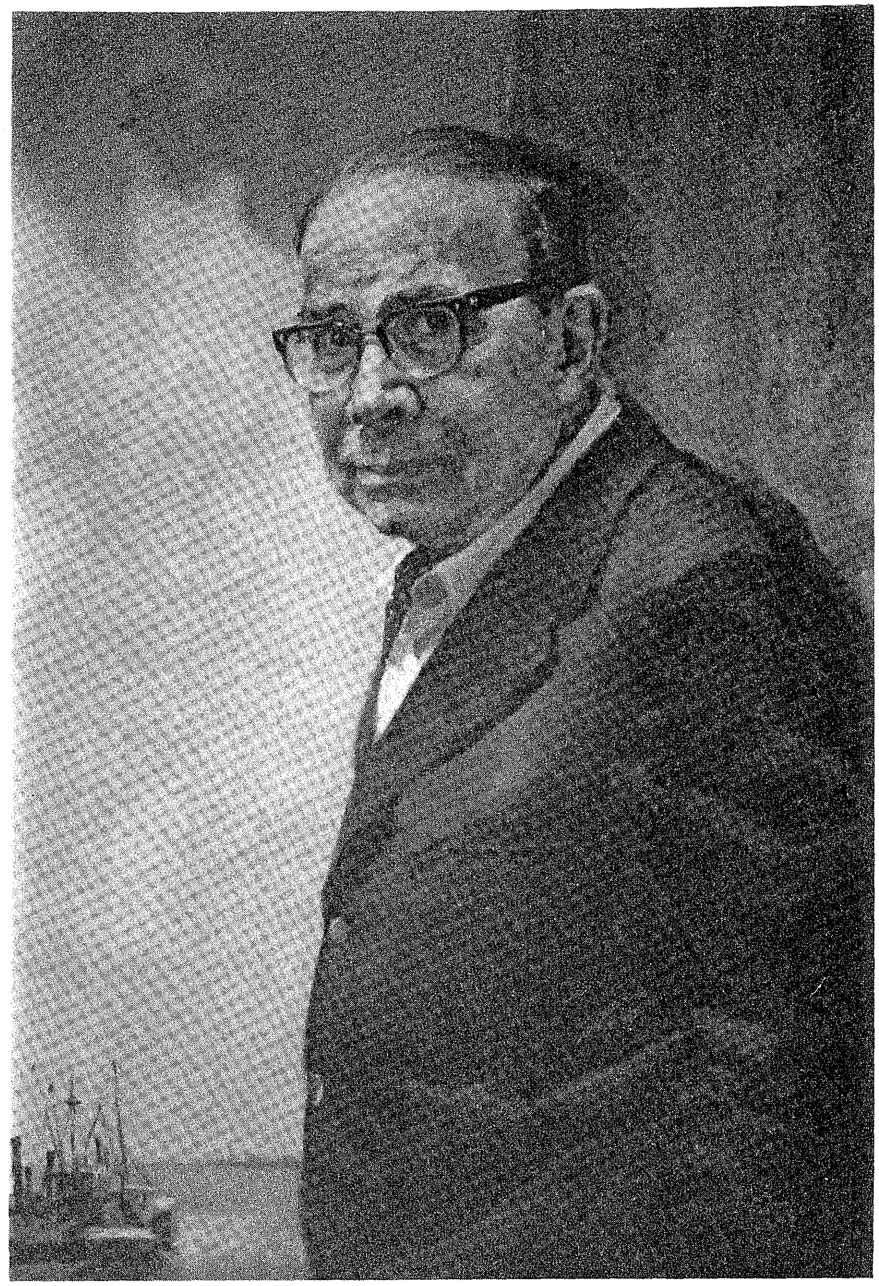

LIONEL A. WALFORD

1905 - 1979

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INTRODUCTION

With the death of Lionel A. Walford, a significant voice in marine science was stilled. To honor him as a friend, advisor and scientist, the marine institutions of Sandy Hook jointly sponsor an annual convocation. This is entirely proper because Dr. Walford was instrumental in organizing and developing not only the Sandy Hook Laboratory, but the American Littoral Society and New Jersey Marine Sciences Consortium.

The theme of the series is to continue some of the concepts he developed during his career, particularly those during his time at Sandy Hook. These concepts centered on fishery conservation, an understanding of the marine environment and its resources as well as the effects of man's impacts on the marine environment. In his memory we will continue to summarize and explore our understanding of the sea and its research frontiers.

Carl J. Sindermann, Director
Sandy Hook Laboratory
Northeast Fisheries Center
National Marine Fisheries Service

AN APPRECIATION

Dr. Daniel Merriman

Professor Emeritus
Yale University

I am deeply honored on this occasion to have been asked to give a "reflection prologue eulogising" Bert Walford as an introduction to the Lionel A. Walford Memorial Lecture Series. The phraseology, "reflective prologue eulogizing Bert", is not mine and I would prefer to have my remarks called an "appreciation". Yet I'm not sure that this title would be right, for I doubt very much that any one of us now alive could fully appreciate Bert in the myriad of facets that characterized his life.

But I am grateful for this opportunity because, as I have reflected about Bert over the past several weeks, I have learned some added humility. Humility of one sort I well know from fly-fishing for Atlantic salmon; one day you catch your limit while companions come up empty-handed and you think you're pretty good; almost invariably the good Lord sees to it that the next day you catch nothing. The humility I learned and speak of here transcends the mundane. Not that Bert ever wanted anyone to suffer humility at his hands. Far from it. It is quite simply because when one thinks of the quiet but many-spendored qualities of this extraordinary man, one inevitably feels humble. And that is a good thing. We should rejoice in it.

My own acquaintance with Bert covers intermittent periods over four decades -- never, to my loss, in intimacy. It would be presumptious of me to talk about him in his several roles since 1960 in this community where he was so well known to many of you here present; and further, I must confess that this is my first visit to the Sandy Hook Marine Laboratory.

I first knew Bert in 1931-32 when he was at Harvard working toward his Ph.D. under Dr. Henry B. Bigelow. I was fresh off Atlantis I, where I had been hired to assist William C. Herrington of the U. S. Bureau of Fisheries in the design of a "savings gear" that would release undersized haddock without loss of marketable fish. Much of my time was spent on the banks testing the gear, but when ashore I worked in the Bureau of Fisheries offices in the newly built Harvard Biological Laboratories. Here I lunched in company with my boss and with O. E. Sette (then engaged in his classic work on mackerel), R. A. Nesbit (weakfish), W. C. Neville (scup), and occasionally L. A. Walford. I was 23 years old, and Bert at 26 appeared, through the eyes of youth, to be well on in middle age. This, coupled with his unassuming and somewhat taciturn manner, made for no easy rapport between us. Besides, my own education in fisheries was still in the diaper stage; mostly I listened in reverential respect to the luncheon conversation. Be that as it may, it is interesting to speculate a little on the influence that Bert's peers and mentors at this time had on his life and work.

Stemming originally from the fear of over-fishing and depletion of fish stocks, attention was now focused on both sides of the Atlantic on the causes of the fluctuations in abundance of the major commercial species such as herring, plaice, cod, haddock, and mackerel. Historically this attention had its impetus from the work of the Scandanavians, Johan Hjort and Einar Lea, in studies published before and after World War I. Lea laid the foundation for age-determination of herring by scale-reading, hence the ability to learn the age-composition of landed catch. Hjort called attention to the great fluctuations in abundance of the major European fisheries; he believed that they resulted from the success or failure of each species to survive a critical stage in its larvae existence -- that of yolk-sac absorption. The contributions of these two men, age-determination in fishes and the documentation of dominant year-classes, appeared in the publications of the Conseil International pour l'Exploration de la Mer between 1910 and 1926. Their works led such as F. S. Russell and Maurice Yonge to write in 1928:

> "It is one of the main aims of fishery research to find out what is the exact combination of conditions necessary to bring about a good "survival year", and this knowledge can only be gained by taking very full and detailed observations over a long period of years."

Dr. Bigelow was in close contact with Hjort and the International Council in the 1920's and indeed addressed it in 1931 when he stressed the importance of cooperation in the study of similar fisheries problems on both sides of the Atlantic. It takes no great imagination to grasp his influence on Bert Walford, whose research under Bigelow -- with, I'm very certain, able assists from Sette and Nesbit -- led to his publication on the "Effects of currents on distribution and survival of the eggs and larvae of the haddock (Melanogrammus aeglefinus) on Georges Bank", Bulletin 29 of the U. S. Bureau of Fisheries, 1938. Thus begun, the interest in environmental studies pervaded the rest of Bert's life, culminating in his direction of the Sandy Hook Laboratory from 1961 to 1971. Tinker to Evers to Chance in baseball surely has its equivalent in fisheries biology -- Hjort to Bigelow to Walford.

All this is not to say that Bert's interests ever suffered from insularity. Look through the list of his publications. They range from the Selachii through the higher teleosts, including the description of a new Carangid, from an abiding concern with game fishes to the management of commercial species and the living resources of the sea, and from the effects of pollution to conservation in the broadest sense of the word. Here I shall mention but two of his works. I select them not alone because of their quality, but also because they both deal with Pacific fishes and are therefore perhaps less appreciated on our coast than they should be.

The first of these is Walford's "Marine Game Fishes of the Pacific Coast from Alaska to the Equator", published in 1937 when Bert was 32. This 205-page book with its magnificant plates served me well in teaching -- that is, as long as I had it in hand; after my first copy disappeared from my shelves I got a second, only to have it suffer a similar fate. While this may not speak very well for Yale students, it does say something about the book. That the students were at least discriminating in their pilferage is amply proven by the fact that this classic was reprinted under the auspices of the Smithsonian in 1974, 37 years after its initial publication.

The other work by Bert is a five-and-one-half page paper appearing in the Journal of Marine Research in Vol. VI (no. 1), 1946, entitled "Correlation between fluctuations in abundance of the Pacific sardine (Sardinops caerulea) and salinity of the sea water". Here Bert reported a remarkable positive and highly significant correlation between the sizes of the year-classes from 1934 through 1941 and the surface salinity as recorded from the end of the pier at the Scripps Institution of Oceanography. The Bigelow influence is clarion clean. Thus Bert wrote:

"This is but another item in the growing body of evidence that fluctuations in the size of year classes is the consequence of fluctuating infant or adolescent mortality, and that this in turn results from fluctuating environmental conditions."

I remember refereeing that paper and thinking that the fit of the correlation was too good to be true, and indeed it did fail to hold up in subsequent years. No matter. The work aimed at the heart of the problem and reflected the importance of the strength of upwelling and hence the availability of nutrient salts and food for the developing young sardines. As such, this paper has received far less attention in the subsequent literature than it merits.

The last time I saw Bert Walford was in 1969 at the Second Thermal Workshop held at the Chesapeake Biological Laboratory at Solomons, Maryland. He and I had been assigned to do a report on the fishery section. I was not much help since I was suffering the indignities of a kidney-stone attack, but what I remember most vividly was Bert's concern for my well-being. His thoughtfulness and consideration were beyond compare; indeed, I think his compassion matched my pain. The memory of that occasion, and of the man, does not fade.

"...God gives to every man the virtue, temper,
understanding, taste, that lifts him into life,
and lets him fall just in the niche he was
ordain'd to fill."

So wrote William Cowper in 1785. Bert's niche was very special, and on this occasion more than anything else we should appreciate and rejoice in our great good fortune in having had him in our midst. *Gloria in excelsis*.

NEW JERSEY FISHERIES - WHAT IS THEIR FUTURE?[1]

J. L. McHugh

Marine Sciences Research Center[2]
State University of New York at Stony Brook

The fisheries of New Jersey are not doing well if total commercial landings are any criterion. Up to 1956 the situation looked good, at least superficially: catches fluctuated somewhat, but the trend was upward, reaching a maximum of about 540 million pounds (nearly 250 thousand metric tons) in that year (Figure 1). The value of these landings, in dollars paid to fishermen, adjusted by the consumer price index to bring them into comparative terms, reached a maximum in 1945, which was not exceeded again until 1977 and 1978. This was the third largest in landings of any state along the Atlantic coast since 1880, exceeded only by Virginia and Massachusetts, and in fact at that time the second state in weight of landings along the entire Atlantic coast.

Following 1956 the picture changed abruptly. Within two years it had dropped to less than 50% of the maximum, and except for a brief uprise early in the 1960s, dropped to a low of less than 20% of the maximum in 1969. Landings had not been so low since the depression years in the early 1930s. Since 1969, landings have improved, reaching more than 220 million pounds (about 100,000 metric tons) in 1976, and reaching an adjusted value of slightly above 21 million dollars in 1978.

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[1] The studies on which this paper is based were supported in part by grants from the New York Sea Grant Institute.

[2] Contribution 325 of the Marine Sciences Research Center of the State University of New York, Stony Brook, N. Y.

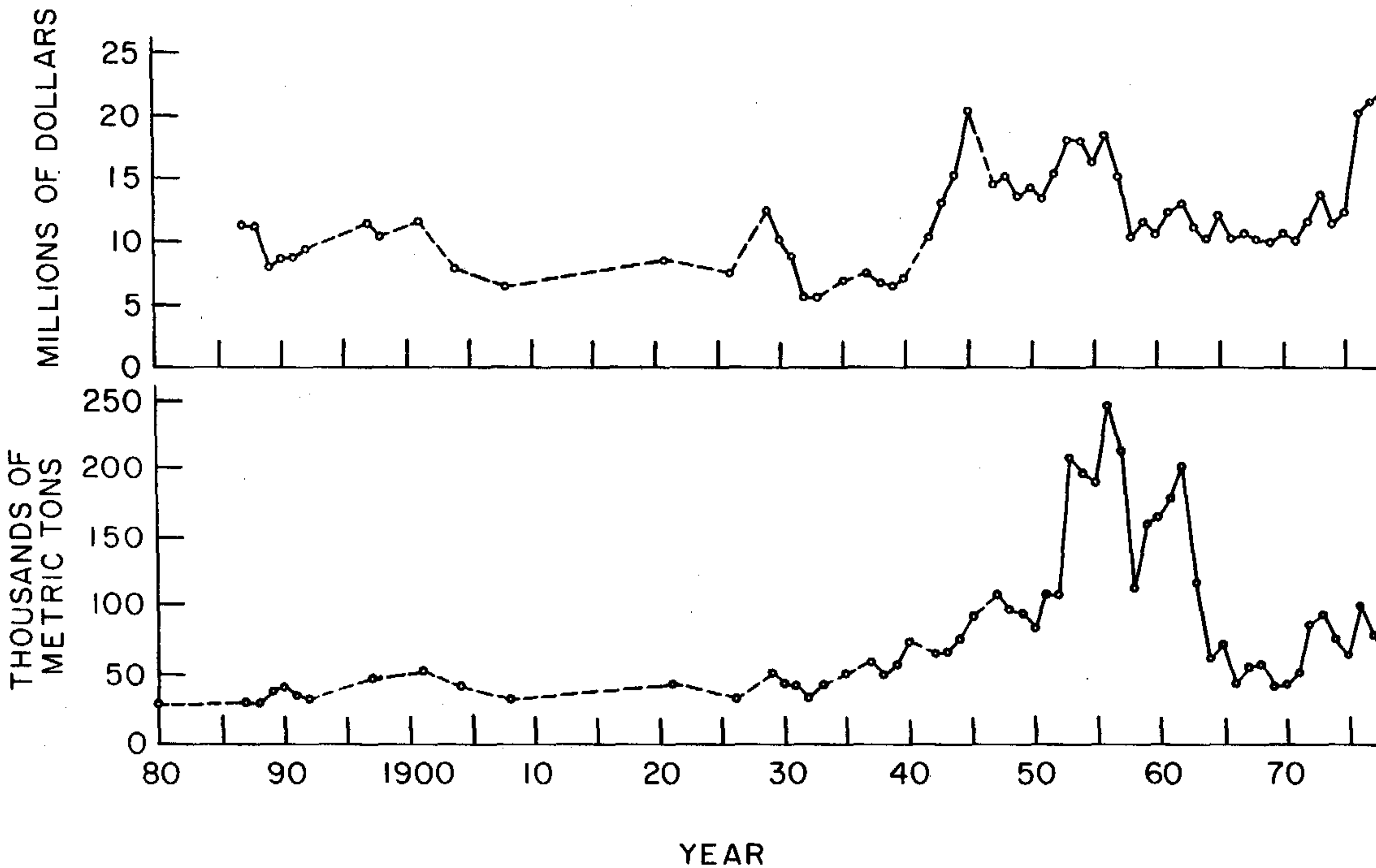

Figure 1. Total commercial landings of all species in New Jersey 1880 to 1978, and total price paid to fishermen, adjusted to standard dollars (1967=100) by the consumer price index. When one or more years were missing, points were joined by broken lines.

This picture of New Jersey fisheries does not by any means tell the whole store, however, for a large part of total landings consisted of menhaden and some other industrial species, used to manufacture oil and meal, or as bait, animal food, or other nonhuman food purposes. Menhaden alone made up most of commercial landings for a large part of this period, and so dominated landings that they parallel the history of the menhaden fishery. When industrial species are removed from the catch, and food finfishes and shellfishes are considered separately, the pattern changes. Food finfishes (Figure 2) fell off irregularly but fairly steadily until 1969 and then recovered partially. The greatest landed value of food finfishes was in 1945 at about $11.2 million, it fell off to about $2.5 million in 1969, then rose to about $7 million in 1978, adjusted value.

Food shellfishes (Figure 3) showed a steady increase in landings after the second world war to a maximum in 1966, falling off irregularly thereafter. The adjusted price of food shellfishes reached a peak in 1945, at slightly over $9 million, remained fairly high until 1957, and did not rise as high as 1945 again until 1976 and succeeding years when it rose to $13 million and higher.

The recreational catch, which consists of food finfishes and shellfishes, was considerably larger than the commercial catch, according to best available records. The catch by recreational fishermen of food finfishes alone in 1974 was estimated to be about 92.8 million pounds (42,000 metric tons), which was about 3.3 times the commercial catch (Figure 2). The recreational catch of food shellfishes was about 12.3 million pounds, but the shells of mollusks must be removed to make it comparable with commercial landings.

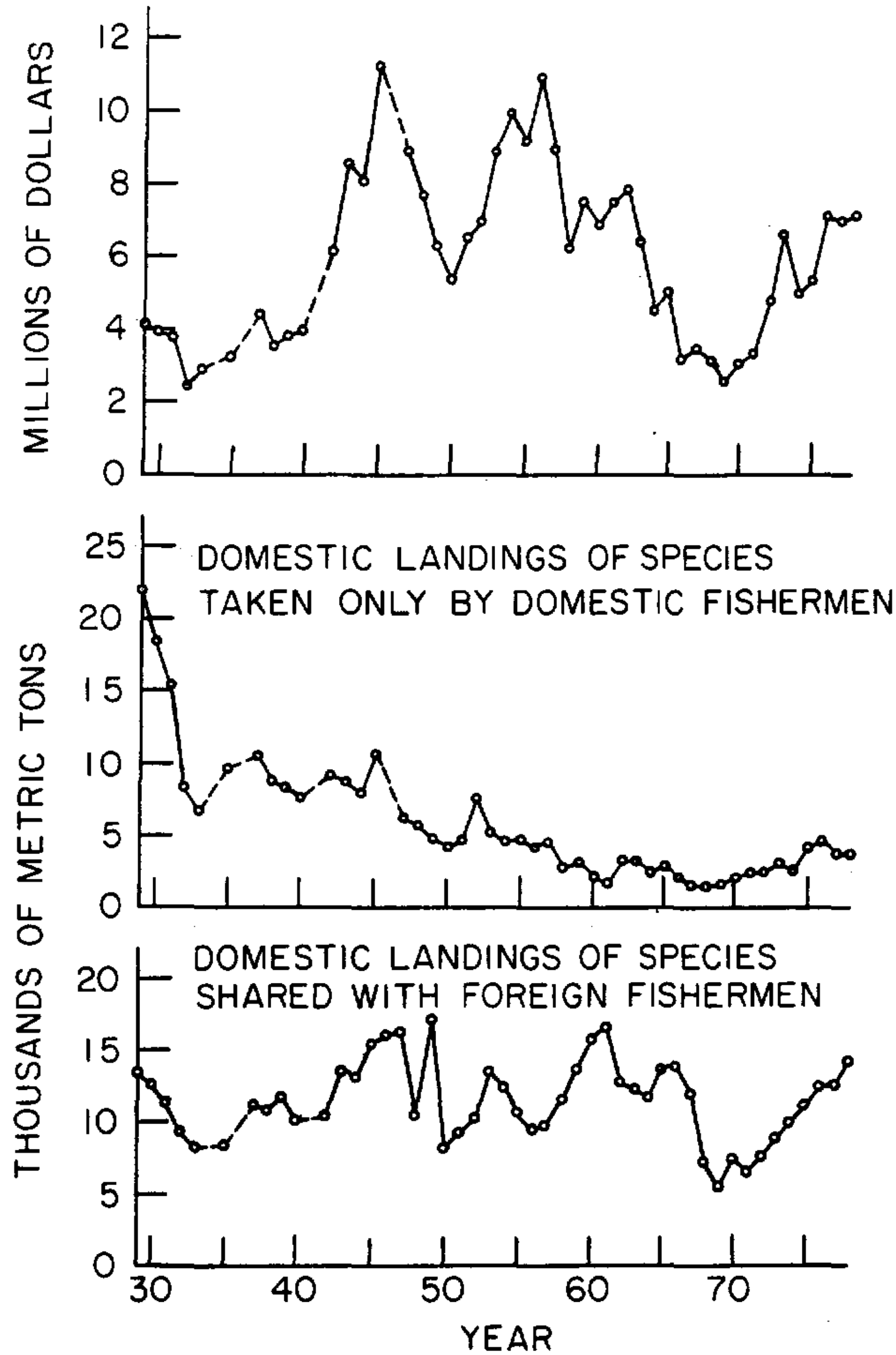

Figure 2. Total commercial landings of food finfishes in New Jersey 1929 to 1978 divided into two categories, those shared with foreign fishermen and those harvested only by domestic fishermen, and the total price paid to fishermen for their catch, adjusted to standard dollars.

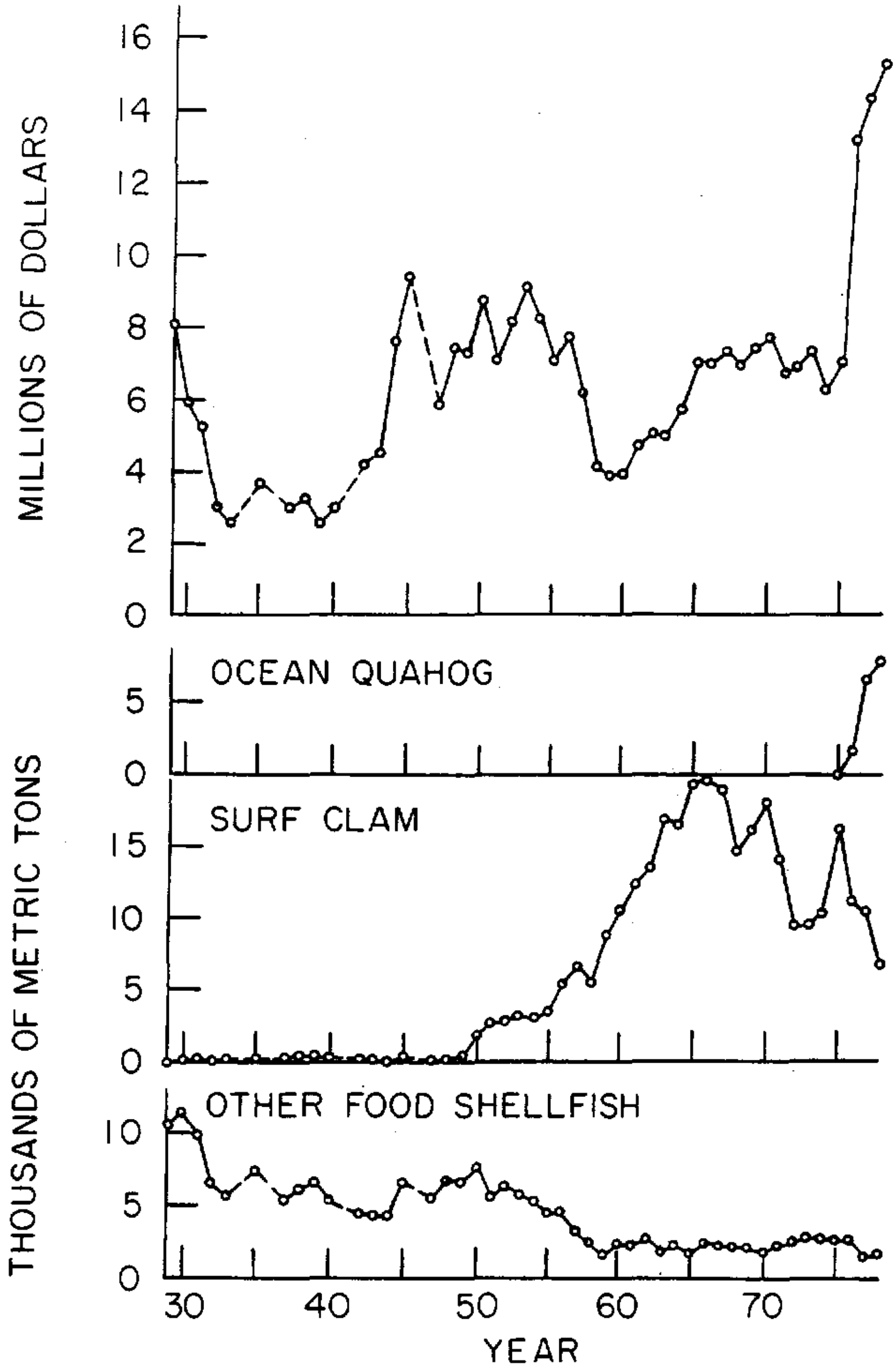

Figure 3. Total commercial landings of food shellfishes in New Jersey 1929 to 1978, with surf clams and ocean quahogs separated, and the total price paid to fishermen for their catch, adjusted to standard dollars.

This can be done only approximately, and the best way is to add the shells to the commercial catch, which brings total shellfish landings to 192.5 million pounds (87,320 metric tons). Thus, the shellfish catch by recreational fishermen was less than 10% of the commercial catch.

The recreational fisheries have been growing, and almost certainly have been taking an increasing percentage of the total catch. If this is true, the recreational fishery may be taking most, if not all, of the difference. However, it is generally conceded that the commercial catch statistics probably underestimate the catch, and recreational catch statistics overestimate. This is a very important matter, which can not be left forever to guesswork. At present the surplus is allocated by the following methods: 1) estimate the total allowable catch; 2) subtract an amount equal to the recreational catch, and reserve that for recreational fishing; 3) allocate a proportion of the remainder, based upon the anticipated domestic commercial capacity, to domestic commercial fishermen; and 4) if any surplus remains, allocate that to foreign fishermen. This has the following weaknesses. If the recreational catch is overestimated, and the commercial catch underestimated, this may provide an inequitable allocation between the two. If the recreational catch continues to take an increasing part of the total, the domestic commercial quota will have to dwindle, if the two are taking all of the surplus. It may also affect the foreign catch, if the total allowable catch is estimated to be larger than the actual amount. The success of fishery management plans depends upon having reasonably accurate and current statistics, and upon making decisions about who gets what and how much. Bluefish, Atlantic mackerel, summer flounder or fluke, weakfish, striped bass, winter flounder or blackback founder, and scup, to name the most important species, can not be managed unless reasonably accurate data are forthcoming. Brown (1976), for example, has suggested that the recreational fishery exerts enough effort to take the entire allowable catch of summer flounder. If so, it is scarcely equitable to allocate the entire surplus to the recreational fishery. How then shall the catch be allocated, and how will the recreational fishery be controlled?

Revealing though food finfish and shellfish landings are when plotted separately, they still do not tell the whole story. Individual species have fluctuated up and down during this 50-year period for a variety of reasons, and the individual landings must be broken out species by species. The source of landings also has changed markedly over this period. For example, food finfish landings were taken mostly by pound nets before the second world war, mostly by otter trawls after about 1950 (Figure 4). A more detailed summary of New Jersey landings were published recently (McHugh, 1977).

Foreign Fishing

Foreign fishing has received much of the blame for declining domestic catches in this area. In fact, this was largely the reason for passage of PL 94-265, the Fishery Conservation and Management Act of 1976. Although I do not mean to minimize the effects of the large foreign catches of some species, the record does not support the view that foreign fishing was the principal culprit. This can be tested quite easily by separating food finfish landings into two categories, those which have been taken by foreign and domestic fishermen, and those which have been taken mostly by domestic fishermen.

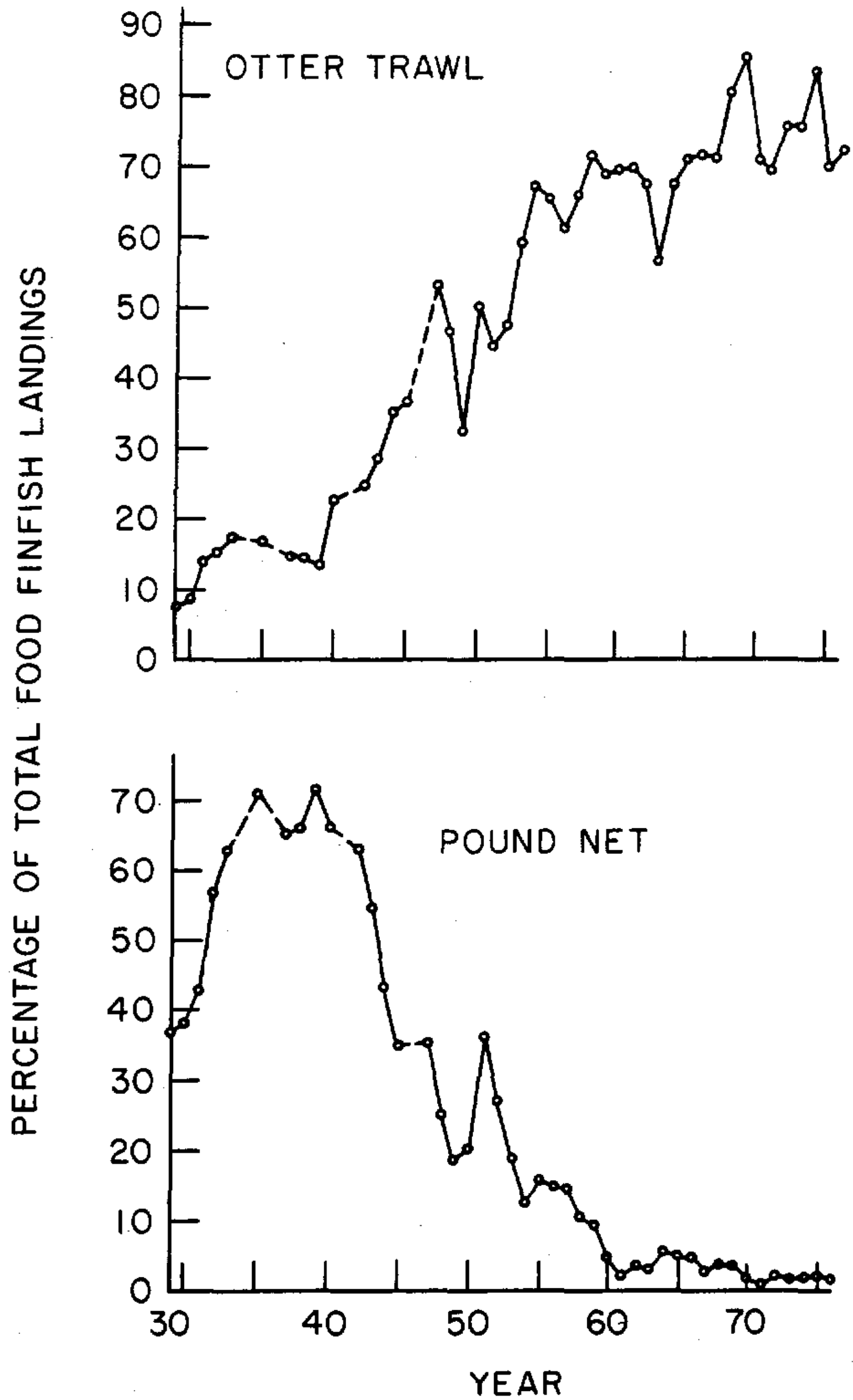

Figure 4. Percentage of total food finfish catch taken by pound nets and by otter trawls in New Jersey 1929 to 1976.

Examples of the first category are silver hake, red hake, yellowtail flounder, Atlantic herring, Atlantic mackerel, butterfish and others. Examples of the second are scup, Atlantic croaker, shad, weakfish, striped bass and others. The first group has declined surprisingly little (Figure 2), from the peak in 1949 to 1978 only a 17% decline, from the maximum catch in 1949 to the minimum subsequent catch in 1969 a 67% drop, much of which can be attributed to economic changes in the domestic fishery and not to a decline in abundance. Purely or largely domestic species, on the other hand, have declined alarmingly, about 94% from the peak in 1929 to the low in 1968, and about 84% from the maximum in 1929 to the present in 1978 (Figure 2). There is no other way to interpret this difference than to say that we have not been able to maintain our own resources, which were mostly confined to domestic waters within 3 or 12 miles, hence never exposed to major foreign fishing. The history of the menhaden fishery (97.3% drop from 1956 to subsequent low in 1966, and 83% drop from 1956 to 1978), and surf clam fishery (64.7% drop from 1966 peak to 1978) are equally illustrative (Figures 3 and 5). Virtually no menhaden, and no surf clams at all, were taken by foreign fishermen.

The effect of foreign fishing upon stocks of fishes harvested jointly by domestic and foreign fishermen can also be shown by combining foreign catches with domestic landings. The figures are not quite comparable because foreign catches are for the whole of subarea 6 (Montauk Point to Cape Hatteras). Nevertheless, these also show that the decline was much less (about 48%) than purely domestic catches from peak in 1971 to 1976, and some of this decline was caused by imposition of quotas by the United States.

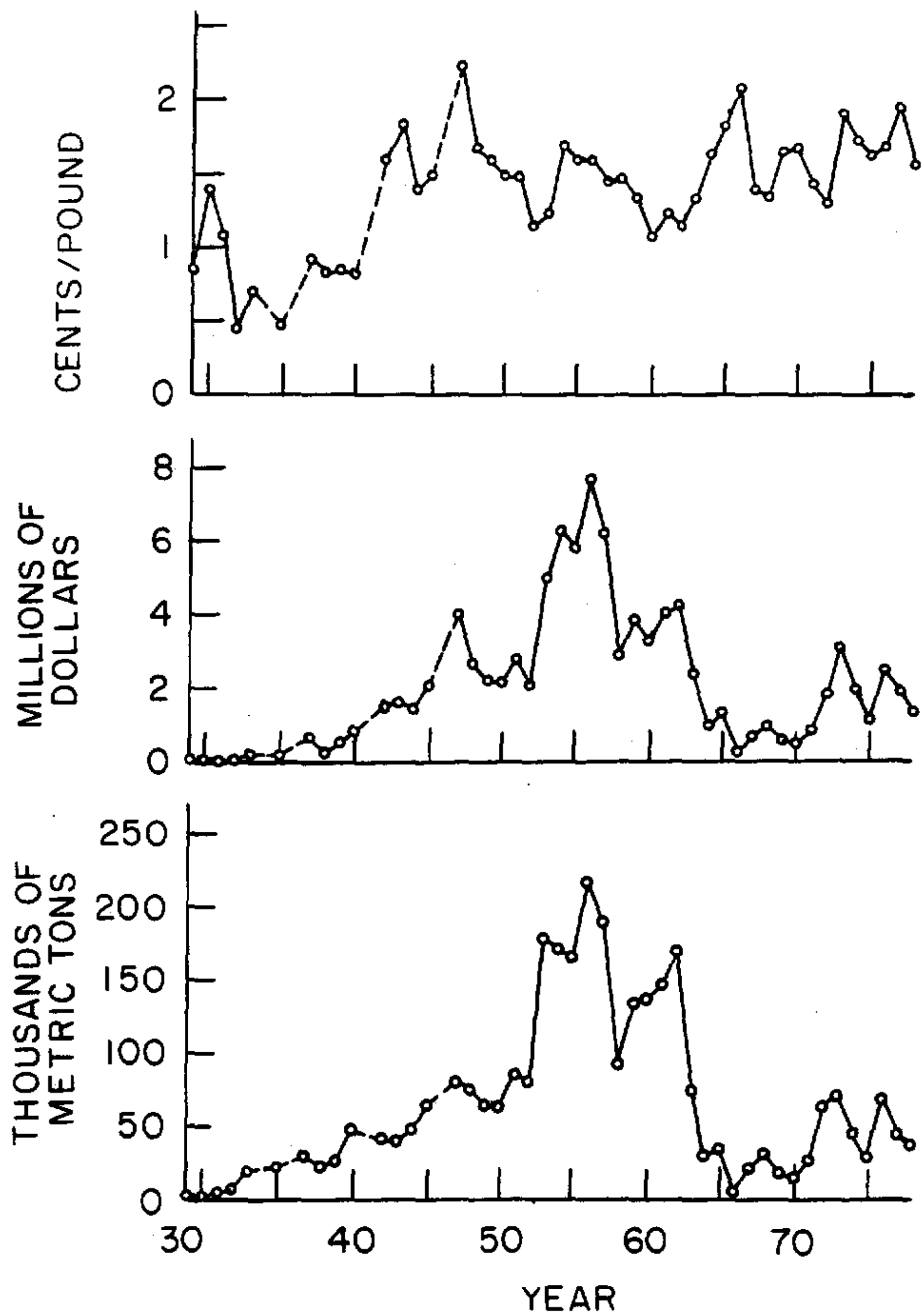

Figure 5. Total commercial landings of menhaden in New Jersey 1929 to 1978, total price paid to fishermen for their catch, adjusted to standard dollars, and the price per pound paid to fishermen, adjusted to standard dollars.

Catch by Gears

The major gears in the domestic food fishery in New Jersey were pound net (early) and otter trawl (later). At its peak in the 1930s pound nets were taking somewhat over 30 million pounds (13,835 metric tons) of about 41,890 million pounds (19,000 metric tons) of total food finfishes. At its peak in 1976 otter trawls were taking about 28 million pounds (12,700 metric tons) of 37,480 million pounds (17,000 metric tons) of food finfishes. Pound nets took their greatest catches from 1937 to 1939, then declined fairly rapidly, especially after the second world war. Otter trawls increased their take up to 1947, then fluctuated, reaching their peak of about 27 million pounds (12,250 metric tons) in 1976. Pound nets were taking about 71% of the total food finfish catch at their peak in 1939 (Figure 4), and otter trawls about 83% of the total in 1969.

Species

In this section species are treated in three categories, finfishes that are more or less fully utilized by domestic fishermen, finfishes that are underutilized by domestic fishermen, and shellfishes. Only the major species are discussed.

Scup

Scup was the major food fish species in New Jersey catches for about 20 years, from 1945 to 1965 (Figure 6). The decline in the mid-1950s was probably a decline in abundance, although it may also have been caused partly by the increase in abundance of summer flounder at the same time, which may have caused a change in fishing strategy. Prior to the 1950s scup apparently was

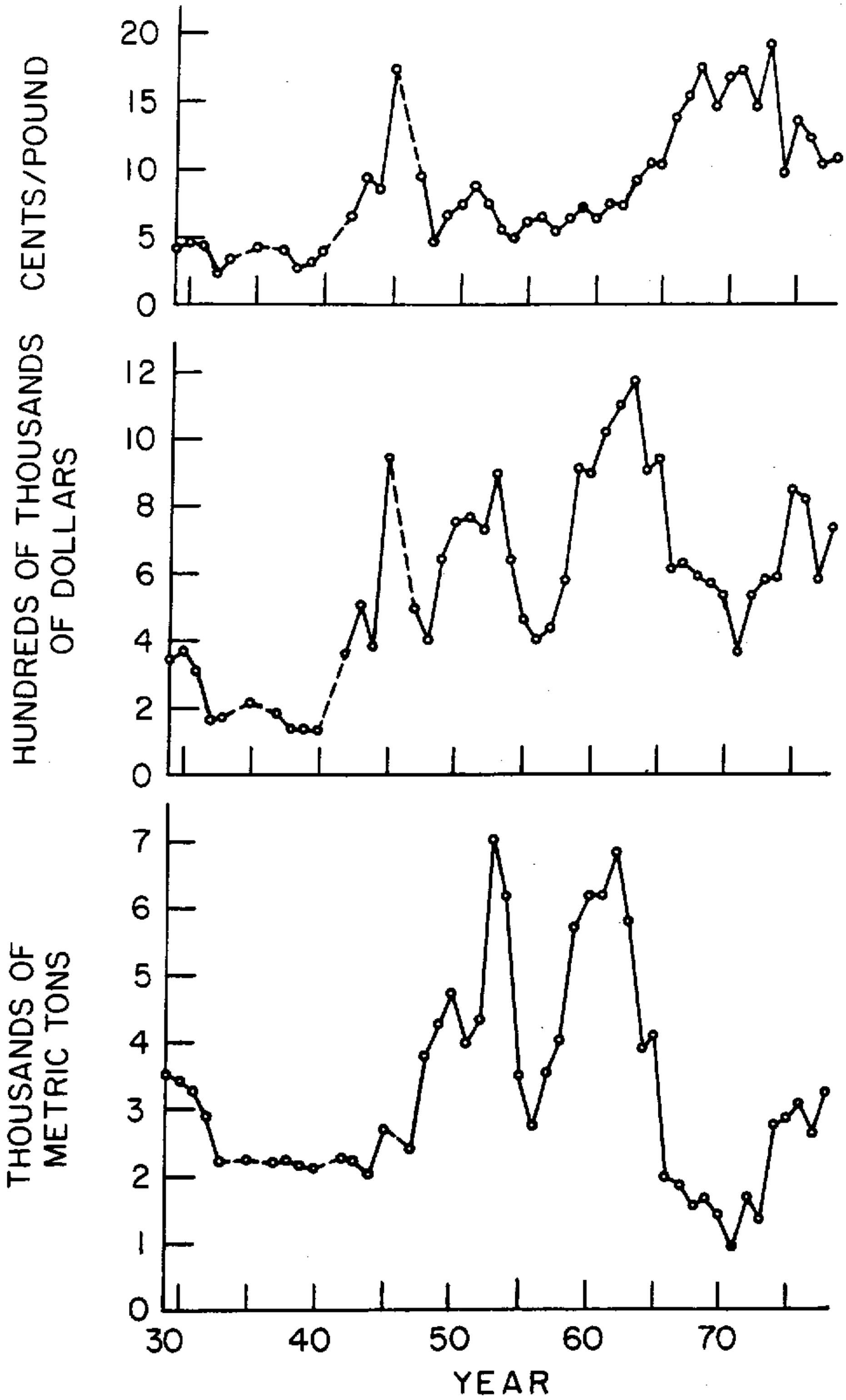

Figure 6. Total commercial landings of scup in New Jersey 1929 to 1978, total price paid to fishermen for their catch, adjusted to standard dollars, and price per pound paid to fishermen, adjusted to standard dollars.

scarce, or was not very desirable because prices were low. In 1945 prices were high because there were shortages of protein food during the latter years of the war, but catches did not rise much because the supply was low. The price dropped after the war and remained low until after 1960. Prices were fairly high when the supply was low in the late 1960s and early 1970s, but dropped off later when the supply increased. Generally speaking, prices fluctuated directly with the supply prior to the war, and inversely with the supply thereafter.

Weakfish

Weakfish declined in abundance, with at least three major changes, from 1929 to the 1960s (Figure 7). The price was highest, however, during the war in 1944. The slight decline in price in 1945 was probably because abundance was much greater. The rather steady trend downwards following the war, with some fluctuations probably related to short-term changes in abundance, may have been related to the increasing catch by sport fishermen, who by giving excess fish to friends and selling direct to local markets, kept markets fairly well saturated with fish and demand for other supplies poor. This appears to be the only reasonable explanation, especially for low prices in the second half of the 1960s, when the supply was apparently at an all time low.

Bluefish

Bluefish had somewhat the same history as weakfish, with high abundance in the early 1930s, low in the early 1940s, peaking in the early 1950s, reaching a low again in 1958, then increasing fairly steadily to the present (Figure 8). The price dropped during the depression, rose to a peak in 1947

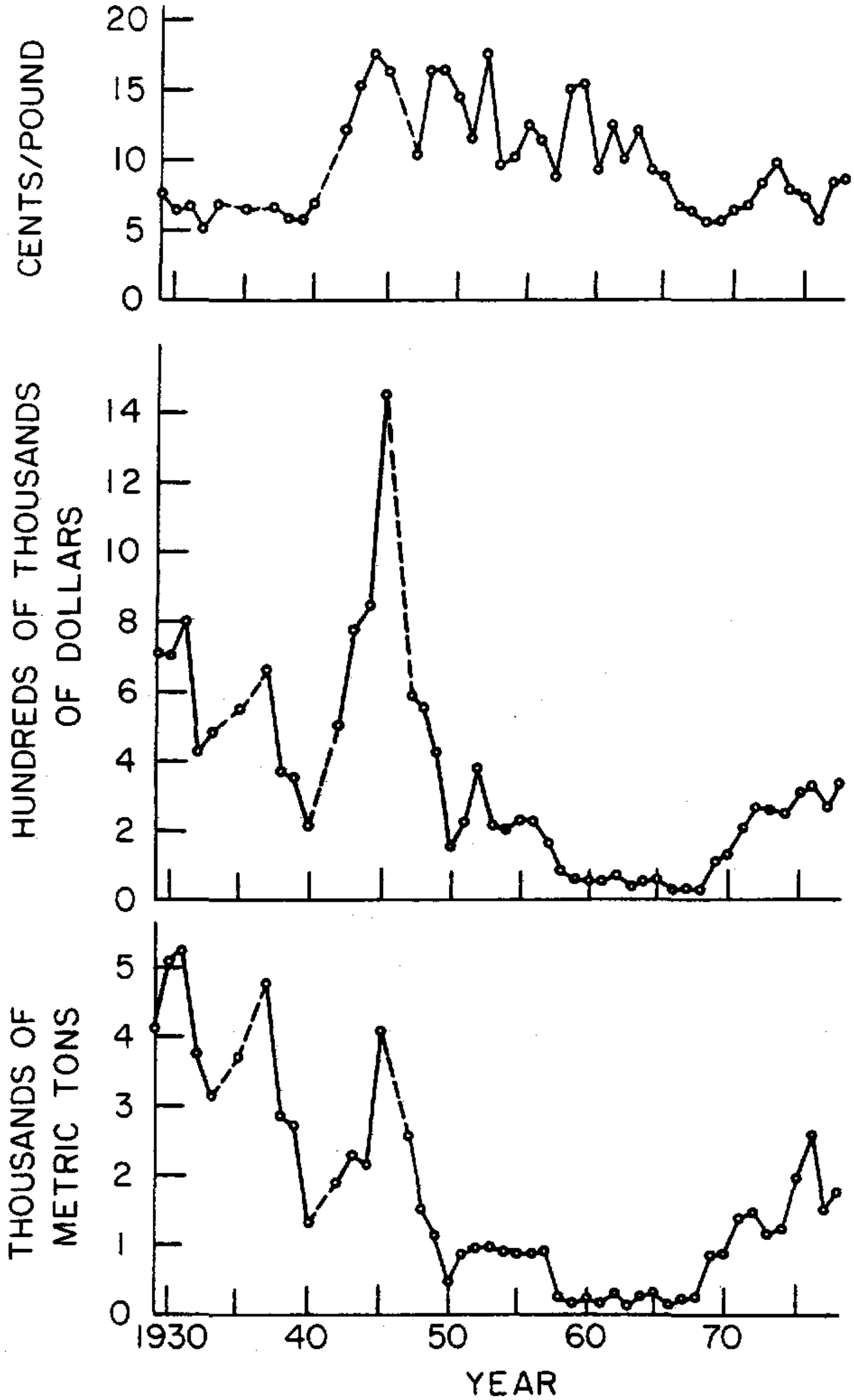

Figure 7. Total commercial landings of weakfish in New Jersey 1929 to 1978, total price paid to fishermen for their catch, adjusted to standard dollars, and price per pound paid to fishermen, adjusted to standard dollars.

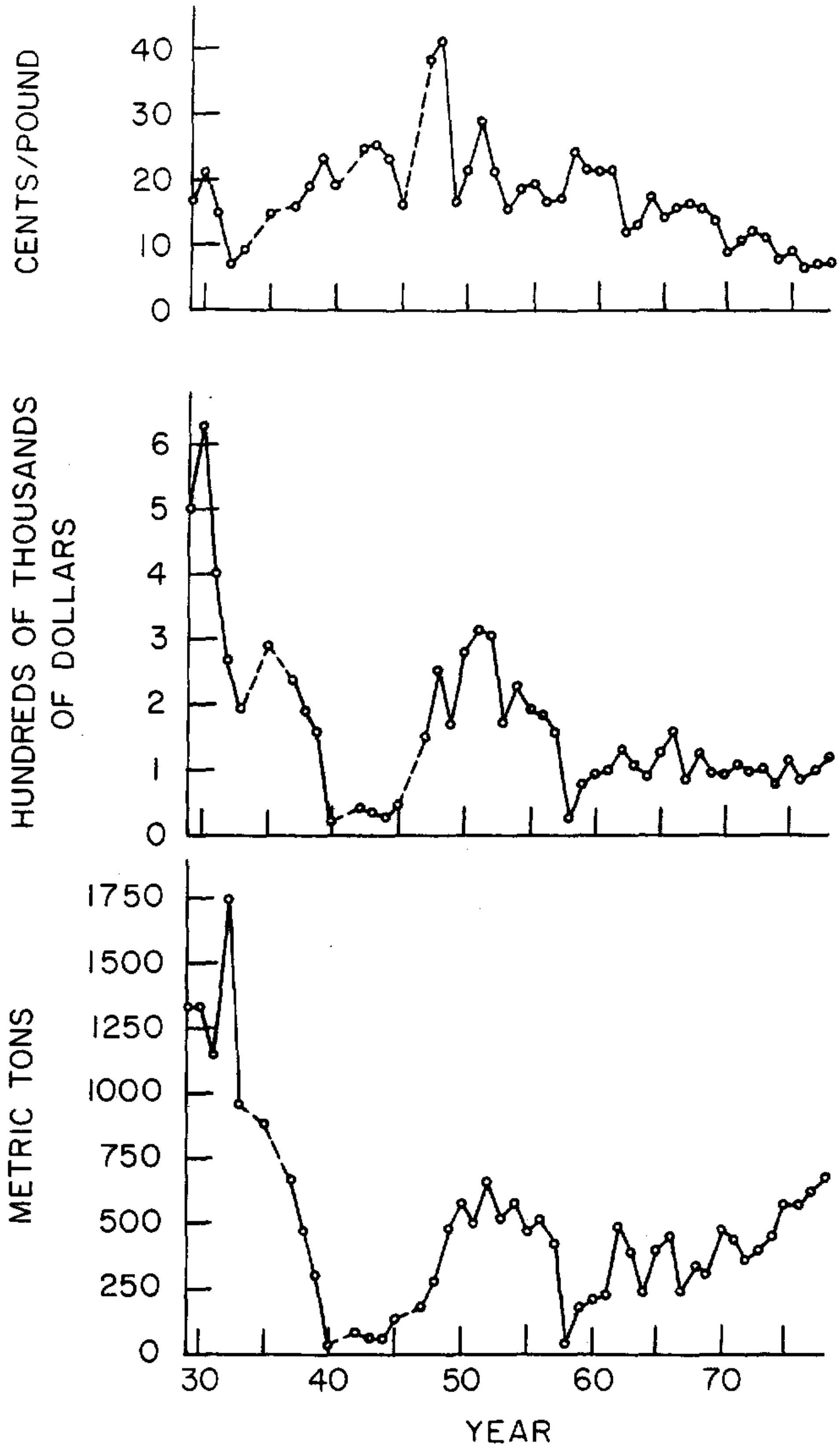

Figure 8. Total commercial landings of bluefish in New Jersey 1929 to 1978, total price paid to fishermen for their catch, adjusted to standard dollars, and price per pound paid to fishermen, adjusted to standard dollars.

and 1948, then fell off irregularly but fairly steadily. This is now a major recreational fish, and most of the catch is made by sport fishermen. The steady decline in prices is believed to be related to the sport fishery, which gives excess catches to friends or sells direct to local markets, keeping demand low. The fatty flesh, strong flavor, and poor keeping quality of this fish is probably also a factor. Actual abundance of bluefish may be as great or greater now, with the large recreational catch, than it has been since 1929.

Black Sea Bass

Black sea bass is a relatively high priced fish and demand is probably fairly high at all times. Demand fell off during the depression of the early 1930s, however, as shown by falling abundance and falling catches (Figure 9). The peak in price was reached in 1945, and since abundance was low it rose to unusually high levels. Following the war price and abundance fluctuated more or less inversely, as might be expected, but never to the high levels of 1945.

Summer Flounder

Summer flounder or fluke was not separated from other flounders prior to 1937, probably because flounders were not highly thought of prior to that time. Prices reached a maximum in 1945 and fell off thereafter (Figure 10), rose in the 1960s as abundance dropped, and fell again in the 1970s as abundance increased again. The sharp rise in 1977 and 1978 probably was caused by an abundance of large fish, which brought premium prices. Although the resource has recovered from the low point in 1969, commercial landings have not risen as high. The growing sport fishery, however, has probably increased the total catch.

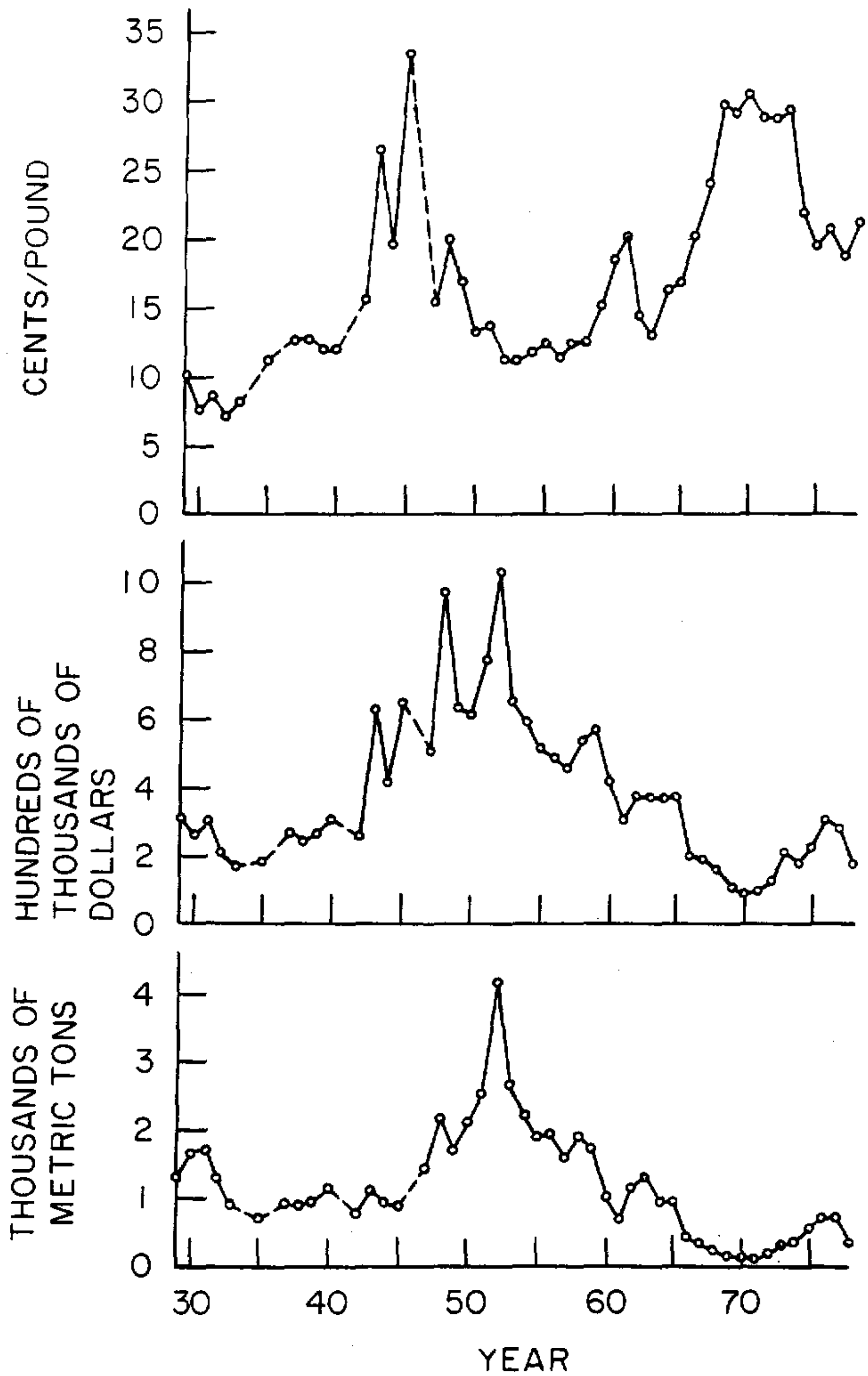

Figure 9. Total commercial landings of black sea bass in New Jersey 1929 to 1978, total price paid to fishermen for their catch, adjusted to standard dollars, and price per pound paid to fishermen, adjusted to standard dollars.

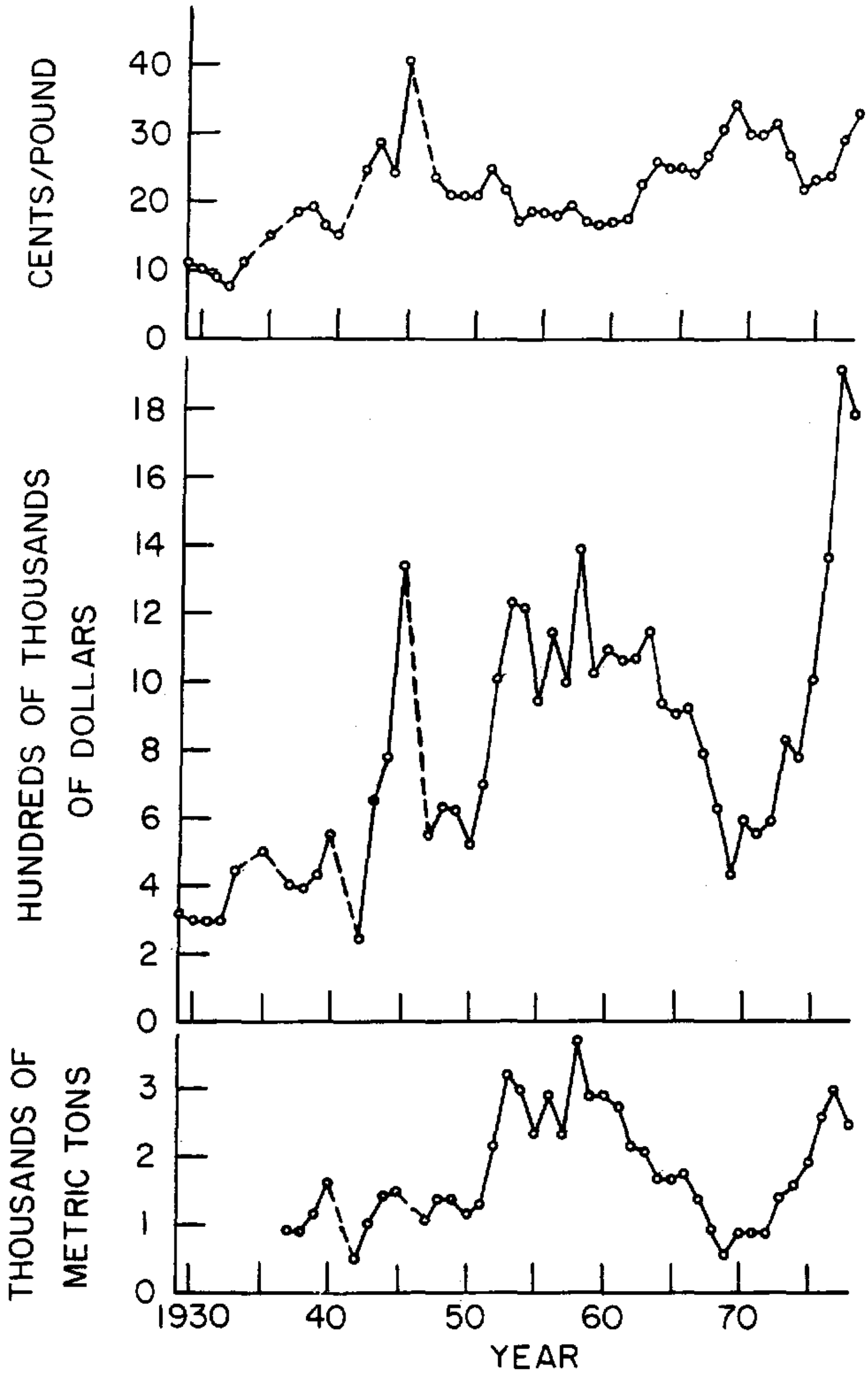

Figure 10. Total commercial landings of summer flounder in New Jersey 1929 to 1978, total price paid to fishermen for their catch, adjusted to standard dollars, and price per pound paid to fishermen, adjusted to standard dollars.

Butterfish

Butterfish has fluctuated rather widely in abundance since 1929, with a downward trend after 1939 (Figure 11). Prices followed a fairly typical pattern, low during the depression, at a peak in 1945, then down to 1960, and generally upwards after than. The increase in price has not compensated for the falling supply, which suggests that butterfish is not one of the most popular fishes locally.

Striped Bass

Striped bass has fluctuated widely in abundance since 1929, but the general trend has been upward until after 1973 (Figure 12). Prices were highest in 1933, even slightly higher than in 1945, but this was a time of extreme scarcity of fish. After 1945 prices fluctuated inversely with abundance, rising almost to 1945 levels in the last two or three years as abundance reached low levels again. Fluctuations have been somewhat greater in New Jersey than in other states, probably because laws were enforced with greater vigor when abundance was low.

American Eel

American eel is not a major species in New Jersey, but it is shown principally because it differs from almost all other species in maintaining a remarkably high and uniform price (Figure 13). The major fluctuations that occurred were when the supply (or the catch) was at a minimum, with a rather modest decline in price as the supply rose sharply from 1963 on. Eel is a specialized product in the United States, appealing to rather limited ethnic markets. Recently, other markets have been found in Europe and Japan, but the price has not risen in response. This is fairly obviously a species that is limited by markets rather than by supply.

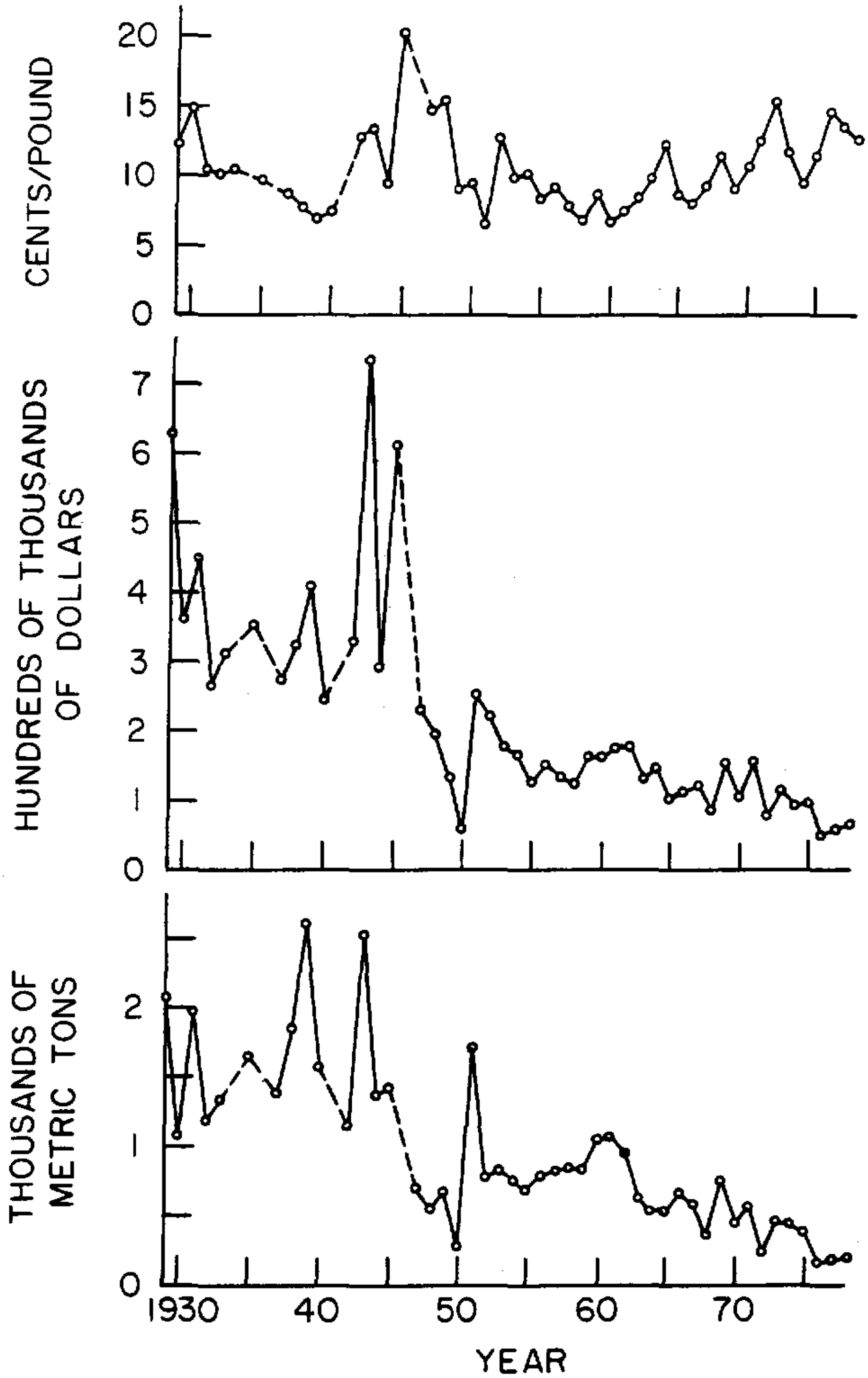

Figure 11. Total commercial landings of butterfish in New Jersey 1929 to 1978, total price paid to fishermen for their catch, adjusted to standard dollars, and price per pound paid to fishermen, adjusted to standard dollars.

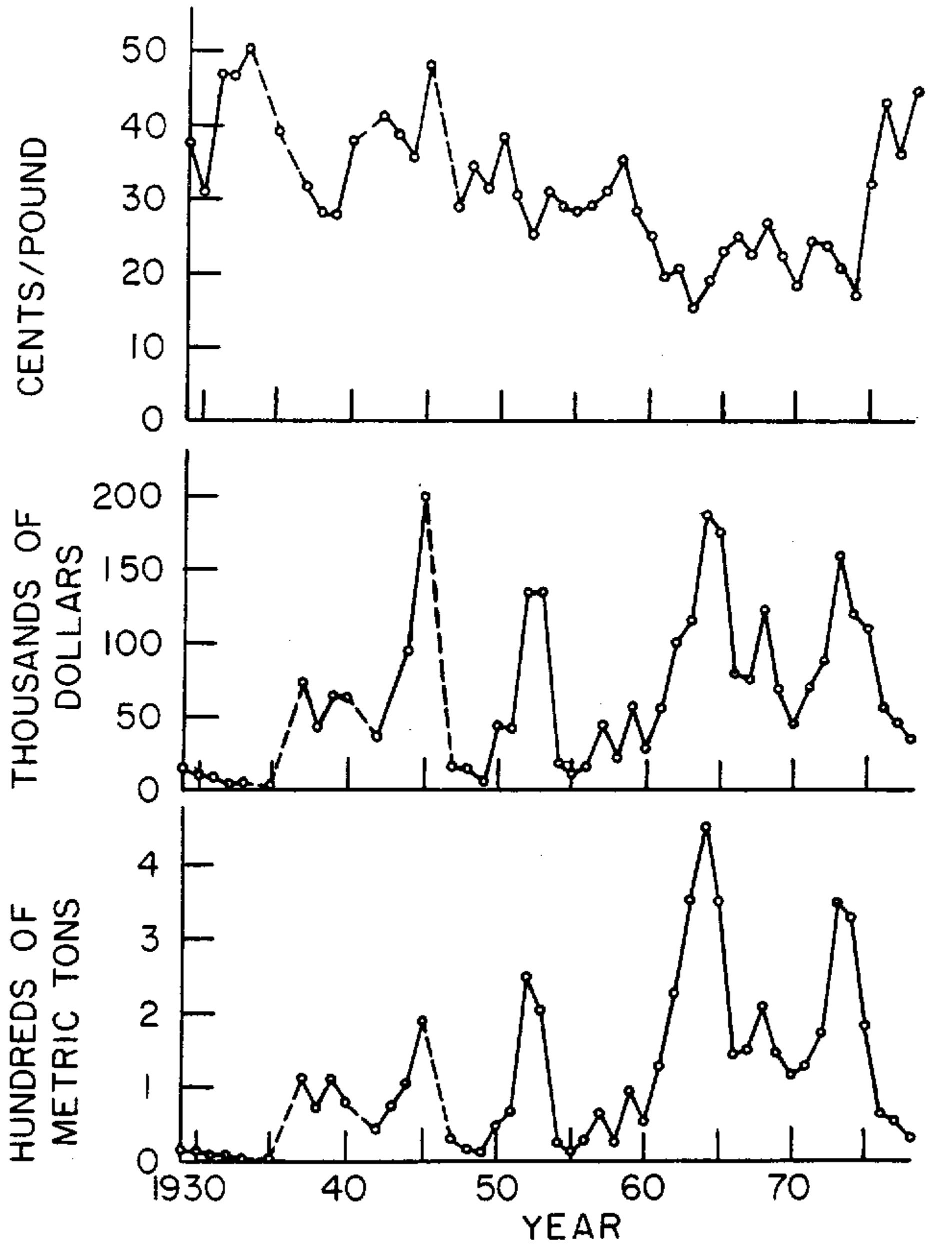

Figure 12. Total commercial landings of striped bass in New Jersey 1929 to 1978, total price paid to fishermen for their catch, adjusted to standard dollars, and price per pound paid to fishermen, adjusted to standard dollars.

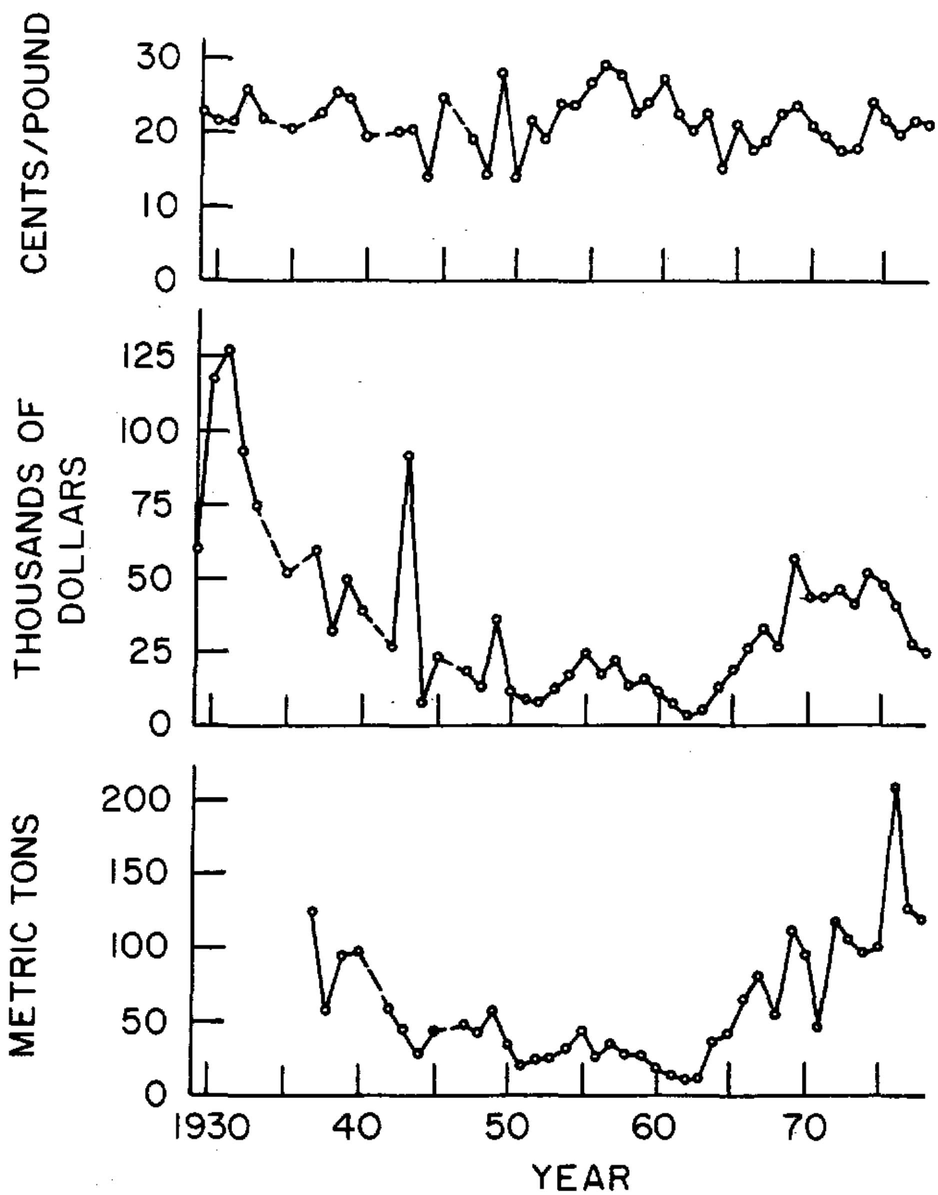

Figure 13. Total commercial landings of American eel in New Jersey 1929 to 1978, total price paid to fishermen for their catch, adjusted to standard dollars, and price per pound paid to fishermen, adjusted to standard dollars.

Menhaden

Menhaden is also a special case, since it is entirely an industrial fish, and price fluctuations are buffered by the fact that the industry is vertically integrated, with control over the fishing vessels by the processors. The price has fluctuated, however, down during the depression, up to a peak in the mid-1940s, then fluctuating more or less inversely with the supply thereafter (Figure 5). The price has not risen sharply after the supply fell in 1963 and 1964, although there is some tendency for price to fluctuate inversely with supply.

Summary for Fully Utilized Species

For eight major finfish species the highest or second highest price per pound, or the highest total price, was during or just after the second world war. When the highest price was not in the period 1944 to 1948, the species was very abundant during the war years and very scarce at some other period. For example, scup was very low in abundance from about 1966 to 1973 and theprice per pound was at its highest, although the price in 1945 was only slightly less. Striped bass was extremely low in abundance in the early 1930s, but despite its relative abundance in 1945 the price per pound was relatively high. Taking all more or less fully exploited species as a group, the highest price per pound was in 1945. American eel was a special case, for it almost certainly has been underexploited, yet prices have been high and fairly uniform over the entire period.

Underutilized Species

The next four species, Atlantic mackerel, silver hake, red hake, and Atlantic herring are unique in that they have been underutilized by domestic fishermen, and now that foreign fishing has come under complete control are among the most likely candidates for increased catches if markets can be established. To varying degrees, depending upon special circumstances, they show the greatest response to changing abundance.

Atlantic Mackerel

Atlantic mackerel shows a typical response of price to supply, fluctuating directly with supply during the depression, reaching a peak during the war, and falling off afterward (Figure 14). After 1949 the price fluctuated inversely with supply, showing marked responses as the supply fluctuated. If markets can be increased by developing good canning techniques, e.g. by removing the oil and canning as skinned fillets, prices should rise and increased landings would be possible. High quality canned mackerel could compete with canned tuna in some markets.

Silver Hake

Silver hake or whiting showed a typical response through the period of the second world war, staying low and dropping even lower during the depression, rising to a peak during the war years, rising even higher in the late 1940s and early 1950s as the small supply probably forced most or all of the catch into the human food market, dropping off fairly sharply later, then fluctuating more or less inversely with the supply, as more fish were diverted to industrial uses (pet food) when the supply was better than usual (Figure 15).

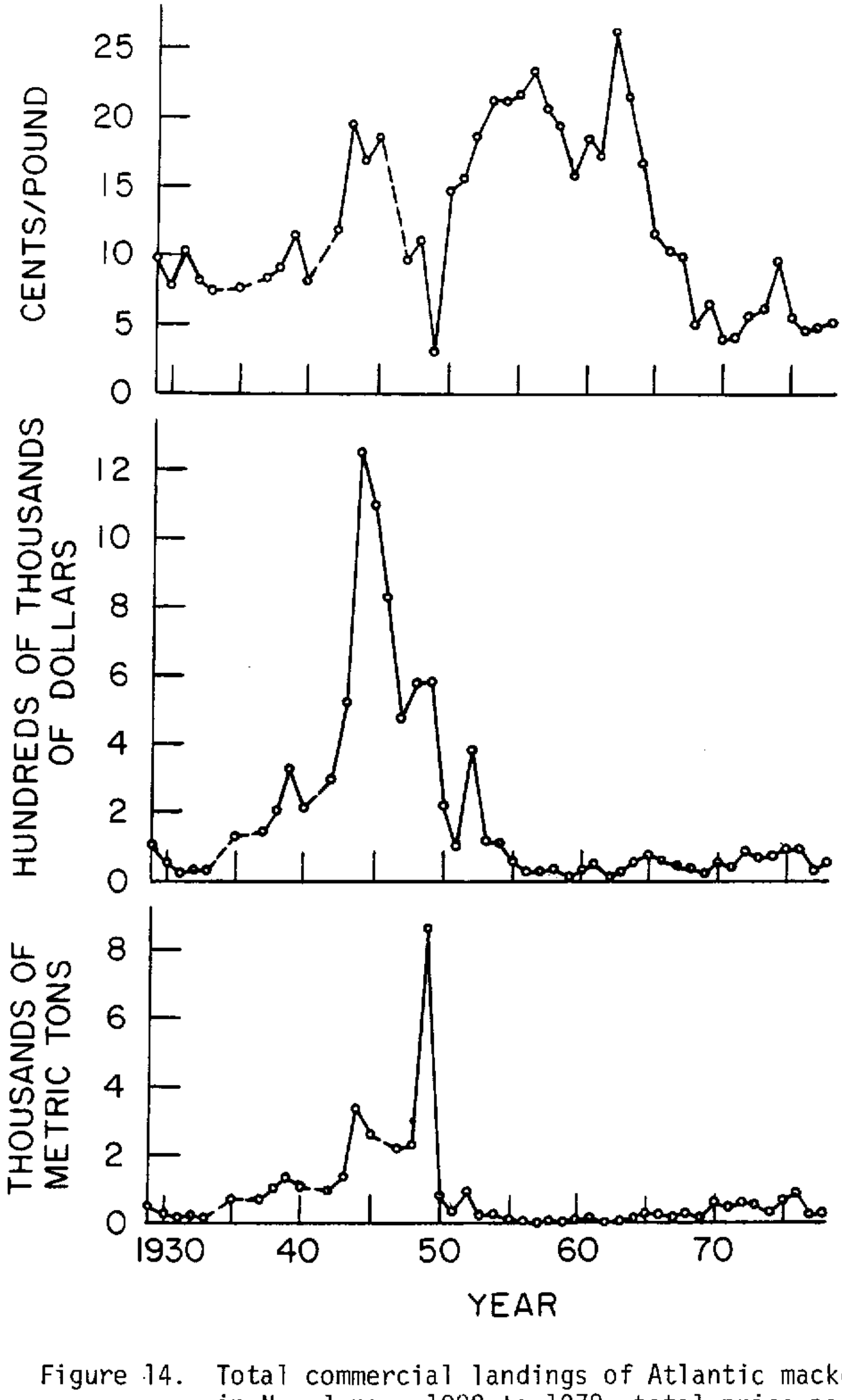

Figure 14. Total commercial landings of Atlantic mackerel in New Jersey 1929 to 1978, total price paid to fishermen for their catch, adjusted to standard dollars, and price per pound paid to fishermen, adjusted to standard dollars.

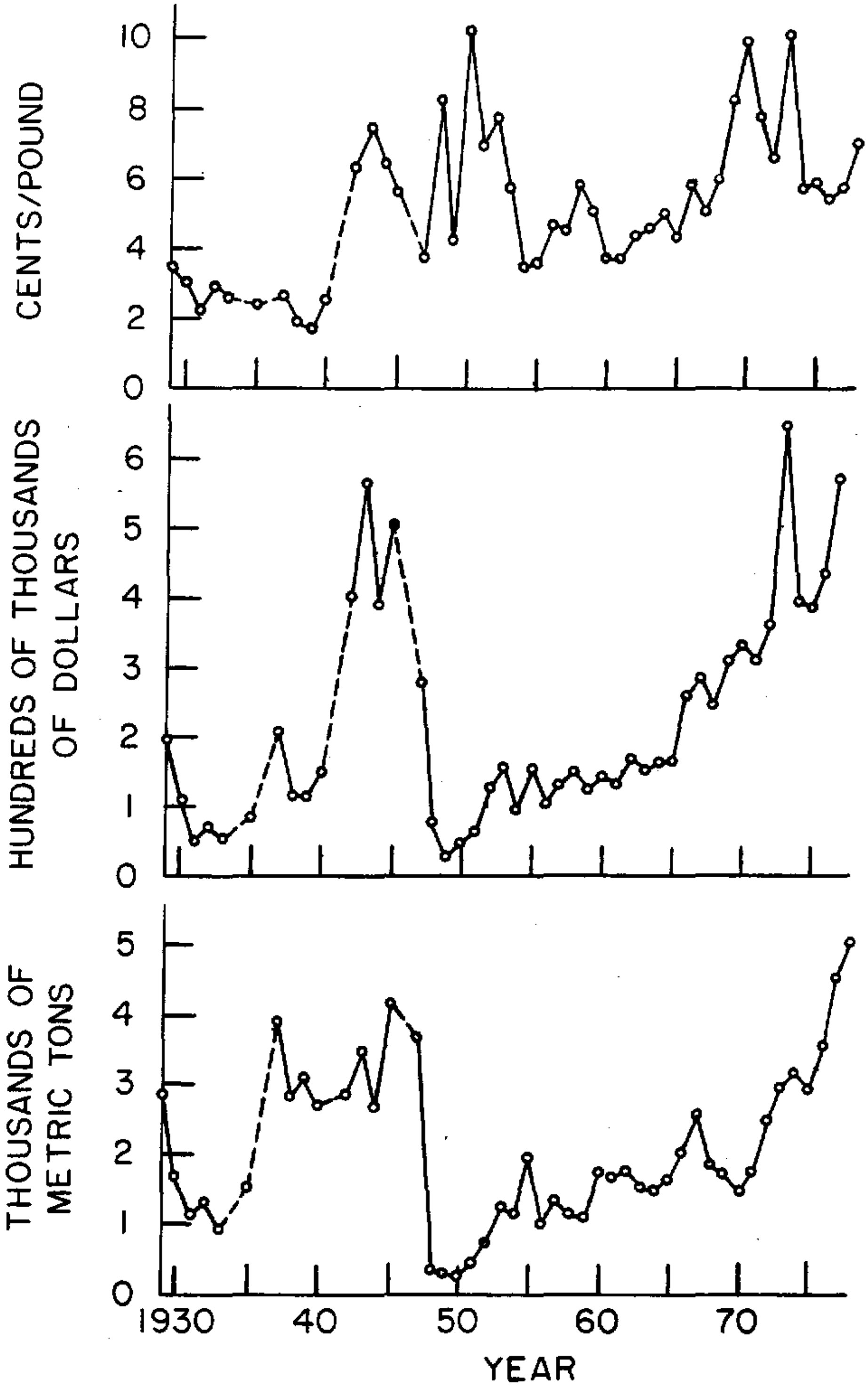

Figure 15. Total commercial landings of silver hake in New Jersey 1929 to 1978, total price paid to fishermen for their catch, adjusted to standard dollars, and price per pound paid to fishermen, adjusted to standard dollars.

Obviously, however, use of silver hake for human food increased through the 1960s and 1970s, as some of the other groundfish became scarce. Silver hake is available as a substitute for other species, and if it can be produced in good quality can capture a larger part of the market.

Red Hake

Red hake is somewhat less desirable as human food than silver hake, but with care in handling could find larger markets. Prices dropped during the depression, rose to a peak early in the war, then dropped abruptly as red hake was obviously abundant in 1945 and 1947, and the price dropped accordingly (Figure 16). The rise in production since about 1969 has been accompanied by an increase in prices, which suggests that red hake is increasing in popularity.

Atlantic Herring

Atlantic herring also shows a drop in price and low landings during the depression and a rise to a peak in the mid-1940s (Figure 17). Dropping after the war, prices then fluctuated more or less inversely with the supply up to 1976, then shot upward. The price is still relatively low, but herring is a popular food fish in Europe and Asia, and foreign markets could be profitable if fish can be taken in volume and can be handled well.

Summary of Underutilized Finfishes

Red hake and Atlantic herring were temporarily valuable during or just after the war. Both had the greatest catch and total value in 1947. Red hake had the highest price per pound in 1943, but Atlantic herring had the highest price per pound in 1978, the second highest in 1943. Atlantic mackerel and

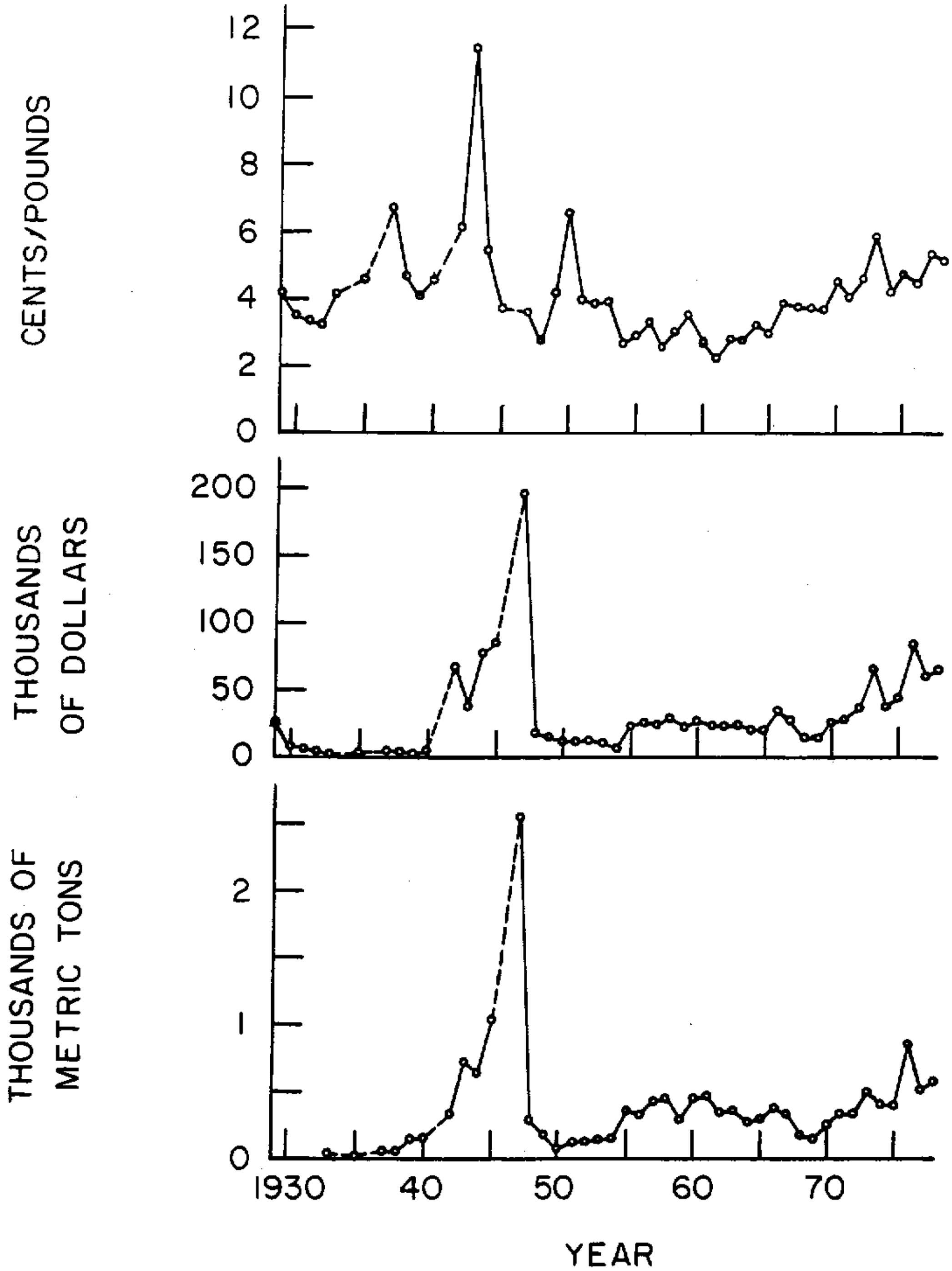

Figure 16. Total commercial landings of red hake in New Jersey 1929 to 1978, total price paid to fishermen for their catch, adjusted to standard dollars, and price per pound paid to fishermen, adjusted to standard dollars.

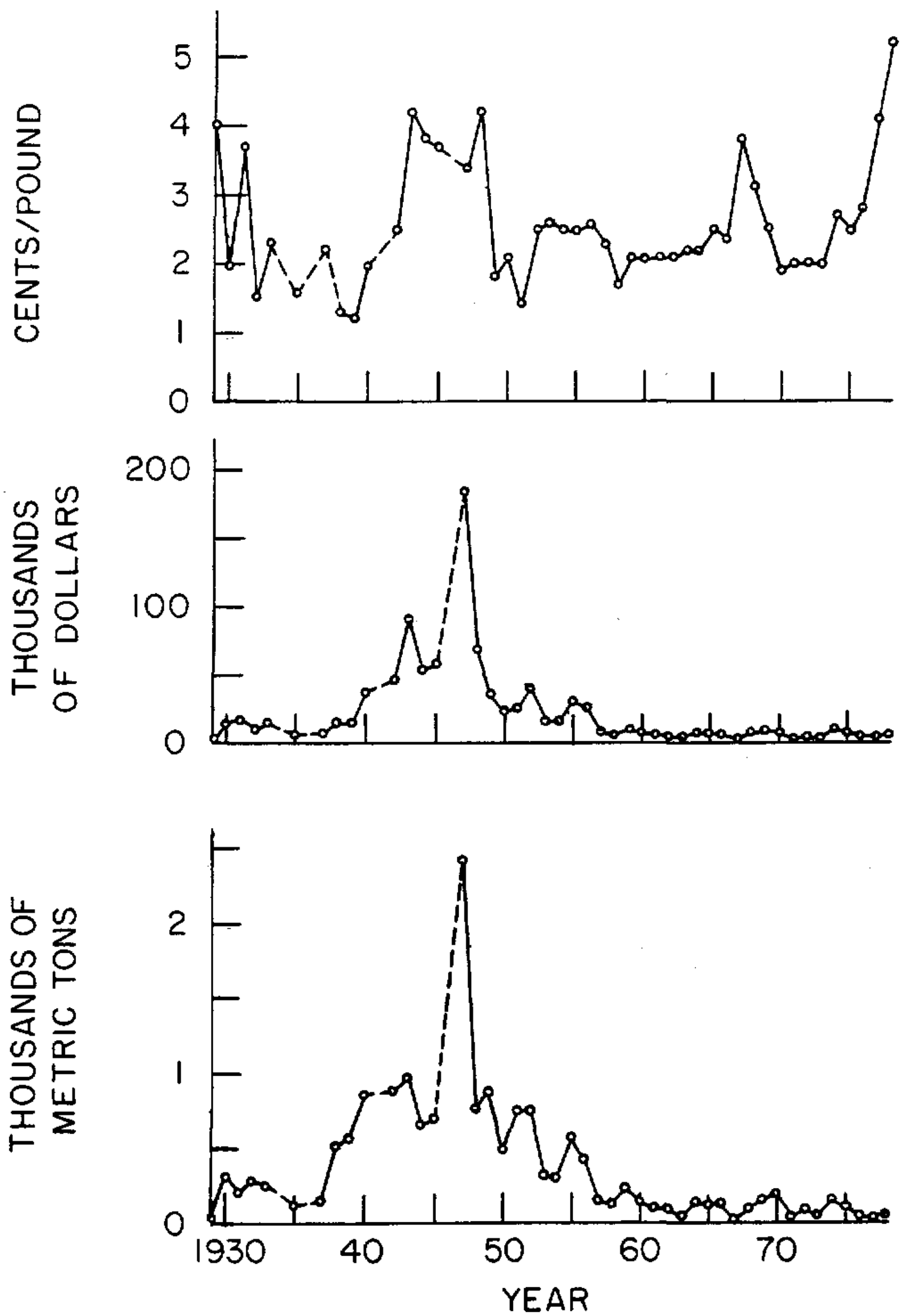

Figure 17. Total commercial landings of Atlantic herring in New Jersey 1929 to 1978, total price paid to fishermen for their catch, adjusted to standard dollars, and price per pound paid to fishermen, adjusted to standard dollars.

silver hake were different. Atlantic mackerel was fairly high in price per pound from 1943 to 1945, and probably would have been considerably higher if the catch had not increased. It was at its highest, however, from 1953 to 1958 and again in 1962 and 1963, when mackerel abundance was at an all time low. Production of silver hake rose to relatively high levels from 1937 to 1947, the unit price was relatively high from 1942 to 1945, as was the total value of the catch. Silver hake dropped in production sharply after 1947 for a few years, then rose slowly but fairly steadily after 1950. The unit price was highest in 1950 when the catch was the smallest, the total value of the catch was at its greatest in 1973, as silver hake became more in demand for human food.

Shellfishes

Except for oysters, which have not held up well in price after 1965, even though the supply is much lower than it was in the 1940s and 1950s, all other major species of shellfish have shown substantial increases in adjusted price, especially American lobster, squids, and sea scallop. Generally speaking, shellfishes have increased in value much better than food finfishes, and adjusted prices are now somewhat higher than in 1945.

Oyster

The American oyster was one of the earliest resources to be exploited along the coast, and it has suffered from overexploitation, water quality deterioration, and other circumstances. Oyster landings have had three phases in New Jersey, the early period from 1880 to 1931, when landings were variable and not frequently reported, but appear to have fluctuated about 6 to 7 thousand metric tons, a second period from about 1932 to 1956 with landings of about 3,000 metric tons, and a period since about 1958 when landings have been slowly trending upward but have remained below 1,000 metric tons (Figure 18). Prices have generally followed these trends, but with special circumstances, generally being lowest in the first period, intermediate during the second period, and highest in the latest period. Superimposed on these general shifts in prices, however, have been a drop in prices during the depression, even though the supply was dropping sharply also, a peak in the mid-1940s followed by a substantial drop, a rise to a considerably higher peak in the mid-1960s, followed by a substantial drop even though landings did not increase very much. This may have been because other types of shellfish were more abundant and demand for oysters had dropped, or because consumers were suspicious of oysters because the decline had been caused by disease, although the disease was not known to affect humans. However, despite the drop in shellfish production after 1974 the price of oysters did not rise. It is more likely that prices of oysters simply rose too high and consumer resistance set in. Oysters are certainly much less in demand now than they were prior to the second world war.

Blue Crab

Blue crab is near the northern limit of its range in New Jersey and has fluctuated widely for that reason. The price has fluctuated inversely, so that in years when the supply is greatest the total value of the catch has usually been lowest (Figure 19). The unit price has been somewhat more variable than many other seafoods, but in general it has followed a typical trend, down during the depression, highest during the war, then down during the 1950s and early 1960s and upward since then.

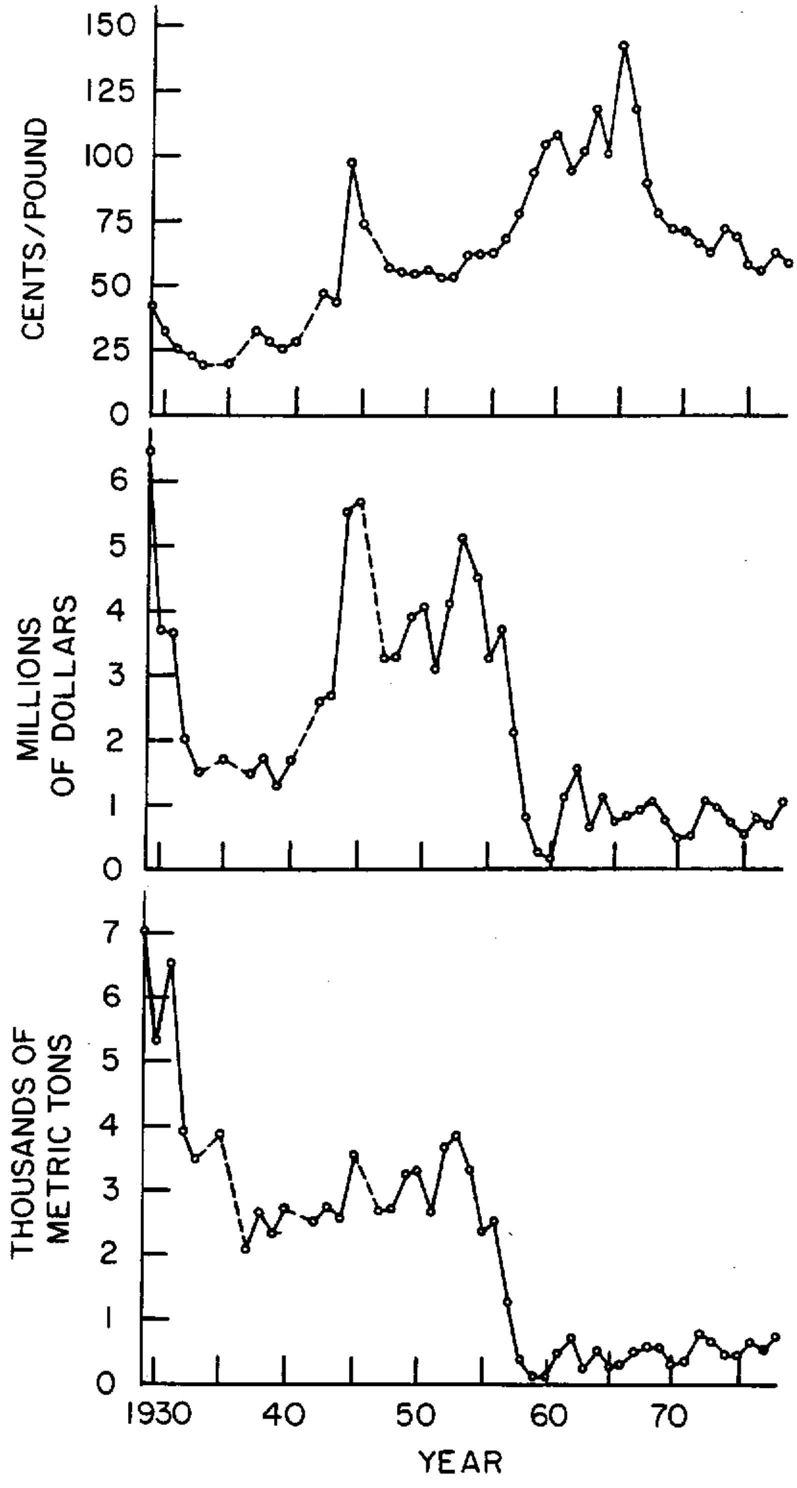

Figure 18. Total commercial landings of American oyster in New Jersey 1929 to 1978, total price paid to fishermen for their catch, adjusted to standard dollars, and price per pound paid to fishermen, adjusted to standard dollars.

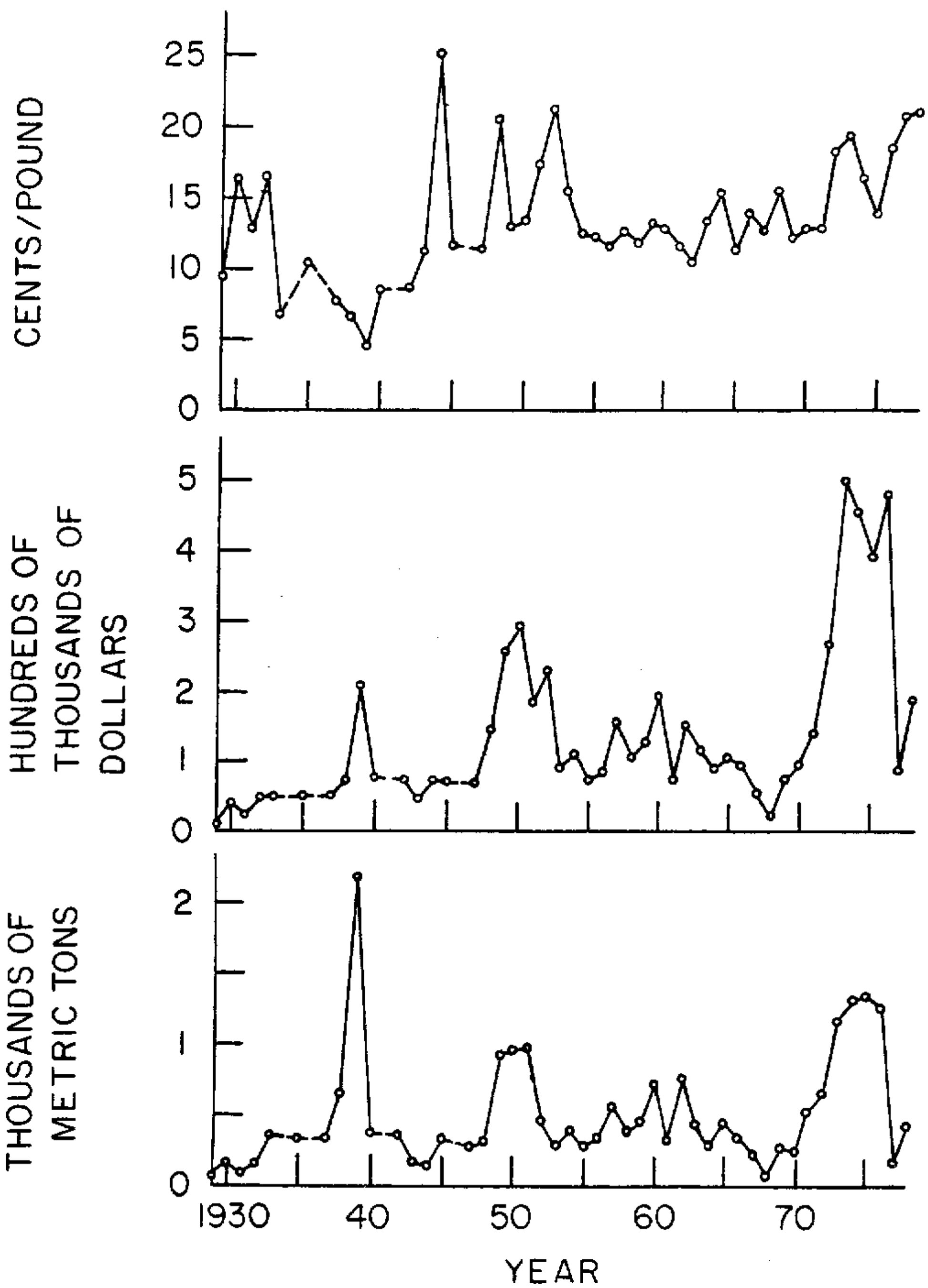

Figure 19. Total commercial landings of blue crab in New Jersey 1929 to 1978, total price paid to fishermen for their catch, adjusted to standard dollars, and price per pound paid to fishermen, adjusted to standard dollars.

Hard Clam

Hard clam prices are a little harder to interpret because the different sizes command different prices, and they are not always equally plentiful in the catch. Nevertheless, in their general trends the adjusted unit prices of hard clams are not too different from those of other shellfishes. The general pattern of a drop during the depression, a rise during the war followed by a drop again, and then a gradual rise after about the mid-1960s is followed (Figure 20). The rise during the war was not very great, however, although production in 1945 was the second highest in history. Failure of the price to rise higher may have been because the catch during wartime was largely cherrystones or chowder clams, which bring much lower prices.

Surf Clam

Surf clam is a relatively recent development, which did not produce much until after the war. In fact it was the war which stimulated production, by creating a need for protein food, which in turn stimulated experiments to remove sand from the meats (Figure 21). Once this problem was solved surf clam landings rose rapidly, and reached maximum production in 1966 with about 43 million pounds (19,500 metric tons). By this time the resource was overfished, and production fell off as the fleet moved farther south in search of other beds. In 1978 production off New Jersey was only about 6.7 thousand metric tons, about a 66% drop. In 1977 the Mid-Atlantic Fishery Management Council began to restrict catches, and the price rose sharply after 1975. Previous to 1976, however, prices followed the usual trend for shellfishes, down during the depression, up during the war, and falling off thereafter, a further drop when production was at its peak and subsequent rises and falls as the supply changed.

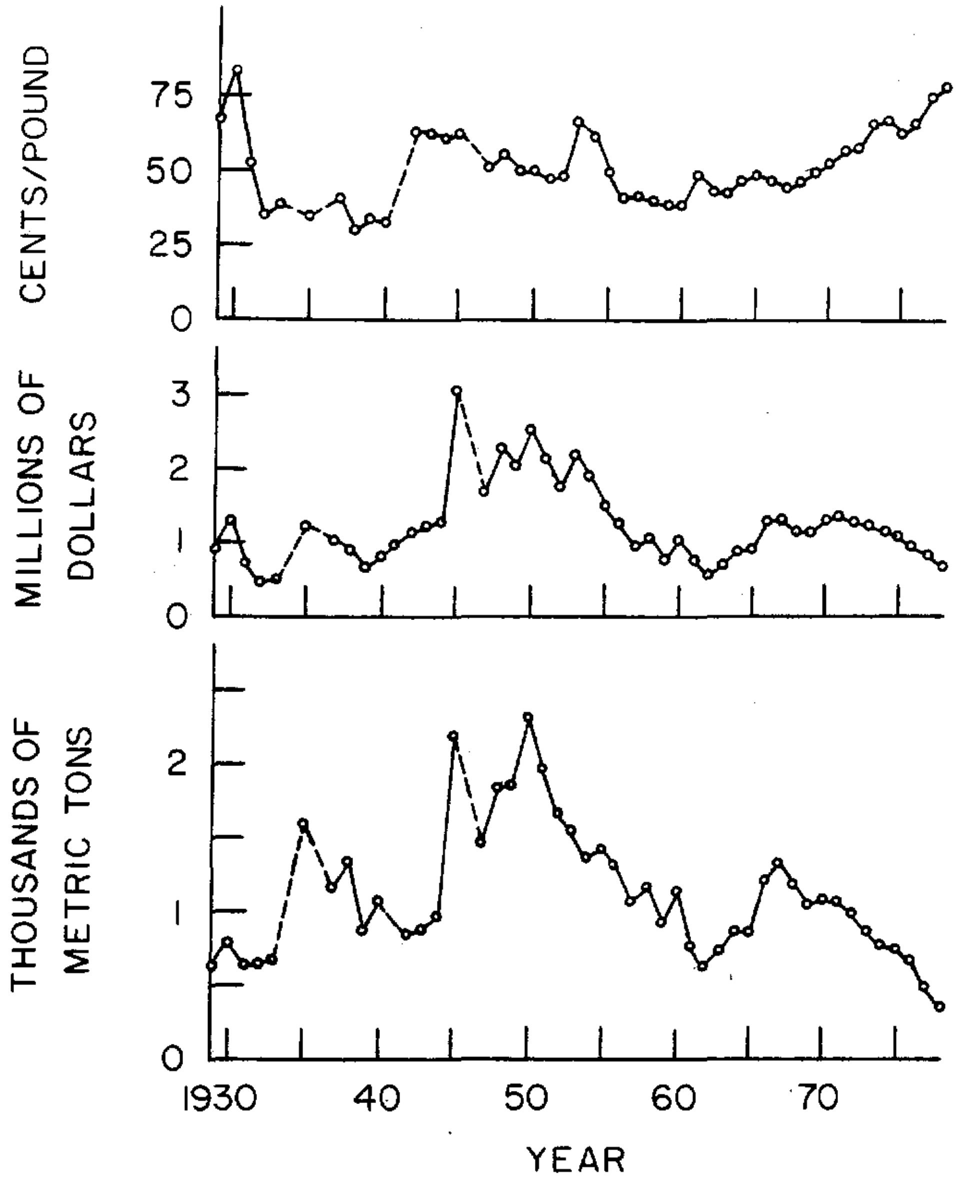

Figure 20. Total commercial landings of hard clam in New Jersey 1929 to 1978, total price paid to fishermen for their catch, adjusted to standard dollars, and price per pound paid to fishermen, adjusted to standard dollars.

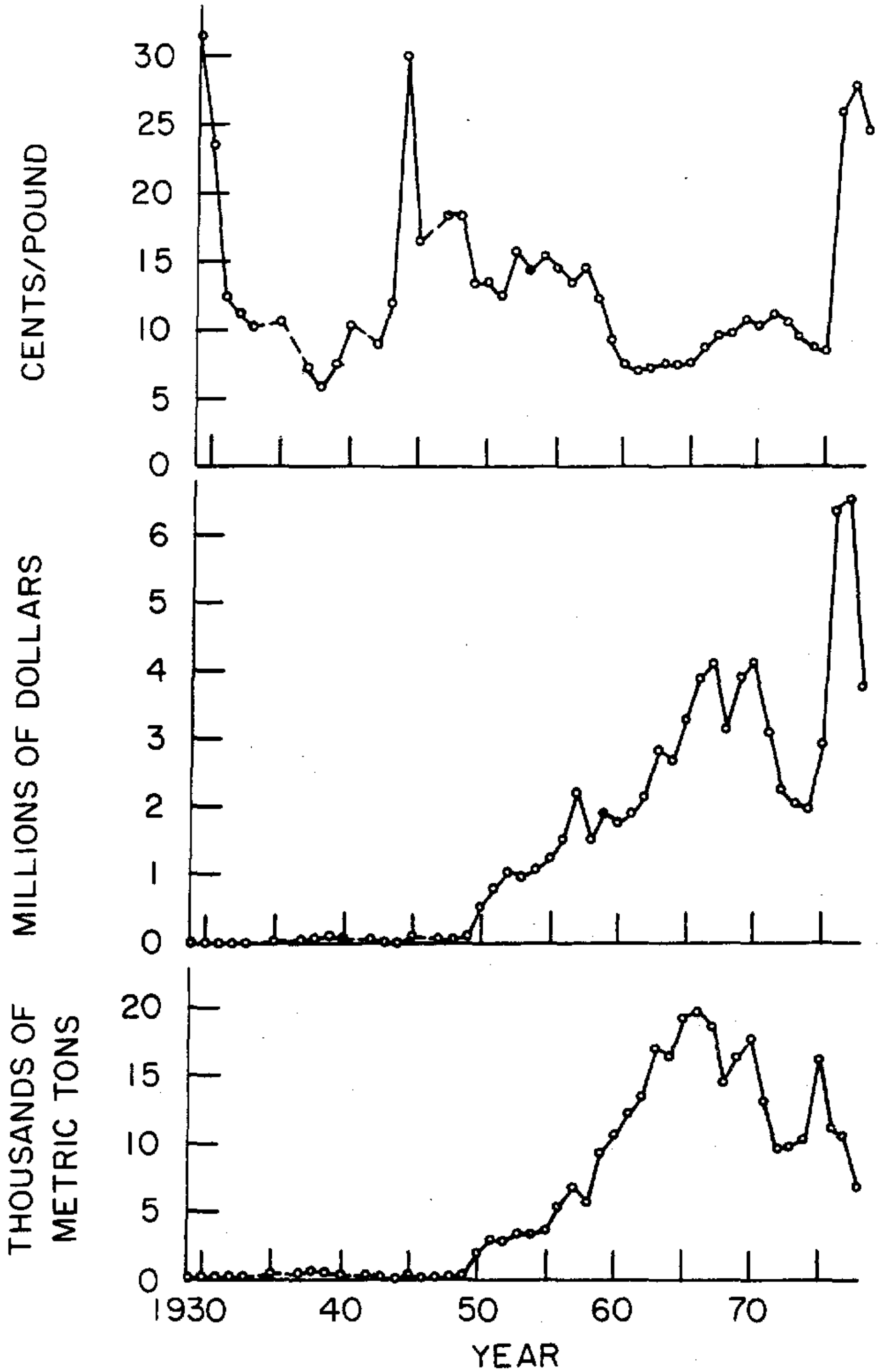

Figure 21. Total commercial landings of surf clam in New Jersey 1929 to 1978, total price paid to fishermen for their catch, adjusted to standard dollars, and price per pound paid to fishermen, adjusted to standard dollars.

Sea Scallop

Sea scallop dropped in price during the depression, rose during the war, did not drop very much thereafter, and began to climb to a much higher peak in 1972 after 1960 (Figure 22). Landings were small during the war, probably because it was too dangerous to go offshore after them, but stayed fairly low until 1975. In 1976 the progeny of an outstandingly successful spawning began to appear in the fishery and catches rose to the highest levels ever. Although prices dropped somewhat as this large group entered the fishery, they did not drop much, and remained considerably higher than at any time prior to the mid-1960s. The sea scallop fishery is very profitable at the moment, but the large year class is already moving out of the fishery, and catches will be much lower.

Lobster

American lobster was not abundant off New Jersey until about 1950, when falling temperatures and discovery of new stocks of lobster offshore increased abundance inshore and opened up a new offshore fishery. Prices dropped slightly during the depression, peaked during the war, and fell off again, but the major rise occurred after 1960 when rising prices and a rising catch increased the value of the catch to levels far above any time previously (Figure 23). The peak was reached in 1970, and the catch has dropped. The price also dropped somewhat after 1973, even though catches were less, as consumer resistance to high prices set in.

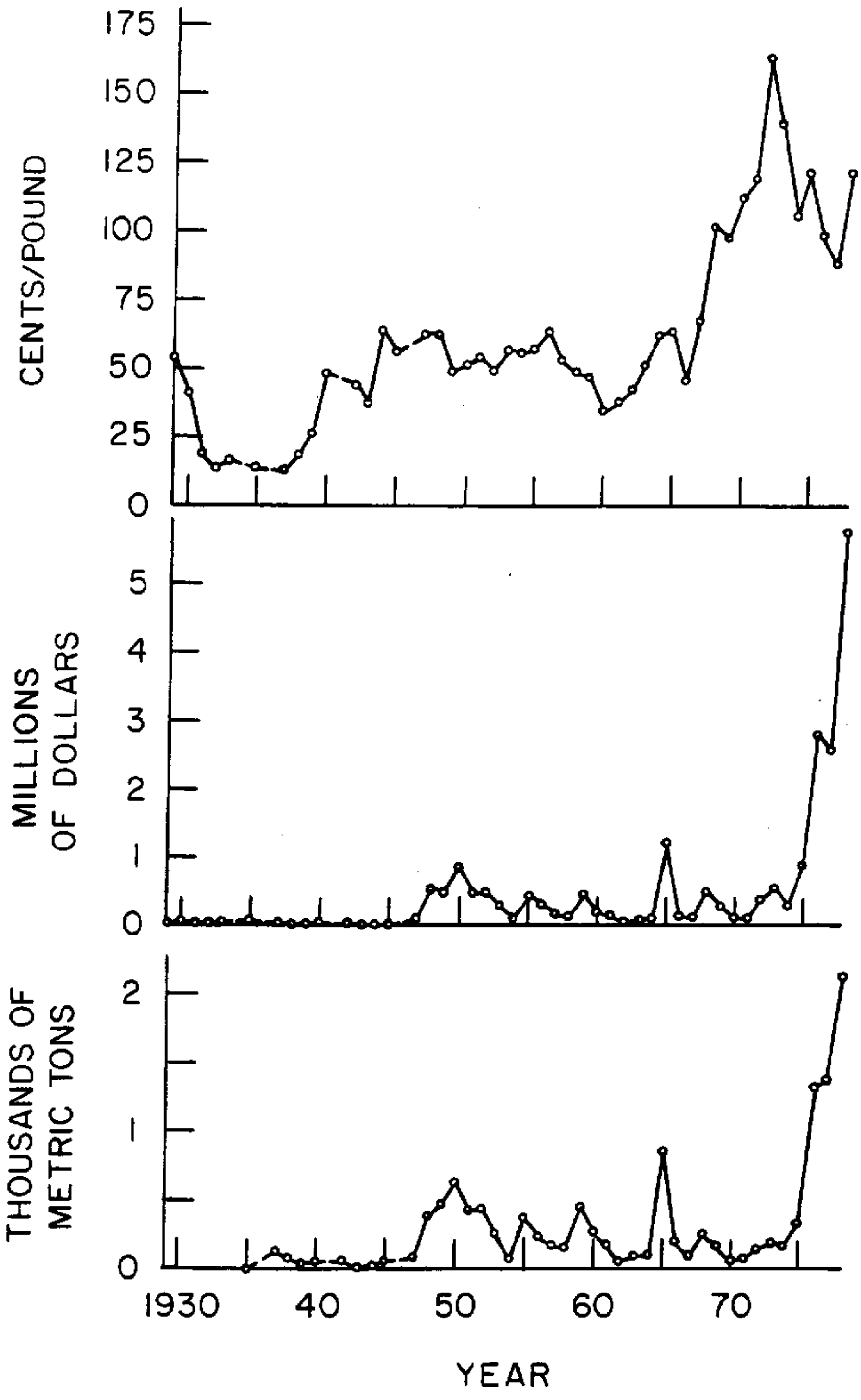

Figure 22. Total commercial landings of sea scallops in New Jersey 1929 to 1978, total price paid to fishermen for their catch, adjusted to standard dollars, and price per pound paid to fishermen, adjusted to standard dollars.

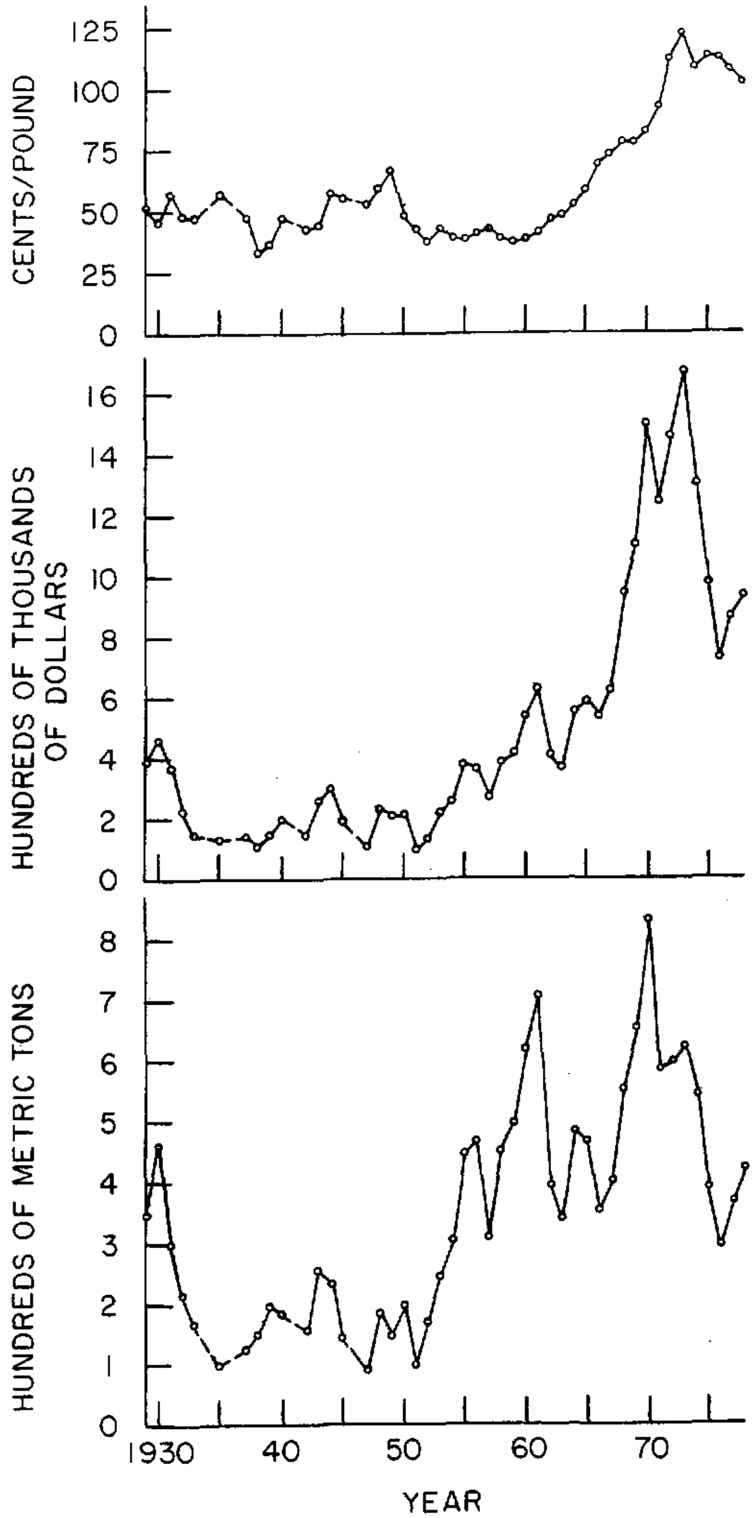

Figure 23. Total commercial landings of American lobster in New Jersey 1929 to 1978, total price paid to fishermen for their catch, adjusted to standard dollars, and price per pound paid to fishermen, adjusted to standard dollars.

Squids

Two species of squid occur in the New Jersey area, but these have never been separated in the statistics, and in fact the long-finned winter squid (Loligo pealei) is the major species in this area. The squid catch is highly variable, and much of the catch is used as bait, in varying amounts depending upon the total catch (Figure 24). Nevertheless, the pattern of prices is similar to that of most other species, dropping during the depression, rising to a peak during the war, dropping again after the war and for most of the 1960s, then rising irregularly to 1978. In 1977 and 1978 the price was higher than ever before. The high prices and great quantities of squids available suggest that a new fishery could be developed. This will require greater attention to quality, and markets overseas or at home. Markets overseas are already in existence and buyers willing to buy, but quality and price need to be improved. Markets at home are limited, but there appear to be opportunities for a large increase in consumption if imagination is used to capture markets.

Summary for Shellfisheries

Shellfish supplies and prices were somewhat different. Oyster tended to stabilize in production at three levels, about 7,000 metric tons prior to 1932, about 3,000 metric tons from 1933 to 1956, and at less than 1,000 metric tons after 1957. Unit price was low during the depression, reached a peak in 1944 and 1945, as did the total value, then dropped off fairly sharply. The price per pound reached the highest peak in 1965, then fell off sharply even though the supply increased only moderately. Hard clam prices per pound

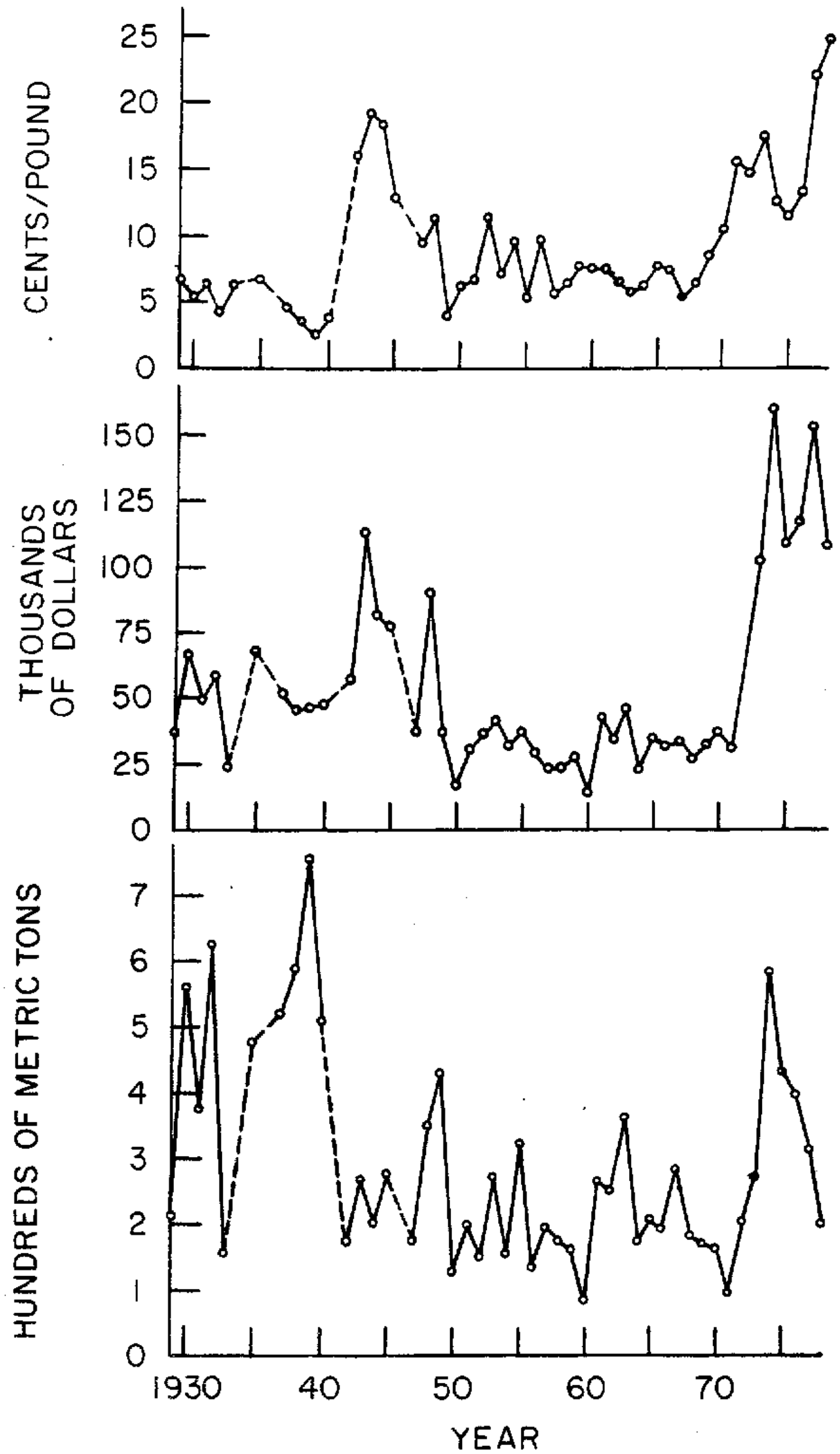

Figure 24. Total commercial landings of squids in New Jersey 1929 to 1978, total price paid to fishermen for their catch, adjusted to standard dollars, and price per pound paid to fishermen, adjusted to standard dollars.

rose only moderately during the war, probably because the supply increased substantially, and the total value, although not the unit price was at an all time high in 1945. The price per pound of surf clam was highest in 1929, fell off during the depression, and reached a secondary high in 1944, probably because it was in demand but not in great supply because the problem of sand in the meats had not yet been completely solved. The price per pound then fell off fairly steadily until after the mid-1970s, when a falling supply interacted with a higher unit price to produce a third maximum. American lobster and sea scallop also rose only moderately during the war, even though supplies were not great. The price per pound of both species rose later, even though the supply was increasing also, as shellfishes generally became popular, and as the major grounds shifted to the middle Atlantic region. Blue crab was more typical of the finfishes, with the maximum price per pound coming in 1944, but blue crab prices have to a large extent, fluctuated inversely with the supply, and have risen to greatest total value recently, even though the supply has been good also. The supply and the price of squids has been good also. The supply and the price of squids have been quite variable, but squids, like the underutilized finfishes, had fairly high price per pound in the 1940s (maximum in 1943), then fluctuated more or less inversely with the unit price until recently, when unit price and total value reached their greatest levels. Taken as a whole, shellfish prices reached a maximum in 1945, fell off thereafter, then rose to even higher levels if the large surf clam catch is omitted, but did not rise so high if surf clam is included.

Finfish and Shellfish Prices Generally

Prices of individual finfish and shellfish species vary from species to species, and there are obviously tradeoffs, some species being more or less interchangeable, depending upon which is most abundant at the time. There are also price tradeoffs, depending upon the total array of species. Thus, the general patterns of prices can be seen most clearly when food finfishes and food shellfishes are grouped as in Figure 25. In both cases there was a substantial initial drop during the depression, followed by a peak toward the end of the war. Finfish prices then declined through the late 1940s and 1950s, then began to rise slowly after 1960, but never attained the 1945 peak again. Shellfish prices were complicated after 1950 by increasing amounts of relatively low-priced surf clam and later ocean quahog in the catch, which dominated the catch after about 1955. If these are eliminated then a similar pattern shows up, with prices falling off during the late 1940s and 1950s and rising again in the 1960s and 1970s. In fact, the prices of shellfish generally rose higher, and by 1978 were higher than in 1944.

These changes are consistent with what we know about market conditions during this period. The depression had a profound effect on all sales, pushing prices to lower levels than every since. The war, on the other hand, stimulated fish prices, pushing them to higher levels than before, and in most cases later also. Thereafter, fish prices sagged through the late 1940s and 1950s, not starting to rise again until about 1960. Thus, fish prices dropped from over 16 cents per pound in 1929 to about 6 cents in 1932, rose again to about 18 cents in 1945, dropped off again to less than 9 cents in 1949, fluctuated about this level until 1960, then rose from less than 10 cents per

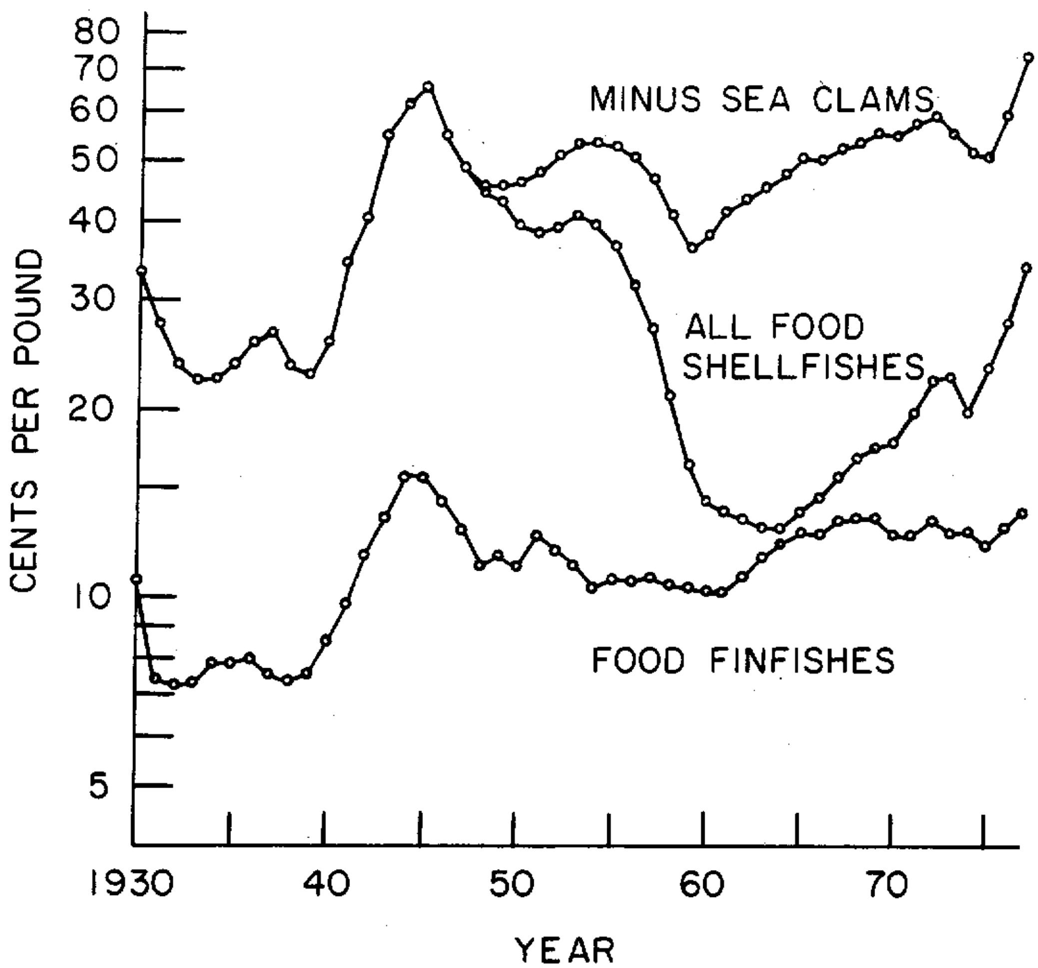

Figure 25. Price per pound paid to fishermen in New Jersey, adjusted to standard dollars and smoothed by a moving average of three, for food finfishes, and for food shellfishes including and omitting sea clams.

pound to almost 15 cents in 1978. Shellfish prices fell from over 40 cents in 1929 to less than 17 cents in 1939, rose sharply to nearly 80 cents in 1944, dropped off thereafter, reaching a low of about 33 cents in 1960, then rose to about 90 cents in 1978. These prices are affected from year to year by variations in the amounts of different kinds of fishes and shellfishes, and a moving average tends to dampen out these fluctuations. Prices of shellfishes fell farther and rose higher than prices of finfishes.

Implications for New Jersey Fisheries

The peak of New Jersey fisheries was reached in 1956 when almost 250,000 metric tons of fishes and shellfishes were landed. Landings have fallen off since and in 1978 were about 55,140 metric tons, about 22 percent of the maximum. Most of this catch was menhaden and some other species, not used as human food. When these are removed the pattern is quite different. The maximum total weight of all fishes was reached in 1945 at about 22,830 metric tons, dropped to a low of less than 7,000 metric tons in 1968, and rose again to about 17,710 metric tons in 1978. Food shellfishes, on the other hand, reached their peak in 1966 at about 22,500 metric tons. In adjusted value, food finfishes also reached a peak in 1945 at $9,067,000 food shellfishes reached its peak in 1978 at $15,035,000, and the total value peaked in 1978 at $20,832,000. It would thus appear that the food shellfish industry as a whole is in better condition than the food finfish industry, although the finfish industry has a better chance in the long run of growing. The problems of the shellfish industry are more difficult to solve because many segments of the industry are hurt by water pollution and will be difficult to correct. The finfish industry also has problems which will be difficult to correct as long as fishermen are at the mercy of buyers. Fishermen would do well to consider the formation of a cooperative, to free themselves from the influence of buyers. This will only work, however, if certain essential criteria are followed, such as hiring competent people to run the coop, be willing to stick with it to give it a fair chance of success, and investing reasonable amounts of capital as a working fund. The success of the coop at Point Judith, R. I. is an example of what can be done with proper organization.

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RECOLLECTIONS OF BERT WALFORD

Dr. J. Lockwood Chamberlin
Oceanographer

Atlantic Environmental Group; NMFS
Narragansett, R. I.

I first worked with Bert Walford when he directed the Atlantic Fishery Oceanographic Research Center. He said there that when you're small, you must have a big title if people are to notice you. And we were small and therefore had a big title. I want to comment on the significance of what he was attempting then. He had been in administration for a number of years and in research on the West Coast prior to that for the most part. He was returning to research -- and also, I think, to oceanography. His graduate work at Harvard in the early 30's was on the relation of haddock larvae to circulation of George's Bank, done under the guidance of Henry Bigelow. Subsequently, he did life history studies and authored a famous Pacific game fish book. He did some significant work applying ingenious mathematical techniques to the area of population dynamics. I think that in the course of his research and in his later administrative work, he realized the limitations of the fashionable field of population dynamics and in assuming a primarily mathematical approach to fishery science. There are distinct mathematical limitations in the sense of geography -- distribution of fish, environmental conditions and their influence on where fish occur, when they migrate, when they reproduce, and why they are more abundant in some parts of the range. A mathematical approach doesn't always handle geographic problems well. He was attempting with this Washington group to foster the idea of assembling data on the environment and the biology of the various species primarily in map form, and in that way to get a better feeling for geographical aspects. Of course, you can all realize when you develop a cartographical approach, then you don't deal well with the mathematical part; but the two approaches complement each other. He was strong in both. He felt there was a great gap of knowledge insofar as people integrating facts on where and why and how the various species occur off our coast.

In 1958 his book, Living Resources of the Sea, was published. In it he took a global look at fisheries in a rather significant way. By this time, he had also become associated with the American Geographical Society and they had provided a number of maps for this book, some global in scope -- the distributions of data, the distributions of marine laboratories and distributions of many other things. I think he probably developed a much broader attitude about oceanography during this time than he had before, and so became concerned with the whole western North Atlantic region. At that time Elton Sette, who also had been in Washington administration for some years, had moved to the West Coast and was pursuing something similar, but dealing with an extremely different ocean regime -- a regime of wide-ranging oceanic species. Bert was concerned with the western Atlantic where we primarily have very concentrated fishing grounds on the continental shelf and slope for demersal species, as opposed to surface dwellers such as the great tuna schools of the Pacific.

In his association with the American Geographical Society, he became acquainted with its' president, Charles Hitchcock, and together they found a mutual interest; Hitchcock wanted to get the American Geographical Society into ocean science and Bert wanted a vehicle for publishing cartographical analyses of marine animals and their environment. So both needs were satisfied by the establishment of a new publication called the "Serial Atlas of the Marine Environment" which had a large page format and took advantage of the excellent cartographical capabilities of the American Geographical Society. Bert was able to bring together a rather extraordinary advisory group. Among the notable ones who stayed on for a number of years were Columbus Iselan from the Woods Hole Oceanographic Institution, Harry Hess from Princeton and Max Dunbar from McGill University and of eastern Arctic exploration fame. I had joined Bert because I was interested from graduate school times in what I call ecological biogeography. It came in the course of studying a group of marine bivalves. I found it very intriguing to figure out why the ranges of one species in the north Pacific and north Atlantic were quite different with respect to latitudinal extent and other characteristics, so I started to look into oceanographic reports to see if the environmental data would explain this. So I was pre-conditioned to Bert's approach in this new center, but of a different orientation. He wasn't too enthusiastic about what I wanted to do at first and really had his sights set on what I considered a far more difficult proposition, that of the changing distributions of migratory fish and plankton. With the clams I dealt with stationary distributions, intrinsically an easier problem, and I felt the existing data held more promise for making good progress. So I told him that I felt his ambitions exceeded his grasp; and indeed, the grasp of data available. He felt my ambitions were meager. Of course, when somebody implies that clams are dull, it's difficult to marshall a compelling rebuttal. I managed to make up a few preliminary charts and he then liked the idea and supported me wholeheartedly. I think we managed to complement each other rather well from then on as far as the development of a serial atlas was concerned.

I think it's now time to review a partial shift in his career, considering Walford the visionary, versus Walford the realist. While he was working at heading up this small Washington group, opportunities for really large support from the agency there were rather small and he was discovering that available data for solving many of the problems were rather meager. We could make reasonably good maps of the surface temperature, river discharge and bottom sediments; but as far as having the data necessary to draw comprehensive pictures of distributions of fish and plankton in relation to their environment -- no. He then had the opportunity to join the Bureau of Sport Fisheries and Wildlife and set up a laboratory. So after almost three years in which I worked for him, he moved to Sandy Hook and set up this laboratory. We continued, however, closely associated with the serial atlas and for another six or seven years I continued to foster the broad scale approach that we had been pursuing.

I can say that after he moved to Sandy Hook his efforts in behalf of broad scale studies certainly intensified -- major contributions to the serial atlas were produced. He undertook to reduce deficiencies in the data most vigorously with cruises of the R/V Dolphin; probably the most intensive, most frequent surveys of plankton in any ocean region in history. He supported a monthly survey ten months of the year for two years and for the first time it became possible to truly see where a number of the important species spawned, when they spawned and how the area of spawning shifted along the continental shelf during the season of spawning. For the first time we really got an idea of what this event looked like in space and time. He had found it necessary to collect some of the data himself. He found support to do things and they were done. We haven't had anything since that's as good. During this time however, some things didn't go too smoothly and some things weren't under his total control. We came to lose something rather useful -- the Serial Atlas. There were a series of tragic events -- Charles Hitchcock died, Harry Hess died, Columbus Iselin died. Hitchcock was the keystone in providing the publication support; his successors in the American Geographical Society didn't choose to support marine science as Hitchcock had, so the Serial Atlas has not been continued. This didn't stop Walford's pursuit of marine science. It didn't stop me, for that matter, but it's one of those things one has to face.

Now I'd like to turn to just a few more personal matters of my relationship with Bert Walford and how he helped me in my own career. One of the things that I found most important was teaching me how to write. I was pretty well skilled in grammar; I could write sentences and paragraphs. But he was the first person who ever taught me how to write the introduction. I never could write introductions. I never knew how to tell the reader what it was I was going to tell him, but Bert showed me how. He was famous for his eloquence as a writer and as a speaker, and he encouraged me in my own rather intense desire for precise language. We both shared the feeling that precise writing was every bit as important in science as precise analytical methods. There's not much point in having good results if you report them inaccurately and describe them inaccurately or ambiguously. Getting just the right phraseology, saying no more and no less than the data warrant is important to me, and he taught me how to do it better. I never did acquire his eloquence in writing, nor in speaking; but it was educational to watch

Bert write. In fact, he didn't have the facility to writing as many people might think. He struggled over his writing -- he wrote and rewrote. His characteristic expression of frustration was standing up from his desk and throwing his pencil at the paper. I can also remember him as a companion and a conversationalist. We were all somewhat parsimonious and none of us like a big lunch, so we brought our lunch in bags and we talked. Our conversations often were extremely interesting. I can dwell on just one, on the subject of writing -- the limitations of writing as an art medium. The whole idea was to try to write in a stylish way as well in an adequate way. His thought was presented by comparison to the limitations of other art media. In painting you attempt to show three dimensions but on a two dimensional flat surface. With sculpture, you can show three dimensions, but you have no background, no foreground, and therefore no context. Then he pointed out that writing is particularly difficult because it's one dimensional, it's linear. You can never say anything except before you've said something else or after you've said something else. Yet you must somehow convey to the reader the feeling he is living in three dimensional space through time. A good writer does that. A poet places an additional burden on himself by demanding a meter and perhaps verse. When we come to scientific writing, there is a further constraint. If still desiring to have literary quality, poetic quality, or art, the scientist -- let's take the oceanographer -- may not write about the ocean. He can only write properly about his data and if his writings have literary quality the reader will feel he is reading about the ocean, and there's the art.

Bert had a subtle sense of humor, often he most enjoyed the foibles of man but his sense of humor extended to the frivolous. He's the person who introduced me to a classification of bureaucrats and managers -- a completely outrageous thing. It supposes that all bureaucrats and managers fall into two types; big pinks and small ovals. He visualized the big pink as a large, charging, florid person, and the small oval as small, oval and dull, but a good housekeeper. If oval is the assistant of the big pink he may tend to keep pink out of jail by minding the store. Of course, the ridiculousness of this, and the game, is when you have to classify every bureaucrat or manager as being one or the other. Now if you see someone extremely emaciated, for example, the task is to decide whether the heart of the big pink or the small oval dwells within this emaciated frame. Bert could enjoy this kind of total foolishness.

I'll close by turning to a conflict I had for many years about dealing with people. Something I probably fretted over for longer than made sense when I should have realized the answer earlier. In our lives we are much helped by certain people -- a certain few people. We can all probably name those helpful to us; perhaps our parents, a brother, a sister, a teacher, a supervisor, a colleague, most usually older. Life is a parade, the old pass things on to the younger. What I fretted about was that one seldom seems to have the opportunity to repay the people who help most, in time or kind. Of course, if you borrowed money from them. you paid them back, but that's not what I'm talking about. I finally realized that you just don't worry about this. You can't expect to pay back the people who helped you since you seldom have the opportunity. What you try to do is to pass on the same kind of thing to other people. So I think I can close by saying in regard to Bert Walford's help ...let's try to keep passing it on.

ARTIFICIAL REEF DEVELOPMENT ON THE ATLANTIC COAST

Richard B. Stone

Recreational Fisheries
National Marine Fisheries Service
Washington, D. C.

It is a pleasure to return to the site where my career started in the early sixties. Then the laboratory was small with a handful of biologists seeking scientific breakthroughs, but definitely in need of guidance. Bert Walford provided that guidance and succeeded in getting us started on a variety of activities in the marine environment related to recreational fisheries. One of his many interests concerned the distribution and abundance of game fishes in relation to water temperature patterns. The first task I was given involved an aerial survey of sea-surface temperature with infrared gear to monitor the effects of water temperature on the distribution and abundance of migratory game fish. It was an interesting program and we managed to expand the survey from a small segment of the New York Bight to the whole Atlantic coast, and then convinced the Coast Guard, years later, to take it over. It developed into a useful service program, providing information on a monthly basis to marine anglers and to others interested in temperature patterns and the distribution of certain game fishes. I then did some work on benthic sampling off Long Island, before and after an outfall was built. Shortly after that, I became involved in the Artificial Reef Program. Bert Walford had the ability to perceive projects that would be useful and also provide an additional source of funds for the laboratory. At that time, Lyndon Johnson was in office and his wife, Lady Bird, endorsed a beautification program. We saw the opportunity to use scrap materials that were lying around the landscape to improve the marine resources. The substrate off New Jersey, as well as many areas, is fairly barren, and we believed that we could put some of that scrap material to good use as habitat for fishes. One of the things that Bert Walford was stressing in those days was a better understanding of the offshore habitats. It was apparent that very little of the habitat was really productive for reef fishes or fishes that were of particular interest to recreational fishermen. Bert managed to take advantage of Lady Bird's beautification program and get some support from Congress for us to start a habitat enhancement program with scrap materials. He needed someone to head up that program and asked if I would be interested. I responded positively and started working on the program in early 1966. My presentation tonight is a brief history of that program and some thoughts about future prospects for artificial reefs.

An artificial reef is an accumulation of man-made or natural materials in selected areas of marine environments to provide or improve rough bottom habitat. They function the same as natural reefs. As I mentioned, much of the offshore bottom is lacking rough bottom habitats. If you live in south Florida or in areas with natural reefs, then the need for artificial reefs may be less than in other areas. Even in Florida, however, there is little natural reef available off most coasts.

Our initial objectives were to explore what types of materials could be used to build artificial reefs, where they should be placed, how much it would cost to build these reefs, what species of fishes would be attracted to these reefs, how marine organisms used the reefs, and to determine whether these reefs, would in fact, increase total biomass. Some of the west coast states were doing research on artificial reefs at that time, but there hadn't been much work done on the east coast. Our ultimate goal was to see how artificial reefs could be used to improve fishery resources.

One of the first things we noticed as we put materials down was that fishes and invertebrates quickly occupied the new habitat provided by the reefs. They used the reefs for a variety of reasons. Shelter seemed to be the most important aspect. This was true for motile shellfish and fishes in both temperate and tropical areas (Figure 1). There are a variety of territorial species that need the shelter. Fishes will often use the shelter of a reef to conserve energy. In a reef built from a number of vessels off of Palm Beach, Florida, the snappers and grunts use the shelter provided by the inside of the vessel when the current is strong. When the current is slack, the fish would move out around the edges of the vessel.

Another feature that a reef, either natural or artificial, provides is food. Looking carefully at the surface of reef material, you often see graze marks. A variety of species, such as angelfish, surgeonfish, and parrotfish are grazers. Reefs also provide orientation in a rather featureless environment. Fishes will occupy reef material, forage away from it and drift back to a particular section of reef.

During our early efforts to build research reefs, we experimented with various scrap materials. Scrap cars, particularly in metropolitan areas, seemed to be one of the materials that might be readily available. As a matter of fact, the City of New York helped us with this program, but we quickly found out that scrap cars were difficult to handle and expensive to use. Once on the bottom, they did develop growths of invertebrates and plants and many

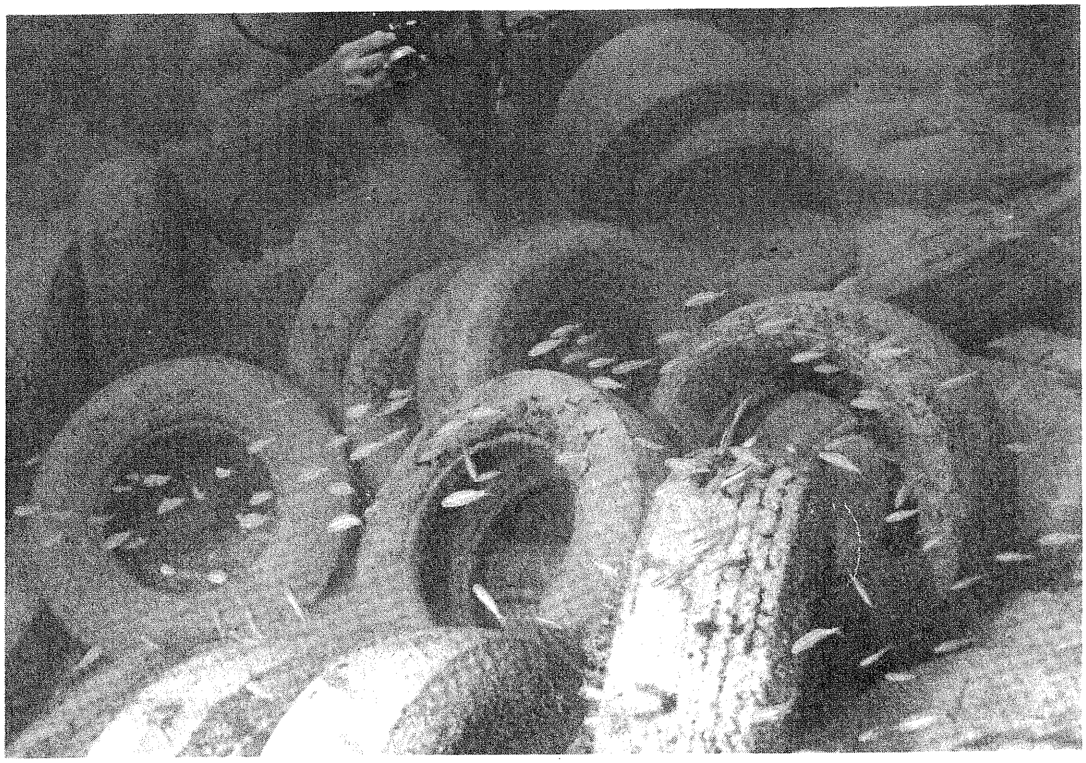

Figure 1. Juvenile fishes inhabiting a new artificial reef.

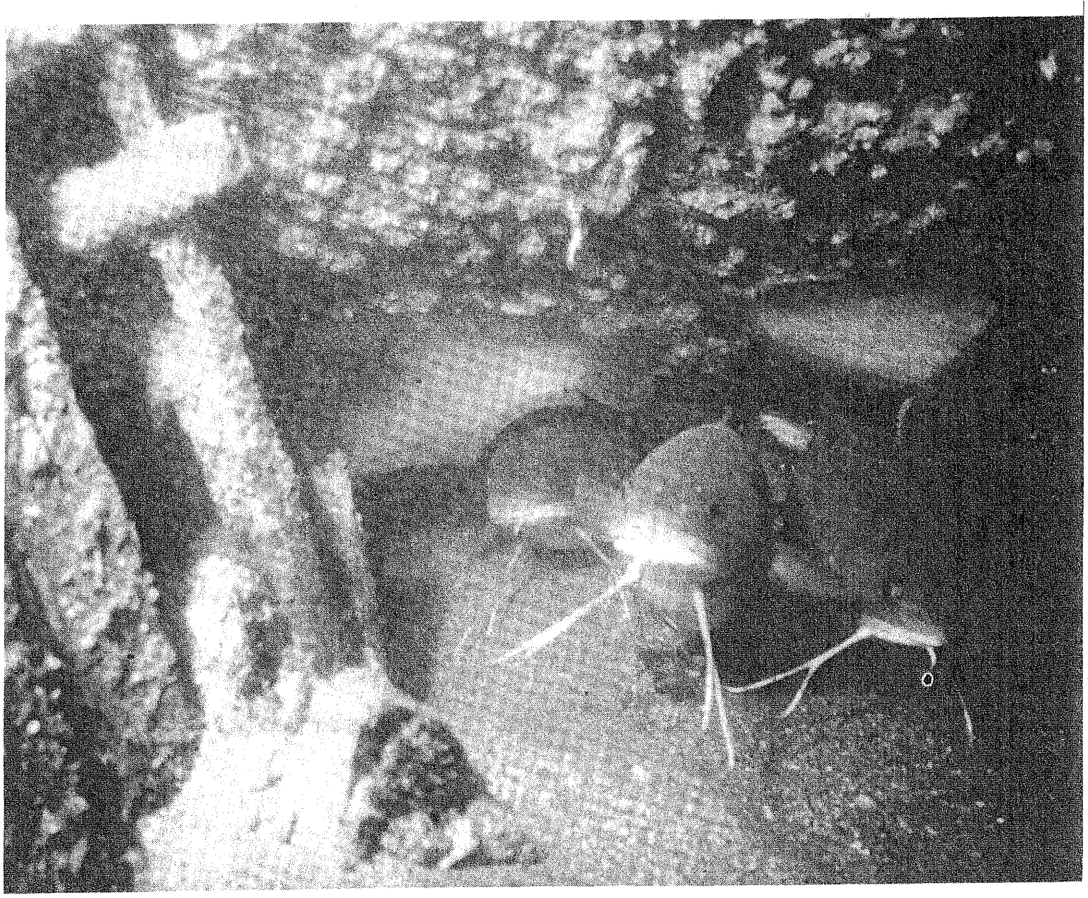

Figure 2. Southern hake inside a sunken landing craft on a reef off Murrell's Inlet, S. C.

fishes used these reefs, but the reefs didn't last because the metal deteriorated. Concrete materials, such as building rubble and bridge material proved much more effective than car bodies since it lasted much longer. However, low profile rubble tends to settle into the bottom, while higher profile concrete materials, such as large drain pipe, are generally more effective. Reefs also have been built with prefabricated materials. We considered using prefabricated materials, but determined that they were too expensive for our research effort. Now, the Japanese have demonstrated the feasibility of using prefabricated materials rather than, or in addition to, scrap materials.

Old vessels are good reef material. They provide a high profile that is attractive to mid-water, schooling fishes. No matter what material is used, invertebrate and algal growth develops rapidly. Small vessels can be effective reef material, particularly when used in conjunction with other reef material. We found that there was not one reef material that was best for all situations, but usually a combination of materials at a reef site would provide the variety of habitats, with both low and high profile, needed to duplicate a natural reef environment.

A review of early efforts provides an example of local reef building operations. We worked closely with the Artificial Reef Committee of New Jersey. They didn't spend much money to build a reef. They got the Boy Scouts, Jaycee's, sport fishermen, divers, and charter boat and party boat captains to help. These people would come down on weekends and after work hours on weekdays to take material offshore and dump it. The Committee built a tire reef off Manasquan Inlet, New Jersey, using about 70,000 tires. We occasionally used our research vessel to pull barge loads of tires to reef sites. We later bought a barge and worked with the State of New York to build a reef off Atlantic Beach, Long Island, where we experimented with different types of tire units.

Reef environments develop around gas and oil structures. Recreational fishermen have suggested saving some of these structures, after they have served their original purpose, to continue functioning as artificial reefs. Gas and oil companies are interested in the concept, but liability problems must be solved before this becomes practical.

In 1972, the reef program was moved to Beaufort, North Carolina, and, at first, we were thwarted in answering the question of whether reefs increase biomass. We subsequently established a study area off Elliot Key in Biscayne National Monument, Florida, and built a tire reef next to a natural patch reef. We were fortunate enough to have an underwater habitat at two separate times early in the study of this particular reef. During these periods, we developed the sampling techniques used throughout the next two and one half years to monitor this reef. As the reef developed, we were able to watch the species of fishes that were recruited to the reef. We were able to document how they came into the reef -- whether as adults or as juveniles, and what they did once on the reef. The reef was small enough so that we could view the whole reef. It was close enough to the natural reef so that we also could see the natural reef. One of the questions that we wanted to answer was whether the artificial reef would attract fish from the natural reef, or would develop it's own population. Most of the fishes were recruited to the reef as juveniles with some adults moving in immediately. These were adults that normally use a series of reefs. After two and one half years we poisoned and removed the reef. This was a difficult task, but we did it all in one day, with twenty-six divers and seven vessels. This included poisoning the reef and catching the fish in an encircling net. We made a total count to compare with our visual counts. We lost a few, some of the larger fishes escaped over the side, and a few of the small, secretive fishes drifted through the mesh.

Our visual estimates started on the natural reef in January, but actual monitoring of both reefs for species composition and numbers of individuals started in February. For the first months, both species and individuals were lower, as expected, on the artificial reef. Species increased quickly -- we had considerable recruitment in the spring of the same species that occurred on the natural reef. By August of 1972 (about 7 months after we put the reef in), the carrying capacity of the natural and artificial reefs was similar. The numbers of fishes on both reefs at this time also were similar and remained that way with seasonal fluctuations. The species composition also remained similar. There was good correlation between the total number of individuals that we collected on the reef with our visual counts. We had a problem identifying the juvenile grunts because of the similarity of tomtate grunt and striped grunt.

We satisfied most of our major goals. We produced a "how-to" publication which provides information to the state interests and others on how to build artificial reefs and quantitatively demonstrated that artificial reefs can increase reef fish biomass in a given area. It was an extremely rewarding program because not only were we able to conduct research, but we were able to provide people with information they could use. The results were better fishing for saltwater anglers and better communications between government and public fishing interests.

Although we terminated our research phase of the program in 1974, we have continued to provide limited technical assistance to interested groups. Most of the reef efforts along our coast are conducted by the states or local groups using scrap materials. Sometimes materials are installed without really knowing some of the basic answers required for success. For instance, "How large does a reef need to be to handle a given amount of fishing pressure?" If a crowd of people are going out to fish, there's no sense in putting in a small reef because successful fishing will not continue. Another question of management is an interest in what types of reefs could be used to improve the stock sizes of certain species of fishes". An example is the snapper-grouper complex. The possibility exists that reefs could be used to help offset lack of suitable natural habitat in certain areas. We have looked at how best to go about doing this and have found Japanese technology much ahead of ours. They have computer programs to integrate information on area, sediment, current, and species, to determine the optimum type of unit, including height and ballast. We may not become that sophisticated very soon, however, we should at least experiment sufficiently, to assure success even with scrap materials. Reefs hould stay in place and accomplish the objectives desired or much effort will be wasted. It's not particularly simple -- many things must be balanced properly and the whole series of operations properly planned. We are working with Aquabio, Inc., to transfer some of the Japanese technology. One Japanese company has donated some reef material to use and we're trying to raise the money for shipping costs. Their reef material and technology will be tested at sites in Florida, probably off both the East and Gulf Coasts. We have been through the trial and error era. Now is the time to become more sophisticated in our use of artificial reefs.

RECENT RESEARCH FINDINGS ON
NEW JERSEY'S SURF CLAM POPULATION

Dr. Harold Haskin

Rutgers University
New Brunswick, N. J.

ABSTRACT

The United States clam fishery demonstrates a classical example of resource over-exploitation. Virgin stocks were systematically overfished and the process accompanied by over-capitalization of the fleet. The increased harvesting began during World War II; before this, the surf clam was mainly used as cod bait. Harvesting technology improved as a market developed for surf clams as a food item for humans. Early catches rose from about five million pounds; mostly from Long Island beds. From about 1955 to 1965 virtually all United States landings were from New Jersey waters. By 1966 harvest from the larger beds off New Jersey increased market landings to a high of 95 million pounds. As beds off Point Pleasant and Cape May were depleted the fleet moved south. By 1974 New Jersey landings were less than 20 million pounds; in 1975 total United States production had dropped to about 84 million pounds and by 1977, 50 million pounds. Federal catch quotas began in late 1977, restricting annual catch to 30 million pounds. Fleet size had increased from about 100 vessels in 1970 to about 168, however the new vessels were considerably larger and the fleet catching capacity was increased threefold. Under Federal quota regulations, the new fleet was restricted much of the time to a single day's fishing per week.

Rutgers research on surf clams began in the early 1970's when the fleet had begun moving southward from New Jersey beds. As the fishery shifted, concern developed because little or no recovery was evident in the major

New Jersey beds. As southern beds became depleted, there was further concern for the impact of the returning Jersey-based fleet, particularly on inshore beds. In 1972 there was a State-Federal surf clam survey, based on about 500 stations from Cape May to Sandy Hook. Standing stock was estimated then at 15 million bushels inside the 10-f line and about 12 million bushels within the 3-mile limit of New Jersey. Within the 3-mile limit south of Beach Haven Inlet were 9 of the 15 million bushels.

Research problems included determining rate of exploitation and growth on beds of Atlantic and Cape May counties. In 1972 modal size of these clams was about 110 mm, they were estimated to be 3 to 5 years old and comprised about 14 percent of the whole population. Early estimates suggested a 20 to 30 year period for building up stock and the recommendation was made to harvest not more than 5 percent of the standing stock. This remained the DEP guideline.

From 1972 to 1975 surveys indicated young-of-the-year surf clam densities at 6-7/0.1 m^2. Over the next few years the counts increased to about 400/m^2, follow-up surveys however indicated poor survival of 25 mm clams. This stimulated a special study in a 60 mile area off Wildwood where over 2 or 3 years we found about 10-20 percent of the recruits drilled by boring clams, an additional 30-40 percent were attacked by crabs, and the balance of shells were intact, but dead. Surf clams were preyed upon almost as fast as they set.

An exception occurred in the summer of 1976 off Wildwood and Atlantic City when in late summer there was an existing population of 14 to 18 mm juveniles. In the 1977 inventory these were 25-50 mm and in 1978 had grown large enough to be retained in a dredge. This persistent population is now forming a large proportion of New Jersey stock. The old population declined from 9 million bushels in 1972 to some 4 million survivors. This year (1981) there are 5 million bushels within a 10-mile stretch off Atlantic City, almost entirely 1976 year class, which more than doubles New Jersey's inshore standing stock.

Conjecture on the cause of successful survival revolves on the 1976 anoxic blight. Mortality of horseshoe crabs and lady crabs occurred, the die-off of these predators enhancing surf clam survival. Recent surveys indicate there are 22 million bushels of 1976 surf clams (ca. 170 thousand metric tons), in about 100 mi^2 -- more than offsetting the 147 thousand metric ton anoxia-caused mortality in 1976.

This 1976 recruitment event has been useful to answer questions of inshore growth, survival, and mortality rates. From a transect normal to shore we find clams of the same year class progressively larger offshore. The fishermen think inshore beds have smaller clams because of crowding and competition. It appears they are also smaller because summer water temperatures above the thermocline inhibit growth. About two years after setting, clams at 50 ft depth grew to 90 mm. This rate is faster than any reported. We found a bimodal length curve in clams taken from a transect from 15 to 49 ft depths north of Absecon Inlet. One mode included the 1971 and one the 1976 year class. Size of the 1976 year class varied from 90 mm inshore to 100-115 mm offshore.

Population density may also inhibit growth. The southern inshore population are growing slowest. The north transect population offshore at 50 ft grow faster -- one station has 100 mm clams, four years after setting, and in deeper water are super sizes -- 115 mm in four years. In our catches of greater than 10 clams/m^2 we find growth inhibition. To meet the present quota of 30 million pounds of meats/year the fishery lands 1.8 million bushels. The 22 million bushels off New Jersey centered around Atlantic City represents more than a 10-year supply for the entire Atlantic fleet.

In 1979 we made a new discovery at stations off Island Beach. Here we found the highest juvenile densities ever recorded -- 8-14 thousand/m^2 in a 4 x 1-mile area. Recent surveys indicate good survival and this concentration should add another few million bushels to the inshore resource. Apparently the interplay of the thermocline with reproductive cycles can enhance survival. Inshore surf clams spawn in May and June when temperatures reach 12-14°C. The offshore clams under the thermocline will not spawn until the overturn in late September and October. The result is two waves of spawning from the two different groups of surf clams.

DR. WALFORD REMEMBERED

Robert Wicklund

Senate Aide, Office of Lowell Weicker
Washington, D. C.

When I entered the hallowed halls of the Sandy Hook Marine Laboratory in 1961 to interview for a job, little did I know that I was about to meet a man who was going to have a dramatic effect on my life and my career. I clearly remember my first meeting with this man called Bert to many, Lionel to a few, and Dr. Walford to most of us. When I entered his office I confronted a tall, rather gangly gentleman, his thinning hair combed straight forward, wearing glasses and a bow tie. A genial but somehow imposing aura surrounded him. He shook my hand lightly and asked me to sit. After staring quietly at me for a few minutes, he said, "So, you are interested in working at the Sandy Hook Marine Lab?" "John, (John Clark, Assistant Director at the time) tells me that you have actually no experience -- you have no formal education in biology. What then, my boy, is your interest?" I thought for a second and I said to him, "I love the sea" -- and I was hired there on the spot. Although it was the only bond that we had at the time, Dr. Walford understood something of people who love the sea, for no man that I have known in the past or probably in the future, has loved or will ever love the sea more than he has. His intense curiosity toward the ocean and its resources, his interest in everything about the sea, was boundless. He continually asked questions, he believed that we must know everything about the sea -- its natural processes and its basic functions. His interests were pure and simple, but complete. I left his office feeling good and I thought it was going to be pretty easy, for since I love the sea, I must have it made. But I was wrong, very wrong as a matter of fact. For not only was Dr. Walford a great scientist, he was a teacher and demanded no less than excellence from his people, an unequaled task master. I was about to learn that working for Lionel Walford was not automatic, and I was also to learn the true mental agony of working with him. Strangely enough, I found myself returning for more. A case in point -- was the experience of writing a scientific paper. After submitting a draft to him for review, the inevitable would happen. Dr. Walford would come out into the second-story hall and call up the hallway, "Wicklund, come down here immediately". After running down and sitting by his desk he would start. "Now you say here that the range of the bluefish on the Atlantic coast extends to the Gulf of Mexico and the Florida Keys, but .... What do you mean by <u>but</u>?" After a very painful pause the answer usually, at least for me, would turn out something like "but is a conjunction" and then he would say "Yes, yes, I read the dictionary, but what I want to know is what are you trying to say". By the time it was over I was, and I suspect most others in a similar circumstance, in a sweat, squirming, and most likely would offer the word up to him in any way he liked. But he never let you off the hook. He forced you to think. He cared in a very special way about the way you thought, not only from a scientific stnadpoint but for yourself. He cared about us as much as the science which came out of his laboratory. We were his family. He constantly challenged us to succeed.

Dr. Walford was also a man of dreams that never faded. He believed that anything was possible. Sometimes we served as surrogates to his dreams. I can give you some examples. One time, I remember very clearly, he came out of his hallway and said, "Bob, get down here, there are some sleeping fish off the Barnegat coast. Get your diving gear and check it out". Well, I went down and checked it out. Or "Bob, there is a man with a flying submarine down in Manasquan. Check it out and see if we can use it". And indeed, there was a man with a flying submarine, but by the time I got there his son, who was the test pilot, had crashed it three times. We decided not to use it. At another time he thought it would be a good idea if we had our own submarine, and he found one for us and we used it for a whole summer. [As a matter of fact, I still have it in my backyard. I live in Virginia, and I have it in my backyard hoping that some day to get it back into the water, but without Dr. Walford, I am not sure I will ever get it back in.] He would sent John Mahoney out to look at bioluminescence in the Sandy Hook Bay, and my father, the vessel captain, out to look at boat equipment. He was always thinking, always wanting something to go on. Once, fairly early on in our marine lab experience, we sighted a rather strange ribbon-shaped organism off the coast, and in some strange way, although we agreed to keep quiet about it, since we didn't know what it was, the information got to the New York Times and Sandy Hook became internationally famous overnight. We had our own Loch Ness monster. In his special way, Dr. Walford was probably responsible for that, even though he was a scientist, he saw the merit in getting some publicity for the laboratory, and he did. His dreams, his curiosity, kept the lab and all of us alive. Sandy Hook was, to say the least, always interesting. Although lots of things turned out to be wild goose chases, some paid off. The point is, Dr. Walford kept Sandy Hook exciting and stimulating.

Although he could barely swim a stroke and it took about 20 pounds of weight to get him just below the surface, he had an incredible interest in diving. He couldn't do it himself but he saw the merit of putting man's eyes beneath the sea to see first-hand the processes from a natural viewpoint. He pushed hard to get a diving program started at Sandy Hook and as a result the lab has had one since. When he finally got underwater in this little submarine I mentioned, nicknamed Schmoo, he was a little frightened, but his absolute lust to see what was beneath the sea overcame any of the fears he had. When he went into this tiny little submarine the first time in his life and went down, he was excited as any man, woman, or child could ever be.

I remember, Dr. Walford in another way when we attended lectures or workshops. He would quickly get the feeling for the man who was lecturing and if he didn't like him or if he didn't like what was said, he would write little notes on a piece of paper and pass them off to us. Things like "this man is full of it", or "...indeed...". He would sometimes approach it in another way by saying in a stage whisper "Can you believe what this man is saying?". He was embarrassing to go with but a lot of fun.

I have said a few things about a good friend and there are so many more things to say -- we could spend the whole night reminiscing about Dr. Walford. But my last rememberance was the time I saw him in Riverview Hospital, three years ago. He was near death, slipping in and out of a coma and couldn't see very well. When I leaned down to say hello and tell him how I was, he said "Oh, Bob, I'm really glad you are here". "Please sit down and tell me what's going on, I want to know everything." That unfaltering curiosity, is the legacy of Dr. Lionel A. Walford, scientist, philosopher, humanist, friend, and a fine person.

PROTECTION OF THE MARINE ENVIRONMENT IN THE 80's

Kenneth S. Kamlet

Director, Pollution and Toxic Substances Division
National Wildlife Federation
Washington, D. C.

A good place to begin picking up on the discussion is to observe that during the presidential campaign prior to Mr. Reagan's election, much was said about the need to bolster environmental standards and environmental regulations with much more in the way of scientific support, much more research backup. There was an awful lot of discussion, as well, of the importance of getting more input from the public, the affected public, in the formulation of regulations. The suggestion was made that most regulations are drafted by bureaucrats who never get out of their offices and that bureaucrats very often in drafting these regulations don't have the remotest conception of what the real problems are, what the real needs are of the people affected by these regulations. Then Mr. Reagan got elected President, and the major theme of his budget-cutting activities seems to be to trim research programs on the part of environmental agencies like the Environmental Protection Agency and to close down "public participation activities" within those agencies. One has to question to some extent, based on that, the motivations behind those kinds of cuts.

There has been a fair bit of press coverage in the last few days of analyses done by Bill Drayton, a former assistant administrator for EPA under the Carter Administration (and I think he had come onboard even before Mr. Carter arrived under the prior Republican Administration). He was the planning chief for EPA in those earlier days and he made some interesting comments. He points out that the budget cuts that EPA has experienced have been extraordinarily disproportionate compared to the cuts that nonenvironmental agencies within the administration have experienced. EPA constituted seven tenths of one percent of the 1982 Carter projected budget, but Mr. Reagan has obtained 10 percent of his proposed cuts from EPA programs, and at the same time these cuts have been going on, the responsibilities of EPA have expanded. EPA's real purchasing power has been cut by over 60% thus far and its staff has been cut between 25 and 40% during this administration's first 20 months in office and one can expect more in the same spirit to follow.

Let me focus on some of the marine protection programs and marine pollution activities within the administration, as those are presumably the areas of greatest interest to most of you and they happen to be areas I know more about than others.

Let me give you a short catalogue of some of the things that are going on in those areas.

EPA is in the process of relaxing the ocean dumping criteria. The proposed revisions to the ocean dumping criteria are due out sometime later this month. (Editor's note: as of late April 1982 these revised criteria had still not been issued.)

The London Dumping Convention is an international treaty, which the United States was instrumental in putting together, getting adopted, and which now is adhered to by some 40 odd countries around the world. United States delegations to the London Dumping Convention consultative meetings are getting progressively less vigorous in defense of marine protection programs and now the Corps of Engineers representative on the U.S. delegation is openly calling for relaxation of the controls on the ocean dumping of dredged materials.

The theme within the administration seems to be that the ocean environment be given an equal footing with other media for waste disposal purposes. I will return to that a bit in a little while.

Most of you in this area are aware that back in April of this year (1981) a federal district court in New York City rendered a decision regarding New York City's ocean dumping of sewage sludge in the New York Bight. That decision was a significant setback. But it was not a terribly surprising decision in light of the fact that the federal government in the form of EPA and the Department of Justice did not really uphold their end of the lawsuit very vigorously. In essence the court was able to read some things into the 1977 Amendment to the Ocean Dumping Law, which required the ocean dumping of "harmful" sewage sludge to be phased out by the end of 1981. The court was somehow able to read into that requirement that the impacts on the marine environment of ocean dumping be weighed against the economic cost as well as environmental impacts of disposal of sewage sludge on the land. Given the fact that the reason ocean dumping is as attractive as it is, is that it's a good deal cheaper than land-based alternatives, any balancing kind of analysis that puts economic considerations on an equal footing with environmental ones is not likely, and certainly not likely in the foreseeable future, to wind up sustaining the phase-out requirement.

Just two days ago on another front, the House Public Works Committee approved an amendment to the Clean Water Act which would make it easier for coastal municipalities to obtain waivers from secondary treatment requirements for sewage disposal activities into the ocean and to other marine waters in estuarine areas. This was justified primarily on the basis of reducing the federal exposure, i.e., financial responsibility under the construction grants program, to help fund treatment activities by these sewage treatment plants.

There has been increasing reliance placed in recent days to the concept of assimilative capacity of marine waters. A presidential advisory committee, the National Advisory Committee on Oceans and the Atmosphere, issued a report several months ago which supported a multi-medium analysis approach toward consideration of waste disposal options -- in itself something that was very hard to dispute. The problem is, this committee itself had no land-based expertise represented on it and it seems as though it should have taken its own advice when it pointed to what it viewed as increased greater harm potential connected with waste disposal on the land as opposed to the ocean. (It should have done a better job of comparing the land with the ocean in leaping to that conclusion.) It was not too long ago when the concept of assimilative capacity was known by a somewhat different name. The idea that "dilution is the solution to pollution" has now returned in another form to haunt us and is now the watchword of EPA in pursuing modifications to its ocean disposal policies.

I took part in a panel discussion last night in Washington that was focused on the Federal Ocean Plan modifications that NOAA is going to be issuing shortly. This is under a statute passed several years ago that requires NOAA to take a 5-year look every two years at where federal marine pollution research, development, monitoring and so on is going and to recommend goals and priorities for these federal agencies to follow in the course of the subsequent 5 years. One think I was struck by, having reviewed the current draft plan, is that most of the recommendations involved retrospective looks at environmental impacts that existing or prospective waste disposal activities will have. Much less emphasis is being placed on pre-screening types of procedures -- predictive approaches -- to allow one to determine how acceptable, if at all, a given waste disposal activity will be, and whether it ought to be allowed to take place. That says quite a bit about the uses to which research is tending to be put these days.

I would just like to make two other points. Garrett Hardin wrote a famous essay about the "tragedy of the commons" a number of years ago. His point was that, because no-one owns the ocean, waste disposers don't have to purchase a disposal site or rent it. In fact, there is no cost connected with disposal in the ocean other than the transportation cost of barging the material out to sea and whatever limited monitoring requirements may have been imposed. But the insidious aspect of this is that it is in each individual ocean dumper's best self-interest to maximize the amount of dumping that he is able to do. The dumping doesn't cost him anything in terms of harms; the harms are experienced by society at large. He shares in those harms only in a minute degree as one member of society. He reaps <u>all</u> the benefits, and that is the problem. That is the prototypical example of where it is essential for government to step in if the resource is going to be protected. The free market system and private enterprise are unable to work in that kind of situation.

As an analogy, a number of years ago Congress very wisely enacted a provision as part of the Department of Transportation Act which provided some added protection to public parks, recognizing that unless it were made a little more difficult to build a highway through a park, developers would always prefer to go through a park rather than to go through a residential or commercial neighborhood -- having to displace property owners and reimburse them, and so on.

So it passed Section 4(f) of the Department of Transportation Act that requires "all feasible and prudent alternatives" to be exhausted before going through a public park can be allowed. I would submit that similar protections really are essential for the marine environment or we stand a real risk of harming it irrevocably.

One final point which ties in with this as well, is that regulatory programs tend to be excessively oriented in my view toward individual disposal activities. We are becoming more and more oriented toward cost-benefit balancing, which is not necessarily bad in the abstract, but is focused on individual waste disposal events rather than on cumulative impacts in a particular area of the environment.

We run a real risk of piece-mealing the environment to death. The Public Works Committee Amendment that I referred to a few minutes ago is an example of that. That amendment would open up, essentially for all time, the opportunity of coastal waste dischargers, past, present, and future, to discharge their waste into the ocean under relaxed treatment requirements. We talked to proponents of the amendment about the prospect it would open up of hundreds of new outfalls appearing in coastal areas. They say: "Well, the existing provision of the statute that this amends has eight prerequisites that have to be met before a discharger can qualify for a waiver. If those safeguards are adequate, what's the problem? Why do you want to limit the proliferation of these outfalls in the future?" The problem is precisely the failure to focus on accumulative impacts and the evaluation of each individual discharge on its own merits. And whereas the coastal ocean may be able very readily to accommodate the impacts of a single waste discharger or even a small group of them, there may well come a point, particularly in urban areas where persistent toxic chemicals are quite abundant in these discharges, that the assimilative capacity will be far exceeded by the combined input of these contaminants.

In conclusion, as long as society and our political leaders permit ocean dumping to be regarded as the path of least cost and resistance, it will continue to proliferate. Just as bulldozing a road through a public park costs less than going around it, ocean dumping is almost always a coastal facility's least expensive means of getting rid of its waste. If only the wastes being dumped were treated as resources to be recovered rather than as waste to be disposed of, then perhaps economics might dictate a different and more sensible result.

Unless we reorient our thinking in this regard, a future generation of children will ask with regard to a polluted ocean: "Why did you let them do it?"

THE FISHERIES

Raymond T. Richardson

Director of Public Relations
Seacoast Products, Inc.
Port Monmouth, N. J.

I would like, for just a moment, to relate back to Dr. Walford. I had the privilege when serving on the Fish and Game Council to be invited to a ceremony for the official ribbon-cutting to open the Sandy Hook Marine Laboratory. When we came out here, Director Underhill of Fish and Game was on hand and he mentioned to me that he understood Dr. Walford was going to be the director. I had met Dr. Walford on a few prior occasions in Washington and got to know him as a fine marine scientist. After he came here as the Sandy Hook Laboratory director we became very good friends. I admired him, as one of the top marine scientists, and I, for the most part, was just a humble commercial fisherman. He enjoyed evaluating his findings, his theories, with what we found as commercial fishermen working every day with the resource and he liked to put these things together to see if they matched. He invited me to his home winter evenings to have fireside chats and I would relate all my fish catch records to him to compare with his findings. We did this for a number of years and I think I may have impressed him, back in those times as a commercial fisherman when I suggested to him that I felt that proper management of any species of fish, after estimating the correct yield per recruit of that species from any fishery, would be beneficial to the commercial fisherman. And he told me, "You know, Ray, not many commercial fishermen think this way, mostly they think just to catch what you can catch, whether it's small, big, or whatever". But I felt deeply that proper management was the key to maximizing the harvest in a given fishery. What I want to talk to you about tonight are my feelings of management at the present time within the territorial sea.

In 1976, Public Law (94-265), the Fisheries Conservation and Management Act was enacted to provide management of U. S. fisheries out to 200 miles. This at present is being accomplished through the various councils established for the purpose of management of fishery stocks that are harvested predominantly within the 200 mile zone. Public Law (94-265) did not mandate that the fishery councils manage those fisheries that are predominantly harvested within the territorial waters of the U. S. coastal states, but rather left management arrangements of these stocks to continue under the individual states. Currently, the only vehicle available that has the sanction of Congress for two or more states to attempt to manage a fishery throughout its range are the Commissions, the Atlantic States Marine Fisheries Commission, the Gulf States Marine Fisheries Commission, and the Pacific States Marine Fisheries Commission. Although some management plans have been developed for these territorial sea fisheries, the commissions do not have the authority under their congressional mandate to implement these plans in the territorial waters of a state having interest in a particular fishery. The commissions can only recommend that a state adopt a plan, leaving the decision to that state's method of implementation, whether it be by regulatory process or legislative process, whichever the case might be. Under this agreement it could take years for a plan to be fully implemented by all the states involved and under these conditions some plans may never be fully implemented throughout the range of a given species. Meanwhile, management, such as it is, within the territorial sea fisheries, that presumably produce 67% of the total fishery products utilized by U. S. citizens, continued to be embroiled in a hodge-podge sociopolitical system that each and every day threatens the continuance of existing commercial fisheries, discourages further investment by those presently involved, and spells a definite "no" to those who would consider large investments in new concepts, technology, and development for greater production from the territorial sea for the benefit of all U. S. citizens. This gives you a brief insight of what I believe to be a major problem in our attempt to have proper management of our fishery resources. There is a saying, "If it is not broken don't try to fix it". I have been involved in and around commercial fisheries all my life and as I continue to get older, the problems of commercial fishermen operating within the territorial sea continue to worsen and I believe, are reaching a breaking point. Therefore, I think, we have reached a point in time when we better try to fix it. The U. S. has the richest fishery resources of any nation in the world; therefore, it could be expected that we should be the number one producing nation of fishery products in the world. Not only are we not the number one producing nation, but we continue to slide down the ladder in rank. When you consider that currently 67% (National Marine Fisheries Service estimates) of U. S. fishery products are coming from the territorial sea zone and are threatened with further reduction in the foreseeable future through political and social pressures, unrelated to biological facts, we are facing a grave future for the U. S. as a ranking nation in world fisheries. The Atlantic States Marine Fisheries Commission, the first commission to be established, will be celebrating their 40th year of existence at their annual meeting next week in Charleston, South Carolina. They will be considering the adoption of management plans for striped bass, summer flounder, and Atlantic menhaden -- to manage these species throughout their range under the Commission. I wish them the best of luck, but I do not think that they can accomplish the job under their current mandate by Congress. Forty years ago the mandate by Congress for the commissions may have been adequate for that time. However, in 1981, their mandate is not designed to meet the present-day challenge for proper management within the territorial sea. Alternatives that could be considered to do the management job needed in the territorial sea are: 1) broadening the scope of the fisheries management councils to include the territorial sea fisheries, or 2) federal preemption of the territorial sea for management of fisheries.

The 1979 statistics show that the U. S. fishing industry employed 270,000 persons and contributed 7 billion dollars to the gross national product. I firmly believe that these same quarter of a million plus people could double this contribution to the gross national product if the socio-political interference that goes on in every state were removed and harvesting under proper management using biological facts became the policy for production of this valuable food source from our renewable marine resources.

I want to say that I am discouraged with the plight that is imposed on commercial fisheries at this time through political maneuvering in every state under certain pressure groups. They are active not only in New Jersey, but all along the Atlantic Coast, the Gulf Coast, and the Pacific Coast, in trying to put commercial fishing activities out of business and to take over the territorial sea for the purpose of certain uses of the resource in their own interest. I think we can all work together, I think there should be understanding, but I am also sure that every citizen will suffer from not having fishery products available if disharmony continues and commercial fishermen continue to be put out of business.

UTILITIES AND THE ENVIRONMENTAL PROTECTION OUTLOOK

Dana E. Cooley

Manager, Environmental Licensing
Public Service Electric and Gas Company
Newark, N. J.

Utilities Must be Reliable

I didn't know I was scheduled to talk on utilities and the new regulatory situation under President Reagan. I thought I was supopsed to talk out firewood. Since my first reference is all about firewood, I would like to begin my remarks by conducting a survey. Does anybody have a wood burning stove or a fireplace?... Quite a few. Now do you cut your own wood or would you be willing to admit that you buy wood?... Has anyone here bought firewood yet this year?... I want to tell you a story about someone in our Commercial Departemnt who worked for PSE&G for many years and went into selling firewood part-time. He got so much into it that we finally had to let him go. A layd called the Company one day and said "My electricity has been out for more than an hour. What are you going to do about it?" And he said, "Well, we're sold out right now, ma'm, but I expect we will be getting more in about a month; how about if I give you a call back in two weeks?" Needless to say, that doesn't go over very well in the electric utility industry.

Power has to be available when people want it, and this affects how we in a utility deal with what's going on now in the Reagan regulatory agency changes. We have to be always there. We have to back up solar, wind, resource-recovery, co-generation and all the other "appropriate" technologies. When all is said and done, the electric power and the gas have to be there. This is especially important to PSE&G because we are an urban utility. Our sites are limited, our resources are in short supply, our labor is very expensive and capital is hard for us to get. Our customers may not need more power in the immediate future nor will we anticipate rapid degrees of growth, but we need a steady source of power, and we need to deliver it to our customers at as reasonable a cost as we can.

Where The Regulatory Agencies Fit In

So, my job at PSE&G is to deal with a number of regulatory agencies, keep our existing power plants in compliance with laws and regulations and try to get new and more efficient energy facilities licensed on the basis of these regulations. President Reagan has entered the scene and created significant changes both in the regulatory agencies themselves and in the budgets they have to work with. (I'm sure those of you who are scientists dependent on funding from governmental agencies can agree with that.) The question you may be thinking right now is, "Will the cuts in regulatory agencies cause a slackening in environmental regulations and in environmental quality? Will the utilities and other industries be allowed to run away with the cart?"

EPA has had many budget cuts; for example, their purchasing power for outside services and consulting contracts is going to be reduced by 50% in the next 18 months. The Department of Energy, which was behind many of the alternative energy programs, had 19,500 employees under President Carter; thousands of them have been laid off already and this will continue. We have seen two every controversial and colorful individuals, Anne Gorsuch and James Watt, installed as heads of their respective agencies. Mr. Watt, who is upsetting many environmentally-concerned people, seems particularly as if he is turning his back on everything we gained in the environmental decade of the 70's. But I don't think the situation is that grim. I think that the laws and regulations which are on the books and in place, and the underlying science behind them, will survive this period, and that no particular administration or President can sweep the gains away in the space of a few months.

What Lies Ahead?

We will see more results-oriented environmental policies on the part of the government and results-oriented approaches on the part of industry. If you ran a regulatory agency and your budget were cut, it would be a lot like fighting a fire or saving a leaky ship. You would have to put the resources where they would do the most good. You would probably concentrate on those areas giving the greatest environmental benefits and perhaps function less intensively in some of the areas that were administratively or research-oriented. There will be a greater emphasis on industry initiative. PSE&G and most other industries do have an environmental conscience, and we are not going to turn our backs on the environment, even though there will be less direct involvement by the agencies in watching over us or in telling us what to do. To compensate, there will be economic forces steering America toward sound environmental policies and sound energy policies. For example, the federal government will not tell us anymore to convert from oil to coal, but if it's economically attractive, and if it can be done without harming the environment, it will be done. We and other utilities will pursue it because it seems to be economical. The same air and water quality standards will be met as if the government ordered us to convert.

EPA will have less money to spend on inspection and enforcement. Will this mean that we are going to be able to get away with more? I don't think so, because reliance will be placed instead on independent audits of industry, either by environmental firms engaged by the industry and overseen by EPA, or by firms mutually agreed upon among the EPA, other agencies and the utility and/or industry. There will still be environmental compliance.

<u>State Role To Grow</u>

Much of the federal role will be placed on the shoulders of states, and this includes action on air, water, and solid wastes. It is very evident right now in New Jersey that the State is getting ready to take over more environmental programs. By early 1982 the National Pollutant Discharge Elimination Permit Program will be administered by NJDEP. An "Atlantic Alliance" of New York, New Jersey and possibly Connecticut will determine the pace of utility coal conversions.

Reagan and Gorsuch have not abolished the blue-ribbon Science Advisory Board to the EPA; in fact, they redirected it. This Science Advisory Board is not composed of EPA employees but of independent scientists who adivse EPA on the usefulness and effectiveness of their regulations. Through the SAB there will be a greater emphasis on the scientific basis for a given regulation and the statistical validity of the data one collects in response to a permit condition. Do the data really show that the permit holder is not polluting? If not, the data collection will be eliminated because it is not cost effective. If not doing the agency any good, gathering the data certainly is not doing the utility any good. Industry and agencies will be looking at indicator organisms and chemical species more than doing comprehensive testing, and I think the protection of water resources will still be good. There is going to be a departure from technology-based effluent limitations and a return to environmental quality-based limits. If given river or land areas can absorb more environmental pollutants, heat, or solid waste, these areas are going to be used for that purpose to spare other areas which are already highly populated or, conversely, pristine. Health standards and their associated margins of safety will not be tampered with, as we see it. At the same time, regulatory areas that are more subjective may well experience a delay in implementation by President Reagan and his Administration.

Private Industry Will Step In

There is a fine example of how private industry steps in when government leaves off. I don't know if this has any application to you in the fisheries area, but there was a fellow named Barry Levy who ran a Department of Energy project called "The Western Coal Survey". Thousands of federal dollars were funneled to this gentleman who went around and surveyed all the coal mines, recording the coal quality and so on. Then the government published his reports free for the benefit of the coal industry. Well, he was laid off by Reagan. He quickly proceeded to set himself up in business and is now selling the same data to coal companies and utility companies, and they are eager to have it. Solar energy lost its socially-oriented director, Denis Hayes, in June. By the end of summer, 345 out of 959 Solar Energy Research Institute personnel were laid off. Those who remain will look at long-term technical merits. So my thoughts as far as ocean related research is concerned are that more projects will find themselves turning to industry's needs and applications. Perhaps, for a time, there will be movement away from pure science. Don't be offended by inferring that I believe pure science is not good, but the best opportunities may be in applied research and exploration, where data can be immediately put to use in industry programs. More and more of our research funds may stem from those private sources rather than the federal government.

There are still checks and balances within the Reagan Administration, as I see it. You have Mr. Watt, on one hand, distinctly pro-industry about outer continental shelf leasing. I am sure that additional petroleum supplies are of interest to everyone here (whether there should be <u>more</u> oil or not is an individual matter!). The Department of Interior wants to proceed with the leasing. At the same time, John V. Byrne, the National Oceanic and Atmospheric Administration Administrator is saying that he will not categorically support offshore oil and gas development if it is detrimental to renewable resources or to other uses of the ocean. We in utilities feel the same way. If something will cause an irrevocable or serious environmental impact or use a resource that cannot readily be replaced, then we will try our best to fit our project into the environment under other circumstances. If the ocean, or an estuary or a piece of land can't be used and then its condition restored or the impact mitigated in some way, we are against that.

<u>Serious Degradation Not In Sight</u>

Such conscientious use of the environment is necessary for maintaining our standard of living even if we are not supporting much growth. I have had recent personal experience with a cooling water intake structure at the Salem Nuclear Generating Station, on Artificial Island in Salem County, New Jersey. For several years we have studied in tremendous detail the aquatic population of the Delaware estuary; now we have a much reduced list of indicator species we are looking at. We are studying the effects of fish being impinged against the intake screens and also fish and organisms which are small enough to go through the cooling system and suffer from heat and chlorination. I wondered personally whether the EPA would remain as interested after Reagan as they had been two years ago. We have seen no change at all in their interest or requirements. Every three months we sit down with them and go over our results. There has been every bit as much concern shown under the Reagan Administration for protecting and enhancing the environment at Salem as was previously shown under President Carter.

EPA seems to recognize the vulnerability of the oceans and rivers and is putting their resources where they count. My friend Tom Fikslin of the Edison laboratory was here at Sandy Hook today demonstrating EPA's mobile bioassay laboratory. Since bricks and tires are not nearly as dangerous as chemicals and sludges, I asked Tom if he saw any diminishing of interest or support for this efforts. He di not; his schedule is normal.

Our Company, as is the case with many other industries, will conduct environmentally-related research and will pursue ideas which would result in effective use of waste products or enhancement of some environmental value. This will be particularly true if a connection can be shown between that project and some form of profit to the Company. As an example, consider the aquaculture project at our Mercer Generating Station. Initially we received about $1.2 million from the National Science Foundation in 1974-79. You might call that seed money, but we believe in 1982 that the proje may become self-sustaining. We will rear some 300,000 pounds of trout in a facility which is only a proof-of-concept facility, not even a full-sized project. We will actually sell those trout to a variety of outlets including supermarket chains in the Northeast. Here is an area where waste heat is being used in a beneficial way and it isn't requiring any federal money or more complex regulations.

In conclusion, as an environmental manager for a major utility, I see no diminishing of the environmental protection effort in this country. I do see environmental regulations being scrutinized for their true benefit to society, and I see proving compliance becoming more reasonable for industry.

Thank you for allowing me to participate in this Convocation of concerned scientists and citizens.

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