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Estimates of abundance : VIMS small fish trawl survey, York and Rappahannock Rivers, 1955 to 1982

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Special thanks are due to Paul Gerdes and Dean Estes who headed up most of the recent field parties, and Ms. Lillian Hudgins who entered the data into the computer and helped with its editing.

Abstract

This report presents information on catch of juvenile fish with a 30 ft. semi-ballon trawl in the York and Rappahannock Rivers, and graphically compares those with the commercial landings in Virginia waters for the years 1955 through part of 1982.

ESTIMATES OF ABUNDANCE -VIMS SMALL FISH TRAWL SURVEY
-YORK AND RAPPAHANNOCK RIVERS, 1955 TO 1982

-Frank J. Wojcik and Herbert M. Austin

INTRODUCTION

VIMS has been collecting data on abundance and distribution of juvenile fishes in Virginia waters with bottom trawls since February 1955. Efforts have been focused primarily on the sciaenids (croaker, spot, and weakfish), hence the choice of bottom trawls. Analysis of these data through March 1982 are presented by species and river, and include annual estimates of relative abundance, five point moving averages, and Virginia commercial landings.

METHODS AND MATERIALS

Gear

Two different sized trawls; each with minor modifications, have been used over the course of the surveys. Data collected with a smaller 16′ semi-balloon are not presented. All data presented here were collected with a four seam, 30′ semi-balloon trawl fabricated of 1 1/4" stretch mesh netting in the wing and 1 1/4" stretch mesh in the body. The net used in 1955 was of cotton twine, but is now of nylon. The cod end of the original net was the same as the body, but since 1974 has been lined with a 1/4" mesh. An initial perusal of the plots showed no changes in catch coincident with changes in mesh size. Initially, trawl doors were 22" x 48", and heavily weighted. Since 1978 they have increased to 25" x 54", and not weighted. Tickler chains were not used until 1978, and bridles prior to 1979 were about 30′ long, but since 1980 have been increased to 60′. These changes have increased the trawls efficiency.

VESSEL TYPES

Over the period of the surveys, several vessels have been used, beginning with the Virginia Lee, overall length 35′, beam 7′, draft 2′; the R.V.Pathfinder, overall length 55′3", beam 16′5", draft 6′8"; a ferry-boat the Langley, with an overall length of 80′, beam 32′, and draft of 5.5′. At present we are using the Capt. John Smith, overall length of 42′, beam 14′, draft 4′. In addition, occasional vessels were rented when a VIMS vessel was not available. Adjustments for differences in catch by vessel have not been made. However, attemnpt have been made to maintain a towing speed of 3 knots by all vessels.

SAMPLING PERIODS

Monthly surveys, conducted in the channels only, were initiated in the York River in February 1955 and in the Rappahannock River in 1962. A detailed description of these early surveys were presented by Massman (1962), and Chao and Musick (1977). They remained unchanged through December, 1972, at which time they were changed to a stratified, randomized survey conducted twice a year (winter and summer). A description of the methodology and rational for the sampling plan was contained in a report on the James River Finfish Biomass report (Wojcik, 1980). The random sampling continued until

1978, after which time the monthly channel sampling was resumed when it was found that bi-annual sampling proved inadequate. For example, analysis of the data in 1978 relative to previous years showed that the presence of some species ,ie weakfish and croaker did not coincide with cruise schedules, so efforts to estimate their abundance failed. This was particularilly true of the weakfish. The data indicated practically no small weakfish in the area for the years 1973 through 1978. Yet the production of juvenile weakfish during these years resulted in a substantial increase in the subsequent commercial landings, and so we attempted to determine the cause.

Reasons for our failure to assess the size of the stocks became obvious when the data for the years 1955 to 1970 were viewed critically, month by month. The random surveys (1973-1978) were run in July and early August, and again in December and early January. Yet, data from the monthly cruises made prior to 1973 indicate that juvenile weakfish were only in nursery areas between late August and early November. Thus our failure to sample at a time when the juveniles were in the nursery areas resulted in our grossly underestimating the weakfish populations for the years between 1973-1978. Fortunately, similiar monthly abundance data are available from the Department of Crustaceology at VIMS for the years in question. These data are being prepared for loading onto the trawl data file, and as soon as they have been verified, will be integrated into the full file. This should supply the information missing from our files for this period.

Abundance estimates for only one species, spot, were improved by the randomized sampling because it included shoal as well as deep water sampling. Our sampling results indicate that the spot primarily occupies the inshore shoal areas, especially eelgrass beds, all summer.

These were the conclusions obtained from analyses of catches made at various depths, and they were just the opposite of conclusions obtained for other sciaenids which were most numerous in the deep channels.

LENGTH OF TOW

Length of tow has varied considerably over the years from .25 to over 1.5 nautical miles. In some cases the length of tow was determined by actual distance covered, and in others by elapsed time. Attempts have been made to maintain a towing speed of 3 knots, with timed tows converted to distance (a 5 minute tow being equivalent to 1/4 nautical mile). All trawl catches here reported were standardized to number per 1/4 mile.

RESULTS AND DISCUSSIONS

ERRORS RESULTING FROM MORTALITY

Visual comparison of the croaker data to the Virginia Commercial landings indicated similiar trends up to about the mid 1970's, after which time the coherence disappeared. The 1979 juvenile abundance index was far above normal, yet the 1980 and 1981 index was low and dropping. It soon became evident that these indices were developed from catches made over the entire year, and while the December and January catches were large, a late winter cold snap reduced water temperatures, and killed most of the young-of-the-year croakers in the nursery areas. Trawls often caught only small dead croaker after the cold weather. The early winter catch, however, had been so large as to produce in very high biased index, although few croakers actually survived. From these observations, it appears that the March and April index would provide a better estimate of the resulting croaker stocks than did the entire annual index.

This possibility was not tested because much of the monthly data needed were not available, preventing us from doing so even though we feel such recomputations would result in better correspondence of juvenile abundance to commercial landings. The Crustaceology data, previously mentioned, lacked winter observations.

SEASONALITY OR TIMING

Use of the rivers by various estuarine fishes is seasonal, varying from three months, to a full year. As such, the data presented here are an integration of annual abundance for each species whether collected for three out of 12 months, or 12 out of 12 months. Seasonal spawning differences further confuse the issue. For example late summer, or early fall spawners of one year may be assigned two different ages, depending upon whether they were taken between November and December of the spawning year, or in January through April of the following year. Two graphs are presented here for croaker to exemplify this problem, one computed for calendar year, and the other for a biological year (December through November).

NURSERY AREAS

Virginia's four large rivers constitute major nursery grounds for many east coast estuarine fishes. The York-Pamunkey system has been described by Van Engel and Joseph (1968), and their results indicate that while some species use the rivers from the mouth upriver to the fresh-water line, others use only the more saline lower reaches . Juvenile croaker, on the other hand, inhabit the rivers from the mouth upstream to above the salt wedge, almost to the end of tidal zone.

SPECIES DISCUSSIONS

Clupeid Fishes

Alosine Fishes

Alewife, *Alosa pseudoharengus* (Figures 1,19)

Commercial catch of alewife and blueback herring in Virginia waters have declined during the last half of the 1970's. Causes for this have not definitely been established; however, Sindermann(1979) has related the reduction during 1965-1975 to overfishing, principally by foreign vessels. Domestic fishing pressure may also have contributed to the low catches, and may have prevented their normal recovery. The trawl doesn't adequately sample juveniles on the nursery ground, hence their low abundance estimates, even during periods of abundance.

Blueback Herring, *Alosa aestivalis* (Figures 2,20)

See Alewife.

American Shad, Alosa sapidissima (Figures 3,21)

Commercial landings of American shad have declined from 2 to 3 million lbs during 1965 - 1970 to less than a million since 1975. Bottom trawls do not adequately sample the alosine fishes, consequently the index is generally very low, even when stocks are high, and is generally not representative of stock abundance.

Other Clupeids

Atlantic Menhaden, Brevoortia tyrannus (Figures 4,22)

Menhaden production along both the Gulf and Atlantic Coasts is monitored by the National Marine Fisheries Service (NMFS). Based upon their juvenile sampling, they are able to predict future commercial landings with reasonable accuracy. River and bay trawl sampling does not sample juvenile menhaden, as they are surface species probably and this accounts for the lack of catch.

Engraulid Fishes

Bay Anchovy, Anchoa mitchilli (Figures 5,23)

The bay anchovy is one of the most important species of forage fishes in the Chesapeake Bay. Juvenile indices show large interannual fluctuations ranging from 0 to 400 per 5 minute tow. Their absence from the catch prior to 1970 may be the result of a change in sampling gears, as the trawl with a 1/4" cod end came into use at this time. The trend of increased abundance is real, and they are increasing at a time when pressure from weakfish, summer flounder, and bluefish is high.

Ictalurid Fishes

Channel Catfish, *Ictalurus punctatus* (Figures 6,24)

Estimates of abundance of channel as well as white catfish appear to fluctuate with annual changes in river salinities. Both our sampling and the commercial landings indicate that they are most numerous (or available) when salinities are normally low. This is particularly true of the Rappahannock River where the abundance of both adult and juveniles was highest during the mid-1970's. The York River however, produced more fish, during the drought of the 1960's. This may be a reflection of vulnerability to the gear in the upper reaches of the river, or an actual population increase. Peaks in abundance were also recorded during the drought of 1980-81.

White Catfish, *Ictalurus catus* (Figures 7,25)

See channel catfish.

Perchichid Fishes

Striped Bass, *Morone saxatilis* (Figures 8,26)

Young-of-the-year striped bass, called rockfish in Virginia, are not adequately sampled by the bottom trawl as they are sub-littoral. An exception occurs during very cold weather when it appears that winter trawling in the channels is an effective means of sampling 1+ and 2+ fish (up to a length of 14"). However, in comparison to the other species, juvenile rockfish indices are never high, even when they were abundant during the late 60's and early 70's.

The Rappahannock did yield peaks in yearling fish in 1967 and 1971, representing the dominant 1966 and 1970 year classes. The York, on the other hand, showed evidence of the 1958, 1966, and 1970 dominant year classes. The 1980 juvenile index in the York was the highest recorded, the results of this should begin to appear in the 1982 commercial catch if a dominent, or better than average year class, was produced.

White Perch, Morone americana (Figures 9,27)

Juvenile white perch have historically been more abundant, or available in the Rapphannock than in the York; but their abundance has shown more interannual fluctuations in the Rappahannock. Juveniles were most abundant in both rivers during the late 60's and early 70's, then dropped during the mid-1970's. They have shown a steady recovery since 1974-1976, and collections in 1980-1981 were the second highest. The commercial landings are so insignificant as not to show up on the plots.

Pomatomid Fishes

Bluefish, Pomatomus salatrix (Figures 10,28)

Bluefish stocks have been well above average levels for at least a decade, with record commercial catches recorded in 1976. Unfortunately, bluefish generally inhabit the mid to surface levels, and are not adequately sampled, as either snappers or tailors, by our trawls. The graphs show that they were taken periodically during 1973 and 1981 from both rivers.

Sciaenid Fishes

Atlantic Croaker, *Micropogonias undulatus* (Figures 11,18,29)

Ocean spawning croakers have been "abundant" three times during the 1900's. The first peak in the commercial catch (55 million lbs.) extended from 1930 through 1948 (18 years). The second (15 million lbs.) from 1955 to 1960 (5 years), and the third (approximately 8 million lbs.) from 1975 to 1978 (3 years).

Each period has been progressively lower and shorter than the previous. The periods of abundance and scarcity since 1955 have been shown to be dependent in part on winter (January - February) temperatures in the Virginia tributaries of the Chesapeake Bay where the young-of-the-year (spawned the previous October-December) over-winter (Joseph,1972, Wojcik,1978, Norcross and Austin,1981).

Examination of the annual croaker indices (calender year) for the Rappahannock and York Rivers show 1975, 1979, and 1980 to be periods of peak abundance. The five year running average peaked in 1977, but due to their sequence, only the 1975 collections are reflected two years later by an increasing commercial catch. The peak in 1979 is misleading as many of those taken in the winter survey were known to have been killed by low temperatures and were subsequently missing from the following summer survey (Norcross and Austin, 1981).

The 1975 York River collection (1974 year class) is the largest at 265 per 5 minute tow, and is the result of good survival during the warmest January- February measured (8 deg. C). The continued upward trend exhibited by the Rappahannock River 5 year average is misleading as counts are actually down. The trend in commercial catch is expected to continue downward throughout Virginia at least through the 1983 season.

Spot, Leiostomus xanthurus (Figures 12,30)

Spot spawn in the late winter or early spring outside the mouth of the Bay. The juveniles are passively transported into the Bay, and by late April or early May are found at the mouths of the rivers. The work of Chao and Musick(1977) indicates that like the croaker, the spot gradually move up the rivers, growing rapidly as they go. This up-river movement is reversed in late summer as they return to the river mouths by August or September. This normally occurs in time for them to migrate out of the Bay before the first hard freeze. Occasionally their exit from the Bay is held up by unusually warm fall weather, and they can be caught in the Bay by a sudden cold snap. Reports of such winterkills of spot in late fall frequently come from fishermen working in the area of the Chesapeake Bay bridge tunnel.

Spot show two periods of juvenile abundance . These periods 1973-1974 and 1980-1981 correspond roughly (lagged by one year) to the periods of juvenile croaker. Commercial landings, however, do not reflect the same degree of fluctuation. These periods have occured since 1970 and may be a reflection of changes in sampling strategy, from the shoals to the channels. Although it is too early to tell, the 1981 peak in juvenile abundance appears to be manifest as a year of increased commercial and sport (1982) catch.

The Rappahannock River has generally yielded more juveniles than the York, due probably to its providing a larger area of preferred habitat.

Weakfish, _Cynoscion regalis_ (Figures 13,31)

Weakfish spawn at the mouth of the Chesapeake Bay and seaside of Virgina's Eastern Shore in spring and have produced two periods of juvenile abundance in the Rappahannock and York. The first period (1969-1971) was followed by a trend of increased commercial landings beginning in 1972 and continuing through 1980.

The juvenile index dropped during the mid-1970's, but recovered to a second peak, with record levels recorded in 1979 and 1980. Consequently, VIMS predicted record commercial catches for 1981, but they did not materialize. We have hypothesized that it may have been due to the drought of 1980-1981 which changed the migratory behavior of the 1+ and 2+ fish; or that there is more than one spawing group of this stock along the east coast with those in the Chesapeake group being the most migratory.

Weakfish overwinter in the Carolina's, and with the approach of spring, migrate northward throughout the Chesapeake system. Some move past the seaside and along the Mid-Atlantic coastal states as far north as Cape Cod. Many adults leave the Bay after spawning and join the northward migration. The extent of the migrations appear related to the size and age of the fish.

Juvenile weakfish are carried into the Bay by early August and move into the rivers and their tributaries which appear to be the major nursery areas (Chao and Musick, 1977). They leave the Bay by early November, migrate to the south, return in late May or June as yearlings, and spend the summer in the Bay area, returning each year to the Carolina's in late fall. The number moving northward from the Bay in early summer may increase with age, until many make a spawning pass through the eastern and lower Bay in the spring, before moving northward to summer in northern waters.

The previously discussed differential migration makes it rather difficult to assess the magnitude of the stock of large weakfish. Predictions are based upon the trawl catch of the young-of-the-year, and the relationship to the subsequent commercial catch which is reasonably good for a few years. Then as these cohorts mature, spending less time in the Bay, the catch appears to fall , and the relationship of the index to commercial landings in Virginia is reduced. This suggests that the Chesapeake Bay is the nursery ground of the larger fish taken in northern Atlantic Bight, and southern New England.

This difference may also help to partially explain the failure of the commercial fishery for weakfish during the 1981 season when large weakfish appeared to bypass the Bay in the spring, continuing northward. The other potential explanation related to the drought was the failure of juvenile menhaden to appear in the Bay in normal numbers during the spring, possibly resulting in the weakfish bypassing the Bay. There has been some improvement in availability of weakfish during the 1982 commercial season, but this was attributable to an increase in the numbers of young fish just entering the fishery.

Fluctuations in the abundance of weakfish appear to be related, at least statistically to the fluctuations of the croaker. Winterkill of weakfish in the Bay area is not responsible for their reduction as it is for the croaker, althought similar losses may occur in the Carolina wintering area south of the Bay. Such a possibility does not appear out of the question, and will be investigated in the near future.

The weakfish stock, which normally spends its first year in the Chesapeake area, appears in good condition. Barring some major environmental event, the stocks should not only remain at their present levels, but should continue to improve, reflected as high catches.

Bothid Fishes

Summer Flounder, Paralichthys dentatus (Figures 14,32)

The juvenile-adult commercial landings relationship for summer flounder in the Chesapeake Bay is complicated by the presence of two independent stocks, one as northern spawned pre-recruit juveniles, and the other as southern spawned Virginia commercial catches. The northern stock, which spawns offshore in the fall in the Mid-Atlantic Bight provides the young-of-the-year in our juvenile surveys. These juveniles are only in the Chesapeake Bay for their first 12 to 18 months, after which as 12-14" recruits they migrate northward and do not return. Their abundance peaked during 1980-1981, due either to successful spawning or increased availability to our gear during the drought years.

The southern stock, which as juveniles winter in Pamlico Sound, appears in the Chesapeake and the Virginia landings as 12-14" (2+) fish. It is this stock that often comprises most of the legal sized Virginia commercial catch. Strong year class successes of both stocks produce accurate Virginia commercial landing predictions, however strong northern year class production can result in an over-prediction .

Reports are that for the summer 1982, large numbers of 10-12" fish were taken commercially, possibly substantiating the 1981 peaks in juveniles, and an indication for mid-Atlantic abundance for 1983- 1984.

Soleid Fishes

Hogchoker, Trinectes maculatus (Figures 15,33)

The hogchoker has shown two periods of abundance since 1965. The first period extended from 1967 through 1973 in both rivers, and from 1979 to the present These periods correspond to periods of abundance of spot and weakfish.

Other Fishes

Yellow Perch, Perca flavescens (Figures 16,34)

Too few yellow perch are taken commercially in Virginia waters to show up in our data.

American Eel, Anguilla rostrata (Figures 17,35)

Too few eels were taken by the trawl to predict trends.

Figure 1

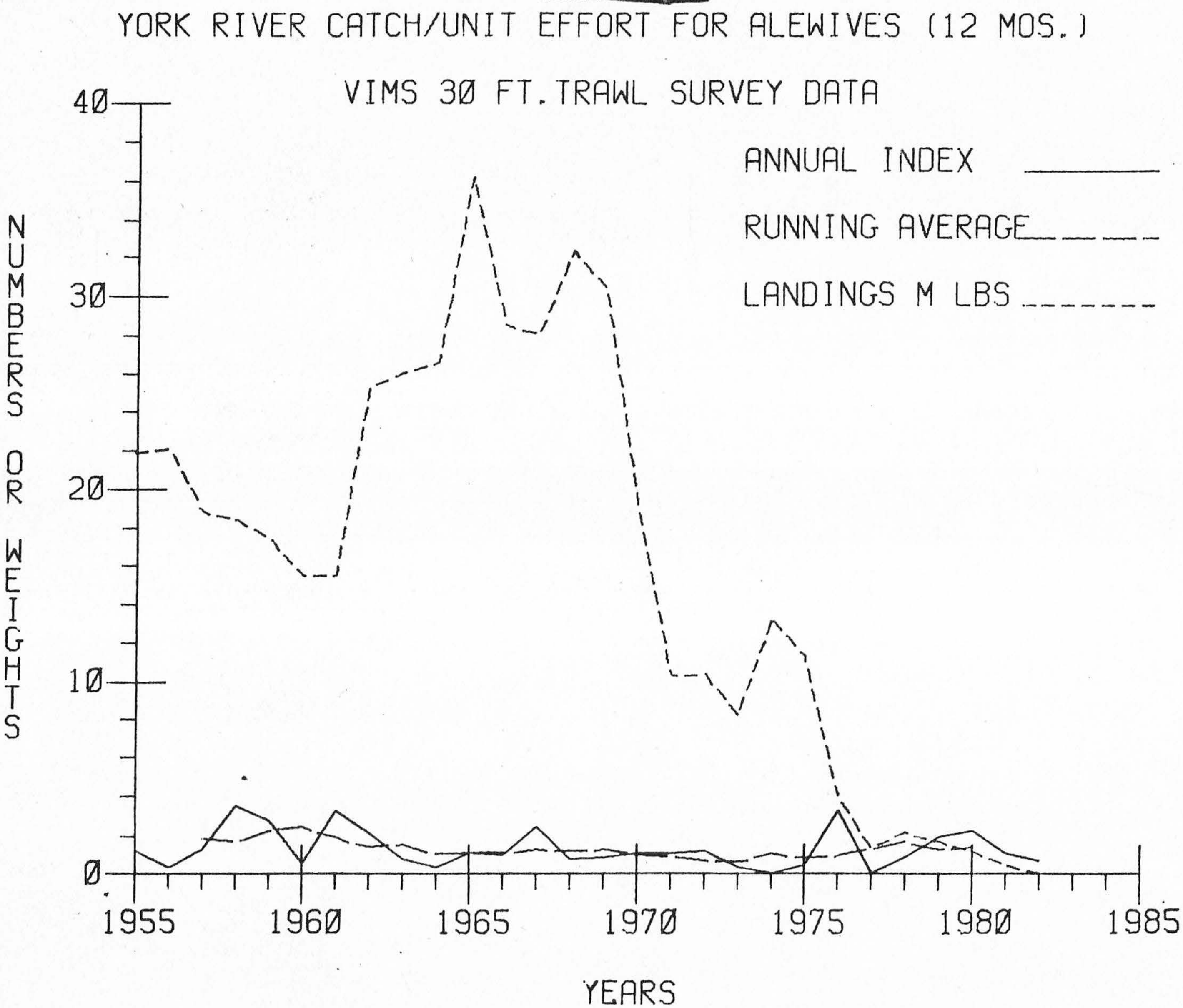

YORK RIVER CATCH/UNIT EFFORT FOR ALEWIVES (12 MOS.)
VIMS 30 FT.TRAWL SURVEY DATA
ANNUAL INDEX
RUNNING AVERAGE
LANDINGS M LBS
NUMBERS OR WEIGHTS
40
30
20
10
0
1955
1960
1965
1970
1975
1980
1985
YEARS

Figure 2

YORK RIVER CATCH/UNIT EFFORT FOR BLUEBACK HERRING (12 MOS.)

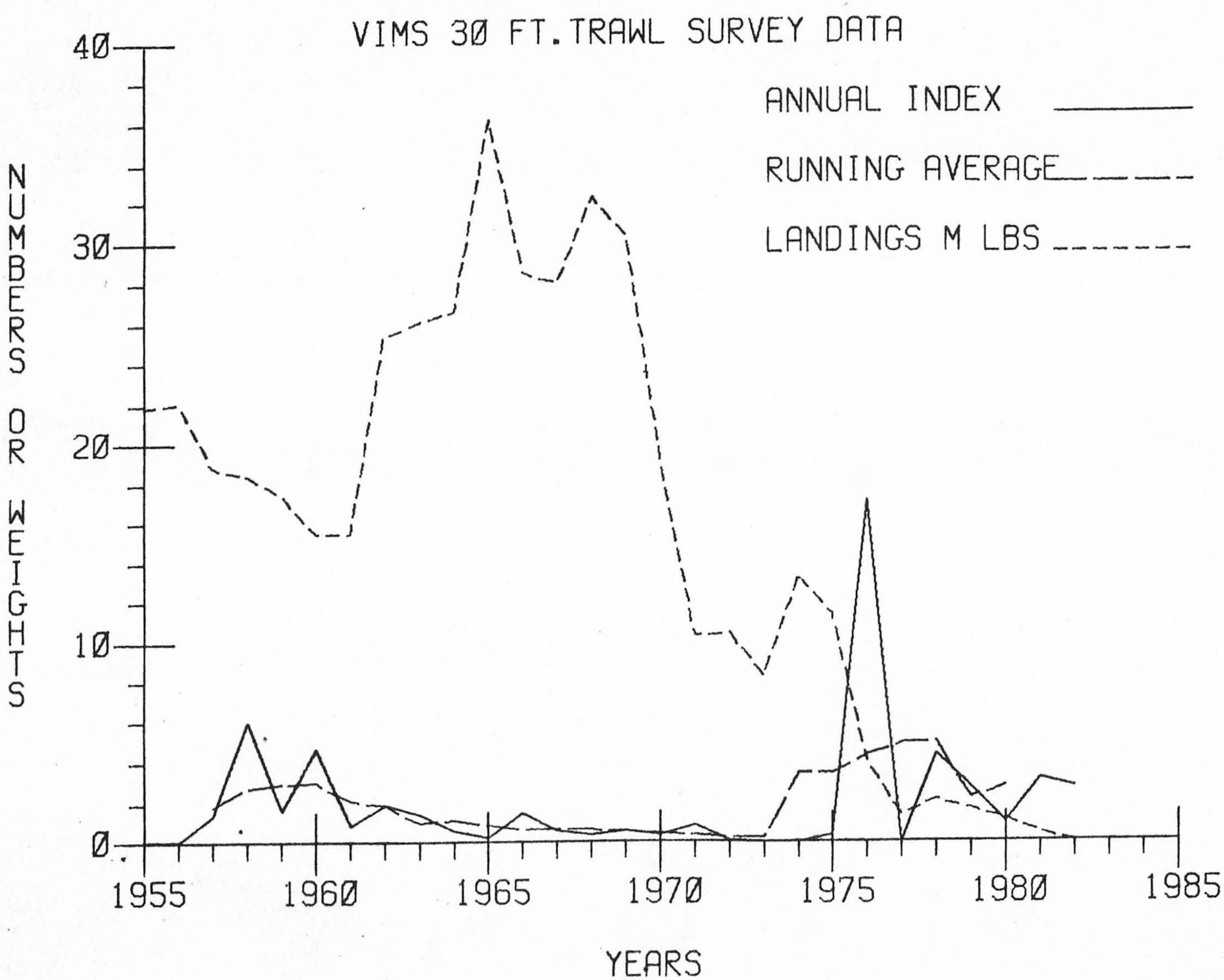


Figure 3

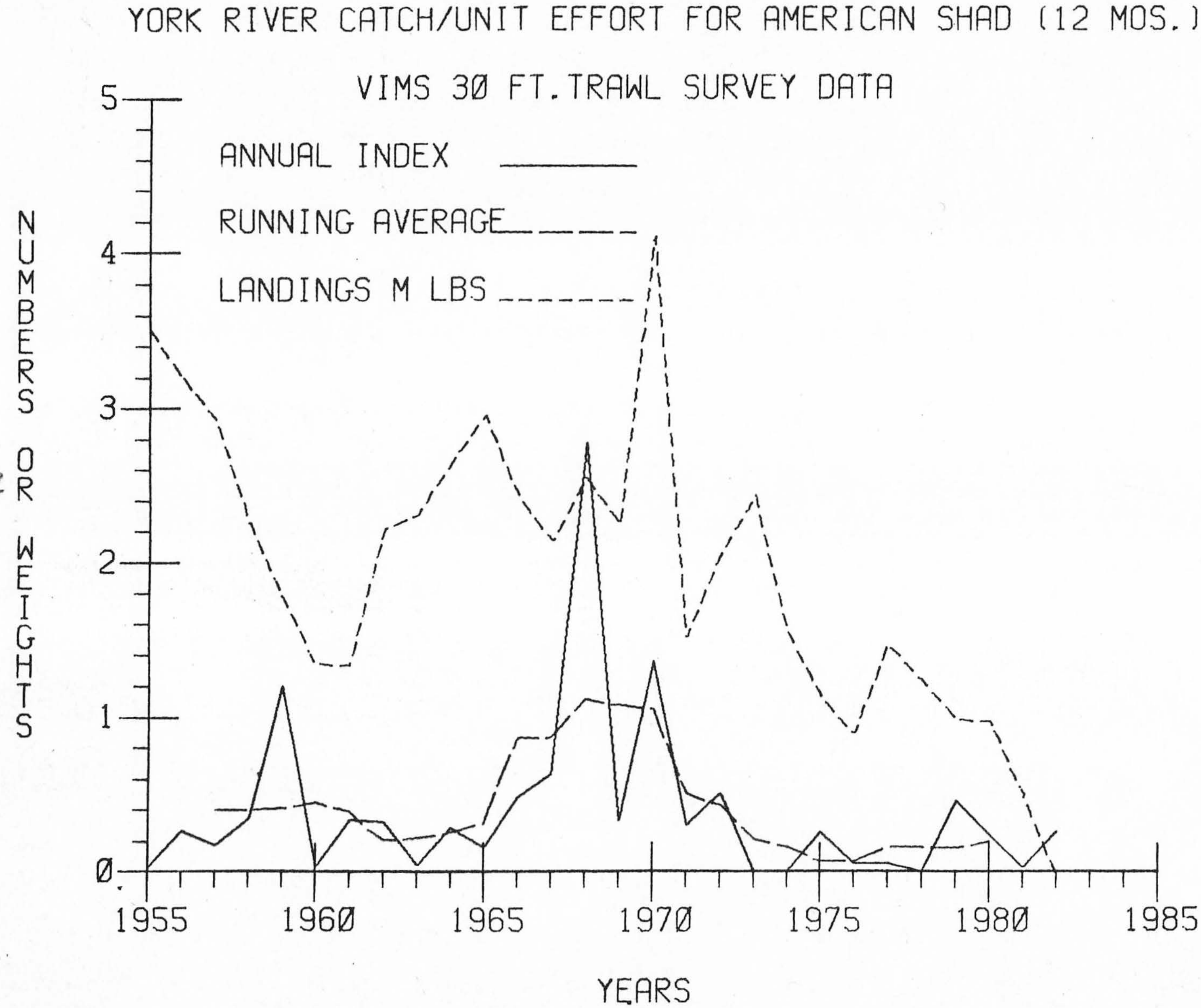

YORK RIVER CATCH/UNIT EFFORT FOR AMERICAN SHAD (12 MOS.)
VIMS 30 FT.TRAWL SURVEY DATA
ANNUAL INDEX
RUNNING AVERAGE
LANDINGS M LBS
NUMBERS OR WEIGHTS
0
1
2
3
4
5
1955
1960
1965
1970
1975
1980
1985
YEARS

Figure 4

YORK RIVER CATCH/UNIT EFFORT FOR ATLANTIC MENHADEN (12 MOS.)

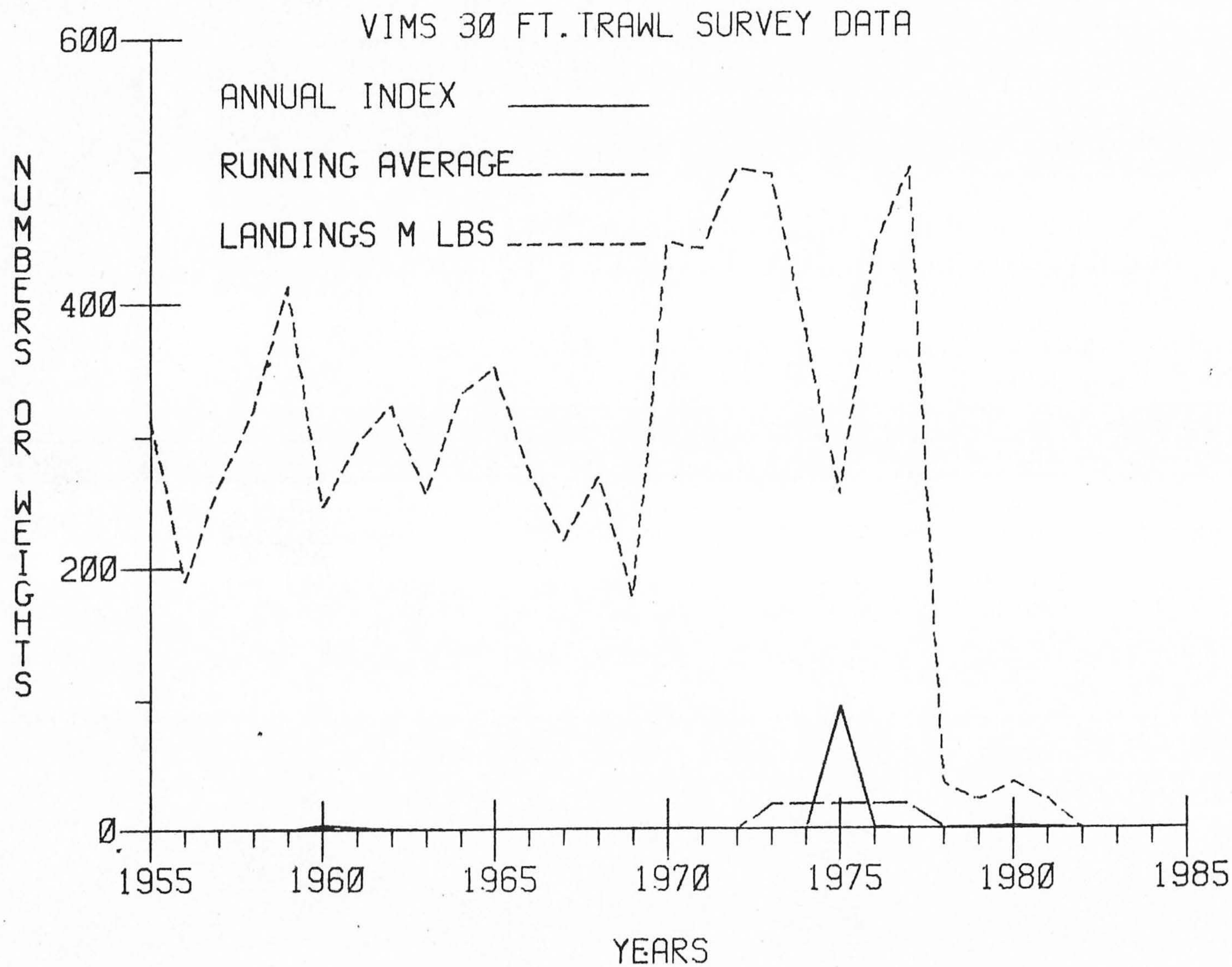


Figure 5

YORK RIVER CATCH/UNIT EFFORT FOR BAY ANCHOVY (12 MOS.)

VIMS 30 FT. TRAWL SURVEY DATA

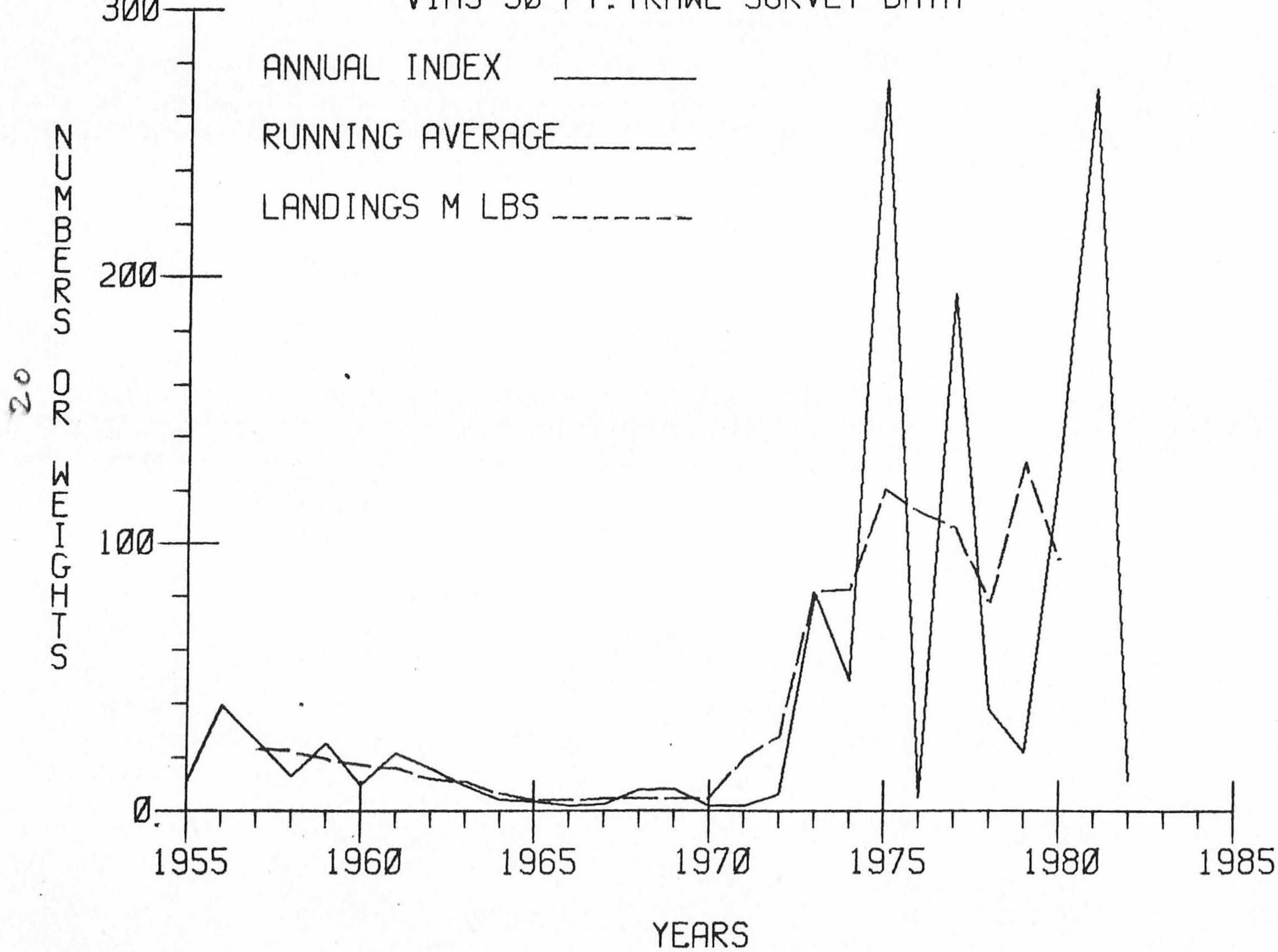


Figure 6

YORK RIVER CATCH/UNIT EFFORT FOR CHANNEL CATFISH (12 MOS.)

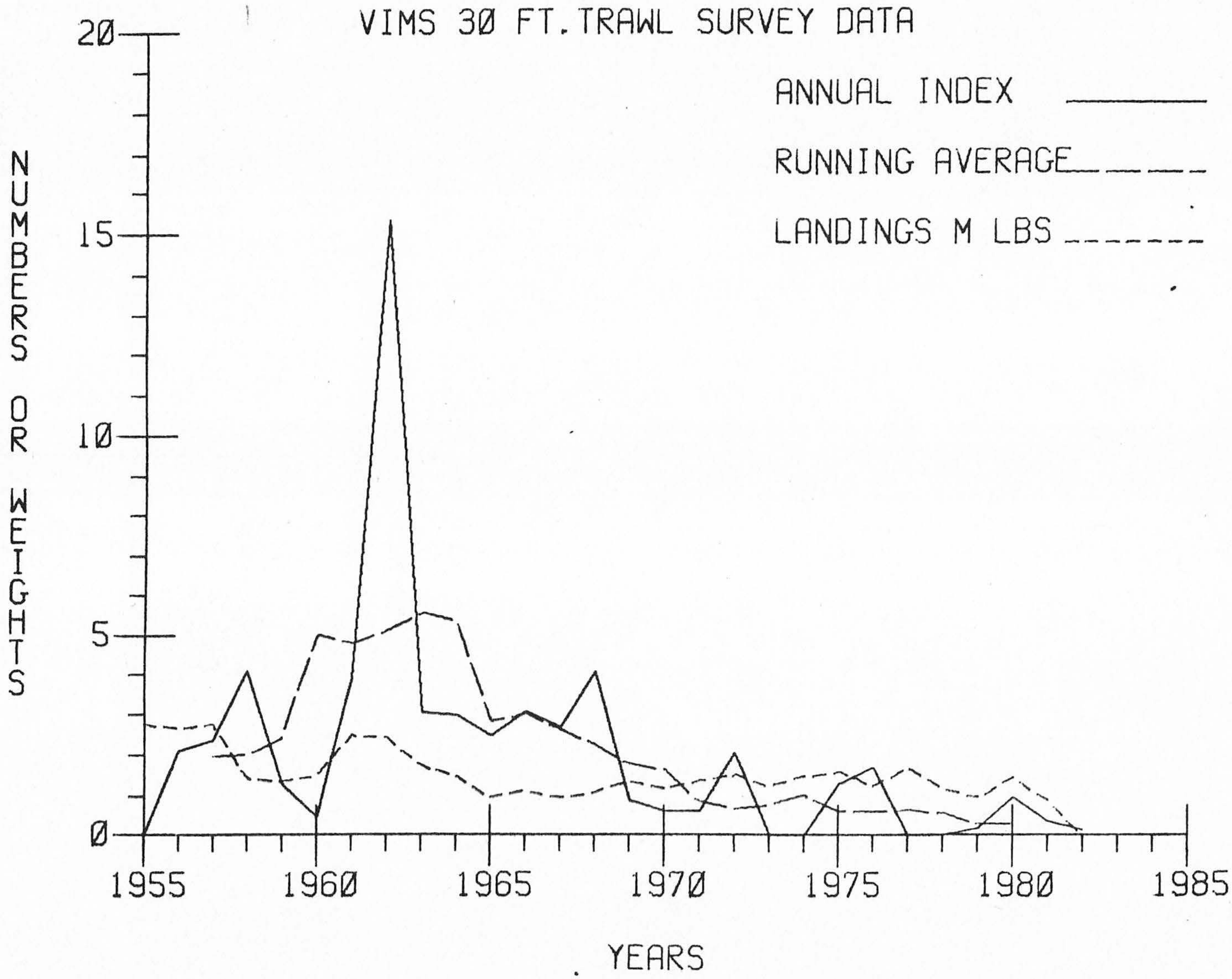
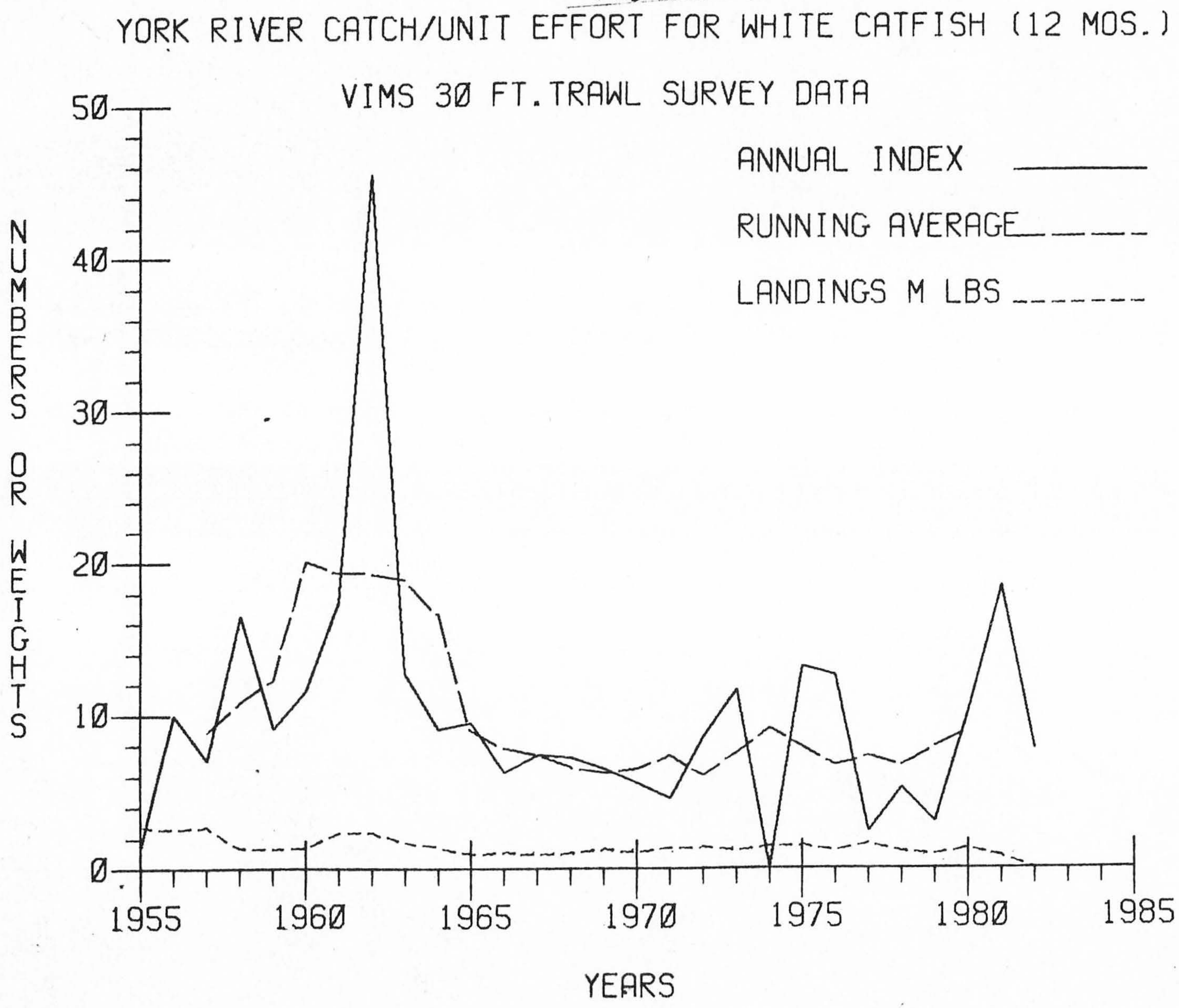


Figure 7



YORK RIVER CATCH/UNIT EFFORT FOR WHITE CATFISH (12 MOS.)
VIMS 30 FT. TRAWL SURVEY DATA
ANNUAL INDEX
RUNNING AVERAGE
LANDINGS M LBS
NUMBERS OR WEIGHTS
50
40
30
20
10
0
1955
1960
1965
1970
1975
1980
1985
YEARS

Figure 8

YORK RIVER CATCH/UNIT EFFORT FOR STRIPED BASS (12 MOS.)

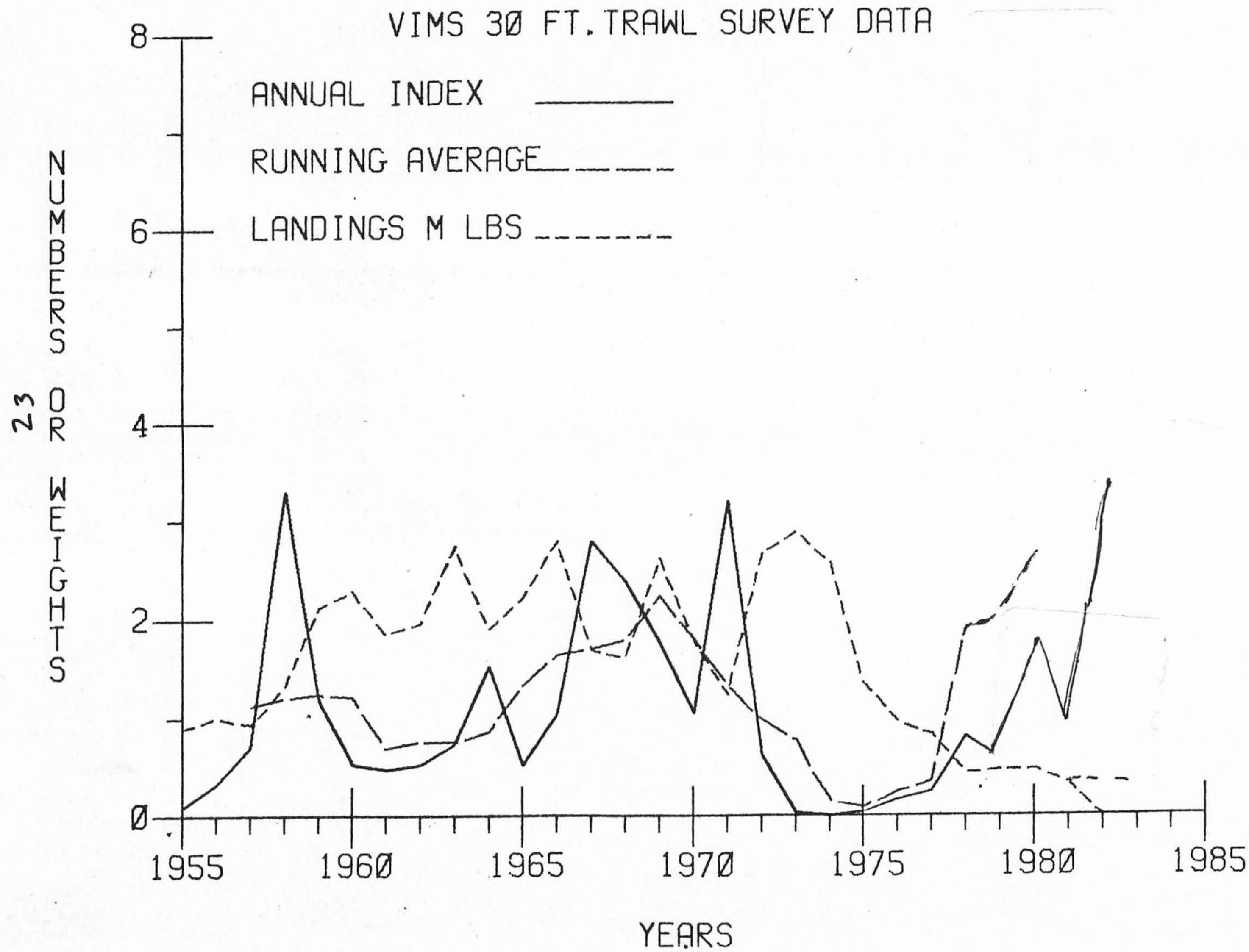


Figure 9

YORK RIVER CATCH/UNIT EFFORT FOR WHITE PERCH (12 MOS.)

VIMS 30 FT. TRAWL SURVEY DATA

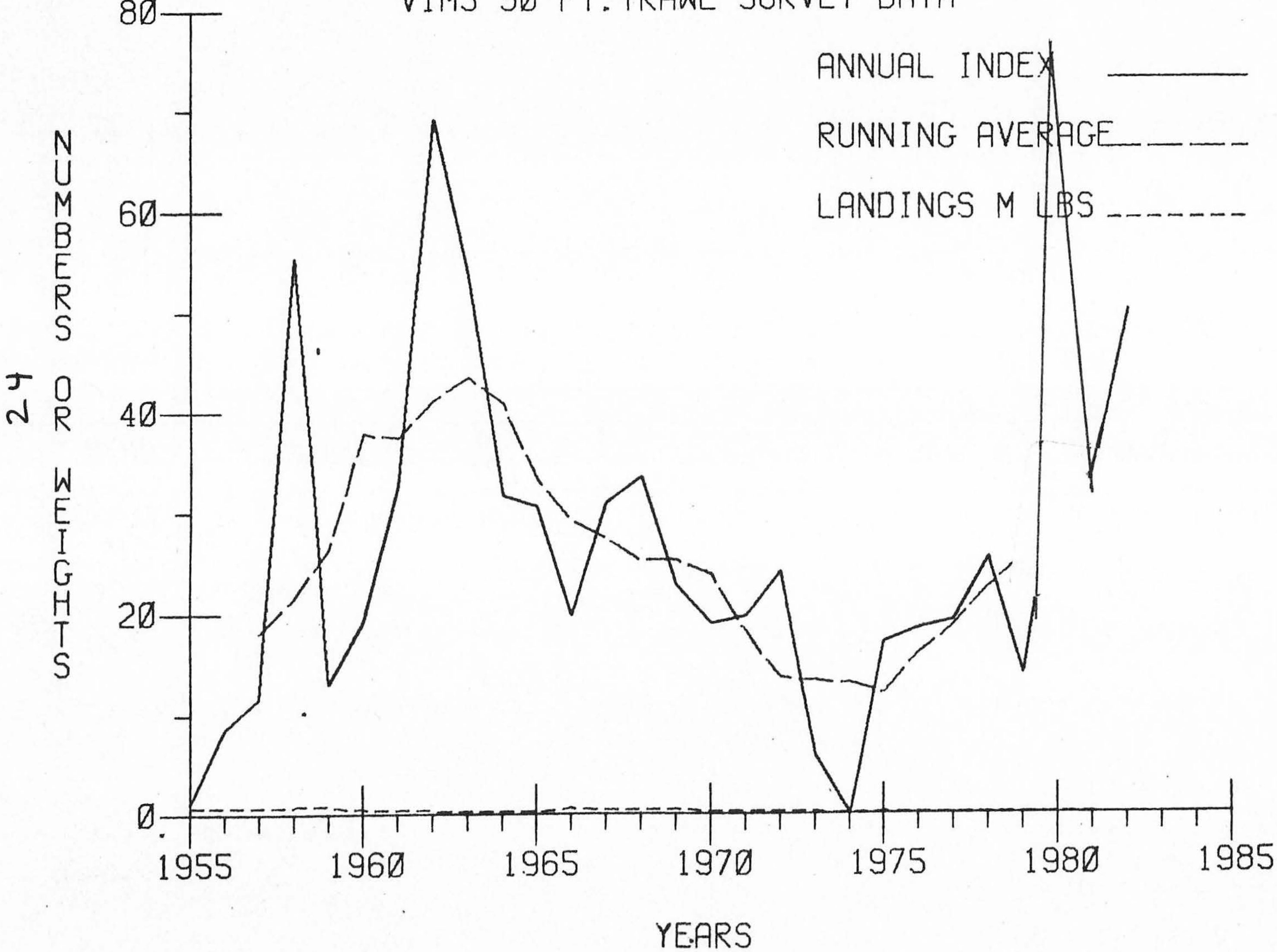


Figure 10

YORK RIVER CATCH/UNIT EFFORT FOR BLUEFISH (12 MOS.)

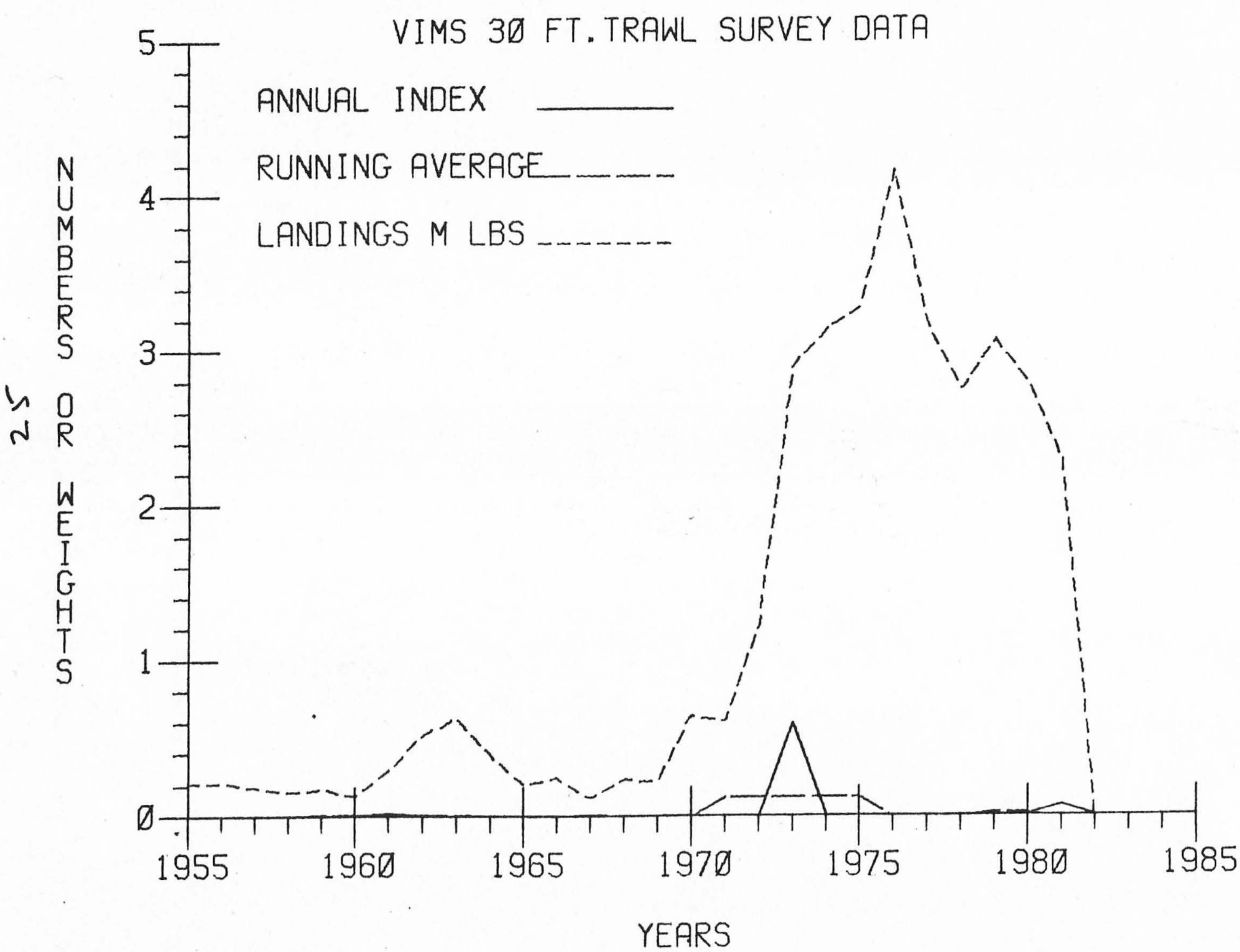


Figure 11

YORK RIVER CATCH/UNIT EFFORT FOR ATLANTIC CROAKER (12 MOS.)

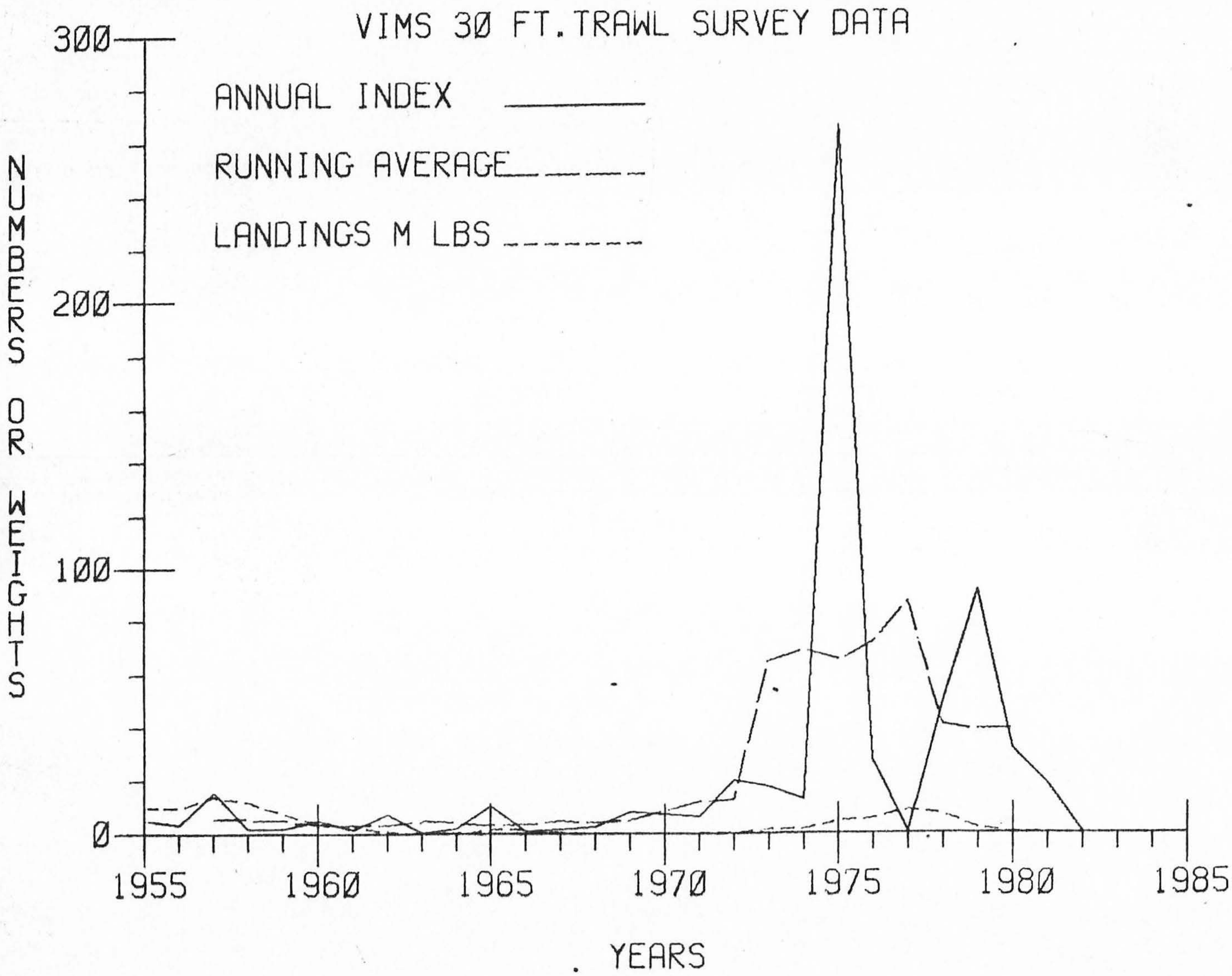
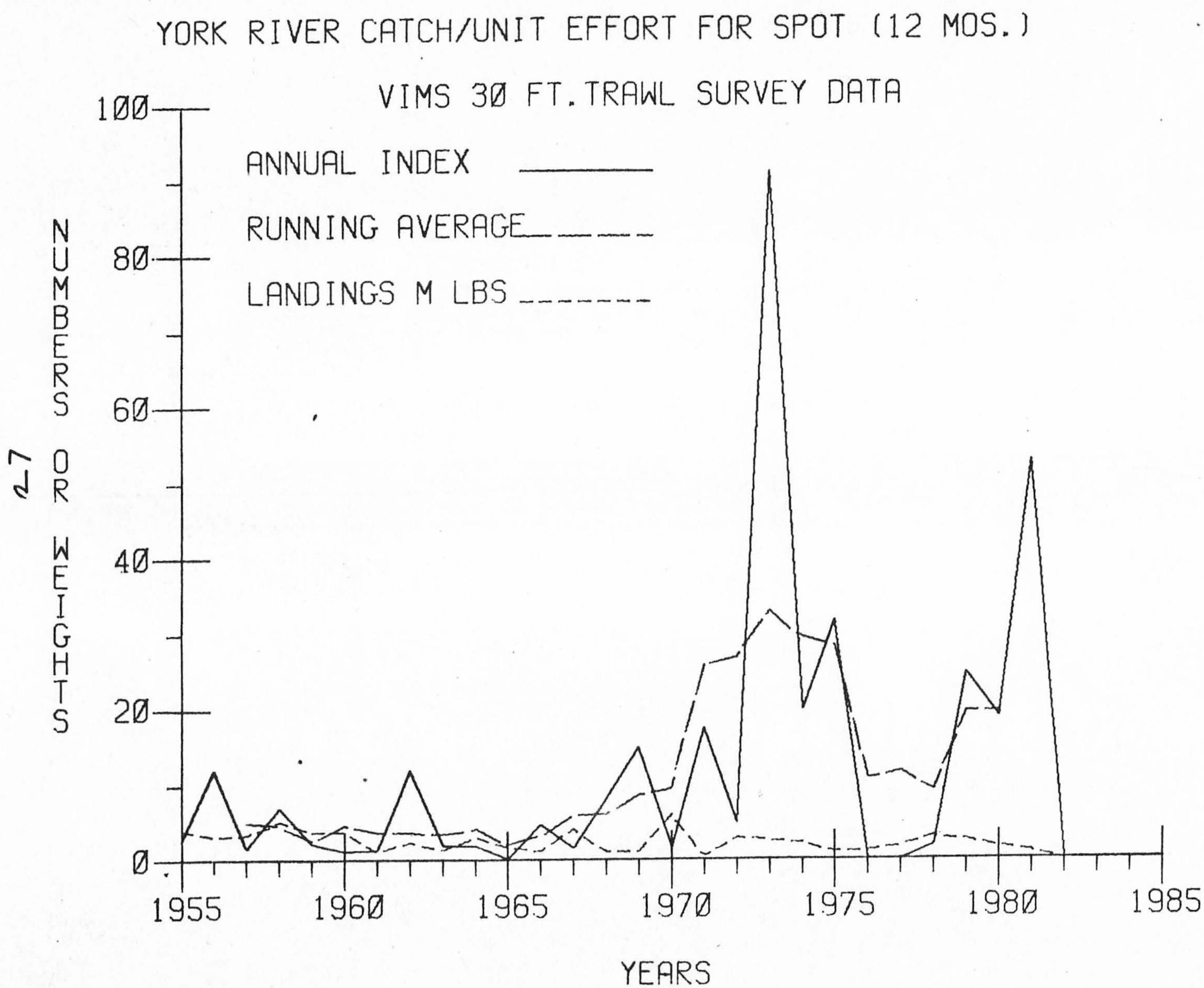


Figure 12



YORK RIVER CATCH/UNIT EFFORT FOR SPOT (12 MOS.)
VIMS 30 FT.TRAWL SURVEY DATA
ANNUAL INDEX
RUNNING AVERAGE
LANDINGS M LBS
NUMBERS OR WEIGHTS
100
80
60
40
20
0
1955
1960
1965
1970
1975
1980
1985
YEARS

Figure 13

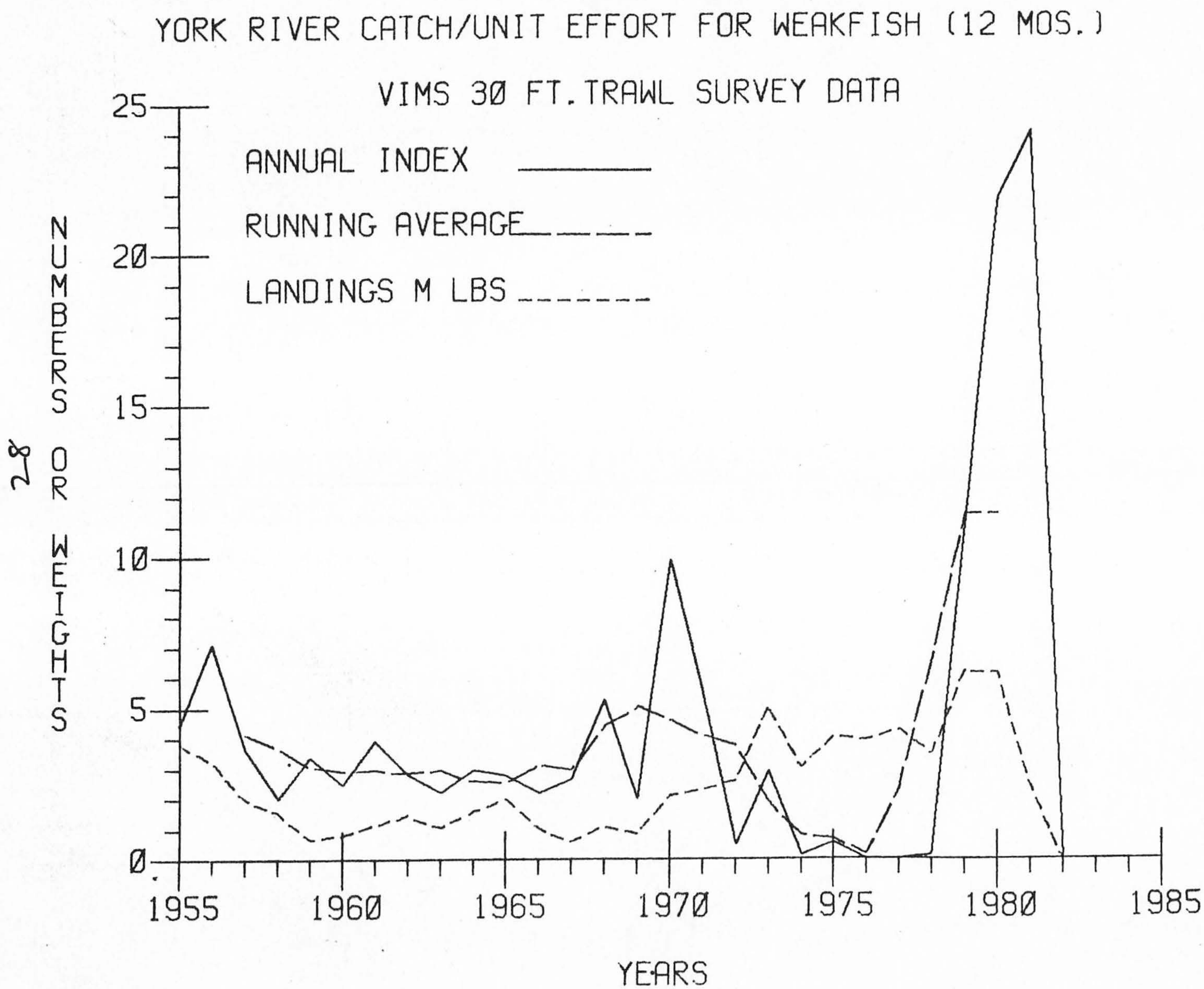

YORK RIVER CATCH/UNIT EFFORT FOR WEAKFISH (12 MOS.)
VIMS 30 FT.TRAWL SURVEY DATA
ANNUAL INDEX
RUNNING AVERAGE
LANDINGS M LBS
NUMBERS OR WEIGHTS
25
20
15
10
5
0
1955
1960
1965
1970
1975
1980
1985
YEARS

Figure 14

YORK RIVER CATCH/UNIT EFFORT FOR SUMMER FLOUNDER (12.MOS.)

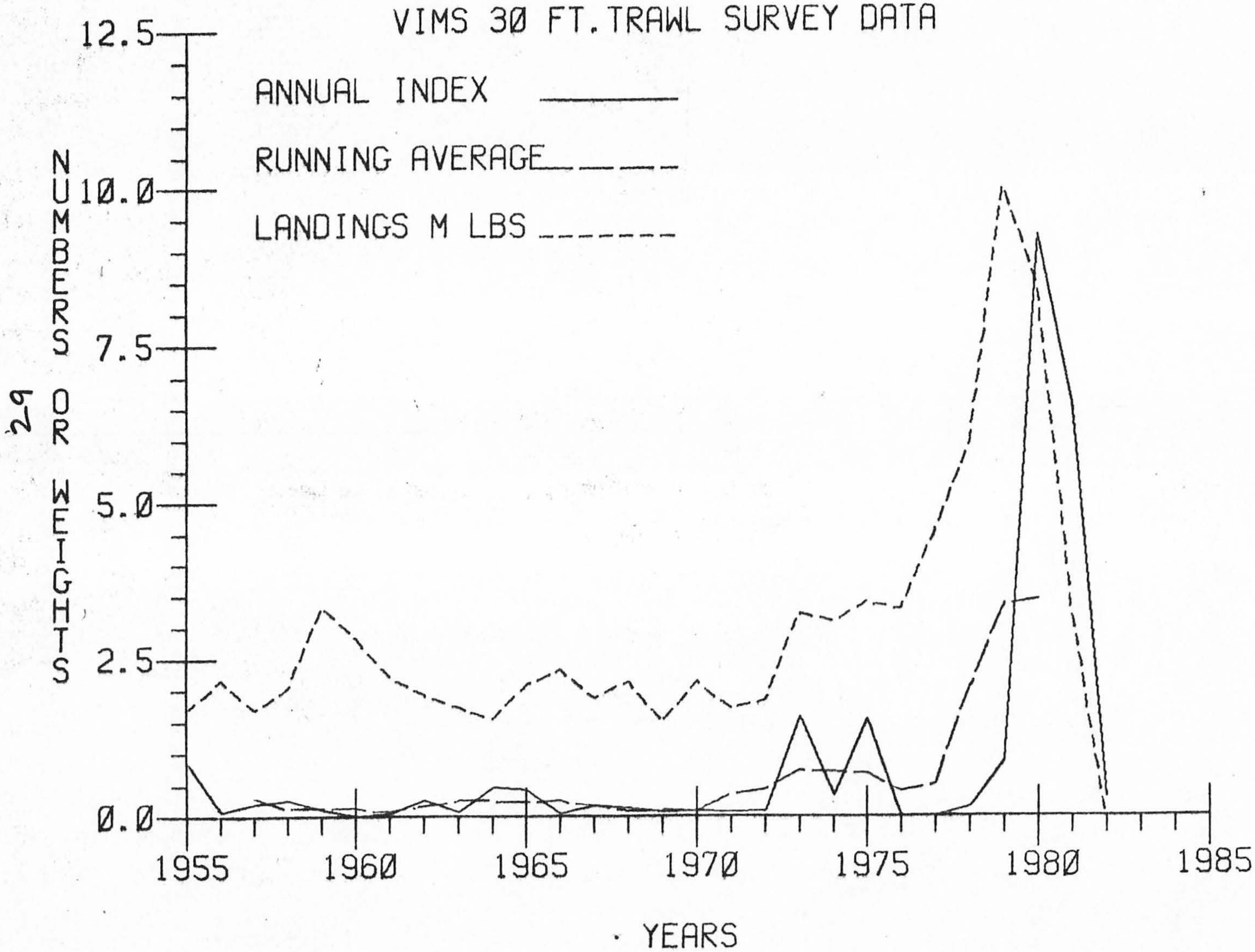


Figure 15

YORK RIVER CATCH/UNIT EFFORT FOR HOGCHOKER (12 MOS.)

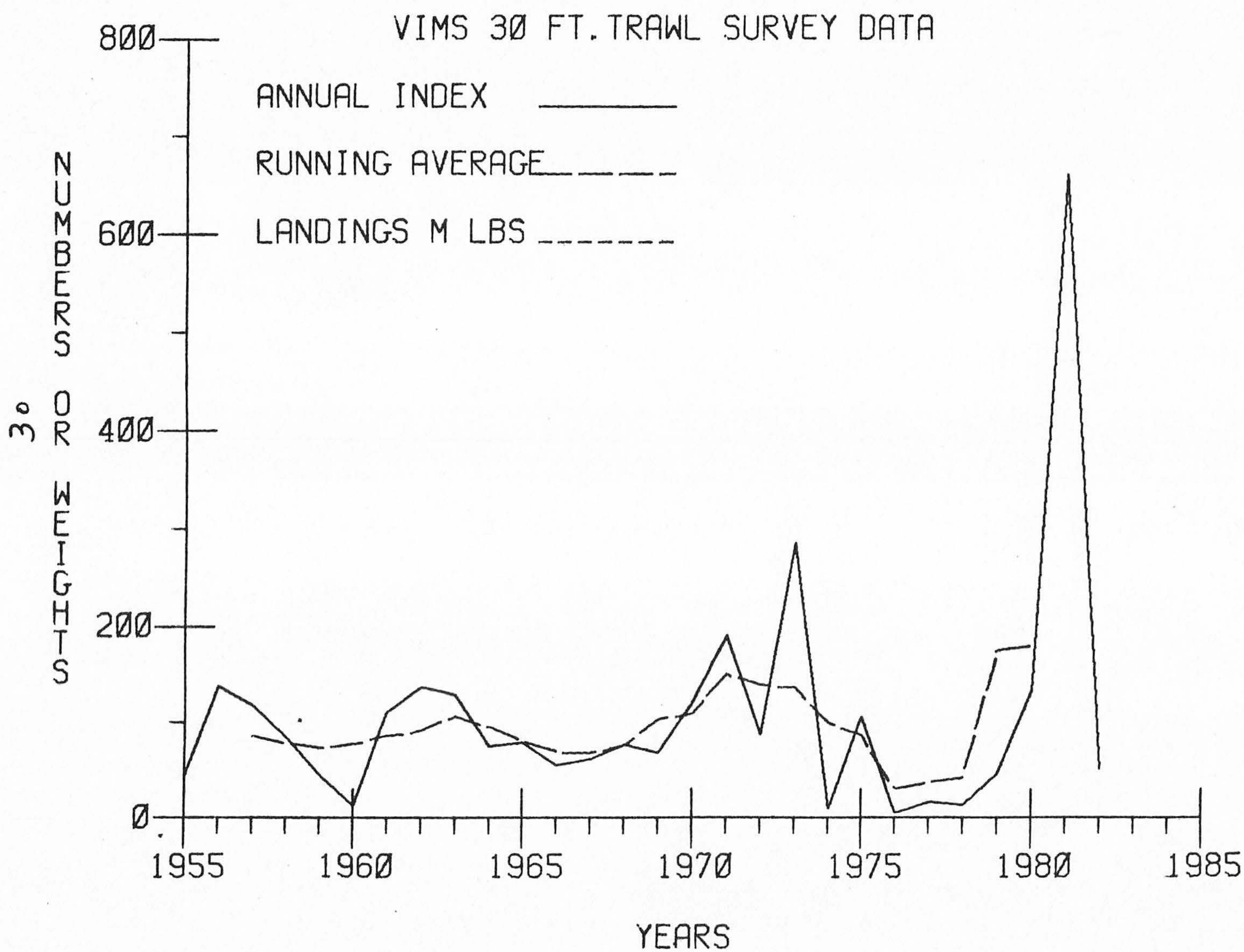
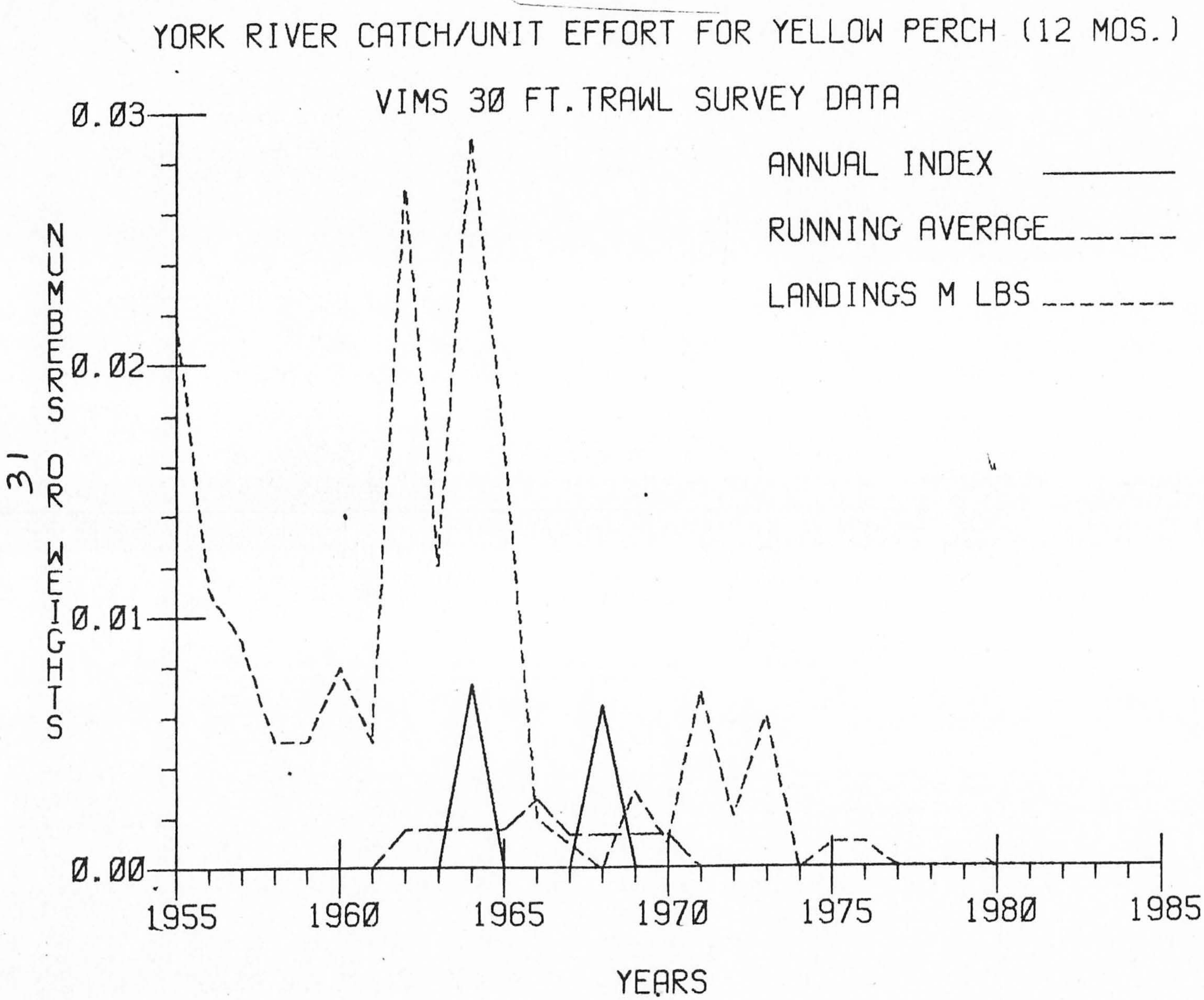


Figure 16

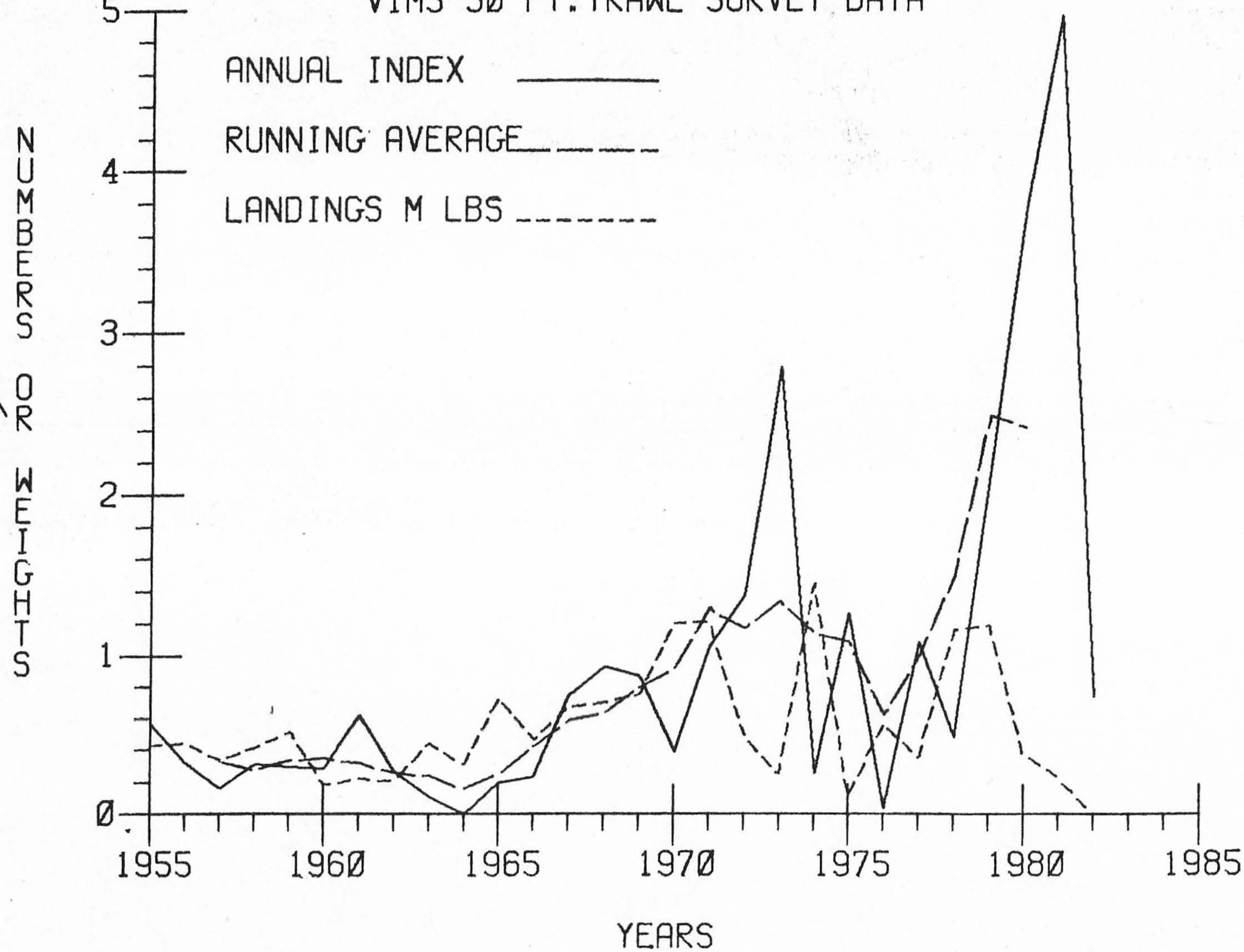


YORK RIVER CATCH/UNIT EFFORT FOR YELLOW PERCH (12 MOS.)
VIMS 30 FT.TRAWL SURVEY DATA
ANNUAL INDEX
RUNNING AVERAGE
LANDINGS M LBS
NUMBERS OR WEIGHTS
0.03
0.02
0.01
0.00
1955
1960
1965
1970
1975
1980
1985
YEARS

Figure 17

YORK RIVER CATCH/UNIT EFFORT FOR AMERICAN EEL (12 MOS.)

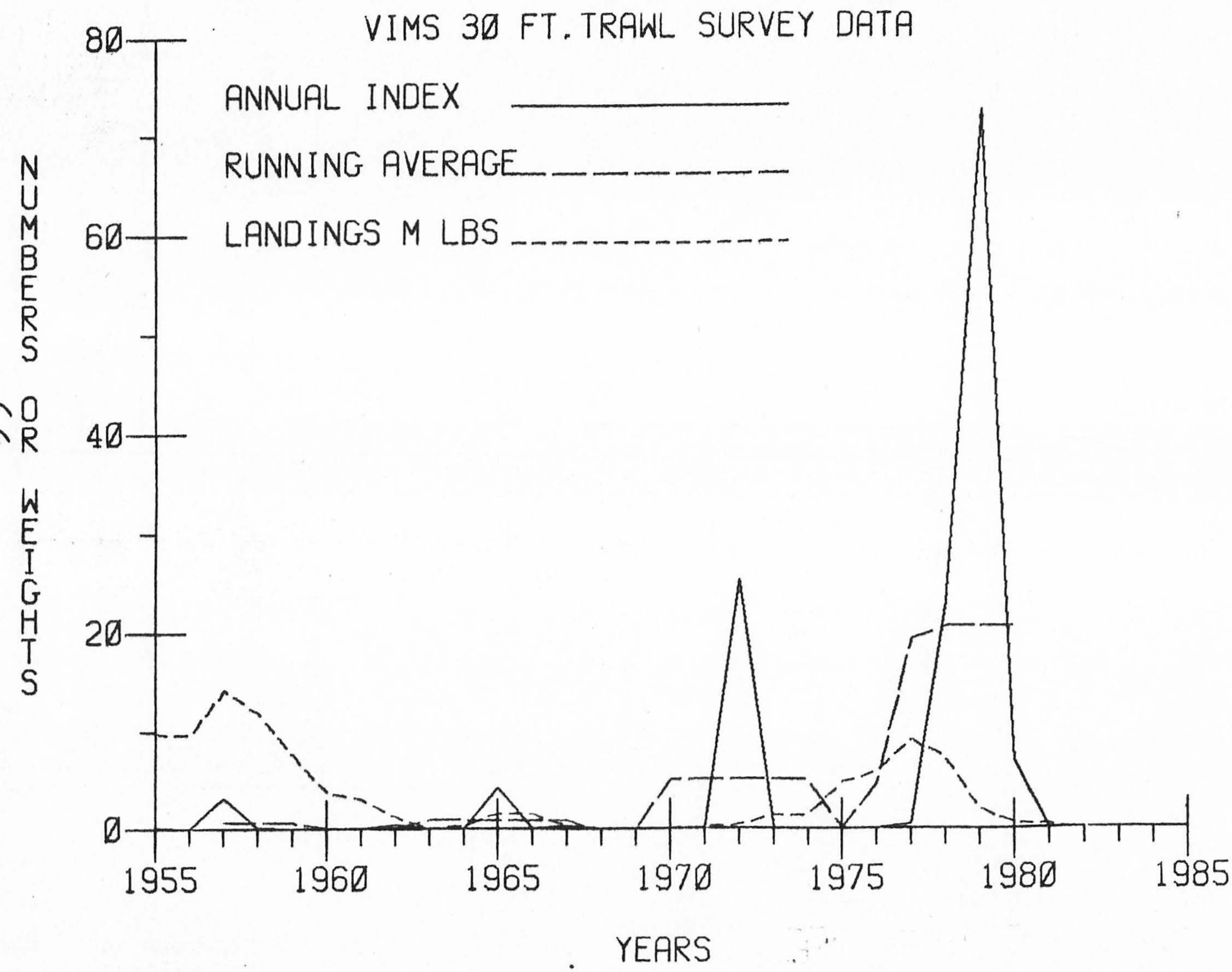
VIMS 30 FT. TRAWL SURVEY DATA



32

Figure 18

YORK RIVER CATCH/UNIT EFFORT FOR ATLANTIC CROAKER (MOS. 12 - 11)



33

Figure 19

RAPP RIVER CATCH/UNIT EFFORT FOR ALEWIVES (12 MOS.)

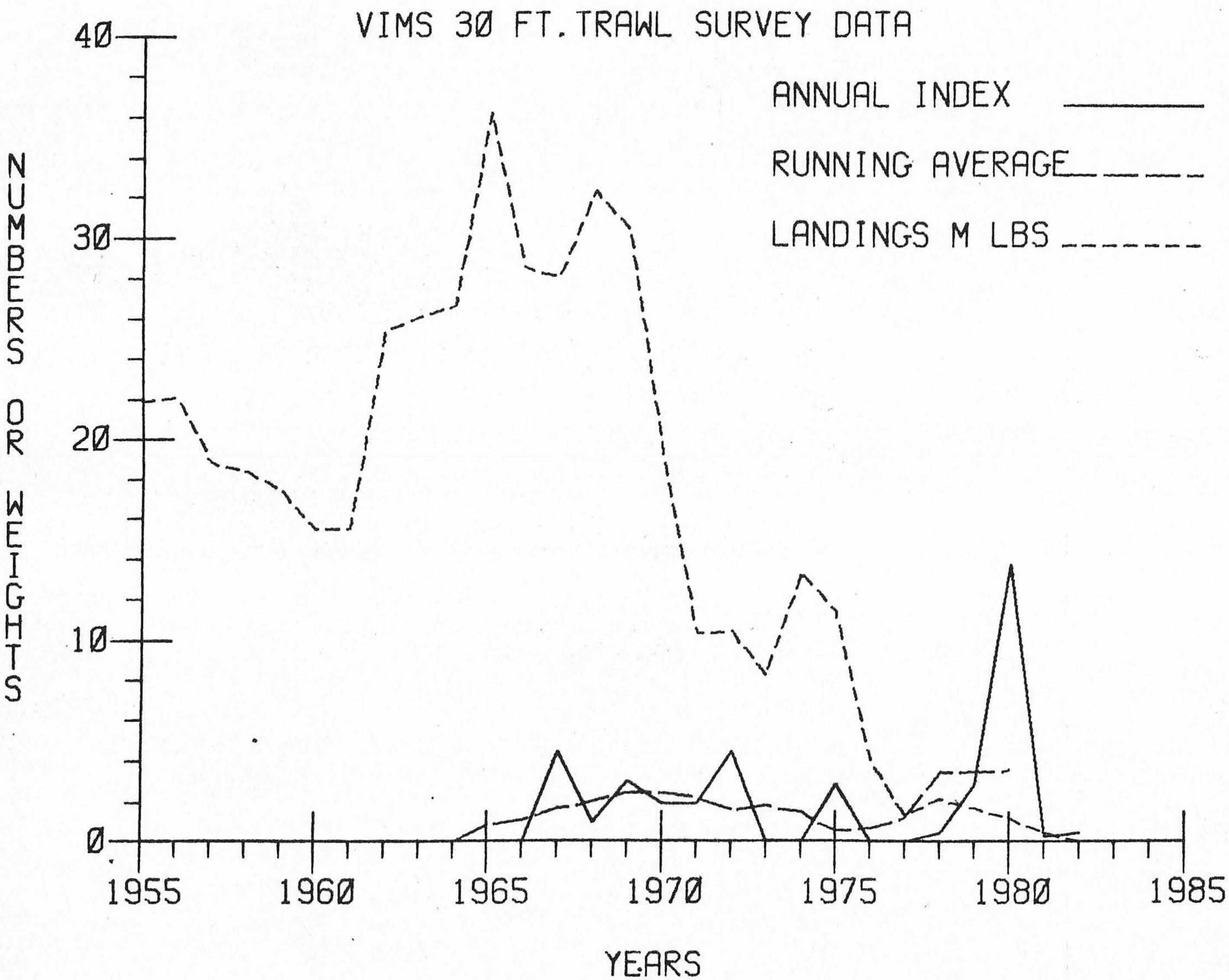


Figure 20

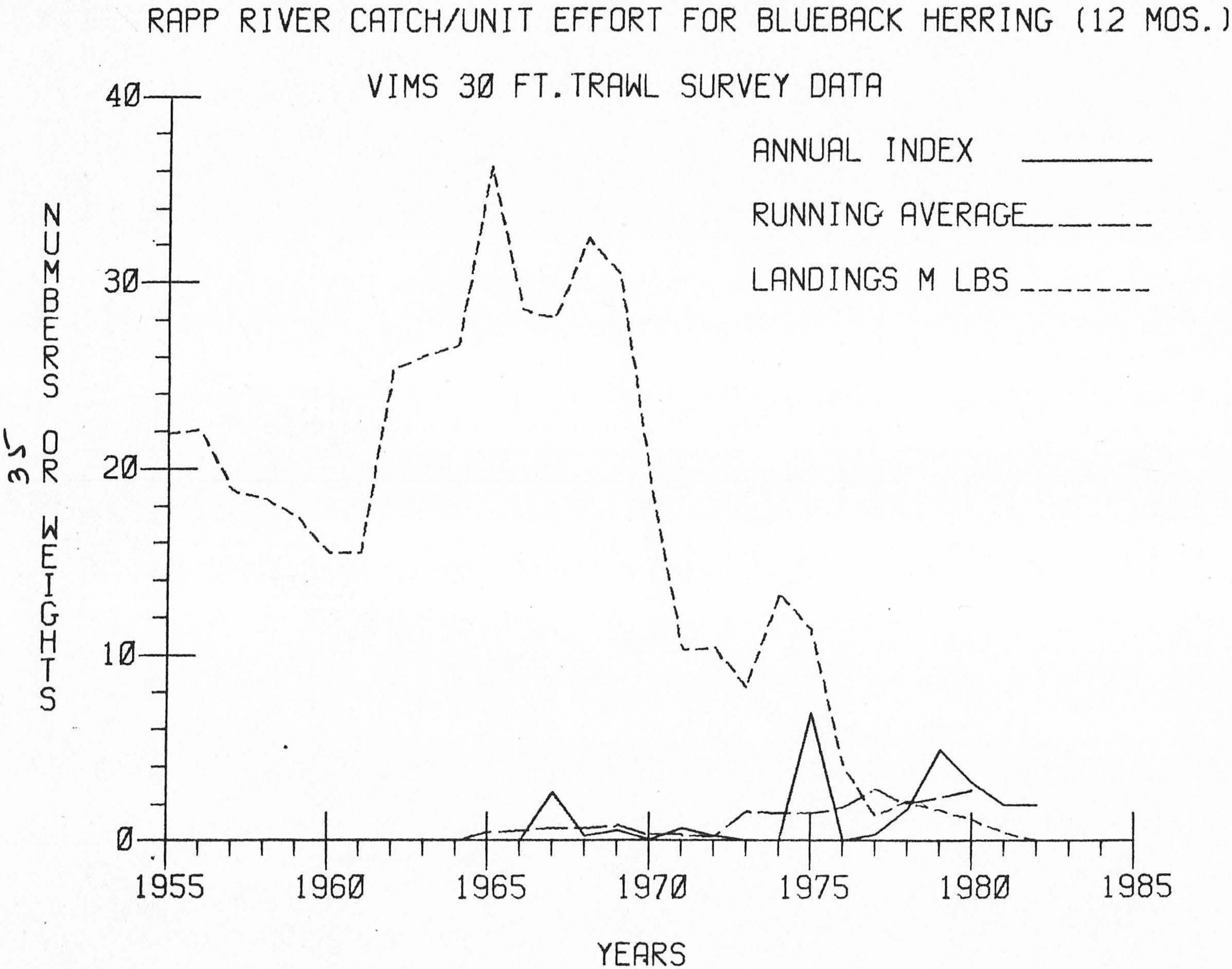

RAPP RIVER CATCH/UNIT EFFORT FOR BLUEBACK HERRING (12 MOS.)
VIMS 30 FT. TRAWL SURVEY DATA
ANNUAL INDEX
RUNNING AVERAGE
LANDINGS M LBS
NUMBERS OR WEIGHTS
0
10
20
30
40
1955
1960
1965
1970
1975
1980
1985
YEARS

Figure 21

RAPP RIVER CATCH/UNIT EFFORT FOR AMERICAN SHAD (12 MOS.)

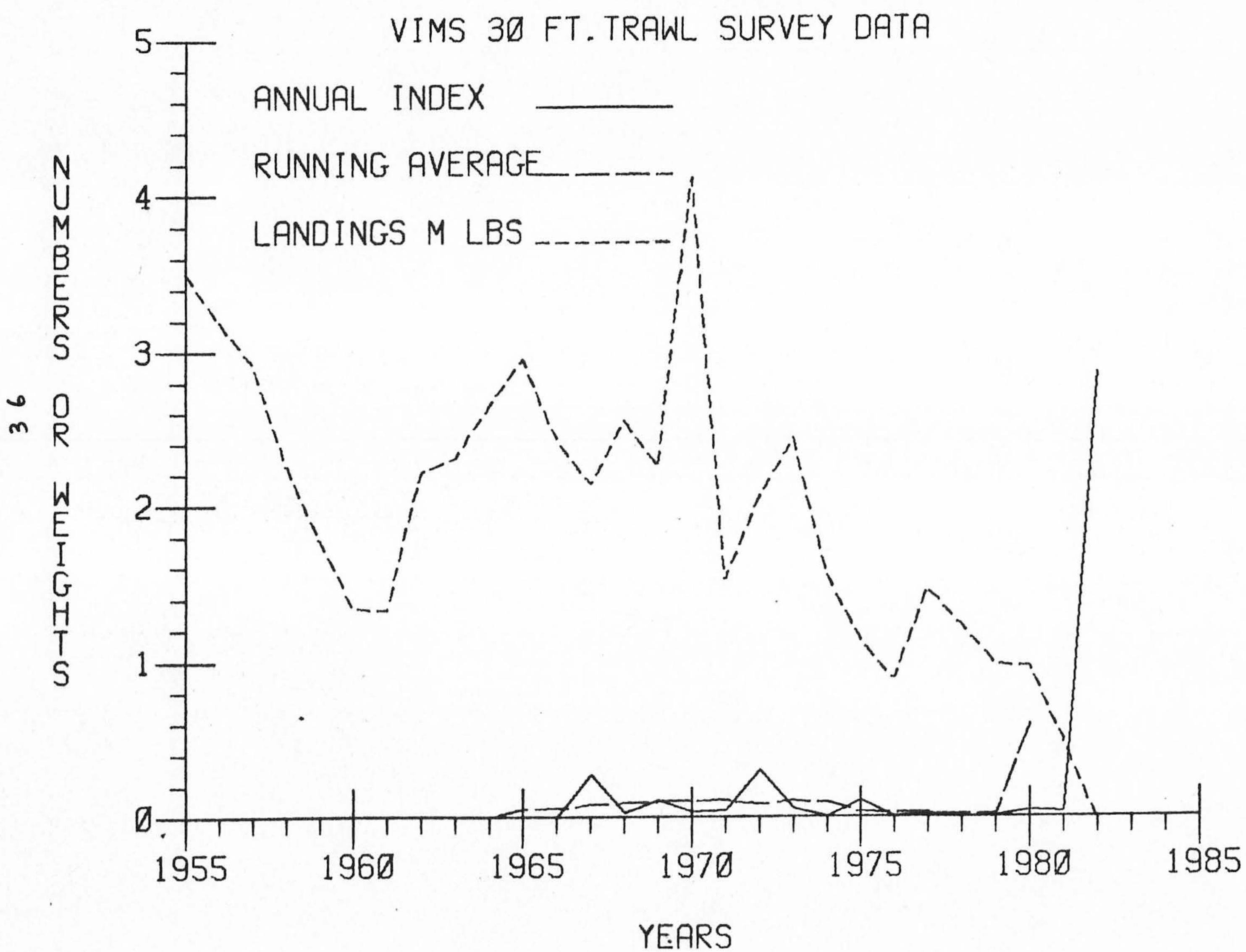


Figure 22

RAPP RIVER CATCH/UNIT EFFORT FOR ATLANTIC MENHADEN (12 MOS.)

VIMS 30 FT. TRAWL SURVEY DATA

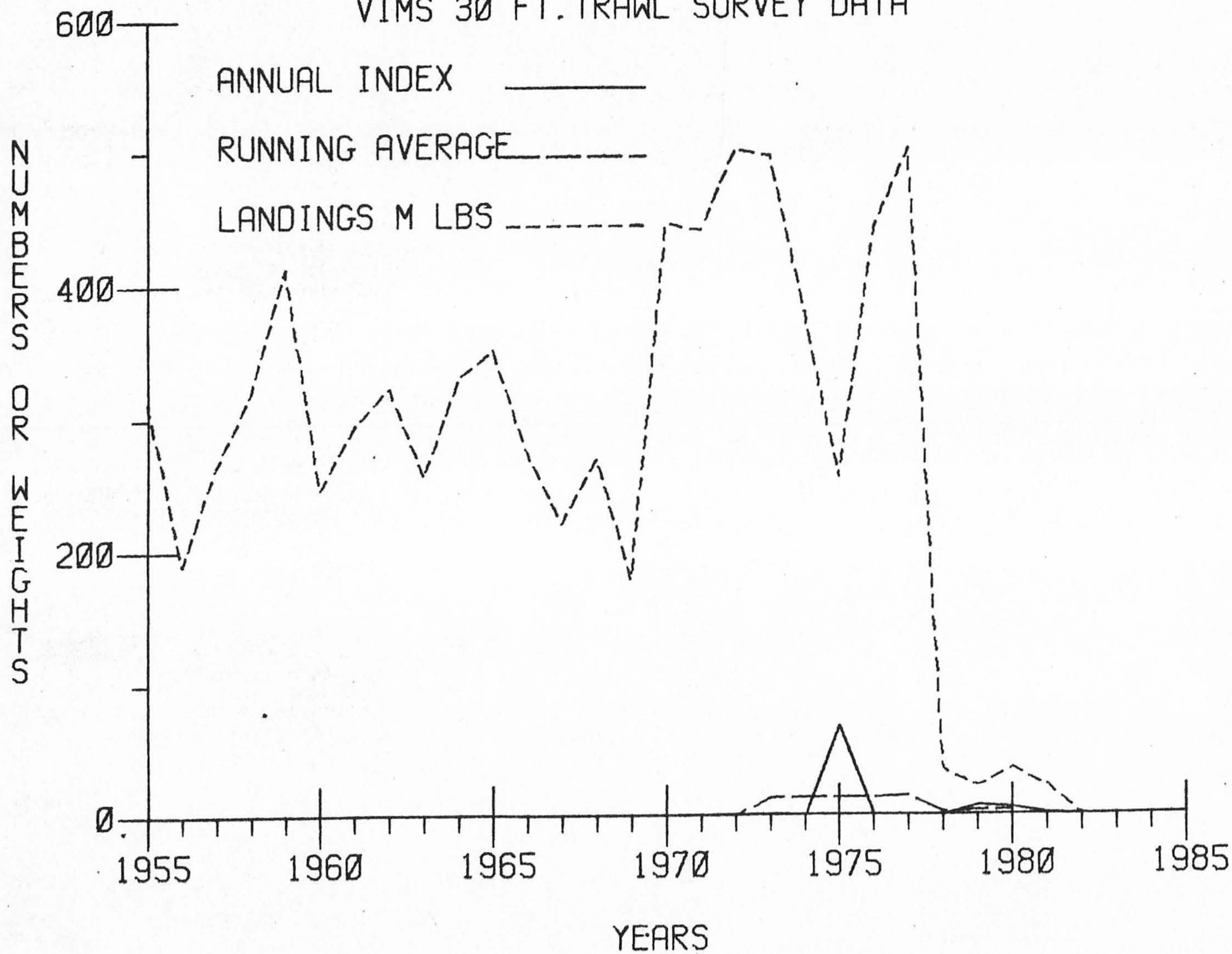
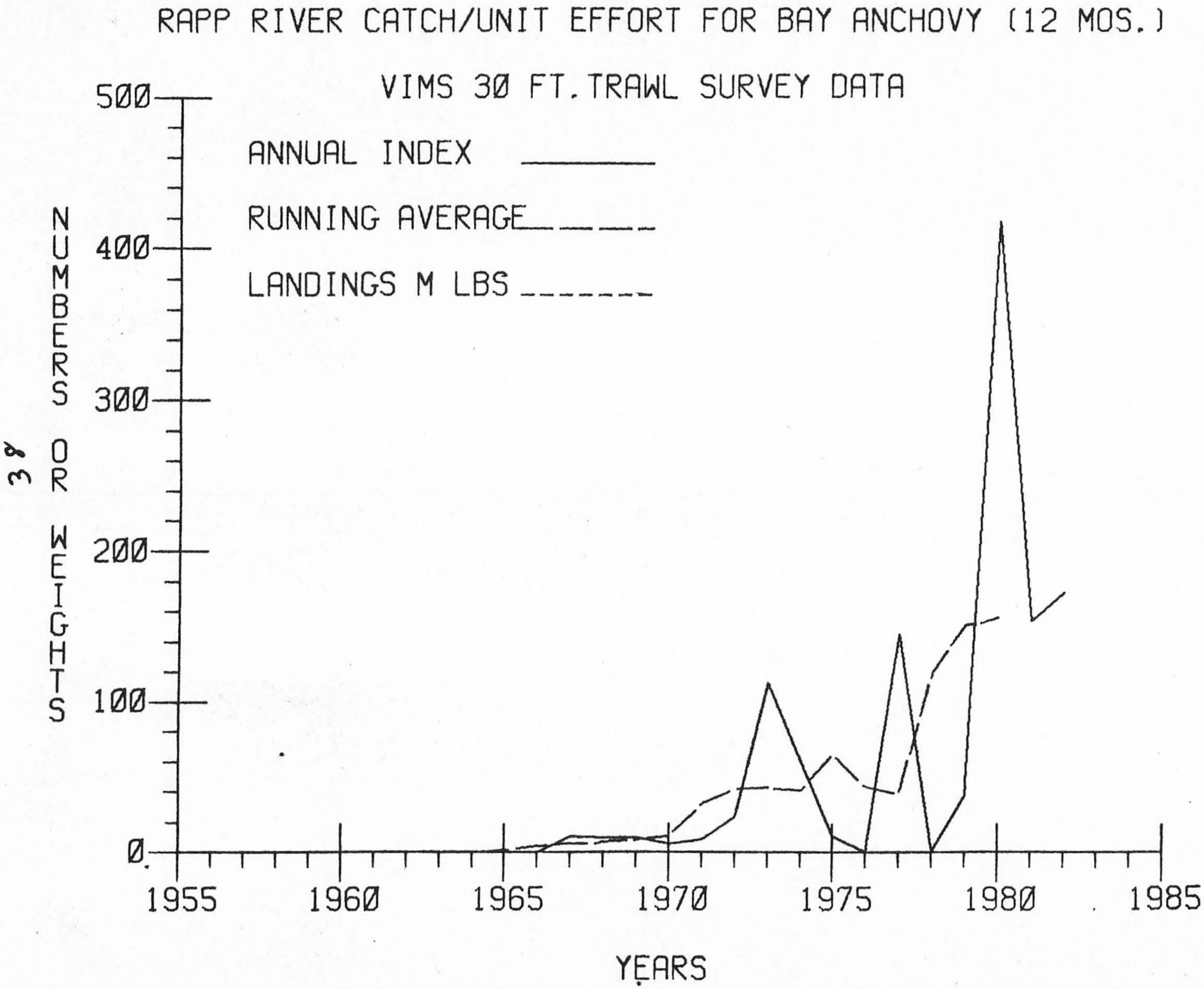


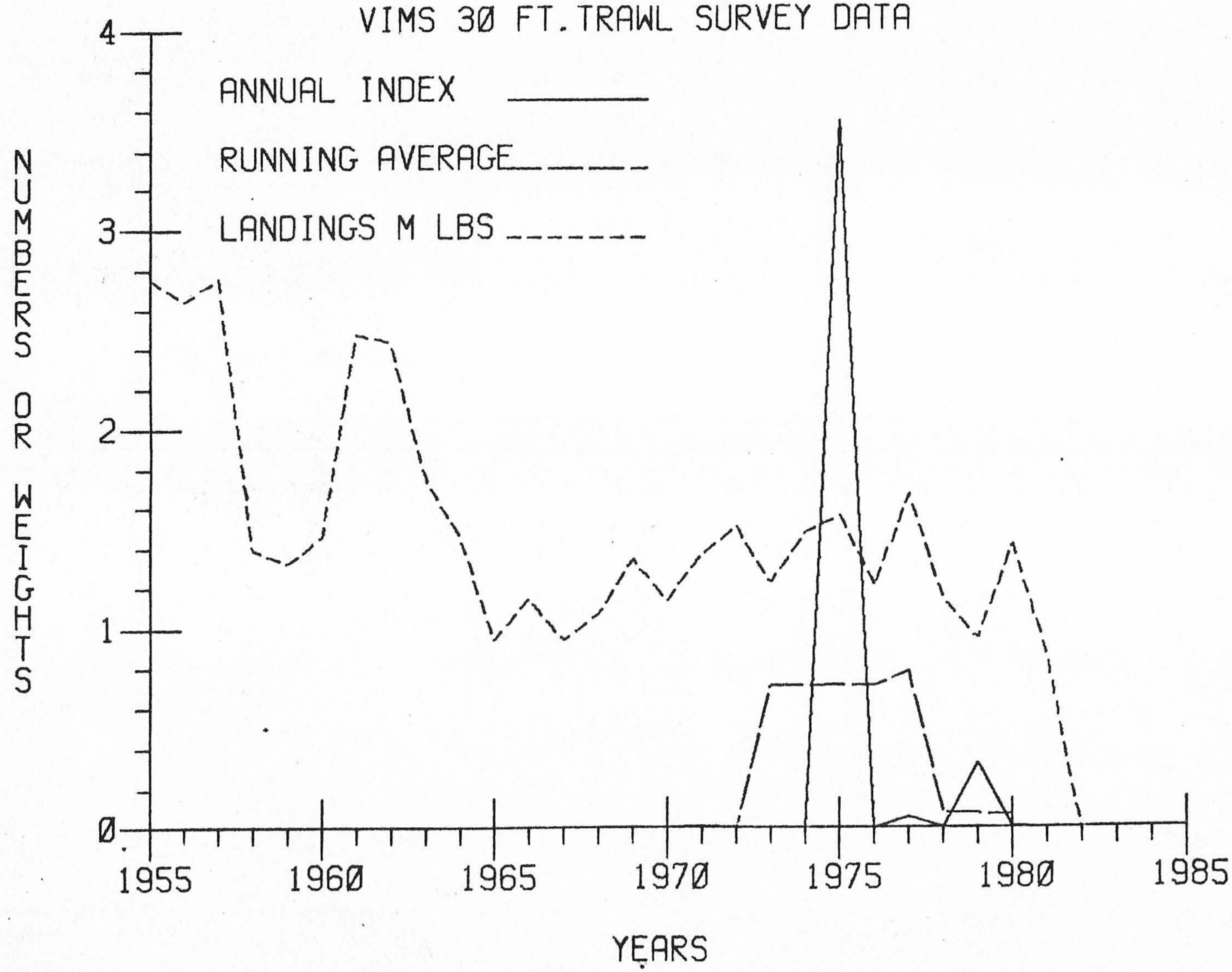
Figure 23



RAPP RIVER CATCH/UNIT EFFORT FOR BAY ANCHOVY (12 MOS.)
VIMS 30 FT. TRAWL SURVEY DATA
ANNUAL INDEX
RUNNING AVERAGE
LANDINGS M LBS
NUMBERS OR WEIGHTS
500
400
300
200
100
0
1955
1960
1965
1970
1975
1980
1985
YEARS

Figure 24

RAPP RIVER CATCH/UNIT EFFORT FOR CHANNEL CATFISH (12 MOS.)



39

Figure 25

RAPP RIVER CATCH/UNIT EFFORT FOR WHITE CATFISH (12 MOS.)

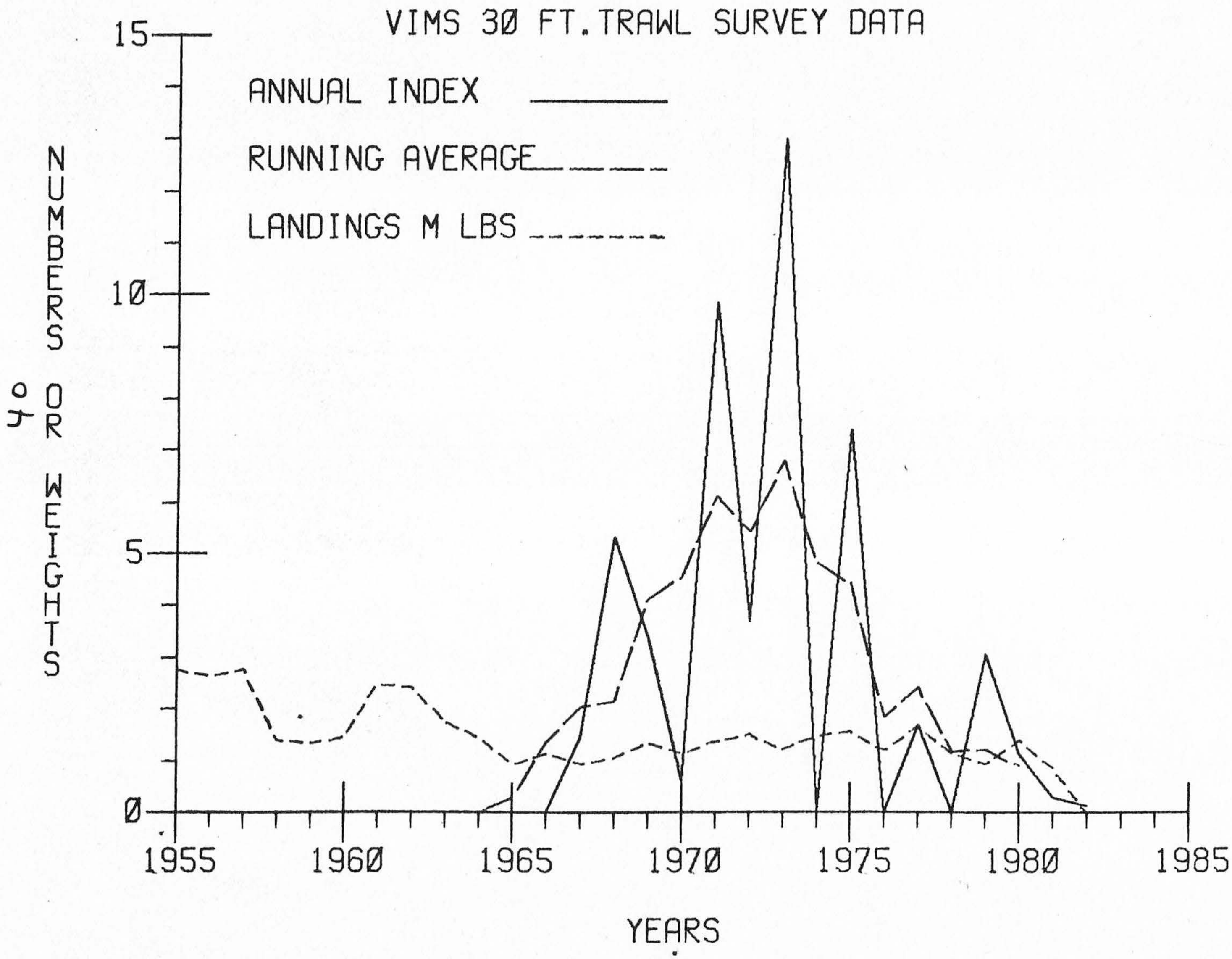


Figure 26

RAPP RIVER CATCH/UNIT EFFORT FOR STRIPED BASS (12 MOS.)

IMS 30 FT.TRAWL SURVEY DATA

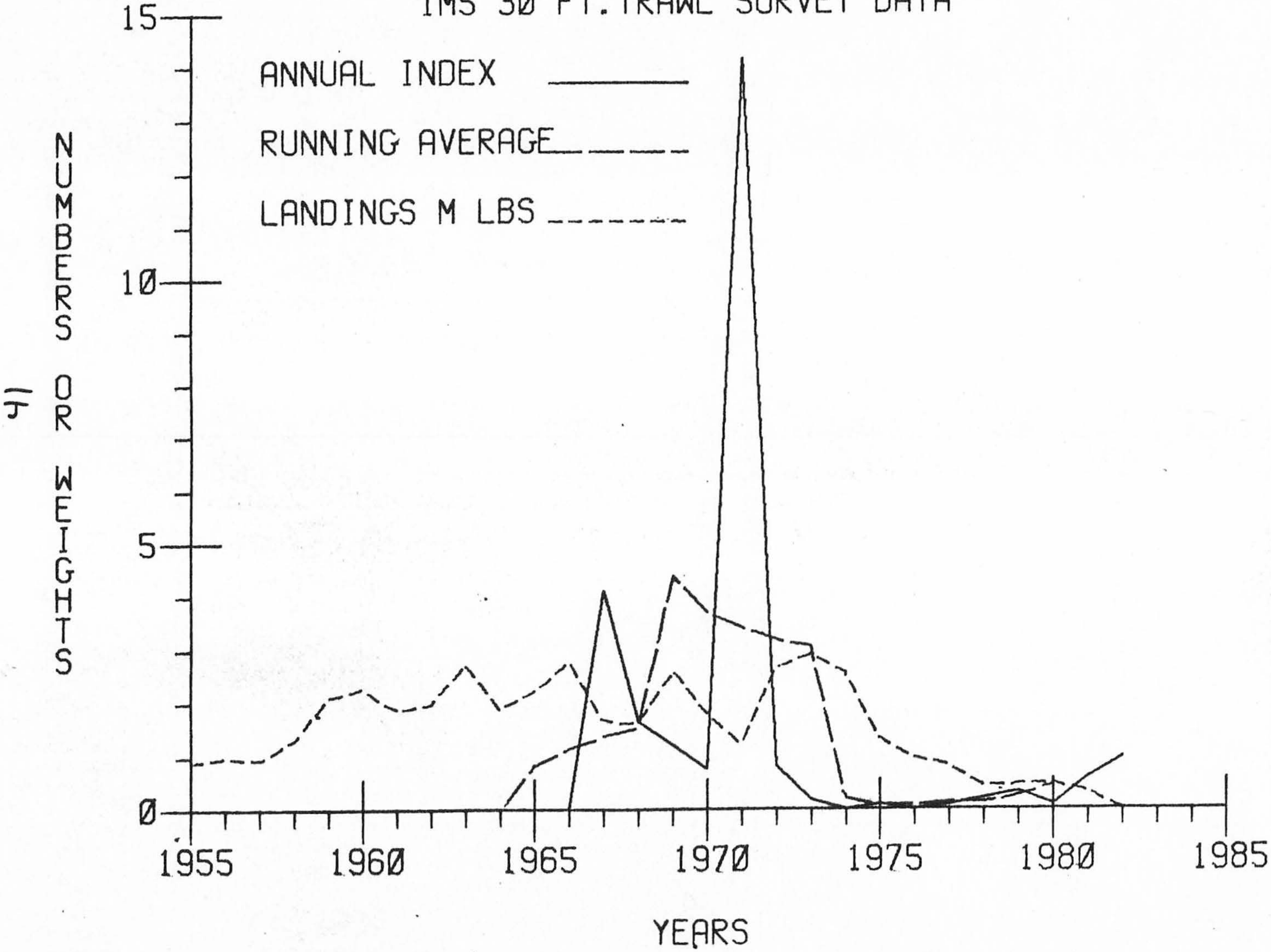


Figure 27

RAPP RIVER CATCH/UNIT EFFORT FOR WHITE PERCH (12 MOS.)

VIMS 30 FT. TRAWL SURVEY DATA

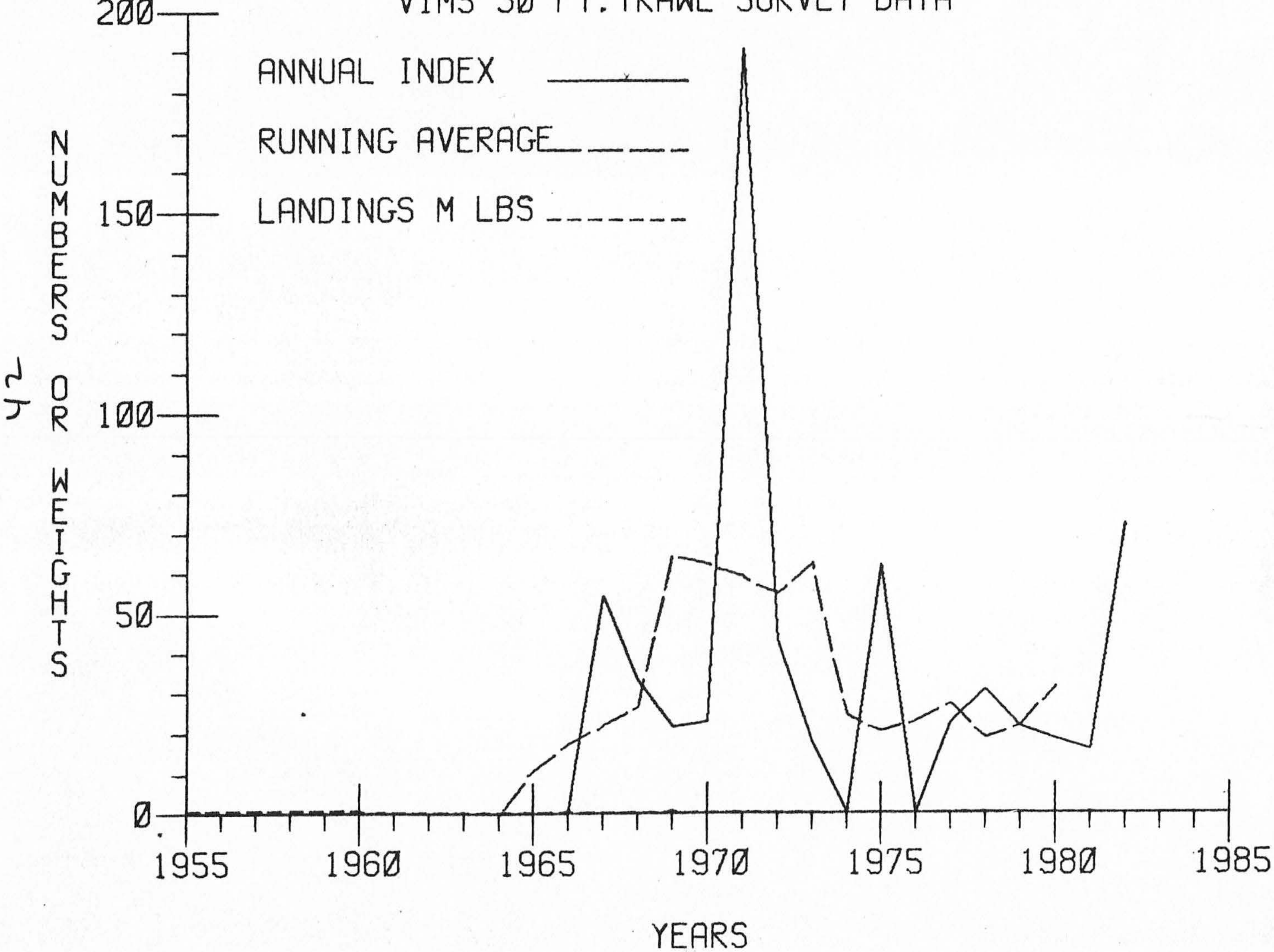


Figure 28

RAPP RIVER CATCH/UNIT EFFORT FOR BLUEFISH (12 MOS.)

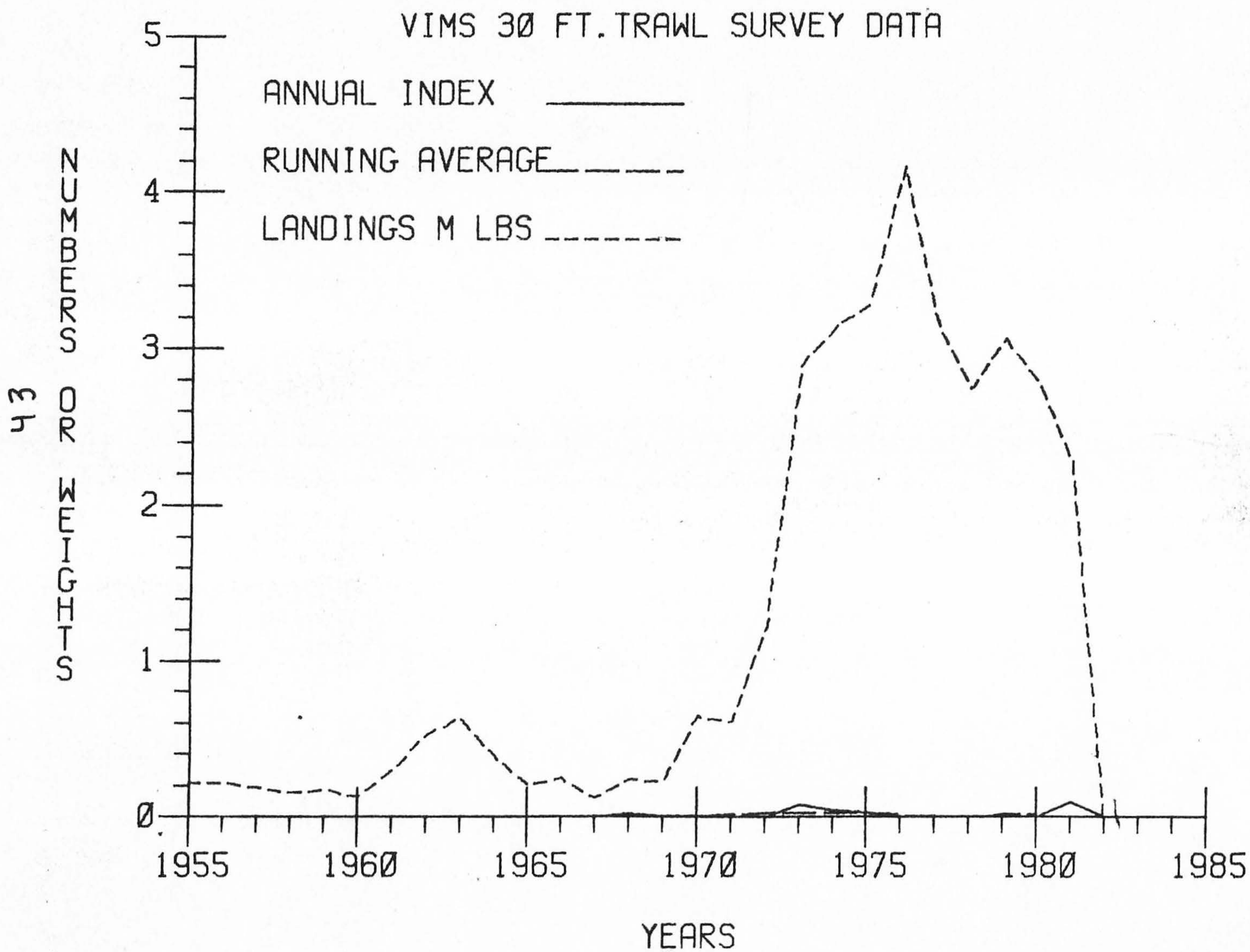


Figure 29

RAPP RIVER CATCH/UNIT EFFORT FOR ATLANTIC CROAKER (12 MOS.)

VIMS 30 FT.TRAWL SURVEY DATA

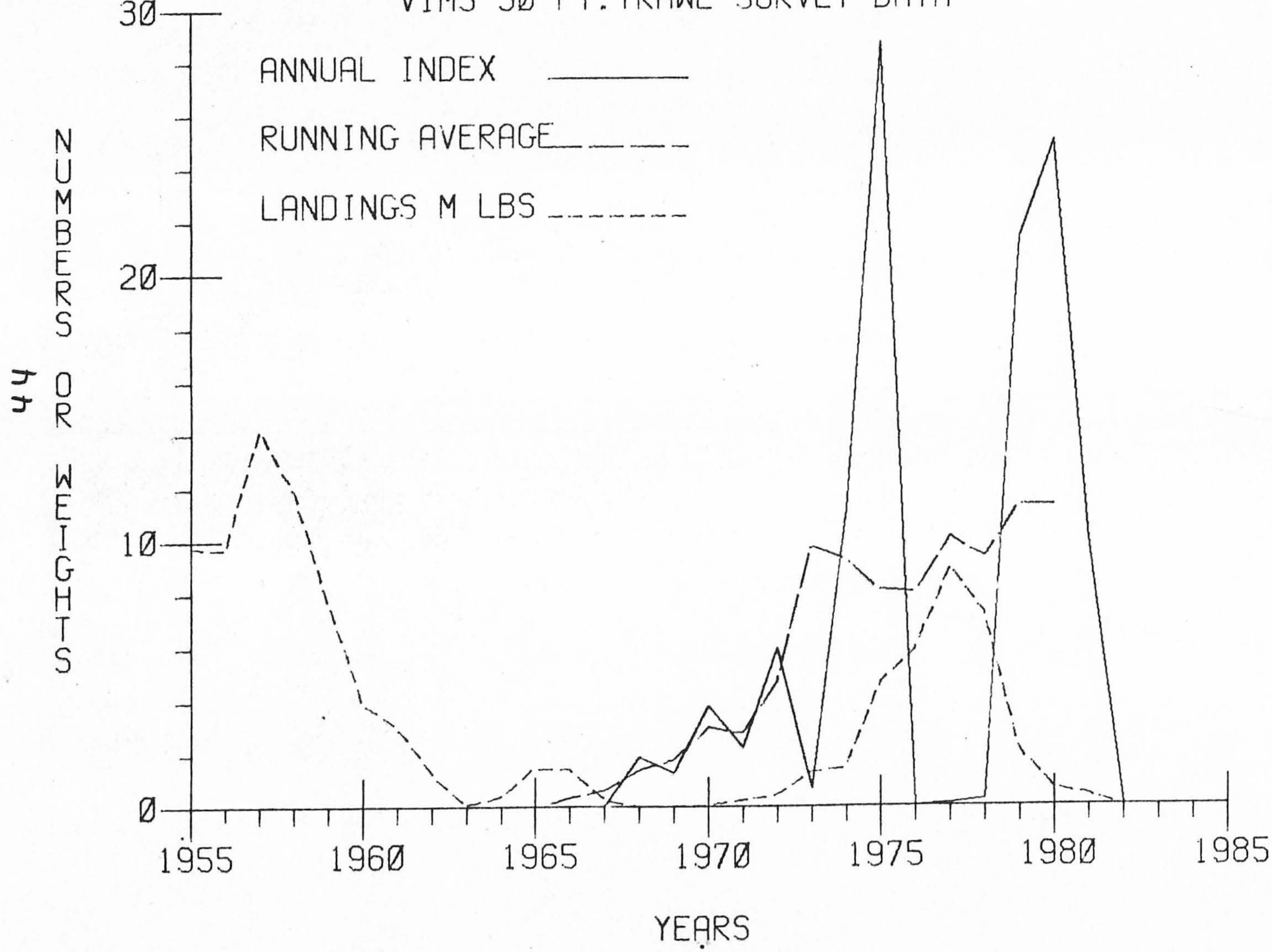


Figure 30

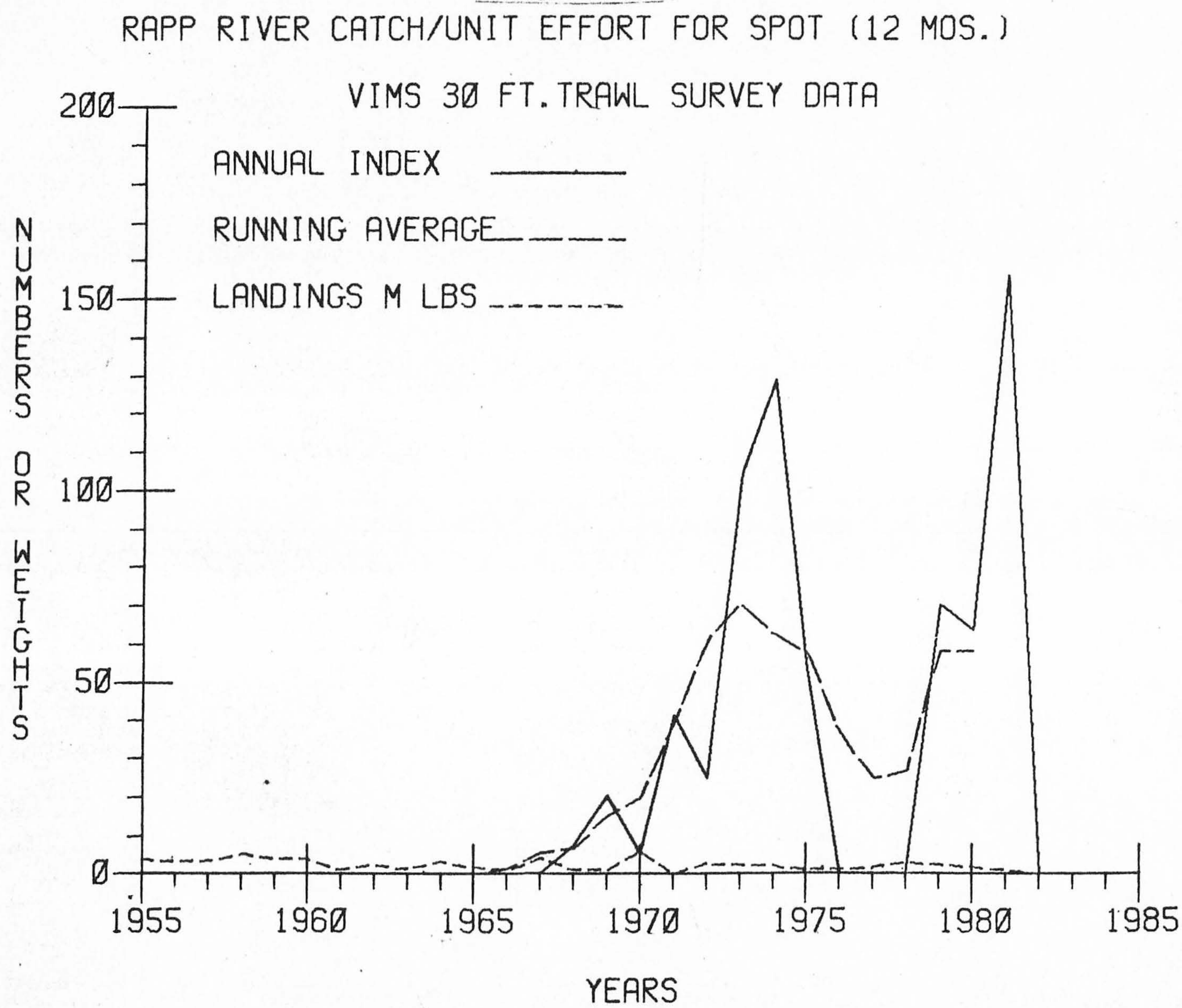
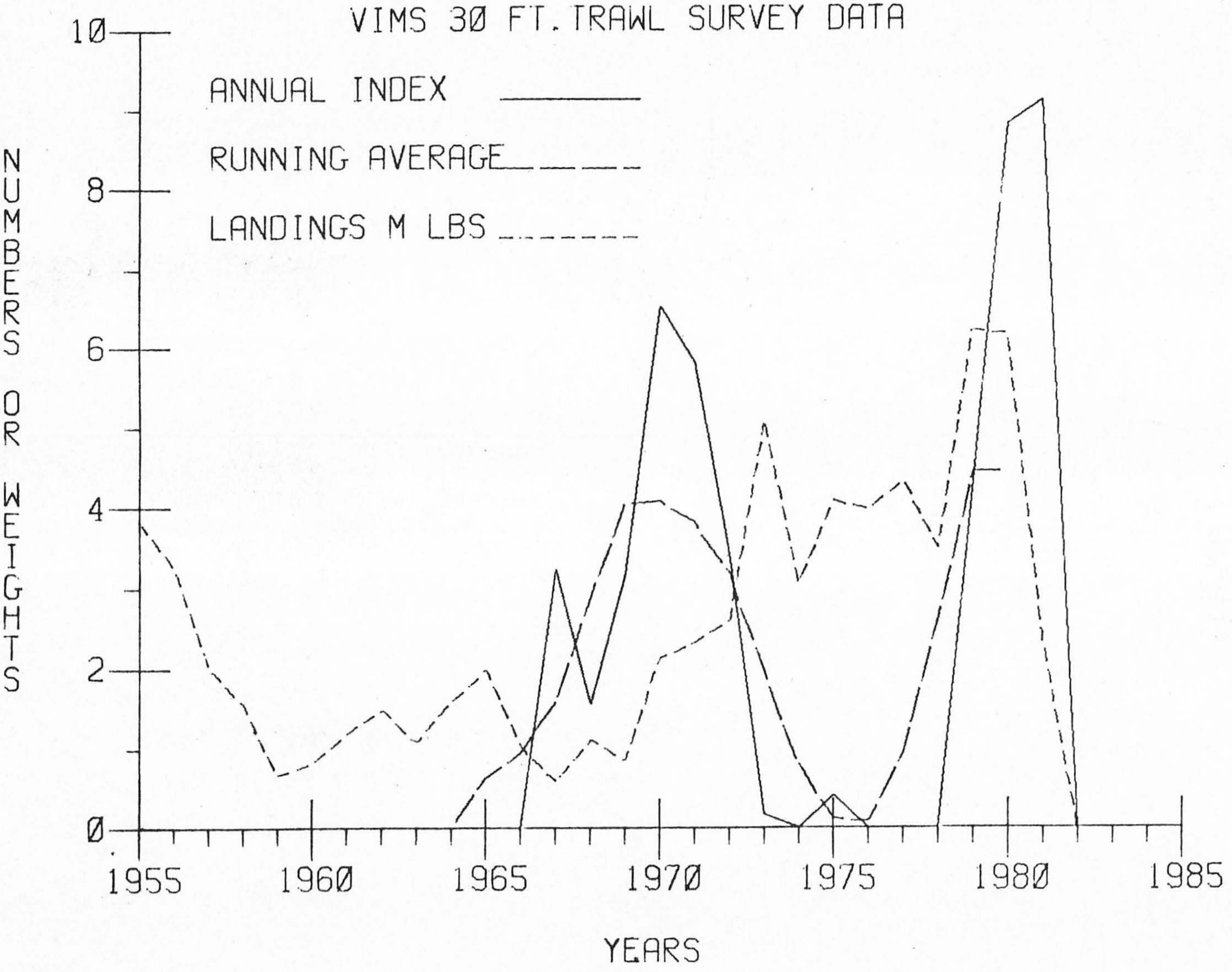

RAPP RIVER CATCH/UNIT EFFORT FOR SPOT (12 MOS.)
VIMS 30 FT. TRAWL SURVEY DATA
ANNUAL INDEX
RUNNING AVERAGE
LANDINGS M LBS
NUMBERS OR WEIGHTS
200
150
100
50
0
1955
1960
1965
1970
1975
1980
1985
YEARS

Figure 31

RAPP RIVER CATCH/UNIT EFFORT FOR WEAKFISH (12 MOS.)



46

Figure 32

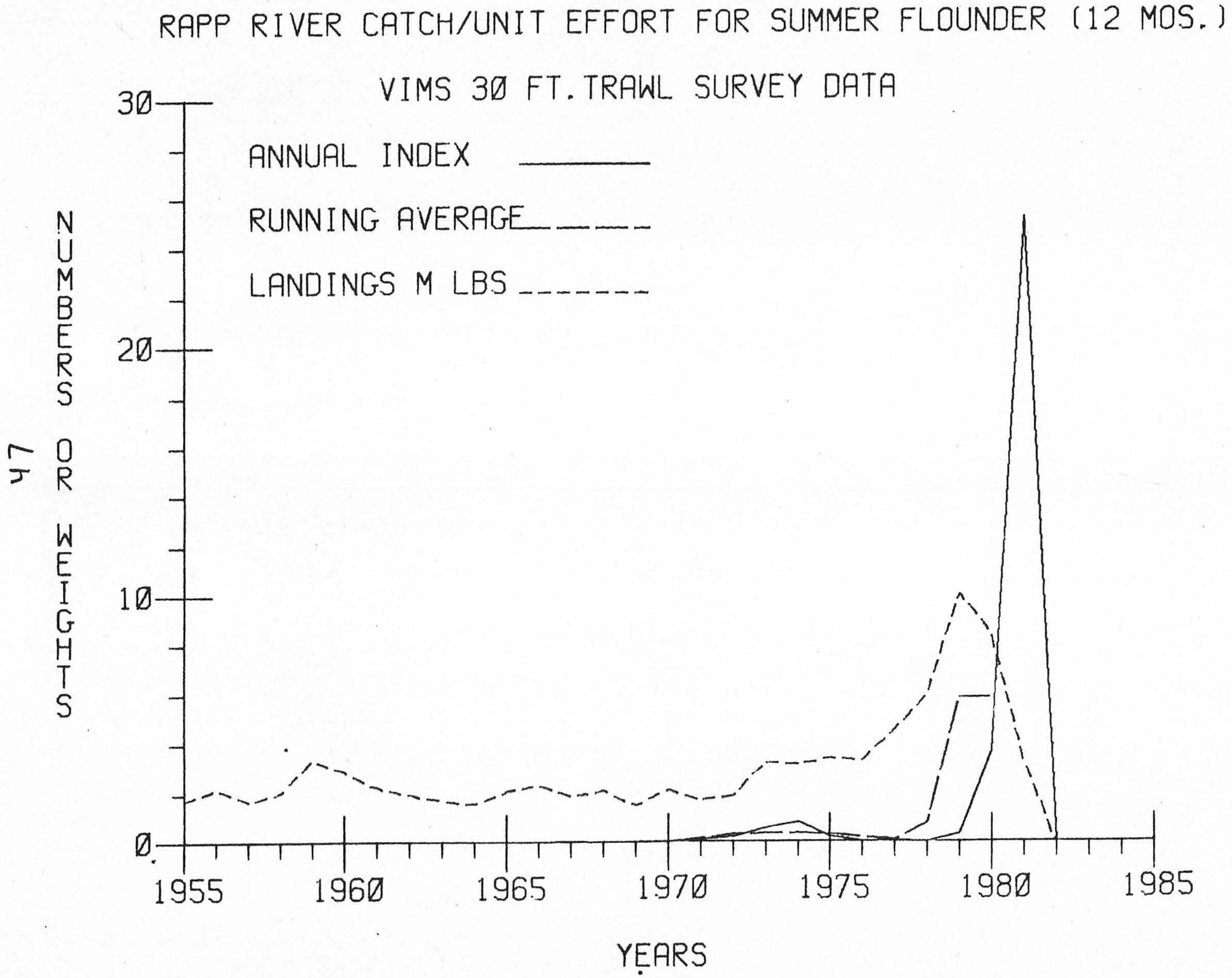

RAPP RIVER CATCH/UNIT EFFORT FOR SUMMER FLOUNDER (12 MOS.)
VIMS 30 FT.TRAWL SURVEY DATA
ANNUAL INDEX
RUNNING AVERAGE
LANDINGS M LBS
NUMBERS OR WEIGHTS
30
20
10
0
1955
1960
1965
1970
1975
1980
1985
YEARS

Figure 33

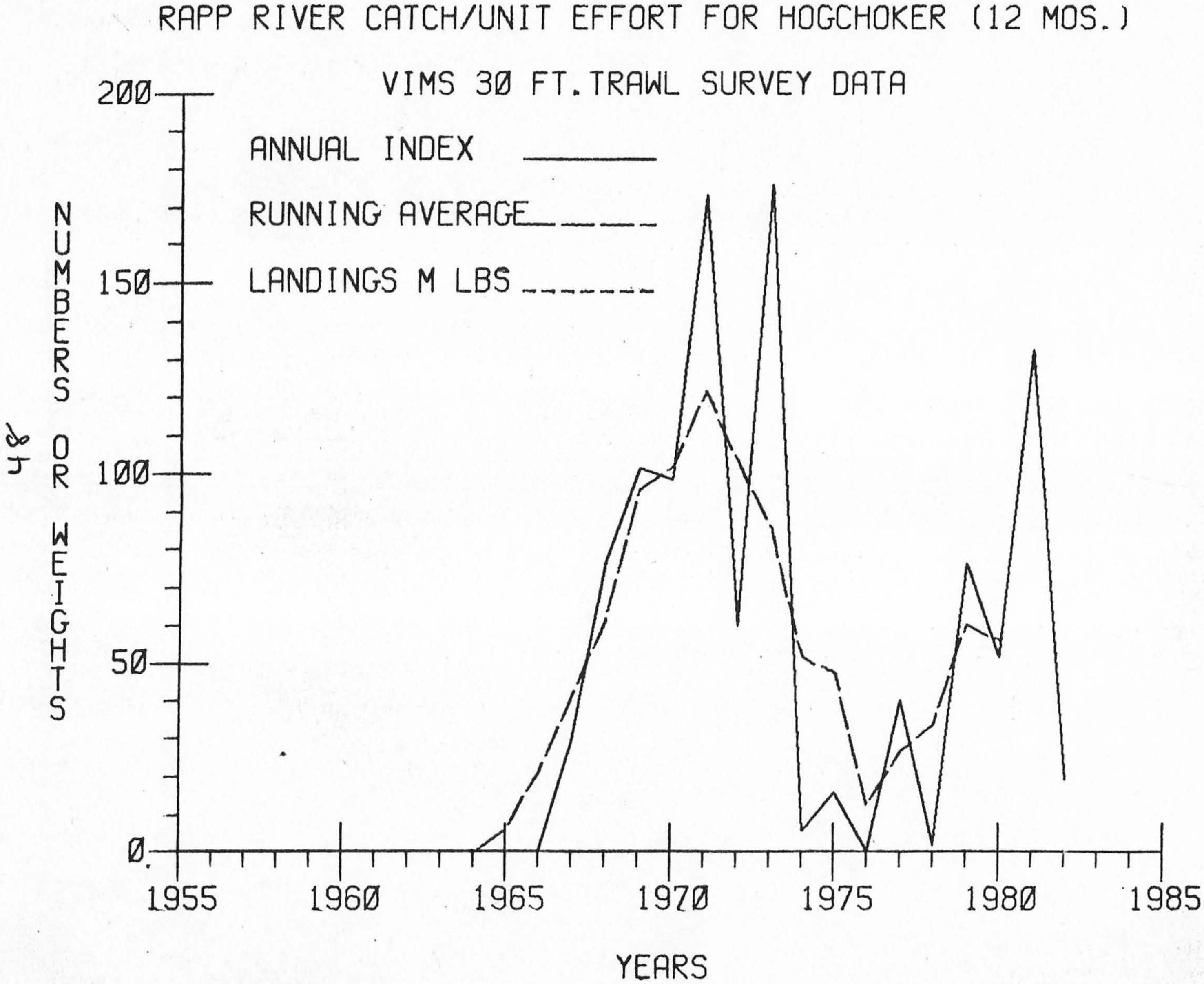

RAPP RIVER CATCH/UNIT EFFORT FOR HOGCHOKER (12 MOS.)
VIMS 30 FT. TRAWL SURVEY DATA
ANNUAL INDEX
RUNNING AVERAGE
LANDINGS M LBS
NUMBERS OR WEIGHTS
200
150
100
50
0
1955
1960
1965
1970
1975
1980
1985
YEARS

Figure 34

RAPP RIVER CATCH/UNIT EFFORT FOR YELLOW PERCH (12 MOS.)

VIMS 30 FT. TRAWL SURVEY DATA

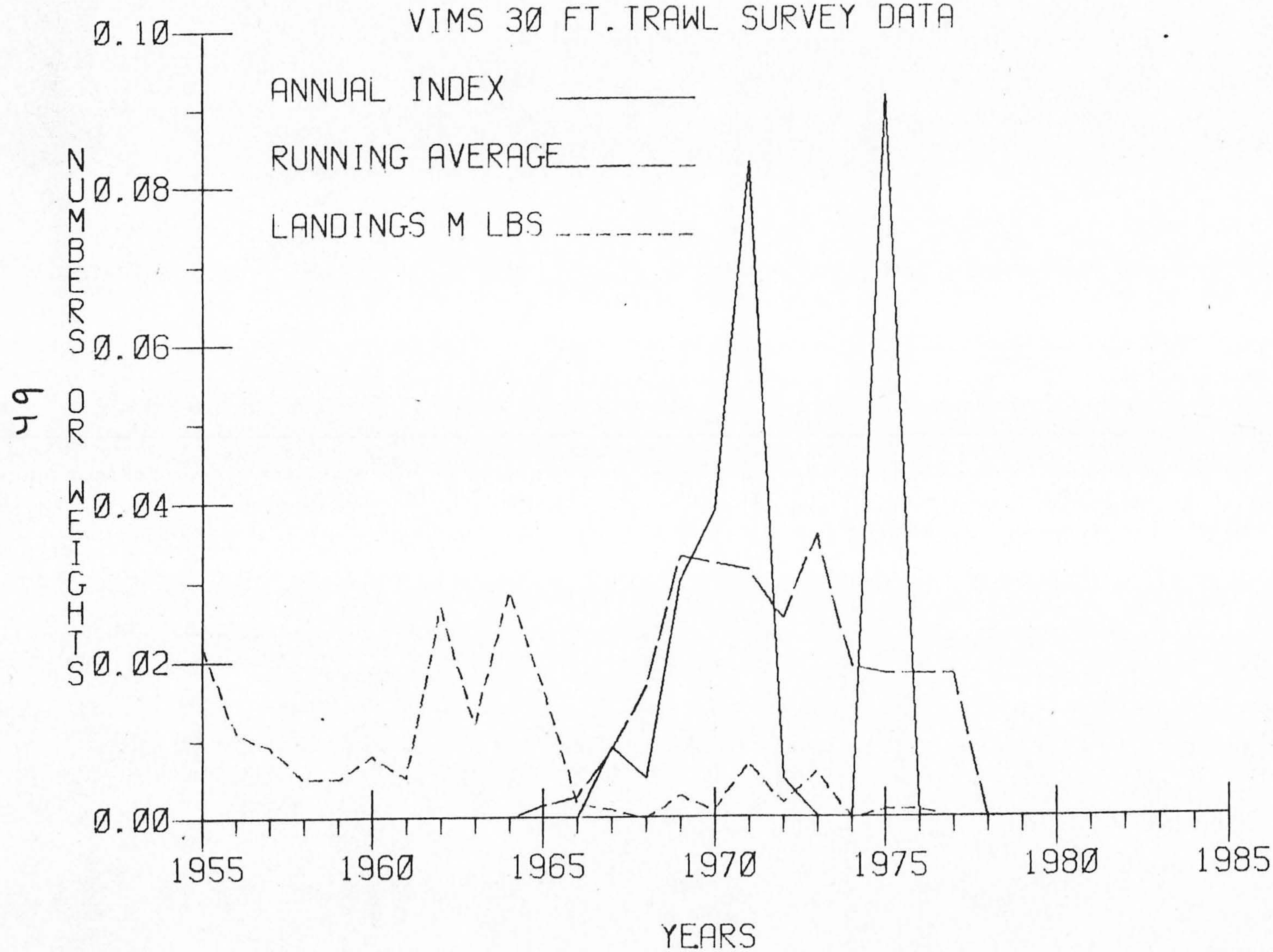
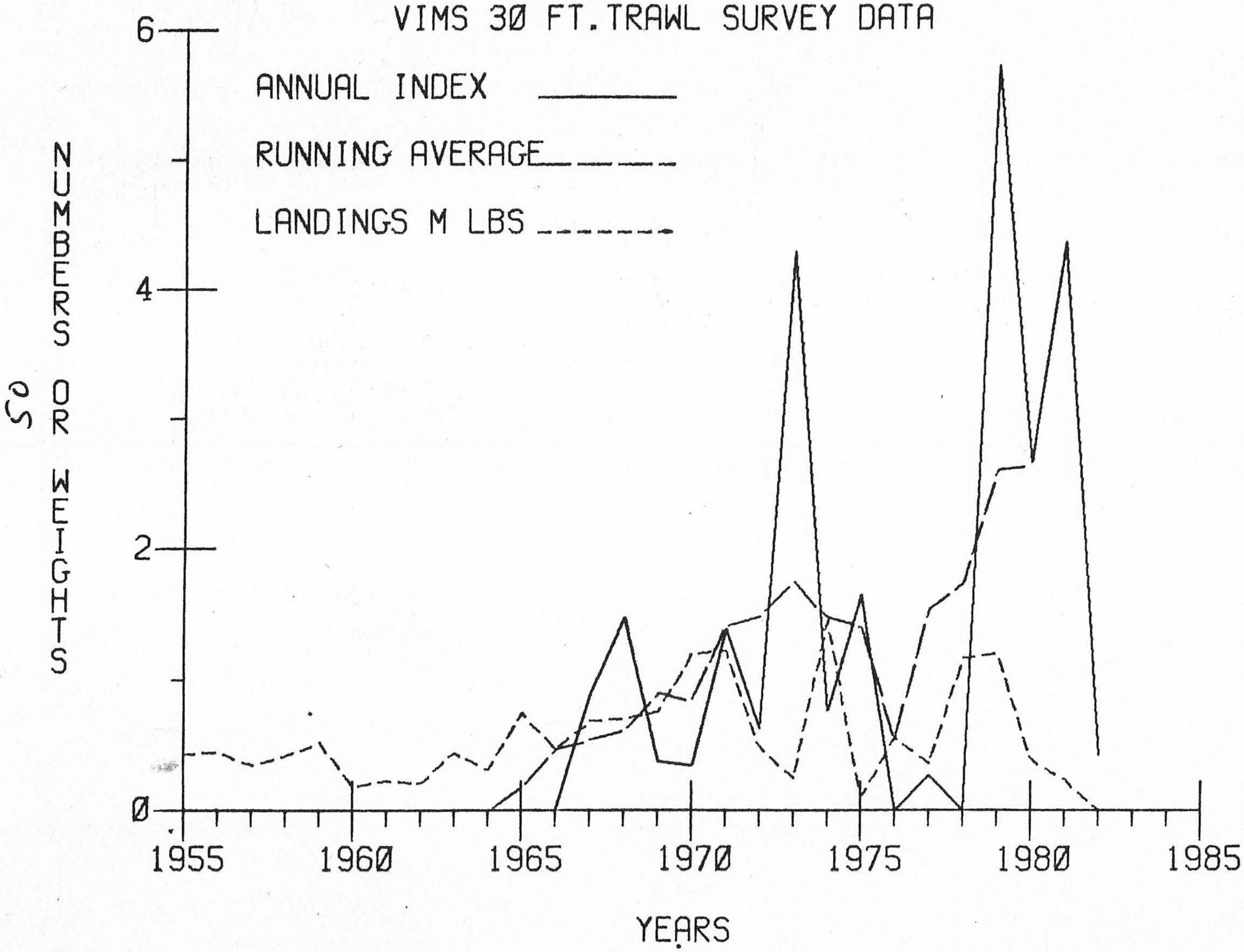


Figure 35

RAPP RIVER CATCH/UNIT EFFORT FOR AMERICAN EEL (12 MOS.)



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