

the department of  
*OCEANOGRAPHY*

Washington State Department of Ecology  
Publication Number 79-e15.

ANNUAL REPORT

BIOLOGICAL SYSTEMS ACOUSTICAL ASSESSMENTS  
IN PORT GARDNER AND ADJACENT WATERS

1 September 1978 to 30 June 1979

by

T. Saunders English  
Department of Oceanography  
University of Washington

Contract Report prepared for the  
State of Washington Department of Ecology

Richard K. Cunningham, Contract Officer

June 1979

Reference A79-14

*seattle, washington 98195* <sup>BT</sup>

Waterbody #  
WA-07-0010

ANNUAL REPORT

BIOLOGICAL SYSTEMS ACOUSTICAL ASSESSMENTS  
IN PORT GARDNER AND ADJACENT WATERS

1 September 1978 to 30 June 1979

by

T. Saunders English  
Department of Oceanography  
University of Washington


Contract Report Prepared for the  
State of Washington Department of Ecology

Richard K. Cunningham, Contract Officer

June 1979

Departmental Concurrence:

REF; A79- 14

  
George C. Anderson  
Associate Chairman for  
Research

BIOLOGICAL SYSTEMS ACOUSTICAL ASSESSMENTS

IN PORT GARDNER AND ADJACENT WATERS

1 SEPTEMBER 1978 TO 30 JUNE 1979

Introduction

The main thrust of the work under this short contract has been to prepare and update graphic representations of data sets from ECOBAM sampling in Port Gardner (Figure 1). The graphs and charts have been designed to be suitable for presentation to the administrative staffs of the Department of Ecology and the Environmental Protection Agency.

The data base collected through December 1978 has been treated; later data have been included when available. The formats for data presentation that were anticipated to be best for administrative use were contour diagrams and time series plots, with bar-charts a possible alternative.

The major data set available for the proposed treatment from Port Gardner were:

- mill discharges
- sulfite waste liquor concentrations
- dissolved oxygen concentrations
- oyster larvae bioassays
- catches by research trawling
- catches by commercial trawling
- chlorophyll a distributions
- secchi disc transparencies
- acoustic surveys

These data sets were expected to combine to tell a story of related changes in mill operations, receiving waters quality, and possible biological changes in Port Gardner. Each data set was treated individually first and then some were combined to attempt to depict relationships between parameters.

Figure 1. Sampling station locations in Port Gardner and adjacent waters.

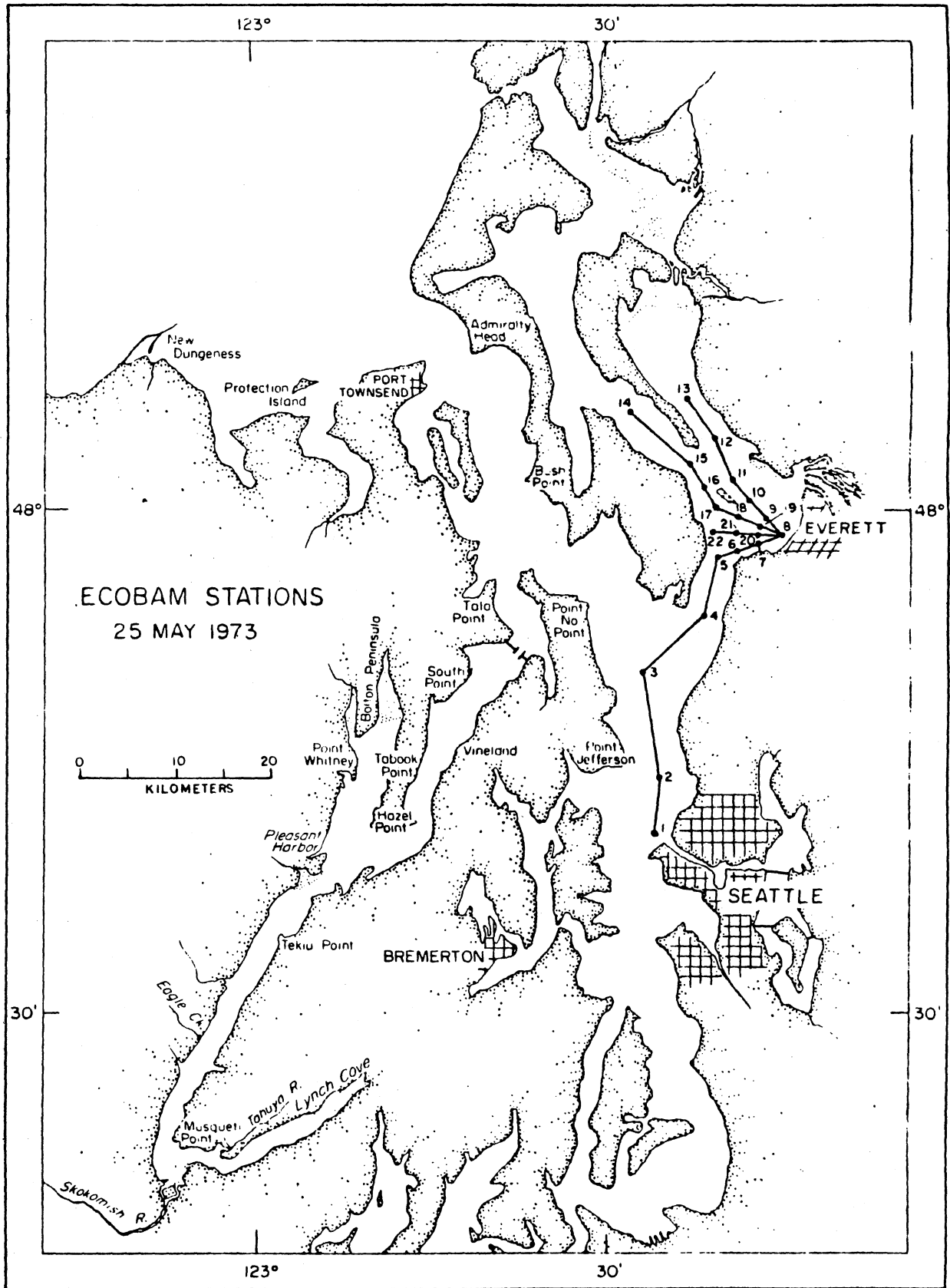


Figure 1

### Area Contour Diagrams

A need was felt for a technique of making contour diagrams for the area of Port Gardner and adjacent waters. The method chosen was to prepare a computer plot of the outline of Port Gardner containing 16 sampling station locations (Figure 2). The easternmost location is over the deepwater diffuser outfall; the southernmost location is in Possession Sound; the northeasternmost location is toward Port Susan; and the northwesternmost location is into Saratoga Passage. The area could then be represented in multiple plots to compare times, depths, and parameters such as sulfite waste liquor concentrations and oyster larvae bioassay responses (Figure 3).

Several contour levels were depicted within an individual plot. The most extreme contour level could be darkened for visual emphasis. Alternatively, the spacing of contour levels alone could be used to compare and contrast times, depths, and parameters.

The choice of contour levels to depict is subjective. The appropriate choice will reflect judgement of the investigator attempting to support a line of reasoning or to suggest possible alternative explanations.

Figure 2. Sampling station locations arranged for area contour diagrams.

Figure 3. Multiple area contour diagrams.



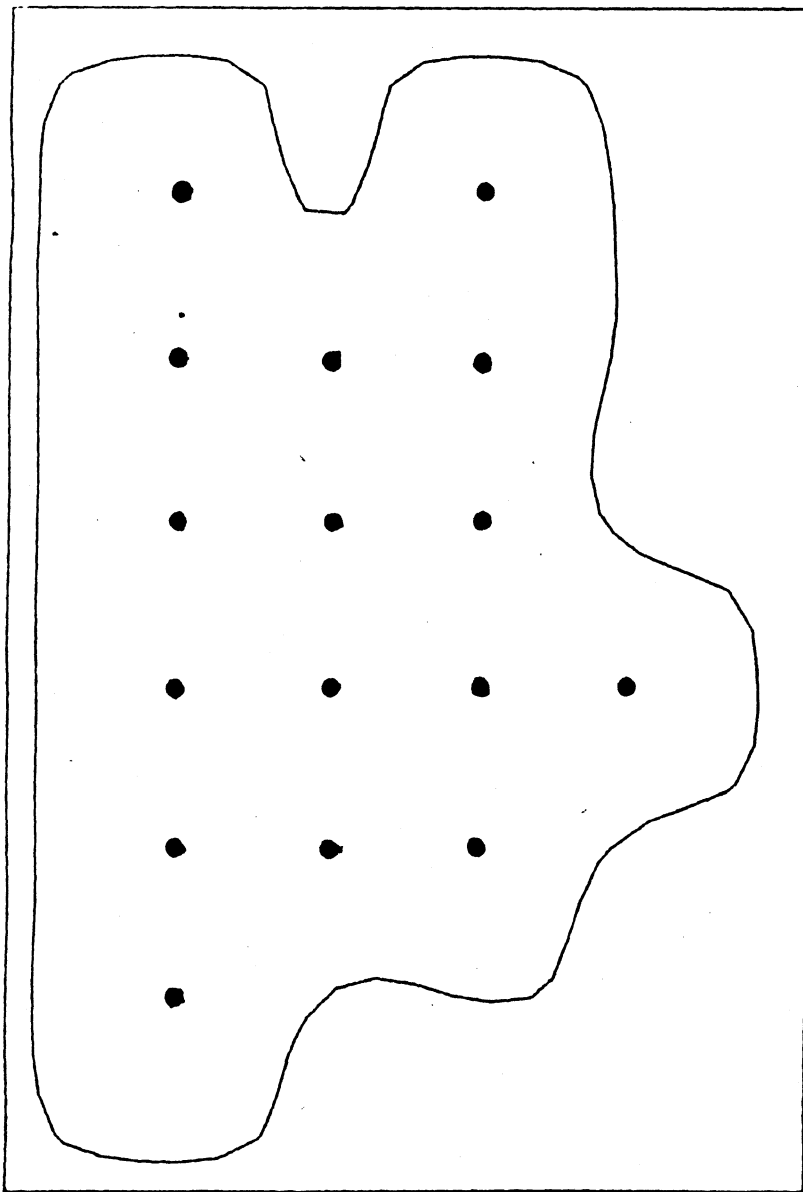


Figure 2

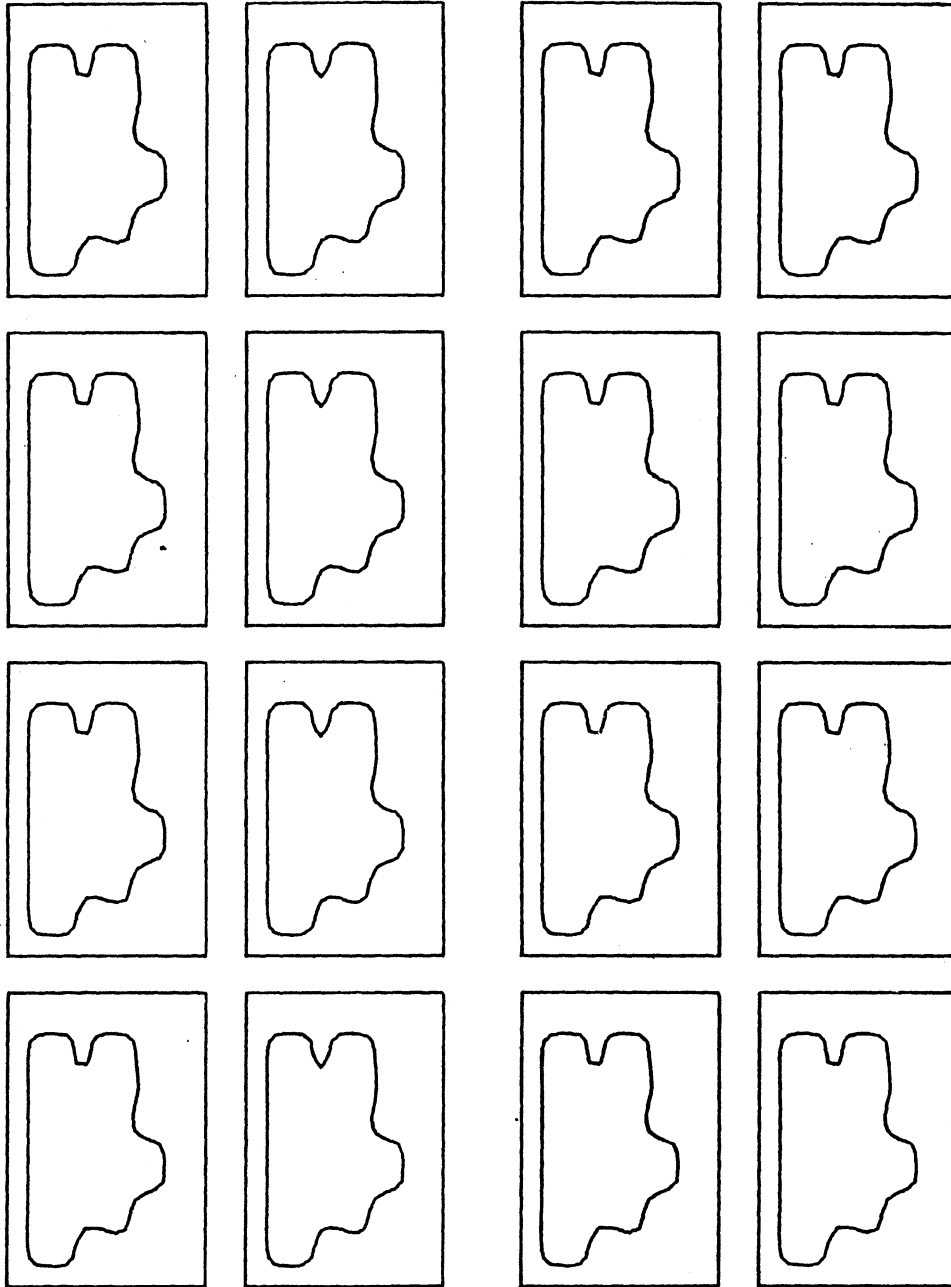


Figure 3

### Mill Discharges

The pulp and paper mill installations of Scott and Weyerhaeuser on Port Gardner discharge wastes to deepwaters and inshore outfalls in Port Gardner. A 12-year record of discharge of total dissolved solids for the deepwaters and inshore outfalls has been prepared as a time-series (Figure 4). The discharge from the deepwater outfalls demonstrates the minor effect of a strike in 1967 and the major effect of the reductions in mill waste that fall in the time frame of ECOBAM. The inshore outfalls show a fairly constant output over the period under consideration.

The deepwater outfall discharge can be partitioned between Scott and Weyerhaeuser (Figure 5). The present contribution from Scott is about one-third of historical levels and the contribution from Weyerhaeuser is negligible.

Figure 4. Mill wastes from shallow and deep diffuser outfalls in Port Gardner.

Figure 5. Total mill wastes and contributions from Scott and Weyerhaeuser into Port Gardner.

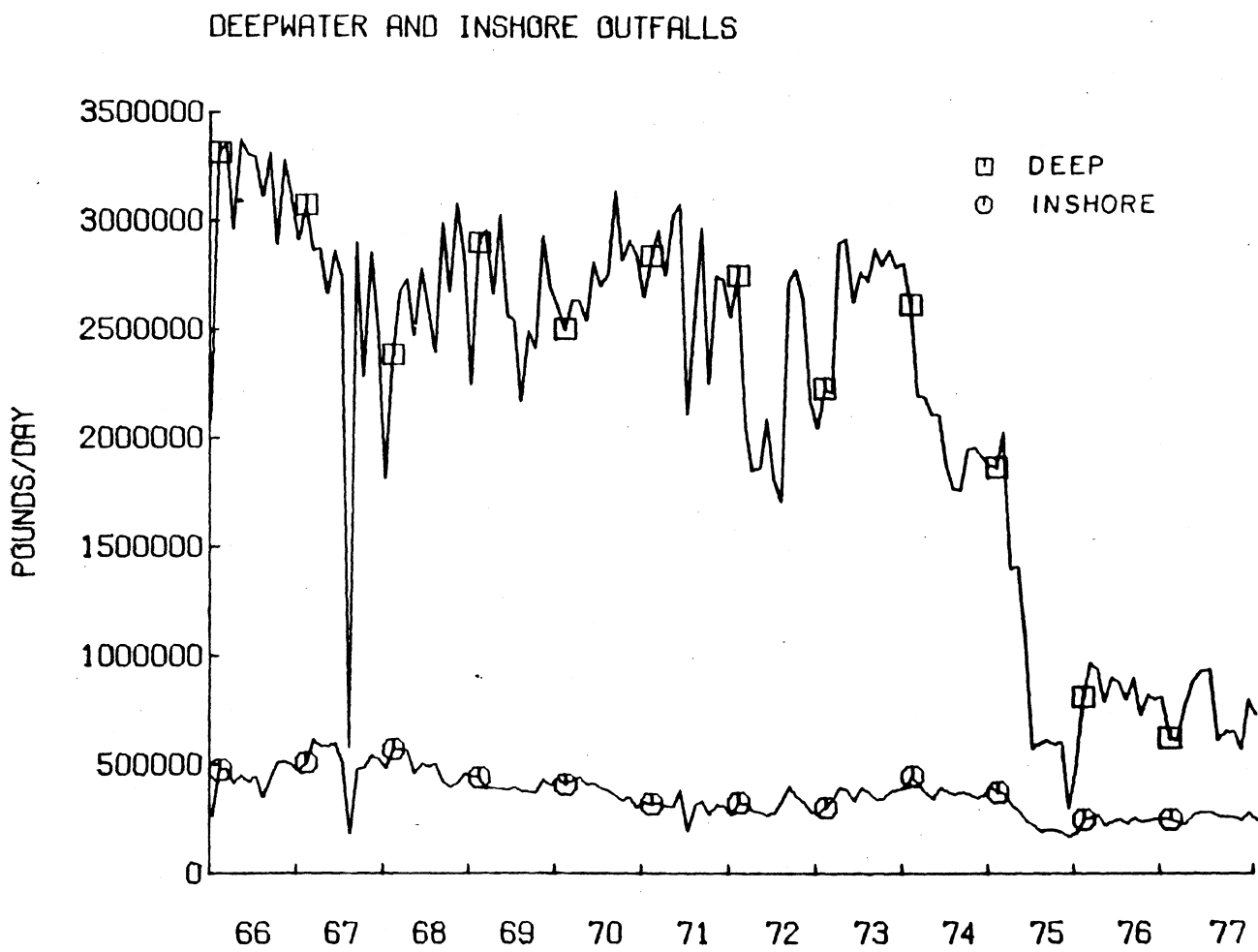


Figure 4

DEEPWATER OUTFALL  
TOTAL, SCOTT, AND WEYERHAEUSER

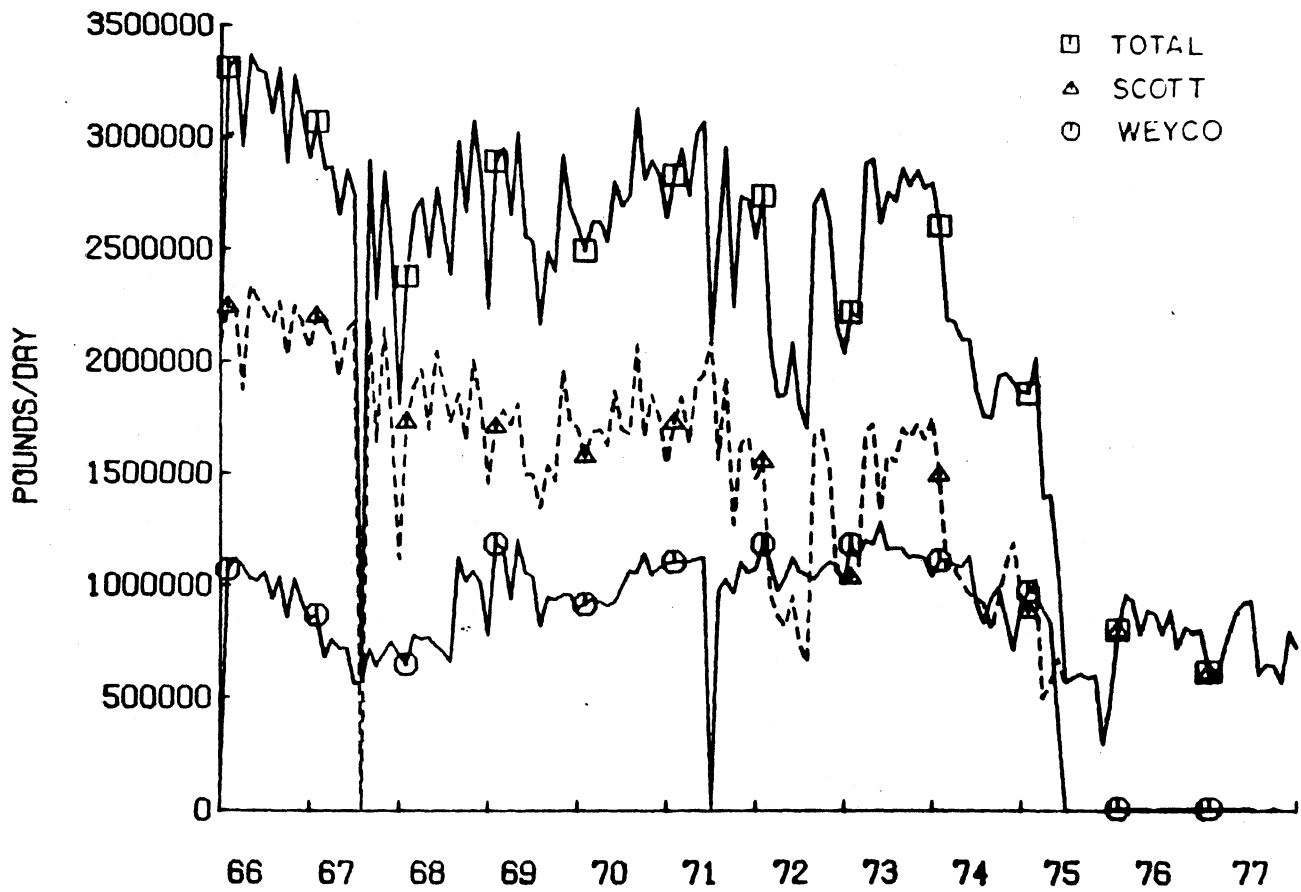


Figure 5

### Sulfite Waste Liquor

Sulfite waste liquor has been used as an indicator of the amounts of mill discharge in the receiving waters of Port Gardner. Repeated time series observations of sulfite waste liquor concentrations have been made in an area near the deepwater diffuser outfall (Figure 6). The decline in waste concentrations in the water column of this index area of Port Gardner has been ten-to-fifteenfold.

Sulfite waste liquor concentrations of 25, 50, 100 and 200 PBI can be represented as quarterly contour diagrams for the Port Gardner index area from summer 1973 through autumn 1977 (Figures 7, 8, 9, and 10). The contour diagrams have been prepared for four levels of concentration of sulfite waste liquor, each of which give a somewhat different impression of decreases of concentration over the time of ECOBAM.

Sulfite waste liquor concentrations can also be depicted as area contour diagrams of the surface and 80 m for Port Gardner and adjacent waters for 6-month periods (Figure 11). The concentrations of waste were greater in earlier periods; the concentrations were generally greater at depth; the affected areas have been greatly reduced over time; the source of the sulfite waste liquor concentrations appears to be the deepwater diffuser outfall and not the shallow outfalls near shore.

Figure 6. Relative sulfite waste liquor concentrations over time as measured in the Port Gardner index area. Each plotted data point is an average of 30 samples taken on one day.



## SULFITE WASTE LIQUOR CONCENTRATIONS IN THE VOLUME OF THE VOID

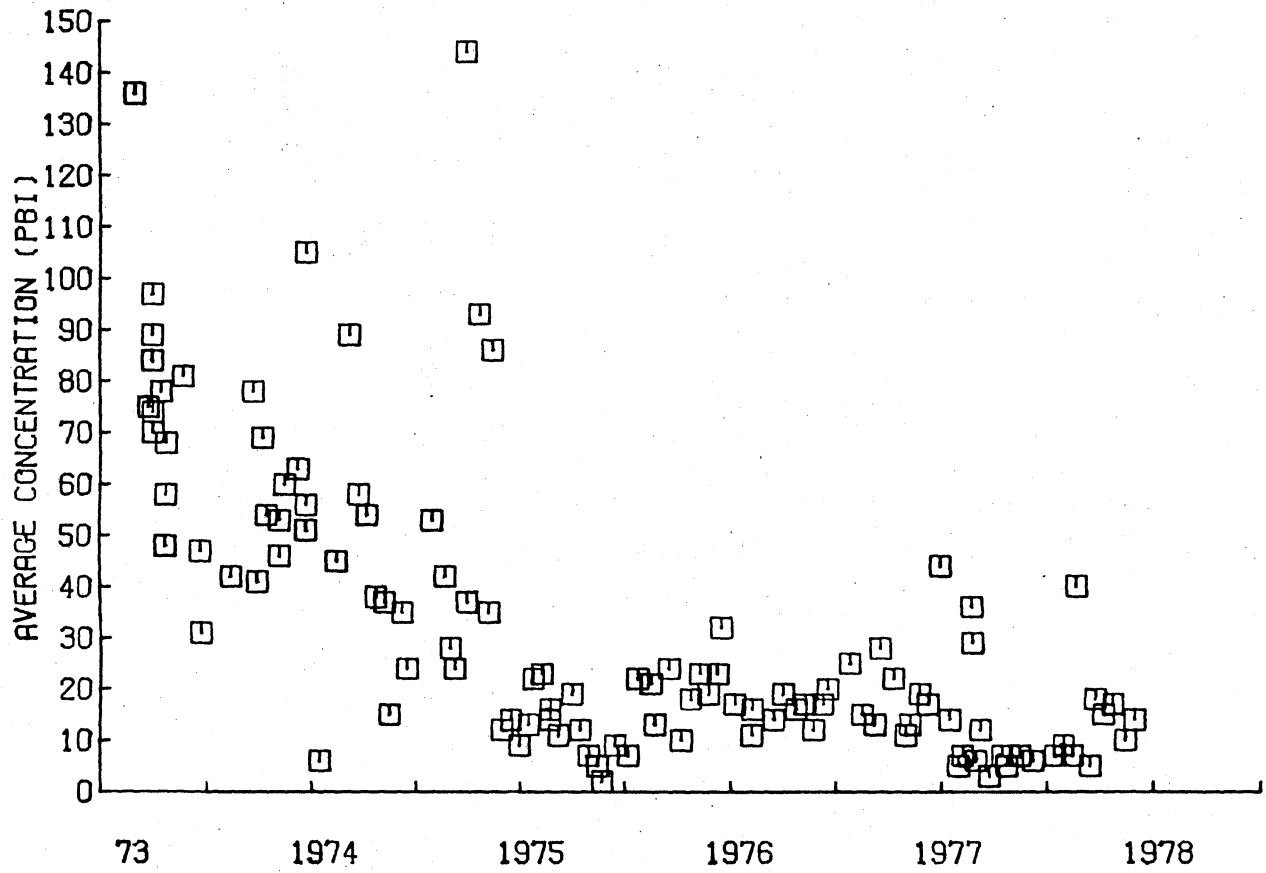


Figure 6

Figures 7 to 10. Sulfite waste liquor concentrations for quarterly periods in the Port Gardner index area:

Figure 7 - 25 PBI or greater is darkened

Figure 8 - 50 PBI or greater is darkened

Figure 9 - 100 PBI or greater is darkened

Figure 10 - 200 PBI or greater is darkened

(See Figure 1 for station locations.)

SWL (PBI)

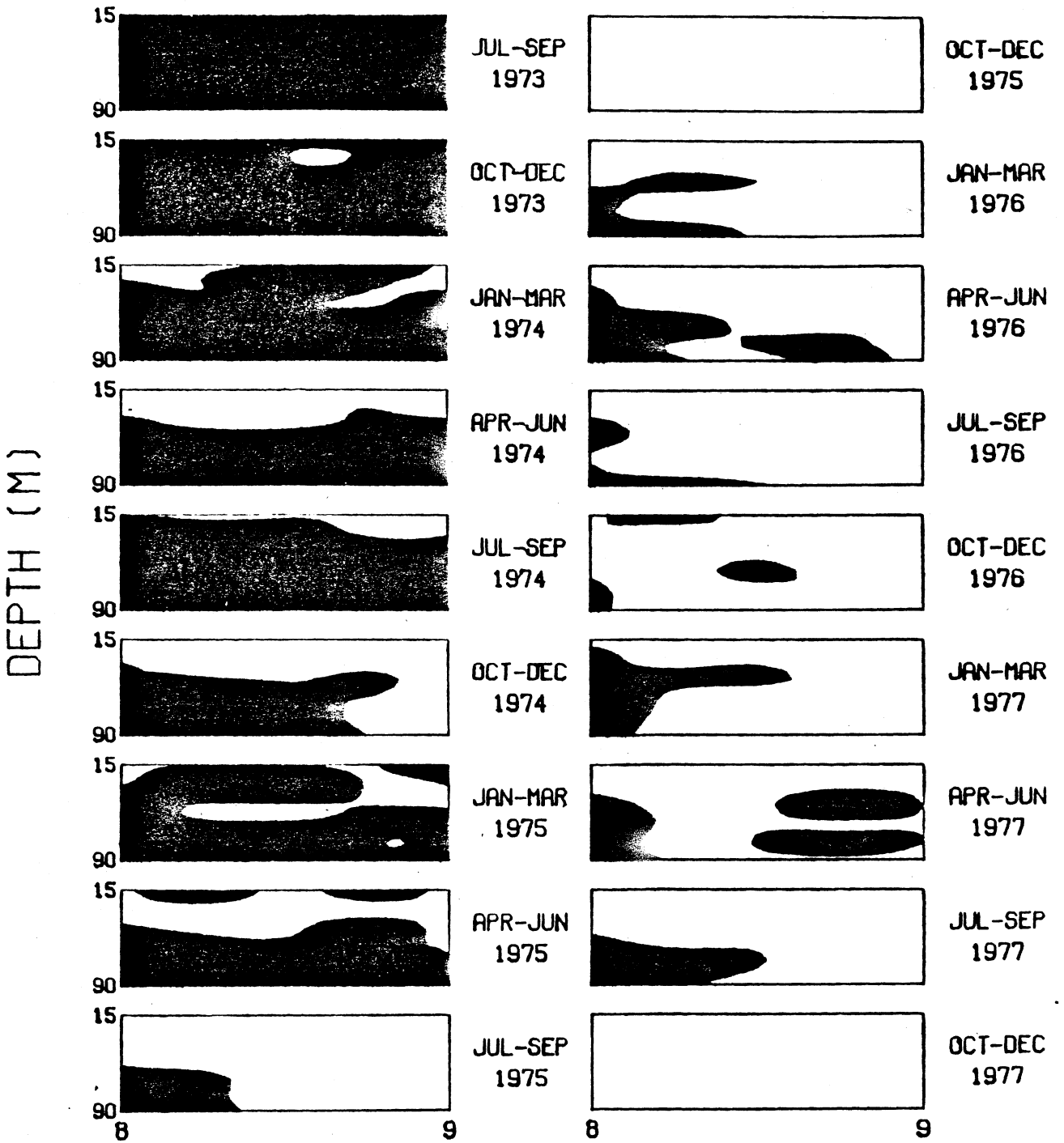


Figure 7

SWL (PBI)

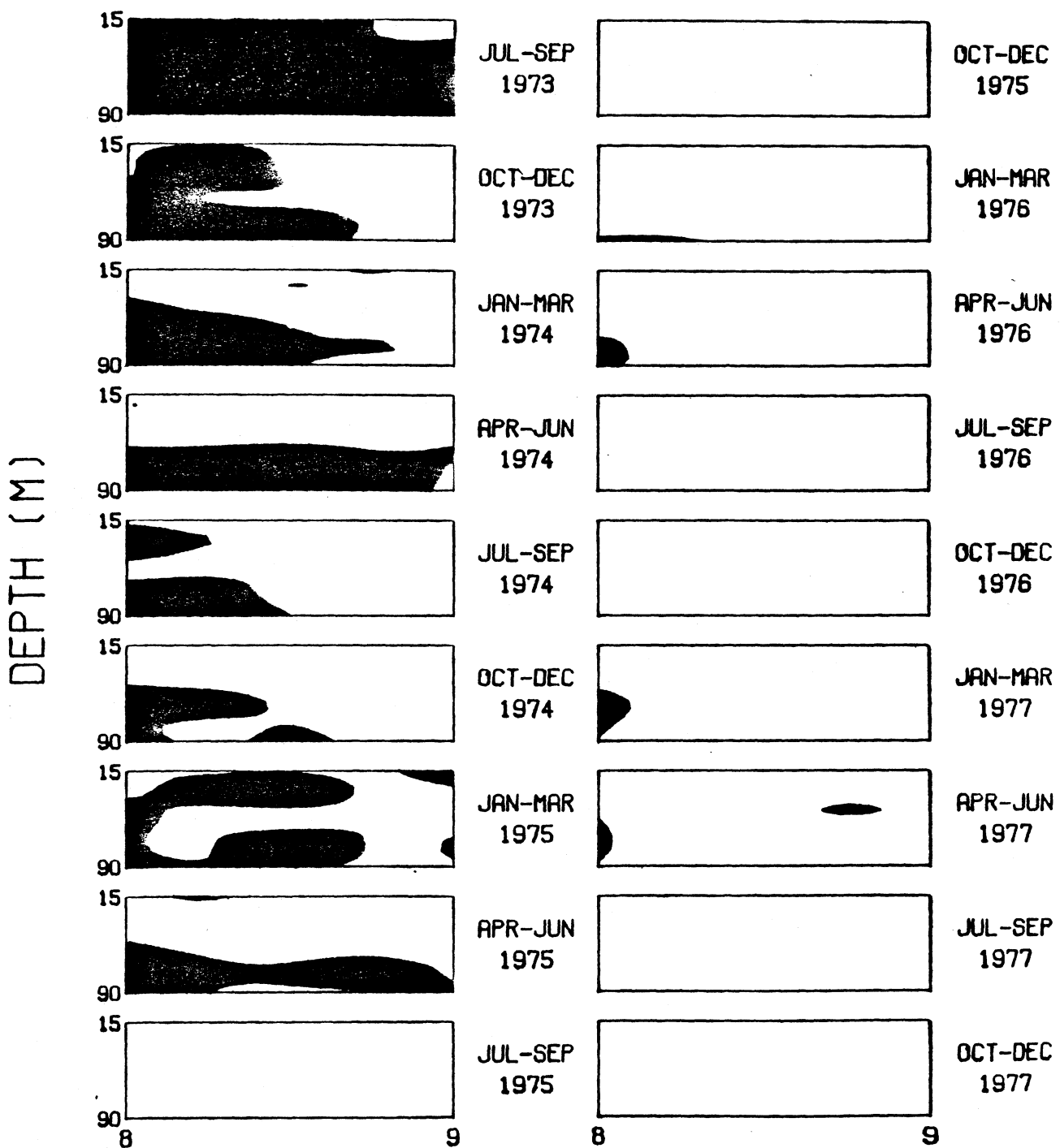


Figure 8

SWL (PBT)

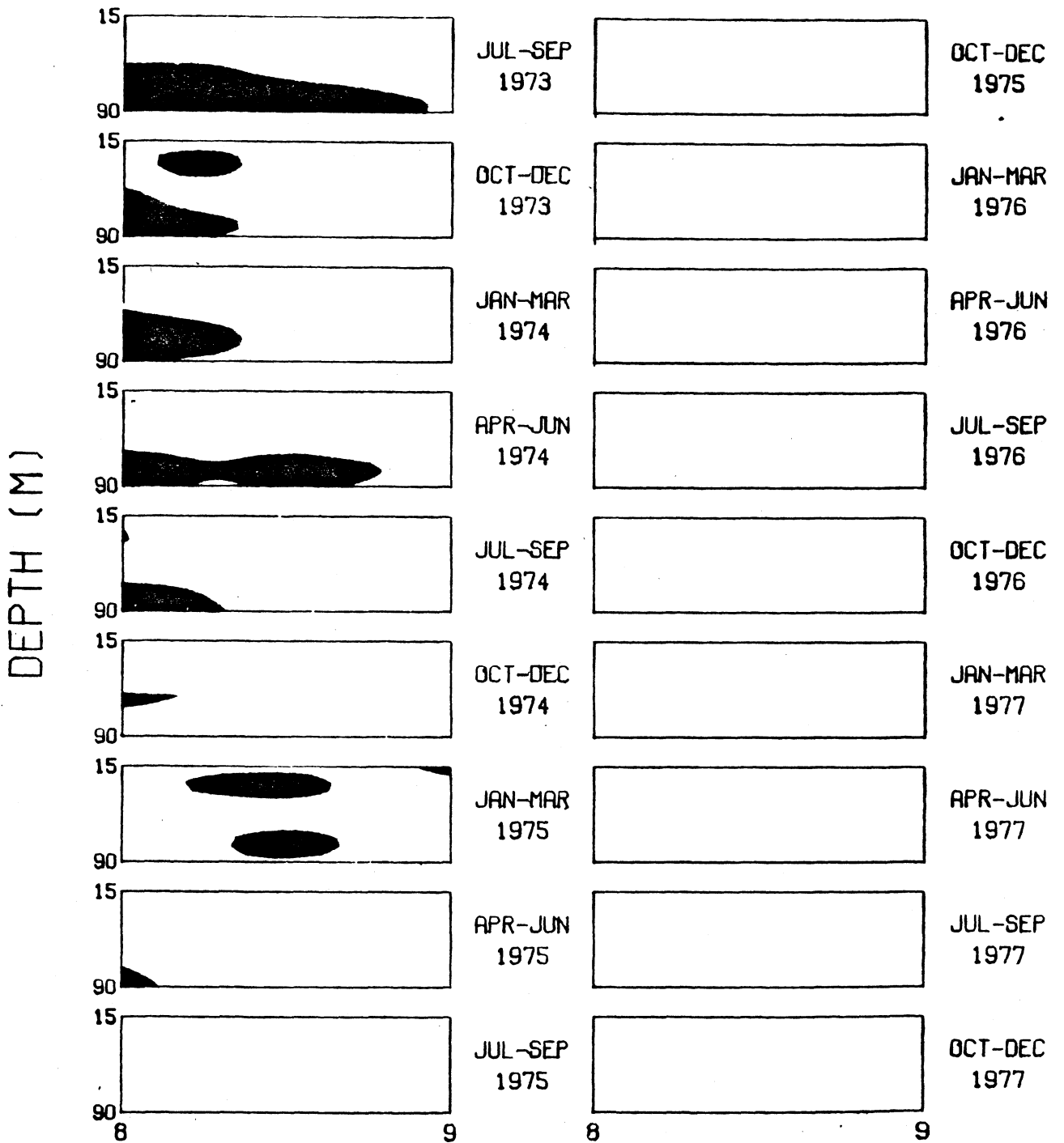
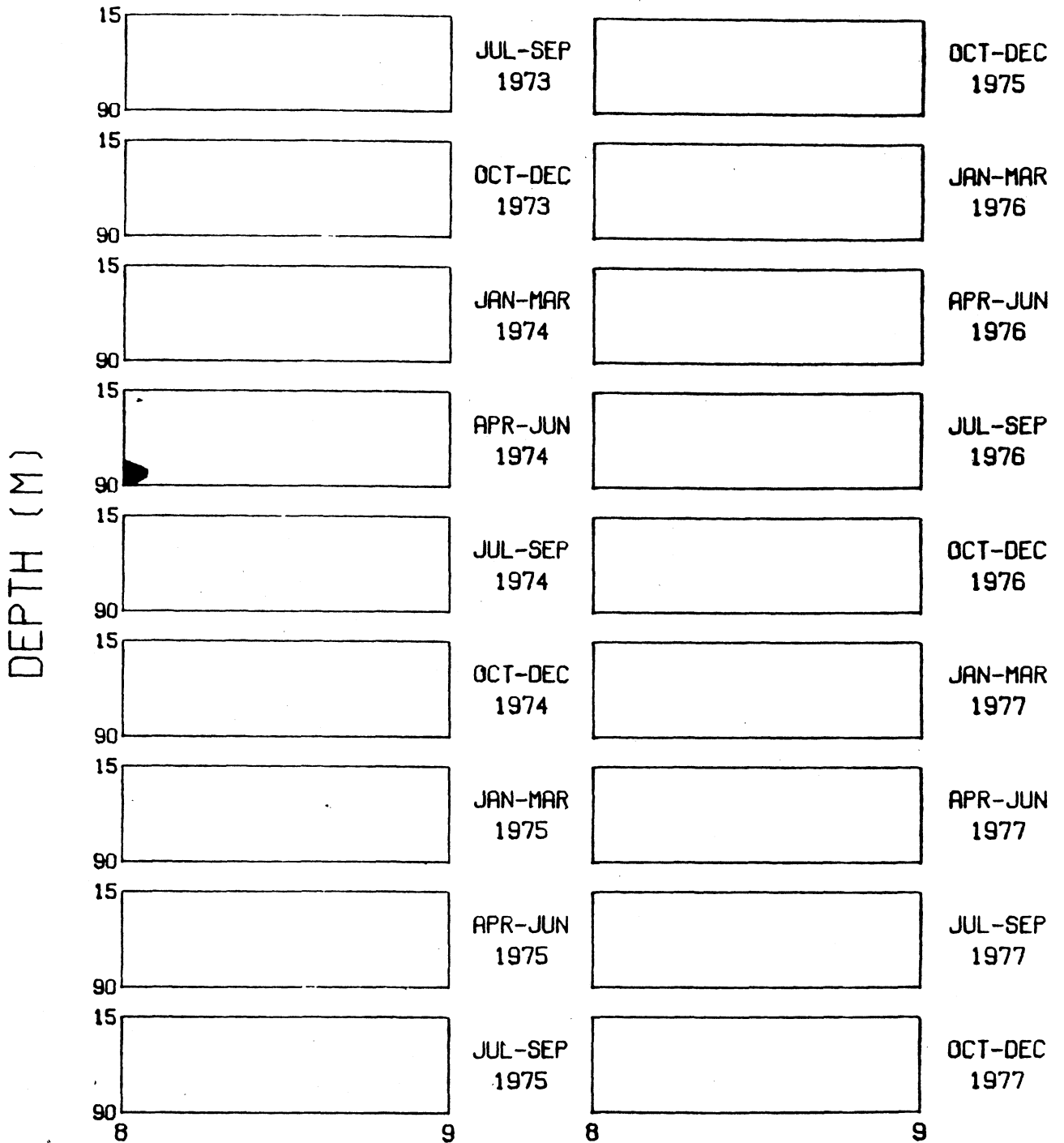


Figure 9

# SWL (PBI)



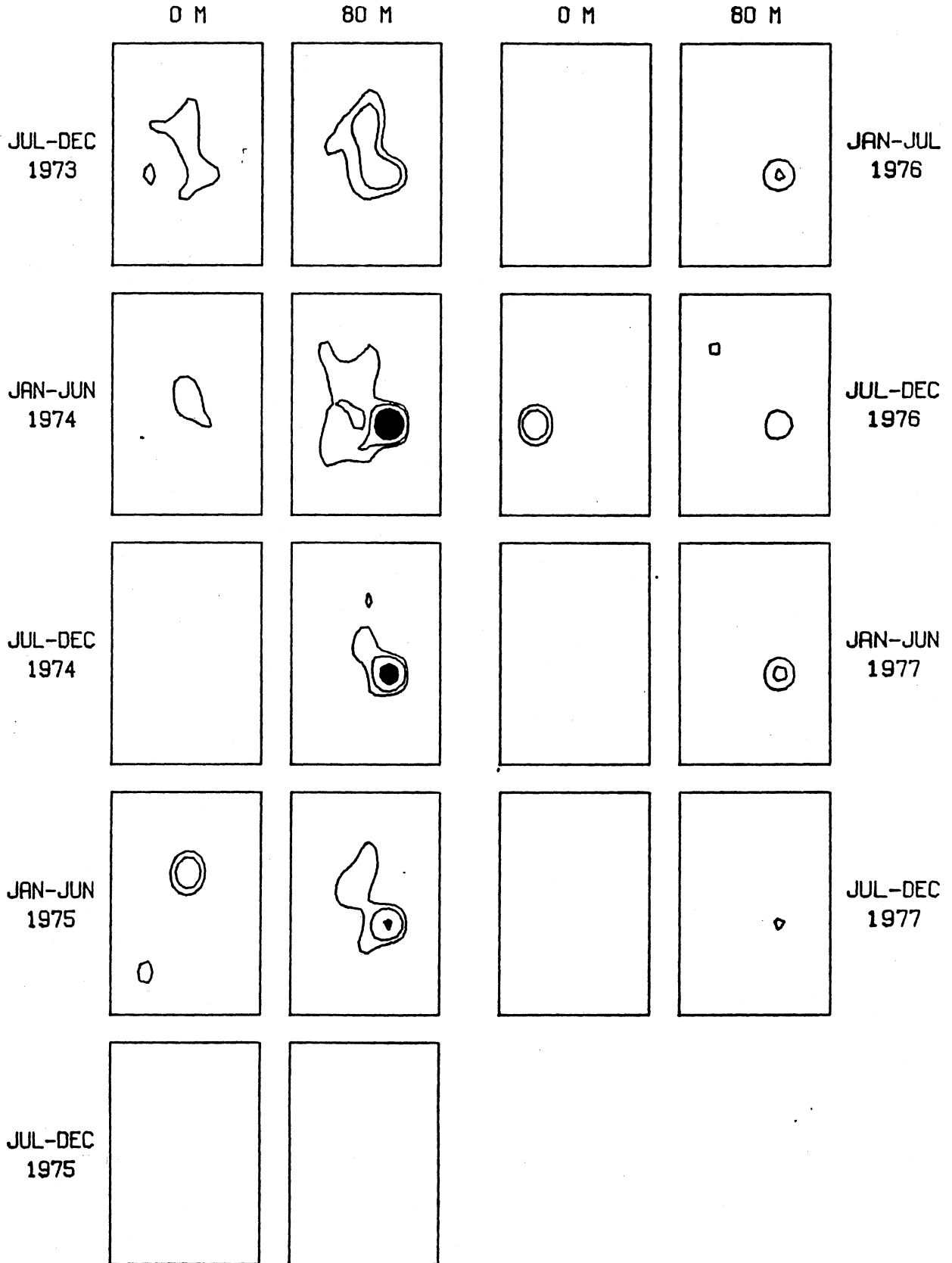
## LOCATIONS

Figure 10

Figure 11. Sulfite waste liquor concentrations at 0 and 80 m for 6-month periods in Port Gardner. Concentrations greater than 100 PBI are darkened.

# SWL(PBI)

100.50.25





### Dissolved Oxygen

Dissolved oxygen has been used as an indicator of possible environmental stress in the receiving waters of Port Gardner. Repeated time series observations of dissolved oxygen concentrations have been made in an area near the deepwater diffuser outfall (Figure 12). A strong seasonal cycle is evident, as is the increased average concentration over the period of ECOBAM.

Dissolved oxygen concentrations can be represented as quarterly contour diagrams for the Port Gardner index area from summer 1973 through autumn 1977 (Figures 13, 14, and 15). Contour levels of 3, 5, and 7 mg/liter of dissolved oxygen have been prepared, each of which gives a somewhat different impression of the increases of concentration over the time of ECOBAM.

Dissolved oxygen concentrations can also be depicted as area contour diagrams at the surface and at 80 m for Port Gardner and adjacent waters for 6-month periods (Figures 16, 17, and 18). The three combinations of contour levels give a somewhat different impression of the concentrations in Port Gardner, but patterns are evident: concentrations are lower in deepwater; concentrations have increased over the time of ECOBAM; the seasonal pattern is evident with lower concentrations in the second half of each year.

Figure 12. Dissolved oxygen concentrations over time as measured in the Port Gardner index area. Each plotted data point is an average of 30 samples taken on one day.

## DISSOLVED OXYGEN CONCENTRATIONS IN THE VOLUME OF THE VOID

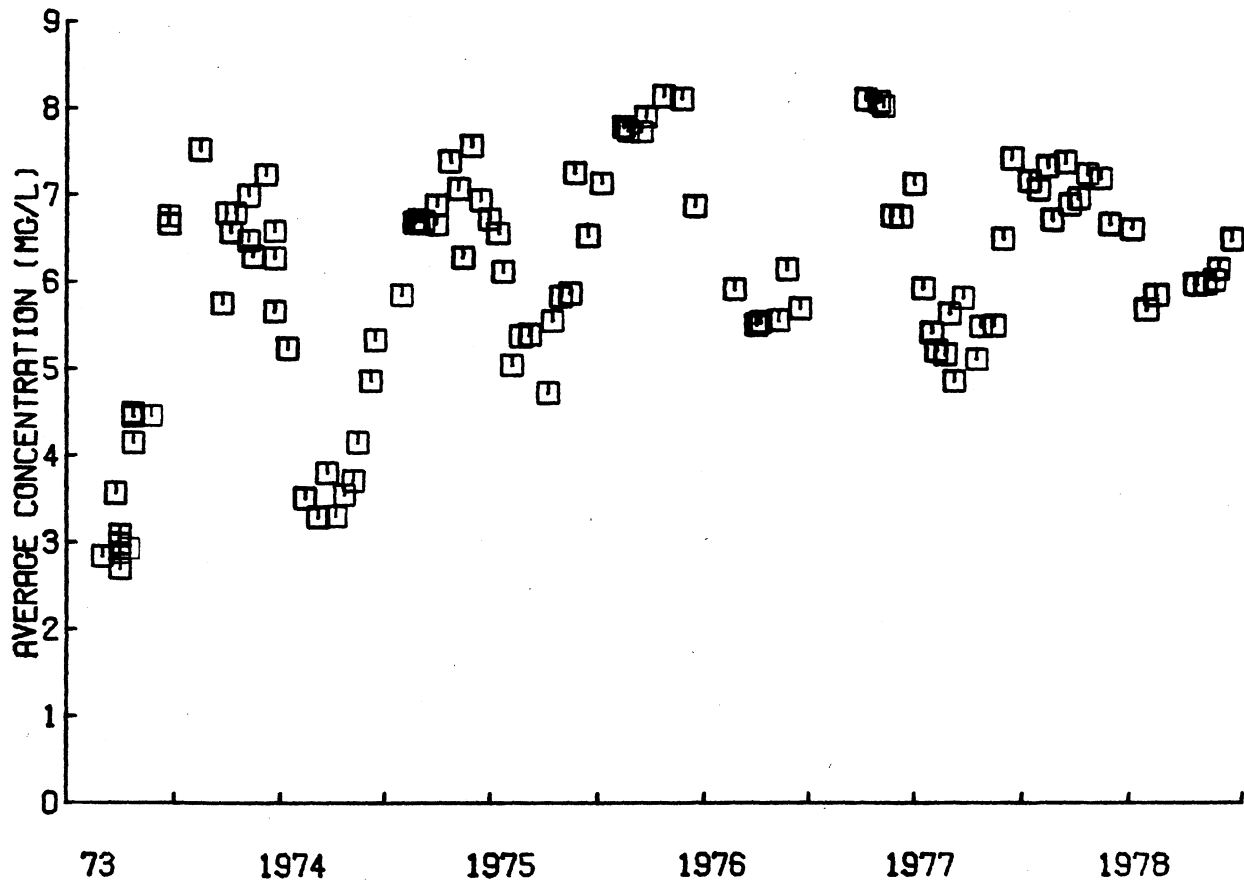


Figure 12

Figures 13 to 15. Dissolved oxygen concentrations for quarterly periods  
in the Port Gardner index area:

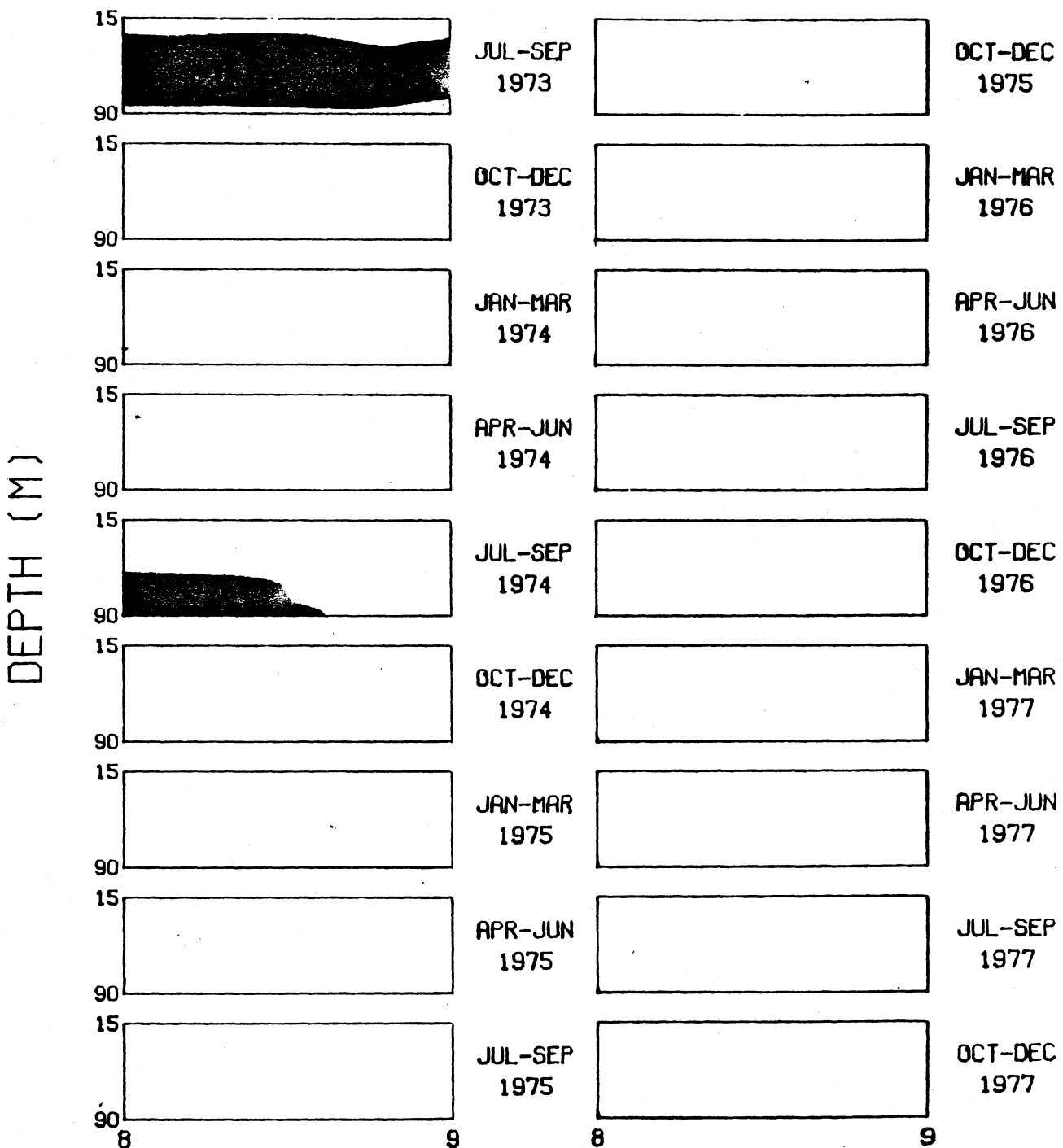
Figure 13 - 3 mg/liter or lower is darkened

Figure 14 - 5 mg/liter or lower is darkened

Figure 15 - 7 mg/liter or lower is darkened

(See Figure 1 for station locations.)

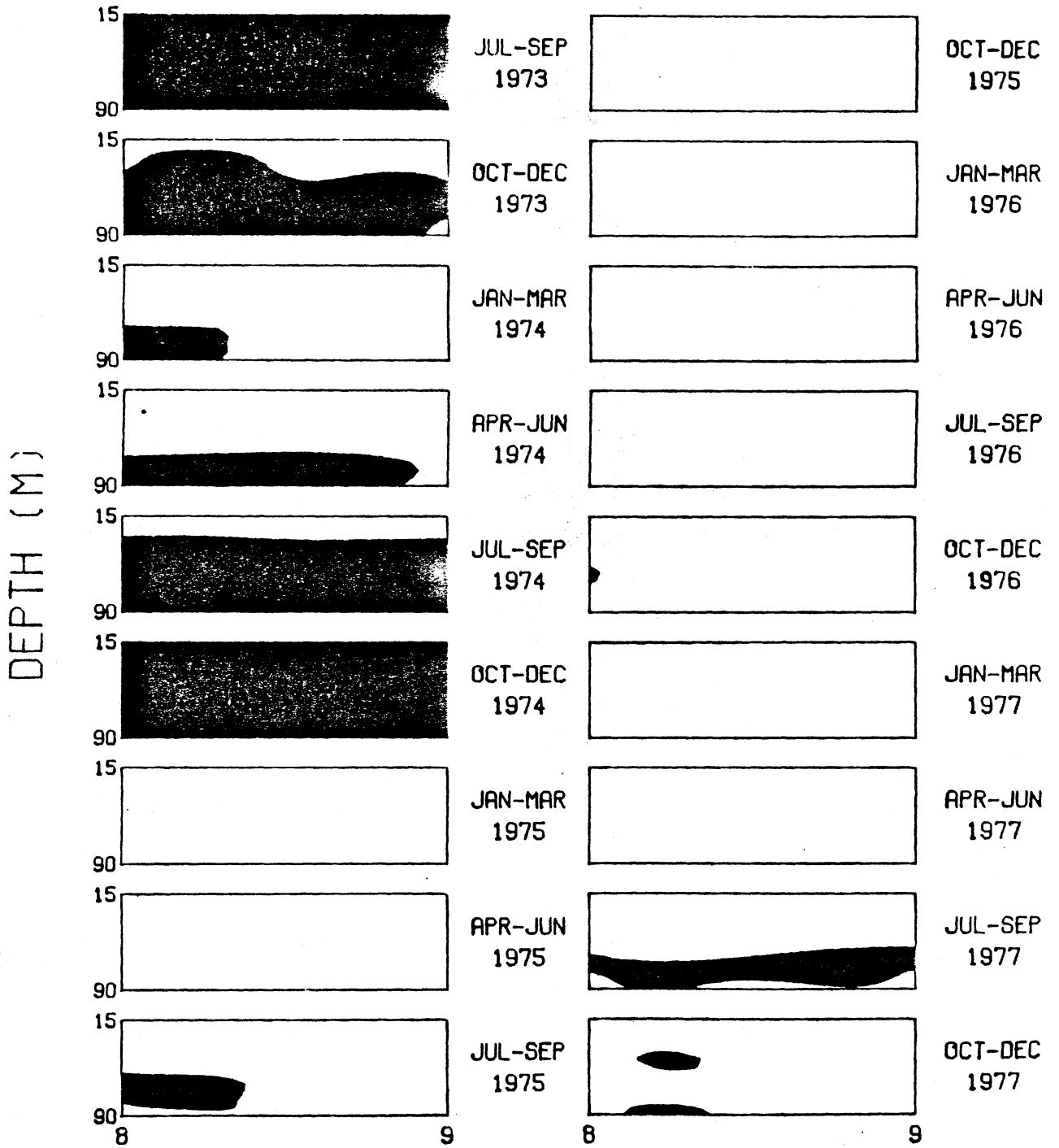
DO (MG/L)



LOCATIONS

Figure 13

DO (MG/L)



LOCATIONS

Figure 14

Figures 16 to 18. Dissolved oxygen concentrations at 0 and 80 m for 6-month periods in Port Gardner. The figure outline shrinks and the innermost contour becomes separated when the dissolved oxygen concentrations are lower.

DO(MG/L)

4.5.6

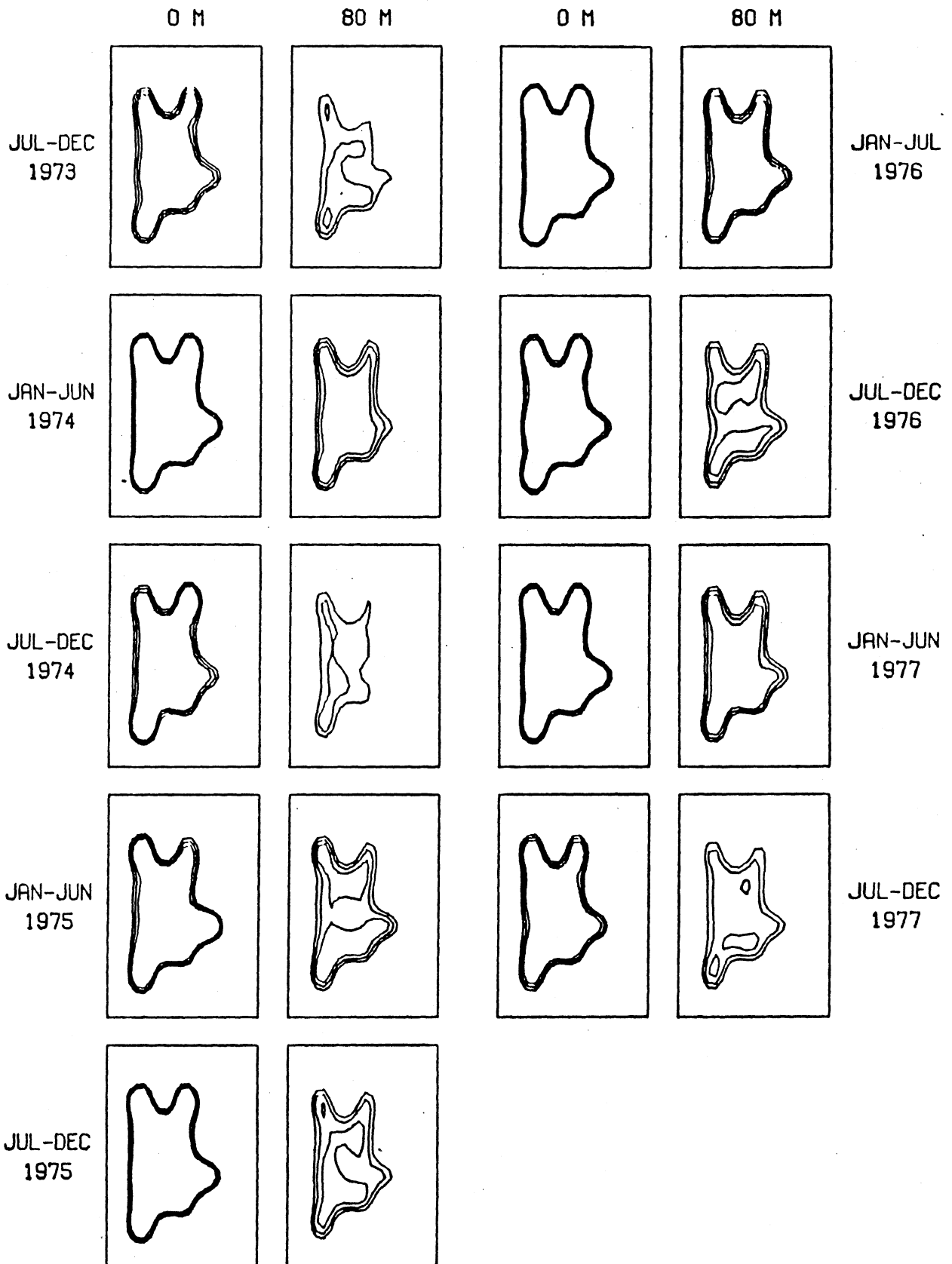


Figure 16



DO (MG/L)  
3.4.5

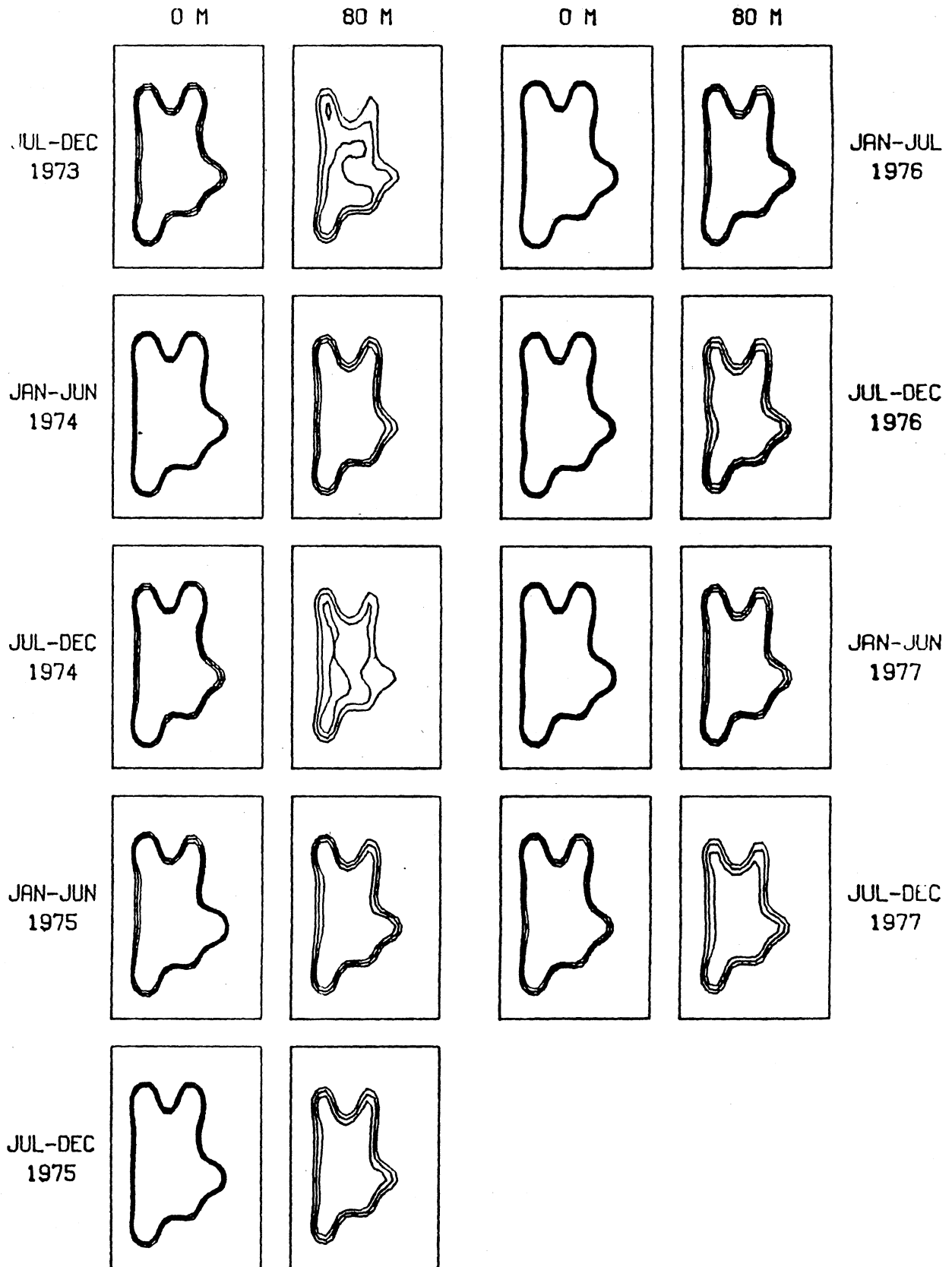
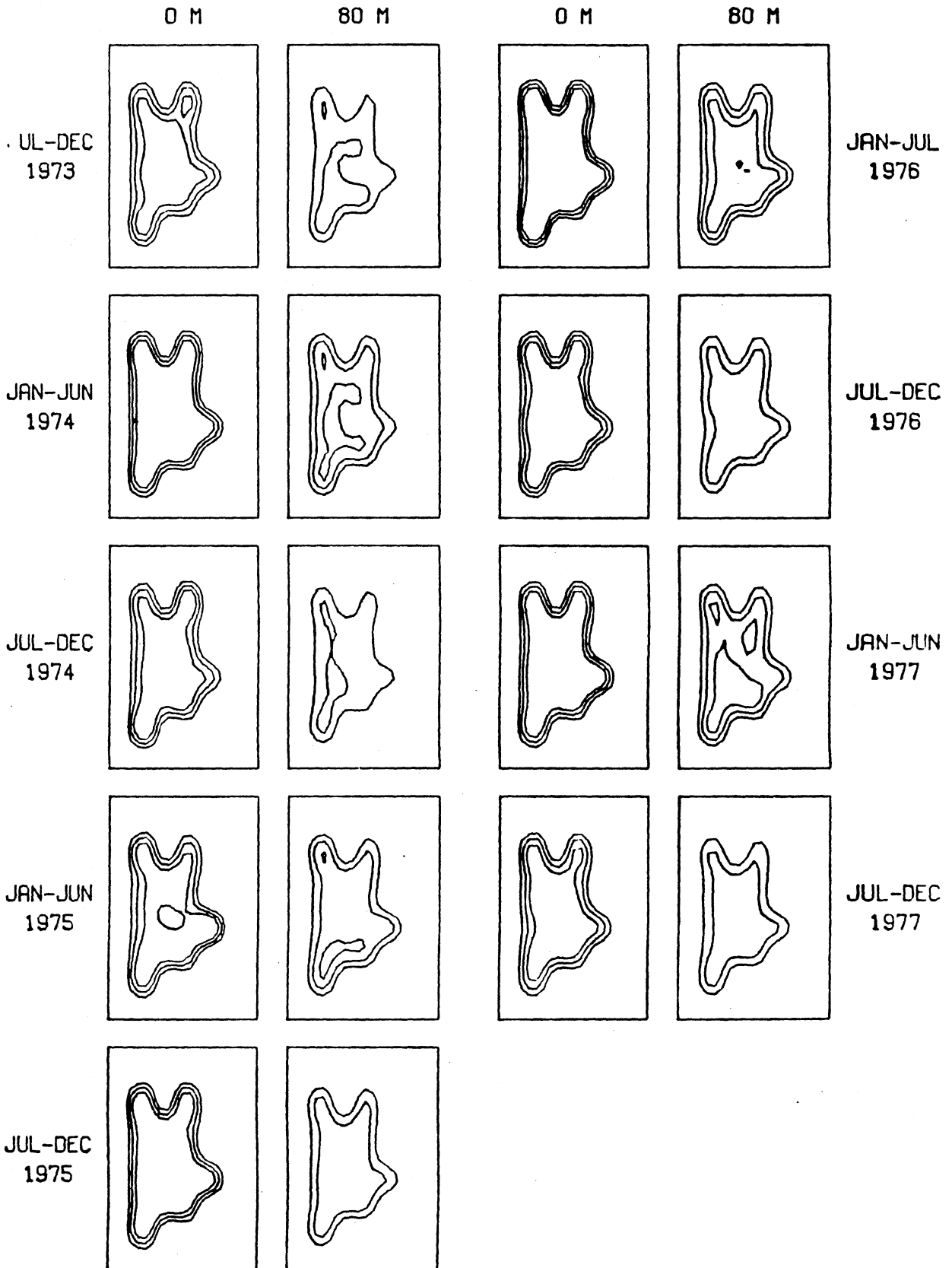


Figure 17

DO (MG/L)

3.5.7



### Sulfite Waste Liquor-Dissolved Oxygen

The relationship between concentrations of sulfite waste liquor and dissolved oxygen in the index area of Port Gardner can be examined by contour diagrams for 6-month periods (Figure 19). The associated decrease in sulfite waste liquor concentration and increase in oxygen concentration is evident. The deeper water is more affected than the surface water; the sulfite waste liquor source appears to be at depth and from the direction of the deep-water diffuser outfall.

Figure 35. Sulfite waste liquor and dissolved oxygen concentrations for 6-month periods in the Port Gardner index area. (See Figure 1 for station locations.) The sulfite waste liquor contours are darkened above 100 PBI; the dissolved oxygen contours are darkened below 5 mg/liter.

SWL (PBI)

DO (MG/L)

25.50.100

5.6

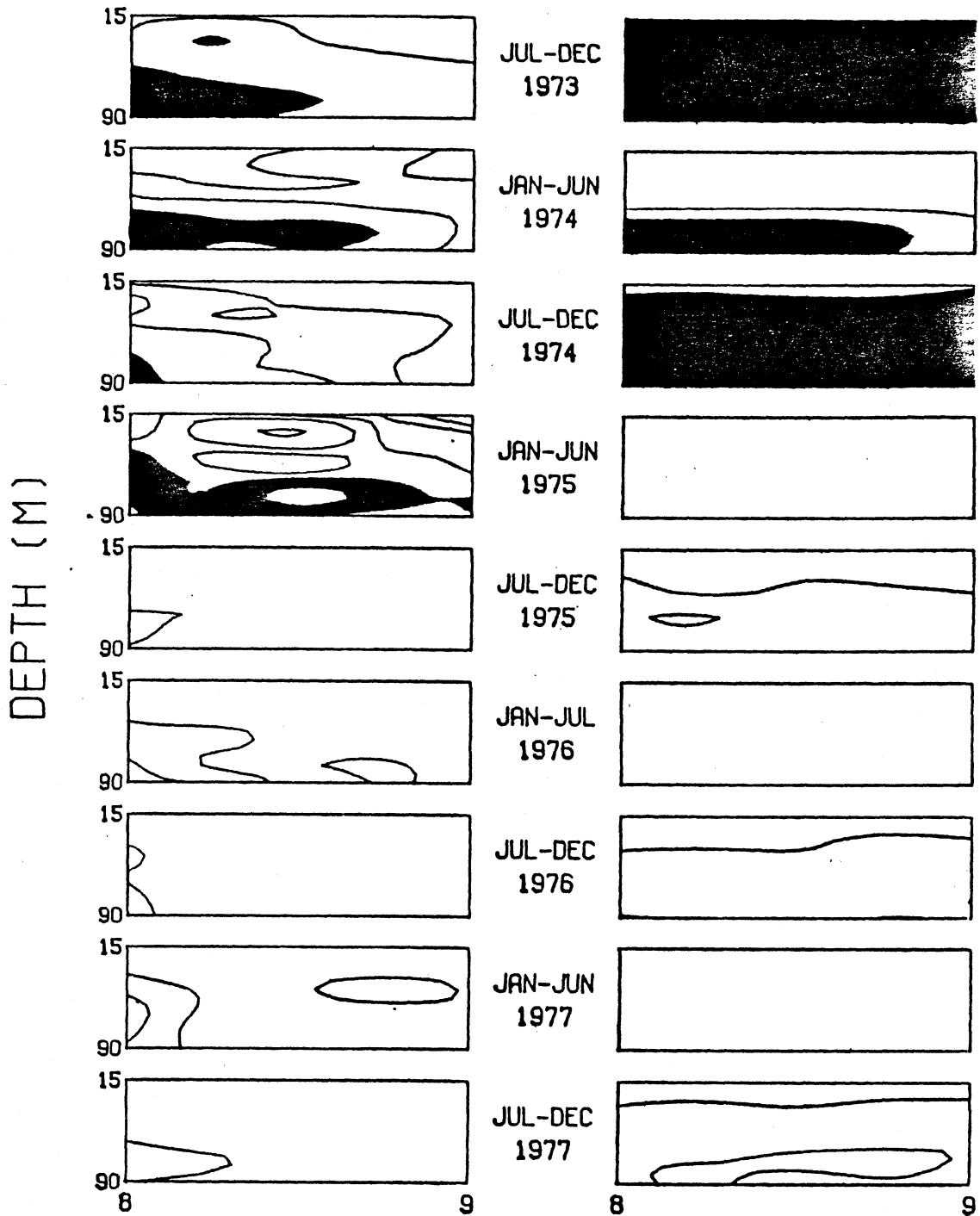


Figure 19

### Oyster Larva Bioassay

The oyster larva bioassay response of percentage abnormal larvae has been used as a screening procedure to identify water that might be suspected of being harmful to marine organisms.

The relationship between several sulfite waste liquor concentrations and abnormal oyster larvae in the bioassay procedure was examined in 4 years during the course of ECOBAM in the Port Gardner index area (Figures 20 and 21). The relationships reflect a close correspondence between these two parameters.

The relationship between sulfite waste liquor concentrations and abnormal larvae in the bioassay procedure can be examined at the surface and at 80 m for 5 years of work by the Washington State Department of Fisheries in an area contour diagram of Port Gardner (Figure 22). These relationships are puzzling, especially when compared to results in the Port Gardner index area. The explanation for differences between shallow and deep samples are especially difficult to interpret. These results suggest that concentrations of sulfite waste liquor and resulting abnormal larvae from the bioassay procedure are not closely coupled, especially in the surface waters of Port Gardner.

Figures 20 and 21. Sulfite waste liquor concentrations and abnormal larvae from the bioassay procedure in the index area of Port Gardner. The samples were taken on one day in each year. The sulfite waste liquor and the abnormal larvae contours are darkened above the level indicated.

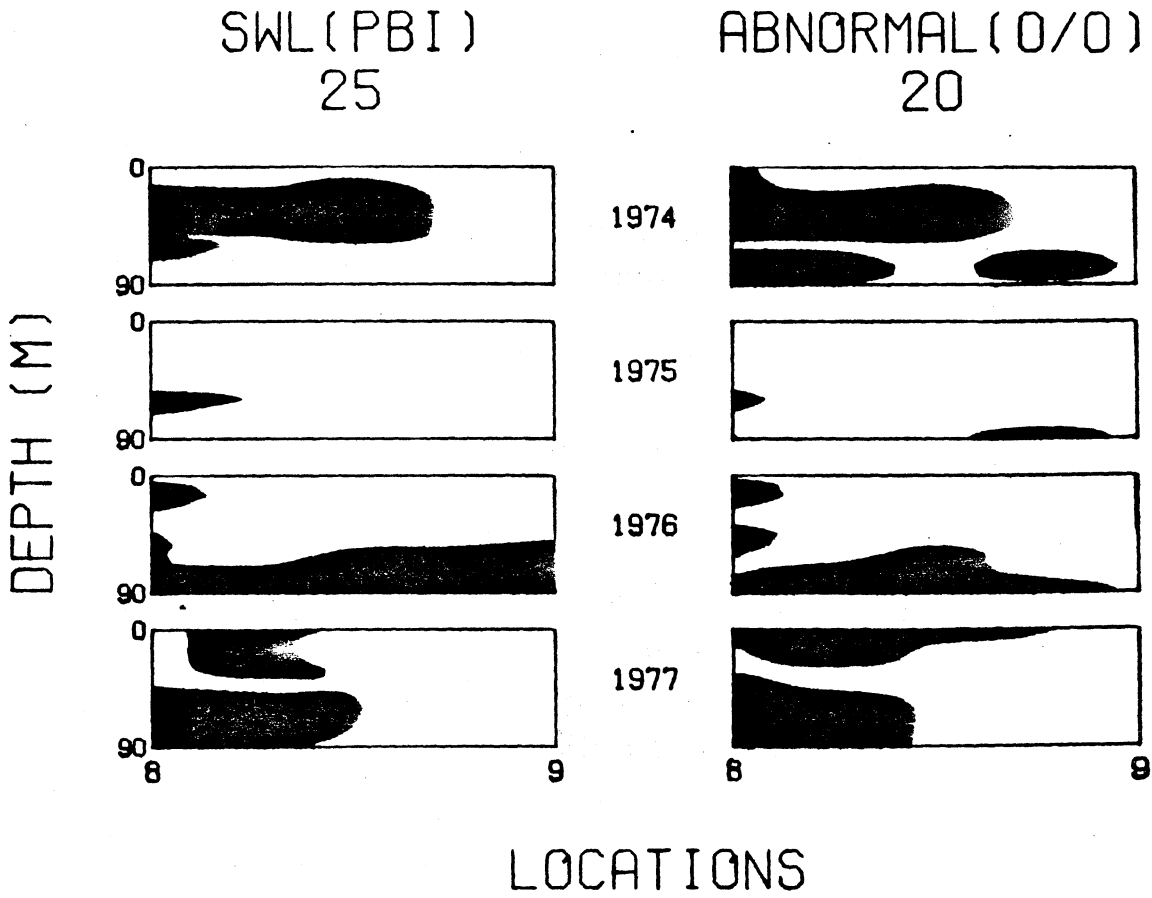


Figure 20



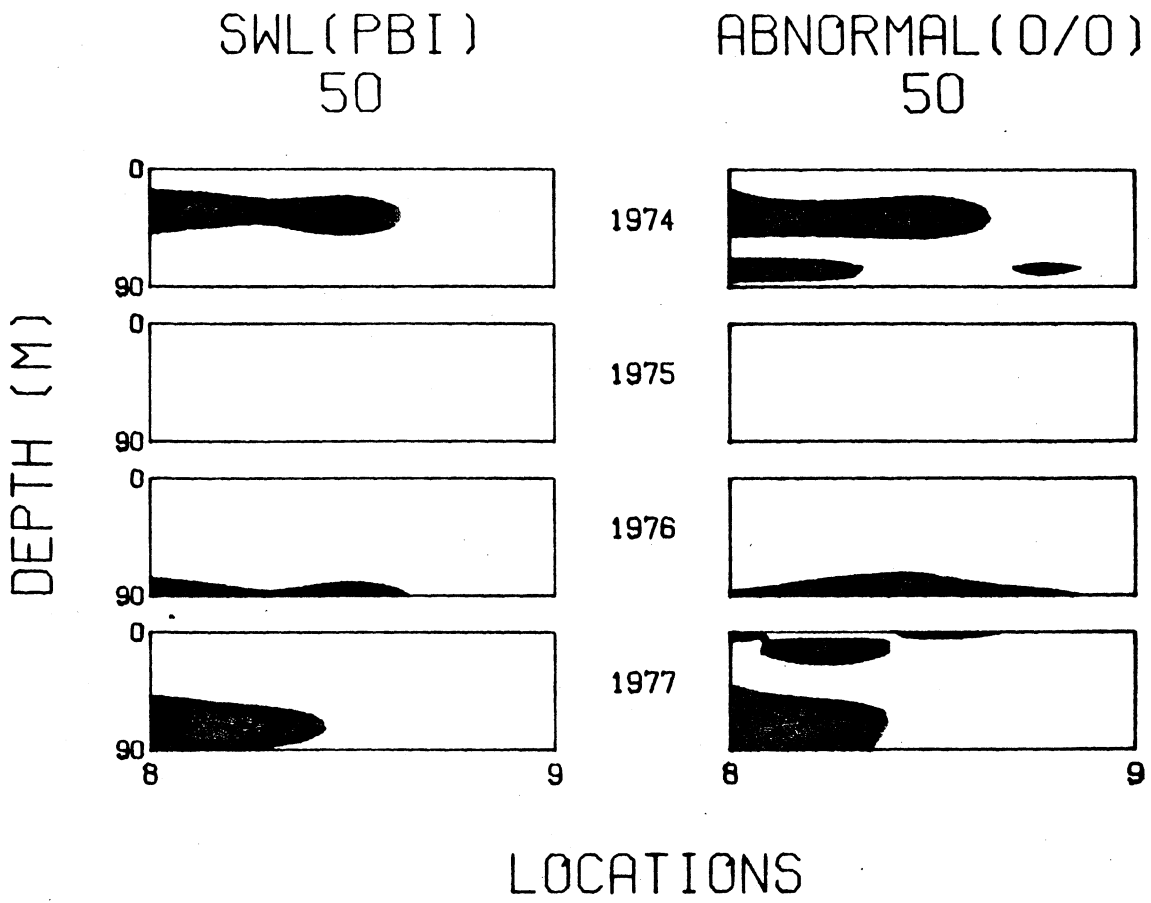


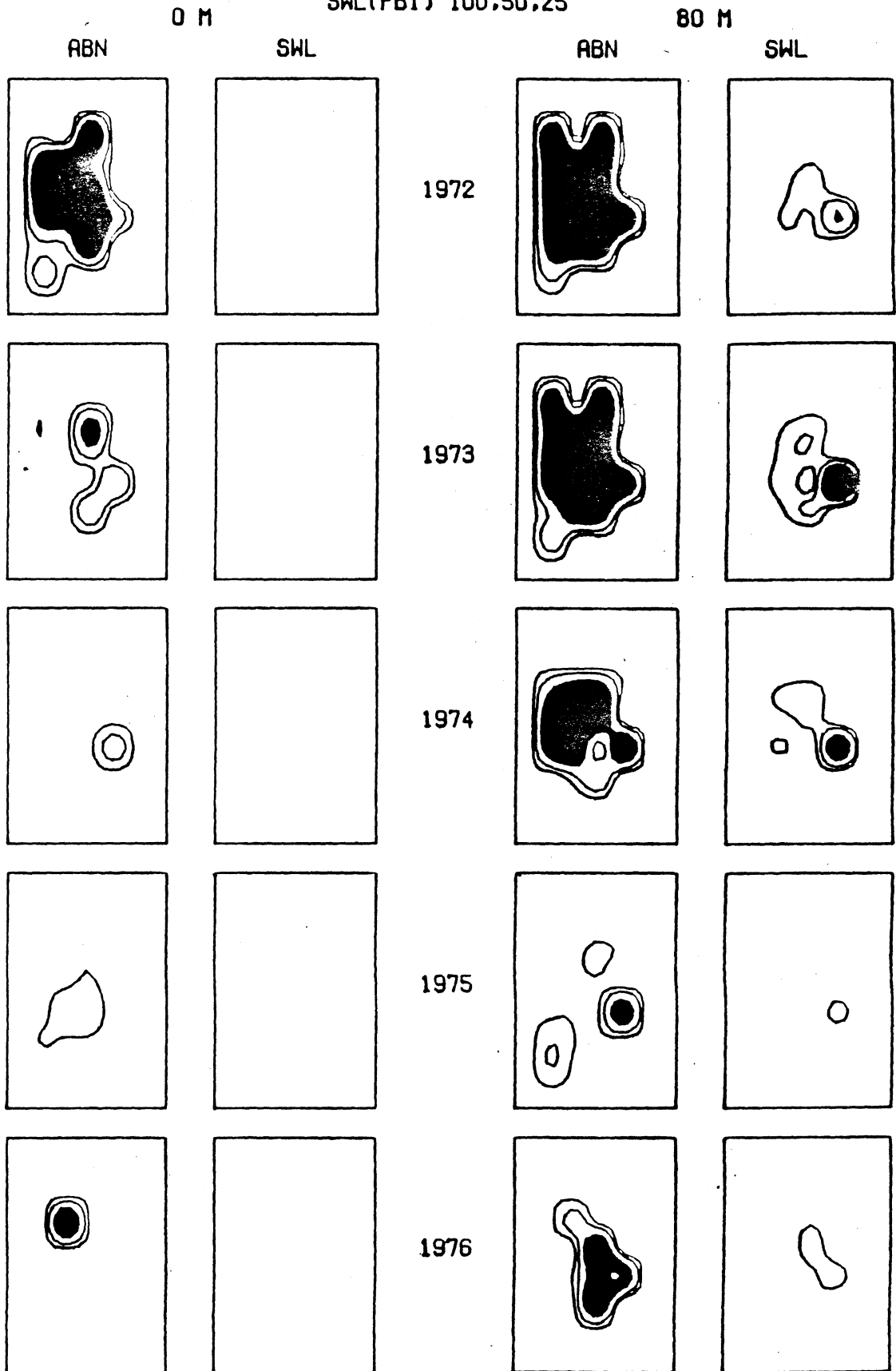
Figure 21

Figure 22. Sulfite waste liquor concentrations and abnormal larvae from the bioassay procedure at 0 and 80 m in Port Gardner (replotted from Washington State Department of Fisheries reports). Concentrations of sulfite waste liquor greater than 100 PBI are darkened; abnormal larvae greater than 50% are darkened. The contours grow smaller as the PBI and abnormal % decrease.

# OYSTER LARVA BIOASSAY

ABNORMAL (0/0) 50,20,5

SWL (PBI) 100,50,25



### Research Trawling

Research trawling has been conducted during the course of ECOBAM. The Port Gardner area, near station 8, was to be compared to areas at Tulalip, near station 12, to the north and Mukilteo, near station 7, to the south (Figure 1). The hauls were made at a range of depths and have been depicted as catch/haul abundance over time (Figure 23 to 45). The catches of abundant fishes, shrimps, and crab have been depicted.

The most important fish to the commercial fleet is the English sole, Parophrys vetulus (Figures 23 and 24). The abundance at Port Gardner has decreased during the course of ECOBAM. Other important flat fishes, Psettichys melanostictus, Microstomus pocificus, Isopsetta isolepis, and Platichthys stellatus, follow the same pattern of decline (Figures 24 to 27). Two species of flat fishes, Lyopsetta exilis and Lepidopsetta bilineata, increased in abundance at Port Gardner during the course of ECOBAM (Figures 28 and 29).

The abundance of the Dungeness crab, Cancer magister, appears to have decreased over the time of ECOBAM (Figure 38). Seven species of shrimp have been depicted (Figures 39 to 45). Some species appears to have increased and some to have decreased, while others appear relatively unchanged.

Other less abundant species have been recorded. The possibility that their abundance will change later in ECOBAM remains open.

The major impression to be gained from these trawl catches is that some populations appear to have changed substantially during the course of ECOBAM. The persistence or intensification of those changes

over a few years would suggest strongly that environmental changes in Port Gardner have caused changes in populations of marine animals.

Figures 23 to 45. The abundance of fishes, crab, and shrimps as catch/haul at Tulalip (TL), Port Gardner (PG), and Mukilteo (MK). Each sampling depth is indicated by a symbol:

□ = 5 METERS  
○ = 10 METERS  
△ = 20 METERS  
+ = 30 METERS  
× = 40 METERS  
◇ = 60 METERS  
✕ = 80 METERS  
\* = 120 METERS  
⊛ = 150 METERS

PAROPHRYS VETULUS  
ENGLISH SOLE

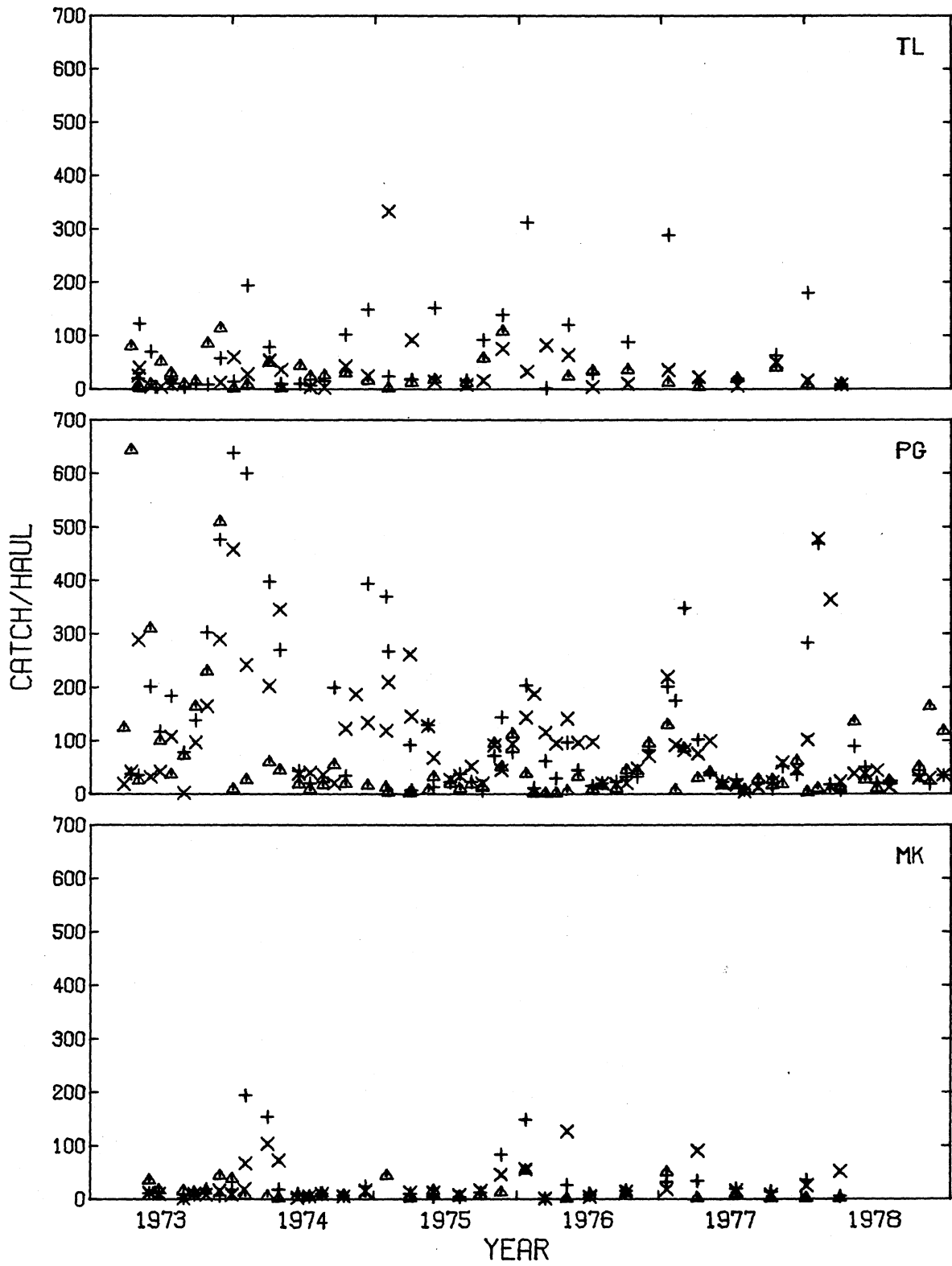


Figure 23

PAROPHRYS VETULUS  
ENGLISH SOLE

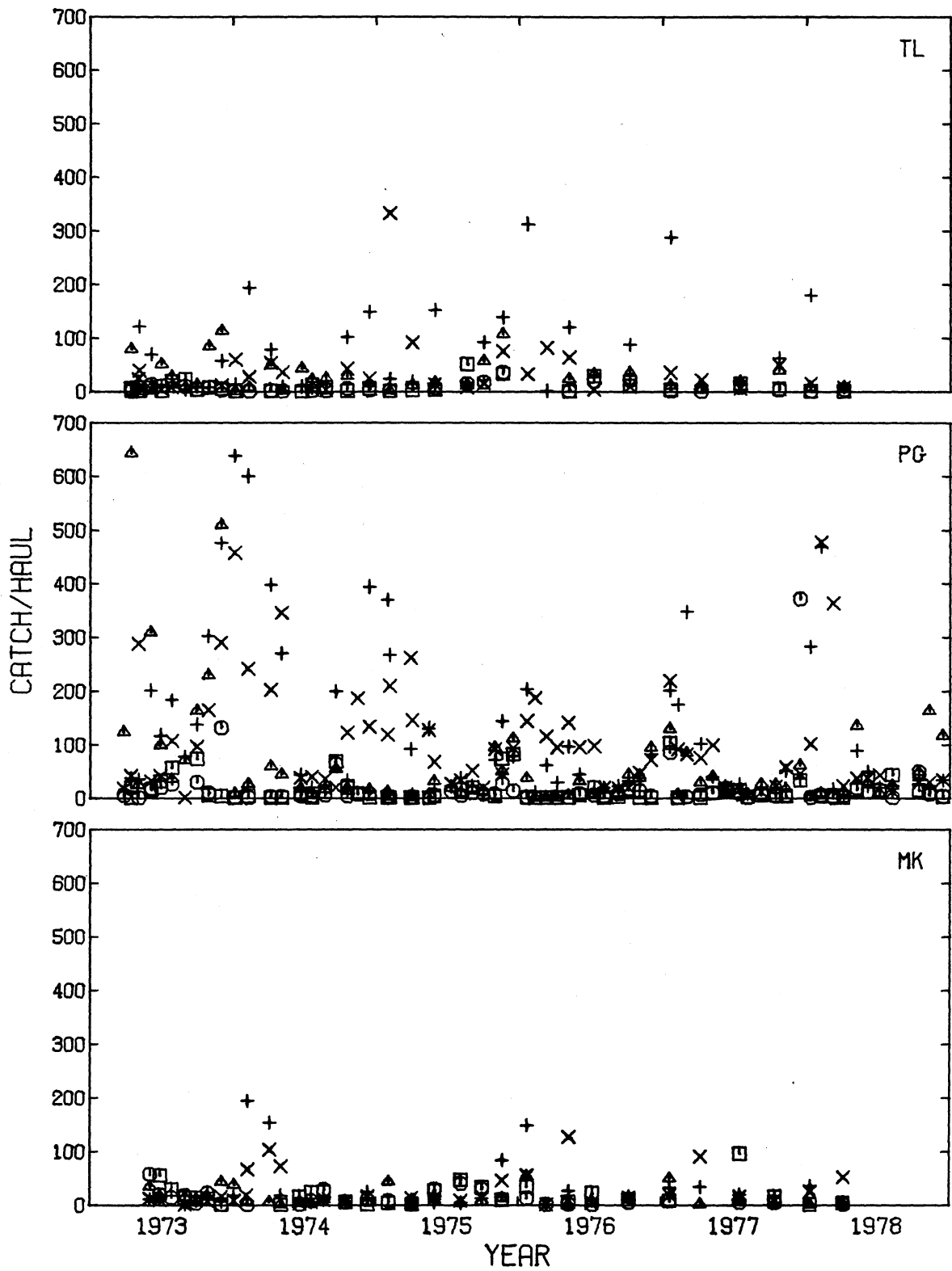


Figure 24



PSETTICHTHYS MELANOSTICTUS  
SAND SOLE

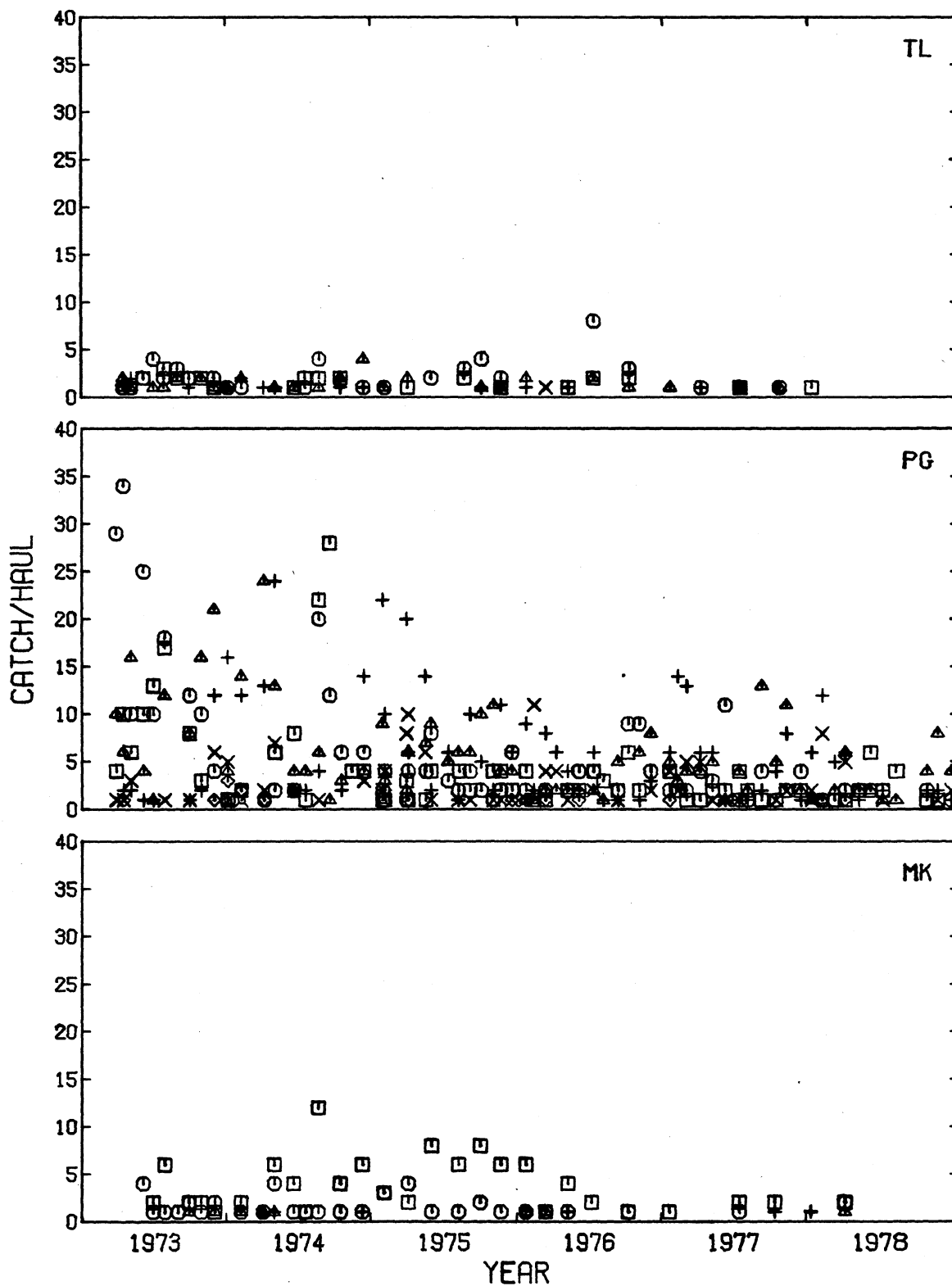


Figure 25

ISOPSETTA ISOLEPIS  
BUTTER SOLE

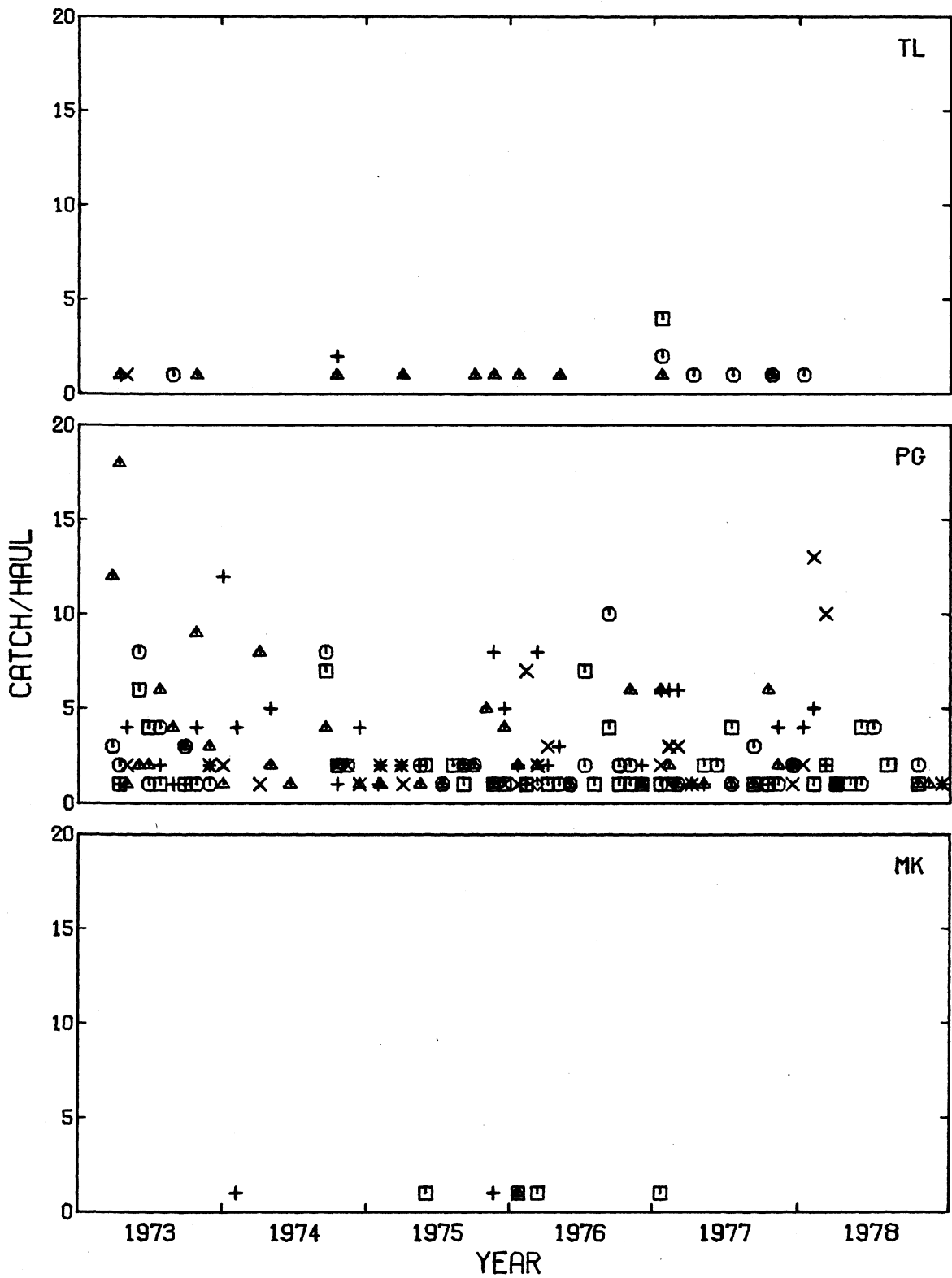


Figure 26

MICROSTOMUS PACIFICUS  
DOVER SOLE

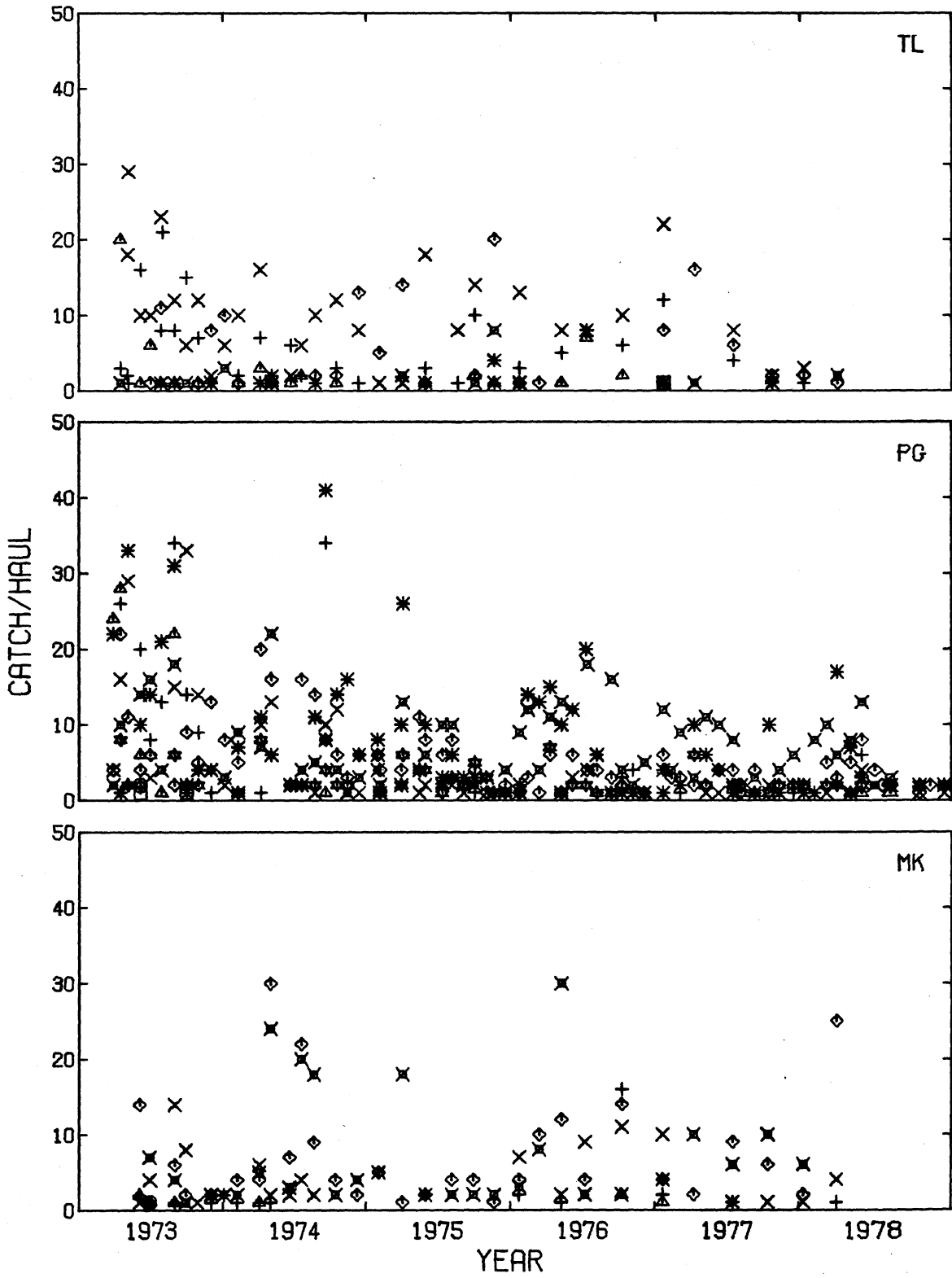


Figure 27

PLATICHTHYS STELLATUS  
STARRY FLOUNDER

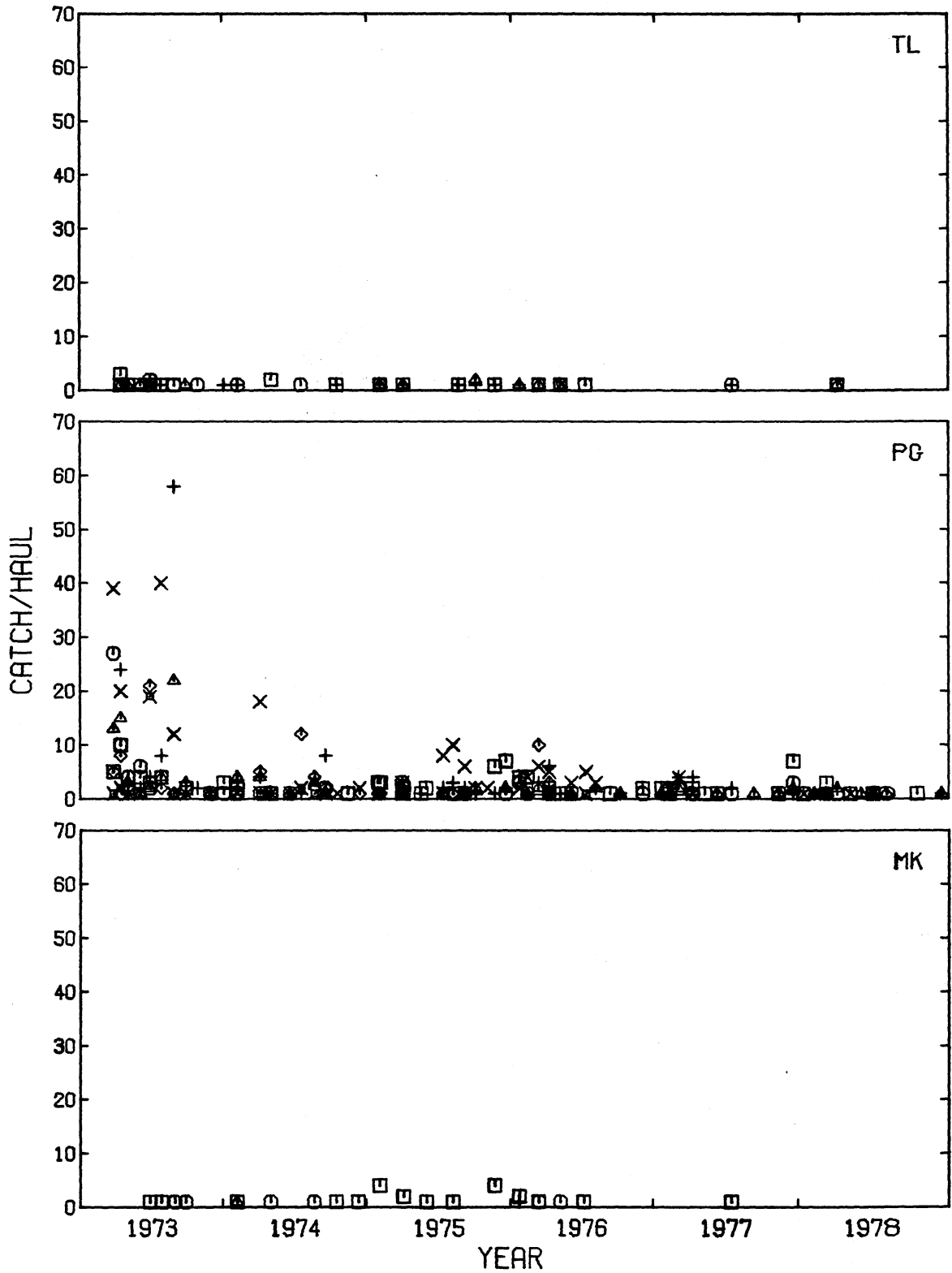


Figure 28

LYOPSETTA EXILIS  
SLENDER SOLE

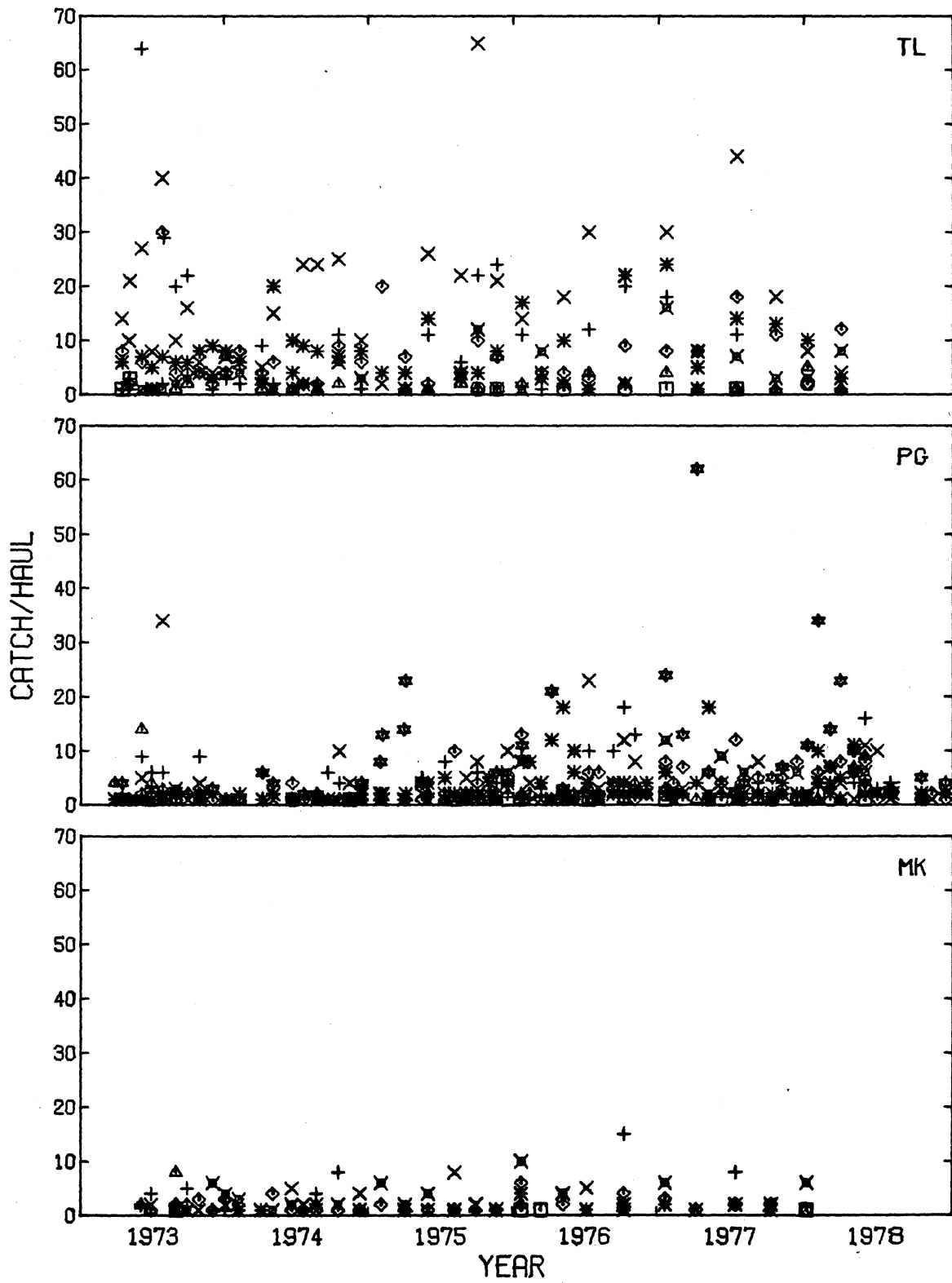


Figure 29

LEPIDOPSETTA BILINEATA  
ROCK SOLE

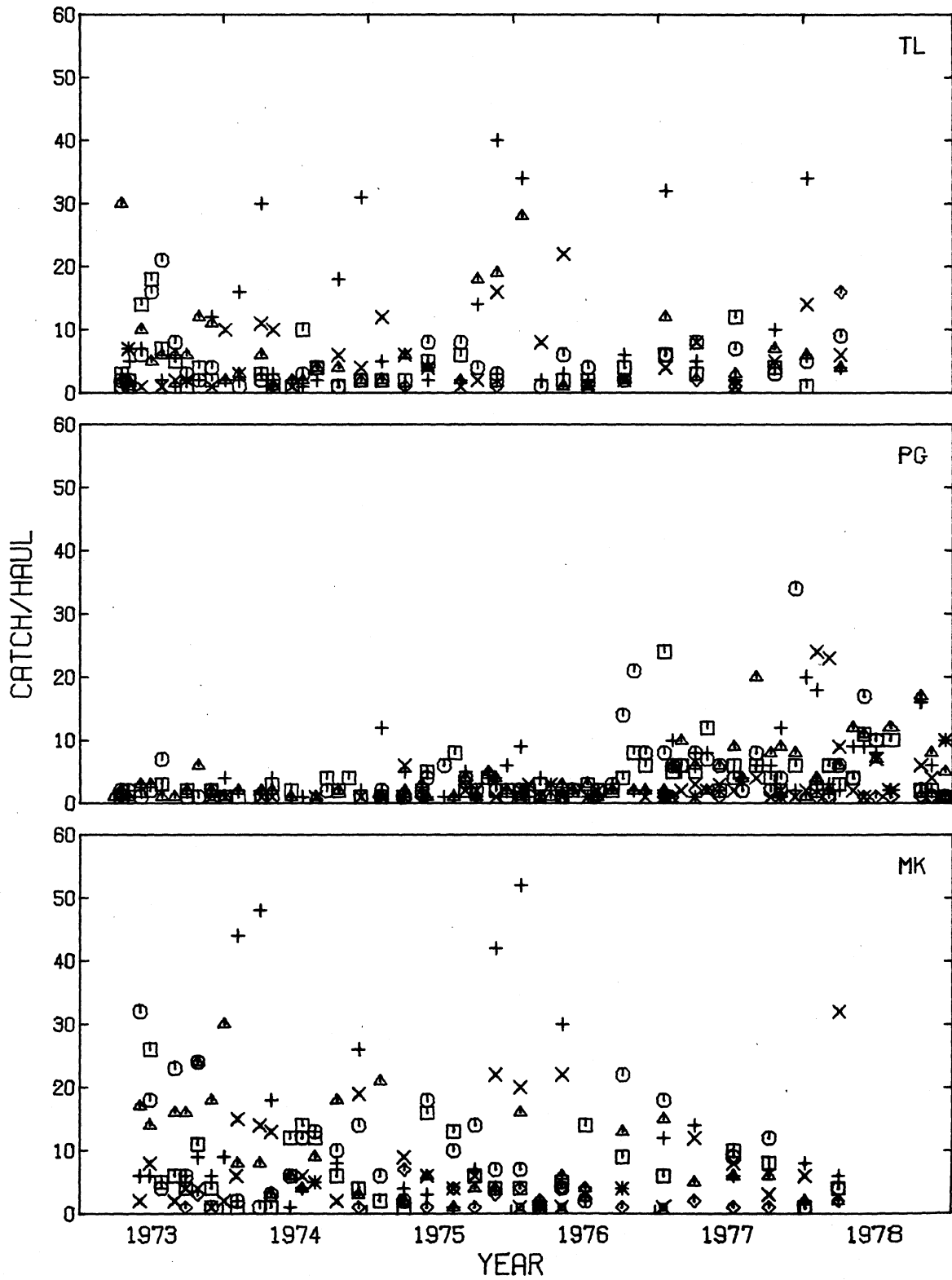


Figure 30

CITHARICHTHYS STIGMAEUS  
SPECKLED SANDDAB

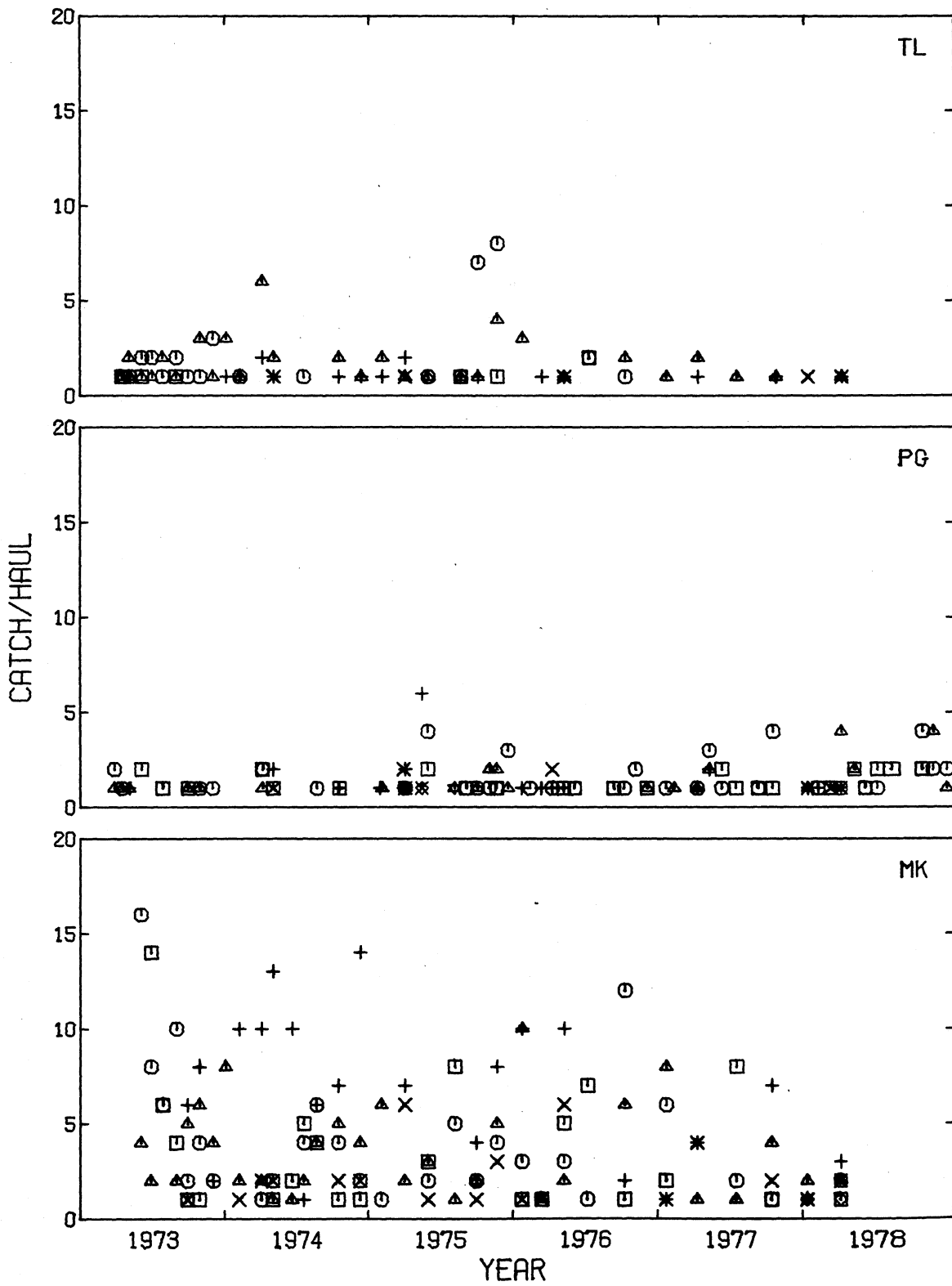


Figure 31

CITHARICHTHYS SORDIDUS  
PACIFIC SANDDAB

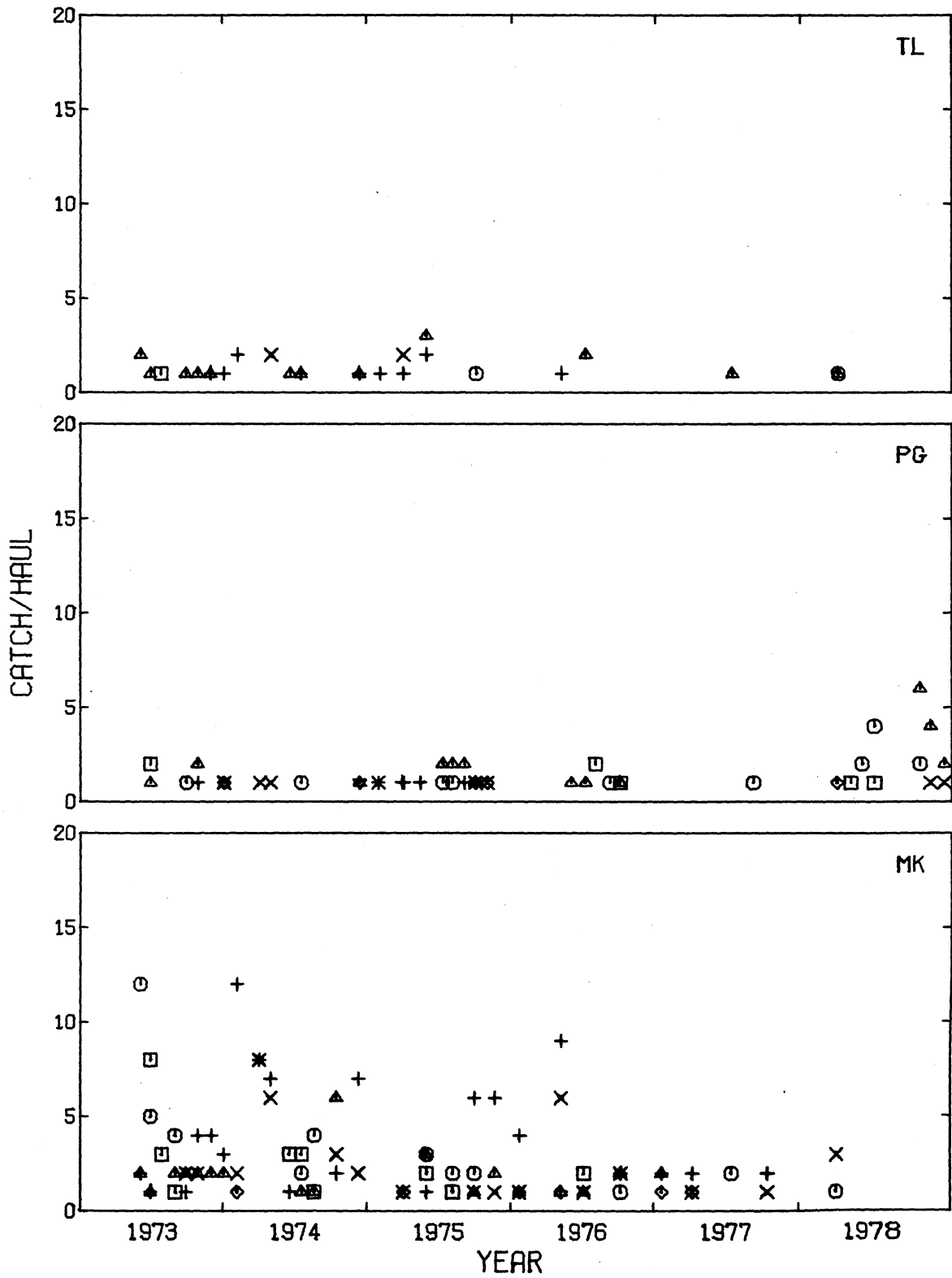


Figure 32



MICROGADUS PROXIMUS  
PACIFIC TOMCOD

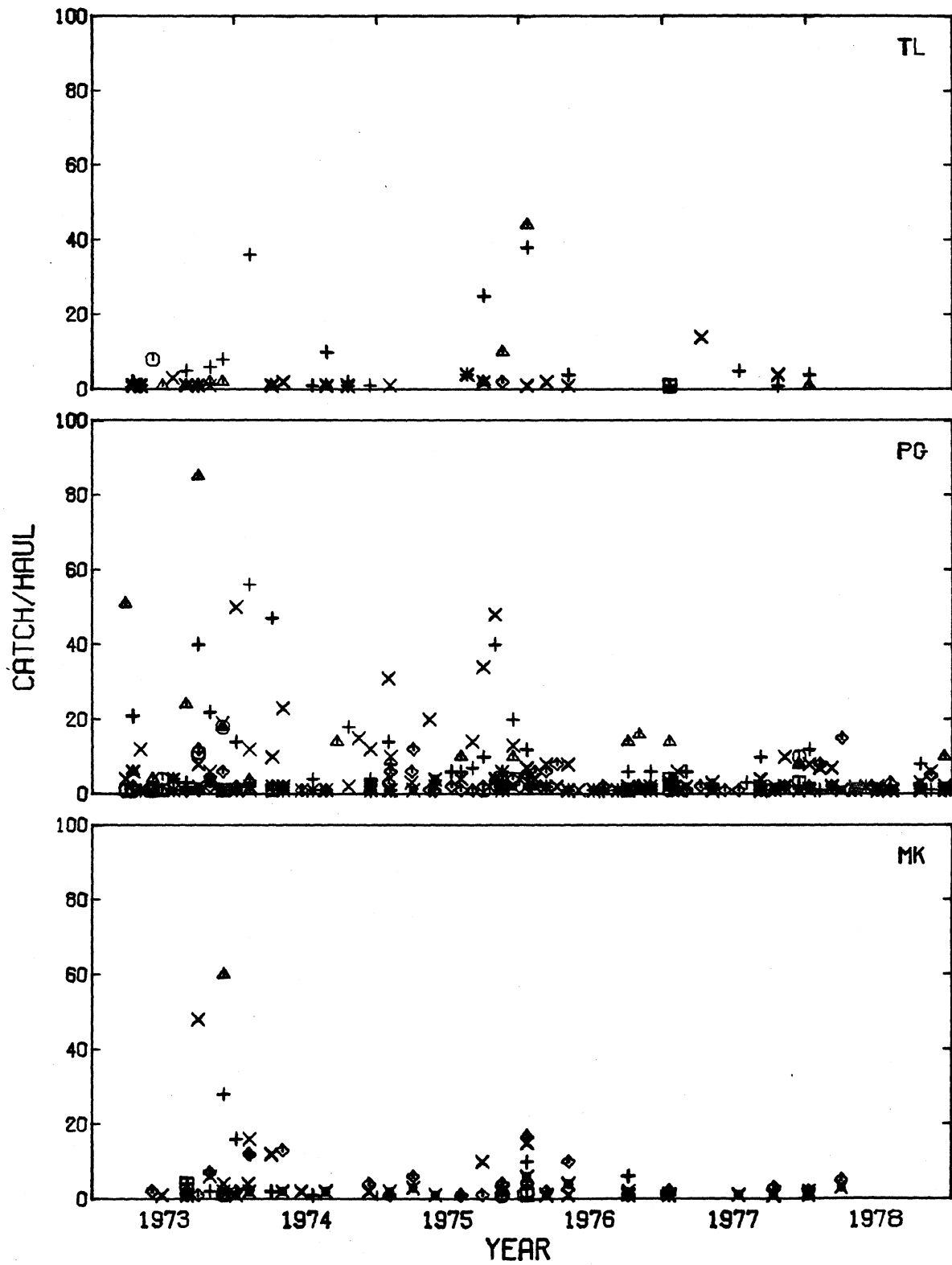


Figure 33

LEPTOCOTTUS ARMATUS  
PACIFIC STAGHORN SCULPIN

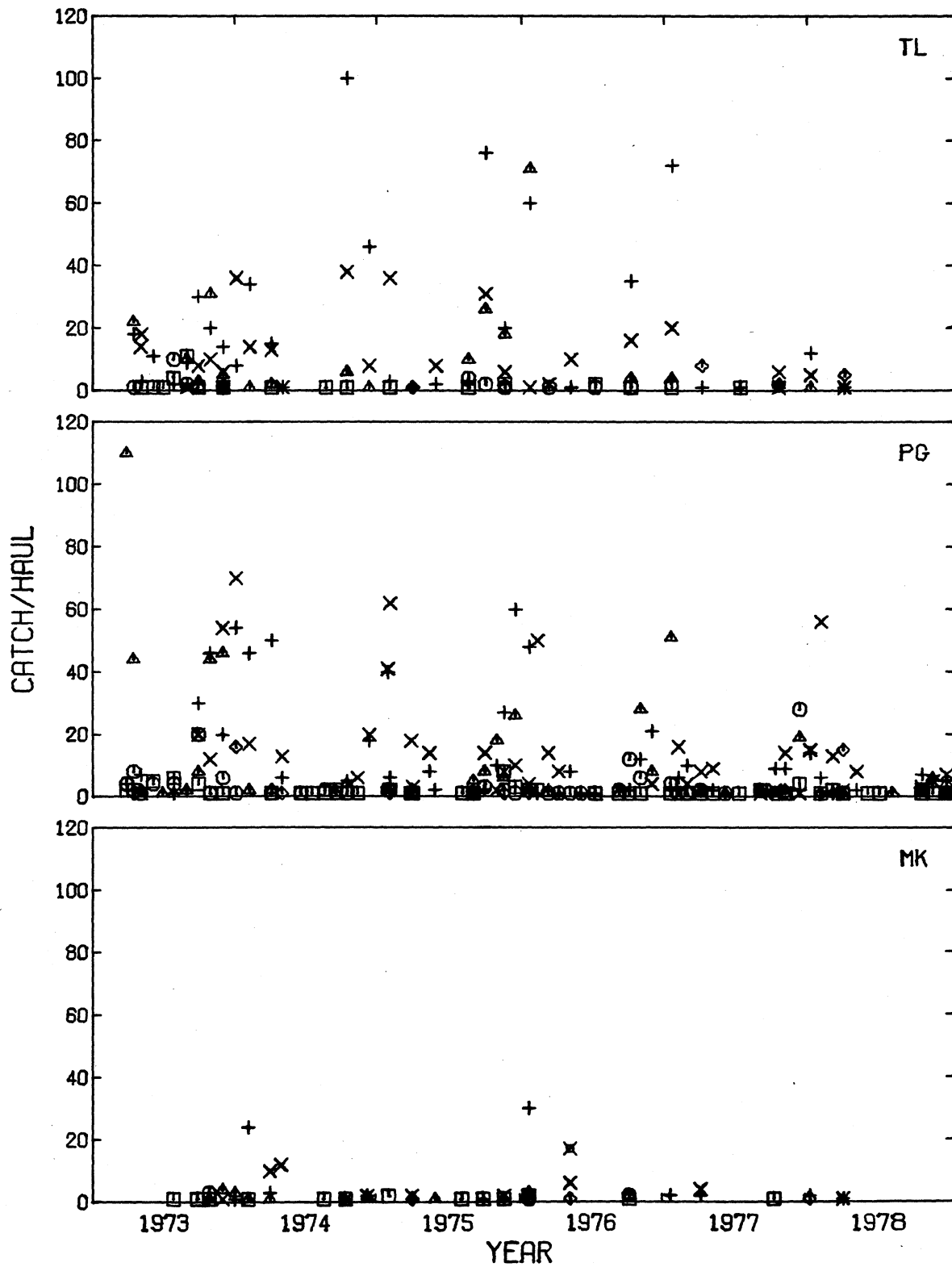


Figure 34

SEBASTES SPP.  
ROCKFISH

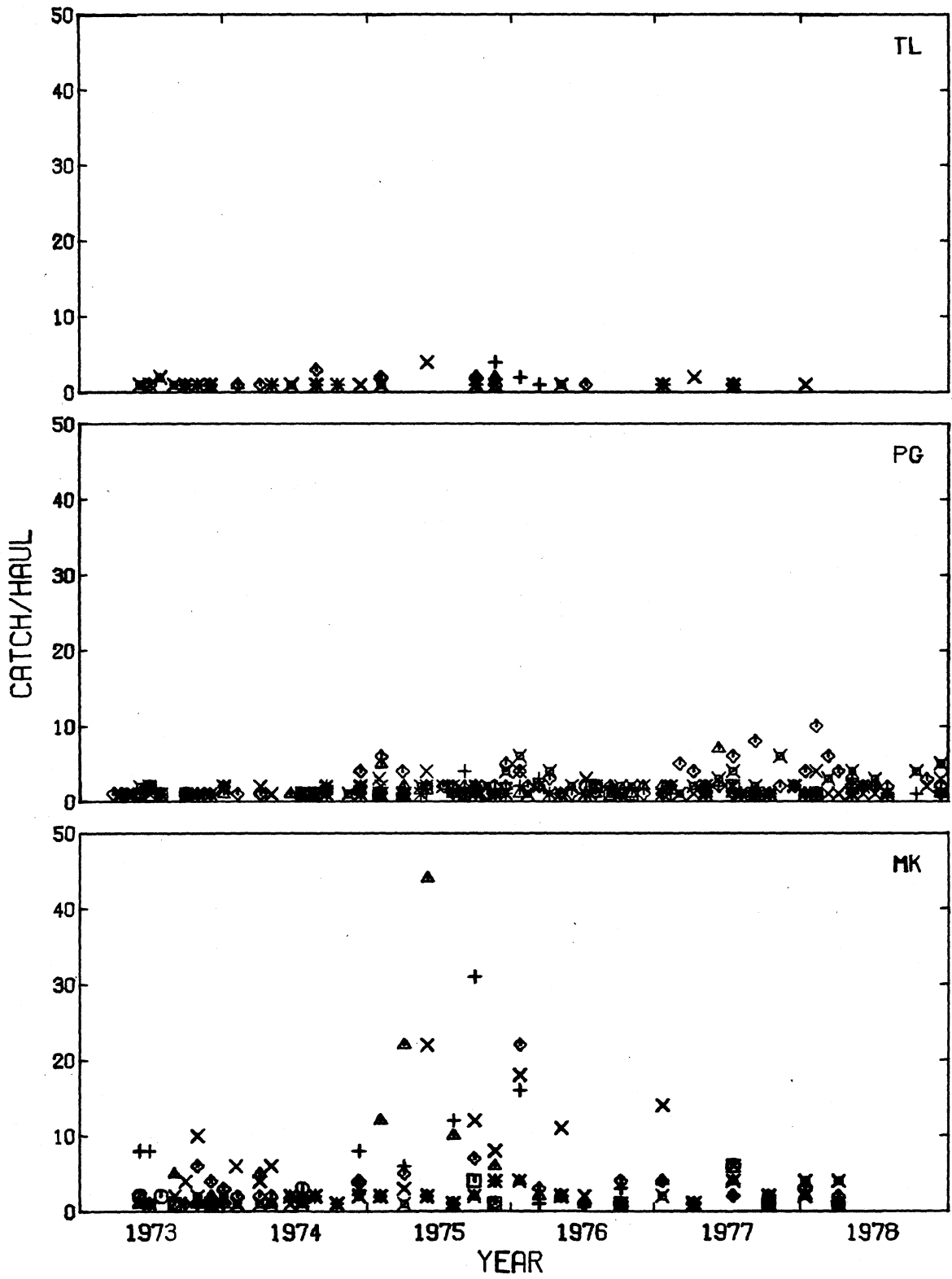


Figure 35

HYDROLAGUS COLLIEI  
RATFISH

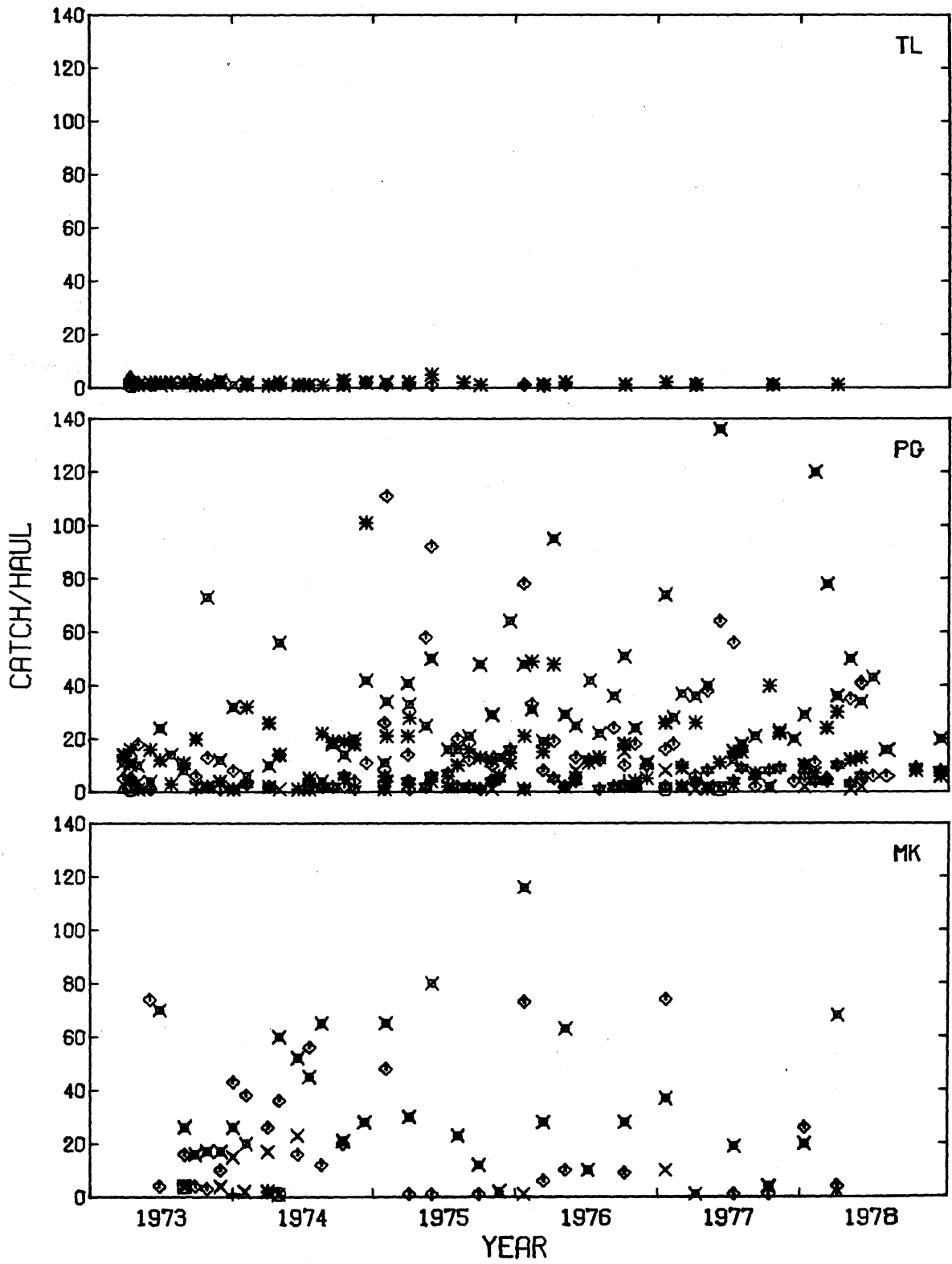


Figure 36

MERLUCCIUS PRODUCTUS  
PACIFIC HAKE

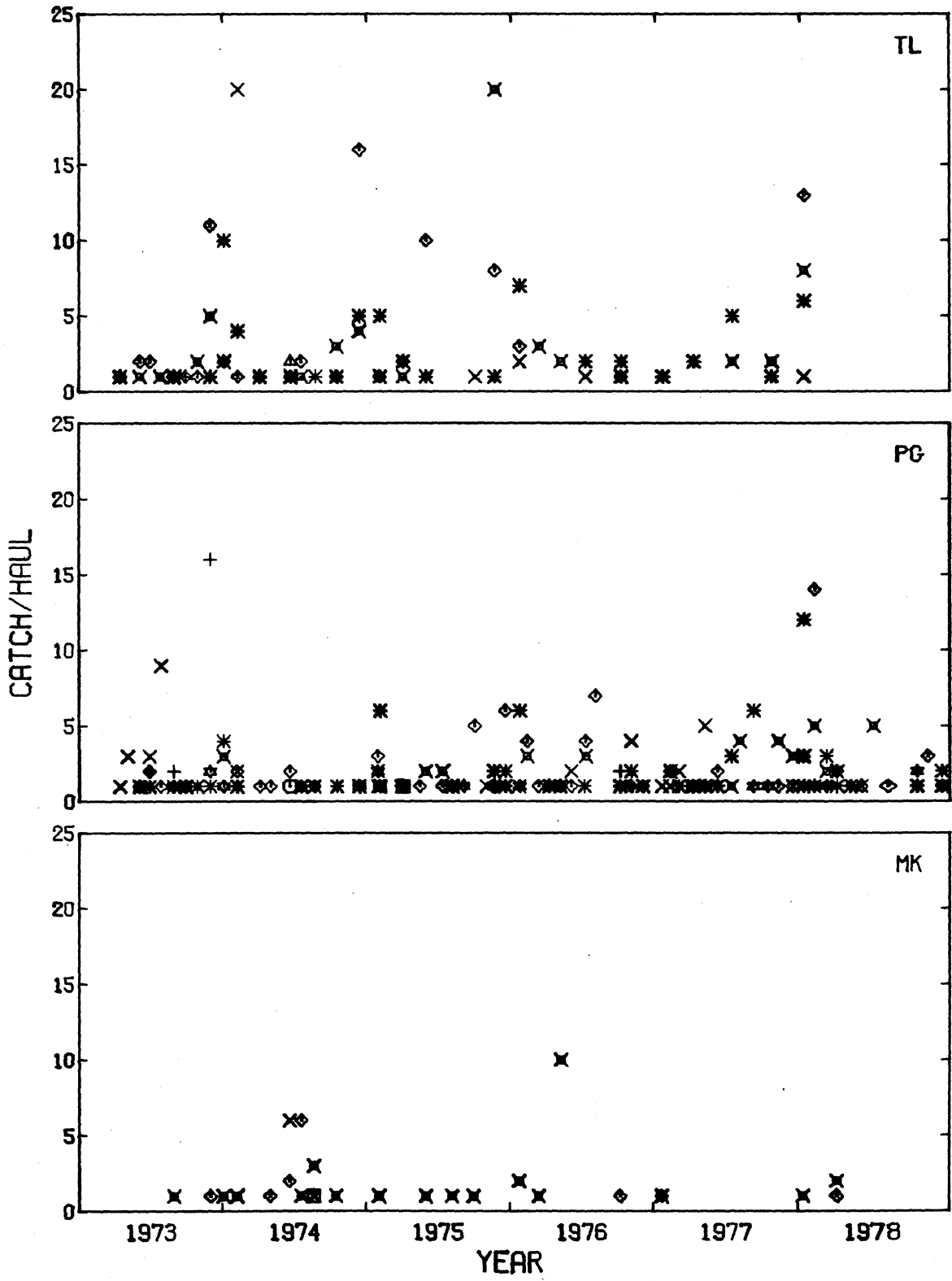


Figure 37

CANCER MAGISTER  
DUNGENESS CRAB

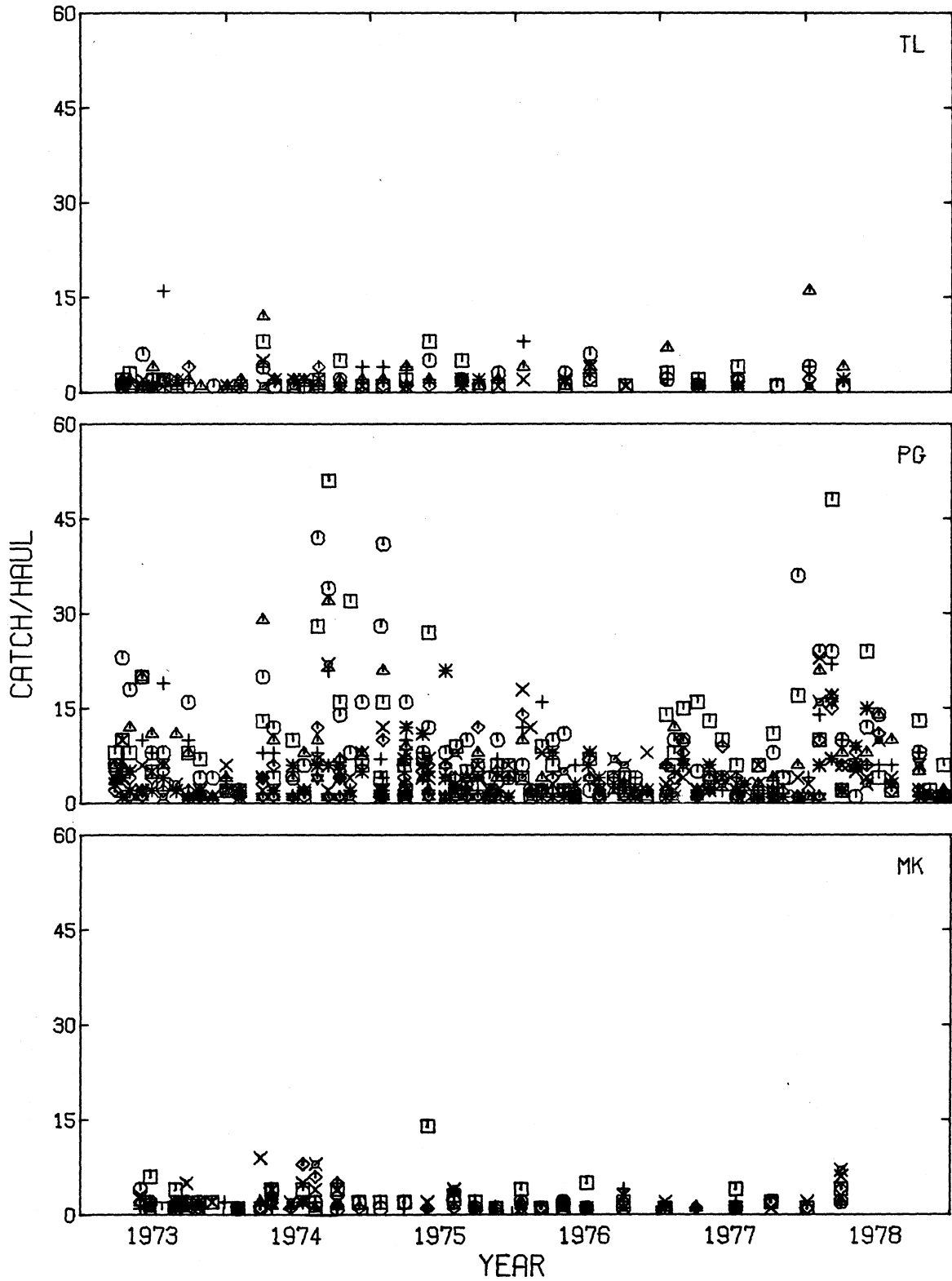


Figure 38

PANDALUS JORDANI  
OCEAN PINK SHRIMP

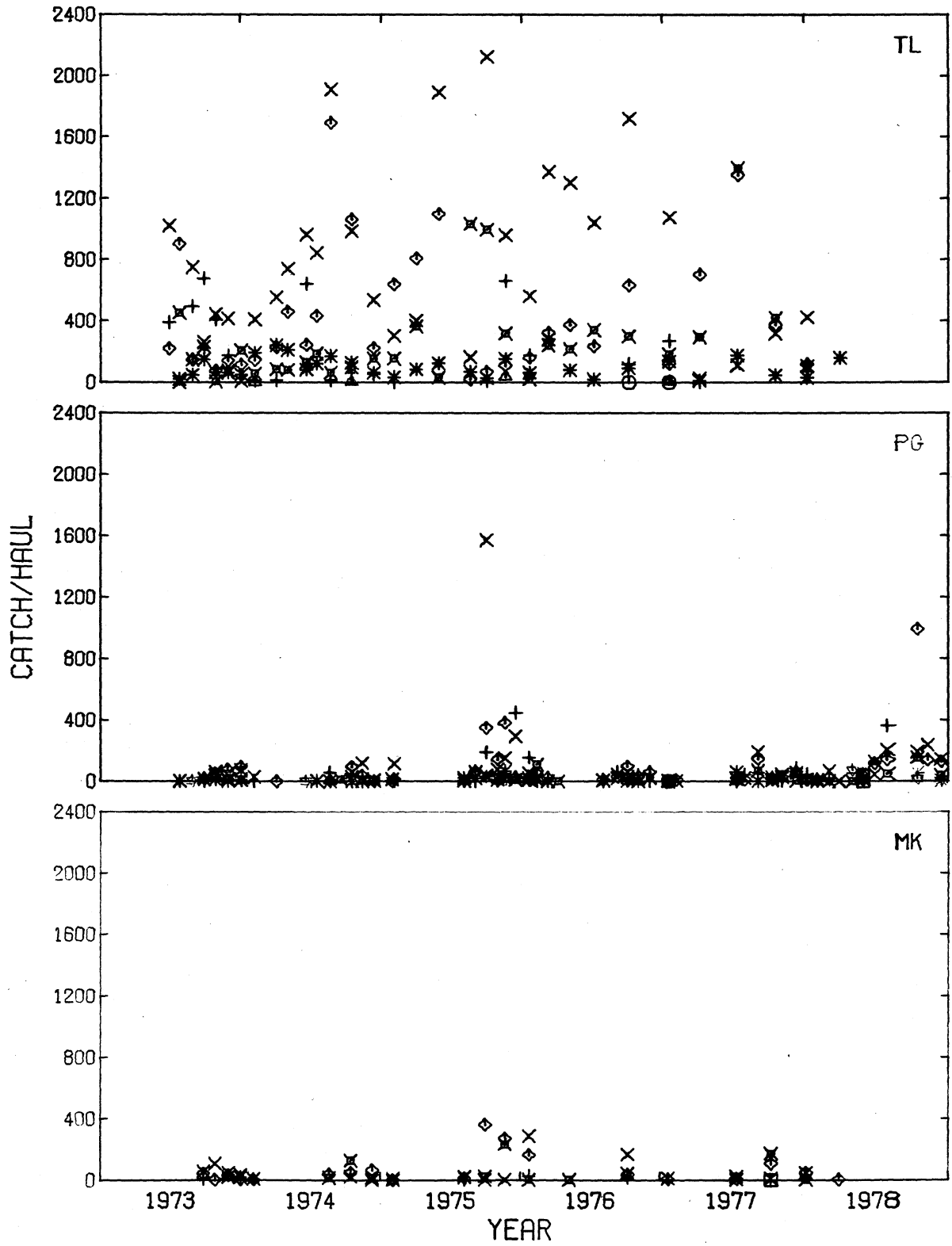


Figure 39

PANDALUS BOREALIS  
NORTHERN PINK SHRIMP

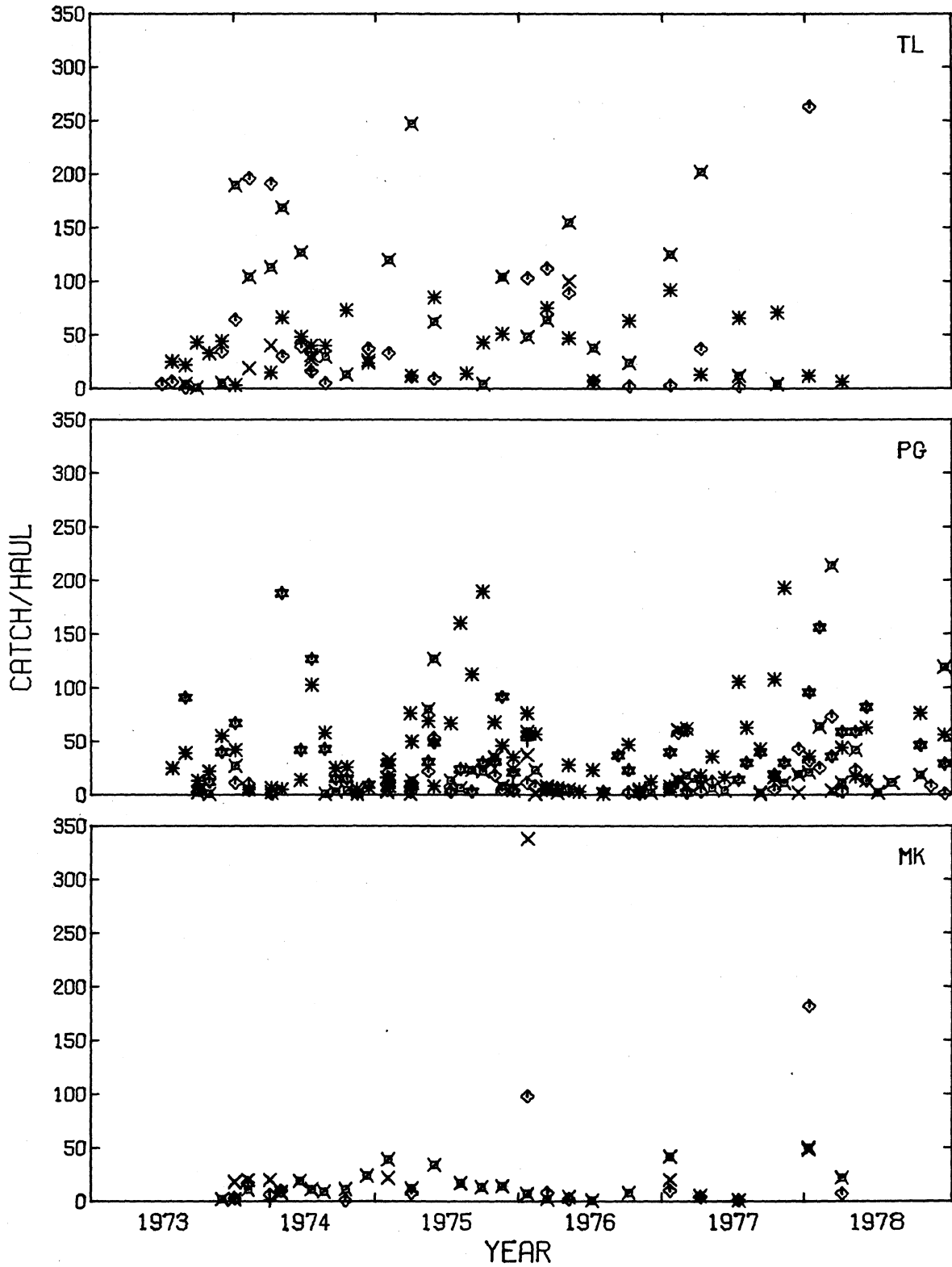


Figure 40



PANDALUS PLATYCEROS  
SPOT SHRIMP

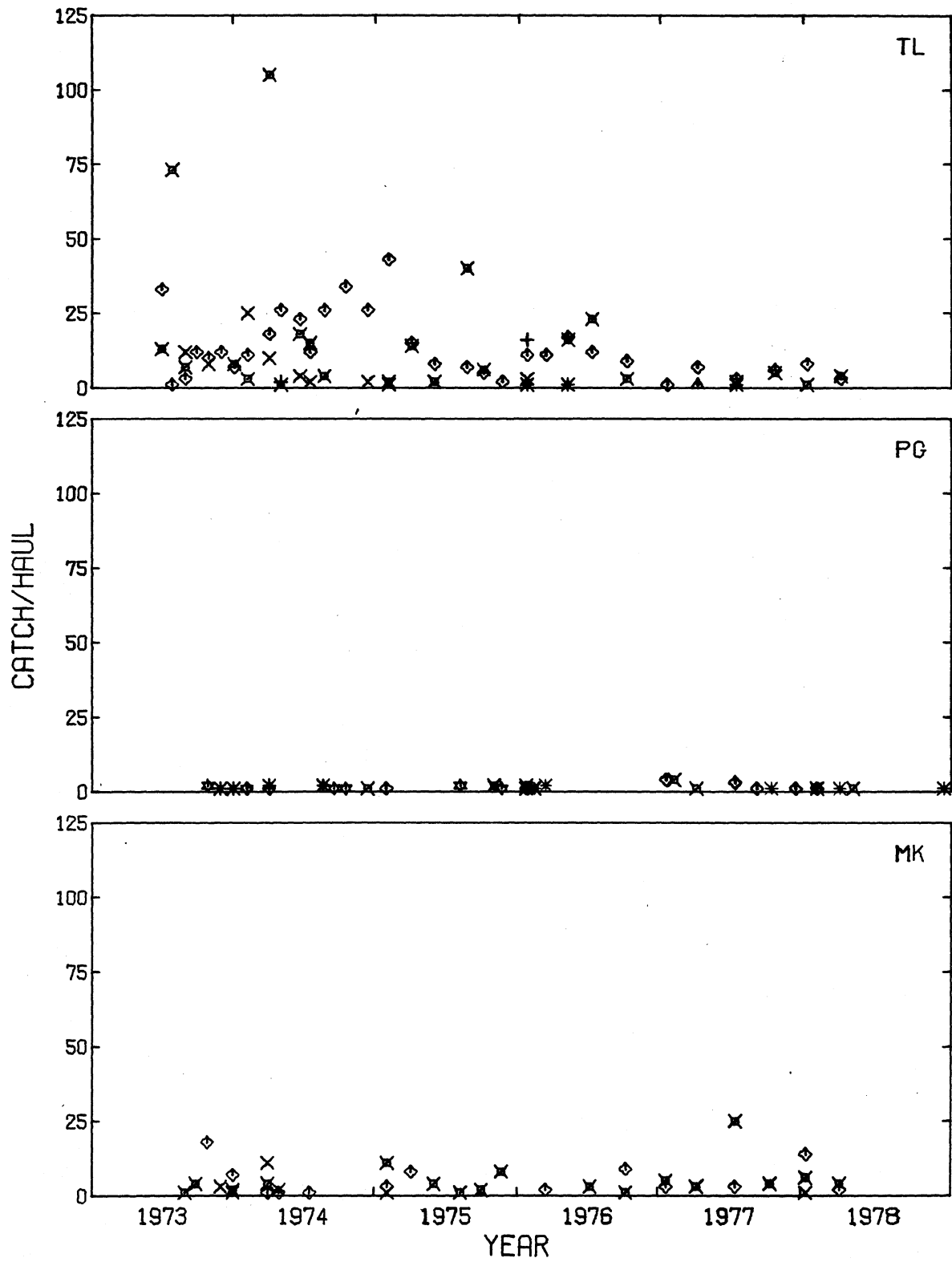


Figure 41

PANDALUS DANAE  
DOCK SHRIMP

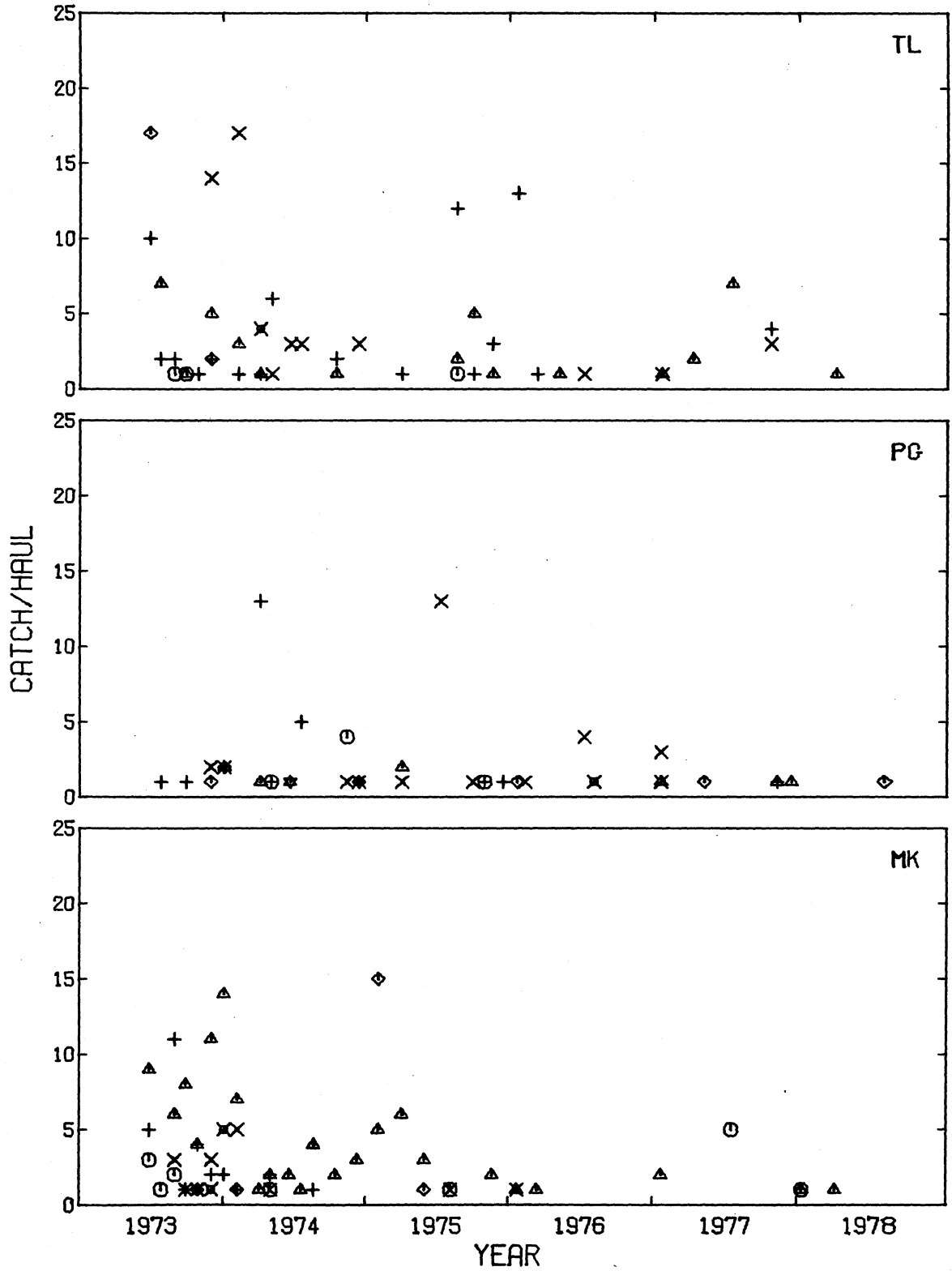


Figure 42

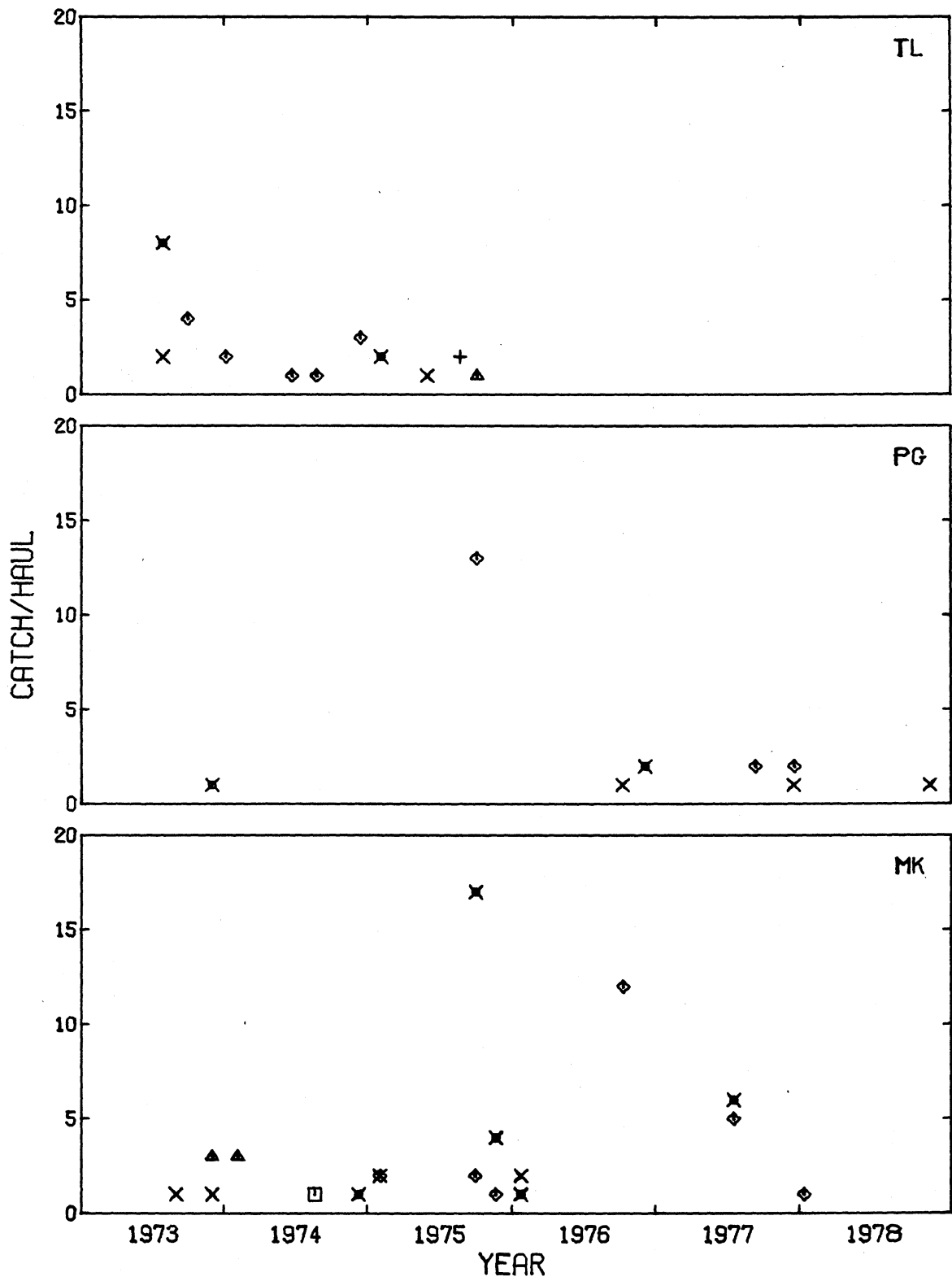
PANDALUS STENOLEPIS

Figure 43

PANDALOPSIS DISPAR  
SIDESTRIPE SHRIMP

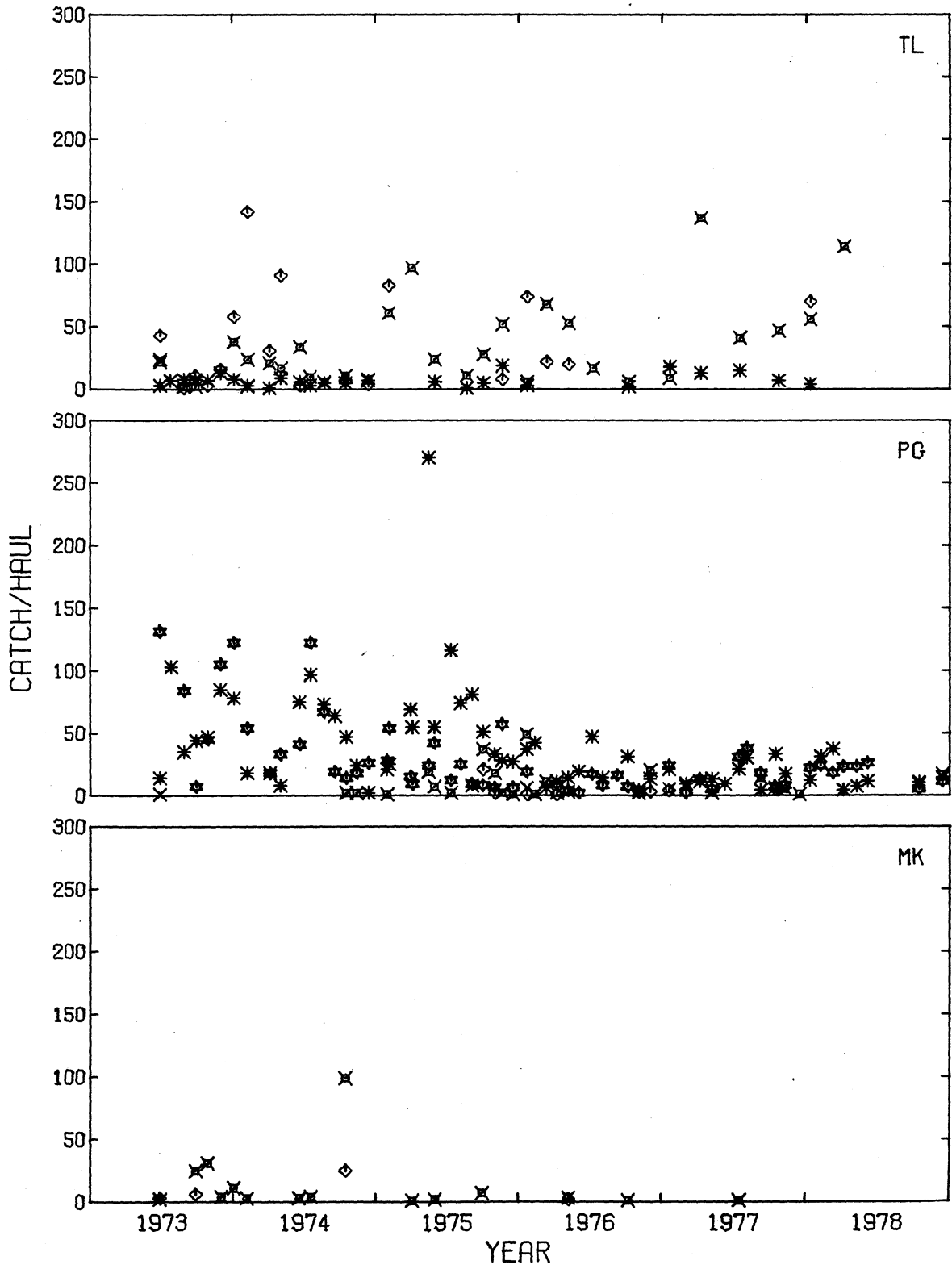


Figure 44

PANDALUS HYP SINOTUS  
COONSTRIBE SHRIMP

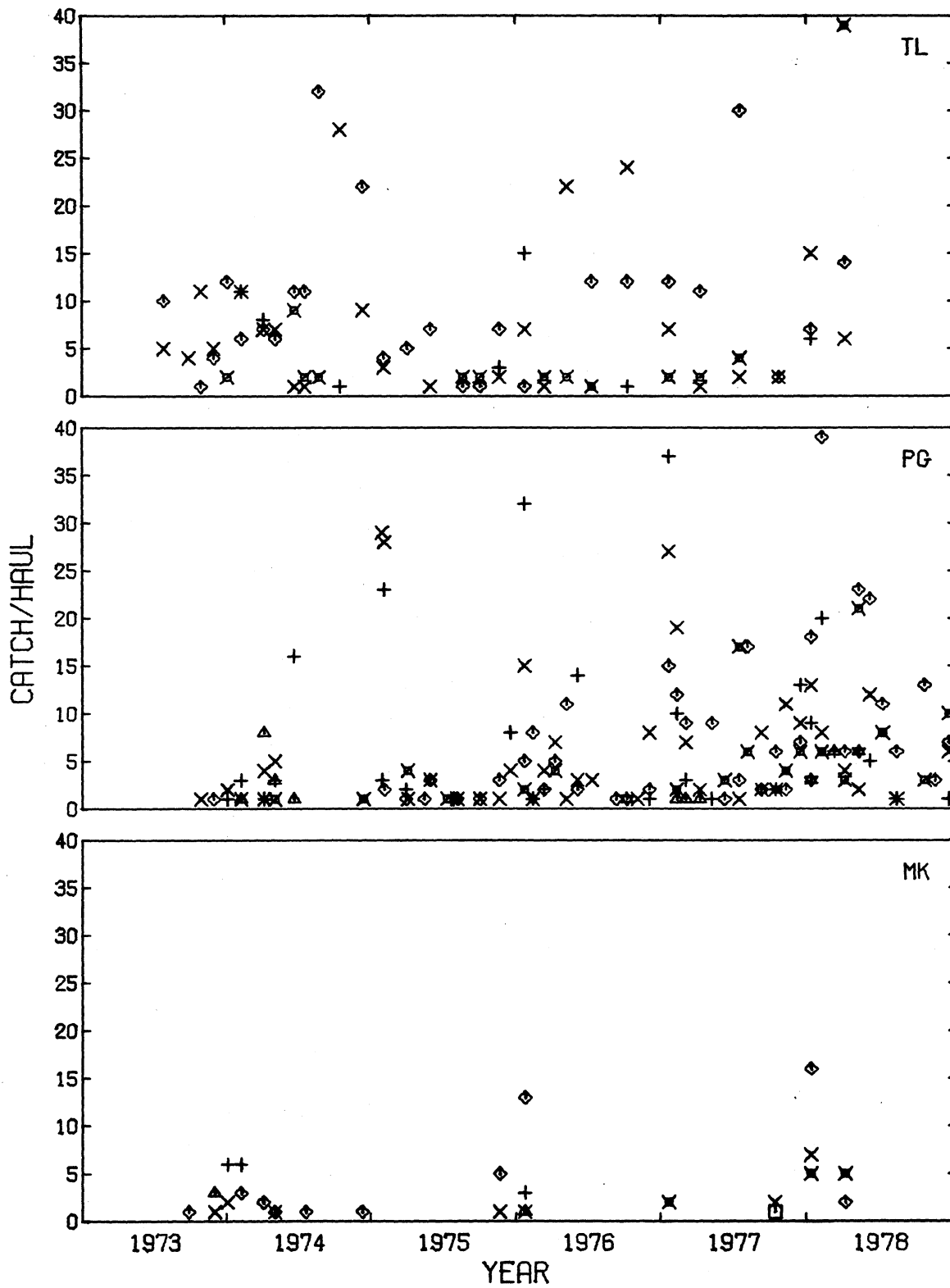


Figure 45

Commercial Trawling

A commercial trawl fishery in Port Gardner lands large quantities of English sole from several trawling grounds (Figure 45A). The State of Washington Department of Fisheries maintains records of the catch per hauls, in pounds, by vessel on numbered trawl grounds in Port Gardner. Those catches by the vessel Lemes have declined over the course of ECOBAM (Figures 46 to 50). The commercial fishermen appear to be acutely aware of the decreased productivity of this fishery and the relationship in time to changes in mill operations mandated by the regulatory agencies.

Figure 45a. Numbered grounds used by commercial trawlers in  
Port Gardner.

Figures 46 to 50. Catches by the commercial trawler LEMES at  
numbered fishing locations in Port Gardner.



EVERETT AREA TRAWL CATCHES  
BOAT LEMES ON GROUND 01

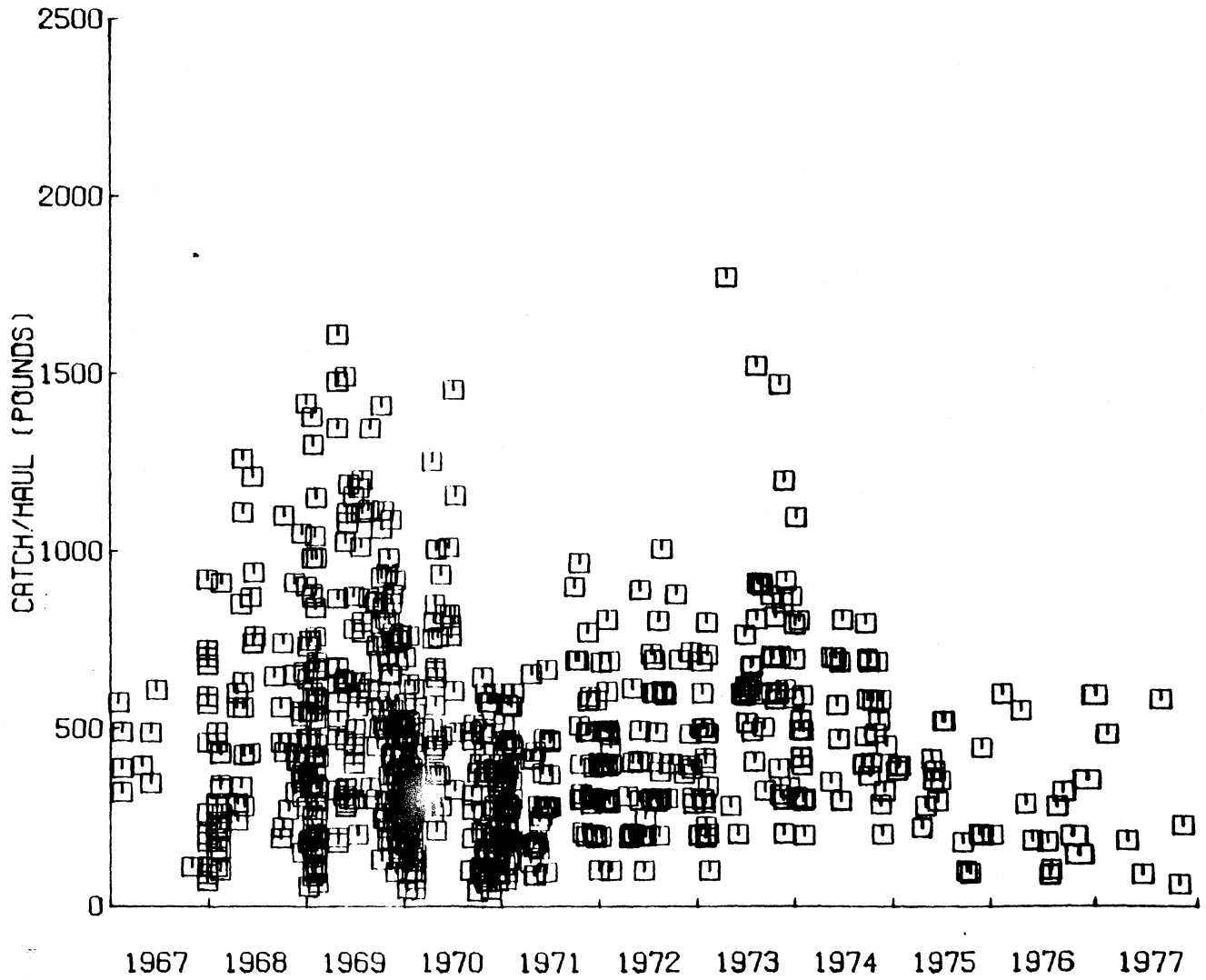


Figure 46

EVERETT AREA TRAWL CATCHES  
BOAT LEMES ON GROUND 25

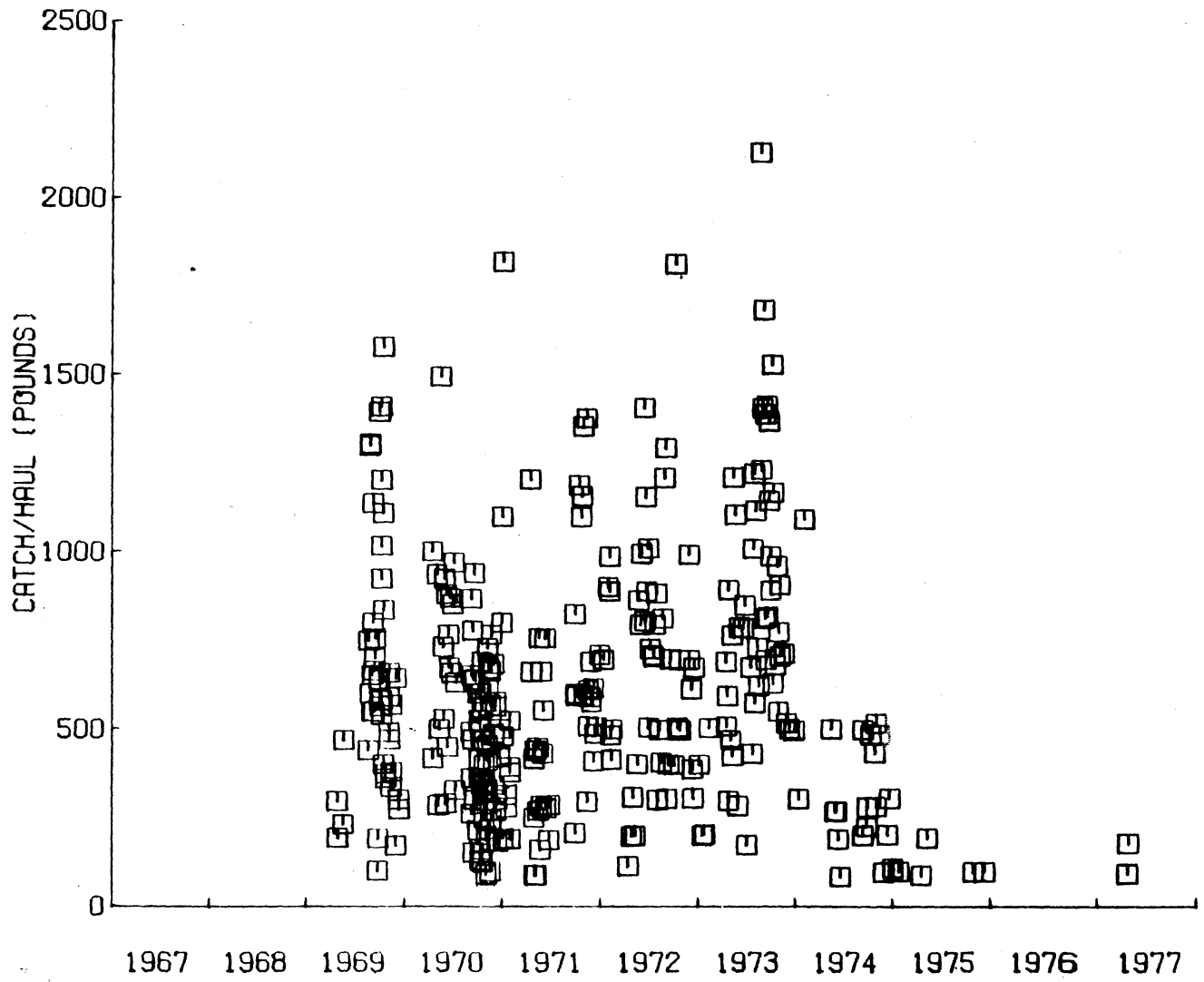


Figure 47

EVERETT AREA TRAWL CATCHES  
BOAT LEMES ON GROUND 30.

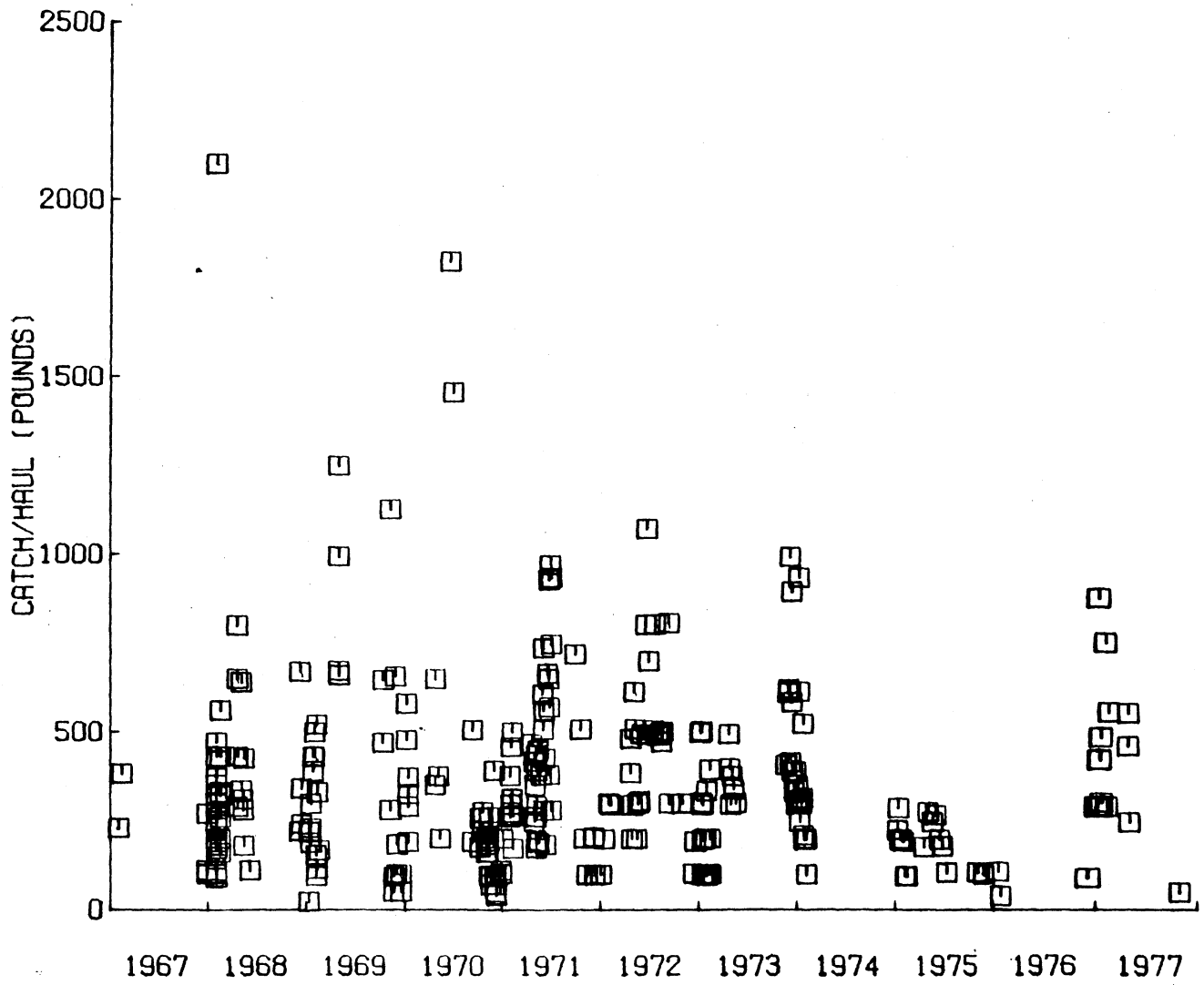


Figure 48

EVERETT AREA TRAWL CATCHES  
BOAT LEMES ON GROUND 40

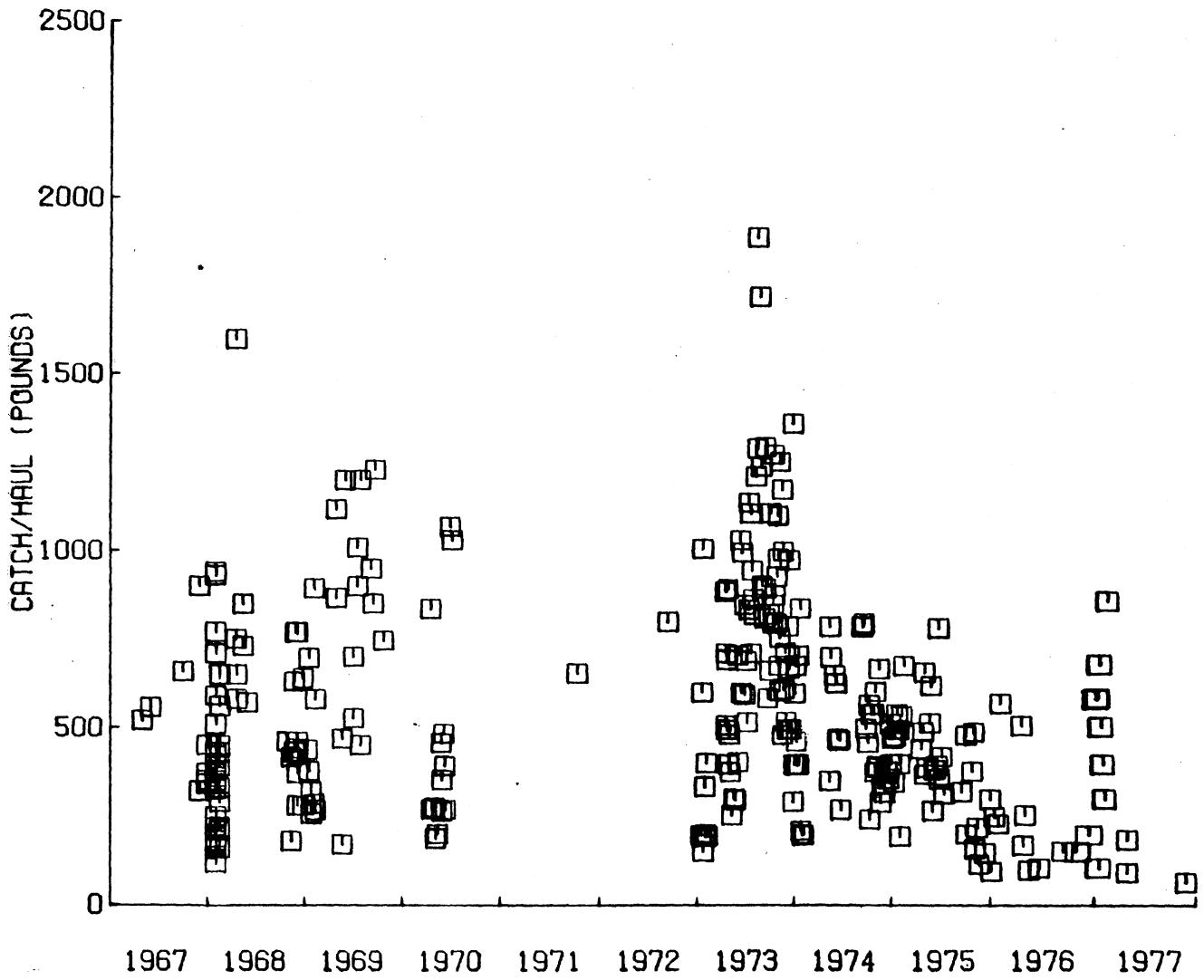


Figure 49

EVERETT AREA TRAWL CATCHES  
BOAT LEMES ON GROUND 55

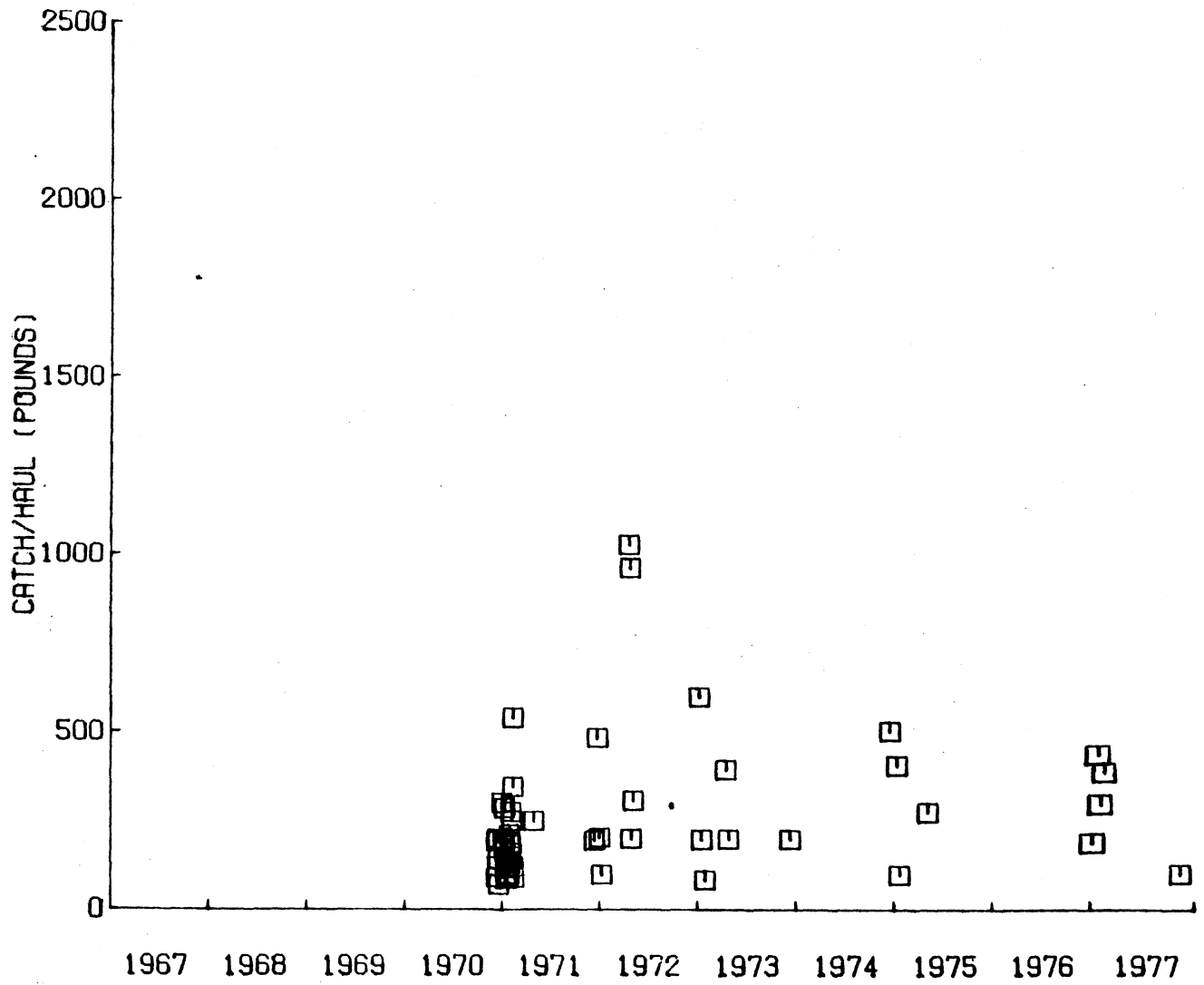


Figure 50

Secchi Disc

The Secchi disc transparency is a relative measure of water clarity. The transparency at location 8 is nearest the deepwater diffuser outfall and the shore was generally lowest; the transparency in the main basin of Puget Sound was generally highest (Figure 51). There is no marked increase in transparency in Port Gardner over the time of ECOBAM.

Figure 51. Secchi disc transparencies at station locations  
2, 8, and 20. (See Figure 1 for station locations.)

### SECCHI DISK

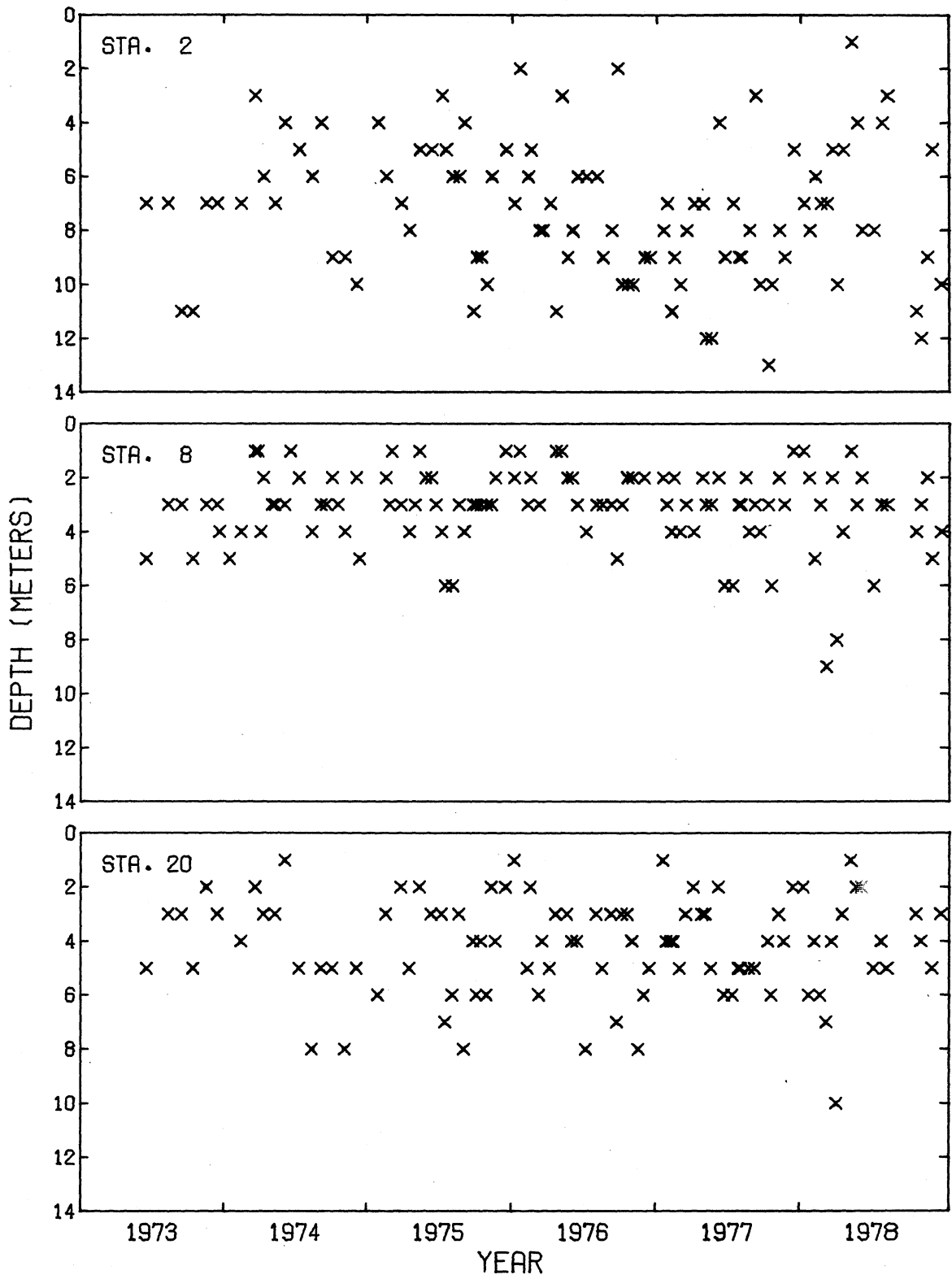


Figure 51



Chlorophyll

Chlorophyll concentration is a measure of the standing stock of plants in a water column. The chlorophyll concentration at two locations in Port Gardner appears to have remained about the same, with marked seasonal changes during the time of ECOBAM (Figure 52). The location in the main basin of Puget Sound appears to have higher concentrations of chlorophyll than Port Gardner.

Figure 52. Relative chlorophyll concentrations in the water column at station locations 2, 8, and 20. (See Figure 1 for station locations.)

# CHLOROPHYLL

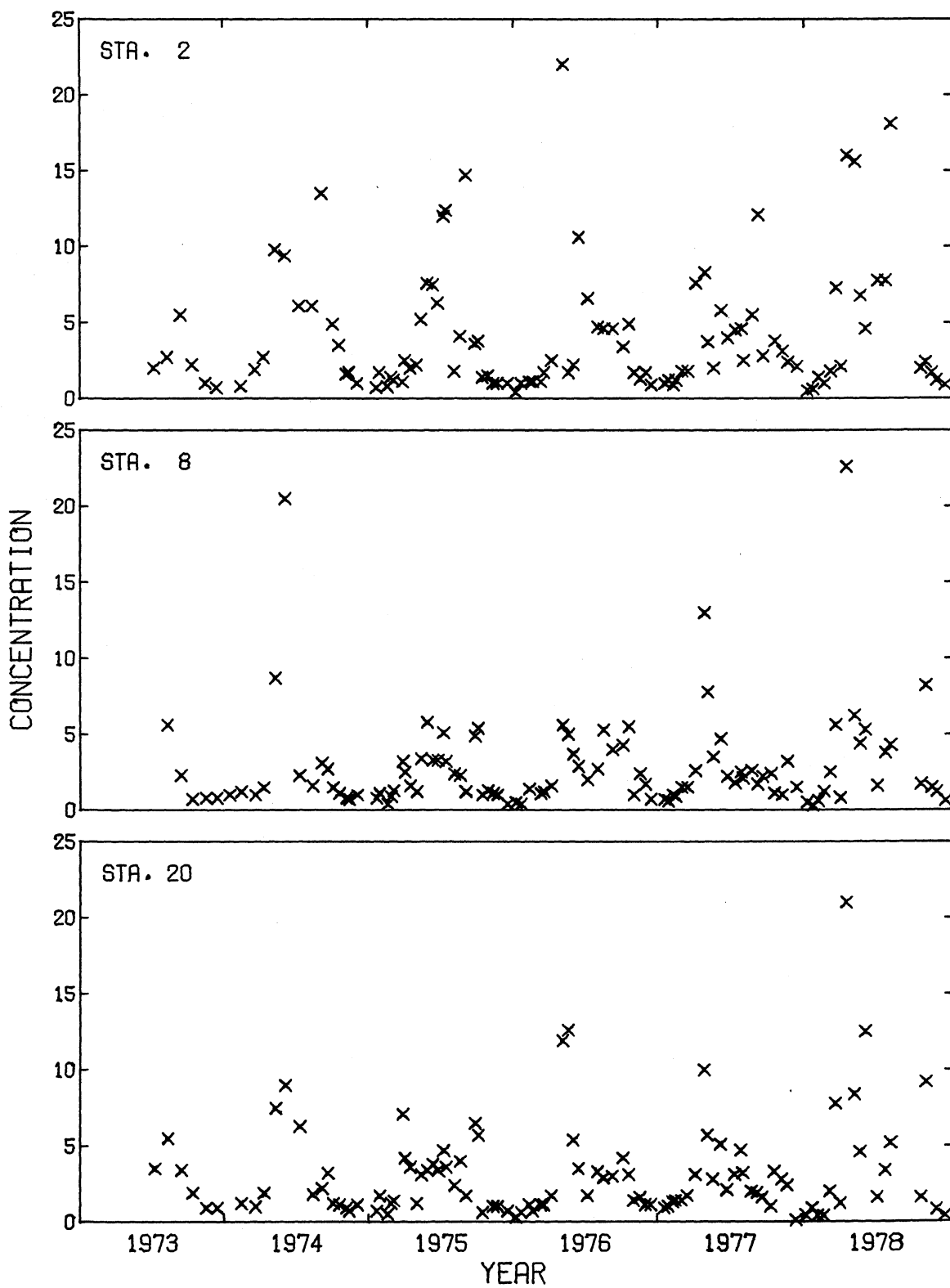


Figure 52

### Acoustic Surveys

Acoustic surveys have been made to observe midwater organisms, fishes and aggregations of zooplankton, over the time span of ECOBAM. The chart records of the high-frequency echo sounder allow realtime location of acoustic targets, including a diffuse midwater sonic scattering layer known to be composed of euphausiids in Puget Sound.

In the summer of 1973, when the euphausiids were abundant and formed a well-defined sound-scattering layer, a volume of water almost devoid of sonic targets was observed between stations 8 and 9, a transect running about one mile from above the deepwater diffuser outfall along the river delta to the northwest (Figure 1). Samples for sulfite waste liquor (SWL) over a range of depths from 15 to 90 meters along the transect confirmed that the absence of acoustic targets was associated with high SWL concentrations.

Although there has been considerable variability over time, the volume devoid of sonic targets has not been evident since early 1974 (Appendix). The computer-enhanced and quantified echograms in the Appendix reflect all or part of a transect between station locations 8.00 and 9.00, which are along the top of each page. The bottom contour is the darkest mark at depths of between 90 and 120 meters. The symbols in the water column indicate five logarithmic levels of target intensity.

The acoustic target strength over time seems to fluctuate so widely that no clear trend over the time of ECOBAM is evident (Figure 53).

Figure 53. Acoustic target strength over time at three locations near the deepwater diffuser outfall. The average target intensity has been integrated over the water column.

## ACOUSTIC TARGET STRENGTH

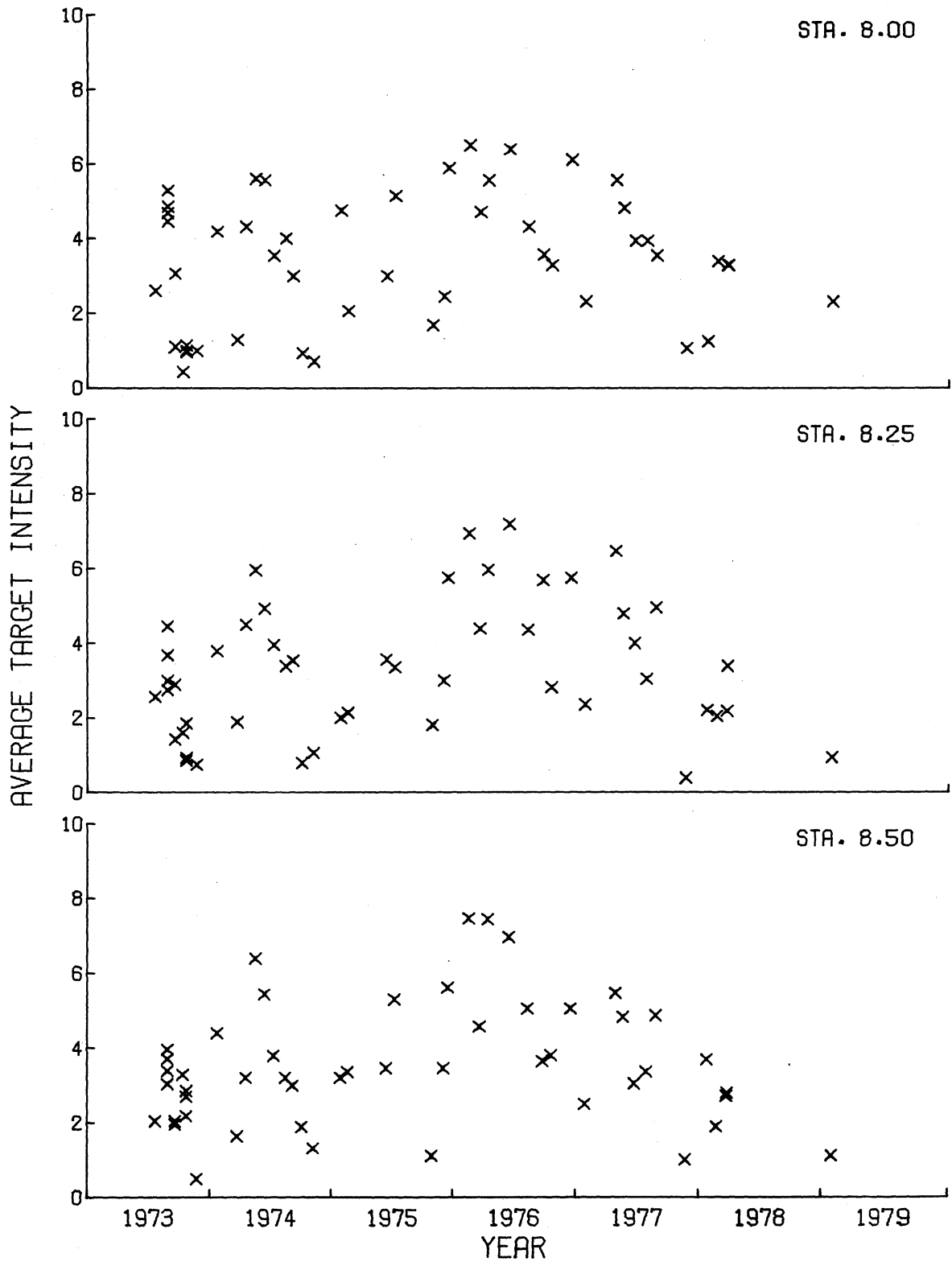


Figure 53

Discussion

The results of ECOBAM through June of 1977 show some expected trends:

1. The mill discharge through the deepwater diffuser outfall has been greatly reduced; the discharge through the surface outfalls is relatively unchanged.
2. The sulfite waste liquor concentrations in the receiving waters has been substantially reduced.
3. The dissolved oxygen concentrations in the receiving waters have increased; there are relatively large seasonal cycles in dissolved oxygen concentrations.
4. The oyster larva bioassay results appear to be strongly related to sulfite waste liquor concentrations near the deepwater diffuser outfall; the relationship is puzzling over larger areas of Port Gardner at the surface and at depth.
5. The research trawling shows a decreased abundance of English sole and some other fishes in Port Gardner, but some fishes have apparently become more abundant over the course of ECOBAM. Crabs appear to be less abundant; shrimps show varying patterns of abundance.
6. Commercial catches of English sole in Port Gardner have decreased over the time of ECOBAM.
7. Chlorophyll concentrations in Port Gardner appear to have remained relatively constant over the time of ECOBAM.

8. Secchi disc transparency appears to have remained relatively constant in Port Gardner over the time of ECOBAM.
9. The acoustic surveys revealed an area devoid of targets near the deepwater diffuser outfall. As mill effluents decreased, the area devoid of targets became unrecognizable.

The major unanswered question of ECOBAM is whether the identified biological changes in Port Gardner will be maintained or intensified with further changes in mill operations. If the observed biological changes are a result of natural population fluctuations, that should also be more clear when later results become available.

The biological changes observed in Port Gardner may be the result of a process which is the opposite of biostimulation. The food and energy contributions by mill wastes to the ecosystem could be the cause of shifting population abundances.

The toxicological implications of the oyster larva bioassay results are puzzling. On the larger scale of Port Gardner, the response of the oyster larvae appears only loosely related to sulfite waste liquor concentrations.

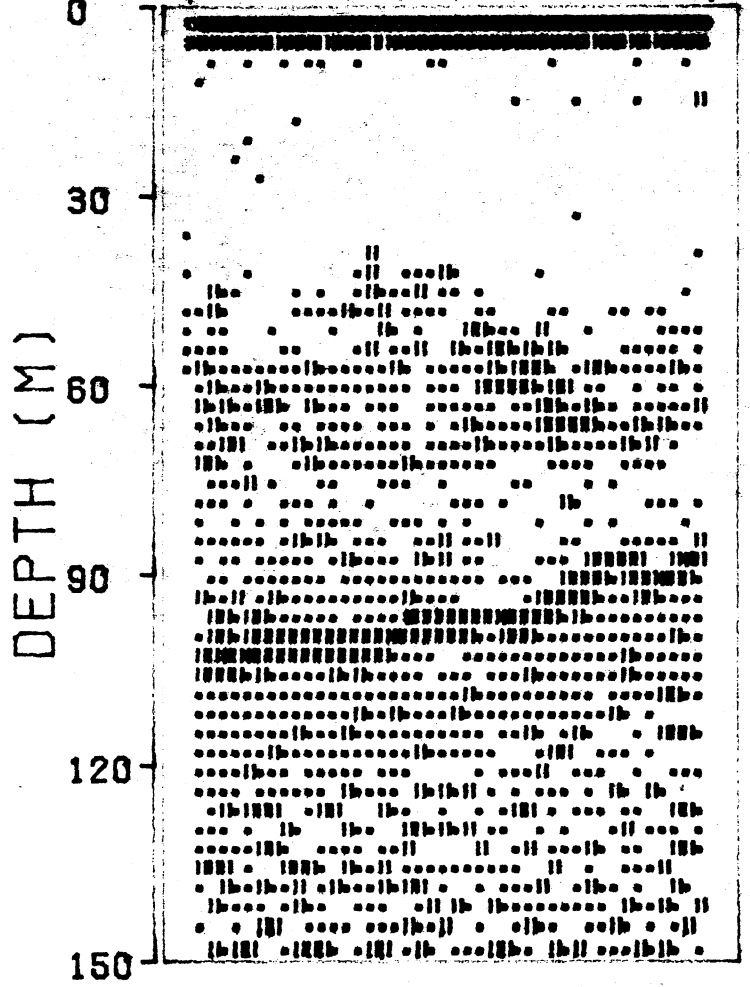


APPENDIX

ECOBAM 21 JULY 1973

STATION

8,00 8,50

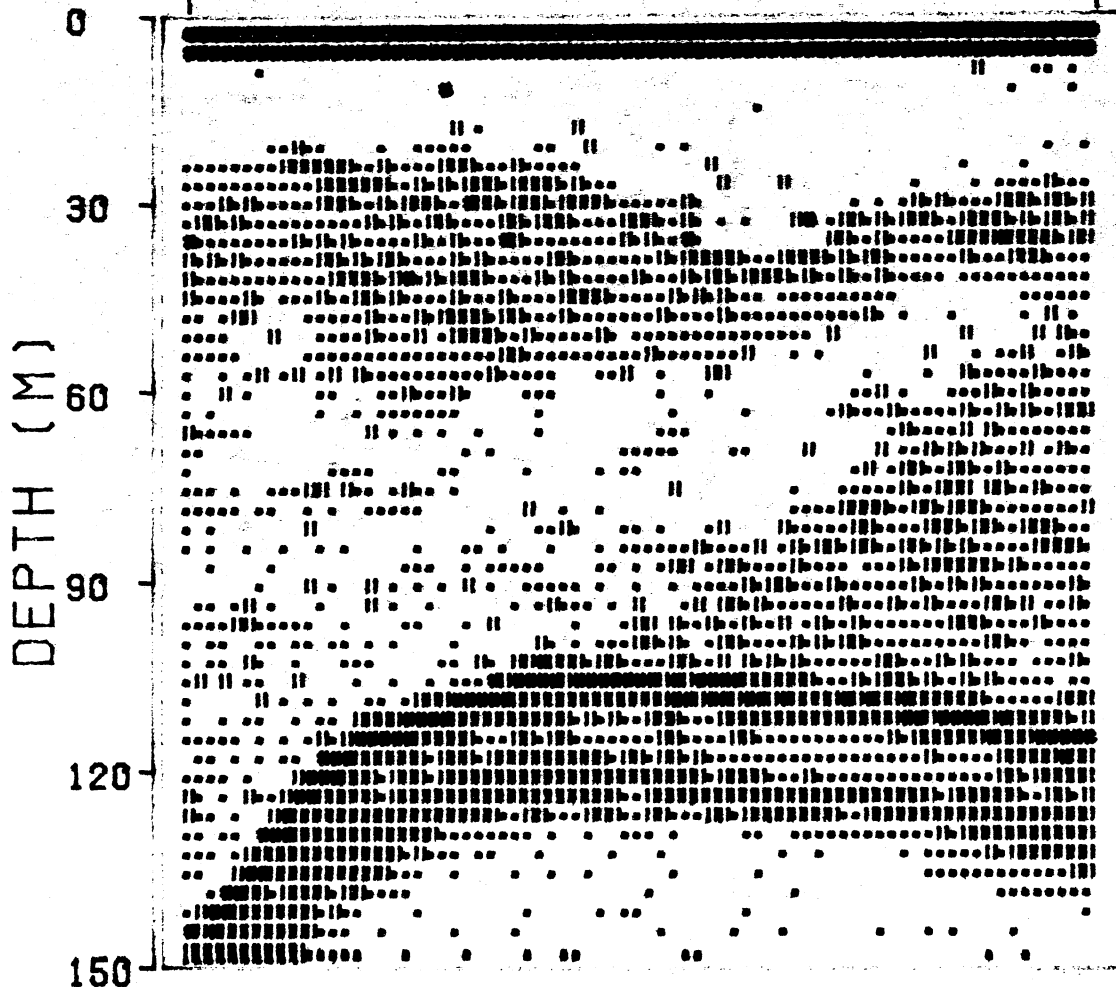


ECOBAM 27 AUGUST 1973

STATION

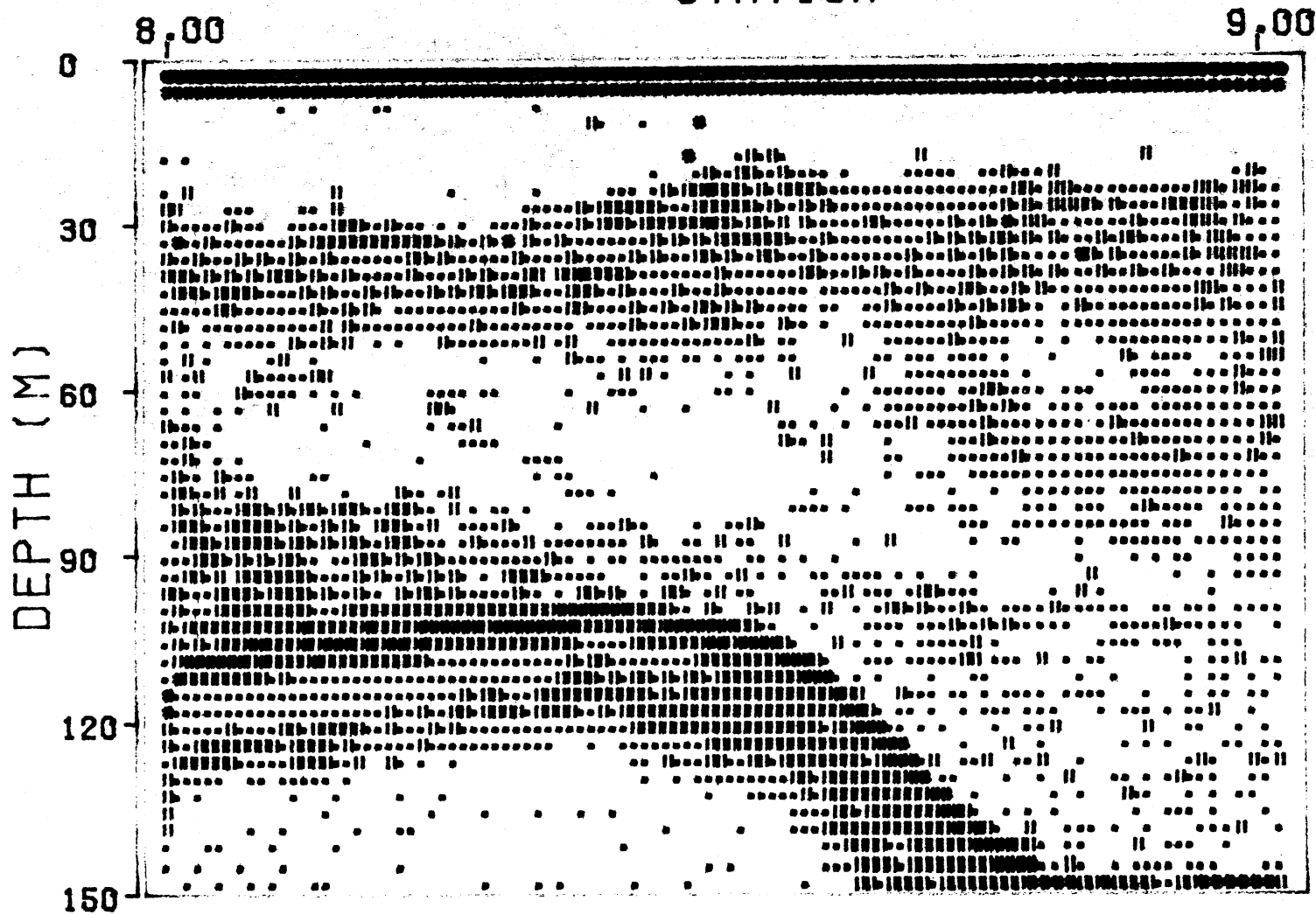
9.00

8.00



ECOBAM 27 AUGUST 1973

# STATION

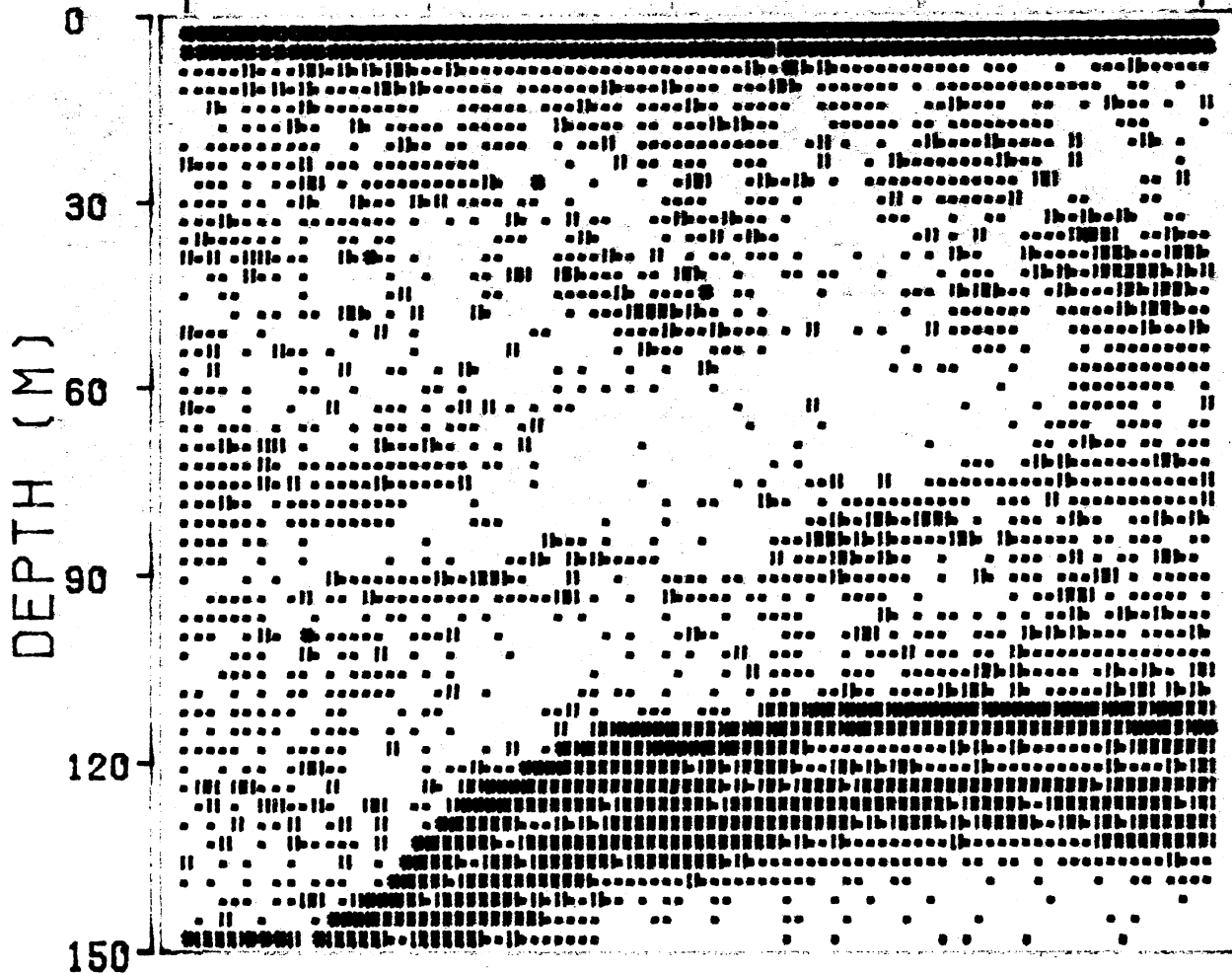


ECOBAM 27 AUGUST 1973

STATION

9.00

8.00

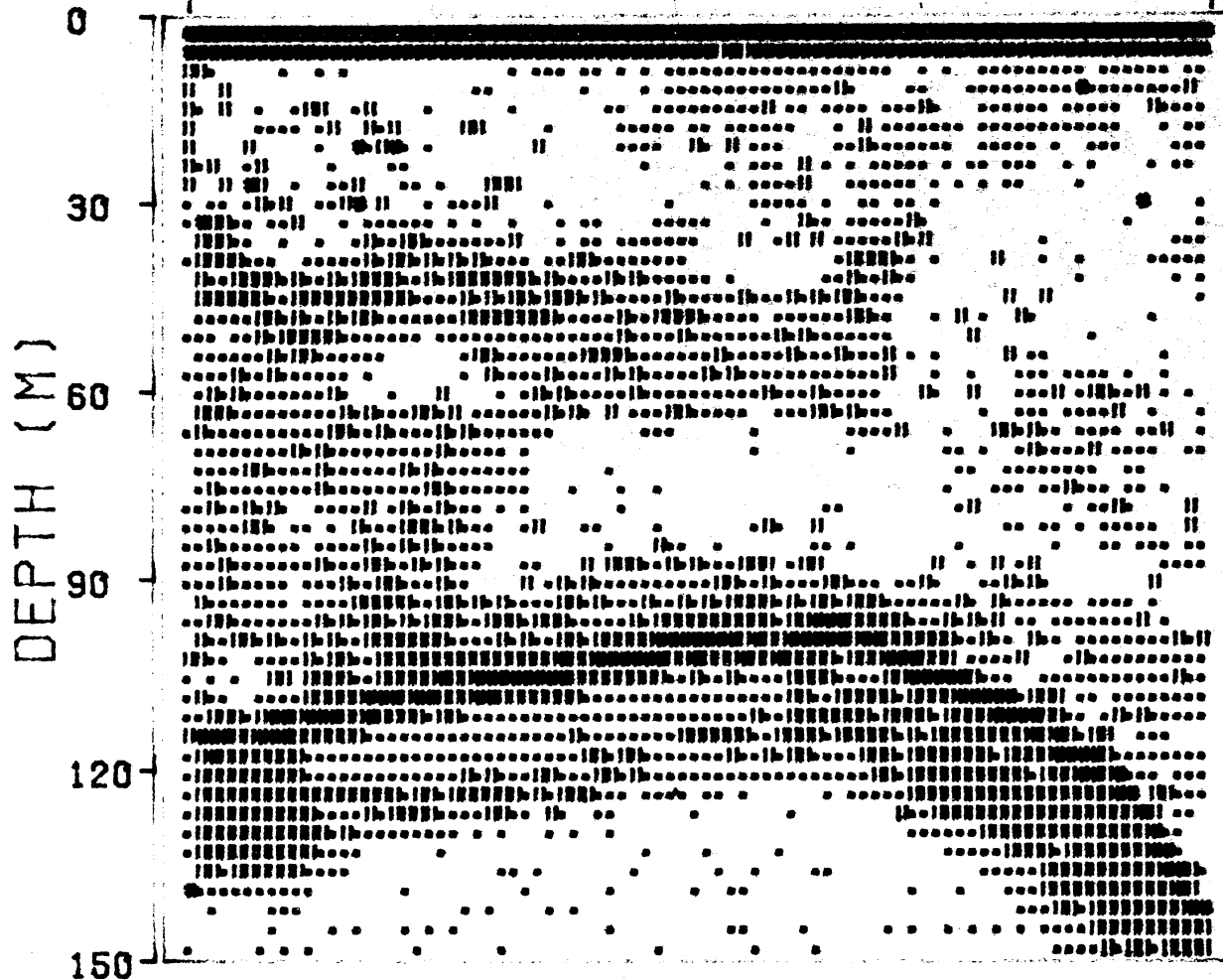


ECOBAM 27 AUGUST 1973

# STATION

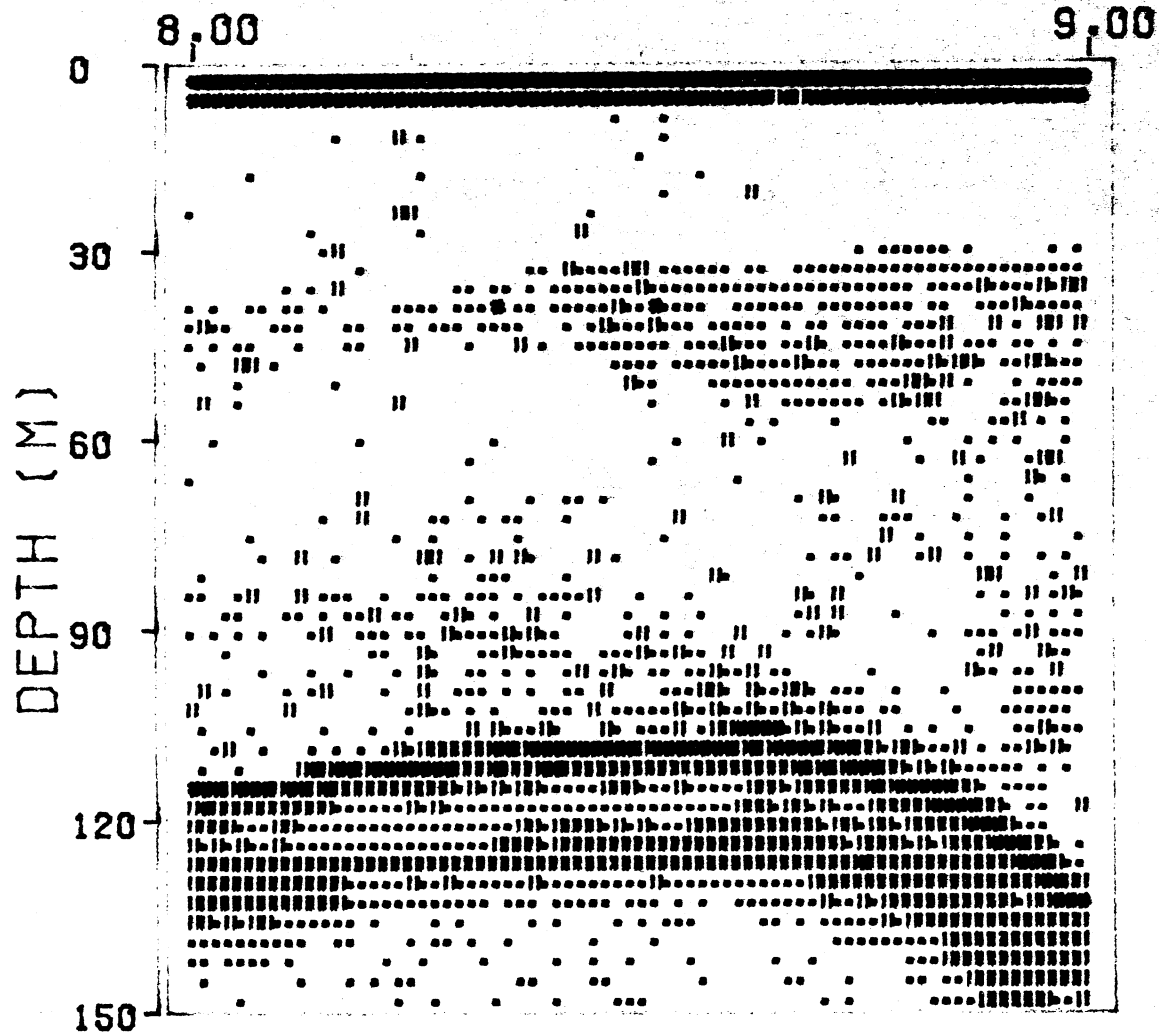
8.00

9.00



ECOBAM 19 SEPTEMBER 1973A

STATION

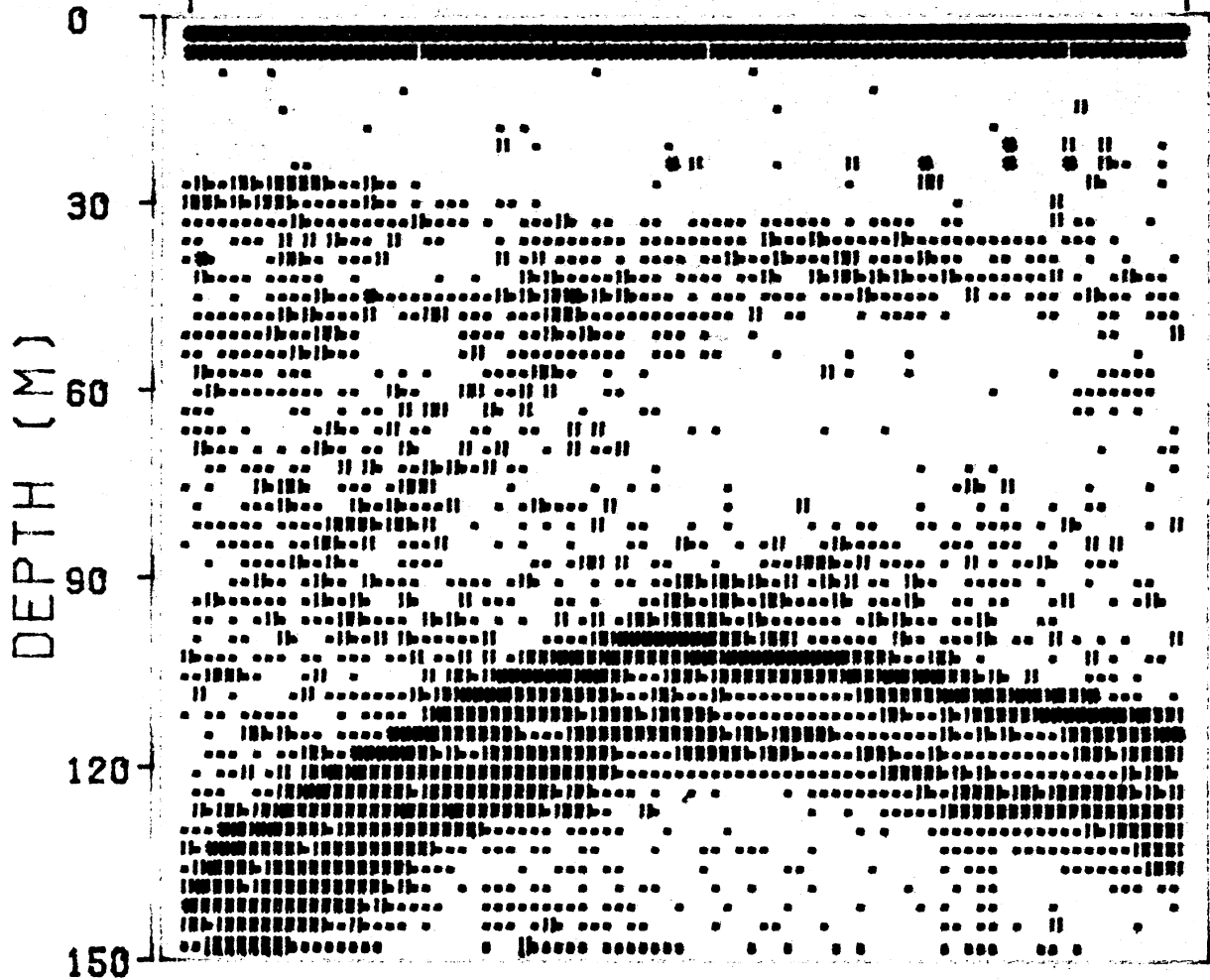


ECOBAM 19 SEPTEMBER 1973

STATION

9.00

8.00





ECOBAM 12 OCTOBER 1973

STATION

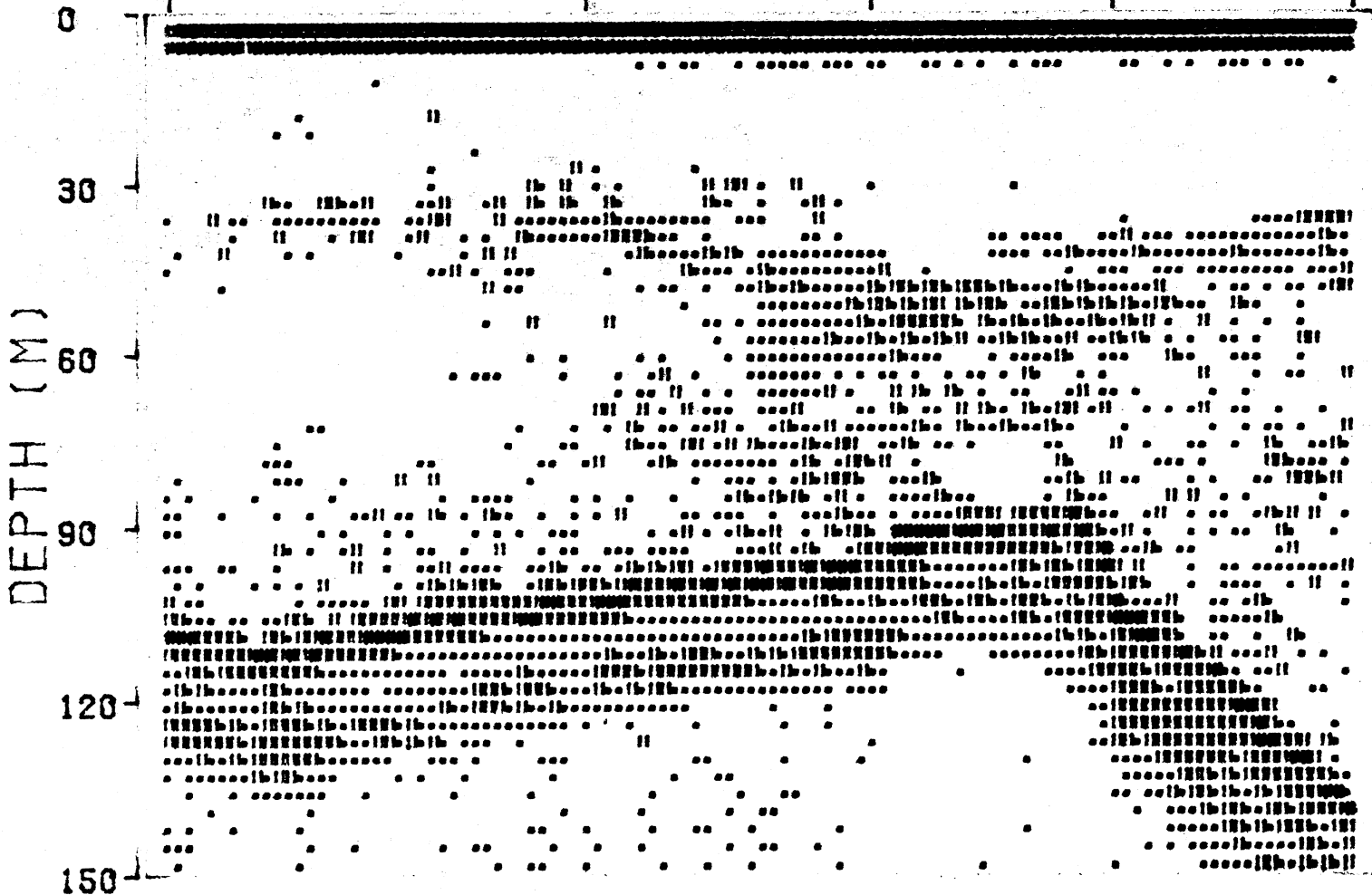
8,00

8,25

8,50

8,75

9,00



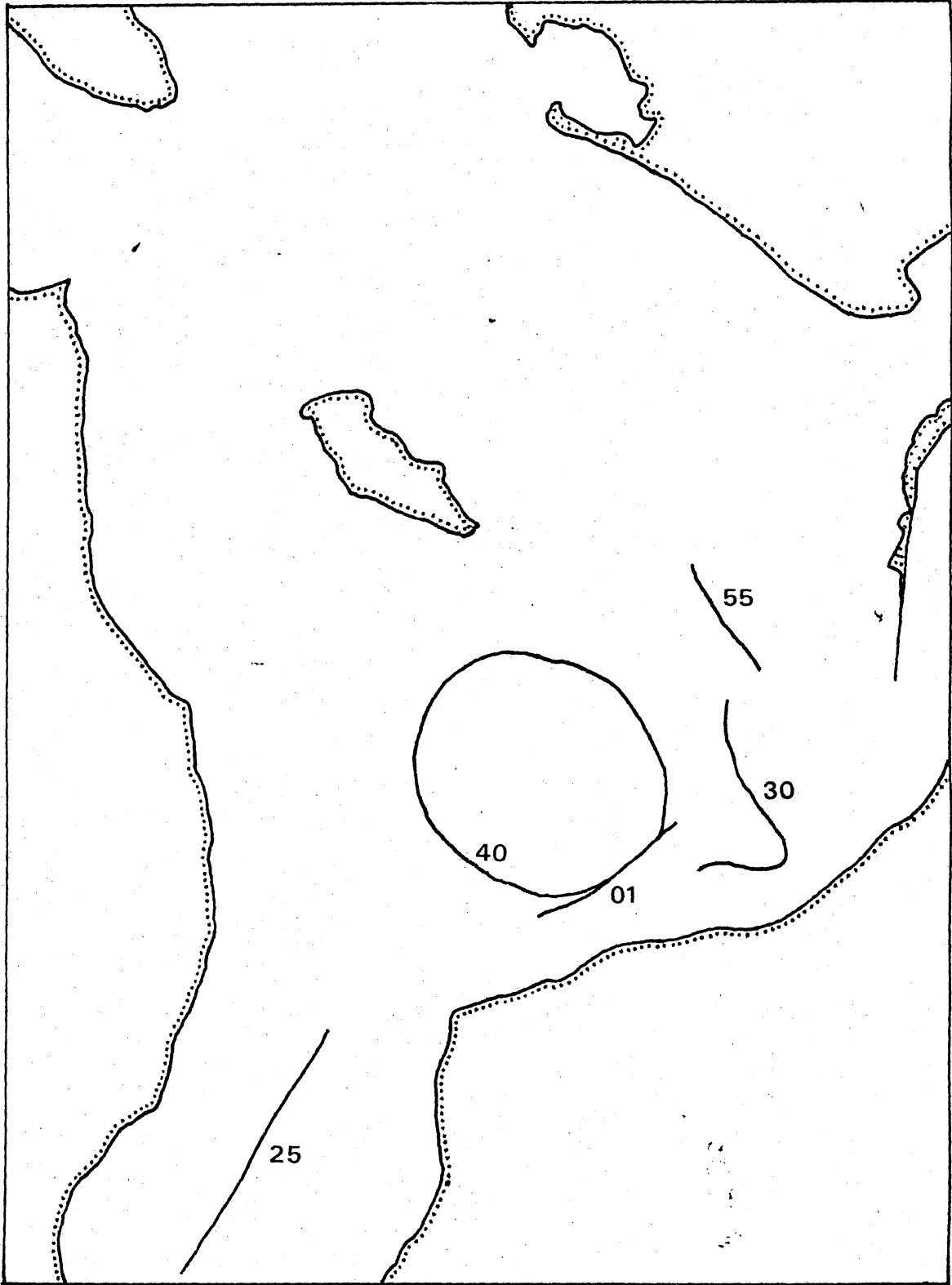


Figure 45a

ECOBAM 22 OCTOBER 1973A

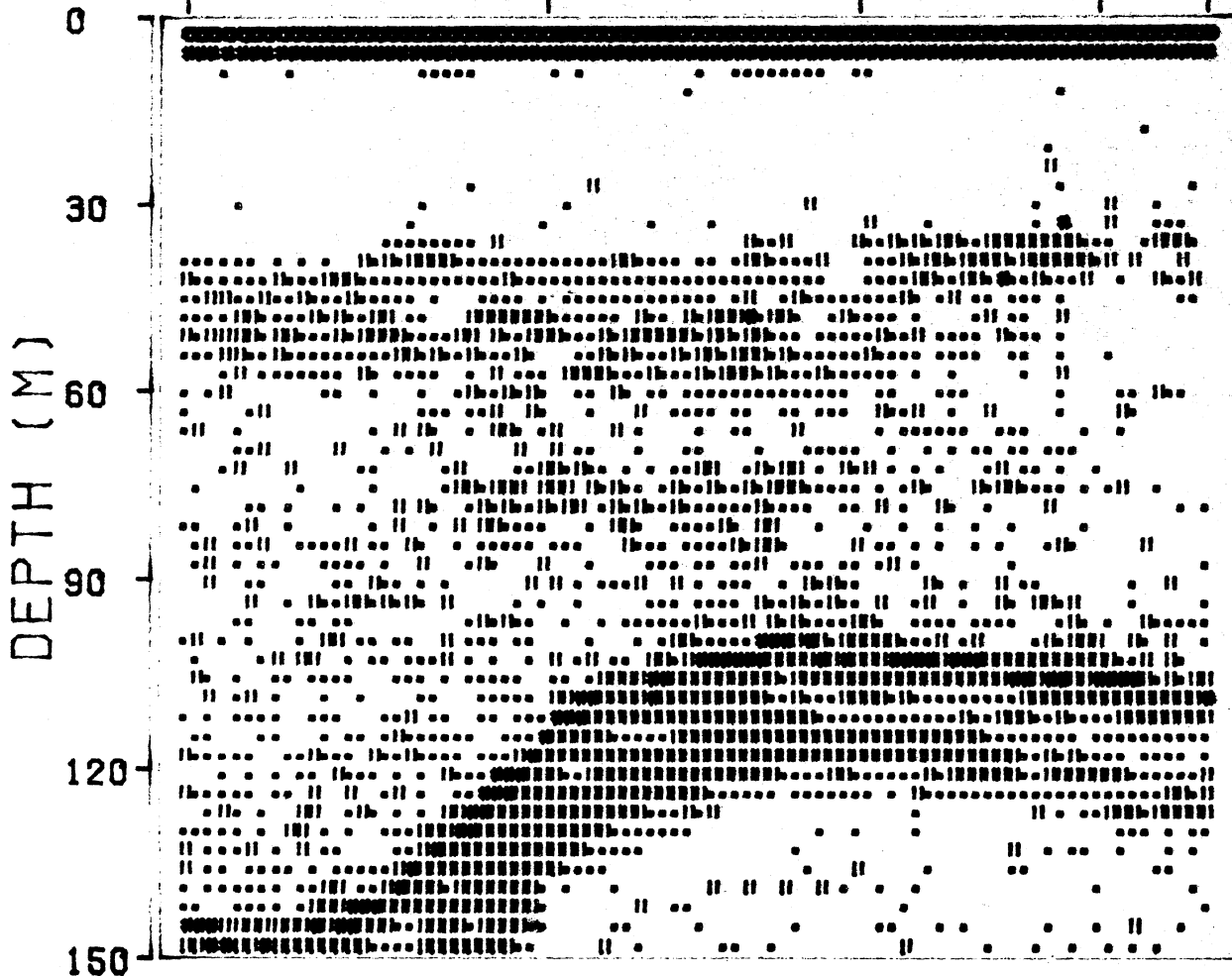
STATION

9,00

8,75

8,50

8,258,00

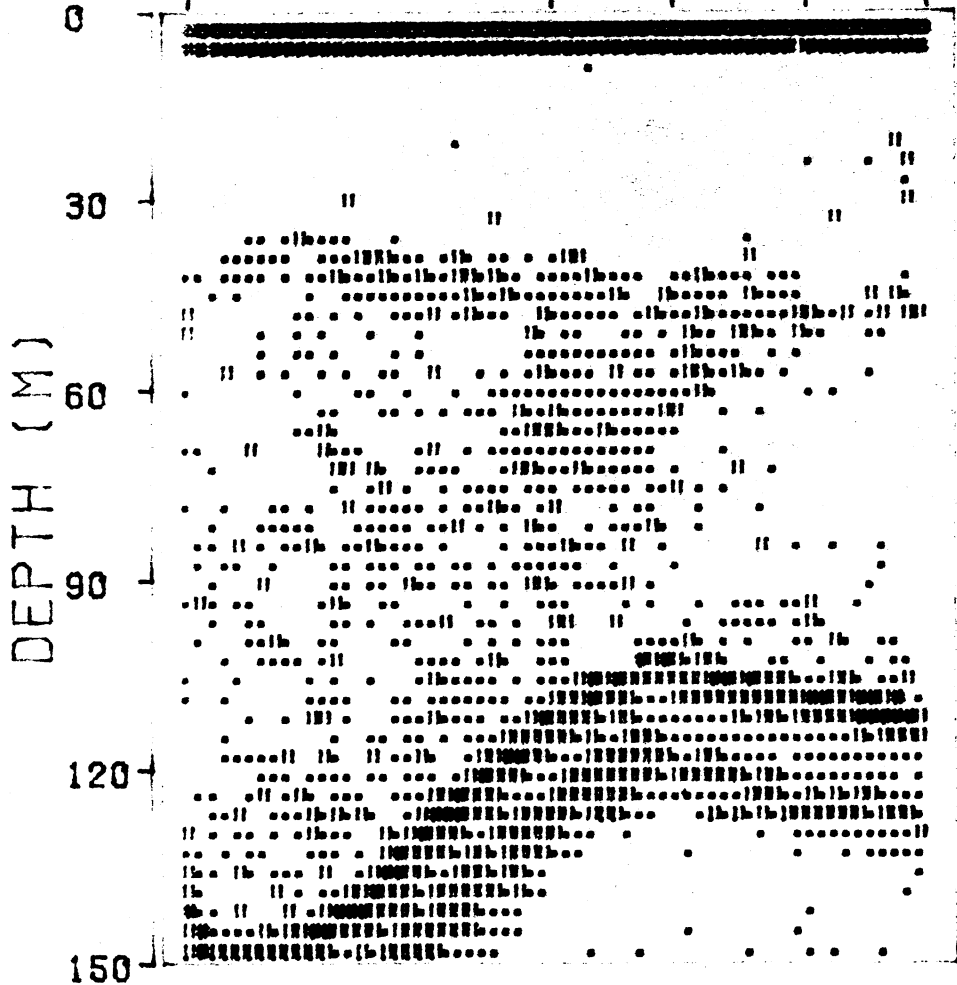


ECOBAM 22 OCTOBER 1973 B

STATION

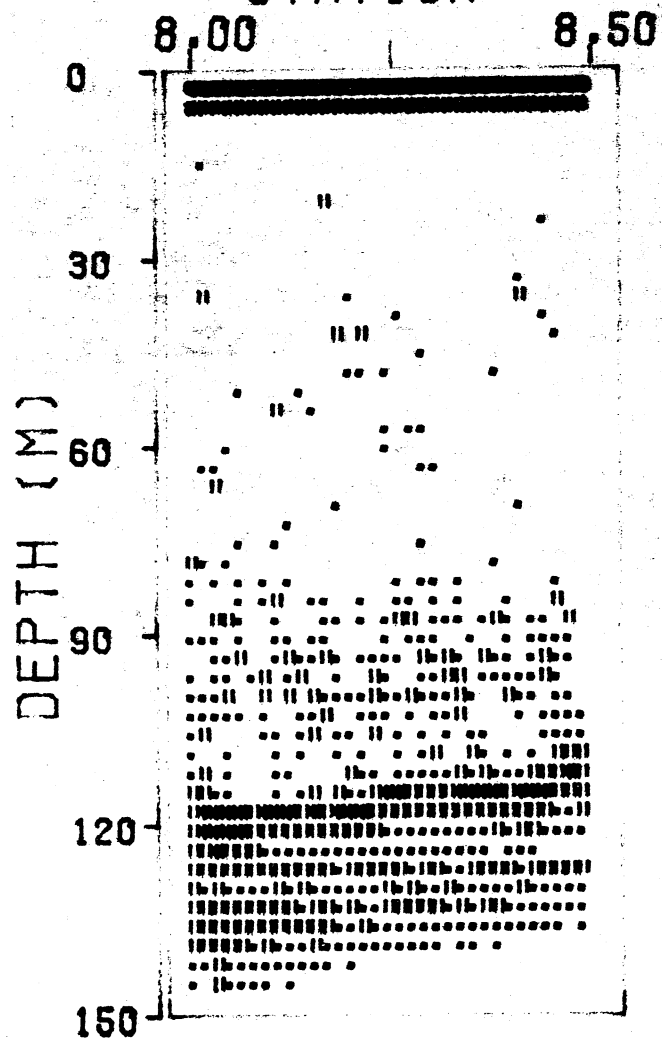
9,00

8,75 8,50 8,25 8,00



ECOBAM 23 NOVEMBER 1973

STATION

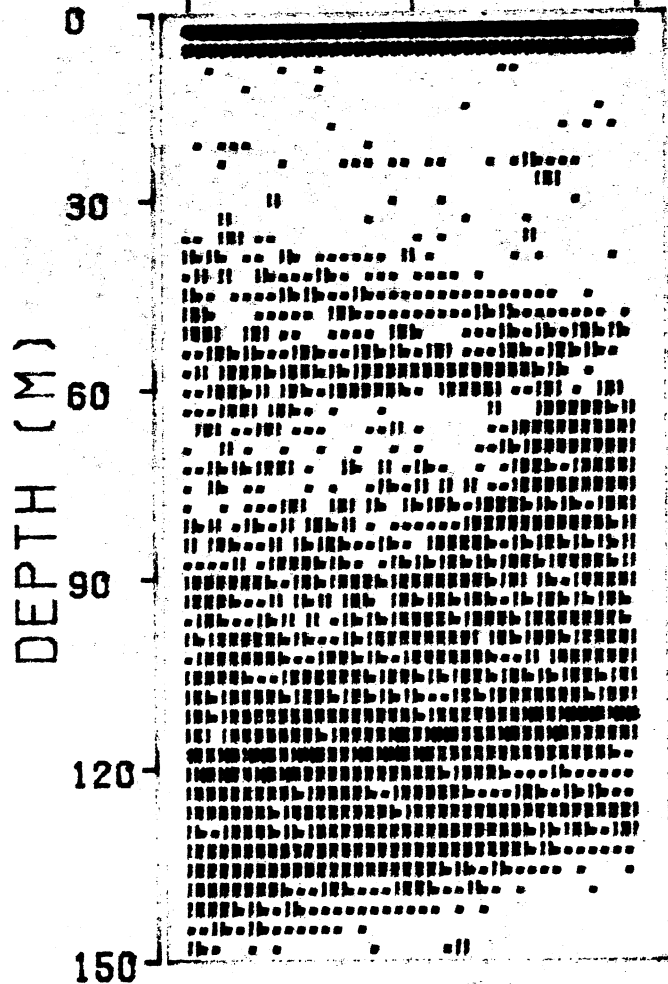


ECOBAM 22 JANUARY 1974

STATION

8.00

8.50

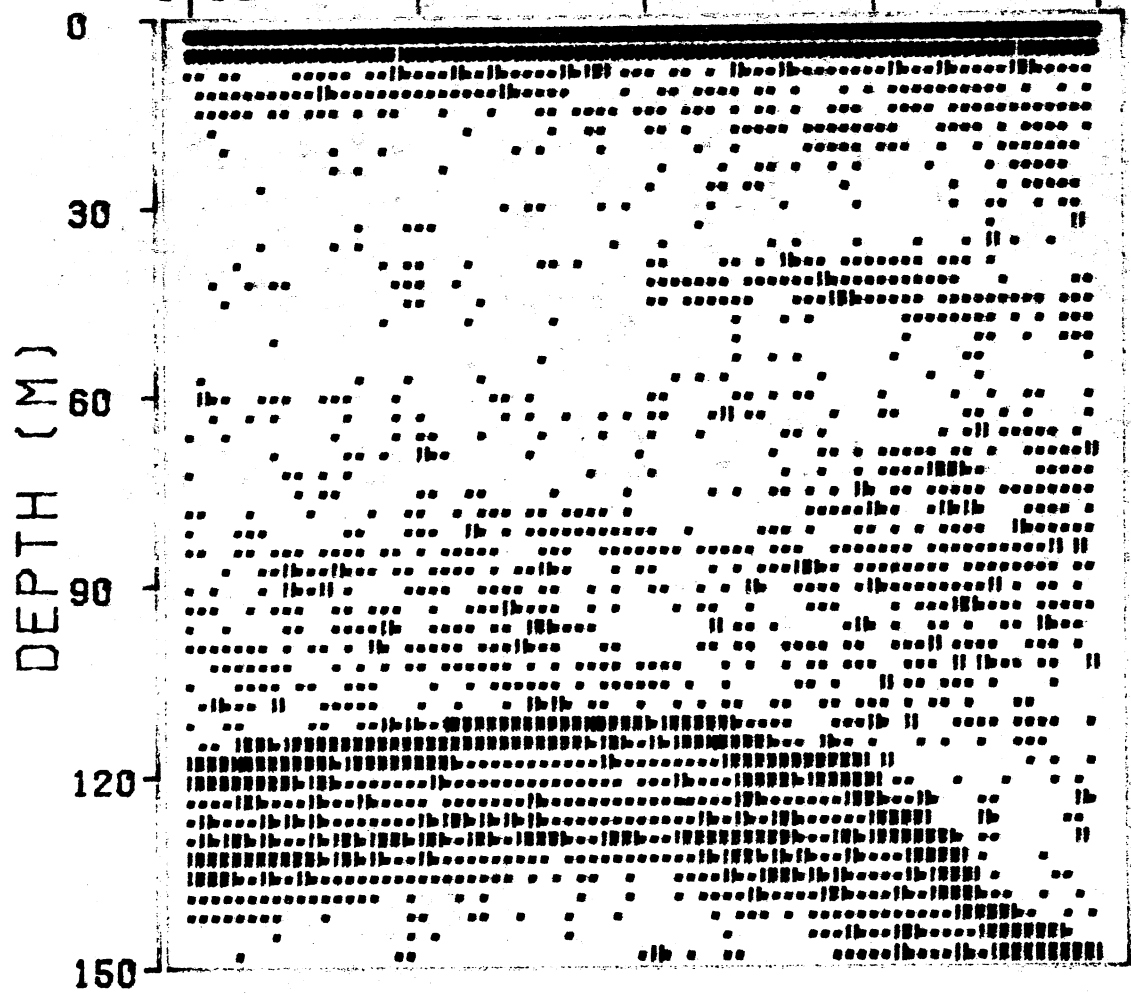


ECOBAM 21 MARCH 1974

# STATION

8.00

9.00

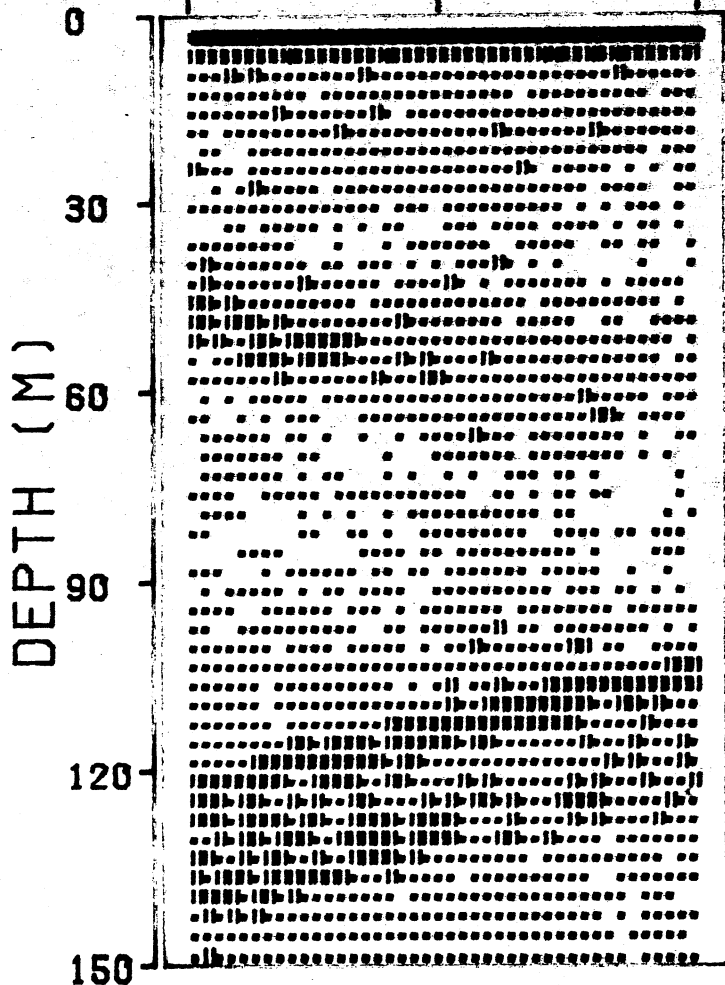


ECOBAM 16 APRIL 1974

STATION

8,00

8,50





ECOBAM 15 MAY 1974

STATION

8,00

8,50

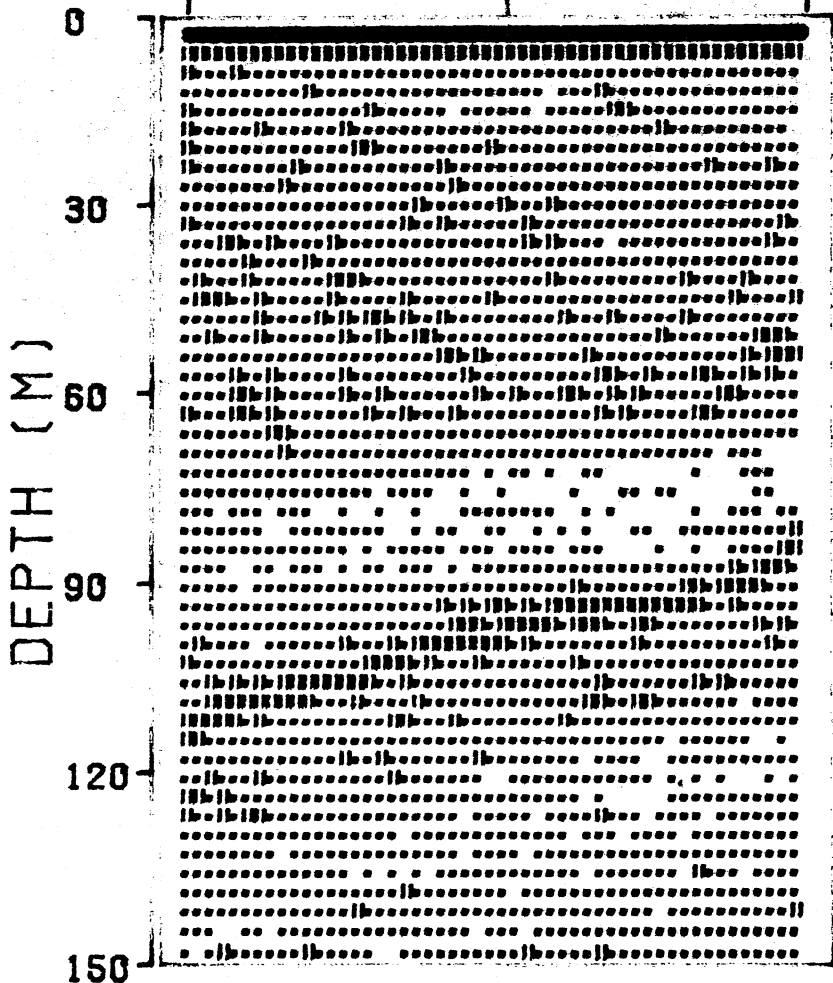


ECOBAM 11 JUNE 1974

STATION

8,00

8,50

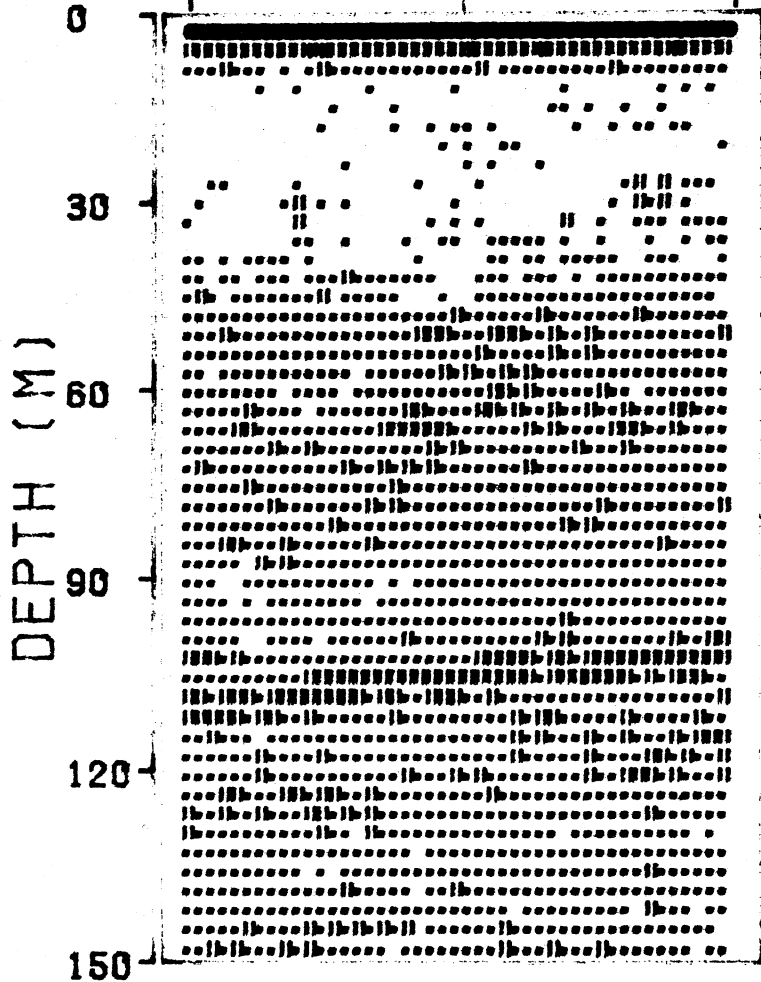


ECOBAM 9 JULY 1974

STATION

8,00

8,50

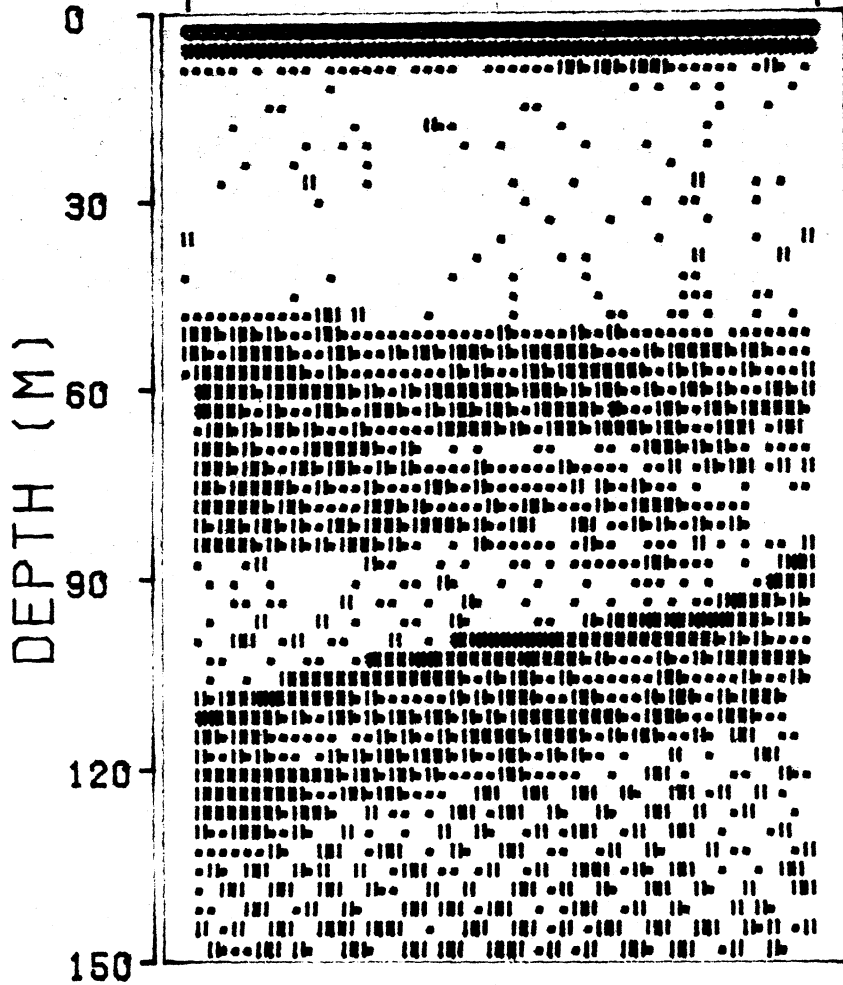


ECOBAM 14 AUGUST 1974

STATION

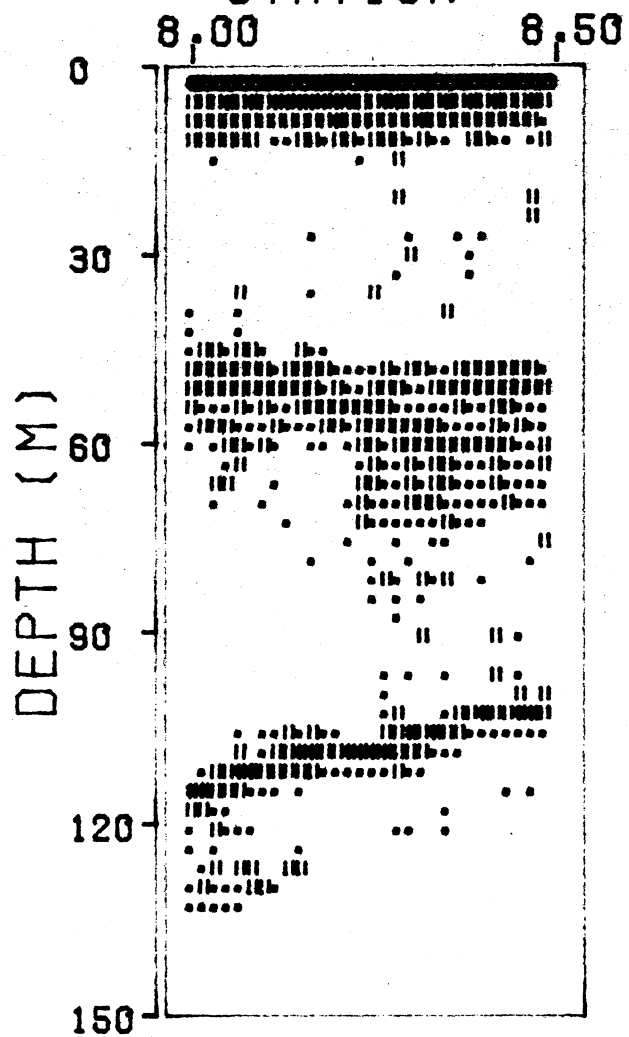
8,00

8,50



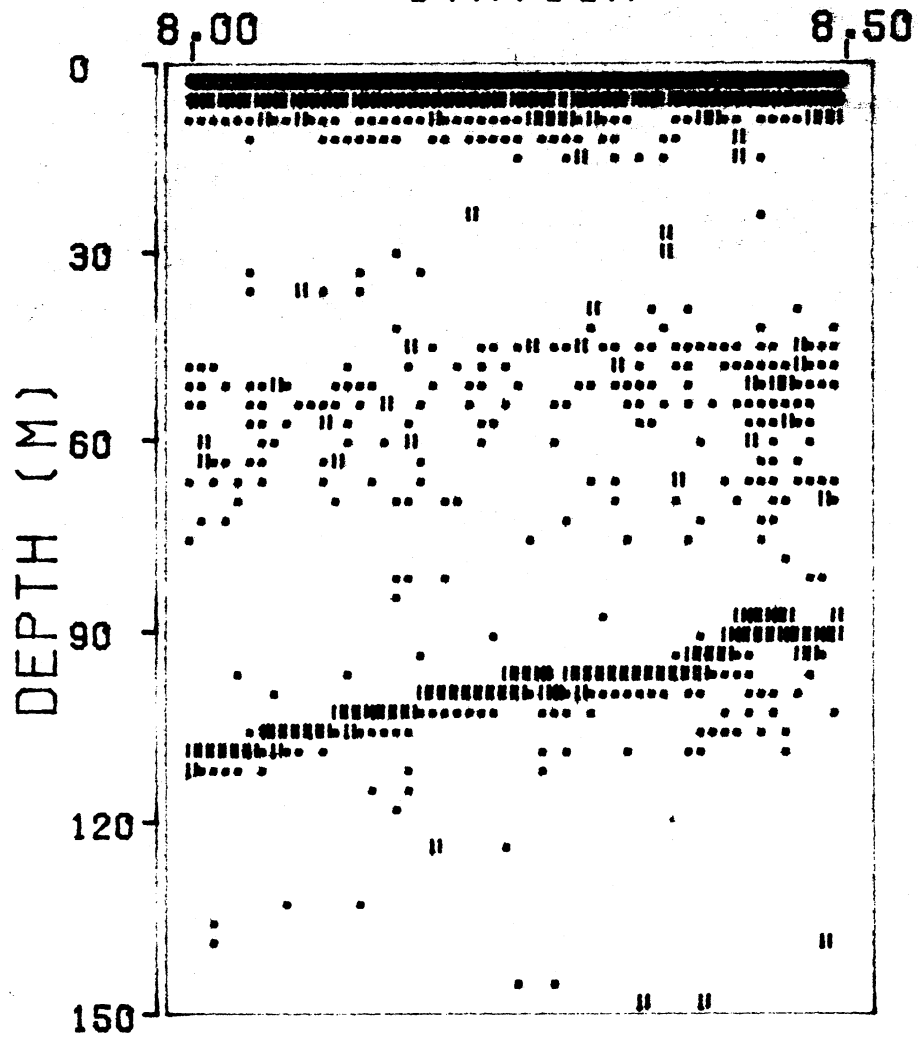
ECOBAM 5 SEPTEMBER 1974

STATION



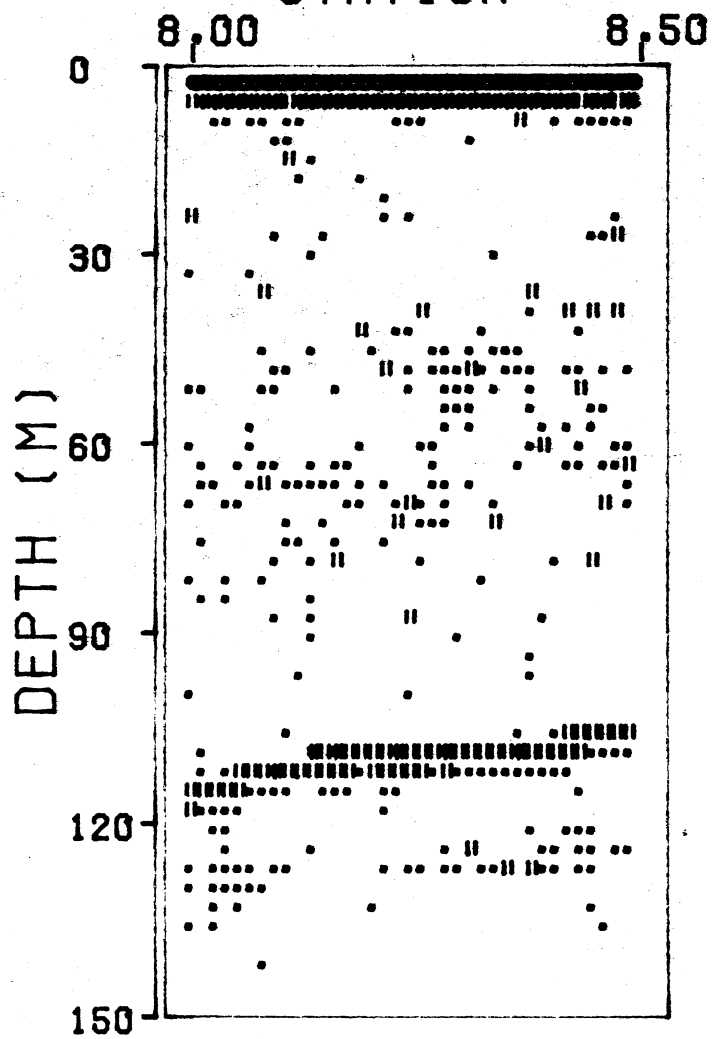
ECOBAM 2 OCTOBER 1974

STATION



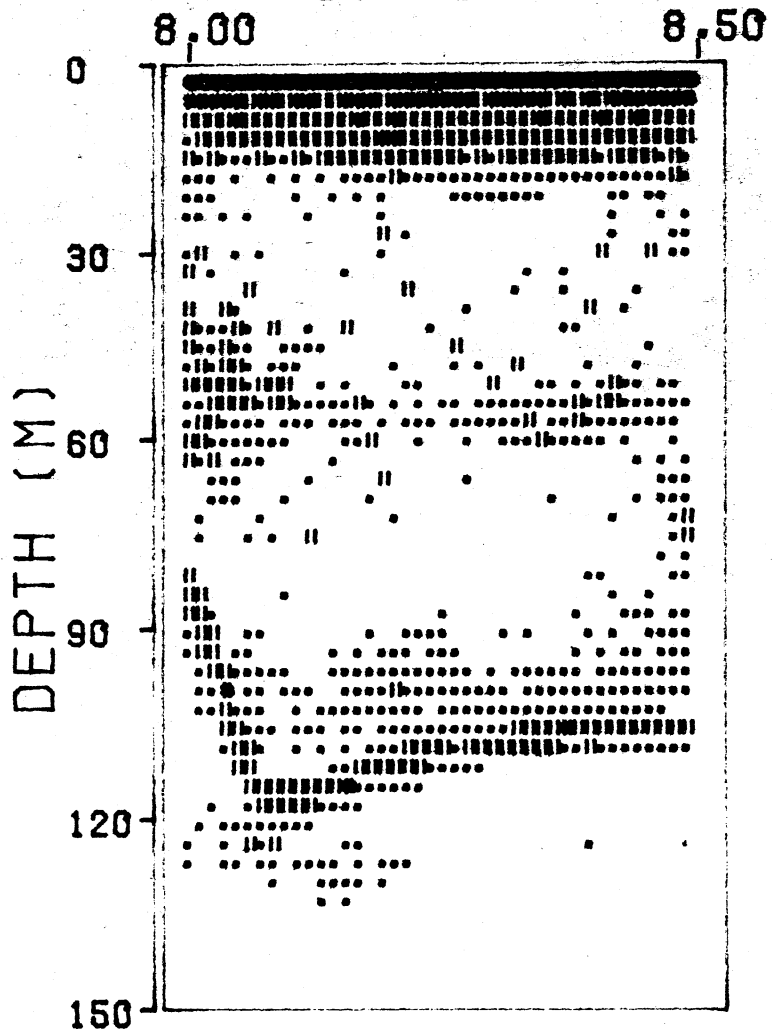
ECOBAM 6 NOVEMBER 1974

STATION



ECOBAM 28 JANUARY 1975

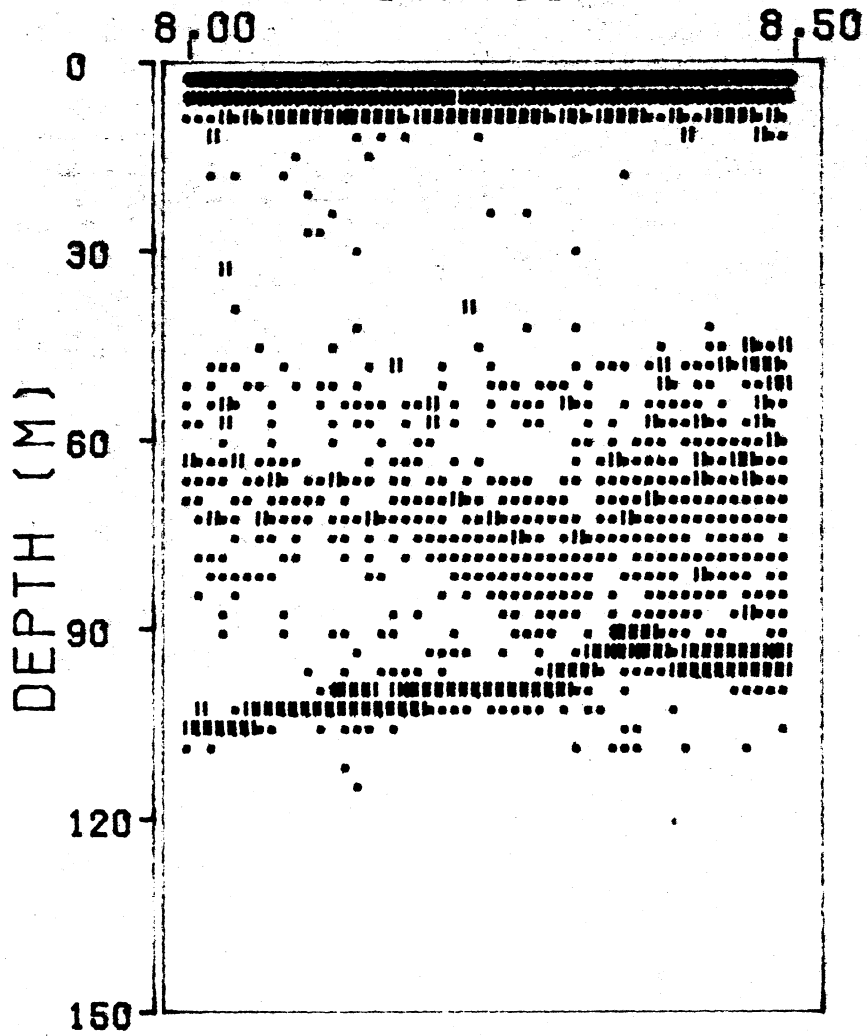
STATION





ECOBAM 19 FEBRUARY 1975

STATION

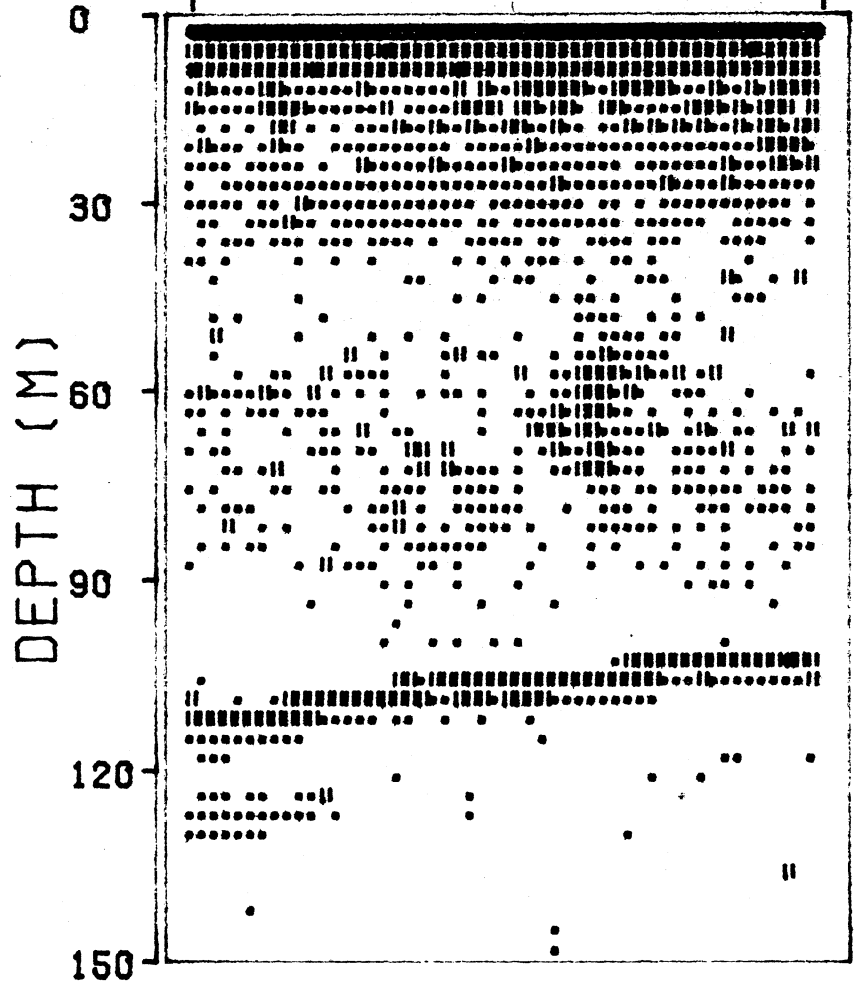


ECOBAM 12 JUNE 1975

STATION

8,00

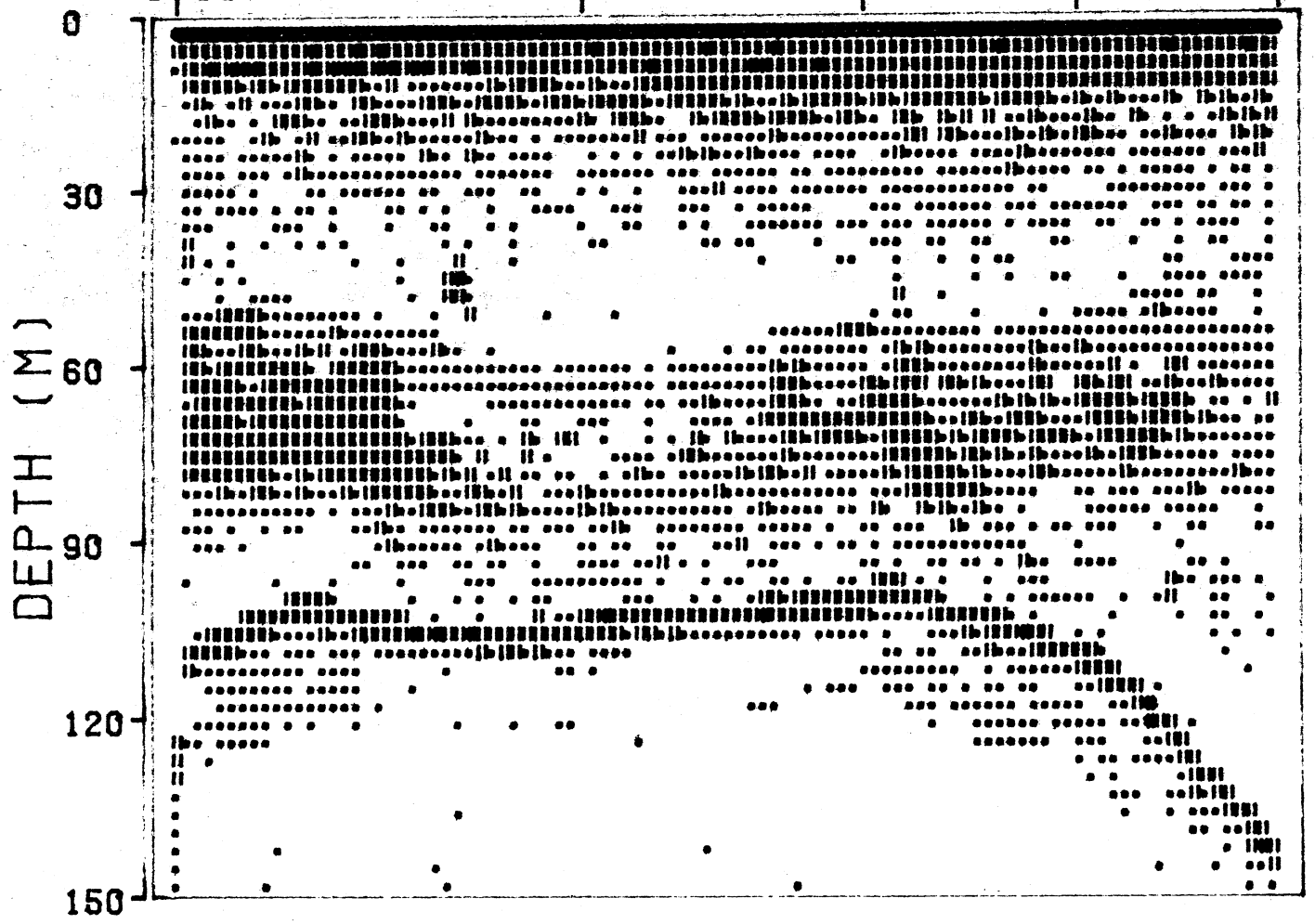
8,50



ECOBAM 7 JULY 1975

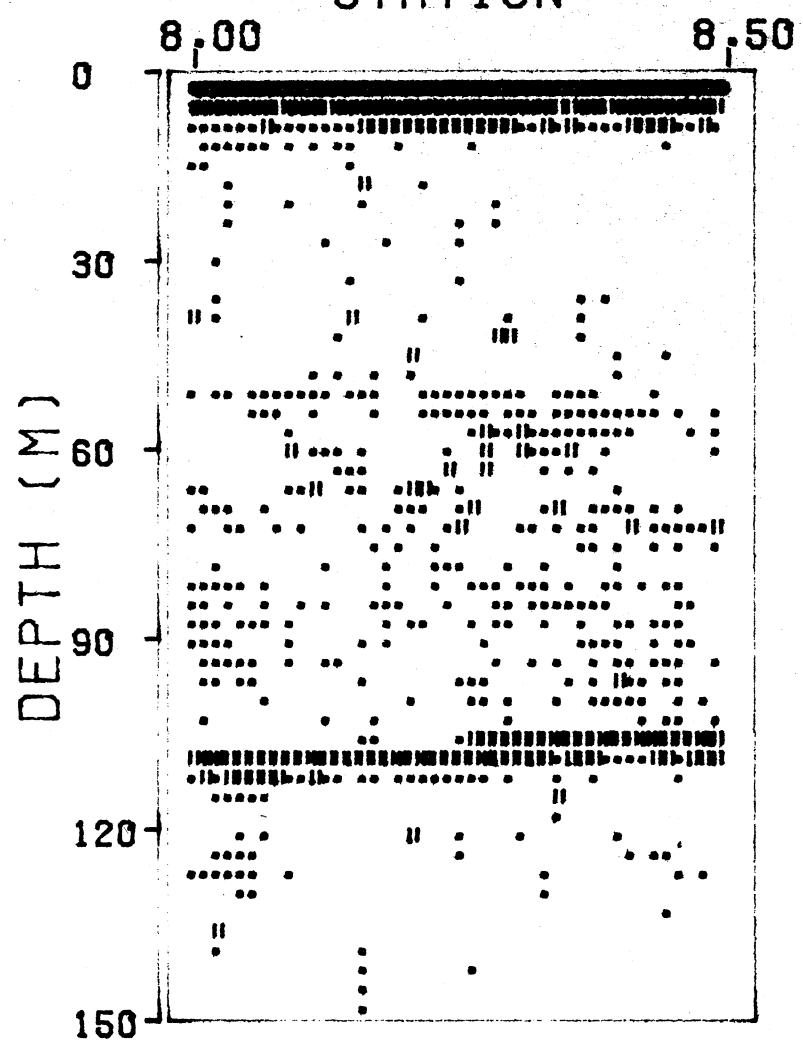
### STATION

8,00                      8,25                      8,50                      8,75                      9,00



ECOBAM 28 OCTOBER 1975

STATION

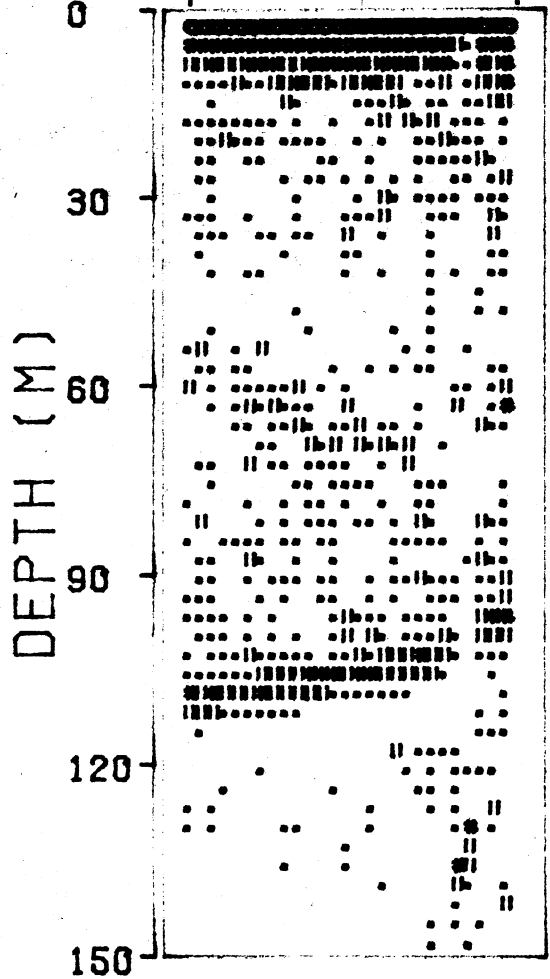


ECOBAM 2 DECEMBER 1975

STATION

8,00

8,50

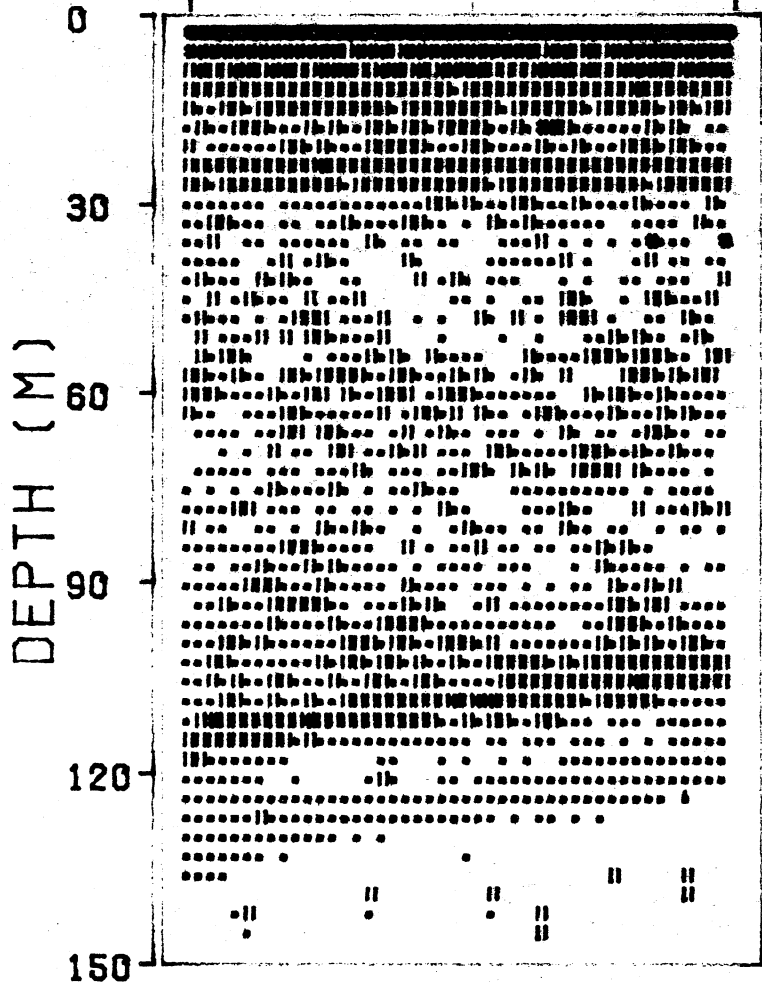


ECOBAM 15 DECEMBER 1975

STATION

8.00

8.50

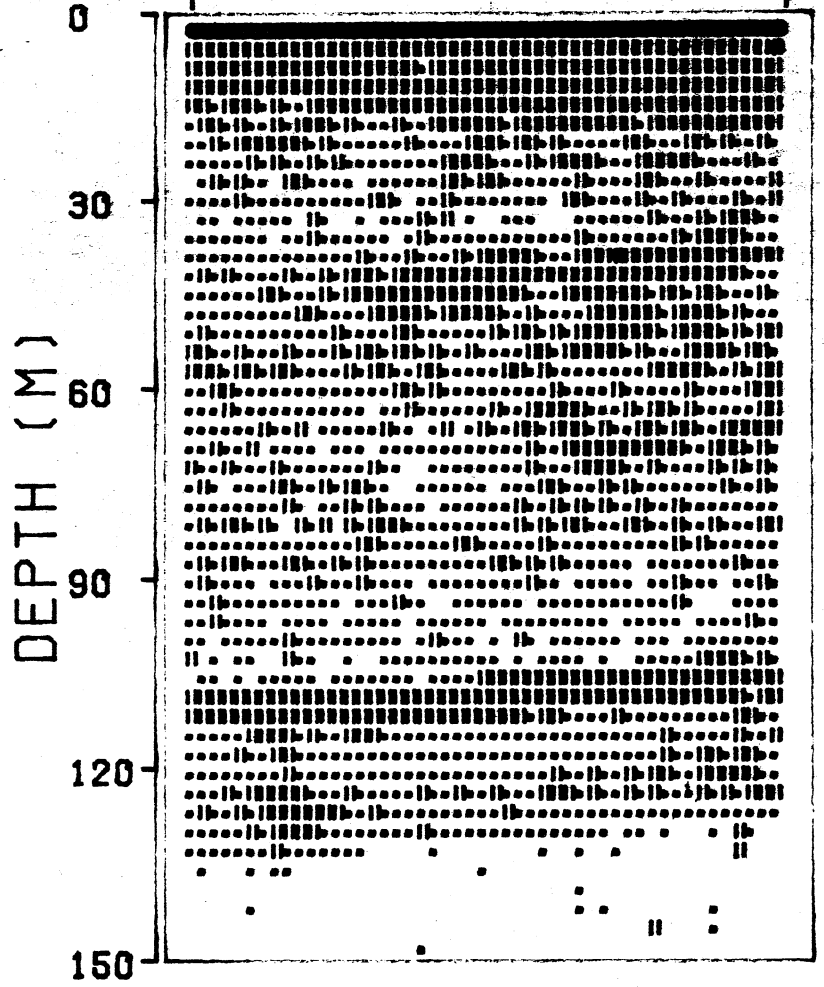


ECOBAM 17 FEBRUARY 1978

STATION

8,00

8,50

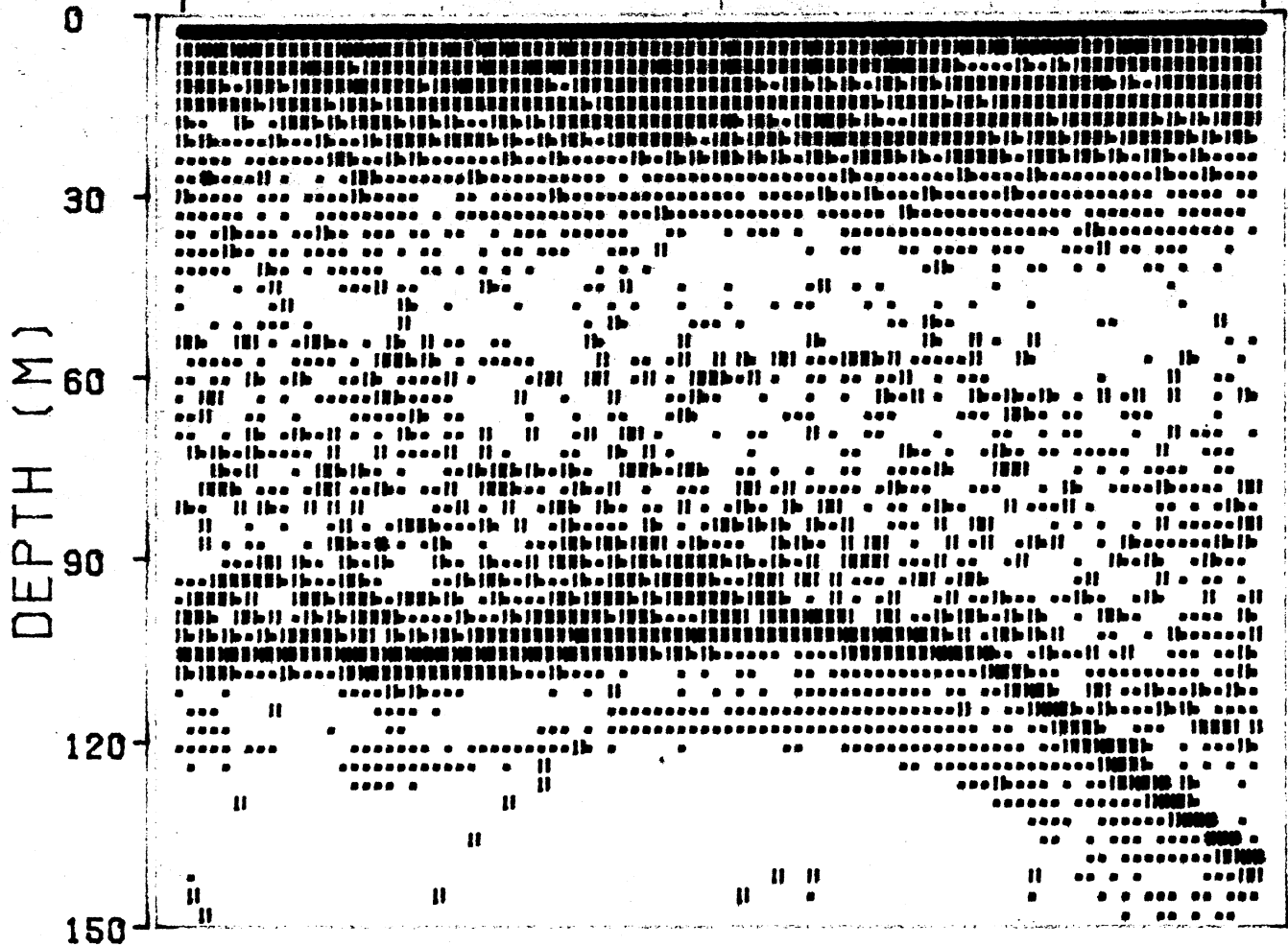


ECOBAM 18 MARCH 1976

STATION

8.00

9.00



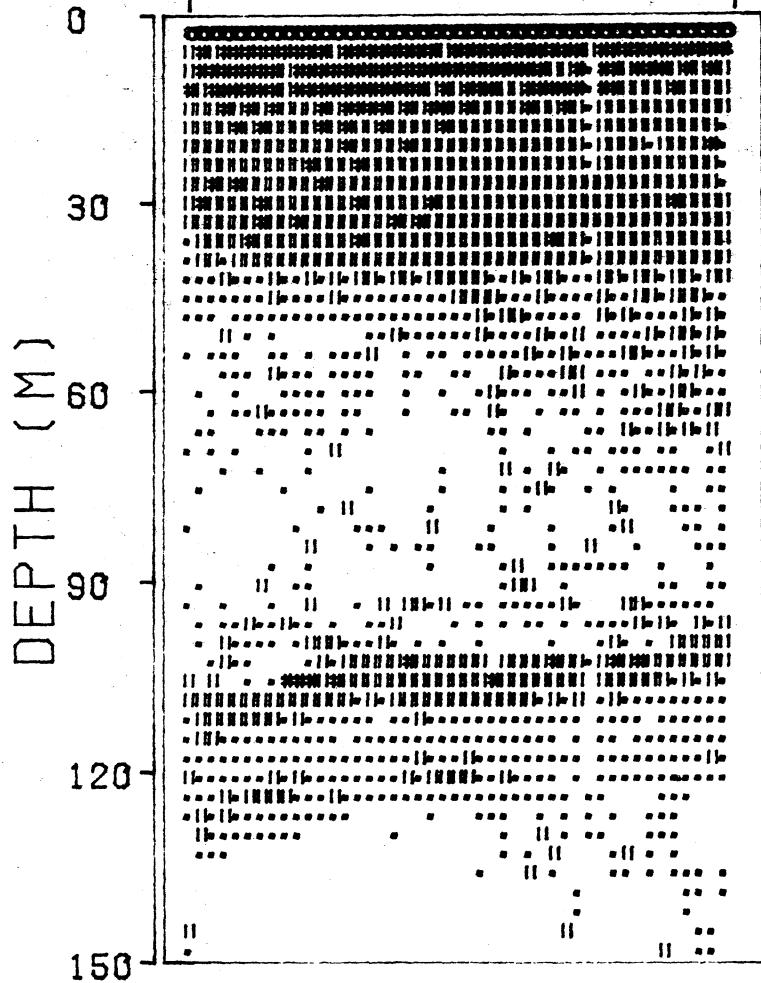


ECOBAM 21 APRIL 1976

STATION

8.00

8.50



ECOBAM 14 JUNE 1976

STATION

8.00

8.50

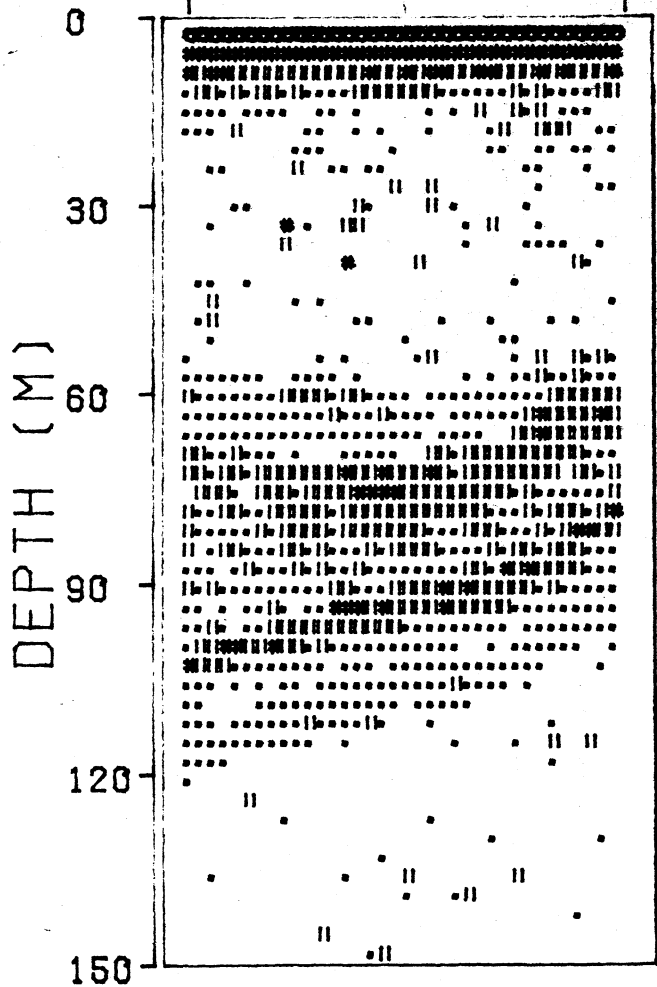


ECOBAM 9 AUGUST 1976

STATION

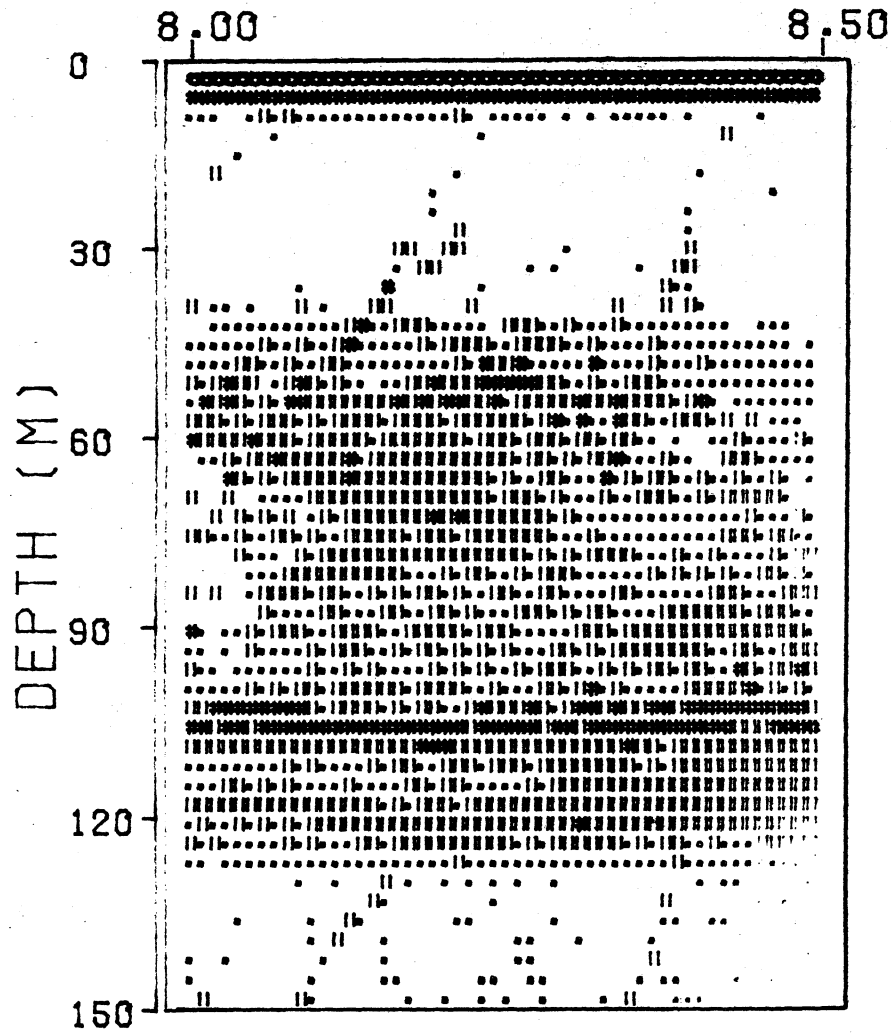
8.00

8.50



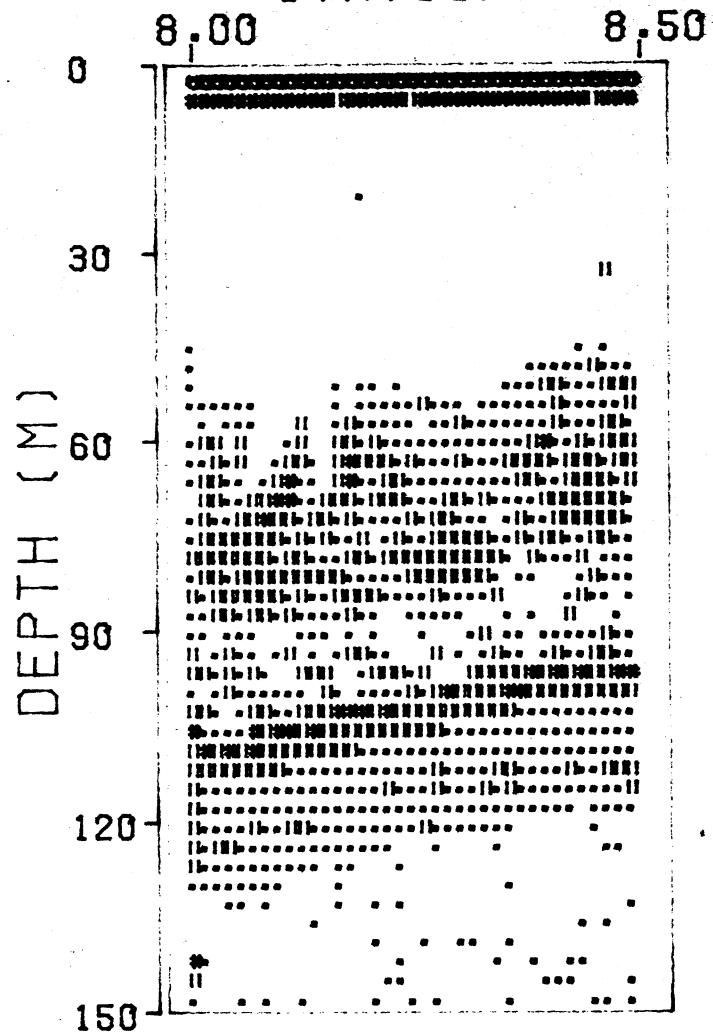
ECOBAM 23 SEPTEMBER 1976

STATION



ECOBAM 18 NOVEMBER 1976

STATION

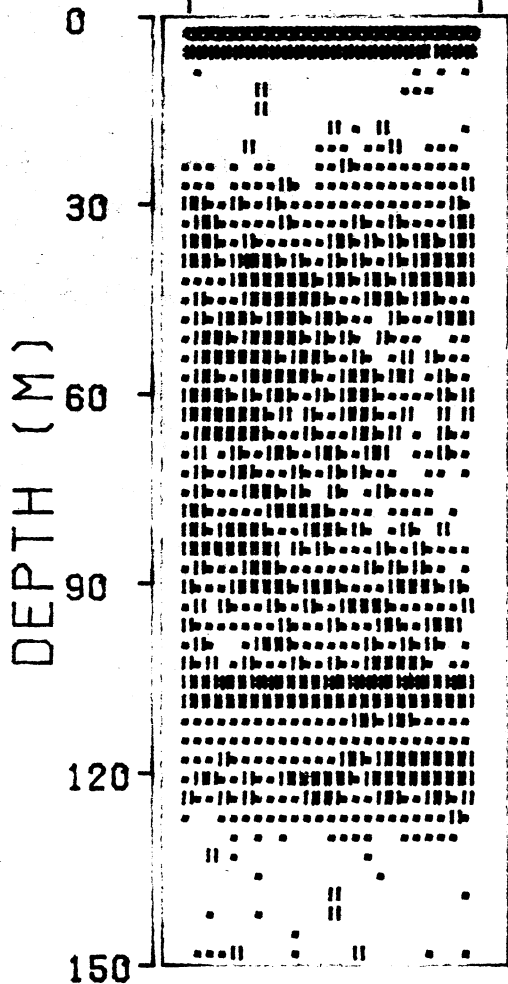


ECOBAM 15 DECEMBER 1976

STATION

8.00

8.50

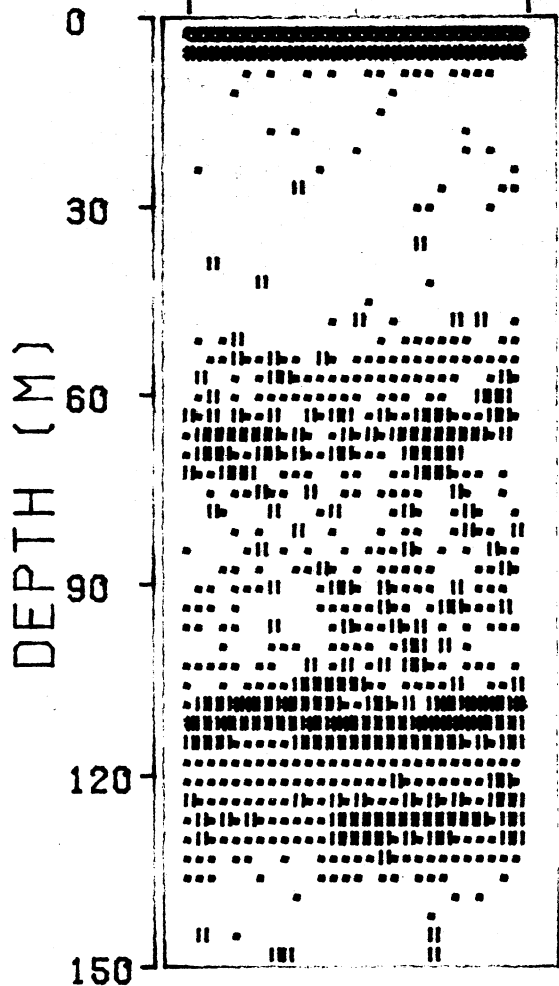


ECOBAM 27 JANUARY 1977

STATION

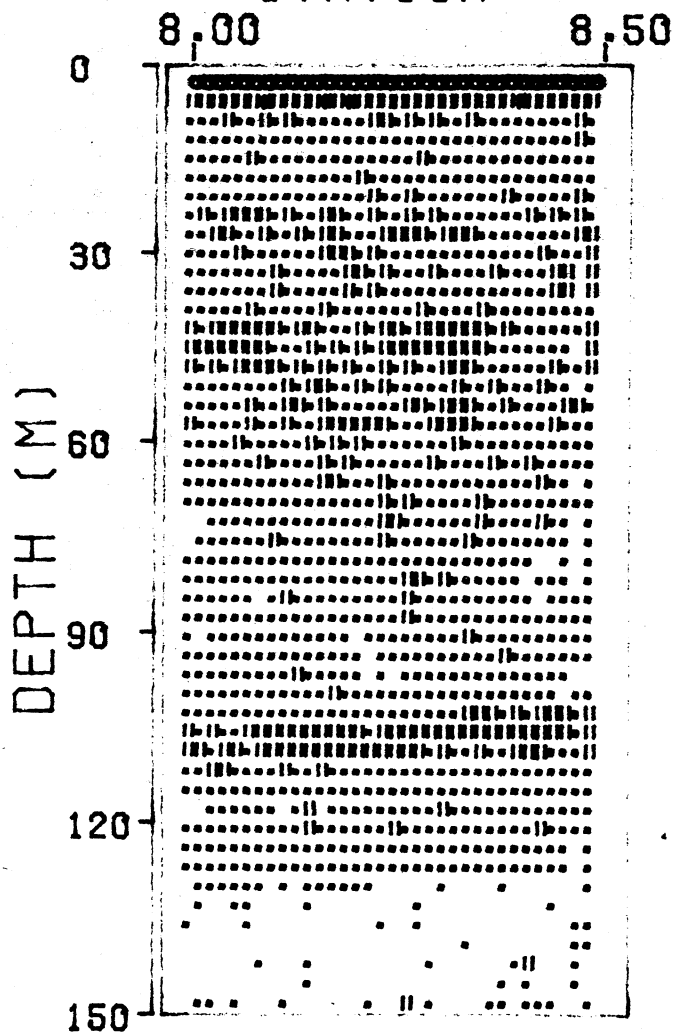
8.00

8.50



ECOBAM 27 APRIL 1977

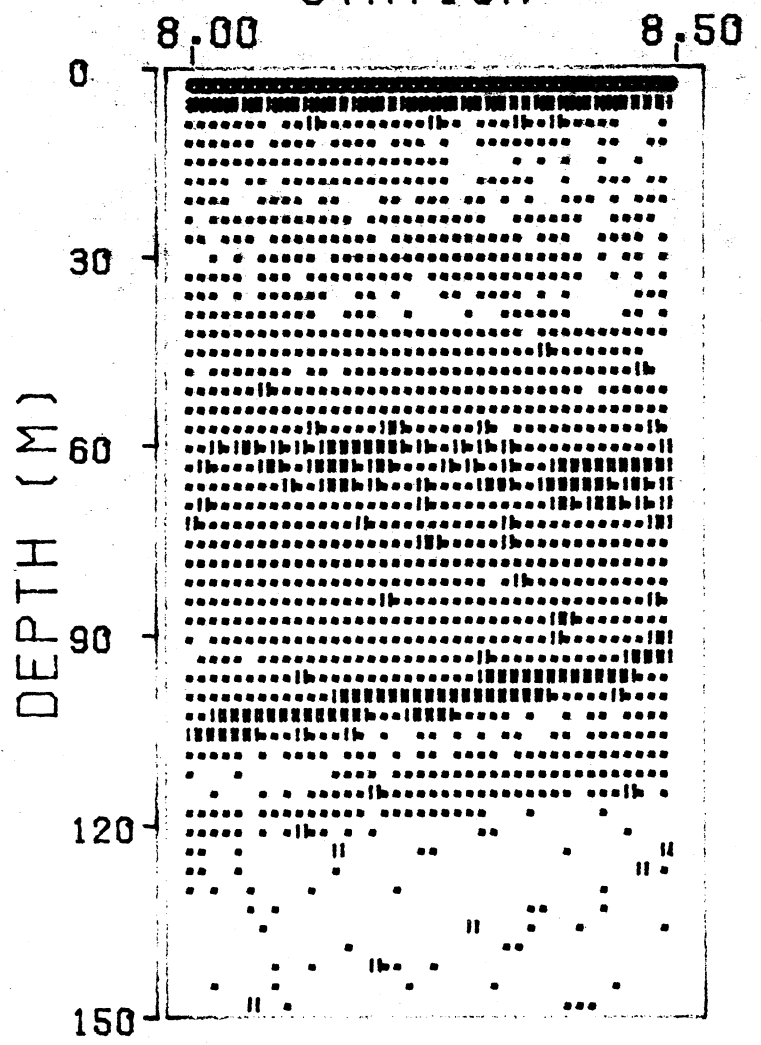
STATION





ECOBAM 19 MAY 1977

STATION

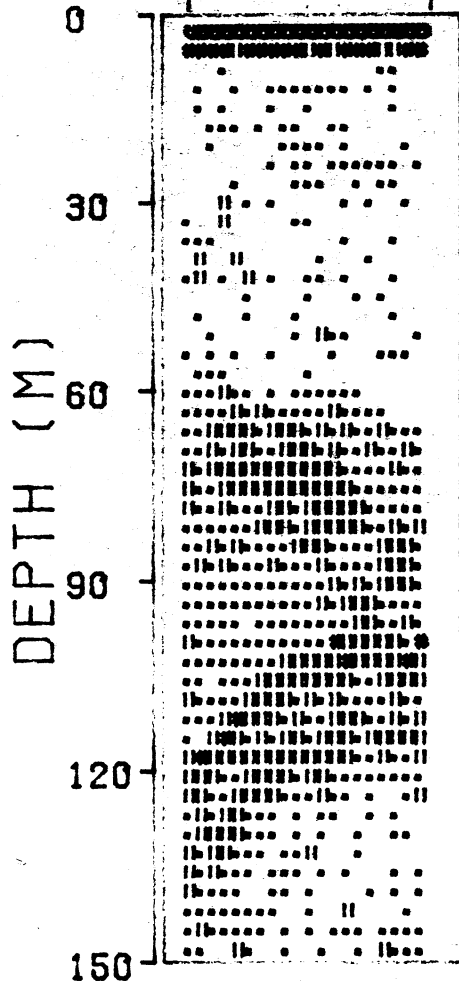


ECOBAM 22 JUNE 1977

STATION

8.00

8.50

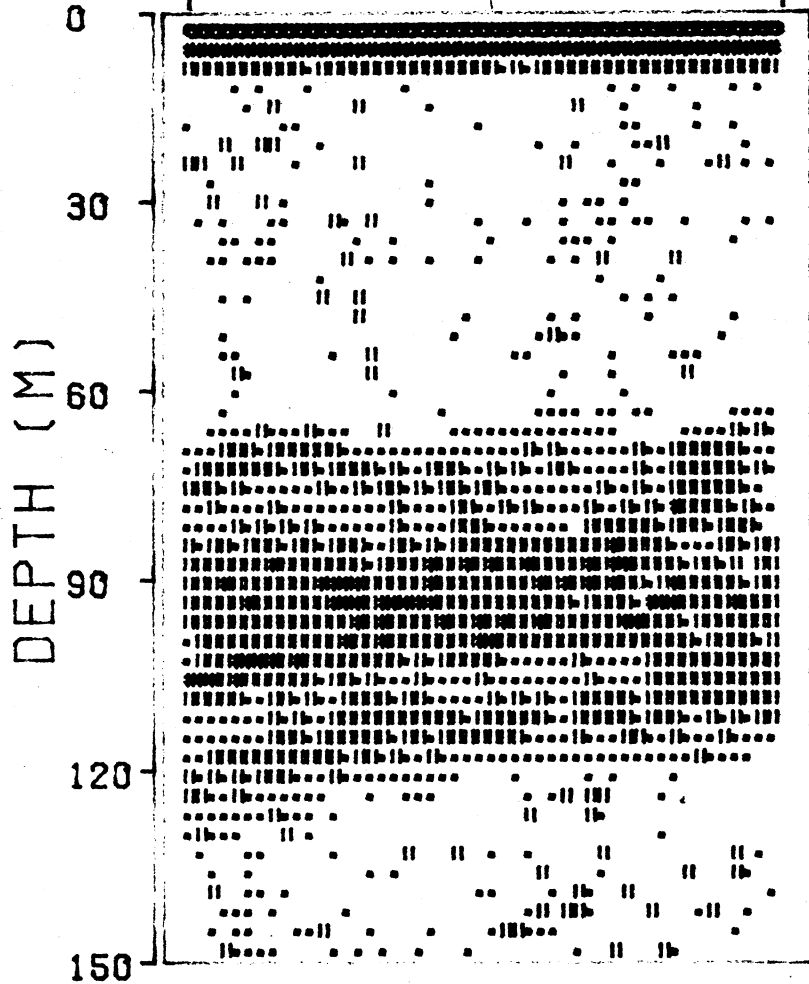


ECOBAM 27 JULY 1977

STATION

8.00

8.50

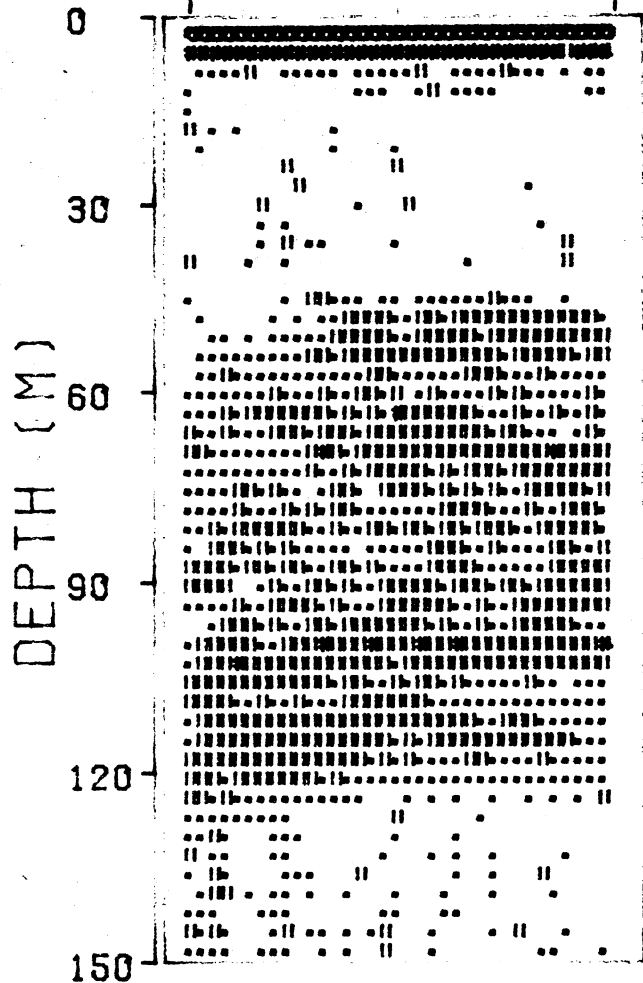


ECOBAM 24 AUGUST 1977

STATION

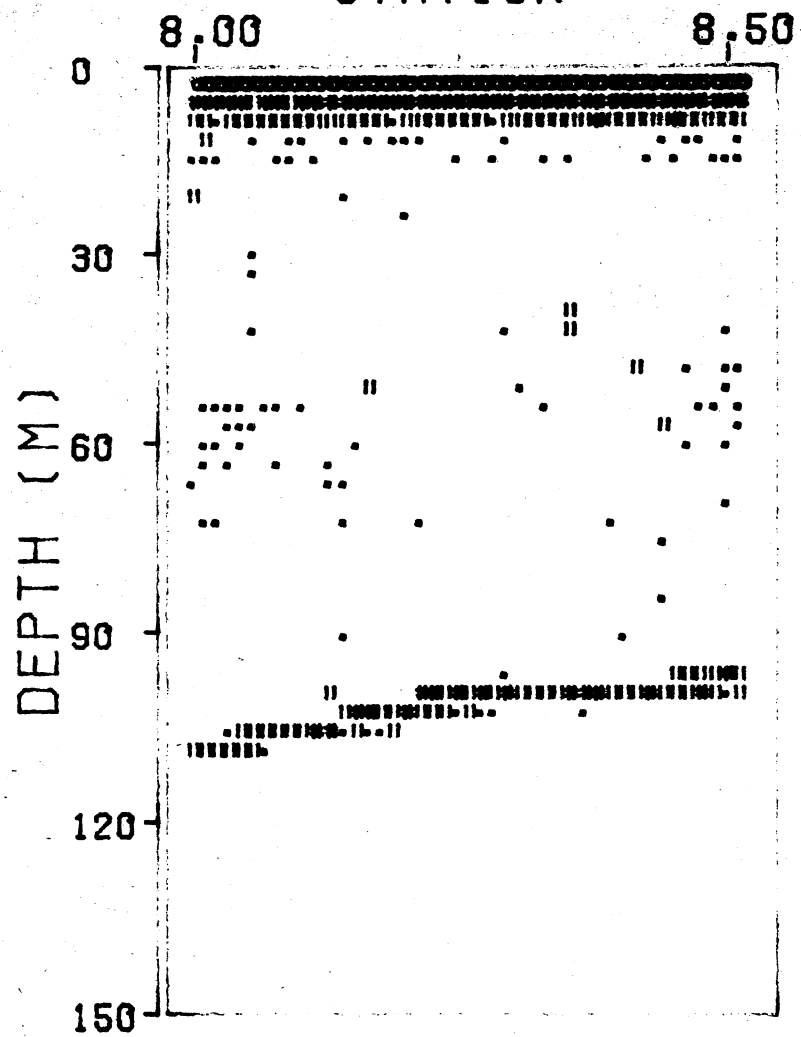
8.00

8.50



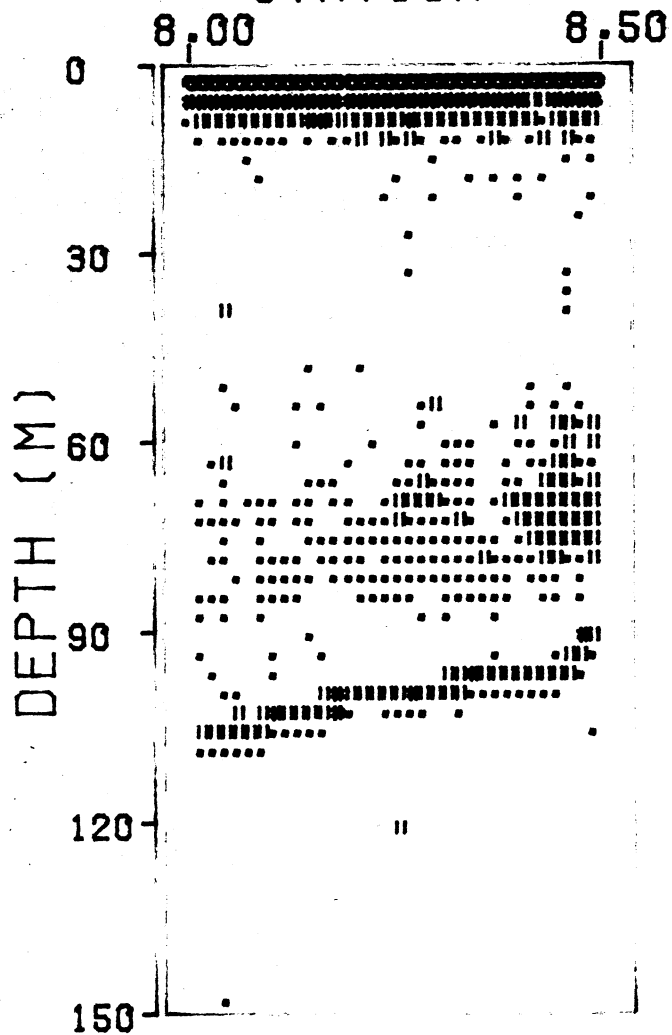
ECOBAM 21 NOVEMBER 1977

STATION



ECOBAM 24 JANUARY 1978

STATION

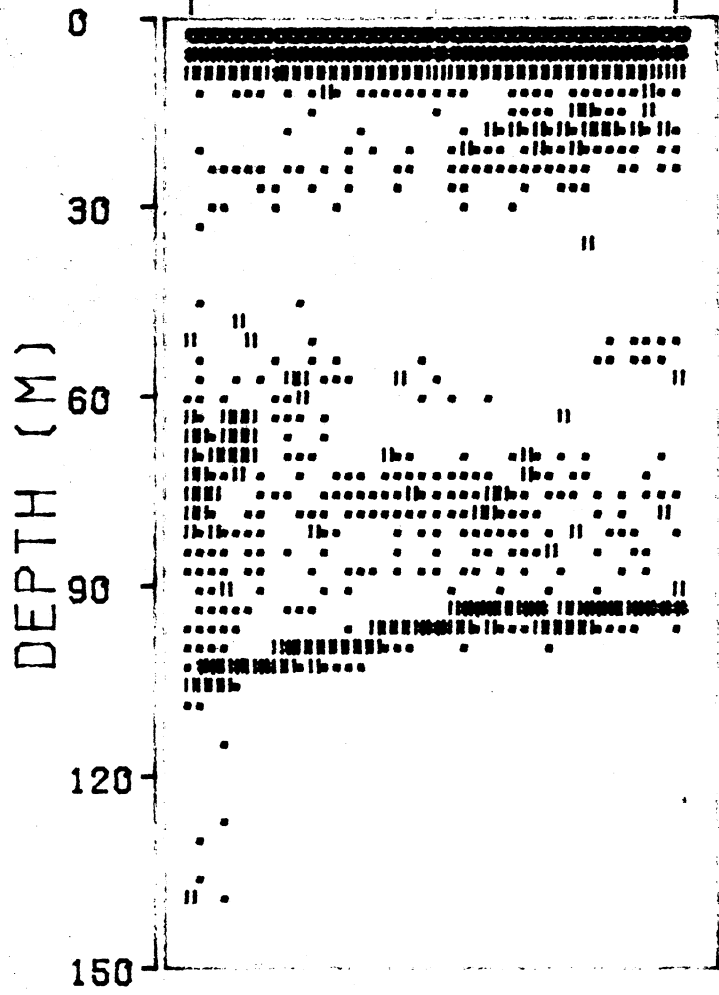


ECOBAM 22 FEBRUARY 1978

STATION

8.00

8.50

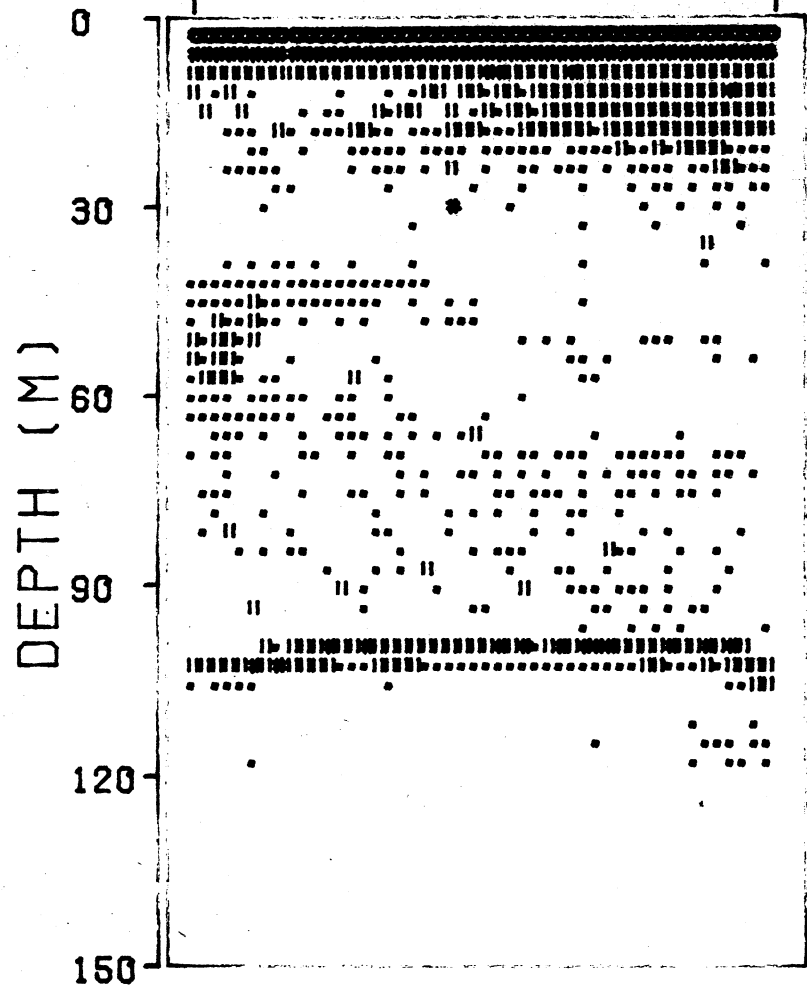


ECOBAM 21 MARCH 1978

STATION

8,00

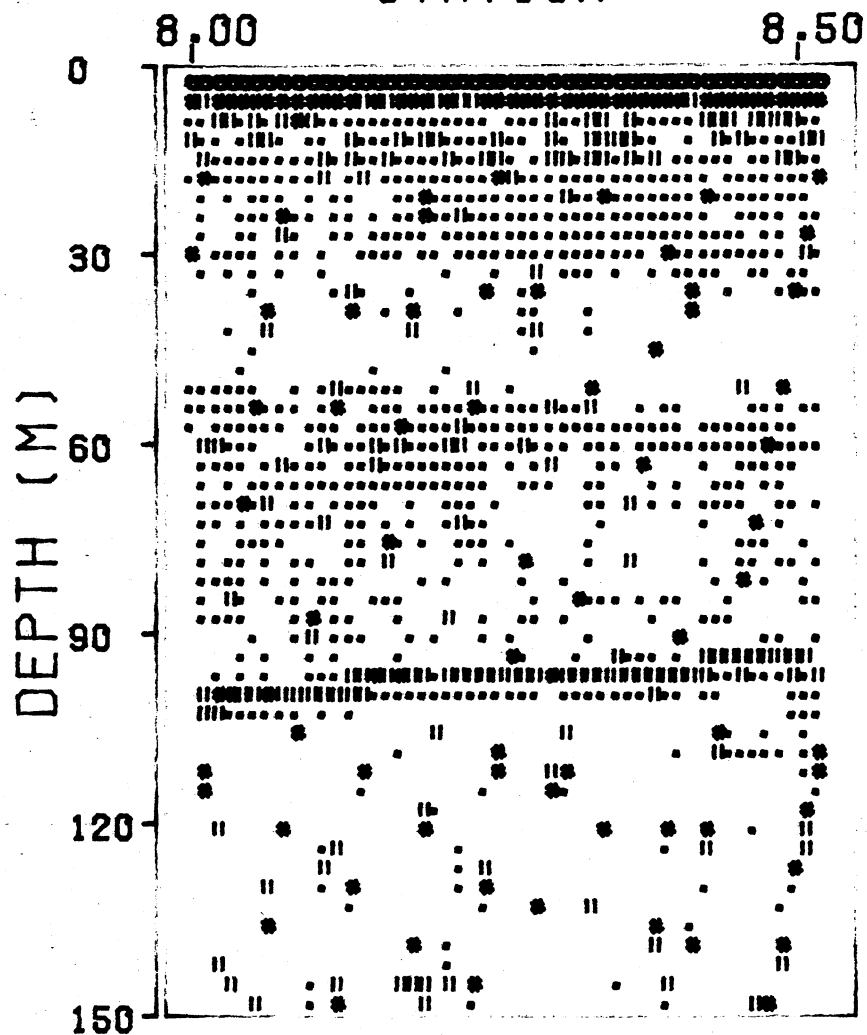
8,50





ECOBAM 23 MAY 1978

STATION

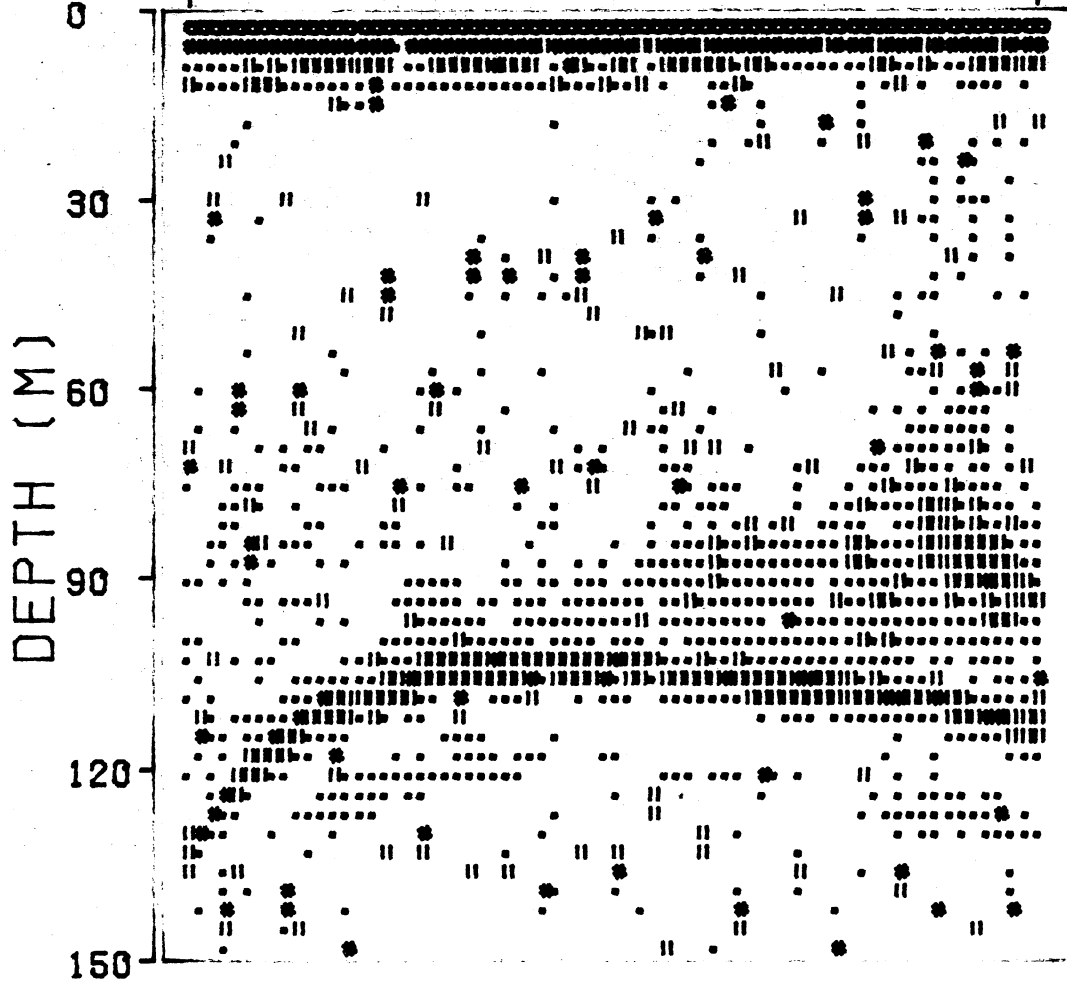


ECOBAM 31 JANUARY 1979

STATION

9,00

8,00



ECOBAM 31 JANUARY 1979

STATION

8.00

20.00

