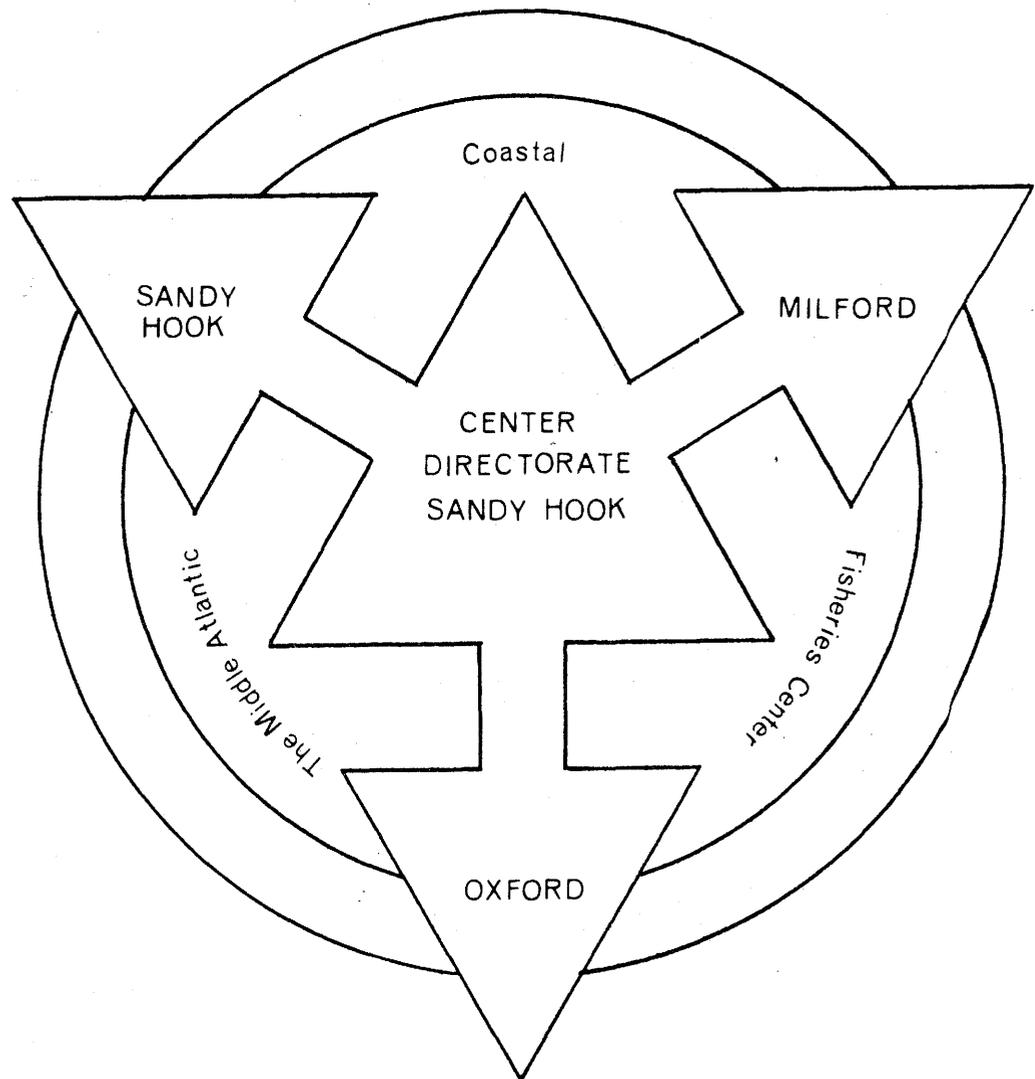


MESA-NYB FUNDED BIOLOGICAL RESEARCH  
TRIMESTER PROGRESS REPORT -- MARCH-JUNE 1976



U.S. DEPARTMENT OF COMMERCE  
National Oceanic and Atmospheric Administration  
National Marine Fisheries Service  
Northeast Region

MIDDLE ATLANTIC COASTAL FISHERIES CENTER



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## I. INTRODUCTION

This report summarizes progress by the Middle Atlantic Coastal Fisheries Center in MESA-funded research from 1 March 1976 through 30 June 1976. Section II consists of a summary of accomplishments. Section III is a detailed description of activities and accomplishments of the following individual studies:

1. Mutagenesis
2. Fin Rot and Invertebrate Disease
3. Benthic Macrofauna
4. Phytoplankton and Primary Productivity
5. Seabed Oxygen Consumption

The first three studies received direct MESA funding during the reporting period. The last two studies are continuations of formerly MESA-funded research.

Section IV is a report on the management of MESA-generated data.

Section V summarizes Dr. Saila's contract research on statistical analyses of benthic data, both biological and nonbiological.

## II. SUMMARY OF ACCOMPLISHMENTS

1. Developing mackerel eggs whose chromosomes were judged to be incapable of normal divisions constituted about 26-97% of eggs sampled in the apex of the New York Bight compared with about 0-19% of eggs sampled outside of the apex in May 1974 by the R/V Westward (Figure 2).
2. We have examined 1,292 of over 5,000 microscopic slide preparations of mackerel embryos sampled during the Westward cruise. Each embryo was classified as to developmental stage (from early cleavage to tail-free larva), then the prevalence of abnormal embryos was counted and mapped by embryonic stage and by type of abnormality (Figures 2-17).
3. All maps show higher prevalence of cytogenetic pathology in the apex than outside the apex. Statistical tests of significance will be run when all microscopic slide preparations have been examined, a task that will require approximately four months.
4. Interestingly, the percentage of dead and dying larvae in the apex was quite uniformly high regardless of larval stage even though the earliest stages have the highest genetic sensitivity to mutagens and cyto-toxins. Apparently, new chromosomal aberrations appear as development proceeds.
5. The condition coefficient of winter flounder exposed in cages at the sludge dump and at a control site did not differ statistically in February, March-April, and in June when water temperature was low (4.0-11.6°C) and dissolved oxygen was high (7.9-10.6 ppm).

6. Further fishing for summer flounder in Great Bay was halted because the prevalence of fin rot there in that species is judged to be zero.
7. Windowpane flounder fin epidermis, especially in distal fin tissue, is thicker and it contains more mucus cells than that of winter flounder.
8. About one-half of 266 rock crabs taken during the surf clam cruise in May from Montauk Point to Cape Fear, North Carolina, had clean gills compared with 80-90% clean of the 251 rock crabs taken in Sandy Hook Bay and near Ambrose Tower in February-March.
9. Phagocytic nodules were present in tissue sections of 70-100% of lobsters collected in Sandy Hook Bay in February-March. The nodules probably are formed as a defense reaction against amoebae and bacteria.
10. "Black gill" in crustaceans, already linked to dumping, probably exacerbates normal stresses resulting from bacterial infections, peritrich ciliates, diatoms, copepods, and other organisms found on and between gill lamellae. For example, although the gills of 25 of 29 rock crabs from Montauk Point were "clean" by gross visual inspection, 86% contained heavy bacterial infections, 73% contained peritrich ciliate infestations, 20% had diatoms, and 50% had copepods between gill lamellae.
11. The benthic macroinvertebrates in 70 Smith-McIntyre grab samples were sorted and identified.
12. Cluster analysis of benthic macroinvertebrate assemblages at 27 stations in the apex was done by hand using four-grab-per-station data.

of the first quarterly cruise, the Jaccard similarity coefficient, and group-average clustering. A faunal assemblage in the Christiaensen Basin, in the rim of the basin to the north of it, and in the Hudson Shelf Valley south of the basin was identified which was distinct from assemblages at the sewage and dredge dump sites and from assemblages elsewhere (Figure 20).

13. Benthic macroinvertebrate species that were present in at least 50% of 19 or 20 grabs at six RECON stations were generally sampled in 3 to 5 replicate grabs at the 95% confidence limit (Figure 21).

14. Dr. Rozette described results of multivariate (factor) analysis showing that the distribution of individual species of benthic macroinvertebrates in the apex follows one of five patterns.

15. Three presentations were made and three manuscripts were being written on phytoplankton and primary productivity in Raritan, Lower, and Sandy Hook Bays.

16. Three presentations were made, two manuscripts were being written, one manuscript was in press (N. Y. Bight Symposium Volume of Limnology and Oceanography), and one data report was published on seabed oxygen consumption.

17. Dr. Saila and his students are developing a simple sequential sampling chart for sampling 24 common benthic macroinvertebrate species.

18. Dr. Saila and his students found in multivariate analyses that the concentrations of chromium, copper, nickel, lead, and zinc in sediments

correlated well with one another, and that of several variables in the biological data, the number of species per sample at each station showed the most clearly defined polynomial response in trend analyses.

### Presentations

Jay O'Reilly gave three presentations on dissolved organic matter productivity in the Lower Hudson estuary and in Raritan Bay at: 1) the Hudson River Environmental Society Symposium at Bear Mountain, New York on 30 March; 2) the New England Estuarine Research Society meeting at Milford, Connecticut on 1 May; and 3) the American Society of Limnology and Oceanography meeting at Savannah Georgia on 22 June.

Dr. Thomas gave three presentations on seabed oxygen consumption at: 1) the Hudson River Environmental Society Symposium at Bear Mountain, New York on 30 March; 2) the New England Estuarine Research Society meeting at Milford, Connecticut on 1 May; and 3) at a colloquium at City College of New York in May.

### Articles Published

Saila, S. B., R. A. Pikanowski, and D. S. Vaughan. 1976. Optimum allocation strategies for sampling benthos in the New York Bight. *Estuarine and Coastal Marine Science* 4(2): 119-128.

### Data Reports Published in Microfiche

Pearce, J. B., J. Caracciolo, A. Frame, L. Rogers, M. Halsey, and J. Thomas. 1976. Distribution and abundance of benthic organisms in the New York Bight, August 1968-December 1971. 114 p. Jan. 1976. NOAA DR ERL MESA-7.

Pearce, J. B., L. Rogers, J. Thomas, J. Caracciolo, M. Halsey, and K. McNulty. 1976. Distribution and abundance of benthic organisms in the outer New York Bight and proposed alternate disposal sites, June 1974 and February 1975. 68 p. Apr. 1976. NOAA DR ERL MESA-10.

Pearce, J., J. Thomas, J. Caracciolo, M. Halsey, and L. Rogers.

1976. Distribution and abundance of benthic organisms in the New York Bight apex, 2-6 August 1973. 131 p. Apr. 1976. NOAA DR ERL MESA-8.

1976. Distribution and abundance of benthic organisms in the New York Bight apex, 26 August-6 September 1974. 88 p. Apr. 1976. NOAA DR ERL MESA-9.

Thomas, J. P., W. Phoel, and F. Steimle.

1976. New York Bight apex data on total oxygen consumption by the seabed, March 1974-February 1975. 92 p. Jan. 1976. NOAA DR ERL MESA-6.

#### Data Reports in Press

Azarovitz, T. R., M. Silverman, V. Anderson, A. Thoms, and C. Aussicker.

Demersal finfish catches in the New York Bight by station and species.

R/V Atlantic Twin October 31-December 5, 1972.

Demersal finfish catches in the New York Bight by station and species.

R/V Atlantic Twin May 8-June 4, 1973.

Demersal finfish catches in the New York Bight by station and species.

R/V Atlantic Twin October 1-November 7, 1973.

Demersal finfish catches in the New York Bight by station and species.

R/V Delaware II and Atlantic Twin April 1-May 2, 1974.

Demersal finfish catches in the New York Bight by station and species.

R/V Albatross IV and Delaware II September 23-October 4, 1974.

Demersal finfish catches in the New York Bight. R/V Albatross IV and

Atlantic Twin March 4-24, 1975.

Ropes, J. W. and A. S. Merrill.

Historical data on surf clams and ocean quahogs.

## Manuscripts

We have classified manuscripts in four categories: 1) approved by Center Director for publication, and either a) funded by MESA, or b) not funded by MESA but highly pertinent to MESA. The latter category tends toward ambiguity because nearly all research by the Center is pertinent to MESA to some degree. We have rather arbitrarily included as highly pertinent to MESA all field-oriented studies conducted geographically in the New York Bight as defined in NOAA Tech. Rep. ERL 321-MESA 2, Ocean Dumping in the New York Bight, March 1975, i.e., seaward from Long Island and New Jersey to the edge of the continental shelf (except we have included work at Deep Water Disposal Site #106); 2) manuscripts not yet approved by the Center Director are by definition subject to revision, hence unfinished, yet knowledge of their existence is useful information, therefore we include them.

### 1) Approved by Center Director -

#### a) Funded by MESA, at least in part.

Babinchak, J. A., J. T. Graikoski, S. Dudley, and M. Nitkowski.

Distribution of fecal coliforms in bottom sediments from the New York Bight. Submitted to Applied and Environmental Microbiology.

Longwell, A. C.

Chromosome mutagenesis in developing mackerel eggs sampled from the New York Bight: Development of rationale, methods, initial data, and discussion of implications for fish populations. Submitted to MESA Tech. Report Series.

Murchelano, R., and C. Brown.

A bacteriologicl and histopathologic study of an ulcerative lesion of the windowpane flounder, Scopthalmus aquosus. Submitted to Trans. Am. Fish. Soc.

Murchelano, R., and J. Ziskowski.

Histopathology of an acute fin lesion in the summer flounder, Paralichthys dentatus, and some speculations on the etiology of fin rot disease in the New York Bight. Submitted to J. Wildlife Diseases.

b) Not funded by MESA, but highly pertinent to MESA.

Greig, R. A., A. Adams, and D. R. Wenzlott.

Trace metal content of plankton and zooplankton collected from the New York Bight and Long Island Sound. Submitted to Bull. Environm. Biochem.

Greig, R. A., D. R. Wenzloff, A. Adams, B. Nelson, and C. Shelpuk.

Trace metals in organisms from ocean disposal sites of the middle eastern United States. Submitted to Marine Biology.

Greig, R. A., D. R. Wenzloff, and J. B. Pearce.

Distribution and abundance of heavy metals in finfish, invertebrates, and sediments collected at Deepwater Disposal Site #106. Submitted to Marine Pollution Bulletin.

Mahoney, J. B., and J. A. McLaughlin.

Consideration of phytoflagellate blooms in New York Harbor and adjacent waters as an effect of eutrophication. Submitted to Biol. Bull.

2) Not yet approved by Center Director -

a) Funded by MESA, at least in part.

O'Reilly, J. E., J. P. Thomas, and C. Evans.

Annual primary production (nannoplankton, netplankton, dissolved organic matter) in the lower Hudson estuary. Plan submitting to Proc. 4th Hudson River Ecology Symposium.

Sawyer, T., S. MacLean, and J. Ziskowski.

Histological studies on Ephelota sp. (Cilicata:Suctorida), an unusual epibiont on gills of decapod crustaceans. Plan submitting to Trans. Am. Microsc. Soc.

b) Not funded by MESA, but highly pertinent to MESA.

Draxler, A.

The short term effects of sewage sludge dumping on the nutrient and particulate concentrations in marine waters. Plan submitting to J. Water Poll. Control Fed.

Nitkowski, M. F., S. Dudley, and J. T. Graikoski.

Identification and characterization of lipolytic and proteolytic bacteria isolated from marine sediments.

Searl, T. D., H. L. Huffman, and J. P. Thomas.

Extractable organics and nonvolatile hydrocarbons in New York Harbor waters.

Waldhauer, R., A. Matte, and R. K. Tucker.

Lead and copper in the waters of Raritan and Lower New York Bays.

### III. DETAILED REPORTS OF PROGRESS

#### 1. MUTAGENESIS

##### 1. Methodology -- New Developments

Every-day experience over the past several months with Atlantic mackerel eggs (Scomber scombrus) has led to the resolution of just about all vestiges of old methodologic problems. Also, we now know well the strengths and weaknesses of cyto-genetic study of fish eggs collected from plankton samples and of mackerel eggs in particular.

A new cruise into the New York Bight this past May provided an opportunity to test some new fixatives under field conditions to ascertain if any improvement might be made over the customary formalin for cyto-genetic study of planktonic fish eggs. One fixative has demonstrated already that the chromosome configurations of late-stage eggs are just as large as those of early-stage eggs when the fixative does not harden the cell membranes and it is, consequently, possible to spread the cell over a larger area. One of the reasons for traditionally analyzing early-stage cells over later-stage cells has been the small size of later-stage cells.

##### 2. Comparison of Eggs over the Seven Early Developmental Stages - Cleavage to Tail-free Larva

An initial systematic cyto-genetic study of all seven early developmental stages of the fish eggs seemed important for three reasons, and it has proved worth the effort. First, it is important to know if data collected at one stage corroborate data for other egg stages collected at the same station. Secondly, it is of value to know just how much and what kind of data are best collected at the several stages. If stages vary little for

the parameter measured, one stage might be substituted for another when a stage elected for study is missing from some stations. Thirdly, data on all stages are necessary to judge what stage would best be studied when funds, time, or large numbers of stations to be covered make it impossible to study all stages.

In a field study, as conducted here, all egg stages are sampled contemporaneously, not successively, throughout development of a single lot of fertilized eggs as in a laboratory experiment. Water conditions could have varied considerably at the times different stages were passing through most critical early cleavage stages though this is less likely in a rapidly developing egg such as the mackerel. Also, by drifting there must be some admixture of eggs from good stations with those from poor stations, one the basis of water quality, and vice versa. In spite of this, differences over the Bight are being detected.

#### Brief Summary of the Cyto-genetic Study of the Seven Early-egg Stages

##### Stage I -- Early Cleavage

This stage appears to have by far the highest frequencies of mortality, mitotic abnormalities, and chromosome aberrations. Impressive as the data on Atlantic mackerel cleavages are as we collect them, the results are not unexpected. Not only does early cleavage have the highest genetic sensitivity to mutagens and cuto-toxins, but also it is expected to reflect more than subsequent stages gametic wastage of the maternal parent. Such gametic wastage could result from poor maternal conditions unrelated or not related directly to pollution. It could result from the background contaminant load of the parents. The background load of the female is particularly

important because that portion of it persisting in the spawned egg would affect the zygote as soon as it was formed, as well as having affected the maternal chromosome complement. Not surprisingly for such a fecund group as fish, chromosome and division abnormalities were so frequent in the early cleavages it proved hardly worth the effort to score their frequency per egg. Instead, eggs were simply categorized as those capable of further development by grossly normal mitotic divisions of their chromosomes, and those incapable of further chromosome divisions normal enough for development to continue. Included in this category were eggs with cell-level deterioration, eggs in which all the mitosing figures had become abnormally nucleated, and eggs with grossly irregular divisions. By these criteria just about all Stage I -- Early Cleavage eggs collected in the vicinity around the dump sites were dead or moribund. The number of viable Stage I eggs increased with distance east of the dump sites.

#### Stage II - Morula

Mortality, mitotic and chromosome abnormalities and aberrations at the morula stage generally reflect the Stage I prevalences. Specific chromosome aberrations, as scored in this study, are far easier to score in Stage II eggs than at Stage I.

#### Stage III -- Blastula

Chromosome and mitotic abnormalities as studied here are readily scored. There seem to be little differences from the preceding Stage II, except for the somewhat smaller size of increased numbers of cells.

#### Stage IV -- Gastrula

At this stage there is a sizeable drop in the frequency of chromosome aberrations at the better stations, and probably also at the stations intermediate between the best and worst. Classic genetic studies on a variety of organisms support this. Only the more genetically normal eggs are capable of gastrulating (gastrulation is the time zygotic genes begin functioning and the embryo becomes less dependent on maternal DNA templates laid down in the egg cytoplasm). The fact that eggs at the poor stations do not seem to diminish much in chromosome aberrations at this stage is most likely attributable to the occurrence of new aberrations as development proceeds.

#### Stage V -- Early Embryo

Probably differs little in most respects from the preceding gastrula stage.

#### Stage VI -- Tail-bud Larva

Cells are very obviously differentiating, the mitoses occur in different cell types. Cells are now much smaller but mitoses can still be reliably scored for aberrations. About 100 telophases per embryo can be scored at the best stations, i.e. stations farthest from the apex.

#### Stage VII -- Tail-free Larva

Not appreciably different in important respects from the preceding Stage VI.

### 3. Development of a Rapid, Multiple Scoring System for Chromosome Aberrations and Mitotic Abnormalities

As slides were being spot-checked, it became obvious that embryos were falling into four categories:

- 1) Dead with deterioration setting in at the zygote cell level, but with no gross deterioration of the egg.
- 2) Moribund as indicated (a) by such total disorganization of cell divisions that no further meaningful division could occur; (b) by such severe and extensive physiological abnormalities of the chromosomes their further division in a normal manner could not be expected; or (c) by total cessation of cell division.
- 3) Embryos with a sufficient number of mitoses to be scored for specific chromosome aberrations at the telophase stage of division.
- 4) Embryos with too few mitoses to obtain an estimate of chromosome aberrations by scoring the telophase stage of cell division.

Also, it became obvious that there was a correlation between mitotic index and normalcy of the chromosomes and division. Again, striking as this may have been for a collection of planktonic eggs, it has plenty of precedents in the classic genetic literature on other groups and cell types. Both very genetic-specific mutagens and less specific cyto-toxins and also adverse physical conditions reduce the rate of cell division.

Accordingly, a scoring system was developed in which eggs are scored for:

- 1) cell deterioration
- 2) gross physiological disturbances of the chromosomes over the entire embryo

- 3) gross physiological disturbances of the nuclei over the entire embryo (as indicated by pale, swollen, vacuolated nuclei)
- 4) total cessation of mitotic activity in the embryo
- 5) disorganized irregular division of the chromosomes over the embryo
- 6) bridging and lagging of the telophase chromosomes for all the telophases over the entire embryo.

One through 5 above an estimate of egg death or impending death at the cell and cyto-genetic levels. Six above gives a traditional estimate of specific chromosome aberrations. At the same time it provides data for an estimate of mitotic index (average number of telophases per embryo). These data on specific chromosome aberrations come only from zygotic eggs which have not experienced more gross cyto-genetic abnormalities. Data on specific chromosome aberration provide a look at the eggs escaping more severe cyto-genetic abnormalities, and mitosing at a high enough frequency to estimate aberrations from the telophase stage alone (embryos with less than 10 telophases were not used in computing data given here although record is kept of their telophase aberrations).

This parameter of specific aberrations at telophase provides a more refined look at mutagenicity apart from cyto-toxicity which also can provoke chromosome and mitotic errors in genetic-sensitive early developmental stages (see Figure 18).

Those eggs in which deterioration has advanced from the cell level of the zygote to the embryo level must be excluded from all the parameters scored for here. Such eggs must rapidly fall out of the plankton as they

were not observed at any of the approximately 40 stations studied. The rapidity with which this removal occurs is probably due to the combined action of non-intact membranes, breaking up the oil globule and bacterial action. R. Lasker of NMFS, LaJolla Laboratory (private communication) noted that dead eggs in artificial cultures quickly drop to the bottom of the culture containers.

Special data sheets are being prepared by the Sandy Hook biometrics group so that microscopic scoring of the embryos can be done directly on forms to be sent to the keypuncher.

The initial scoring system used, a simpler one, lumped together specific chromosome aberrations, cyto-genetically moribund cells and those with severely disorganized divisions, and utilized all division stages for most effects. It could not take into account mitotic index, as embryos were being studied in the course of developing methodology and slide quality varied. Old and new data though are in general agreement, except for mortality which was under-rated in the initial study. This was because embryos and stations alike were being selectively studied on the basis of their propensity for our developing methodology. This naturally excluded most embryos where cell deterioration had proceeded to a point of interfering with normal stainability.

4. Discussion and Comparison of Data on Mortality, Mitotic Index, and Mitotic Abnormalities and Chromosome Aberrations over the New York Bight as Presented in "Data Maps" (See Figures 1-18)

In toto over 5,000 Scomber scombrus embryos have been prepared on microscopic slides for cyto-genetic study. These included various stage embryos for all 40 or so of the 54 Westward stations at which Atlantic

mackerel eggs were sampled. See the first attached map for location of Westward sample stations (Figure 1). Because of time spent on initially collected data and on the reporting of them with development of the rationale for such a study on planktonic eggs, all 5,000 embryos have not been scored microscopically. Time also was spent in developing the scoring system which has been streamlined considerably in the course of its development. It should be emphasized that 5,000 embryos is not too large a number to study in one contract year. It is hoped that by October all the slide preparations can be read. With experience and the rapid scoring system worked out an average embryo requires roughly about 7 minutes to score.

Data summarized here are for those stations and for those stages within stations for which there are sufficient data to warrant a look at trends. Since data on mitotic index exclude dead or moribund eggs, they are based on lower egg numbers than mortality data alone. Data on specific chromosome aberrations are based on still fewer eggs than are data on mitotic index. This is because, as noted above, some eggs had too few telophases to obtain an estimate of any reliability.

Data on mortality and mitotic index on which the figures presented in the maps are based will be turned over shortly to S. Change for multiple range tests. More eggs will be studied before data on specific chromosome aberrations are subjected to multiple range or other tests, probably a month's more microscopic study.

Evidence from classic genetic literature indicates that there can be some combination of chromosome data for the early developmental stages of the egg. This was done for this data preview for the frequencies of

specific chromosome aberrations. All data though on all stages are being collected separately by stage. Once larger egg numbers are studied, all data will be treated separately by stage even though from what has been observed planktonic fish eggs follow the classic pattern - a drop in chromosome aberrations during cleavage and another drop about gastrulation, with stages in between and following differing little, if at all.

As the eggs develop to more advanced stages, the cell number is of course increased. However, the rate of cell division drops. Consequently, a rough indication of mitotic index can still be obtained beginning with the Stage III -- Blastula eggs even when closely related developmental stages are combined as done here.

Because the cytological-cyto-genetic method permits detection of early stages of embryo death, the technique is well applicable to measuring cyto-toxicity aside from mutagenicity and developmental error. In such case the combination of mortality data over the several stages should matter less than in the case of cyto-genetic-based embryo death. Some instances of such extreme toxicity or adverse physical factors appear to occur at four dump site stations reported here. Combined mortality is accordingly presented in one "data map" (Figure 2), as well as in several others by egg stage (Figures 3, 4, 5, 7, 9, 11).

#### Figure 2

Here is shown the general pattern of mortality of all seven early-egg stages combined (Cleavage-Tail-free Larvae) for 19 sample stations distributed over the Bight. Long Island, northeast peripheral and southern

stations have low mortality, 0 to about 10%. By contrast, mortality around the dump sites ranges from a low of 26 to 97%. Southward and westward stations around these sites appear worse than more northern eastward ones.

#### Figure 3

At only 2 of 7 dump site stations, those eastward of the sites, were any Stage I - Cleavage embryos observed microscopically which were not either dead or moribund by the cytological-cyto-genetic criteria described above. The most distant station to dump sites and coast by contrast had 79% of its embryos capable of further meaningful development. A Long Island station had 64% of its embryos capable of further development.

#### Figure 4

Mortality patterns of the Stage II - Morula eggs appear very similar to the Stage I - Cleavage eggs. Of 5 peripheral stations, 4 had no mortality. Of the dump site stations, 4 of 7 had near total mortality, and the remaining 3 had high mortality. This represents mortality of the survivors of Stage I - Cleavage eggs which have high mortality as discussed above.

#### Figure 5

Here is shown mortality of Stage III - Blastula egg. Again, there is a pattern of heavy mortality around dump sites, and no mortality at all at more distal stations. The intermediate mortality at the somewhat peripheral stations eastward across from the dump sites is as in the preceding stage.

#### Figure 6

Here are given figures for the mitotic index of Stage III - Blastula eggs. Long Island and peripheral stations have values which range from 65 to 198. Values of dump site stations range from 0 to 41. Two stations south of the dump sites along the Hudson Canyon area are also low, hinting at what other data indicate may be a significant trend in this region.

#### Figure 7

Mortality pattern of the Stage IV - Gastrula eggs is similar to that of earlier stages. Five of 6 peripheral stations have no mortality. Dump site stations have significant to total mortality.

#### Figure 8

The mitotic index of Stage IV - Gastrula embryos in northern peripheral stations ranges from 80 to 93. The values for dump site stations range from 0 to 59. Two southern stations along the Hudson Canyon, one nearing the continental shelf, also have indices about a quarter of those of the best northern stations.

#### Figure 9

Mortality of the Stage VI - Tail-bud embryo eggs followed the same pattern as mortality of earlier stages. Four peripheral stations, 2 northern and 2 southern, had no mortality at all. Three of 9 dump site stations had total mortality and one near total. Stations somewhat to the east of the most impacted areas had low to moderate mortality. Since mortality recorded for the worst of the stations was total at earlier stages, it is

most probable that later-stage embryos dead at these stations developed at other stations and drifted to these stations.

#### Figure 10

The mitotic index for the Stage VI - Tail-bud embryo stage for 4 dump site stations is 0 to 4. Other eastward stations have somewhat higher values but do not exceed that (53) of the one good northern peripheral station on which there are sufficient data for comparison. Following the trend first observed at earlier-egg Stage IV - Gastrula, 2 southern stations, one approaching the continental shelf, also have low mitotic indices.

#### Figure 11

Mortality for Stage VII - Tail-free embryo eggs is consistent with that of earlier-stage eggs. Mortality is 0 for 3 northern peripheral stations, and 6 for a southern peripheral station. Three dump site stations have 100% mortality, and 2 others, 88 and 96% mortality. Two other dump site stations have lower mortality, 26 and 9%. The dead or moribund tail-bud and tail-free larvae are well-developed. Accordingly, as for mortality of the tail-bud larvae, this probably represents in the case of the worst stations at least death of eggs developed elsewhere and drifted to these sites. For these, mortality may have been caused more physiologically by toxicity of the water, rather than by severe damage to mitoses and chromosomes as occurring at earlier stages with greater genetic vulnerability.

### Figure 12

For the Stage VII - Tail-free embryo eggs the mitotic index of two northern peripheral stations is highest following the trend of earlier-stage eggs. A station westward approaching the dump sites has an intermediate mitotic index. A southern peripheral station again has an index lower than the northern peripheral station. The dump site station with the highest index still has a value only one-third that of the two good peripheral stations. Values for other dump site stations range from 0 to 13.

### Figure 13

This map indicates the problems confronted in obtaining good estimates of specific chromosome aberrations for stations with high mortality and low mitotic index. This is because all embryos dead, moribund and with too few or no mitoses must be prepared and examined carefully before this is recognized and recorded. This map also points up again the large variation in mitotic index at the worst and best stations. Northern and Long Island stations have from 0 to 6% of their embryos in this category of too few telophases to calculate a specific aberration frequency. At 3 dump site stations too few or no viable embryos were found to obtain even this crude estimate. At other dump site stations from 25 to 67% of the embryos have too few mitoses. One station south of the dump sites along the Hudson Canyon had 36% of its embryos with too few telophases. Even though mitotic index is reduced at the southernmost stations, it is not so reduced that significant numbers of embryos have too few telophases available for such scoring of aberrations.

#### Figure 14

Here are shown the average station incidences of specific telophase chromosome aberrations in viable morula and blastula (Stages II and III combined) embryos, excluding those with severest cyto-genetic damage to mitoses and chromosomes and also those with less than 10 telophases per embryo; that is, the average of each embryo's percentage of telophases indicating a chromosome aberration.

Two stations furthestmost north and east have the lowest aberration rates. Westward of the dump sites the rate is about 1.5 X these north and east peripheral stations. One of the Long Island stations just to the west of the two good stations has an aberration rate of 2 X that of the two good stations east of it. In all other parameters studied this station, however, proved one of the better ones. A southern station along the Hudson Canyon about half-way to the continental shelf had a high aberration rate of 65. Previous data maps showed a tendency for lowered mitotic index in this area. The next 2 data maps will show also a high aberration rate for later-stage eggs in this same area. In contrast with dump site regions, there is little mortality in this southern region as shown in preceding maps. There may be no greater specific mutagenicity here than around dump sites, but simply greater survival of affected embryos because of dilution of the same contaminants. For example, 3 dump site stations have such high mortality an estimate of specific chromosome aberrations probably cannot be made on study of any reasonable number of eggs.

#### Figure 15

Here are shown the average incidences of specific chromosome aberrations for gastrula and early-embryo eggs (Stages IV and V combined). More stations are represented here; consequently, there is a better representation of the pattern being observed as data are collected. Embryos with most severely affected chromosomes and mitoses should not gastrulate so these figures are based on a genetically select group with lower incidences of genetic aberrations. Long Island and northeast peripheral stations have the lowest aberration incidences - 4, 4, 6, and 8%. By contrast, dump site and a southern peripheral station have frequencies of 10, 12, 13, 20, 21, and 25. The peripheral station westward toward the dump sites is also high, 22. This is the station which proved intermediate between best and worst in other parameters. Along the Hudson Canyon 2 stations are equally as high, 21 and 23, as are dump site stations. Two southernmost stations nearing the continental shelf in the direction of the Toxic Chemical Disposal Area are also as high, 21 and 23, as dump site stations.

#### Figure 16

Data on the average incidence of specific chromosome aberrations for the tail-bud and tail-free larvae (Stages VI and VII combined) are based on a larger sample of eggs per station. However, only 5 stations are represented so far, although most of about 40 will be represented once all data are in. The northeast peripheral station has a frequency of only 4%. A station southwestward of this in the direction of the dump sites has a value of 2.5 X this. Two dump site stations also have values

2 to 3 X this best station. At 4 other dump site stations mortality is probably too high to obtain values for specific chromosome aberrations. A southern peripheral station off the New Jersey coast half-way to the continental shelf has an incidence a little over 3 X the best northeast peripheral station.

#### Figure 17

Figures on this data map are the average mitotic indices of the tail-bud and tail-free embryos from which the chromosome aberration frequencies of the preceding Figure 15 are based. This gives an impression of the correlation between reduced frequency of mitoses and chromosome aberrations. The northeast peripheral station with the low aberration frequency has the highest mitotic index, 73. Other stations with higher aberration frequencies of 9 to 13 have lower mitotic indices, from 33 to 42.

#### 5. Publications and Publication Plans

First-collected data were presented at a Special Symposium on the Middle Atlantic Continental Shelf and New York Bight co-sponsored by the American Society of Limnology and Oceanography. An expanded abstract of this talk is in press in the Journal of Limnology and Oceanography.

Based on initial studies a report was prepared for the MESA Technical Report Series:

Chromosome mutagenesis in developing mackerel eggs sampled from the New York Bight - by A. Crosby Longwell with several acknowledgements.

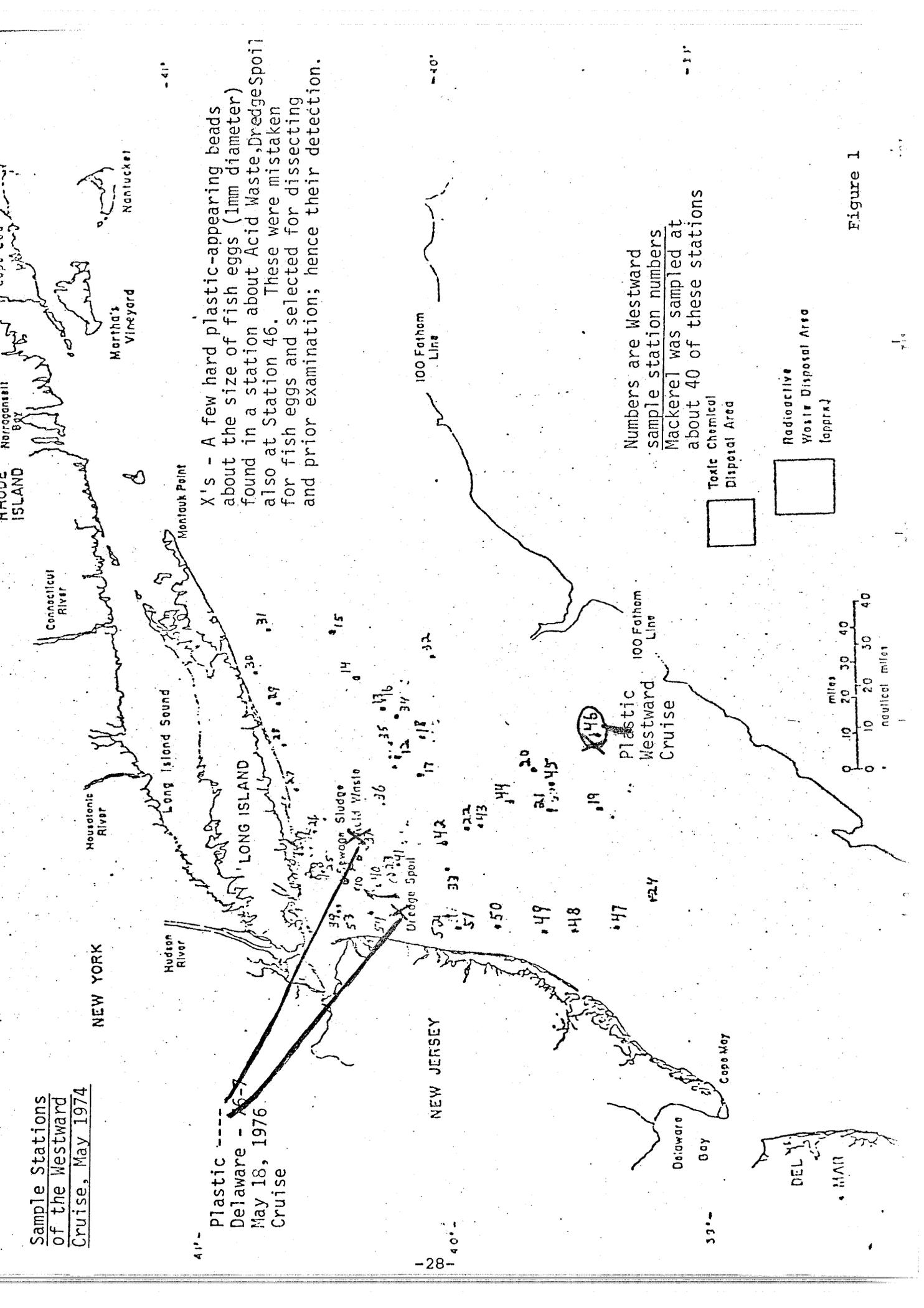
A longer version of the same report fully develops the rationale of such an approach to studying marine pollution and discussed the implications for recruitment of cyto-genetic damage and dominant lethal mutations in developing fish eggs. This paper is documented with about 200 references which represent a thorough research into pertinent literature and its focus on fish eggs developing in plankton. Much of this rationale and discussion will be prepared along with a data synopsis for publication in Marine Technology Society Journal. Also, a short paper combining old and newly collected data will be written for Nature or Science.

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Sample Stations  
of the Westward  
Cruise, May 1974

Plastic -----  
Delaware - X6-7  
May 18, 1976  
Cruise

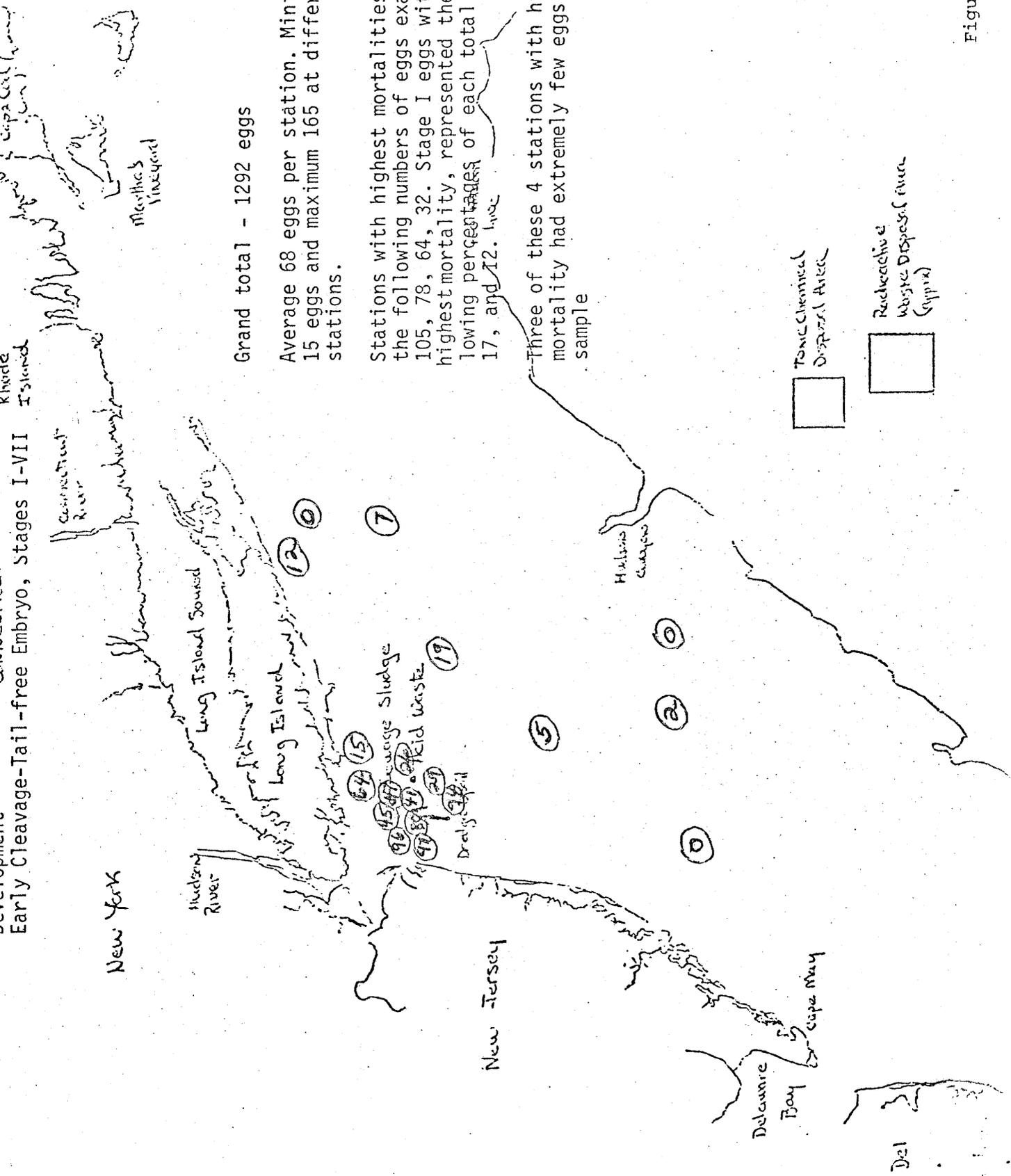
X'S - A few hard plastic-appearing beads about the size of fish eggs (1mm diameter) found in a station about Acid Waste, Dredge Spoil also at Station 46. These were mistaken for fish eggs and selected for dissecting and prior examination; hence their detection.



Numbers are Westward sample station numbers  
Mackerel was sampled at about 40 of these stations

Figure 1

Development of Early Cleavage-Tail-free Embryo, Stages I-VII



Grand total - 1292 eggs

Average 68 eggs per station. Minimum 15 eggs and maximum 165 at different stations.

Stations with highest mortalities had the following numbers of eggs examined: 105, 78, 64, 32. Stage I eggs with highest mortality, represented the following percentages of each total 0, 2, 17, and 12. ~~12~~

Three of these 4 stations with highest mortality had extremely few eggs in the sample

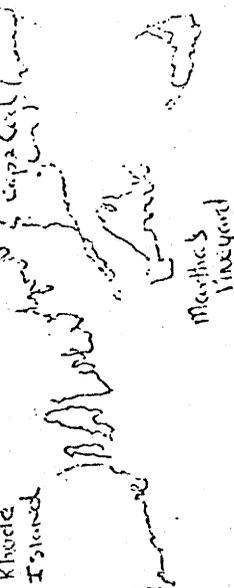
Toxic Chemical Disposal Area

Radioactive Waste Disposal Area (Approx)

Figure 2

abnormalities

Khoole Island



New York

Hudson River

Long Island Sound

Long Island

64

Sludge  
Waste

69

68

67

66

65

77

100 ft from  
line

Hudson  
Channel

New Jersey

Delaware Bay

Cape May

Del

Percentage Stage I (Early Cleavage Mackerel Eggs Capable of Further Development - that is not dead at the cell level or moribund by virtue of totally disorganized chromosome divisions or total cessation of chromosome divisions.

Total about 300 eggs studied. Minimum 5 at one station and maximum 63 at another station.

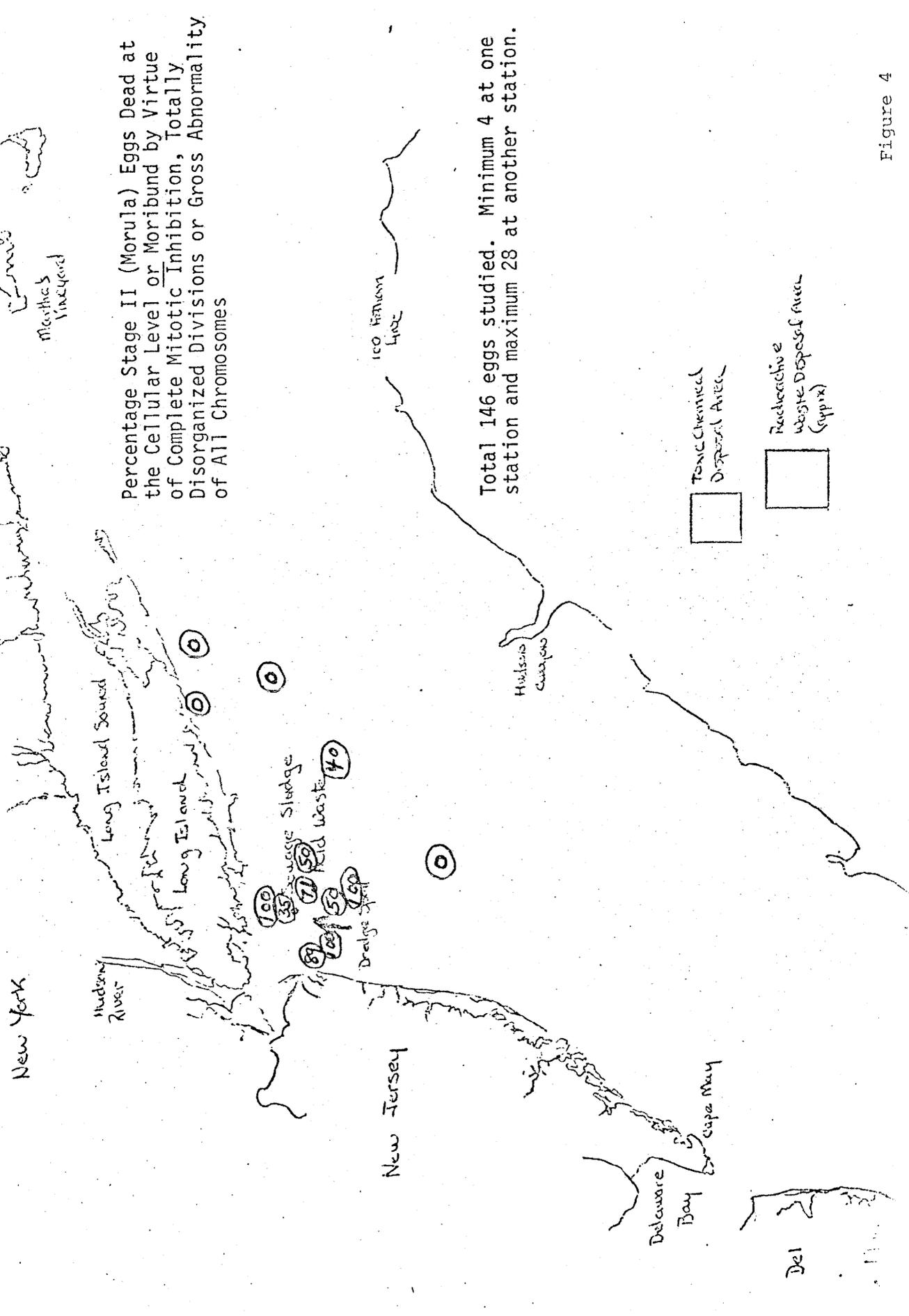
Toxic Chemical Disposal Area

Recreative Waste Disposal Area (Approx)

Figure 3

Connecticut abnormalities

Rhode Island  
Martha's Vineyard



Percentage Stage II (Morula) Eggs Dead at the Cellular Level or Moribund by Virtue of Complete Mitotic Inhibition, Totally Disorganized Divisions or Gross Abnormality of All Chromosomes

Total 146 eggs studied. Minimum 4 at one station and maximum 28 at another station.

Figure 4

abnormalities

Knee Island

Meath's Vineyard

New York

Hudson River

Long Island Sound

Long Island

Sludge

Waste

25

100

50

100

100

100

100

100

100

100

100

100

100

100

100 ft from shore

Hudson Channel

New Jersey

Delaware Bay

Cape May

Del

Percentage Stage IV (Blastula) Eggs Dead at the Cellular Level or Moribund by Virtue of Complete Mitotic Inhibition, Totally Disorganized Divisions or Gross Abnormality of All the Chromosomes.

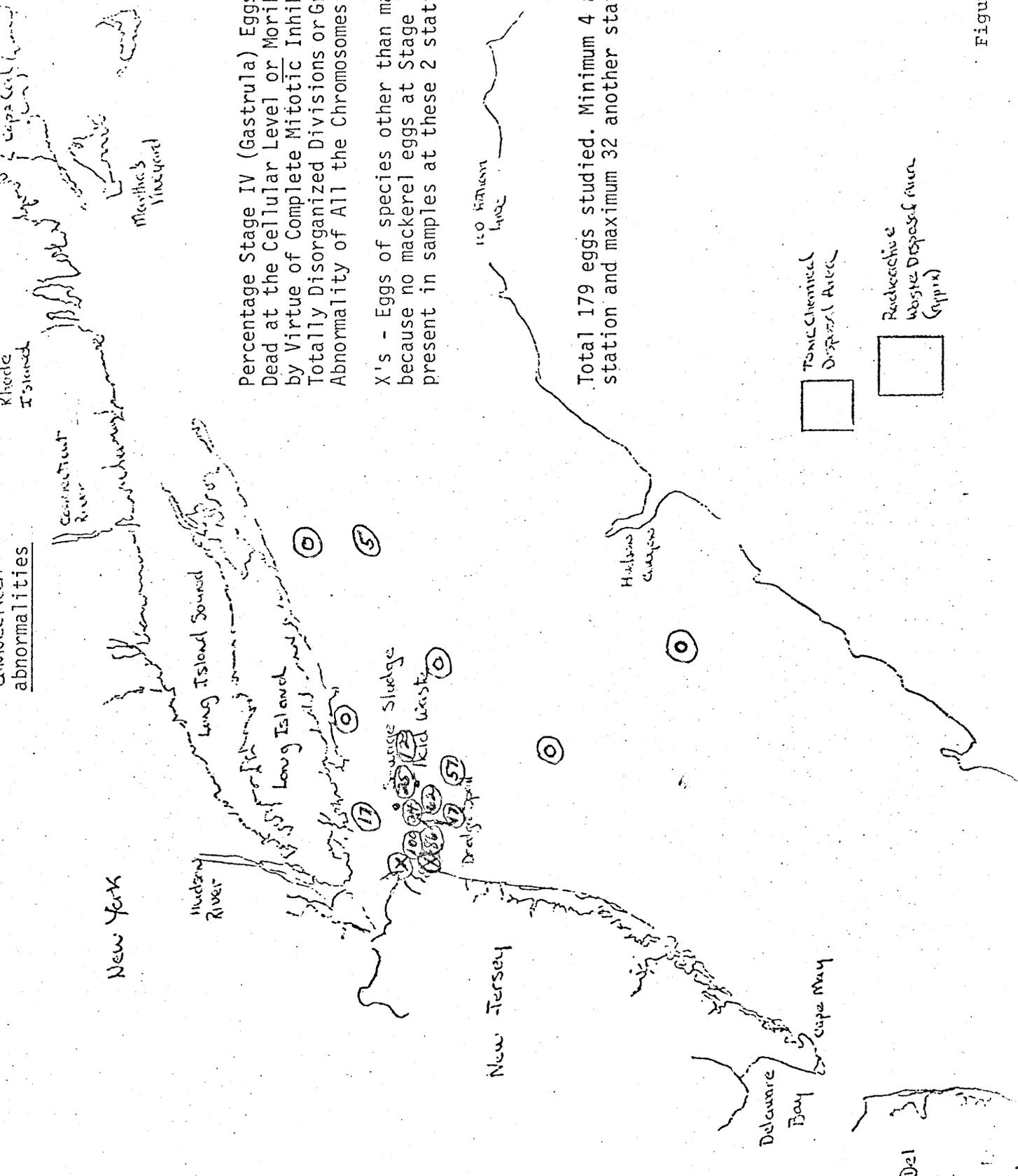
Total 175 eggs studied. Minimum 3 eggs one station and maximum 27 another station.

Toxic Chemical Disposal Area

Radioactive Waste Disposal Area (Supra)

Figure 5





abnormalities

Rhode Island

New York

New Jersey

Del

Percentage Stage IV (Gastrula) Eggs Dead at the Cellular Level or Moribund by Virtue of Complete Mitotic Inhibition, Totally Disorganized Divisions or Gross Abnormality of All the Chromosomes.

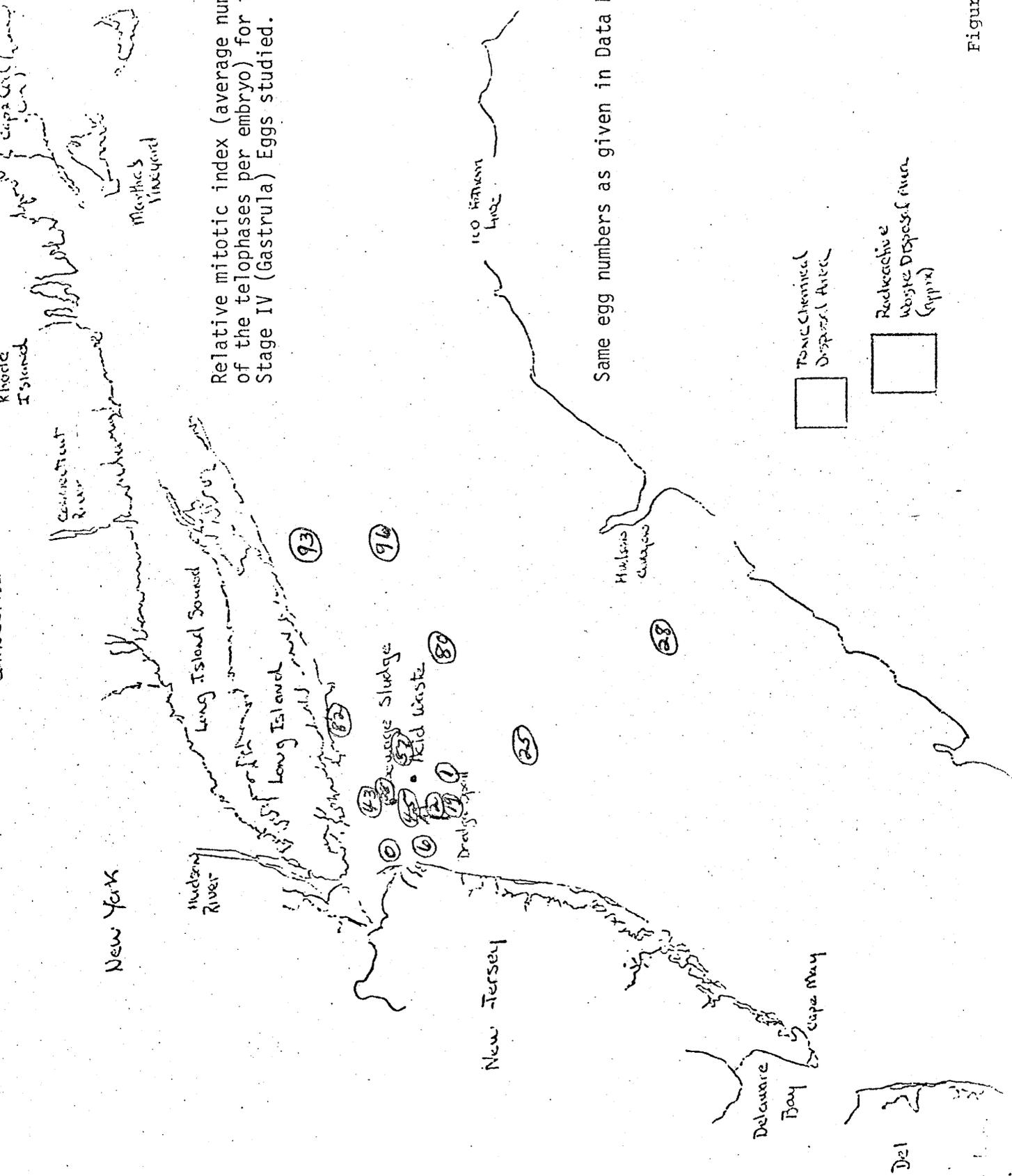
X's - Eggs of species other than mackerel because no mackerel eggs at Stage IV were present in samples at these 2 stations.

Total 179 eggs studied. Minimum 4 at one station and maximum 32 another station.

Toxic Chemical Disposal Areas

Radioactive Waste Disposal Areas (open)

Figure 7



Relative mitotic index (average number of the telophases per embryo) for the Stage IV (Gastrula) Eggs studied.

Same egg numbers as given in Data Map 5

Figure 8

Mortality including gross chromosome and nucleolar abnormalities

MASS.

Rhode Island

New York

Hudson River

Long Island Sound

Long Island

Orange Sludge

acid waste

Drudge Spill

New Jersey

Hudson Channel

100 Fathom Line

Martha's Vineyard

Delaware Bay

Cape May

Del

Percentage Stage VI (Tail-bud) Embryo Eggs Dead or moribund by Virtue of Abnormal Divisions, by Total Cessation of the Divisions or Grossly Abnormal Nuclei and/or Chromosomes.

Total 160 eggs studied. Minimum 4 and maximum 27 at different stations.

TOXIC CHEMICAL DISPOSAL AREA

Radioactive Waste Disposal Area (Gypna)

Figure 9







of mitotic activity in eggs collected about Island  
 Kibbie  
 dumpsites

Cape Cod  
 Vineyard

Martha's  
 Vineyard

Connecticut  
 River

Hudson  
 River

Long Island Sound

Long Island

Waste Sludge  
 • Kid Waste  
 Dredge

100 Foot  
 Line

Hudson  
 Channel

New York

New Jersey

Delaware  
 Bay

Cape May

Del

Percent all stage embryos with divisions  
 with less than 10 telophases (average 40  
 embryos per station).

X's indicate stations with too few viable  
 embryos to obtain even this crude estimate

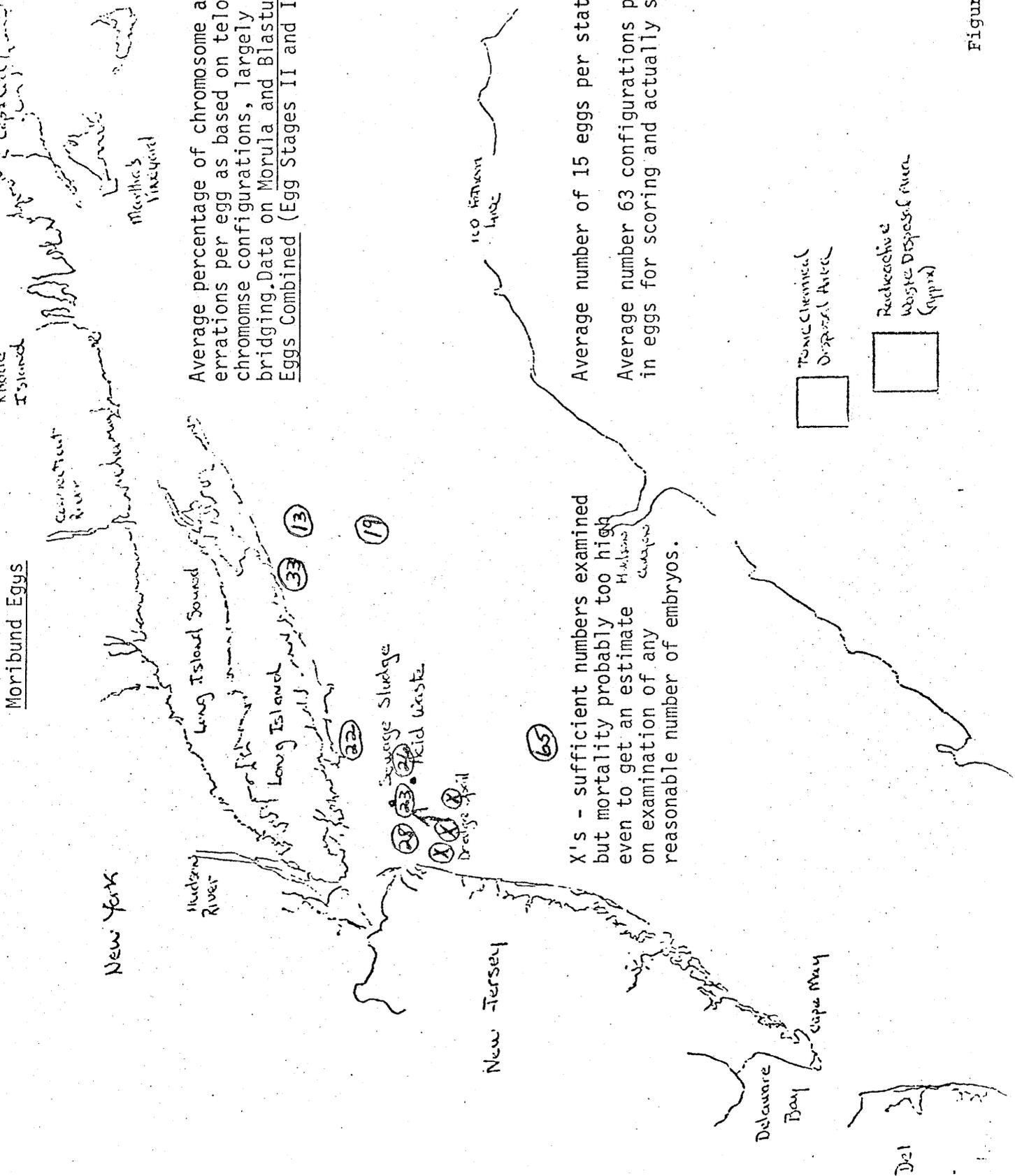
Above means that larger numbers of  
 embryos must be studied at poor than  
 at good stations

Toxic Chemical  
 Disposal Area

Radioactive  
 Waste Disposal Area  
 (approx)

Figure 13

Moribund Eggs



Average percentage of chromosome aberrations per egg as based on telophase chromosome configurations, largely bridging. Data on Morula and Blastula Eggs Combined (Egg Stages II and III)

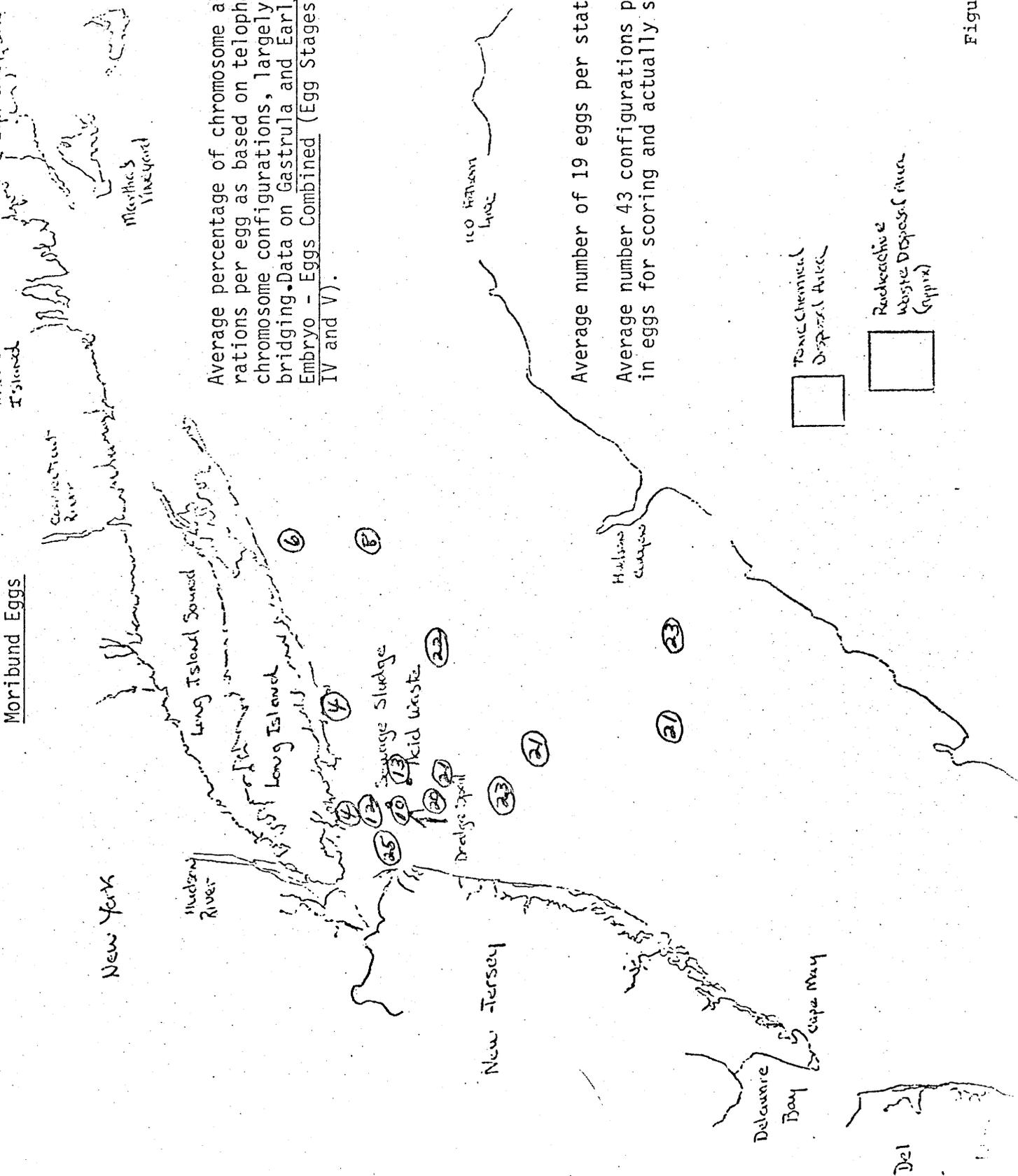
X's - sufficient numbers examined but mortality probably too high even to get an estimate <sup>Hudson</sup> <sup>Claspens</sup> on examination of any reasonable number of embryos.

Average number of 15 eggs per station  
Average number 63 configurations present in eggs for scoring and actually scored

Toxic Chemical Disposal Area  
 Radioactive Waste Disposal Area (Approx)

Figure 14

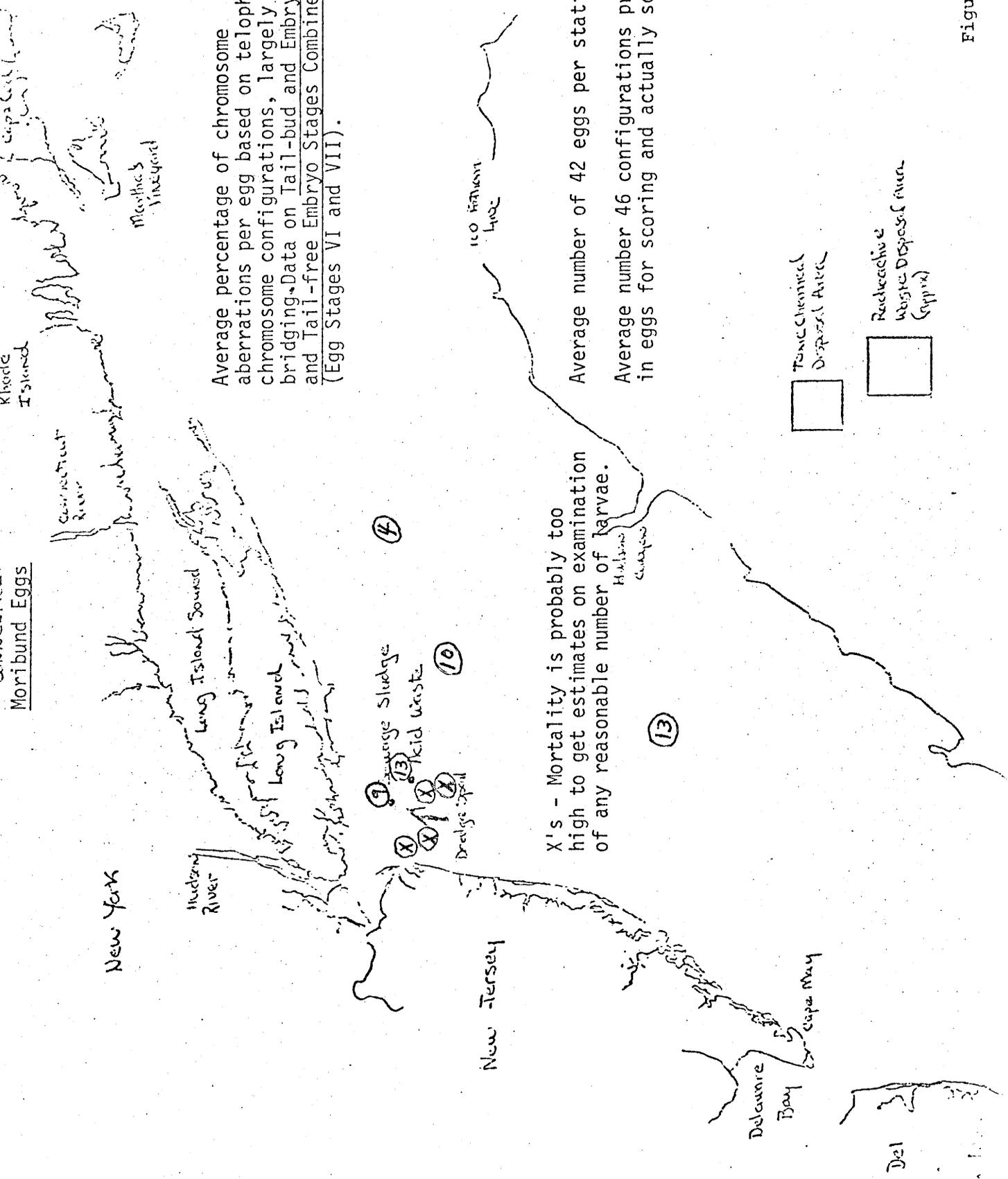
Moribund Eggs



Average percentage of chromosome aberrations per egg as based on telophase chromosome configurations, largely bridging data on Gastrula and Early Embryo - Eggs Combined (Egg Stages IV and V).

Average number of 19 eggs per station.  
Average number 43 configurations present in eggs for scoring and actually scored.

Figure 15



Average percentage of chromosome aberrations per egg based on telophase chromosome configurations, largely bridging. Data on Tail-bud and Embryo and Tail-free Embryo Stages Combined (Egg Stages VI and VII).

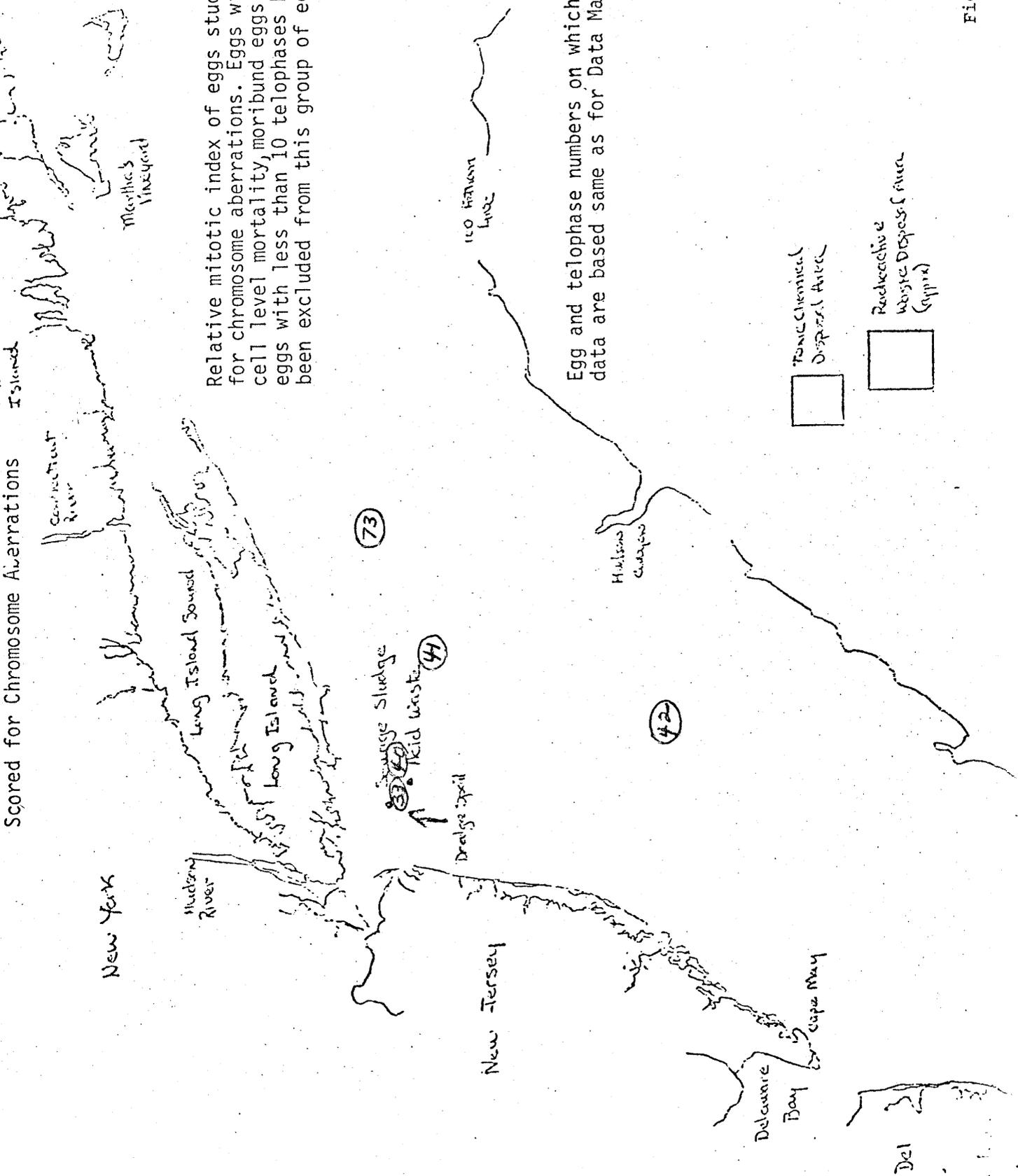
X's - Mortality is probably too high to get estimates on examination of any reasonable number of larvae.

Average number of 42 eggs per station  
 Average number 46 configurations present in eggs for scoring and actually scored.

Toxic Chemical Disposal Area  
 Radioactive Waste Disposal Area (Alpha)

Figure 16

Scored for Chromosome Aberrations



Relative mitotic index of eggs studied for chromosome aberrations. Eggs with cell level mortality, moribund eggs and eggs with less than 10 telophases have been excluded from this group of eggs.

Egg and telophase numbers on which data are based same as for Data Map 15.

Figure 17

FIGURE 18 --

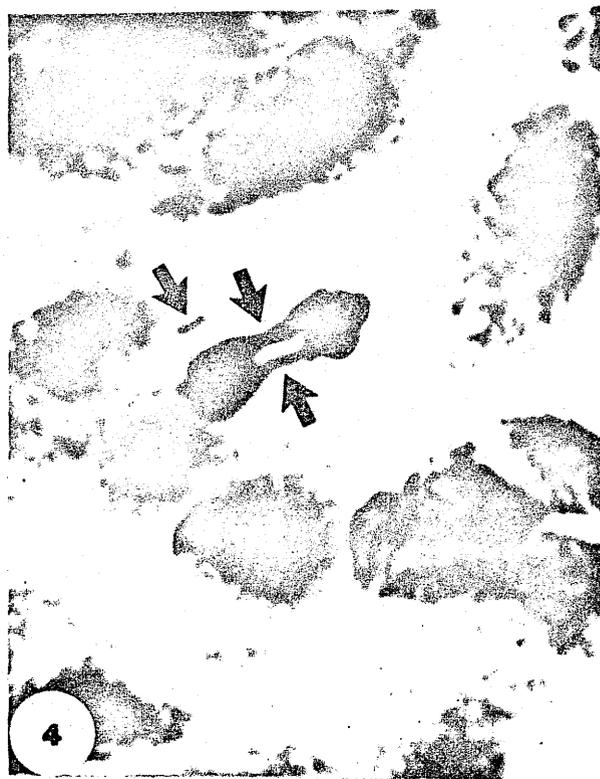
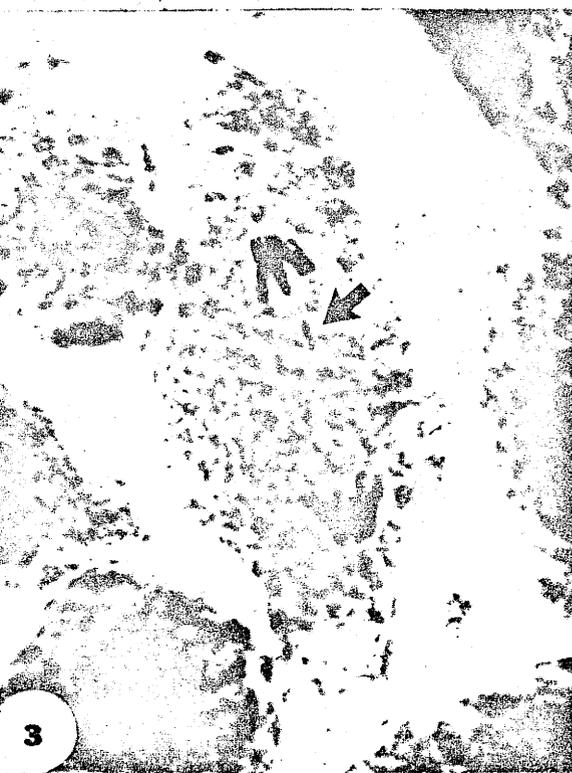
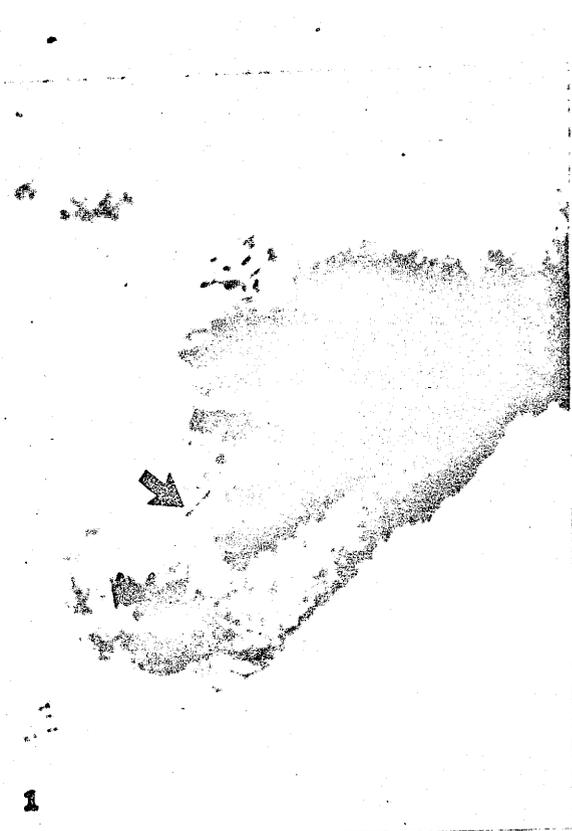
Specific chromosome aberrations are scored for in mitosing embryo cells by recording incidences of bridging and lagging chromosomes at the telophase stage of mitosis. Such bridging and lagging occur when, as a result of chromosome breakage and translocation, some chromosomes have two and others no centromere region.

Upper left (1) shows a chromosome bridge (at arrow) between the two daughter nuclei of a telophase cell.

Upper right (2) shows three chromosome bridges in the uppermost telophase cell (at arrow). Other telophases in this figure are normal and have no bridges.

Lower left (3) shows a laggard chromosome (at arrow) between the daughter telophase nuclei of this cell.

Lower right (4) shows a laggard chromosome to one side of one of the daughter telophase nuclei of this figure (left uppermost arrow). The other two arrows point to two sticky bridges.



## 2. FIN ROT AND INVERTEBRATE DISEASE

### A. Fin Rot Disease

#### 1. Entrapment studies with winter flounder in sewage sludge area. tu

During the reporting period, traps containing winter flounder were placed at the sludge site on February 11, March 31, and June 14. Traps were placed at the control site on February 11, April 6, and June 4. Water temperature was low (4.0-11.6°C) and dissolved oxygen was high (7.9-10.6 ppm). Condition coefficients ranged from 1.0-2.3 and were not statistically different between the sewage sludge and control site.

#### 2. Fin rot incidence in summer flounder from Sandy Hook Bay and Great Bay, New Jersey

All sampling for summer flounder with fin rot disease from Great Bay, New Jersey has been stopped. Sufficient numbers of fish have been obtained to establish a zero prevalence of the disease in Great Bay summer flounder. Cruises to Sandy Hook/Raritan Bay to determine the incidence of fin rot disease in summer flounder took place on March 15, 18, and 19, April 5, 7, 8, 15, May 5, 6, 12, 13, 14, 21, 28, and June 2, 4, 7, 8. The number of summer flounder caught has been small since this species is returning to Sandy Hook/Raritan Bay at the present time. Of 236 fish examined, 2 had fin rot disease (0.84%). As yet, no increased monthly incidence of the disease is detectable.

#### 3. Histologic studies of normal and fin rot flounder epidermis

Differences have been noted between fin epidermis of the summer flounder and that of the windowpane flounder. The histologic structure

of the fin epidermis in both fishes consists of mucus cells and filament cells. In contrast to winter flounder fin epidermis eosinophilic granule cells are seen infrequently in the fin epidermis of summer and windowpane flounder. The thickness of the epidermis of the windowpane flounder appears to be greater than that of the summer flounder. This difference in thickness is especially notable in sections prepared of distal fin tissue. In both fishes, however, the fin epidermis ranges from 5-10 cells in thickness. Filament cells at the basal lamina are columnar but appear to be oriented horizontally outermost. Mucus cells are more abundant in windowpane fin epidermis than in summer flounder epidermis. It also appears that there are more mucus cells on the non-pigmented side of the windowpane flounder than the pigmented side. It repeatedly has been noted that windowpane flounder are covered by abundant mucus (presumably elaborated by the mucus cells observed). The difference between the prevalence of fin rot disease in summer and windowpane flounder cannot be explained on the basis of fin epidermal histology alone.

#### 4. Fin rot disease progression in laboratory-held winter and summer flounder

Winter flounder with fin rot disease were collected on March 16, 29, April 8, 12, and June 1 and placed in large flow-through laboratory aquaria. These fish were observed and photographed until they died. At the present time, it is not possible to draw any meaningful conclusions from the fish observed.

#### 5. Contagion in laboratory-held winter and summer flounder

No progress this reporting period.

6. Fin rot disease in pelagic fish from pound and fyke net fishery in Sandy Hook/Raritan Bay

No progress due to lack of personnel; activity suspended.

7. Data reports 1973, 1974, 1975

During the reporting period over 50% of the time available was utilized in preparation of data reports. The reports were prepared for the years 1973-1975 and include all field data generated during the conduct of fin rot disease assessment cruises.

## B. Invertebrate Disease

### 1. Collections

Rock crabs and lobsters were collected by otter trawl for histopathological study and direct observations on gill color. A large collection of rock crabs was made on the May 1976 surf clam cruise in which 266 animals were taken from stations ranging from Montauk Point to Cape Fear, North Carolina. One hundred and thirty eight rock crabs and 45 lobsters were taken from Sandy Hook Bay and an additional 113 rock crabs were taken from the vicinity of Ambrose Light in the New York Bight. Direct observations on crabs collected from Sandy Hook Bay and the Bight during the winter molting period (February and March) showed that 80-90% of the specimens had clean gills. Progressive blackening will be followed during collection trips in July and August. Crabs collected during the surf clam cruise showed that 50% had clean gills.

### 2. Epibionts and Parasites

Continuing study on the occurrence of phagocytic nodules in tissues of the lobster showed that they are present in 70-100% of the

specimens collected from Sandy Hook Bay. The nodules probably are formed as a defense reaction against amoebae and bacteria. The influence of infecting organisms on mortality in lobsters is not known at the present time. Summary data on rock crabs showed that about 20% of them have heavy bacterial infections on gill epicuticle and 15% have diatom infestations. A collection of crabs from Montauk Point, Long Island, showed that although 25/29 had clean gills, 86% had heavy bacterial infections on gills, 73% had peritrich ciliates, and 20% had diatoms; 50% had copepods between gill lamellae. Preliminary data indicate that while fouling species may be similar in clean and impacted areas, dumping spoils may cause the "black gill" condition and severely stress affected crustaceans.

### 3. BENTHIC MACROFAUNA

#### Sorting and Identifying

Sorting and identifying remained essentially on schedule with completion of 70 samples: 3 from the first monitoring cruise of 11-12 November 1975, 22 replicates from the first quarterly cruise of 2-6 August 1973, and 45 replicates from the fourth quarterly cruise of 22 March - 1 April 1974. The 22 samples from the first quarterly cruise completed the planned series of at least four replicates from 45 stations in the apex on which the cluster analysis described below was performed. The 45 replicates from the fourth quarterly cruise give us 2 replicate samples at 45 stations. Thus, for 45 stations in the apex we now have 2 replicate samples representing cold-water conditions, with which we can compare the 4 replicate samples from the first quarterly cruise, which represent warm-water conditions.

#### Cluster Analysis

We have obtained the very comprehensive program for cluster analysis assembled under Dr. Don Boesch of the Virginia Institute of Marine Science (VIMS). The program in its newly revised form can be used on IBM as well as on Burroughs computers. The program, as originally received by us, was incompatible with our IBM computer. We elected not to adapt it to IBM use when we learned that the adaptation was being done at VIMS. So far we have run some test data, found that corrections to our card deck were needed, made the corrections, and now we are ready to run our quarterly cruise data.

Meanwhile, Dr. McNulty clustered the four-grab-per-station data by hand for 27 stations using the Jaccard similarity coefficient and group-average clustering (Figures 1 and 2). Results show marked similarity of fauna in the Christiaensen Basin, in the rim of the basin to the north of it, and in the Hudson Shelf Valley to the south of the basin. Assemblages at sludge and dredge dump sites were distinctly different from the basin-rim-valley assemblage, and unlike the assemblages in sandy areas outside of the basin, rim, and valley.

#### Monitoring

We think that the benthic macroinvertebrates will provide the basis for an excellent assessment of biological changes with time at and near the dump sites. Consequently, we need to understand the nature of the random errors involved, and to calculate the probability of being able to replicate samples taken in the past. Figure 3 is an example. It shows that four grabs were required to reach a 0.975 probability of sampling a selected group of species. Presence or absence of selected species was the criterion of success. The species are those found in at least 50% of the 20 grabs taken in June 1973 at RECON Station 8. We chose this level of abundance because Thorson used it in his classic review of bottom communities (Thorson 1957, p. 477), because Thorson's "characterizing species of the first order" (those in at least 50% of the standard unit samples) are reasonably synonymous with the so-called "faithful" species of the Braun-Blanquet school of benthic ecology (W. Stephenson, 1973: The validity of the community concept in marine biology. Proc. Royal Soc. Queensland, Vol. 84, No. 7), and because the

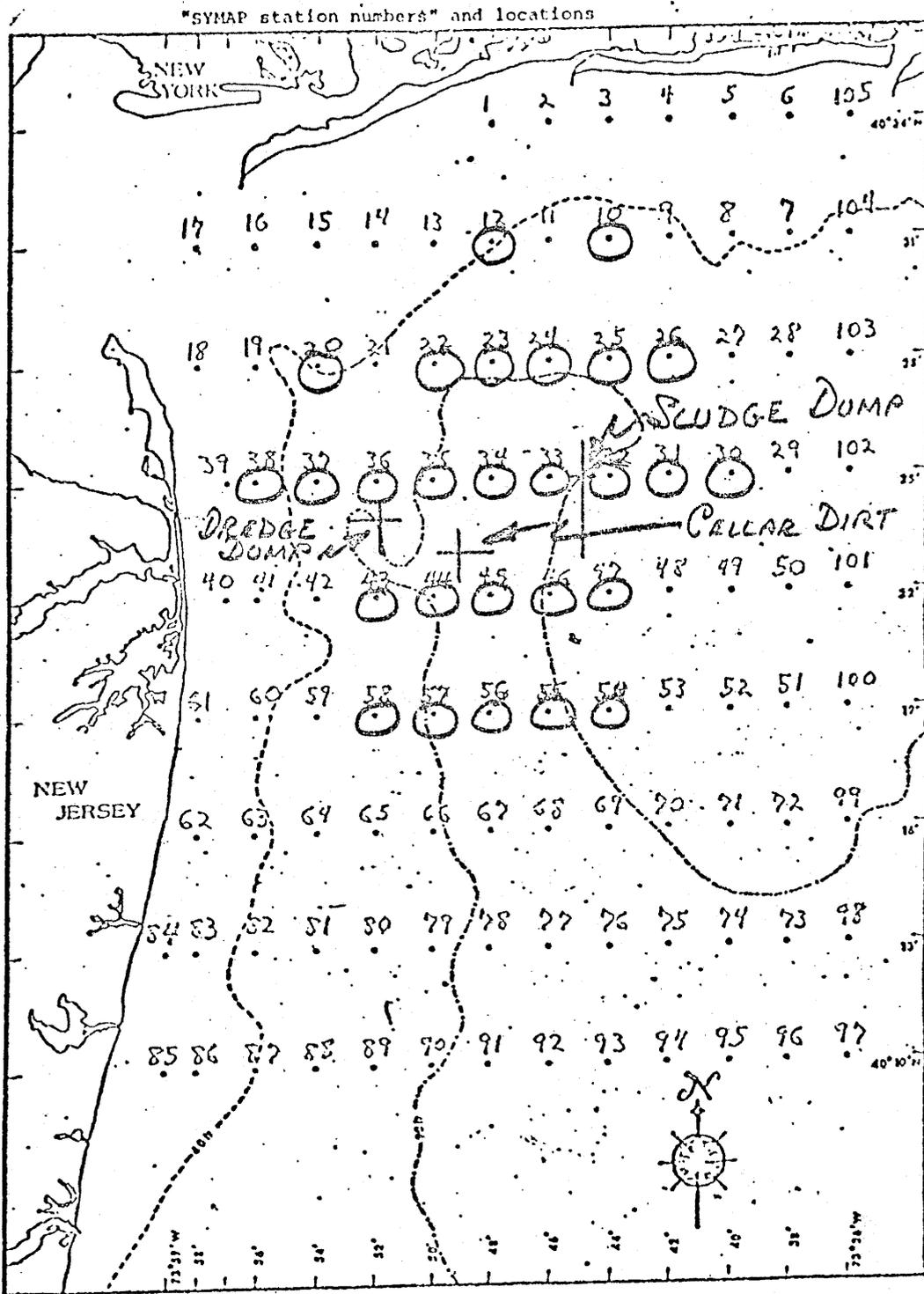


Figure 19-- SYMAP stations used in the cluster analysis.

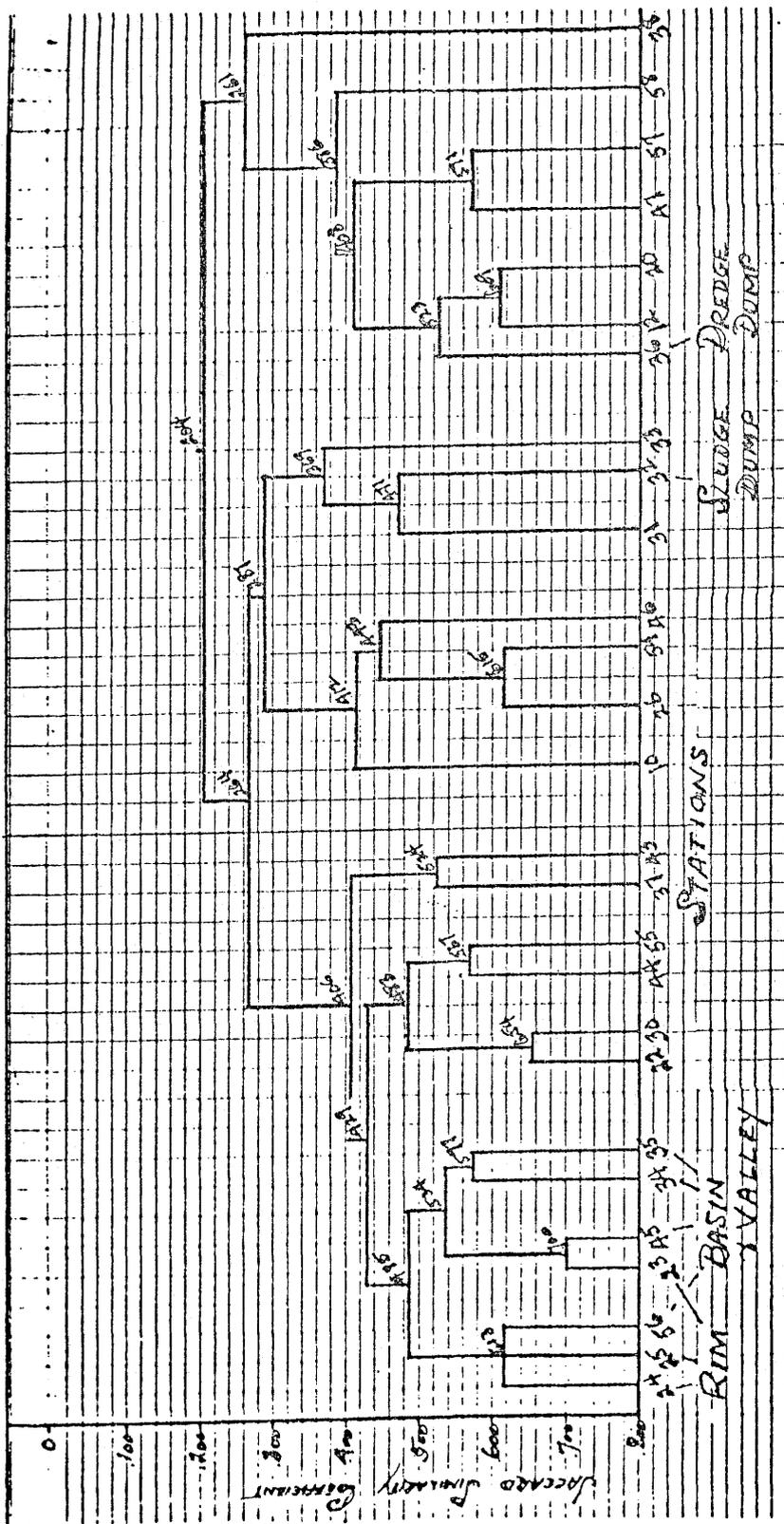


Figure 20 --- Clustering of stations based on the Jaccard similarity coefficient and group average clustering.

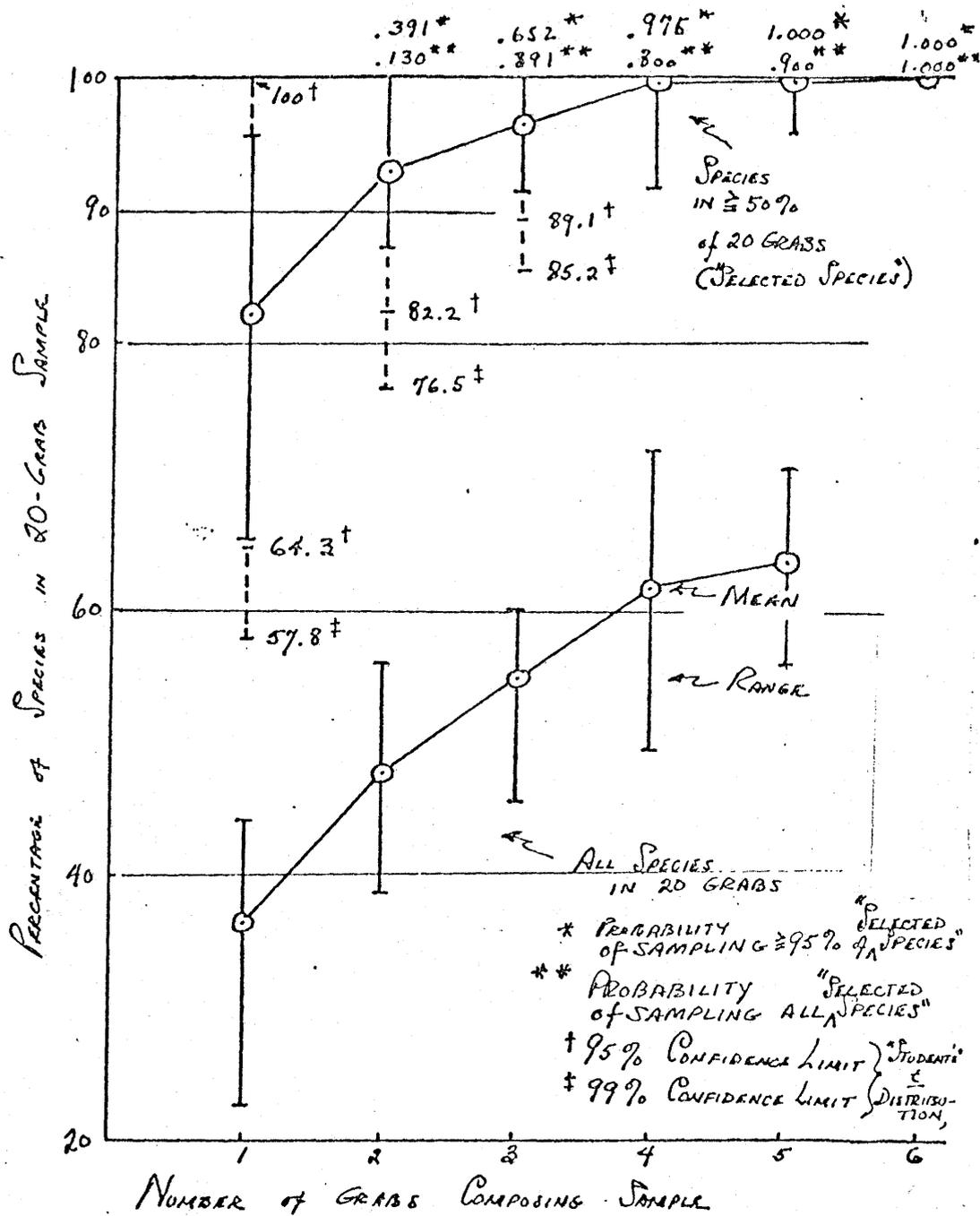


Figure 21 -- The percentages of species at RECON Station 8 contained in samples derived from one, two, three, four, and five grabs. Data are from 20 individual grab samples taken 5 June 1973 at Lat.  $40^{\circ}24.9'N$ , Long.  $73^{\circ}48.0'W$ , which is in the head of the Hudson Shelf Valley near SYMAP Station 45.

50% level of species occurrences make sense in terms of our data. We have repeated this analysis at five of six other RECON stations where 19 or 20 grab samples were taken and we find that the number of grabs required to sample all or nearly all of the species occurring in at least 50% of the grab samples varies in very similar fashion, from about 3 to about 5. Variability was lowest in the middle of the Christiaensen Basin where contaminants may have caused selection of a few tolerant species and elimination of many others.

It should be emphasized that in these analyses we started with a list of species that we thought were important ecologically, and that we used the list as a standard against which to measure the success of sampling at various levels of intensity. It is possible to turn the problem around and start with an acceptable probability of occurrence of individual species. A list is then compiled of the species that are present at and above the accepted probability level. Using this approach, one finds that usually less than ten species are found virtually all of the time in one-grab samples. Species that are consistently present in one-grab samples are the most widespread and usually the most abundant of the species in a study area. As the number of grabs increases, the number of species that are consistently present also increases. These newly-added, consistently-present species are by and large more sensitive qualitatively to environmental change than were those in the single-grab samples. Thus, the problem becomes one of replicating sufficiently to include consistently the more environmentally-sensitive species while at the same time keeping the number of grabs within practical limits.

Completion of this analysis and publication of the results has the highest priority at present.

#### 4. PHYTOPLANKTON AND PRIMARY PRODUCTIVITY

During this trimester, oral presentations were made at the Hudson River Environmental Society Symposium (Primary productivity - dissolved organic matter productivity in the Lower Hudson estuary by O'Reilly, Thomas and Evans) at Bear Mountain, New York; at the New England Estuarine Research Society Meetings (Dissolved organic matter productivity in Raritan - Lower Hudson estuary by O'Reilly, Thomas and Evans) at Milford, Connecticut; and at the Limnology and Oceanography Meetings (Dissolved organic matter productivity in Raritan - Lower Hudson estuary by Thomas, O'Reilly and Evans and presented by O'Reilly) at Savannah, Georgia.

A manuscript (Annual primary productivity and dissolved organic matter production by phytoplankton in the Lower Hudson estuary by O'Reilly, Thomas and Evans) of the presentation at the Hudson River Environmental Society Symposium will shortly be submitted for inclusion in the Proceedings of the symposium.

A Red Tide Briefing Book (Mahoney, Thomas and Blogoslawski) was produced with a chapter by Thomas, O'Reilly and Evans containing much of our Lower New York Bay data including figures. This publication is to be expanded into a formal article for publication.

Christine Evans presented her M.S. research, Effect of Elevated Temperatures on Algal Communities in Oyster Creek, Barnegat Bay, at the New Jersey Academy of Science Meetings in Trenton and at the New England Estuarine Research Society Meetings in Milford, Connecticut.

Data tape concerning primary productivity studies in Raritan-Lower Hudson estuary will be sent to the MESA office by 30 June 1976.

In preparation and expected to be submitted this summer is a data report with figures, "Primary productivity and related environmental characteristics of Raritan-Lower Hudson estuary" with data listings concerning vertical extinction of light, Secchi, temperature, salinity, dissolved oxygen, percent dissolved oxygen saturation, nitrite plus nitrate, nitrite, silicate, phosphate, ammonia, particulate organic carbon, particulate organic nitrogen, chlorophyll a, chlorophyll b, chlorophyll c, carotenoids, phaeopigments, netplankton productivity, nanoplankton productivity, total particulate plus dissolved productivity, dissolved productivity, percent photoassimilate carbon released as dissolved organic matter, and nanno-/netphytoplankton ratios in Lower New York Bay.

## 5. SEABED OXYGEN CONSUMPTION

Oral presentations were given at the Hudson River Environmental Society Symposium (Seabed oxygen consumption in the Lower Hudson estuary by Thomas, Phoel, O'Reilly and Evans) at Bear Mountain, New York, at CCNY (Seabed oxygen consumption in the New York Bight presented by Thomas), at Colloquium in New York City, and at the New England Estuarine Research Society Meetings (Seabed oxygen consumption - Lower Hudson estuary to outer New York Bight by Thomas, Phoel, O'Reilly and Evans).

A paper (Seabed oxygen consumption - Lower Hudson estuary and New York Bight by Thomas, Phoel, O'Reilly and Evans) is being prepared for inclusion in the Proceedings of the Hudson River Environmental Society Symposium.

Abstracts have also been submitted to the Helgoland International Symposium on Ecology and to the 11th European Symposium on Marine Biology.

A paper (Seabed oxygen consumption in the New York Bight by Thomas, Phoel, Steimle, O'Reilly and Evans) presented at the Middle Atlantic Continental Shelf and New York Bight Symposium in New York City in November is nearing the galley proof stage and is to be released this fall as part of a Special Symposium Volume of Limnology and Oceanography.

MESA Data Report-6 (New York Bight apex data on total oxygen consumption by the seabed, March 1974 - February 1975) by Thomas, Phoel and Steimle, has been released and is now available on microfiche. The computer programs were inadvertently omitted from this report. It is hoped that they might be included in an update report being prepared to include data

from the Lower Hudson estuary and outer New York Bight.

A data tape (Seabed oxygen consumption in the New York Bight) will be submitted to the MESA office prior to 30 June 1976.

In addition, a data report with 40 figures (Hydrographic data of the New York Bight apex - temperature, salinity, sigma-t, dissolved oxygen and percent saturation - August 1973 - August 1975) is being prepared.

A joint paper with Exxon Research and Engineering Company, Linden, New Jersey (Extractable organics and nonvolatile hydrocarbons in New York Harbor waters) by T. D. Searl, H. Huffman, and J. P. Thomas, has been submitted as an abstract to the Oil Spill and Prevention Symposium to be held in New Orleans May 1977. The paper is past the first draft stage with Thomas writing the introduction, Huffman the methods and mass spectrophotometer results, and Searl writing most of the results and discussion.

A succeeding paper is to be prepared at a later date dealing with the dissolved and particulate fractions of hydrocarbons in New York Harbor waters sampled at the same time.

Recently, Exxon Production Research of Houston, Texas, has provided us with data on heavy hydrocarbons from the sediments of Lower New York Bay, New York Bight apex dredge spoil and sludge areas, North and South proposed alternate dump sites offshore, and from the Deep Water Disposal Site #106. Additional samples from the Lower Hudson River and Hudson Shelf Valley are presently being analyzed. These data will hopefully be published when these analyses are completed.

Additional samples for nonvolatile hydrocarbons in water are to be collected in June 1976 from the Savannah River estuary and from uncontaminated yet highly productive salt-marsh-estuarine water from the coast of Georgia for comparison with samples from the New York Harbor.

A manuscript (Lead and copper in the waters of Raritan and Lower New York Bays by Waldhauer, Matte and Tucker) has been produced and is ready for review. The manuscript has been produced from data painstakingly developed from water samples collected in Lower New York Bay and tediously analyzed on inadequate equipment. We have a standing request with the MESA office for financial assistance (\$6,000) for a Model 2014 Multiple Anodic Stripping Analyzer which would provide a considerable increase in capabilities and productivity. We are presently severely limited by the number of heavy metal samples we can collect and analyze during our upcoming MESA cruise in August 1976. On this cruise we are interesting in sampling the waters of the Lower Hudson (Tappan Zee), Kills, Lower Bay, to outer New York Bight and to fractionate samples to determine heavy metal relationships to different size classes. Such is not possible at present because of the limited number of samples we can process per unit time with existing equipment. Our objective would be to produce a paper based on the data collected on the August cruise.

In joint effort with Environmental Chemistry Investigation (MACFC/Milford) we produced computer SYMAP's and photographic reproduction of data on heavy metals concentrations in the surficial sediments of the New York Bight apex. A manuscript is in preparation by Greig and Thomas, but will be delayed until additional samples from the apex (December 1974, and February and August 1975) are analyzed to provide seasonal data from

August 1973 to August 1975).

MESA data formats for seabed oxygen consumption and photosynthetically available radiation were also developed.

Environmental Microbiology submitted a paper (Distribution of fecal coliforms in the bottom sediments from the New York Bight by J. Babinchak, J. T. Graikoski, S. Dudley, and M. F. Nitkowski) to Applied and Environmental Microbiology.

Dr. Mahoney with Dr. John J. A. McLaughlin submitted a paper to Biological Bulletin entitled "Consideration of phytoplankton blooms in New York Harbor and adjacent waters as an effect of eutrophication".

#### IV. MESA DATA REPORT

##### Accomplishments

Table 1 shows the current state of processing of each data set resulting from each MESA cruise. It also cites each published data report and each article that has been published in the scientific literature so that the user of the table can trace collection of raw data to published data report and article, and vice versa. Data tapes archived at EDS are also cited. An "x" in a column indicates that data in that category have been collected or that the indicated activity has been completed. A blank in a column indicates either that the activity is incomplete or that an entry is inapplicable.

We continue to improve our ADP capabilities by augmenting both staff and equipment. Mr. Edward O'Brien, a programmer who is well qualified in COBOL as well as in other languages, joined our staff recently, and an interpreter was added to equipment in our remote terminal. The terminal, known as the COPE 1200 Batch-Mode Terminal, was described in some detail in our Trimester Report of November 1975.

This trimester, we have emphasized production of the data tapes which we agreed to send to NODC. They are listed below.

1. Surficial sediments
2. Benthic macrofauna
3. Metals in sediments
4. Demersal finfish
5. Seabed oxygen consumption
6. Primary productivity of Raritan Bay
7. Hydrography of the apex
8. Chemical-physical oceanography of Raritan Bay
9. Fin rot
10. Dissolved oxygen in the apex







TABLE 1 (continued)

Vessel/Date	Purpose and Location	# Stations	# Grabs/ Station	Total # Grabs	ROSCOP Form	Investigator or Discipline	# Samples, Subsamples or Cores	# Sorted	# Identified	# Analyzed (Chem. or Sedim.)	First Contract Report Received	Log Sheets Prepared for Keypunching	# Keypunched	Machine Listed	Edited	Data Report Published	SYMAP	Taped	Tape Edited	Archived at EDS <sup>1/</sup>	Tape to CEDDA <sup>2/</sup>	Article Published in Scientific Literature <sup>3/</sup>					
Kelez 28 May - 2 June 75	Long Island Near Shore (LINS)	59	5	295		Pearce	295			Storage																	
						Heavy metals	295			Storage																	
						Grain size	295			Storage																	
						Hydrography <sup>14/</sup>				x																	
Delaware II 12-24 Aug. 75	Seabed O <sub>2</sub> Consumption Apex	69			x	Thomas	276			276		x	276	x	x												
						Hydrography <sup>14/</sup>				x	x	x												x			
	Alt. Dump Sites	North	6				Thomas	24			24		x	24	x												
		South	6				Thomas	24			24		x	24	x												
							Hydrography <sup>14/</sup>				x		x														
	Lower Hudson Estuary	78					Thomas	312			312		x	312	x												
							Hydrography <sup>14/</sup>				x	x	x														
Hudson Shelf Valley & vicinity	11					Thomas	44			44		x	44	x													
						Hydrography <sup>14/</sup>				x	x	x															
All of the above						Parks (organic)	94			94 <sup>13/</sup>		x															
Rorqual 11-12 Nov. 75	1st Monitoring Apex	13	2	26		Pearce	26	26	26																		
						Heavy metals	26			Storage																	
						Grain size	26			Storage																	
Various Vessels 1973-75	Fin Rot Apex and Bays					Murchelano						x	x	x	x												

TABLE 1 (continued)

Vessel/Date	Purpose and Location	# Stations	# Grabs/Station	Total # Grabs	ROSCOP Form	Investigator or Discipline	# Samples, Subsamples or Cores	# Sorted	# Identified	# Analyzed (Chem. or Sedim.)	First Contract Report Received	Log Sheets Prepared for Key punching	# Key punched	Machine Listed	Edited	Data Report Published	SYMAP	Taped	Tape Edited	Archived at EDS <sup>1/</sup>	Tape to CEDDA <sup>2/</sup>	Article Published in Scientific Literature <sup>3/</sup>	
Various Vessels 1973-75	Demersal Finfish Apex					Merrill						x	x	x	x	x		x	x	x			
Delaware II 17-19 Feb. 76 (Timoney Cruise)	2nd Monitoring Apex	4	2	8		Pearce	8																
						Heavy metals	8			Storage													
						Grain size	8			Storage													
Rorqual 11-12 Mar. 76	3rd Monitoring Apex	12	2	24		Pearce	24			Storage													
						Heavy metals	24			Storage													
						Grain size	24			Storage													
						Burnett																	

<sup>1/</sup> Data tapes archived at EDS: Surficial sediments -- apex seasonal; metals in sediments -- apex seasonal; demersal finfish -- apex seasonal; primary productivity -- Raritan Bay seasonal; chemical-physical oceanography -- Raritan Bay seasonal (incorporated in primary productivity tape above); fin rot -- apex and New Jersey bays seasonal.

<sup>2/</sup> Tape and listing to CEDDA and to Dr. Salla.

<sup>3/</sup> Abstracts excluded.

<sup>4/</sup> Data reports published in microfiche:

Pearce, J. B., J. Caracciolo, A. Frame, L. Rogers, and J. Thomas.  
1976. Distribution and abundance of benthic organisms in the New York Bight, August 1968-December 1971. 114 p.  
Jan. 1976. NOAA DR ERL MESA-7.

Pearce, J. B., L. Rogers, J. Thomas, J. Caracciolo, M. Halsey, and K. McNulty.  
1976. Distribution and abundance of benthic organisms in the outer New York Bight and proposed alternate disposal sites, June 1974 and February 1975. 68 p. Apr. 1976. NOAA DR ERL MESA-10.

Pearce, J., J. Thomas, J. Caracciolo, M. Halsey, and L. Rogers.  
1976. Distribution and abundance of benthic organisms in the New York Bight apex, 2-6 August 1973. 131 p. Apr. 1976.  
NOAA DR ERL MESA-8.

4/ Data reports published in microfiche (continued)

Pearce, J., J. Thomas, J. Caracciolo, M. Halsey, and L. Rogers.  
1976. Distribution and abundance of benthic organisms in the New York Bight apex, 26 August-6 September 1974. 88 p. Apr. 1976.  
NOAA DR ERL MESA-9.

Thomas, J. P., W. Phoel, and F. Steimle.  
1976. New York Bight apex data on total oxygen consumption by the seabed, March 1974-February 1975. 92 p. Jan. 1976. NOAA DR  
ERL MESA-6.

5/ Pearce, J. B.  
1971. Indicators of solid waste pollution. *Marine Pollution Bulletin* 2(1): 11.

6/ Pearce, J. B.  
1972. The effects of solid waste disposal on benthic communities in the New York Bight. pp. 404-411. In Ruivo, M. (ed.),  
*Marine Pollution and Sea Life*. Fishing News (Books) Ltd., London.

7/ Koditschek, L. K., and P. Guyre.  
1974. Antimicrobial-resistant coliforms in New York Bight. *Marine Pollution Bulletin* 5(5): 71-74.

8/ Young, J. S., and J. B. Pearce.  
1975. Shell disease in crabs and lobsters from New York Bight. *Marine Pollution Bulletin* 6(7): 101-105.

9/ Gopalan, U. K., and J. S. Young.  
1975. Incidence of shell disease in shrimp in the New York Bight. *Marine Pollution Bulletin* 6(10): 149-153.

10/ Saila, S. B., R. A. Pikanowski, and D. S. Vaughan.  
1976. Optimum allocation strategies for sampling benthos in the New York Bight. *Estuarine and Coastal Marine Science* 4(2): 119-128.

11/ Carmody, D. J., J. B. Pearce, and W. E. Yasso.  
1973. Trace metals in sediments of New York Bight. *Marine Pollution Bulletin* 4(9): 132-135.

12/ Tape to Dr. Saila.

13/ Analyses not funded by MESA.

14/ Temperature, salinity, dissolved oxygen, percent saturation of oxygen and sigma-t of bottom water.

15/ Cards and listing to CEDDA and to Dr. Salla.

16/ Some subsamples delivered 11 November 1975 to Dr. Parks at Lehigh University for organic carbon analysis using the LECO analyzer.

17/ Pearce, J. B.

1975. Benthic assemblages in the deeper continental shelf waters of the Middle Atlantic Bight. pp. 297-318. In Proceedings of Estuarine Research Federation, Outer Continental Shelf Conference and Workshop on Marine Environmental Implications of Offshore Oil and Gas Development in the Baltimore Canyon Region of the Mid-Atlantic Coast, Center of Adult Education, University of Maryland, College Park, Md., Dec. 2-4, 1974.

18/ Dr. Foerenbach plans to determine chlorinated hydrocarbon residues such as PCB's and DDT, and possibly other contaminants (information from Dennis Sullivan, 12 October 1975).

19/ Exxon's results in MACFC Informal Report 72-A of 21 July 1975; Dr. Duedall's results in Jour. Water Poll. Control Fed. 47(11): 2702-2706.

20/ Ziskowski, J., and R. Murchelano.

1975. Fin erosion in winter flounder. Marine Pollution Bulletin 6(2): 26-29.

21/ Murchelano, R. A.

1975. The histopathology of fin rot disease in winter flounder from the New York Bight. J. Wildl. Dis. 11(2): 263-268.

Tapes 1 and 2 were mailed to NODC on 8 June 1976. Tapes 3, 4, 6, 8, and 9 were nearing completion at the end of the reporting period, and because this report will go out during the week of 19 July, we can record that these tapes were mailed on or before 16 July. Tape 8 was incorporated in Tape 6. Tapes 5, 7, and 10 were nearing completion when this report was mailed.

The time devoted to ADP work is estimated as follows:

<u>Coding, transcribing data, proofing</u>	
	<u>Person/Weeks</u>
Benthic macrofauna project.....	3
Fin rot project.....	20
Mutagenesis.....	2
<u>Programming and proofing tapes</u>	
1. Surficial sediments.....	1
2. Benthic macrofauna.....	1
3. Metals in sediments.....	2
4. Demersal finfish.....	6
5. Seabed oxygen consumption.....	14
6. Primary productivity of Raritan Bay.....	12
7. Hydrography of apex.....	4
8. Chemical-physical oceanography of Raritan Bay.....	4
9. Fin rot.....	
10. Dissolved oxygen in apex.....	6

In the mutagenesis study, the scoring system by which larvae are classified was greatly improved, and a data form based on the system was nearly completed. New observations will be entered on the form as soon as they are made when the form becomes available, and, of course, earlier observations will be recorded on the form and eventually archived.

Fin rot data tapes encompassing all field data of 1973-1975 were prepared. Over 50% of project time was devoted to these activities.

## V. APPENDIX

### Sampling Validity

Sample means and variances have been calculated for 24 species of invertebrates from the New York Bight data. Table 2 lists the species which were considered and their arbitrary serial numbers. Also included in this table are the sample means and variances. These data were then utilized to attempt to calculate a common k parameter for the negative binomial distribution by the method of Bliss. It was found that the regression of sample means ( $\bar{x}$ ) against the reciprocal of all k parameters ( $\frac{1}{k}$ ) has a slope which did not deviate significantly from zero, suggesting that use of a common k was warranted. The value for the common k was found to be 7.01362. This value will be used for developing a simple sequential sampling chart for the above-mentioned species.

Another aspect of the sampling problem has involved an examination of what elements of conventional sampling theory are involved with ascertaining spatial or temporal patterns of contaminants such as trace elements or temporal patterns of organisms. As is well known usual sample methodology is concerned with estimating means or totals.

A brief examination of the sample coefficients of variation of the trace metal data and published literature indicates that they are relatively stable. There appears to be somewhat more skewness in the sample distributions than was indicated initially. In any event, it is reasonable to postulate some allocation schemes for locating contaminants, and these will be considered in the near future.

### Multivariate Analysis

The aim of our analysis is to describe temporal and spatial variations of the parameters sampled on the 64 station grids in the New York Bight. Initially, correlation matrices were computed for all sampled variables and two additional derived diversity indices (Shannon and Gleason) for the data from the first cruise. Levels of heavy metals were highly correlated, with some lower order correlations among other variables which serve to guide our attempts at further analysis.

Next, Trend Analysis, developed for the examination of spatial variation of geological variates was brought to bear on the data. Trend Analysis fits polynomial surfaces to a set of three variates -- usually two spatial and one response-variable. We input several response variables to this analysis for the 64 station grid, with the number of species per sample at each station showing the most clearly defined polynomial response. However, the "goodness of fit" criterion was not above 40% for any of the observed or derived variables. Pielou (Ecological Diversity, 1975) indicates that the use of a single station computed diversity estimator is not a statistically sound procedure for the type of populations we are sampling. Some further work is being done in trying to define an average diversity for differing sediment strata.

Present emphasis is on extension of the trend surface analysis. Canonical correlation is being used to define a two set (dependent-independent) model for the data in which what is essentially a vector of response variables will be fit to polynomial surfaces. It is hoped that the inclusion of the interactions of this combined response variable

TABLE 2. Arithmetic means and variances for 138 replications for each of twenty-four invertebrate species from the New York Bight

Species	Mean	Variance	n = REPS
<u>Arctica islandica</u>	0.00725	0.00725	138
<u>Cancer irroratus</u>	0.09420	0.14435	138
<u>Capitella capitata</u>	0.75362	7.03374	138
<u>Cerianthus americanus</u>	10.73913	148.51541	138
<u>Cossuro longocirrata</u>	4.32609	264.32349	138
<u>Diastylis sculpta</u>	0.01449	0.01439	138
<u>Drilonereis longo</u>	1.26812	6.13927	138
<u>Edotea triloba</u>	1.92754	15.35238	138
<u>Eteone longa</u>	1.00000	2.93431	138
<u>Glycera dibranchiata</u>	3.65217	42.06792	138
<u>Leptochetos pinguis</u>	0.18116	0.74796	138
<u>Mulinia lateralis</u>	0.70290	4.02058	138
<u>Nassarius trivittatus</u>	0.94928	3.78573	138
<u>Nephtys incisa</u>	9.41304	135.14934	138
<u>Ninoe nigripes</u>	3.57246	30.20271	138
<u>Nucula proxima</u>	413.50000	435246.31250	138
<u>Paraonis gracilis</u>	6.95652	455.04907	138
<u>Pherusa affinis</u>	14.98551	465.38647	138
<u>Pitar morrhuana</u>	0.07246	0.08230	138
<u>Prionospio malmgreni</u>	3.94928	76.32587	138
<u>Spiophanes bombyx</u>	45.38405	13224.34766	138
<u>Tellina agilis</u>	5.77536	63.54773	138
<u>Tharyx acutus</u>	160.11594	83037.50000	138
<u>Yoldia limatula</u>	2.02899	12.21813	138

will allow us to generate a polynomial surface with a better fit, and thus have a criterion for defining changes in the spatial distribution of the set of variables over time.