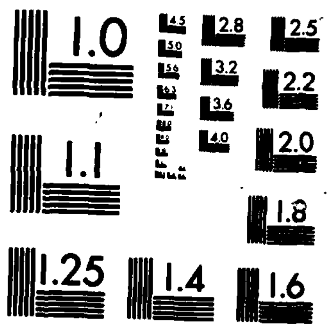
AD-A165 119 EVALUATION OF THE SENSITIVITY OF BASELINE MONITORING: 1/1
MICROCOSM-FIELD WAT..(U) OLD DOMINION UNIV NORFOLK VA
APPLIED MARINE RESEARCH LAB R W ALDEN III AUG 84

UNCLASSIFIED DACW65-81-C-0051 F/G 13/2 NL

END
FILMED
DTIC



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Unclassified
SECURITY CLASSIFICATION OF THIS PAGE

AD-A165 119

DTIC FILE COPY

REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION Unclassified	1b. RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION AUTHORITY 2b. DECLASSIFICATION / DOWNGRADING SCHEDULE	3. DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release, distribution unlimited.
4. PERFORMING ORGANIZATION REPORT NUMBER(S)	5. MONITORING ORGANIZATION REPORT NUMBER(S) B-22
6a. NAME OF PERFORMING ORGANIZATION Old Dominion University Applied Marine Research Laboratory 6b. OFFICE SYMBOL (If applicable)	7a. NAME OF MONITORING ORGANIZATION U.S. Army Corps of Engineers, Norfolk District
6c. ADDRESS (City, State, and ZIP Code) Norfolk, Virginia 23508	7b. ADDRESS (City, State, and ZIP Code) Norfolk, Virginia 23510-1096
8a. NAME OF FUNDING/SPONSORING ORGANIZATION U.S. Army Corps of Engineers, Norfolk District 8b. OFFICE SYMBOL (If applicable) NAOPL; NAOEN	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER DACW65-81-C-0051
8c. ADDRESS (City, State, and ZIP Code) Norfolk, Virginia 23510-1096	10. SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO. / PROJECT NO. / TASK NO. / WORK UNIT ACCESSION NO.

11. TITLE (Include Security Classification)
Evaluation of the Sensitivity of Baseline Monitoring: Microcosm-Field Water Quality

12. PERSONAL AUTHOR(S)
Alder, R.W., III

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (Year, Month, Day)	15. PAGE COUNT
Final	FROM ____ TO ____	1984, August	10

16. SUPPLEMENTARY NOTATION
(Virginia) Disposal Site (NDS)

17. COSATI CODES		
FIELD	GROUP	SUB-GROUP

18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
microcosm, water quality, monitoring program, Norfolk Disposal Site, open ocean disposal,, statistical evaluation, laboratory data vs. field data, impact assessment, trend assess-

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

The monitoring regime and statistical models developed for the NDS appear to provide an effective "early warning system" for major water quality changes which may be associated with disposal activities. The program appears to provide the opportunity for intervention prior to excessive environmental impacts to the region.

Open ocean disposal; evaluations; Laboratory data vs. field data; Environmental impact assessment; Trend assessment; Laboratory ... studies.

DTIC ELECTE MAR 1 1 1986 S D

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT ☐ UNCLASSIFIED/UNLIMITED ☒ SAME AS RPT. ☐ DTIC USERS	21. ABSTRACT SECURITY CLASSIFICATION Unclassified
22a. NAME OF RESPONSIBLE INDIVIDUAL Craig L. Seltzer	22b. TELEPHONE (Include Area Code) (804) 441-3767/827-3767 22c. OFFICE SYMBOL NAOPL-R

DD FORM 1473, 84 MAR — 83 APR edition may be used until exhausted. All other editions are obsolete.

SECURITY CLASSIFICATION OF THIS PAGE
Unclassified

86 3 11 018

APPLIED MARINE RESEARCH LABORATORY
OLD DOMINION UNIVERSITY
NORFOLK, VIRGINIA

EVALUATION OF THE SENSITIVITY OF BASELINE MONITORING: MICROCOSM-FIELD WATER QUALITY COMPARISONS

By

Raymond W. Alden III, Principal Investigator

Supplemental Report
For the period ending August 1984

Prepared for the
Department of the Army
Norfolk District, Corps of Engineers
Fort Norfolk, 803 Front Street
Norfolk, Virginia 23510

Under
Contract DACW65-81-C-0051
Work Order No. 0016

Submitted by the
Old Dominion University Research Foundation
P.O. Box 6369
Norfolk, Virginia 23508

August 1984

US Army Corps
Of Engineers
Norfolk District

Report B- 22

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

EVALUATION OF THE SENSITIVITY OF BASELINE MONITORING: MICROCOSM-FIELD WATER QUALITY COMPARISONS

By

Raymond W. Alden III*

INTRODUCTION

Environmental impact assessments are often evaluated by comparing conditions prior to a particular activity (baseline) and trend assessment studies during, or immediately following the activity. Therefore, investigators should be concerned as to whether their baseline date is adequate to allow the detection of impacts during such studies. In order to address this issue properly, several influential factors must be considered. These are: the spatial and temporal variability in the study area; the intensification and coverage of the monitoring regime; and the sensitivity and "appropriateness" of the statistical models to be employed in the evaluation of the data.

One way to approach the concern over the adequacy of a monitoring effort is to perform a sensitivity evaluation of the baseline program while it is still in progress. The evaluation can be statistical, producing estimates of "Minimum Detectable Impacts" for different models (Alden, 1984). On the other hand, the evaluation may be empirical, using laboratory and field data to test the effectiveness of the program. This report describes the evaluation of a water quality monitoring program at the proposed Norfolk Disposal Site (NDS) using data from a laboratory microcosm study to provide a hypothetical "impact."

The microcosm experiment was designed to simulate the conditions

*Director, Applied Marine Research Laboratory, Old Dominion University, Norfolk, Virginia.

immediately following open ocean disposal of dredged materials. The water quality changes from this experiment were evaluated statistically and significant changes were described (Alden et al., 1981). The question posed in the present report is whether impacts which were clearly defined under laboratory conditions could have been detected if they had been observed in the context of the natural spatio-temporal variability of the monitoring data from the field.

METHODS AND MATERIALS

The water quality monitoring program at the NDS has been previously described (Alden et al., 1982; and in the accompanying report, Alden et al., 1984). The data from the March, April, June, August and October 1981 cruises, were evaluated as the baseline data set in comparison to the water quality measurements from a laboratory microcosm experiment conducted during the Fall of 1980. The experimental "dump" samples from the microcosm represented conditions following disposal of materials dredged from the most contaminated portion of the Southern Branch of the Elizabeth River, while the control samples were for similar disposal conditions using reference sand from the NDS. A full discussion of the statistical treatment of the microcosm water quality data set was previously described (Alden et al., 1981). For the purposes of the present study, the data from 20 "dump" samples (representing the seasonal NDS samples) and 16 "control" samples (representing the seasonal samples from peripheral sites) were randomly selected to represent data from a hypothetical post-"impact" Fall cruise. The data from the simulated cruise were then statistically evaluated by a series of models in the context of the baseline data set.

The statistical models employed in the baseline-microcosm evaluation included the Principal Components Analysis (PCA) probability ellipse models described by Green (1979); discriminant analyses (Klecka 1975) utilizing both seasonal and annual baseline data sets; and the season-area interaction MANOVA model, also suggested by Green (1979). Each of these statistical models and their application to the NDS water quality data set are detailed in an accompanying report (Alden, 1984).

RESULTS AND DISCUSSION

A principal components analysis was conducted on the entire 1981 water quality data set and probability ellipses were calculated for standardized PCAscores. New PCA scores were calculated for the control and "dump" data from the simulated cruise to determine whether they fell significantly outside of baseline conditions. All 16 control replicates (not shown for clarity of graphics) fell within the small 95% confidence ellipse, while the mean "dump" PCA fell outside of the confidence ellipse, and the extreme case was outside of the 99% probability ellipse (Fig.1). Therefore, the method indicates a significant "impact" (e.g. lower D.O. increased nutrients) has occurred at "dump" sites, but not for the controls.

The second approach to the statistical evaluation of the scenario employed discriminant analysis. The first run combined the October 1981 data with the "control" data as one group to be contrasted to the "dump" measurements. The analysis indicated a very significant ($p < 0.0001$) discrimination between the groups, primarily due to elevated nutrients, and lower oxygen and chlorophyll levels for the "dump" conditions (Fig. 2). The classification of the cases into the groups was 100% current, further confirming the strength of the model.

The second discriminant analysis run compared the entire baseline data

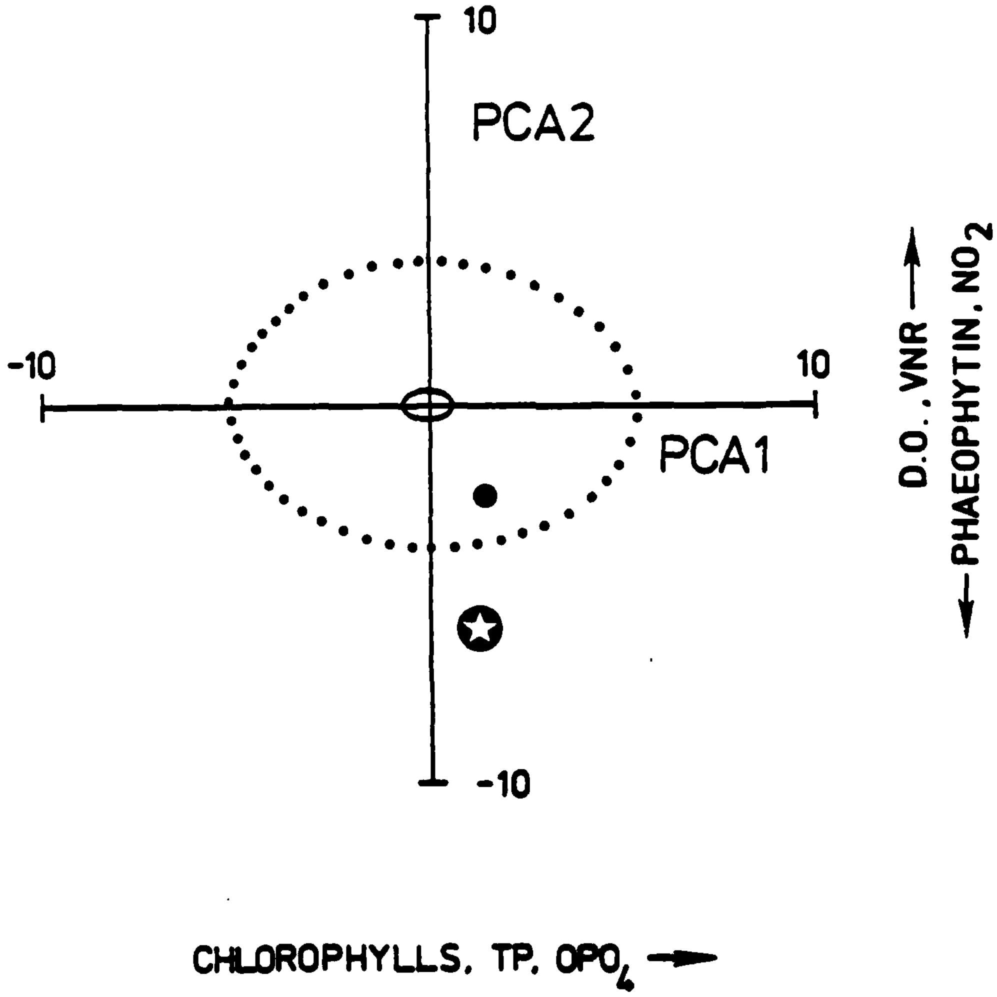
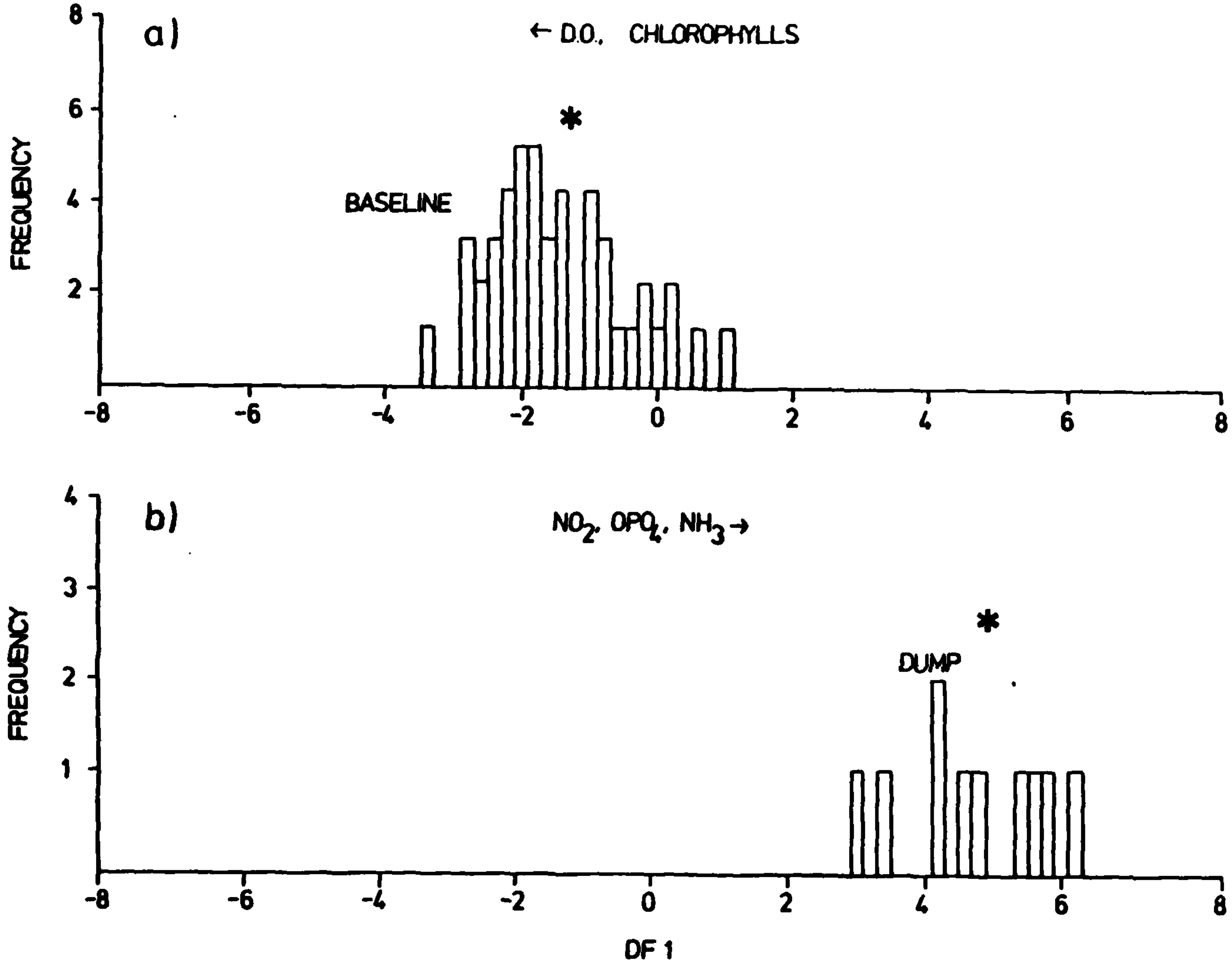


Figure 1. Principal components model for trend assessment. The small ellipse is the 95% confidence limits of the standardized PC. Scores of the 1981 water quality data sets, while the larger ellipse represents the 99% probability limits. The closed circle is the mean of the "dump" standardized PC scores and the star is the extreme case. (See Table 1 for abbreviations).

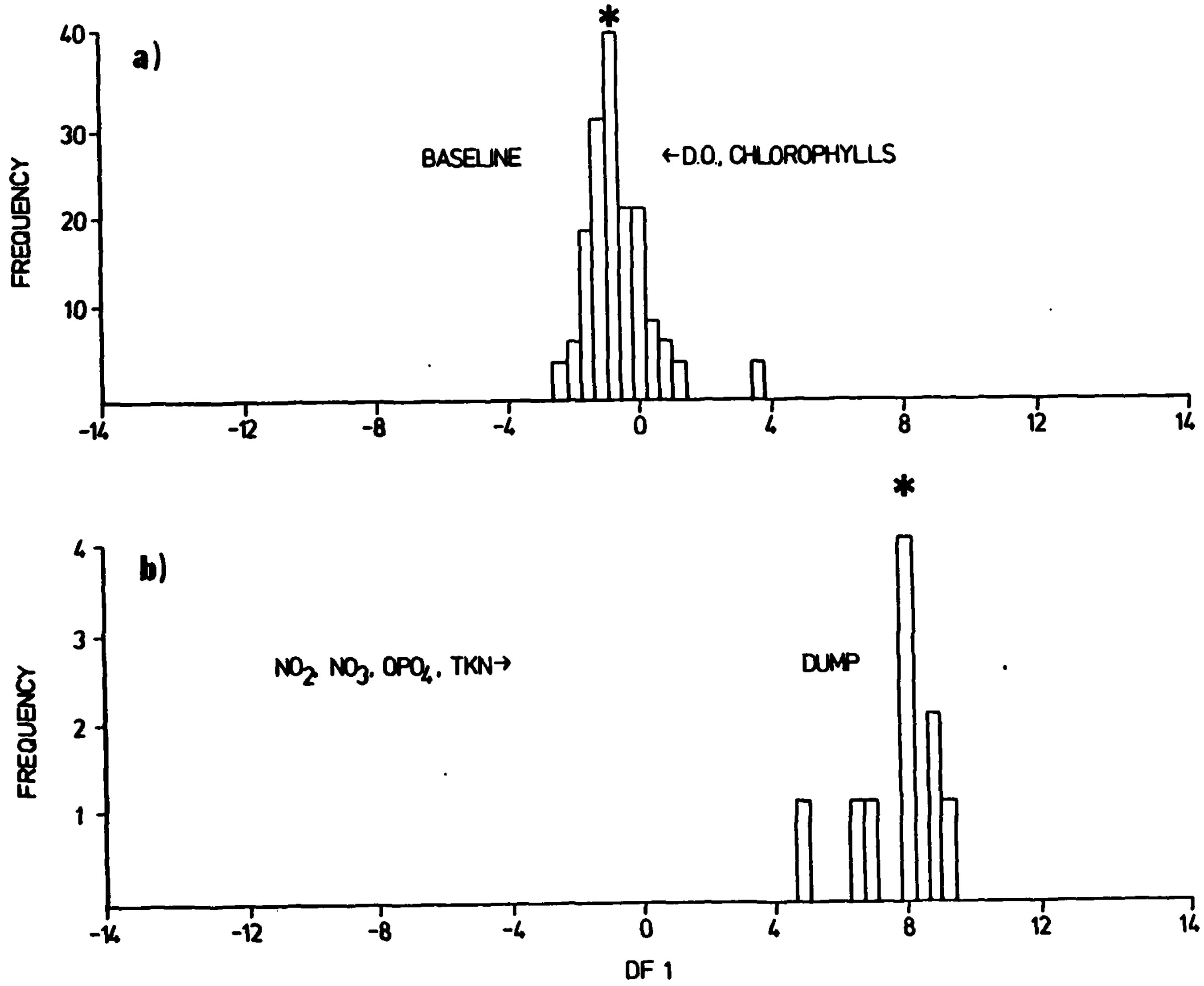


Percent of cases correctly classified: 100%

Figure 2. Discriminant analysis model for trend assessment with 100% of "grouped" cases correctly classified. The frequency of discriminant scores for the (a) October 1981 baseline water quality data, and (b) "dump" data. The asterisks represent group centroids. (See Table 1 for abbreviations).

set (including control readings) to the "dump" data. This model also proved to be highly significant ($p < 0.0001$) and the classification was nearly perfect (98.76% correct) (Fig. 3).

The final statistical model was a MANOVA model designed to determine whether a significant season-area interaction was detectable. In the model, data from the October 1981 cruise was compared to the simulated data for seasonal effect, since the microcosms were conducted during November and may be seen to represent a successive cruise occurring after hypothetical disposal operations have commenced. Once the cruise-to-cruise water quality differences and natural spatial patterns have been mathematically taken into account, an interaction term was tested to determine whether significant changes were occurring at the disposal site following the "dump" that were not also taking place in the control regions. This model not only indicated whether overall changes have occurred due to disposal operations, but points out which parameters were significantly affected. The interaction term was a very highly significant effect ($p < 0.0001$). Chlorophyll and dissolved oxygen were significantly depressed in the "dump" samples, while nutrients and suspended solids were elevated (Table 1). Although the magnitude of change appears to have been quite high (over 200%) for some of the parameters, most of these were found at extremely low levels in the field. Therefore, the absolute concentrations, though significantly different from control levels were still moderately low. In fact, few of the affected parameters fell outside of the natural range reported by Kester and Courant (1973) for the lower Chesapeake Bay waters and none even approached the water quality criteria or "reference levels" recommended by State and Federal agencies for the protection of marine life or the prevention of eutrophication (VSWCB, 1976).



Percent of cases correctly classified: 98.76%

Figure 3. Discriminant analysis model for assessment with 98.76% of "grouped" cases correctly classified. The frequency of discriminant scores for the (a) entire 1981 baseline water quality data and (b) "dump" data. The asterisks represent group centroids. (See Table 1 for abbreviations).

TABLE 1: Summary of results of MANOVA model: baseline cruise versus simulated post-disposal cruises.

Seasonal Change		Dump Site Interaction		Magnitude of Interaction (% Change over Control)
*** D.O.	↑	*** D.O.	↓	- 13 %
*** TP	↑	*** TP	↑	+ 100 %
*** NO_2	↑	*** NO_2	↑	+ 233 %
*** NH_3	↓	*** NH_3	↑	+ 49 %
*** TKN	↑	*** TKN	↑	+ 50 %
*** S.S.	↑	*** S.S.	↑	+ 20 %
*** Chlor. a	↓	*** Chlor. a	↓	- 39 %
*** Chlor. b	↑	*** Chlor. b	↓	- 22 %
** Chlor. c	↑	* NO_3	↑	+ 116 %
*** OPO_4	↑	* pH	↓	- 0.5%

Note: There are no significant differences between control and disposal site data under baseline conditions, so the results of the second main effect of "station location" is not displayed.
* = $p<0.06$; ** = $p<0.01$; *** = $p<0.001$.

Key to Abbreviations:

D.O. - Dissolved Oxygen
Chlor. - Chlorophyll
NH_3 - Ammonia
NO_2 - Nitrite
NO_3 - Nitrate
OPO_4 - Orthophosphates
S.S - Suspended Solids
TP - Total Phosphorus
TKN - Total Kjeldahl Nitrogen

Thus, all of the statistical models allowed the detection of a statistically significant "impact" at a level below that which may be of acute ecological significance. This is the desired situation if the trend assessment statistical models are to act as an "early warning system" for the detection of an impact before the environment deteriorates excessively.

CONCLUSIONS

A sensitivity evaluation was conducted on the water quality monitoring program at the NDS using empirical laboratory microcosm data to simulate a hypothetical impact. The three types of statistical models used to compare baseline and "dump" data were all successful at detecting differences in water quality, despite the fact that the absolute concentrations of the "impacted" samples were moderately low. Thus, the monitoring regime and statistical models developed for the NDS appear to provide an effective "early warning system" for major water quality changes which may be associated with disposal activities. Should statistically significant effects be consistently detected by these techniques in future trend assessment studies after the NDS becomes active, more intensive environmental monitoring investigations can be mounted to confirm the trend, as well as to determine the specific cause and ecological significance of the impact. Therefore, the program would appear to provide the opportunity for intervention prior to excessive environmental impacts to the region.

REFERENCES

Alden, R.W. III, D.M. Dauer, and J.H. Rule. 1981. An assessment of the ecological impact of open ocean disposal of materials dredged from a highly industrialized estuary. Final Report NOAA under Research Grant NA79AA-D-00026. 187 pp.

Alden, R.W. III, D.M. Dauer, and J.H. Rule. 1982. Environmental studies at a proposed mid-Atlantic dredged material disposal site. Oceans: 1034-1041.

Alden, R.W. III. 1984. Statistical Significance and Baseline Monitoring. Accompanying report to the USACOE.

Green R.H. 1979. Sampling design and statistical methods for environmental biologists. Wiley-Interscience, N.Y. 257 pp.

Kester, D.R. and R.A. Courant. 1973. A summary of chemical oceanographic conditions. IN: Coastal and Offshore Environmental Inventory: Cape Hatteras to Nantucket Shoals. Univ. of R.I. Publication Series No. 2; Kingston, R.I.

Klecka, C. 1975. Discriminant analysis. Chapter 23, IN: N.H. Nie, C.H. Hull, J.G. Jenkins, K. Steinbrenner, and D.H. Bent (eds.): Statistical package for the social sciences. McGraw-Hill, N.Y. 434 p.

Virginia State Water Control Board. 1976. Water quality inventory (305(b) Report) to EPA Administration and Congress. Info. Bull. 526. 328 pp.

END

FILMED

[redacted]

DTIC