



MEMORANDUM

TO: MR. ROBERT NYMAN
MR. DOUGLAS PABST

DATE: APRIL 26, 2010

RE: NEI JOB CODE 0286-007, PROJECT
CODE 2009-013 FINAL TECHNICAL
REPORT – ASSESSMENT OF NY BIGHT
DATA TECHNICAL MEMORANDA

FROM: R. L. MILLER

FILE: NEIW.005

INTRODUCTION

HydroQual has been assisting USEPA Region 2 with assessment, on an on-going and “real time” basis, of nutrient and dissolved oxygen data collected in the New York Bight during the summers of 2008 and 2009. These activities have been documented in monthly work descriptions and quarterly progress reports submitted by HydroQual as required to NEIWPCC.

Stakeholder outreach for timely sharing of data collection and review activities has also been ongoing through a variety of forums including: meetings, e-mail updates, other communications with HEP technical workgroups and management/policy committees, Clean Ocean Action, and other stakeholder federal and state agencies, etc.

Formal documentation of data review and statement of recommendations for future monitoring and modeling activities are summarized as technical memoranda, for each of 2008 and 2009. The technical memoranda are presented here jointly as two parts for final technical reporting purposes and overall synthesis.

Part 1 – Assessment of 2008 Data and Recommendations for 2009 Data Collection

On April 1, 2009, HydroQual and Region 2 held a conference call to discuss the results of Region 2’s summer 2008 Bight sampling. HydroQual provided review comments to Region 2 on six key areas that were used to influence/adjust summer 2009 sampling. These key areas of HydroQual 2008 data review comments were:

- Discrepancies in the identification of station locations
- General agreement between 2008 monitoring data and 1994-95 monitoring data and numerical modeling results
- Concern that 2008 measurements of total and dissolved inorganic phosphorus were consistently higher than 1994-95 monitoring data and numerical modeling results
- Notice that there was some disagreement between 2008 and 1994-95 measurements of dissolved organic carbon and dissolved silica, especially in near bottom waters

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- Concern with regard to the large number of non-detects for certain parameters (e.g., 43 out of 86 non-detections reported for ammonia near surface). Ammonia and dissolved silica in near surface waters were of particular concern because of their importance to model calibration for limiting nutrient conditions. The model calibration needs to reproduce nutrient limitations.
- Low dissolved oxygen measured in September 2008 was consistent with the 1994-95 model calculations. This fact minimizes a previous concern that the model may have been “miscalibrated” for September conditions. September 1994-95 data were taken during a mixing event which may not have been representative of most years.

At the time of HydroQual’s review of 2008 data for 2009 planning, instructions for use of fluorescence measurements as a surrogate or relative estimate of chlorophyll a concentration had not been provided by EPA to HydroQual. Accordingly, chlorophyll was not included in HydroQual’s 2008 review per EPA instructions but was included subsequently in the overall 2008/2009 review.

Supporting and underlying HydroQual’s review of the 2008 data were spatial transect and probability plot displays of the 1994-95 data, 2008 data, and 1994-95 modeling results. These model and data comparison plots are presented in Attachments A and B. Attachment A includes profiles along seven spatial plotting transects established by HydroQual in the Bight. Five of the spatial plotting transects run in an east to west direction and two in a north to south direction. These seven spatial plotting transects are displayed on Figure 1 with 2008 sampling locations. Each of the seven spatial plotting transects is repeated for the four summer months, June through September. 2008 data are shown in red. 1994-95 data and model results are shown in black. Attachment B includes probability distributions of 2008 data with and without data at detection limits considered.

Each spatial transect/survey month presented in Attachment A includes eighteen water quality constituents measured and modeled for 1994-95. As available, 2008 data have also been included. Inspection of these diagrams specifically shows that:

For transect north-south 1:

- Overall, 2008 measured dissolved oxygen concentrations agree with 1994-95 measurements and fall within the envelope of model surface maxima and bottom minima calculations. In some cases (e.g. June and September), the 2008 dissolved oxygen measurements are slightly lower than the 1994-95 model calculations predict. This is very important because it sets aside concerns that the model was calibrated to the 1994-95 drought year and might represent a dissolved oxygen problem that doesn’t exist for other years.
- In 1994-95, much of the Bight monitoring took place at night and measurements of light extinction were lacking. 2008 data filled this gap in information. The 2008 measurements of light extinction (i.e., 1.7 divided by the measured secchi disk depth in meters) are in reasonable agreement with 1994-95 model calculations. The model results slightly miss the measurements, especially near the Apex (i.e., mile zero of north-south transects).
- The 2008 measurements of dissolved inorganic phosphorus do not agree with either 1994-95 measurements or model results. The apparent problem with 2008 measurements of dissolved inorganic phosphorus is also evident for total phosphorus.
- The 2008 measurements of dissolved organic carbon are of similar magnitude to 1994-95 measurements and model calculations, but show more stratification in June/July 2008 than

observed in 1994-95. Agreement in stratification is better between the years for August and September. For September, the 1994-95 model calculations actually more closely resemble 2008 data than 1994-95 data.

- Particulate organic carbon and biogenic particulate silica measured in 2008 agree well with 1994-95 model results and measurements for August and September. For August particulate organic carbon, the 1994-95 model results more closely resemble the 2008 measurements than the 1994-95 measurements. The comparisons for July are also favorable, especially in near-bottom waters with model calculations for surface waters approaching the measured stratification. Comparisons for June are less favorable.
- Model and data comparisons for dissolved silica are somewhat problematic. The model doesn't capture the stratification in the 2008 measurements in particular.
- Ammonia, nitrate plus nitrite, and total nitrogen data for both 1994-95 and 2008 are in excellent agreement with the 1994-95 model calculations.

Inspection, of the remainder of transect plotting diagrams, leads to similar conclusions as presented above for north-south transect 1 with few exceptions. Some of these exceptions include: unfavorable nitrate plus nitrite comparisons for transect north-south 2 in July; 2008 dissolved oxygen measurements different than 1994-95 dissolved oxygen for transect north-south 2 in August; model and data comparisons for light extinction very good in August for transect north-south 2 and east-west 3; for September, on transects north-south 2 and east-west 3, the 2008 data agree with low dissolved oxygen calculated for 1994-95 but perhaps the spatial extent of calculated low dissolved oxygen is too broad; and the agreement between model and data for dissolved silica improves somewhat in the further Bight vs. closer to the Apex and in later portions of the summer (e.g., transect east-west 4 for September).

Probability distributions shown in Attachment B highlight that there were a large number of non-detections reported for ammonia nitrogen and several other parameters. This was of concern for several reasons:

- The 2008 sampling was focused on the inner Bight where concentrations would be higher than in the outer Bight where 2009 sampling would take place.
- Non-detects wasn't an issue when 1994-95 sampling was performed using other analytical methods and laboratories.
- Low level measurements of dissolved inorganic nutrients are essential for confirming model calculations of nutrient limitations.

An important outcome of the HydroQual review of the 2008 data was that Region 2 retained an outside contract laboratory to perform analysis of ammonia nitrogen and dissolved silica samples collected in 2009 in the far Bight. The goal was to achieve a lower detection limit for ammonia nitrogen and dissolved silica in 2009 than was achieved in 2008, especially at the most ocean-ward stations where concentrations would be expected to be the lowest. Particulate silica was also analyzed at a lower detection limit in 2009 to reduce the number of reported non-detects. While 2008 data collection focused on the Inner Bight due to vessel availability, 2009 data collection focused on both the Inner and Outer Bight.

Part 2 – Assessment of 2008/2009 Data and Recommendations for Future Data Collection and Modeling Needs

For purposes of making recommendations to EPA for moving forward with TMDL development for the Bight, the 2008 and 2009 data were reviewed. The review is organized by parameter. In support of the review, 1994-95 data and modeling are displayed with 2008 and 2009 data along spatial plotting transects included in Attachment C. The plotting transect locations are the same as presented in Figure 1. Probability diagrams of selected 2008 and 2009 data are displayed in Attachment D. Note that the diagrams in Attachment D are intended to highlight non-detections for the 2009 data. While the 2008 data are also shown, there are fundamental differences between the 2008 and 2009 data distributions related to sampling at different stations and switching laboratories/analytical methods for some parameters.

Salinity and Temperature

While it is expected that temperature and salinity could fluctuate from year to year and that seasonal patterns might vary, temperature and salinity measurements made in the Bight in 2008 and 2009 are relatively similar to 1994-95 modeling and measurements. Stratification is also similar. One apparent exception is that August 2009 tended to be warmer and fresher than the other years in the Inner Bight (see east-west plotting transect 1). Another example of a difference is that September 2008 data showed greater temperature stratification than 1994-95 data and model results at locations along east-west plotting transect 3. This difference in temperature stratification is coincident with a dissolved oxygen stratification difference.

Chlorophyll

Actual direct measurements of chlorophyll a were not obtained for either 2008 or 2009. Instead, measurements which are estimates of relative chlorophyll fluorescence are available. These measurements are based on “factory-calibrated” chlorophyll a concentration for planktonic algae in clean water. Since color and dissolved organic matter in local Bight waters would interfere with the fluorescence reading and chlorophyll a concentration conversion, the data are only estimates. It would be necessary to obtain a fluorescence reading that is calibrated to local conditions. Without having corresponding lab-verified samples of chlorophyll-a for the fluorescence data, it can't be corrected to site specific conditions and definitively converted to chlorophyll a concentration. For these reasons, only estimates of relative chlorophyll fluorescence are available for 2008 and 2009. The 2008 and 2009 chlorophyll estimates have been included on spatial plotting transects along with actual 1994-95 direct measurements and model results for chlorophyll a.

The chlorophyll estimates appear to be slightly lower than but not dissimilar to direct chlorophyll measurements, chlorophyll model calculations, and chlorophyll concentrations inferred from POC measurements and model results.

Dissolved Oxygen

The NYSDEC water quality standards for dissolved oxygen in SA, SB, and SC marine waters are patterned after EPA's marine dissolved oxygen criteria. These standards provide a reference point for the Bight. A “floor” on the NYSDEC standard is never less than 3 mg/L with allowances for episodes of 24-hr average dissolved oxygen to fluctuate between 3.0 and 4.8 mg/L. The 2008/2009

Bight data show measurements below 3 mg/L on several occasions. These include: August 2009 along spatial plotting transect east-west 1; August 1995 along spatial plotting transect east-west 2; September 2008 along spatial plotting transect east-west 3; August 1995 along spatial plotting transect east-west 4; July 2008 along spatial plotting transect east-west 5; August 1995 along spatial plotting transect east-west 5; August 1995 along spatial plotting transect north-south 1; and September 2008 along spatial plotting transect north-south 1.

A dissolved oxygen data set unfortunately doesn't exist for the Bight that provides 24-hr average dissolved oxygen measurements. Further assessment of marine dissolved oxygen criteria violations requires the use of numerical modeling to provide estimates of 24-hr average dissolved oxygen. Numerical modeling also has the advantage of being able to predict dissolved oxygen conditions in the Bight after implementation of Harbor nutrient TMDLs. Figures E-1 and E-2 in Attachment E illustrate a SWEM projection of dissolved oxygen standards violations in the New York Bight after implementation of preliminary sub-regional TMDL planning reductions. For comparison purposes, the dissolved oxygen standards violations are shown on Figures E-3 and E-4 in Attachment E for baseline conditions before implementation of Harbor nutrient TMDL planning. Harbor TMDLs do little to improve Bight conditions per the SWEM results. Figures E-5 and E-6 in Attachment E show that the NYSDEC dissolved oxygen standards for SA, SB, and SC waters would not be met in the Bight even under a pastoral loading condition. The NYSDEC dissolved oxygen standards for SA, SB, and SC waters appear unattainable for the Bight at all depths.

Overall, 2008 and 2009 measured dissolved oxygen concentrations agree with 1994-95 measurements and fall within the envelope of model surface maxima and bottom minima calculations. In some cases, the 2008 and 2009 dissolved oxygen measurements are slightly lower than the 1994-95 model calculations predict. This is very important because it sets aside concerns that the model was calibrated to the severe 1994-95 drought year and might represent a dissolved oxygen problem that doesn't exist for other years.

Light Extinction

In 1994-95, much of the Bight monitoring took place at night and measurements of light extinction were lacking. 2008 and 2009 data filled this gap in information. The 2008 and 2009 measurements of light extinction (i.e., 1.7 divided by the measured secchi disk depth in meters) are in reasonable agreement with 1994-95 model calculations. The model results slightly miss the measurements, especially near the Apex (i.e., mile zero of north-south transects).

Dissolved Inorganic Phosphorus

2009 measurements of dissolved inorganic phosphorus were similar to, and perhaps slightly lower than, 2008 measurements (see Attachment D probability plots), but were not nearly as low as 1994-95 measurements (see Attachment C transect plots). The differences in measured dissolved inorganic phosphorus measurements between 1994/95 and 2008/2009 remains an unresolved discrepancy. A decision will need to be made regarding the use of one or the other of these data sets for future modeling and/or TMDL development. An EPA monitoring consideration for 2010 is whether or not additional dissolved inorganic phosphorus data could be collected and/or analyzed by a different method or laboratory.

The level of calibration of the model suggests that the dissolved inorganic phosphorus measured in 1994/95 in the Bight was consistent with dissolved inorganic phosphorus measurements of loadings made at that time. It is unlikely that loadings of dissolved inorganic phosphorus have changed enough between 1994-95 and 2008/2009 to support the higher 2008/2009 Bight measurements. This suggests that they might be a problem with the 2008/2009 Bight measurements.

An important point of consideration is that in marine waters such as the Bight, nitrogen, rather than phosphorus, is the major nutrient of concern for limitation of algal growth and dissolved oxygen depletion. However, the measured concentrations in the Bight in 1994-95, at the hundredths of mg/L level, would limit algal growth if other nutrients and sufficient light were available.

Dissolved Organic Carbon

In general the 2008 and 2009 data are of similar magnitude to the 1994-95 data with 2008 data usually having the lowest magnitude. The 1994-95 model calibration calculations are often in the middle of the range covered by 1994-95, 2008, and 2009 measurements.

Particulate Organic Carbon

The particulate organic carbon measurements across the three summers are generally consistent. The 1994-95 model results seem to “split” any differences between 1994-95 measurements and 2008 and 2009 measurements. North-South transect 1 shows evidence of a large July bloom (i.e., elevated POC concentrations, strong stratification in POC) unique to 2008.

Biogenic Silica

In general, the model is in reasonable agreement with the data from the three summers and the data across years are consistent. There are some instances where the model slightly over predicts the biogenic silica and where 2008 and 2009 measurements are lower than 1994-95 measurements. The model over-prediction of biogenic silica is related to an under-prediction of dissolved silica.

Dissolved Silica

The 2008 and 2009 dissolved silica data are generally higher than the 1994-95 dissolved silica data and are often more stratified. The 1994-95 model results do not pick up the range of the measurements. The model results tend to be biased low. From a nutrient-limitation and dissolved oxygen consequences perspective, the model calculations are conservative (i.e., magnifying the role of low dissolved silica concentrations).

Dissolved Inorganic Nitrogen (Ammonia Nitrogen and Nitrate and Nitrite Nitrogen)

Despite there being a very large number of non-detects reported for 2008 (50% of the surface measurements) and 2009 (83% of the surface measurements), there is excellent agreement between the 1995, 2008, and 2009 measurements. Agreement is also very good for nitrate and nitrite nitrogen measurements across years and with model results.

Specific Recommendations for Next Modeling/HydroQual Steps

1. Complete (i.e., develop and gain approval of) a modeling QAPP.
2. Obtain and assess zooplankton data.
3. Revise 1994-95 SWEM calibration. HydroQual does not believe that the 2008 and 2009 data provide justification for discontinuing the use of the 1994-95 based SWEM for Bight TMDL purposes. Further, there isn't a pressing need for moving forward with SWEM calibrations for 2008 and 2009. Some "tweaking" of the 1994-95 SWEM calibration is appropriate in recognition of new information.
4. Revise specification of light extinction in model based on 2008 and 2009 measured data (there were no 1994-95 data).
5. Consider revision of model formulation for zooplankton grazing of phytoplankton in the NY Bight pending review of zooplankton carbon data.
6. Adjust specification of boundary conditions in SWEM based on North East Coastal Shelf Eutrophication Model (NECSEM) findings.
7. Troubleshoot and improve if possible the dissolved silica calibration.
8. Re-evaluate standards attainability in the Bight for pastoral loading conditions (i.e., repeat pastoral conditions SWEM simulation with final version of SWEM).
9. Consider standards attainability in the Bight at multiple depths in the water column as opposed to most extreme case. Attainment might be better closer to surface, for example.

Specific Recommendations for Next Monitoring/EPA Steps, if Possible

1. Collect additional measurement of phosphorus by different methods/laboratory
2. Deploy sondes moored to buoys to collect continuous dissolved oxygen measurements. Target locations identified as having discrete measurements less than 3 mg/L in 2008, 2009, or 1994/95. Target locations where model projections suggest 24-hr average based standards violations will persist even after/with Harbor TMDLs or pastoral loadings conditions. The goal is to have some continuous measurements that support model-indicated violations of marine DO criteria that are based on 24-hr averages.
3. Collect coincident site-specific measurements of chlorophyll a and fluorescence.

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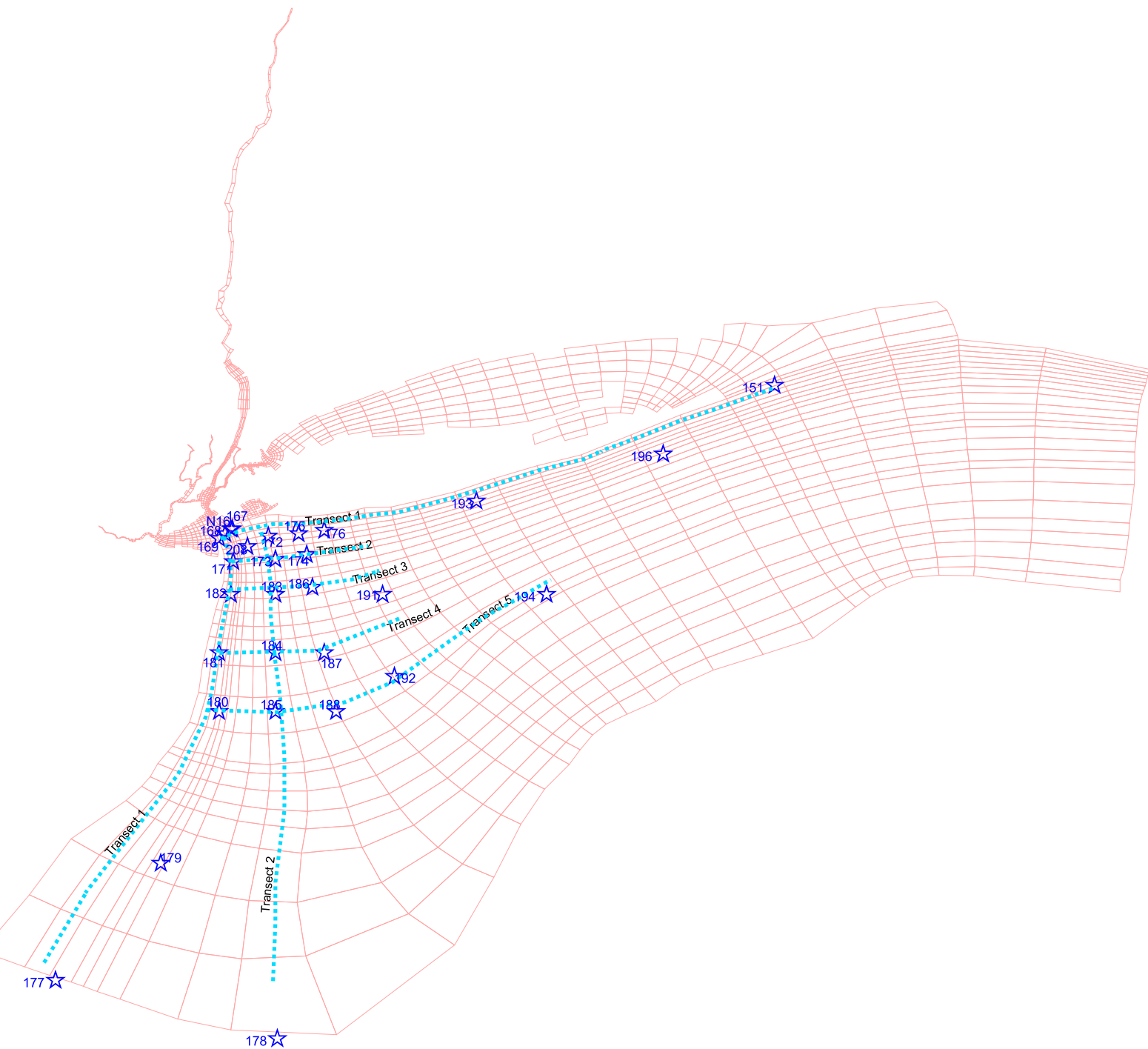


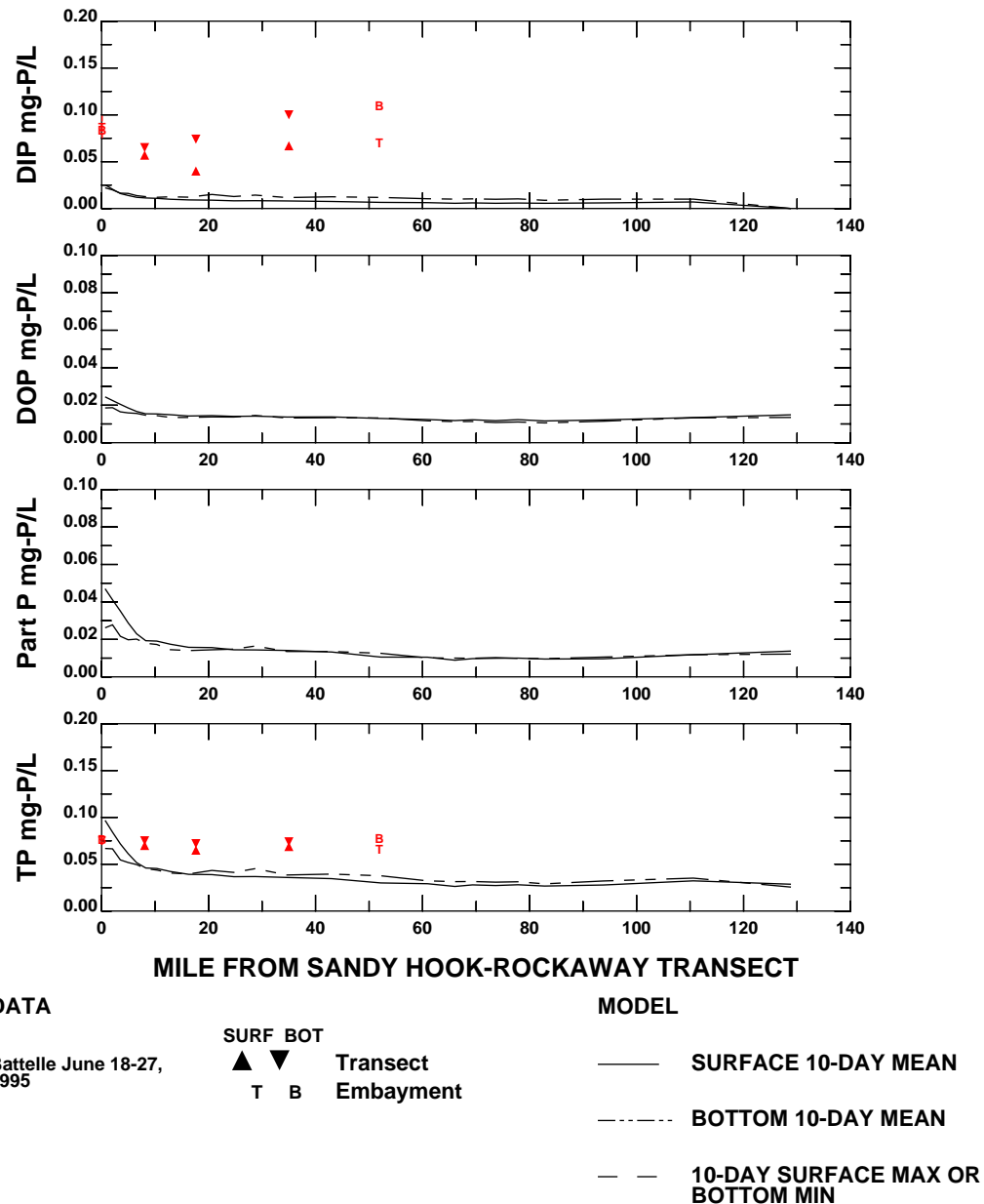
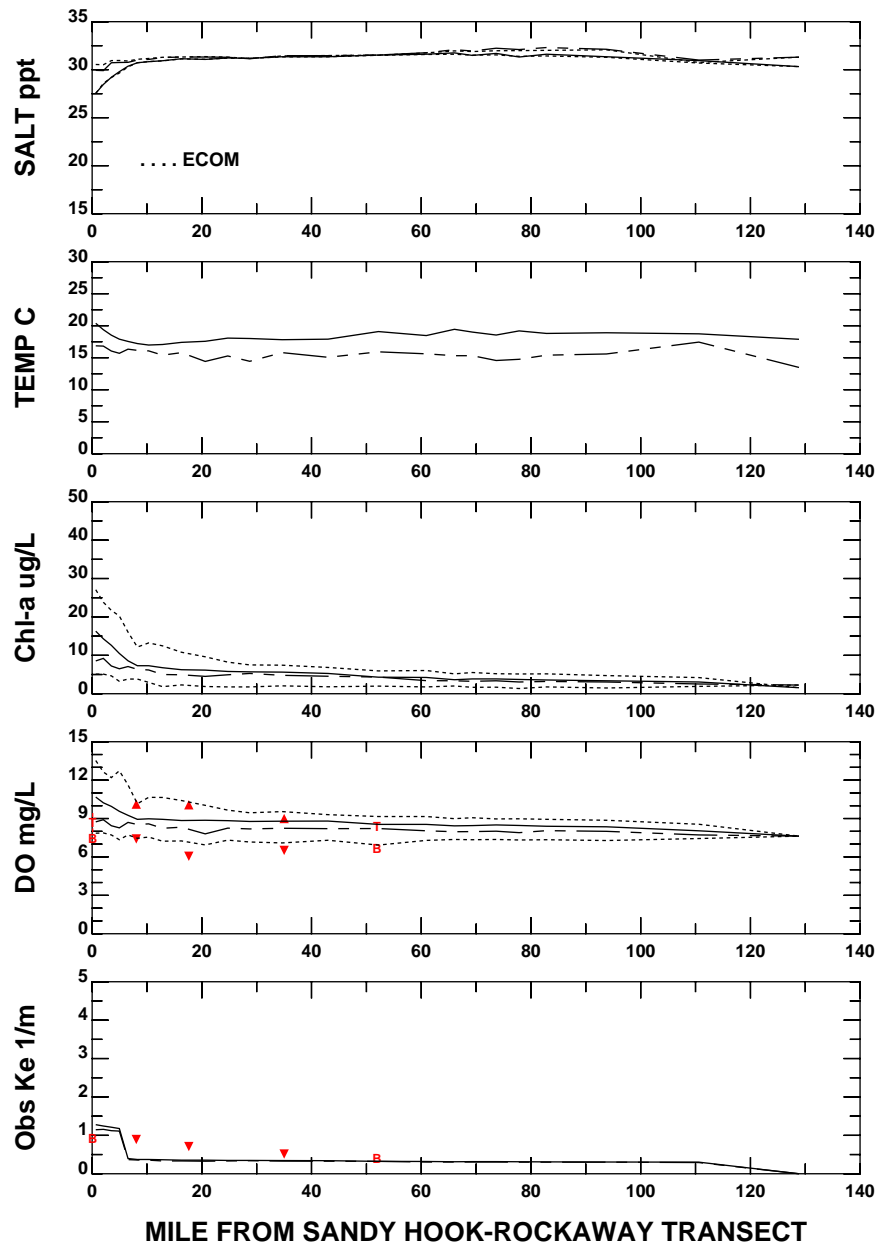
Figure 1. Display of seven New York Bight spatial plotting transects and alignment of 2008 monitoring stations.

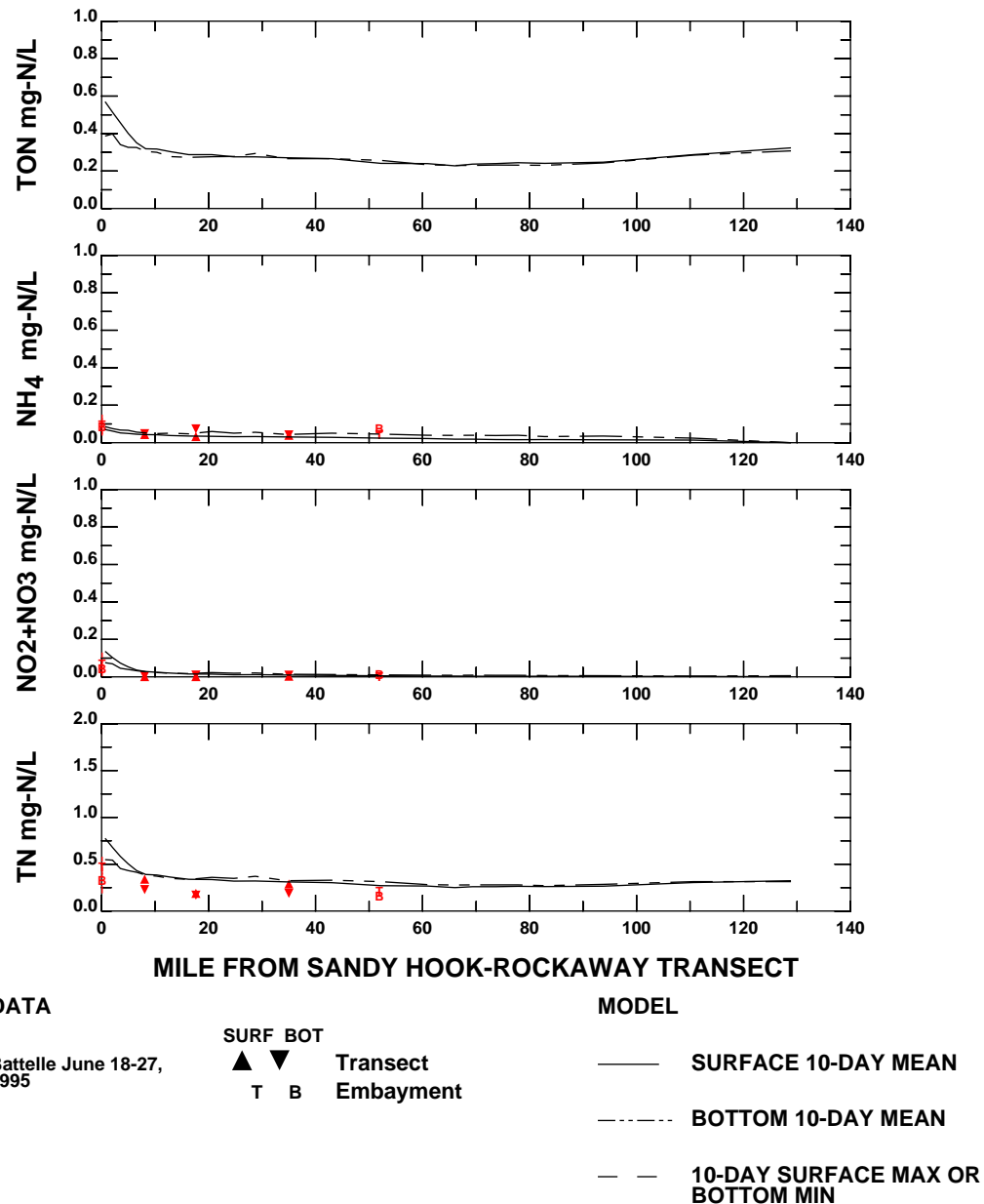
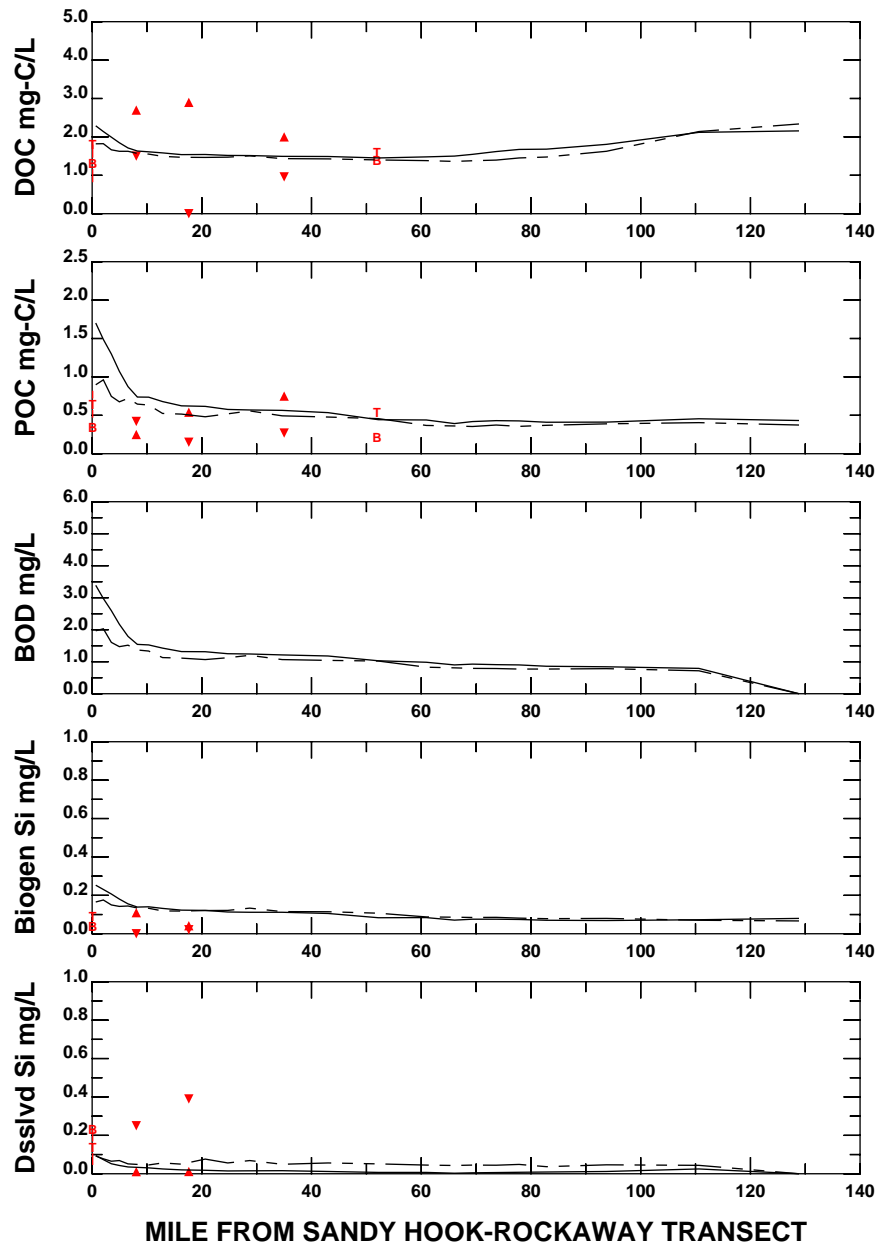
**ATTACHMENT A
2008 SPATIAL TRANSECT PLOTS**

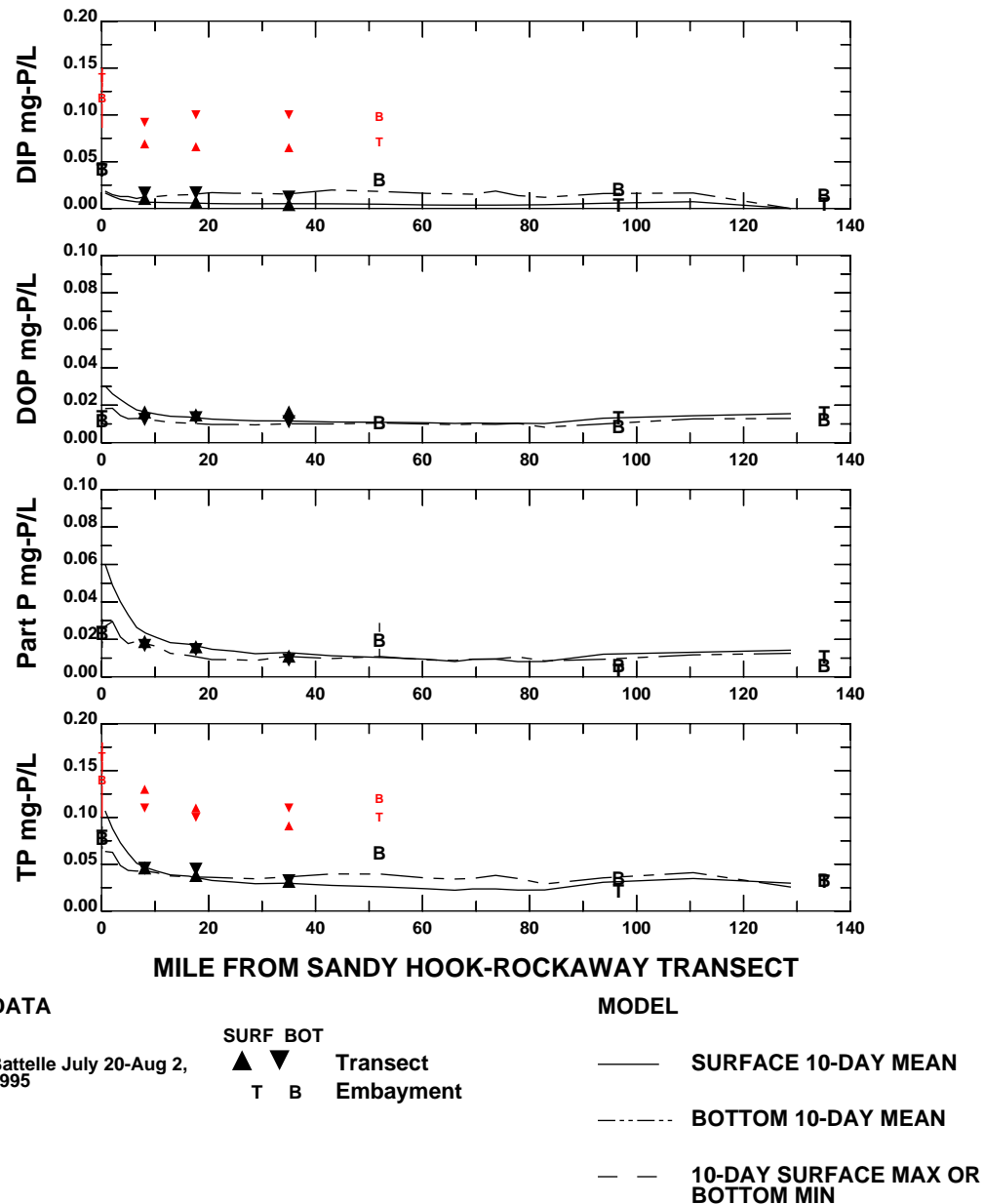
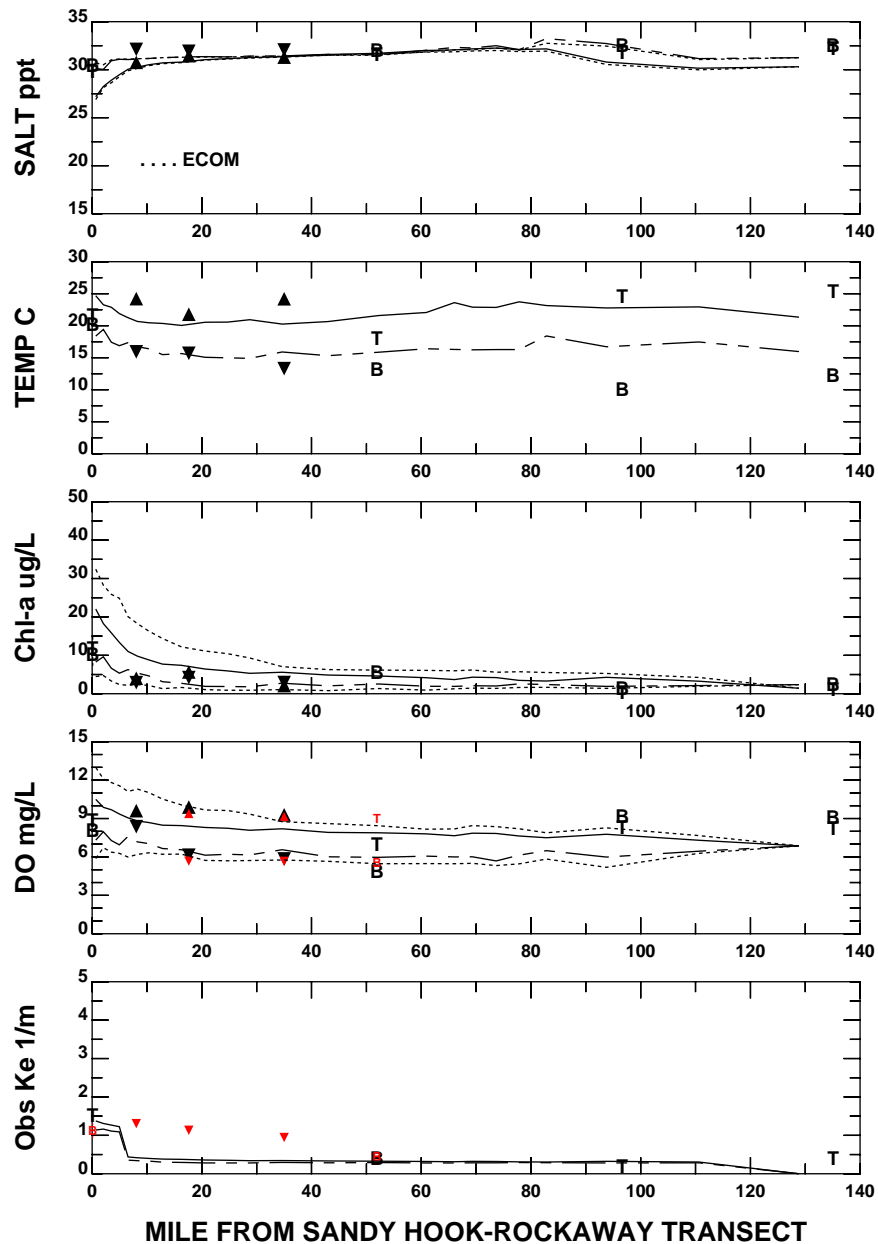
(note: 2008 data shown in red)

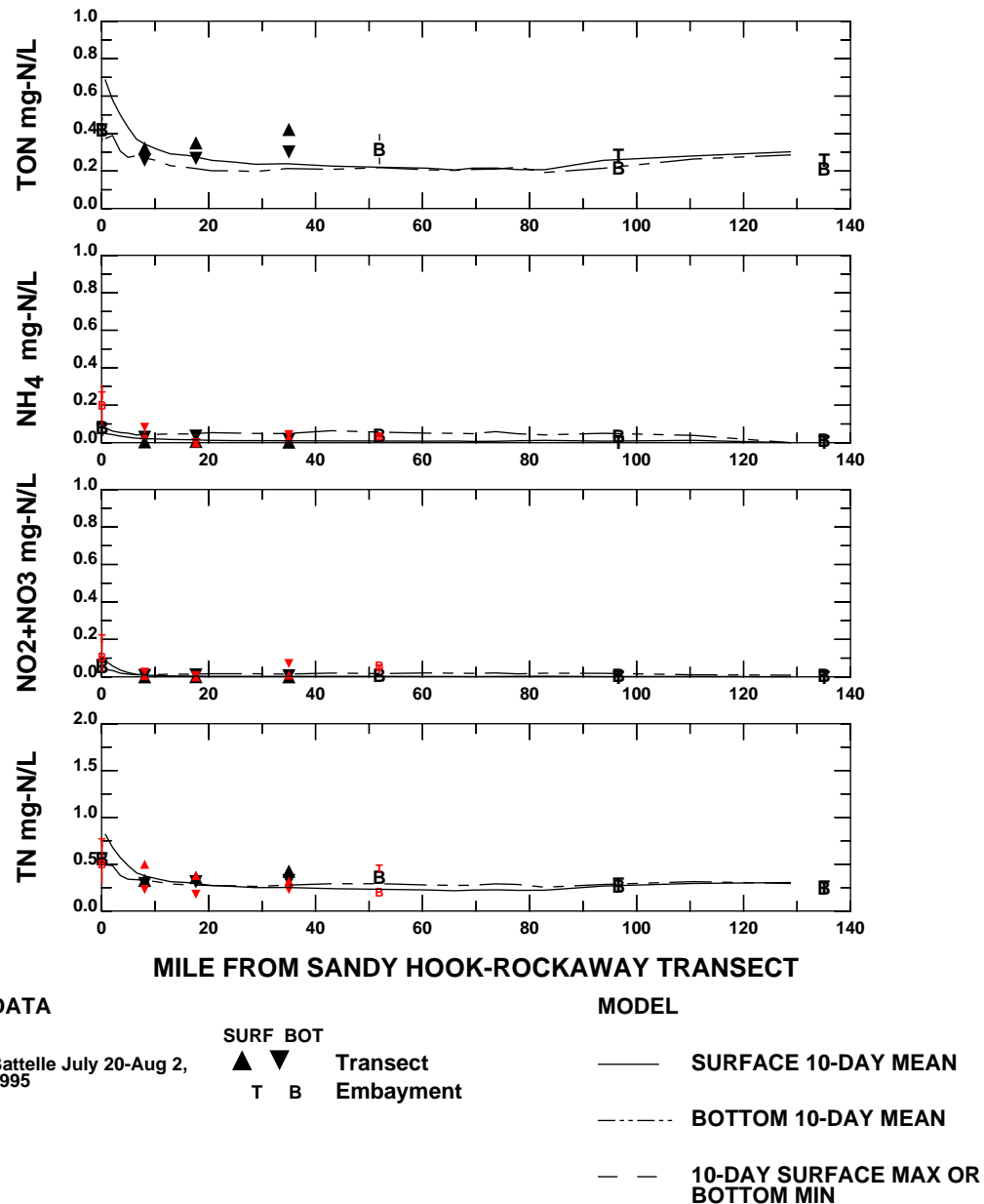
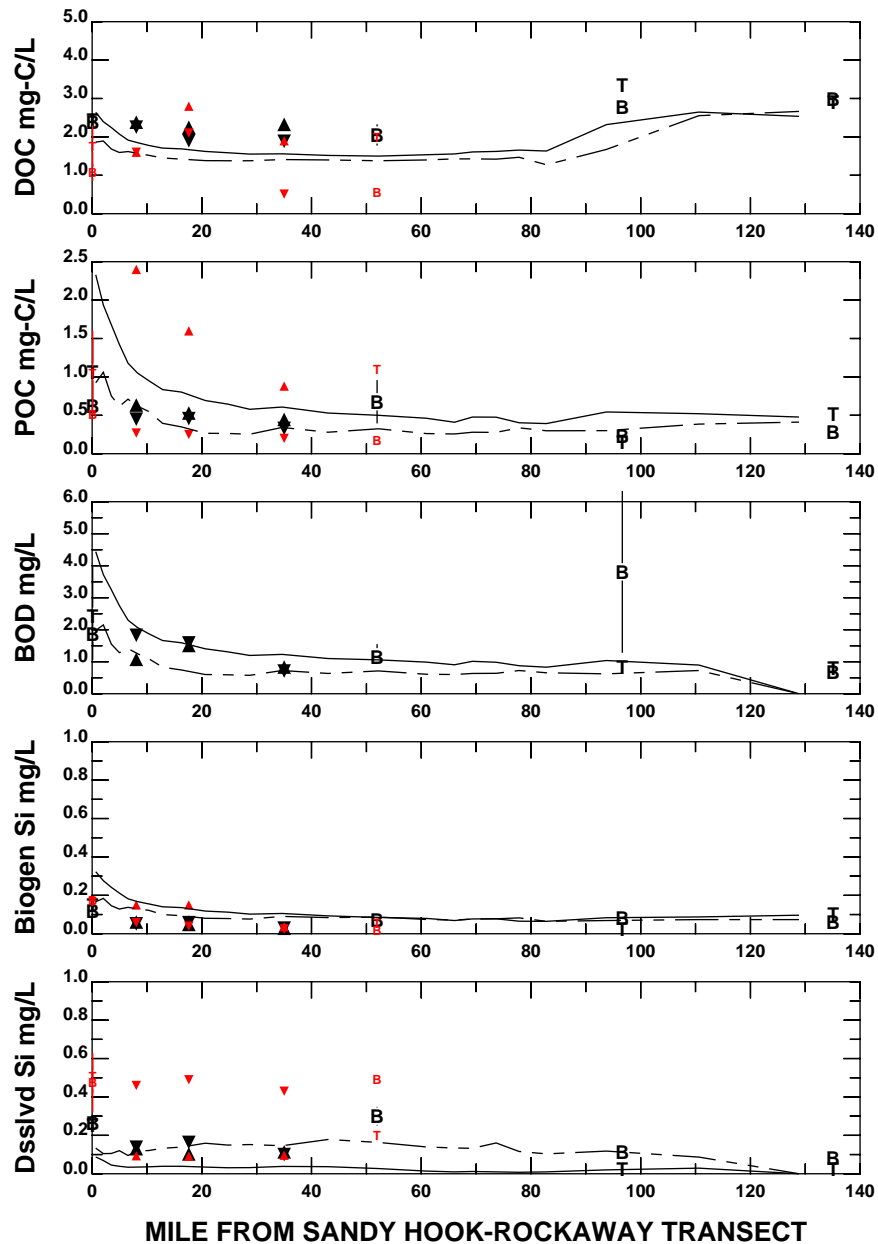
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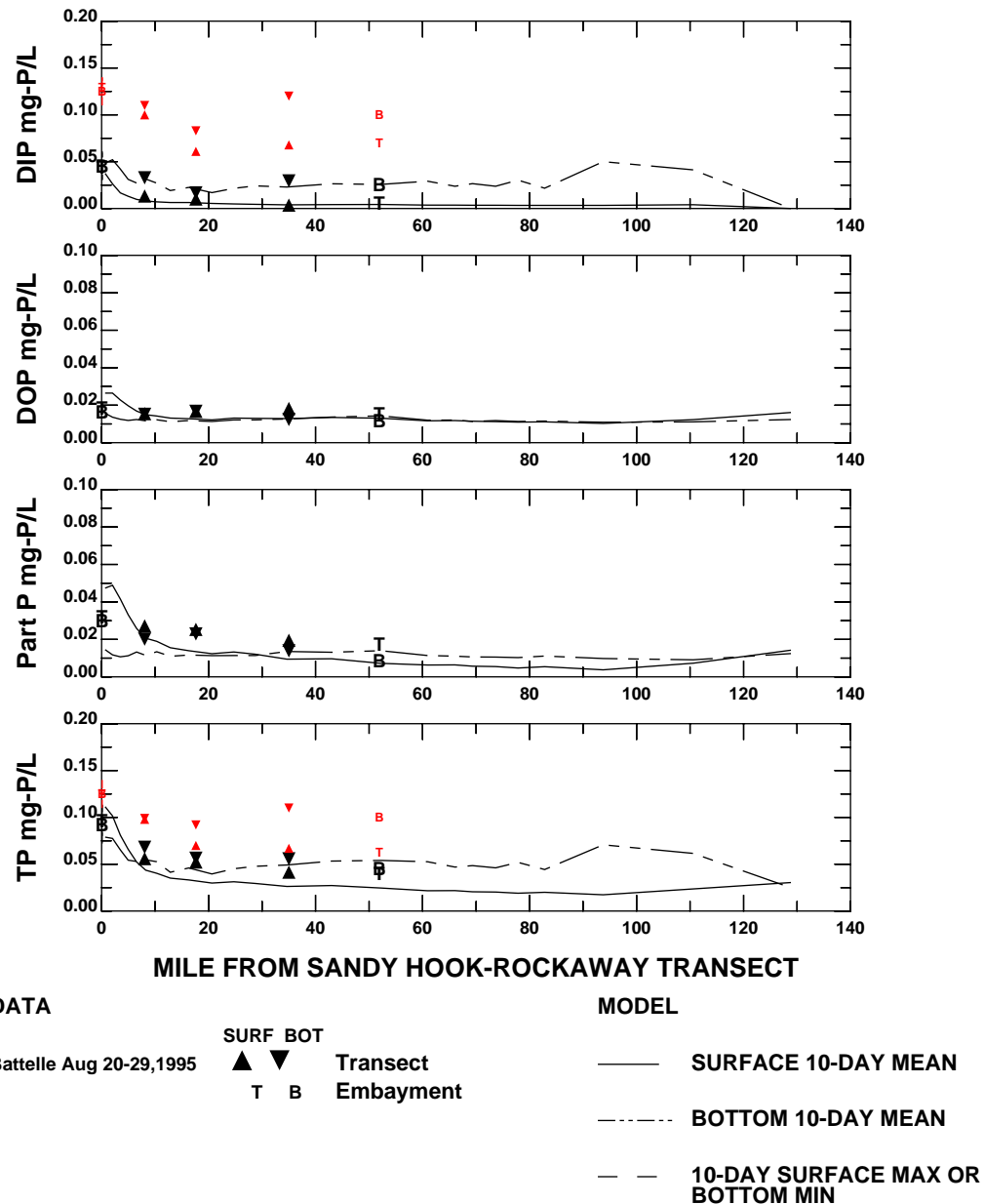
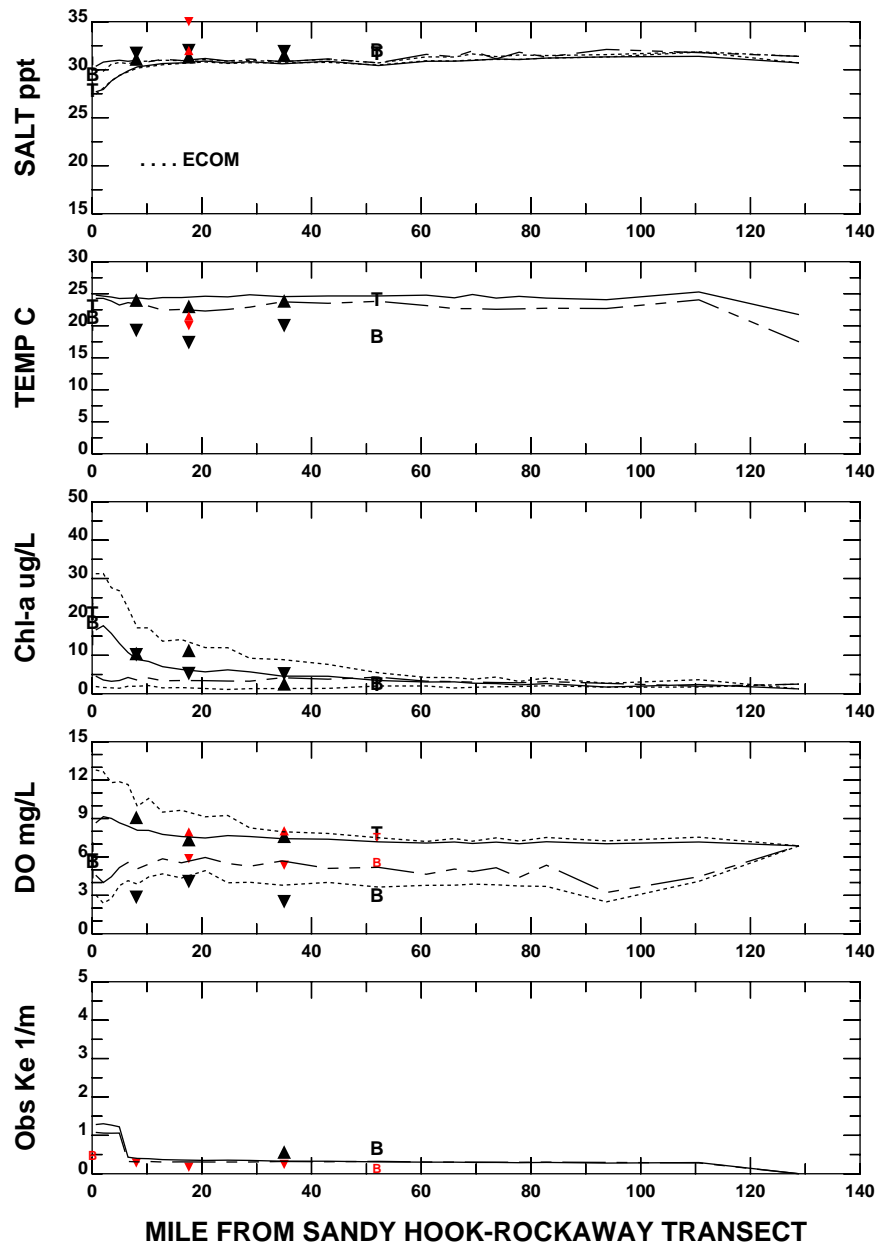
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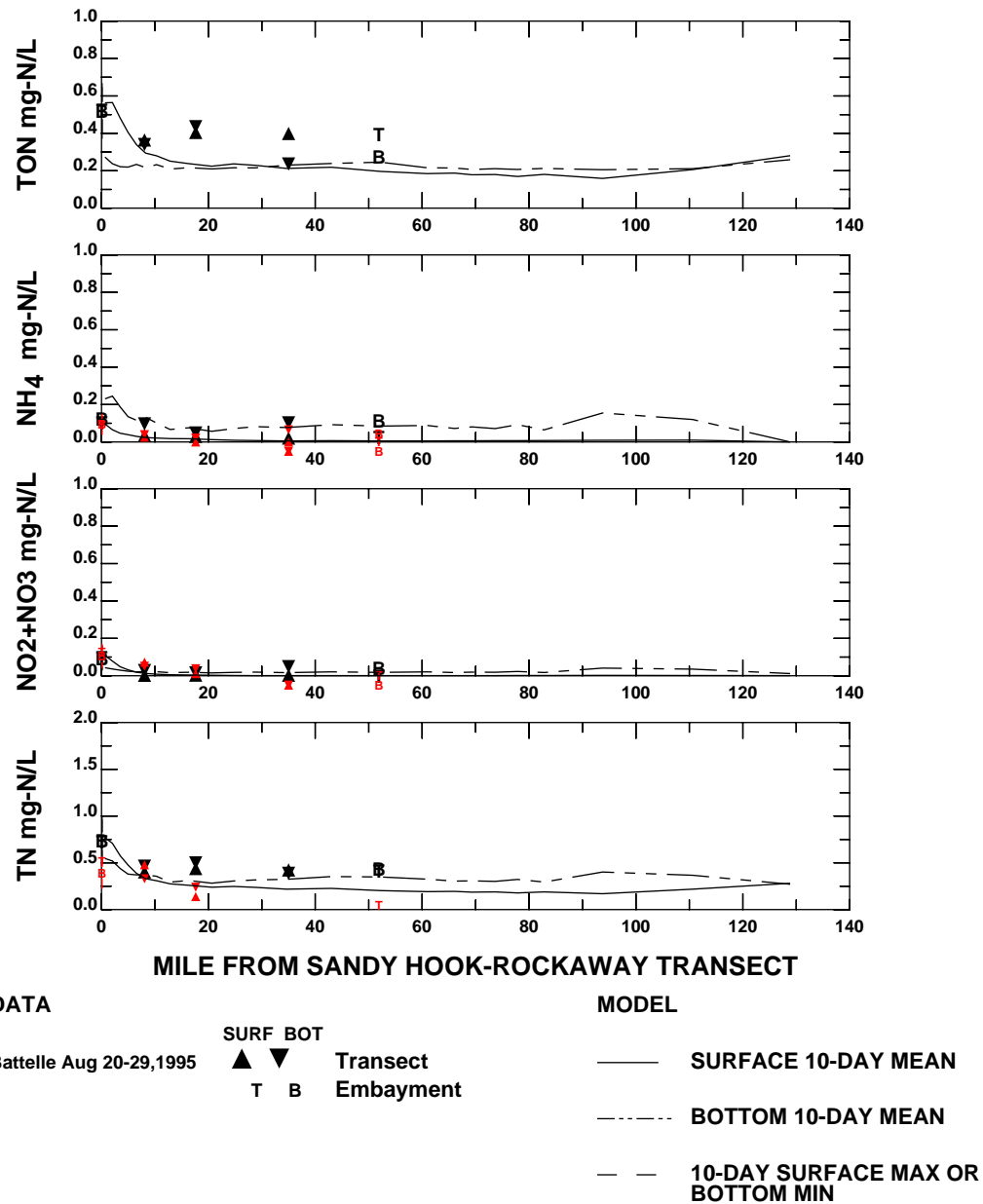
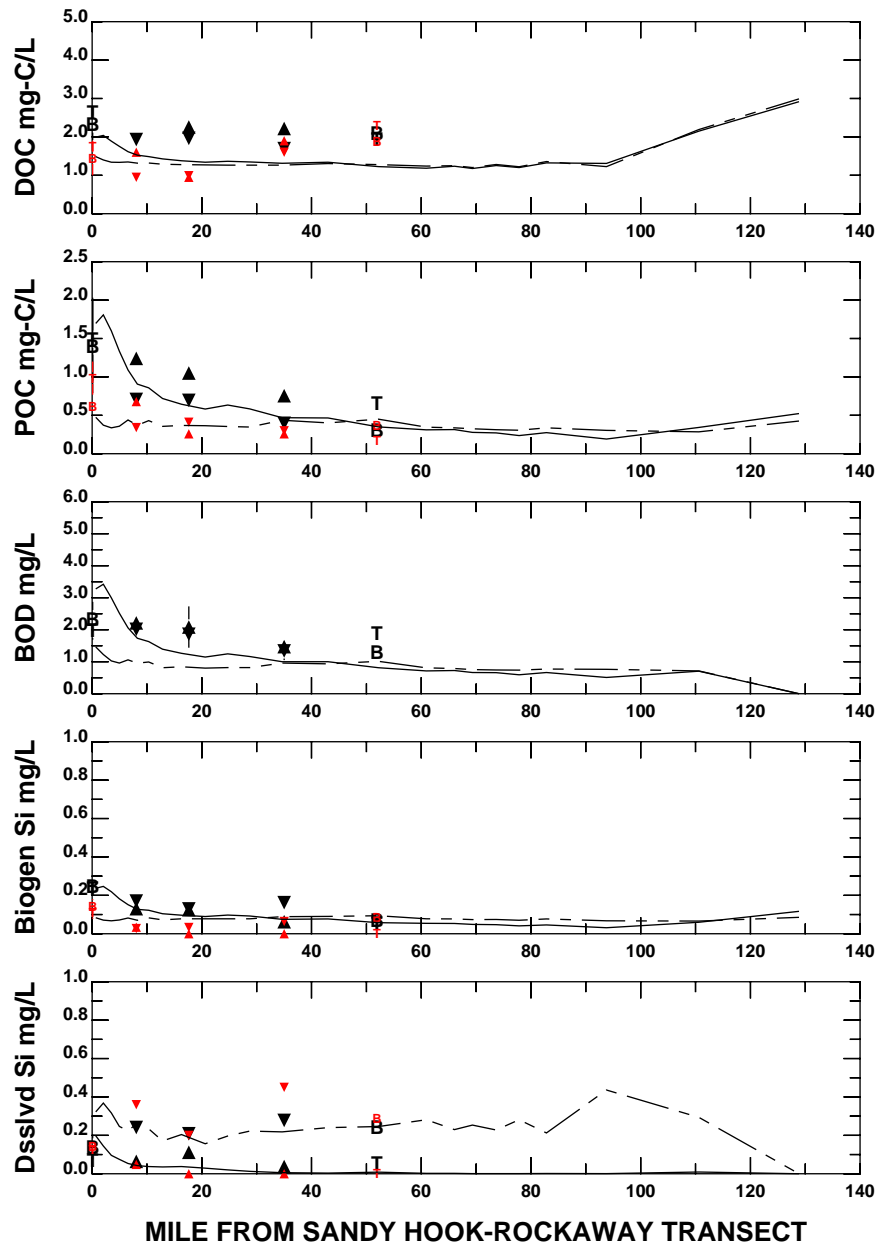


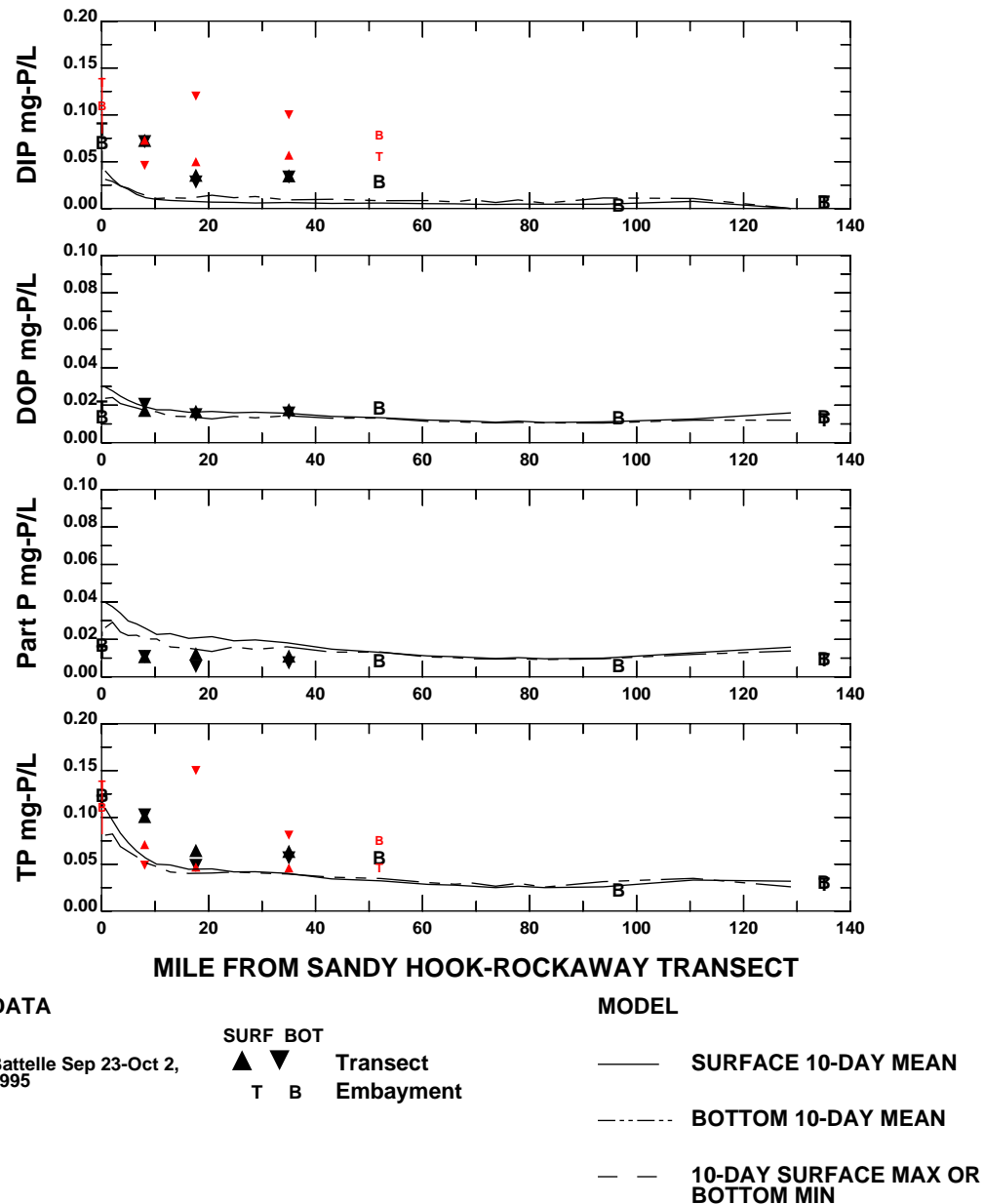
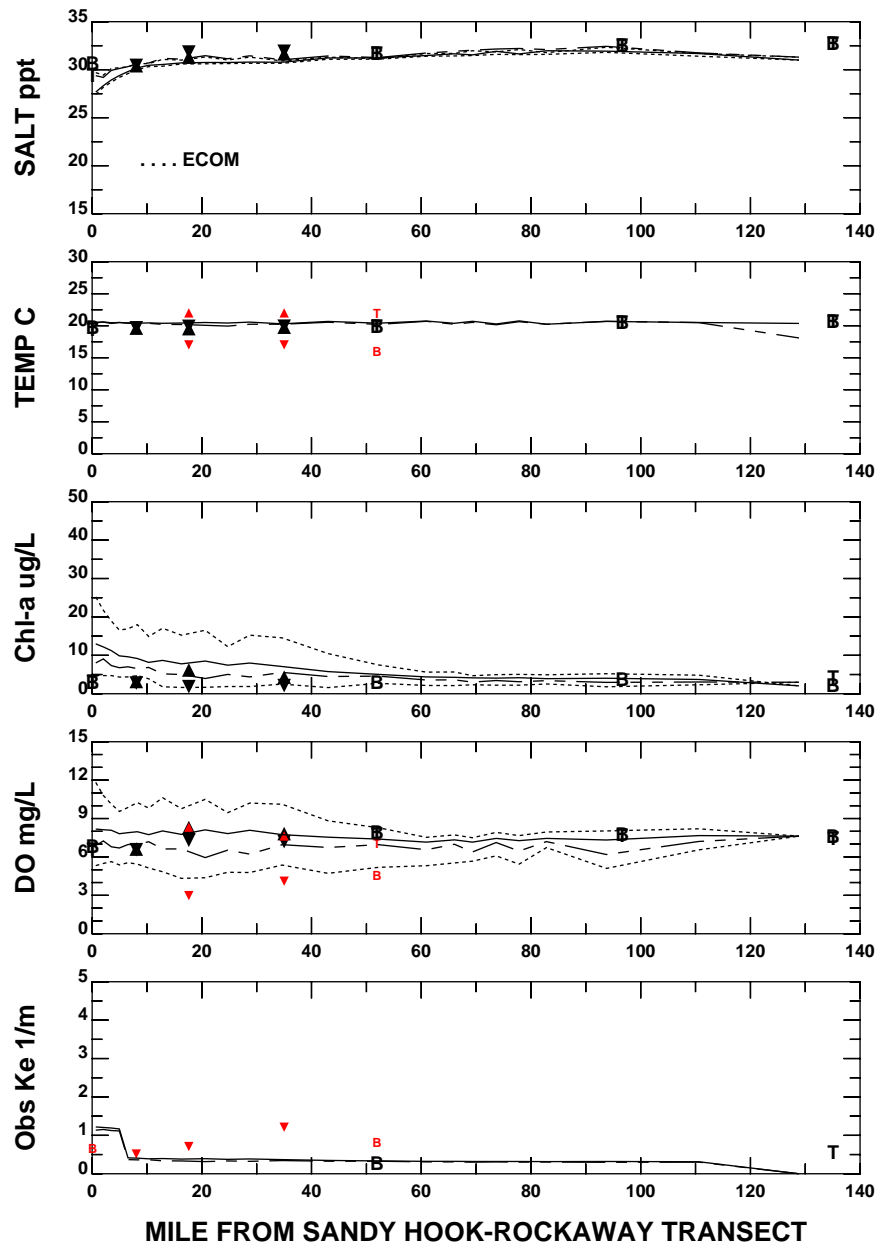


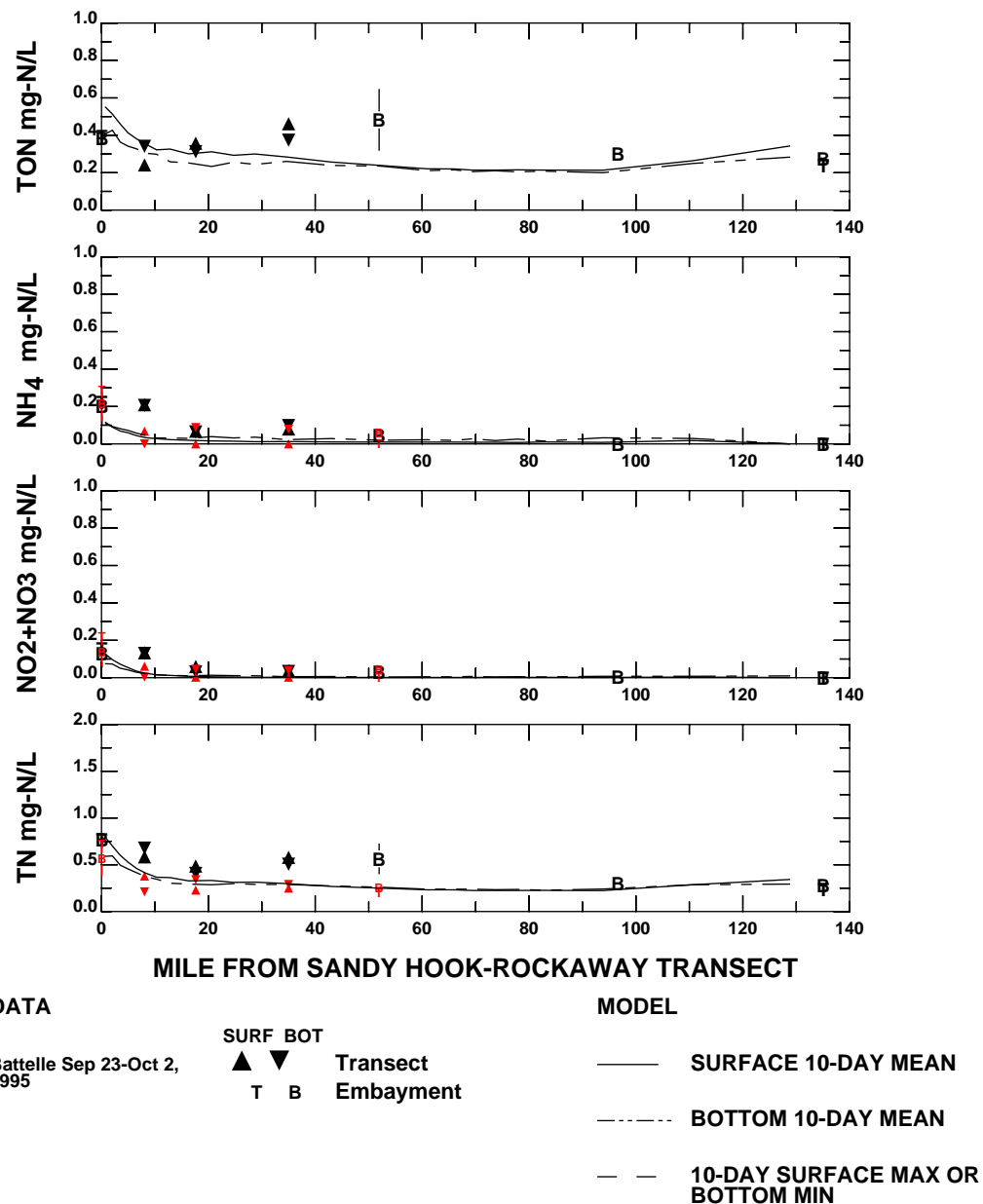
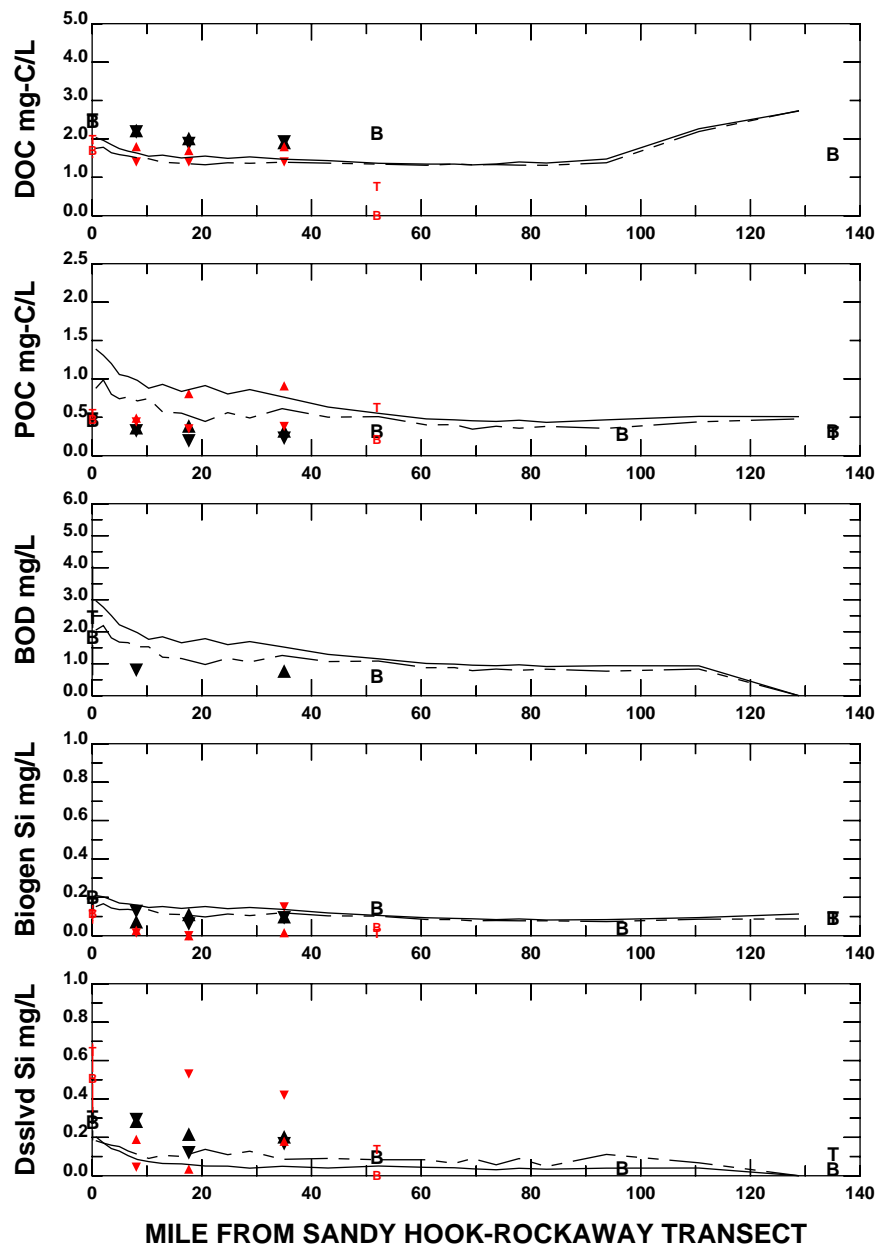


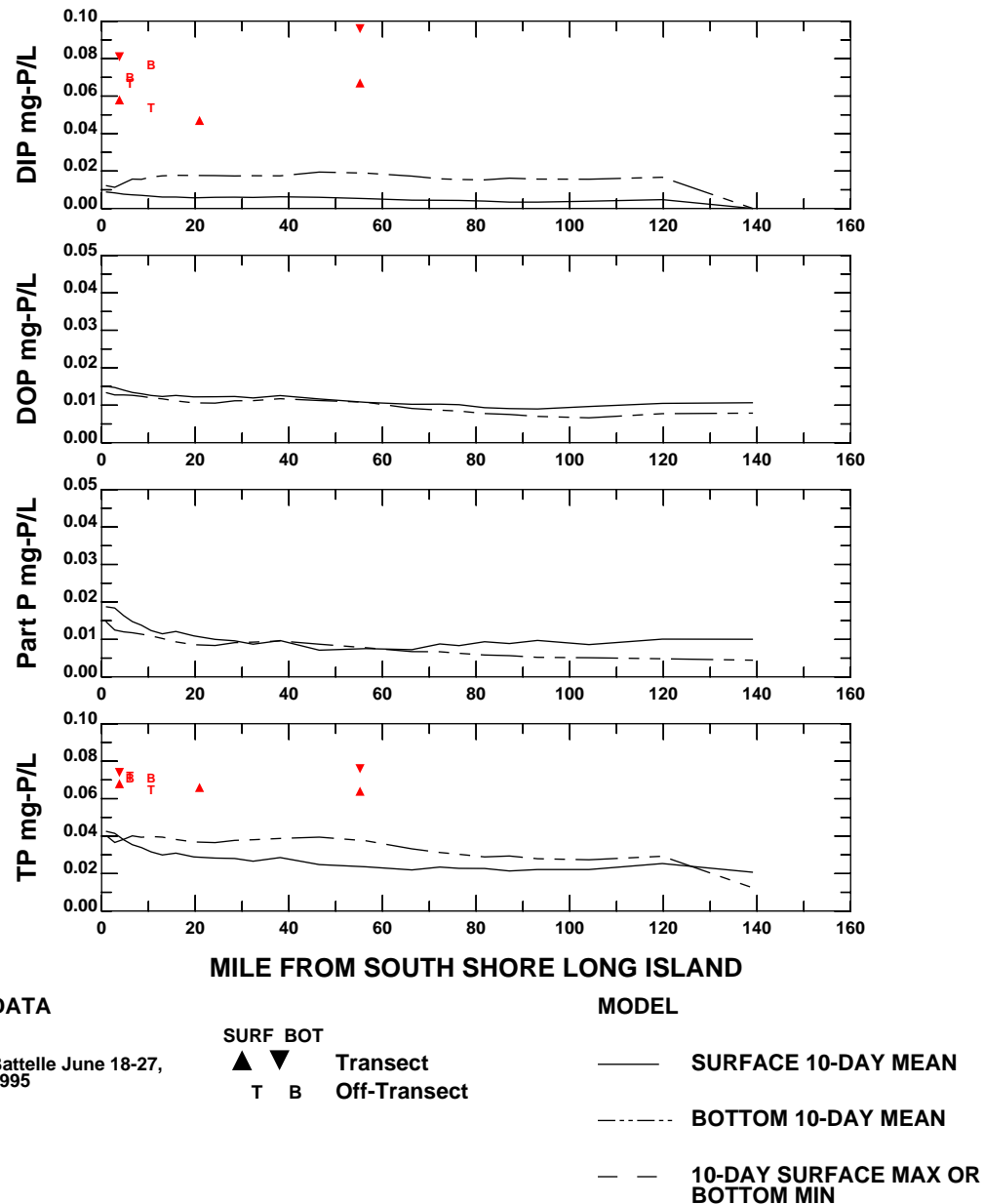
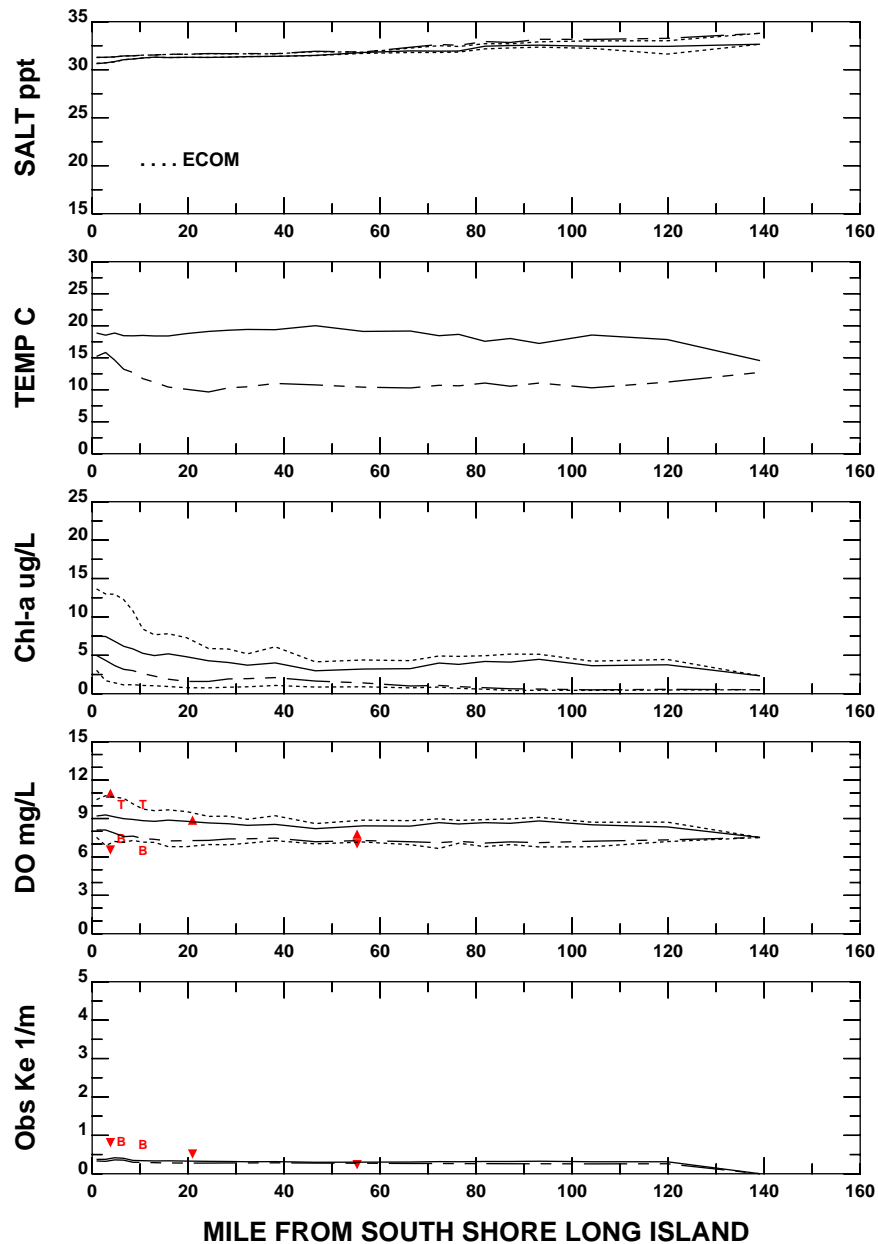


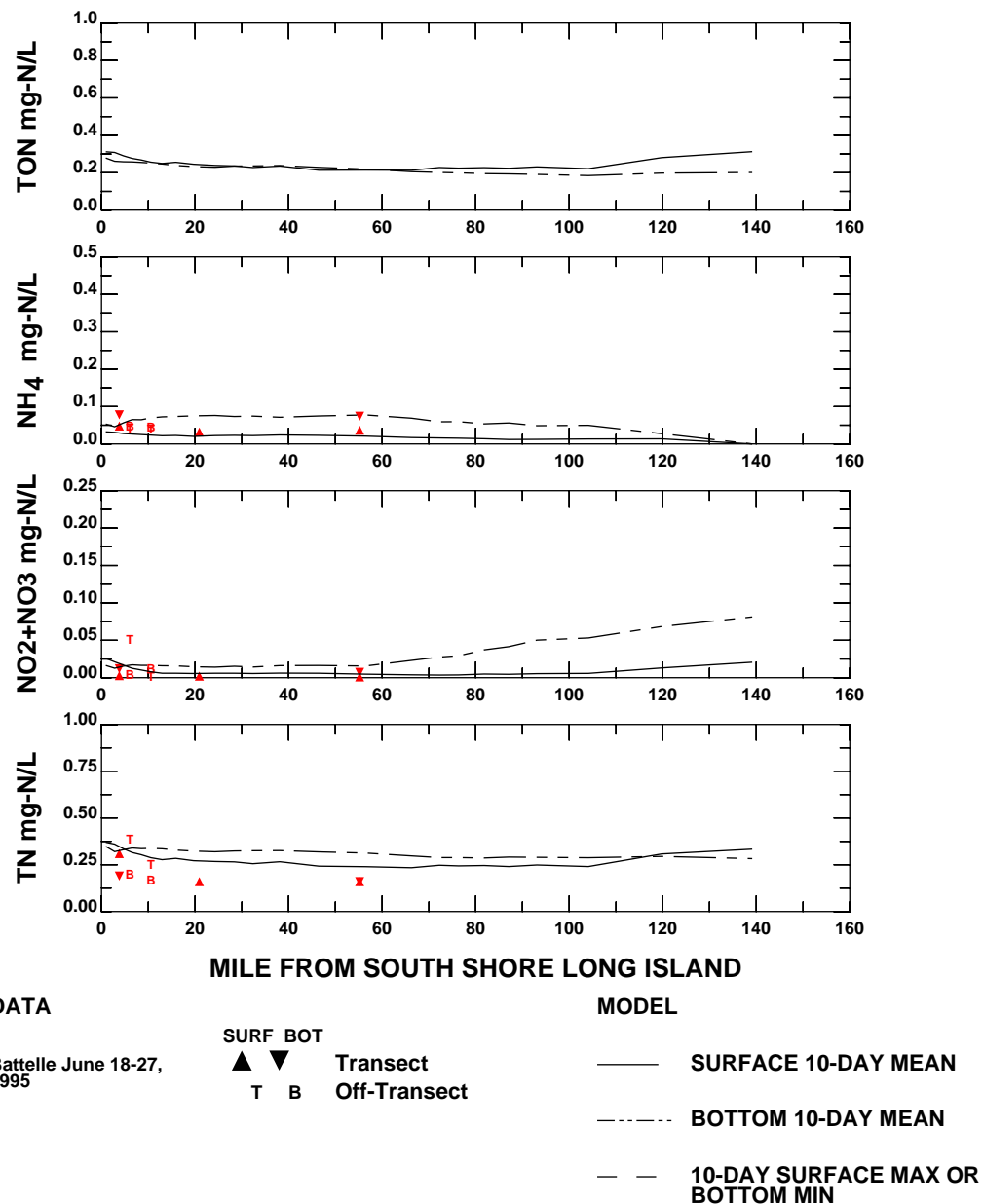
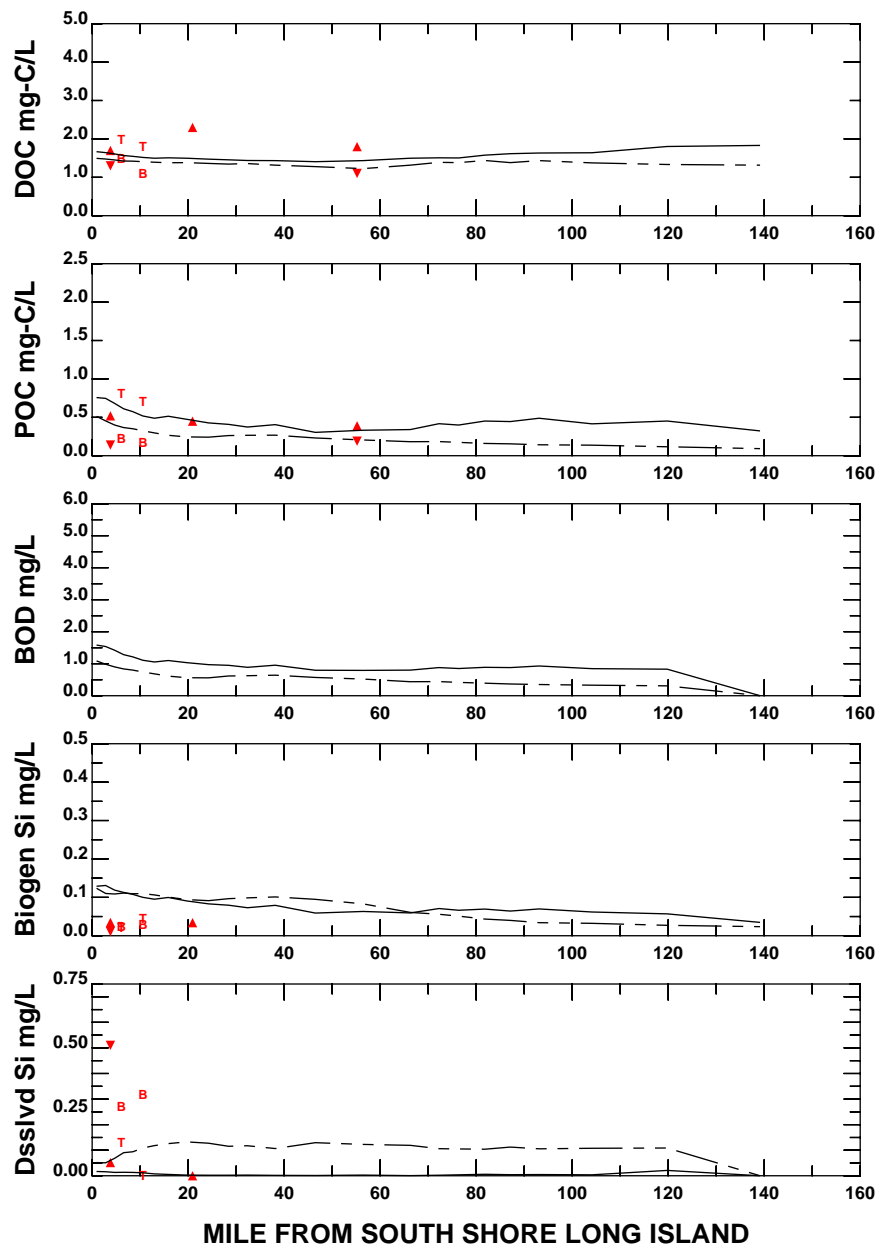


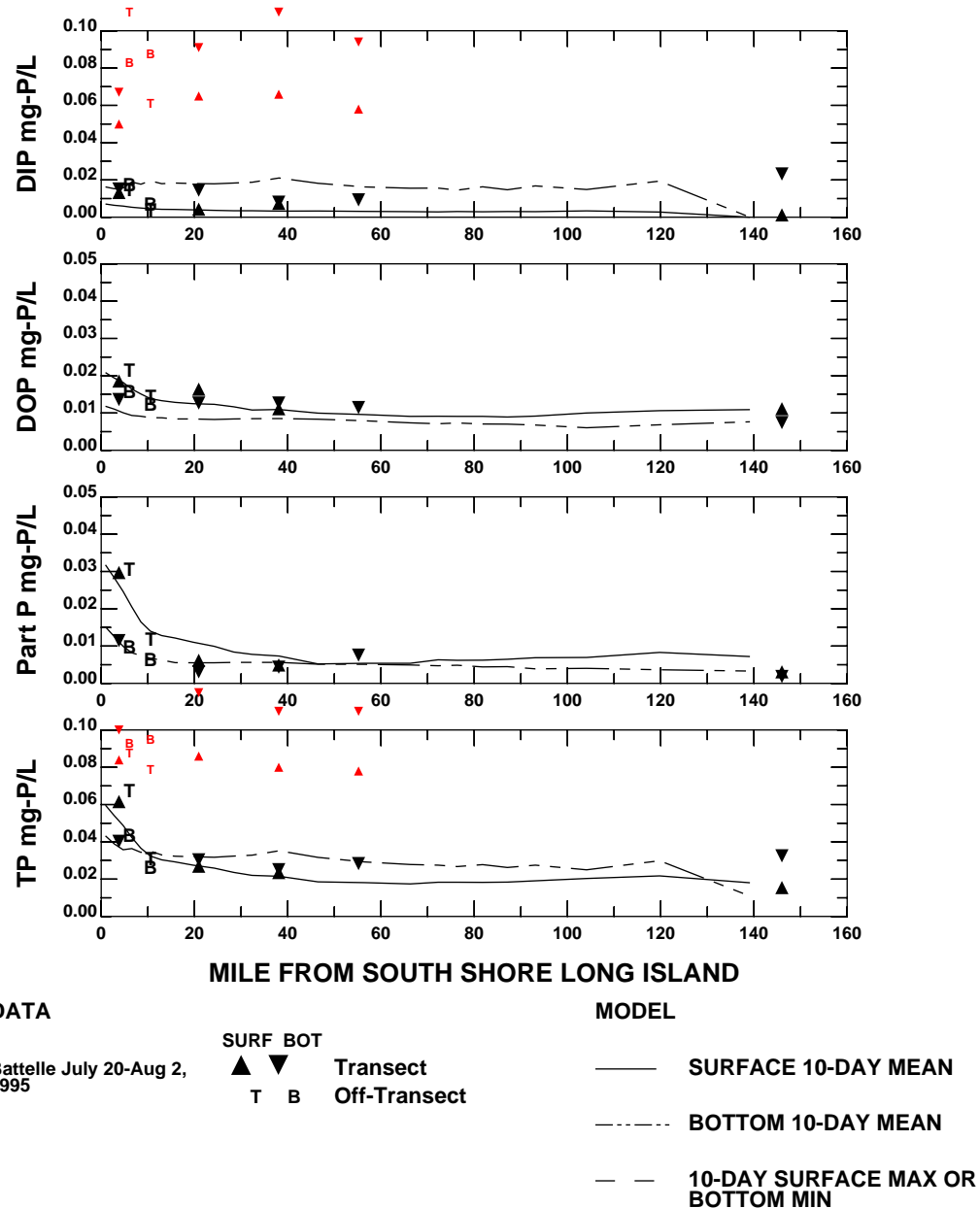
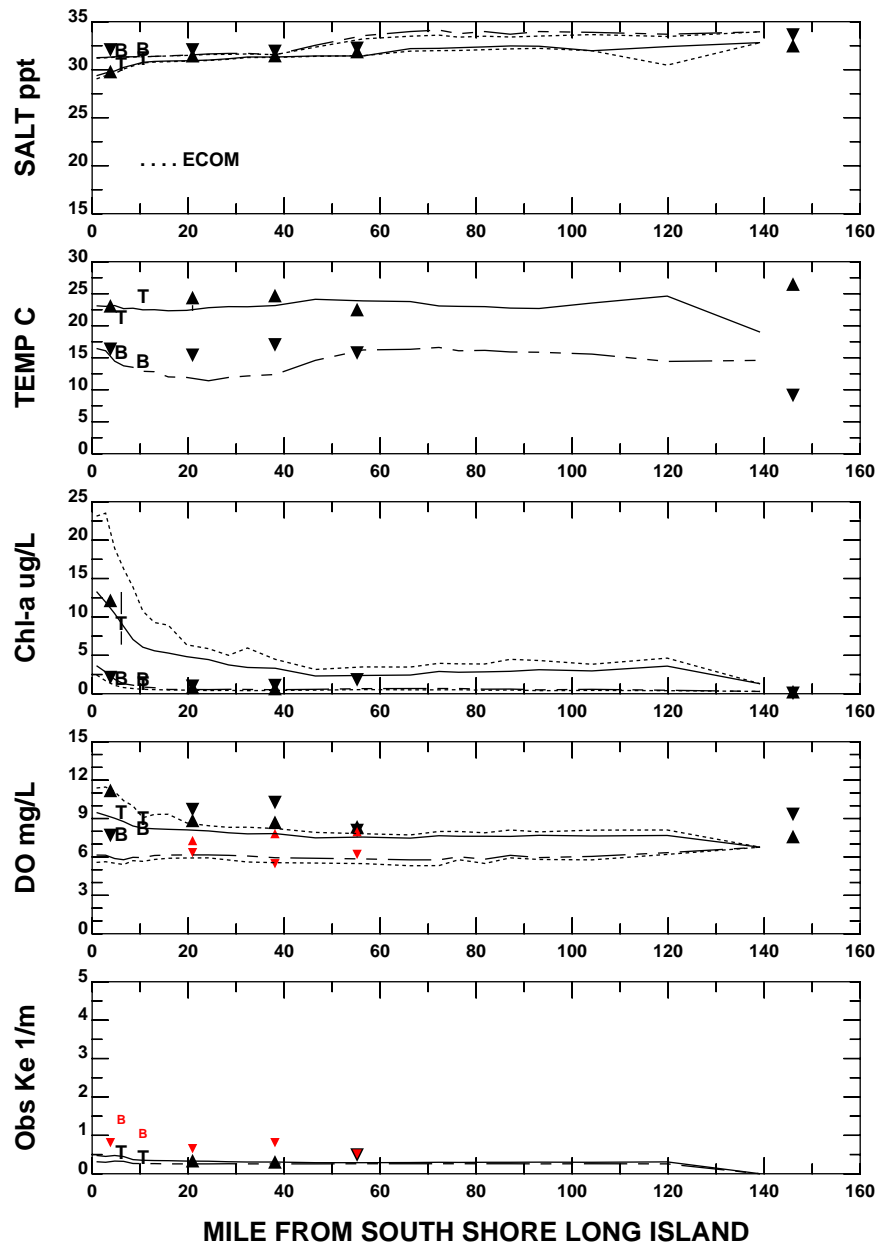


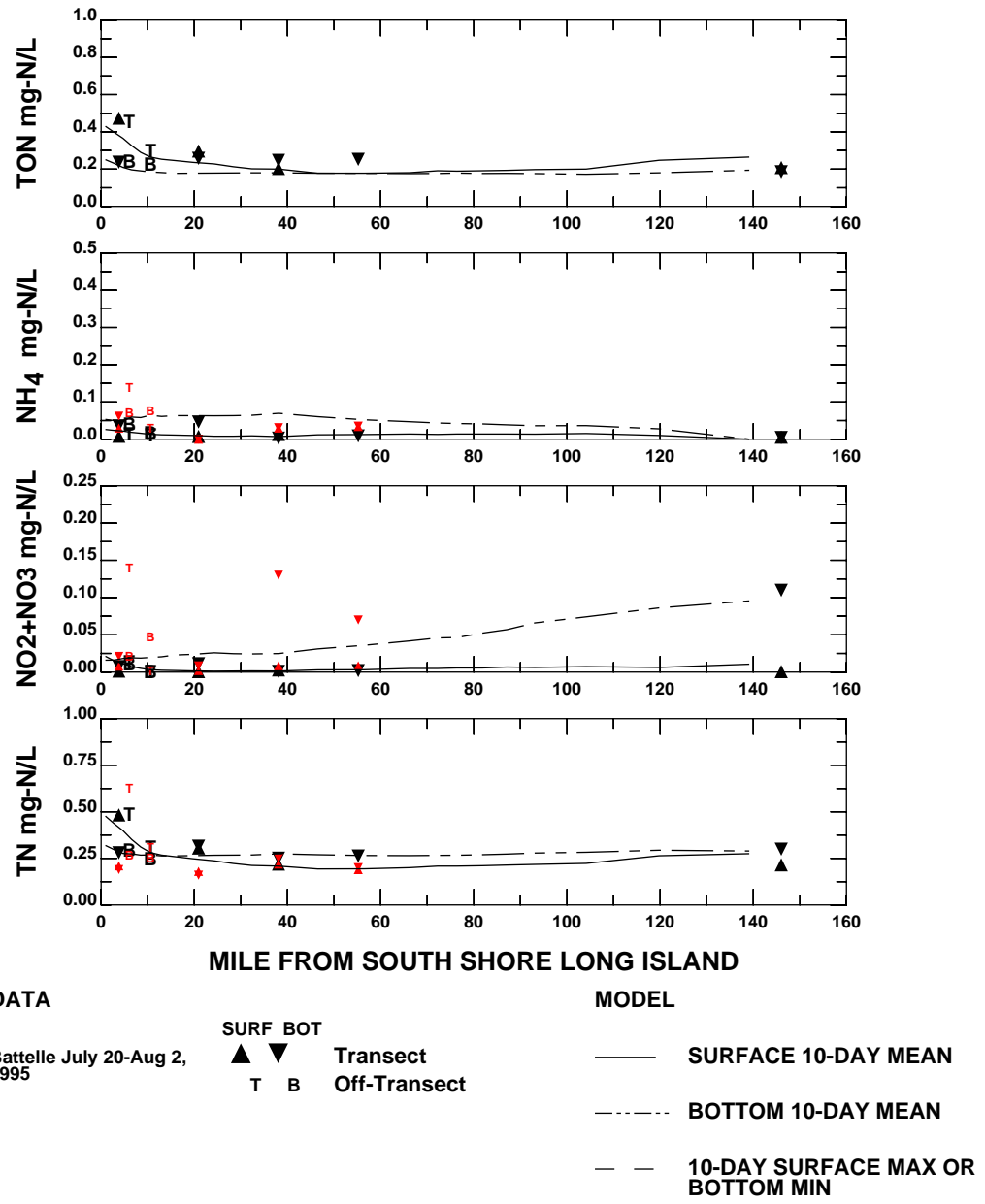
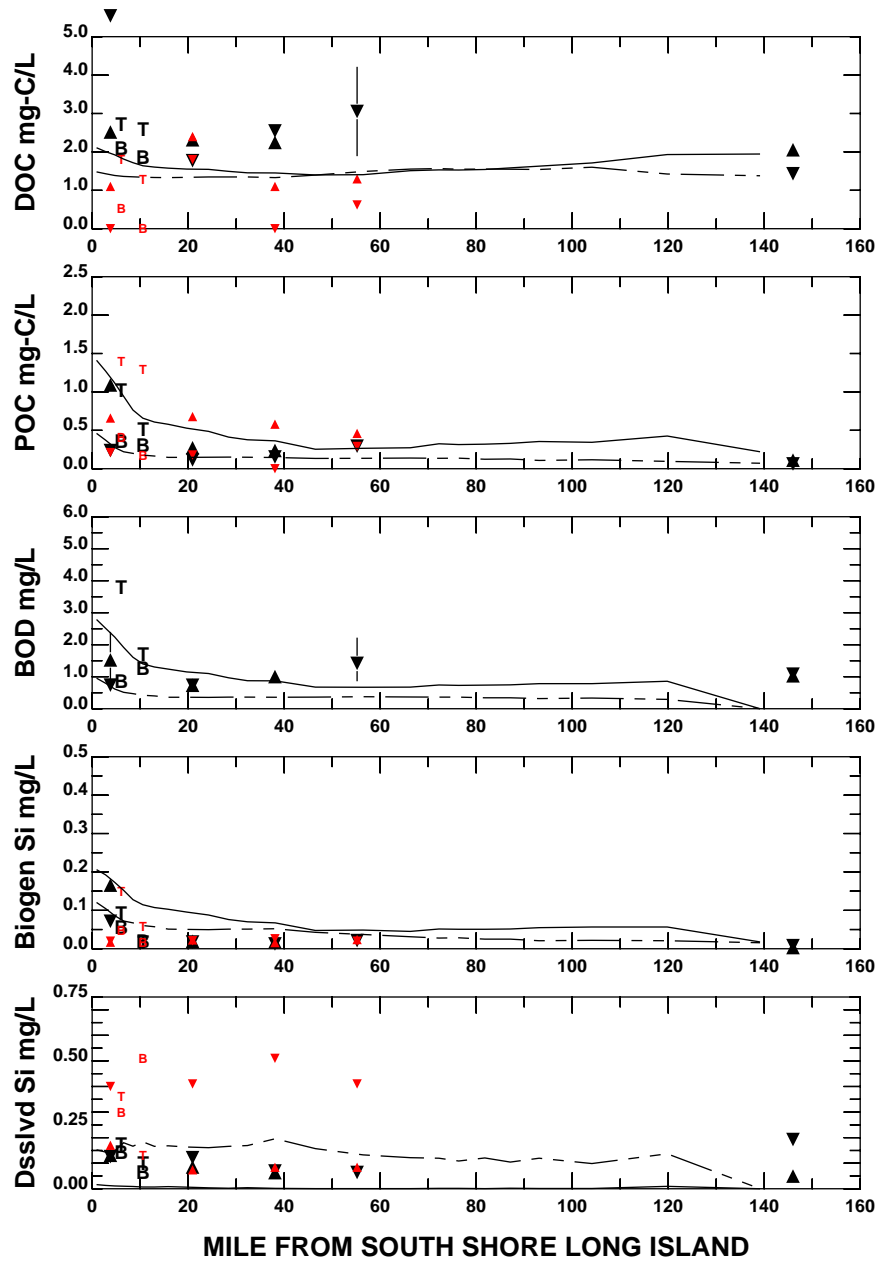


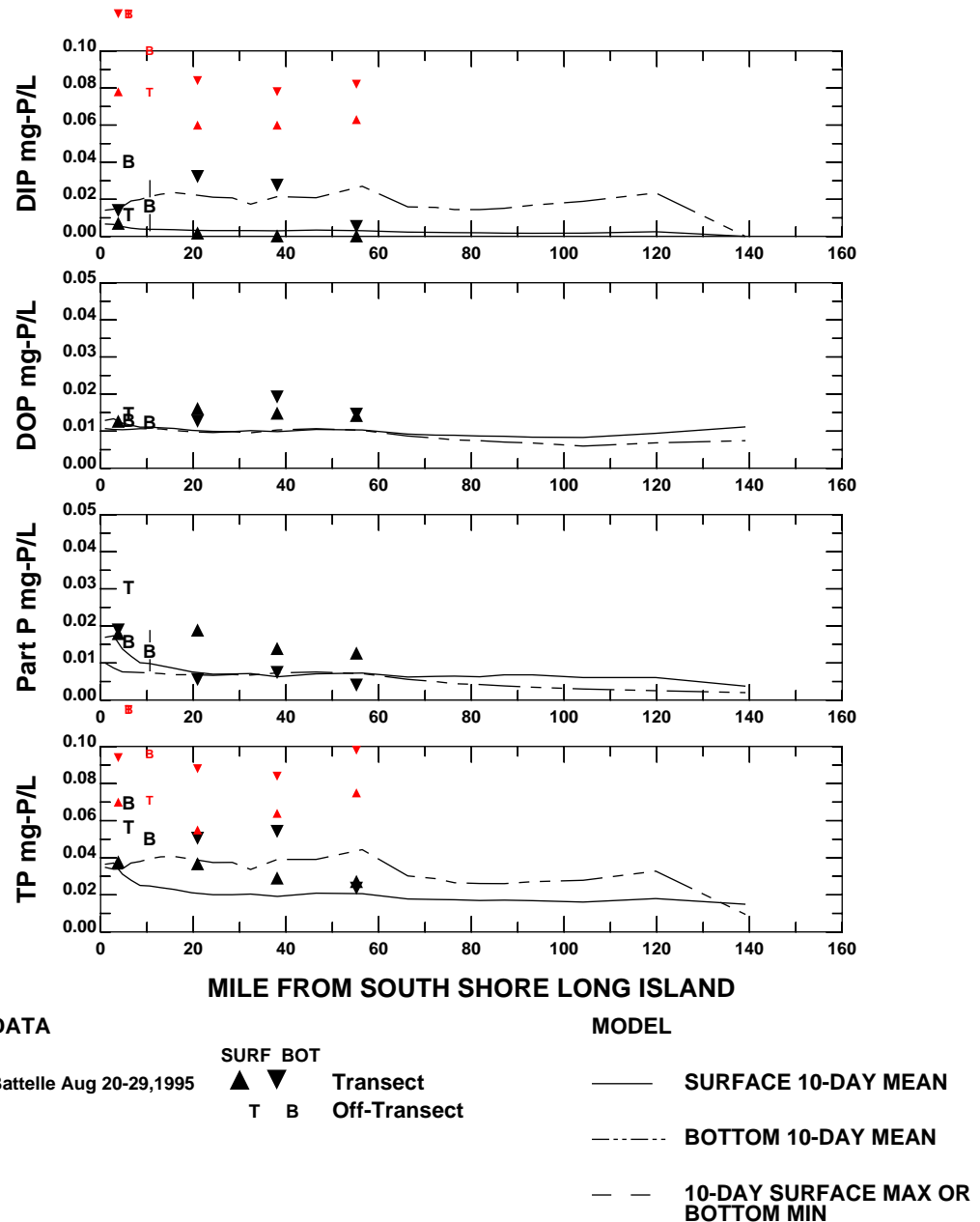
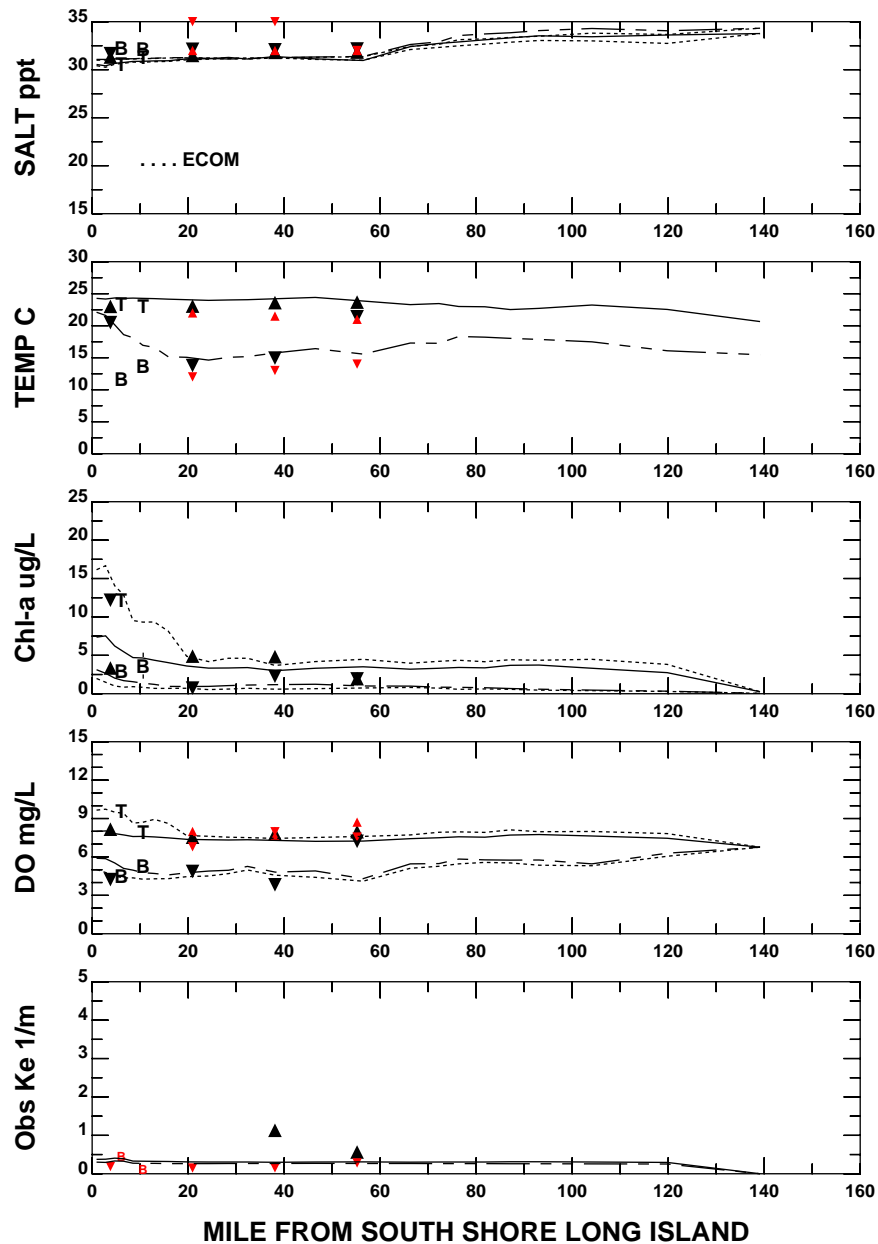


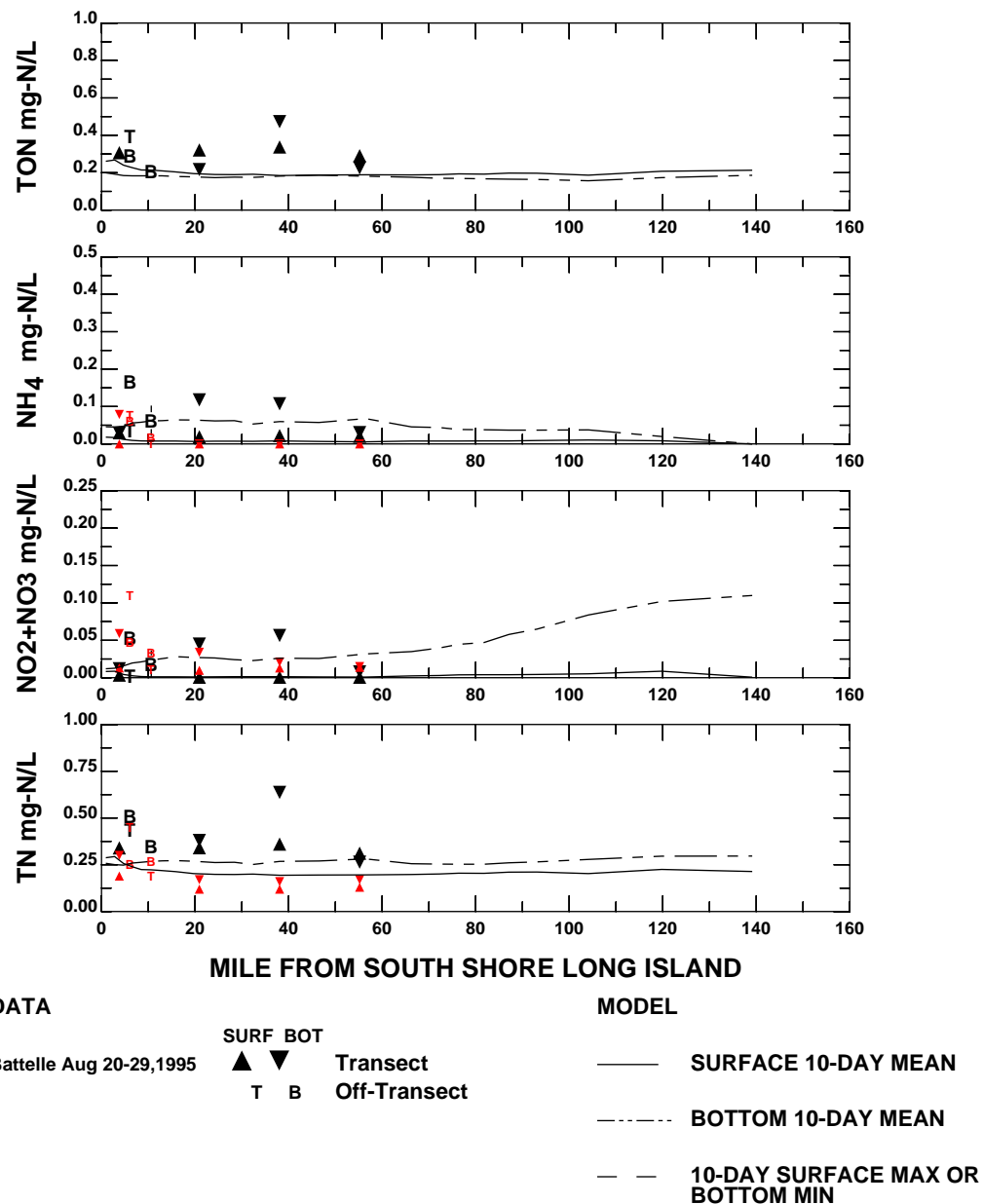
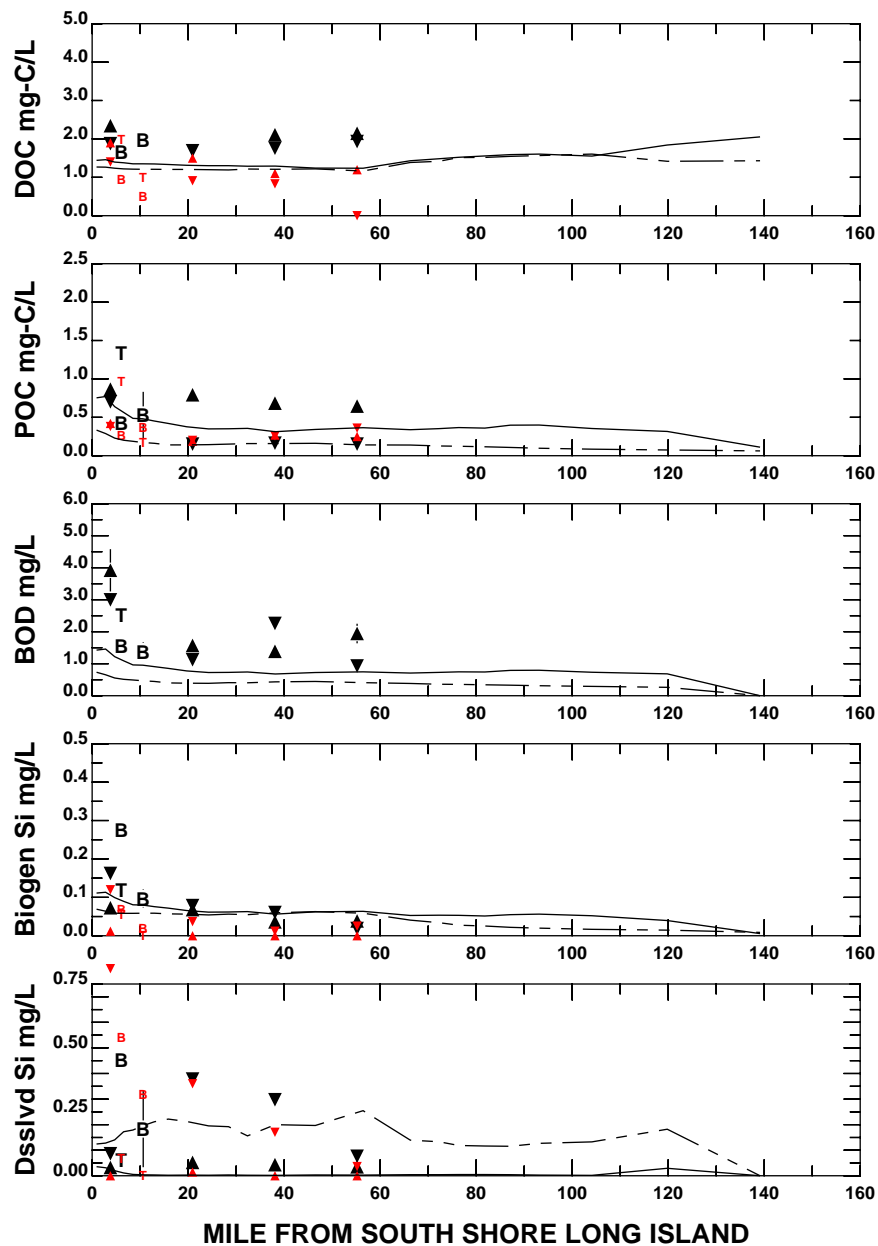


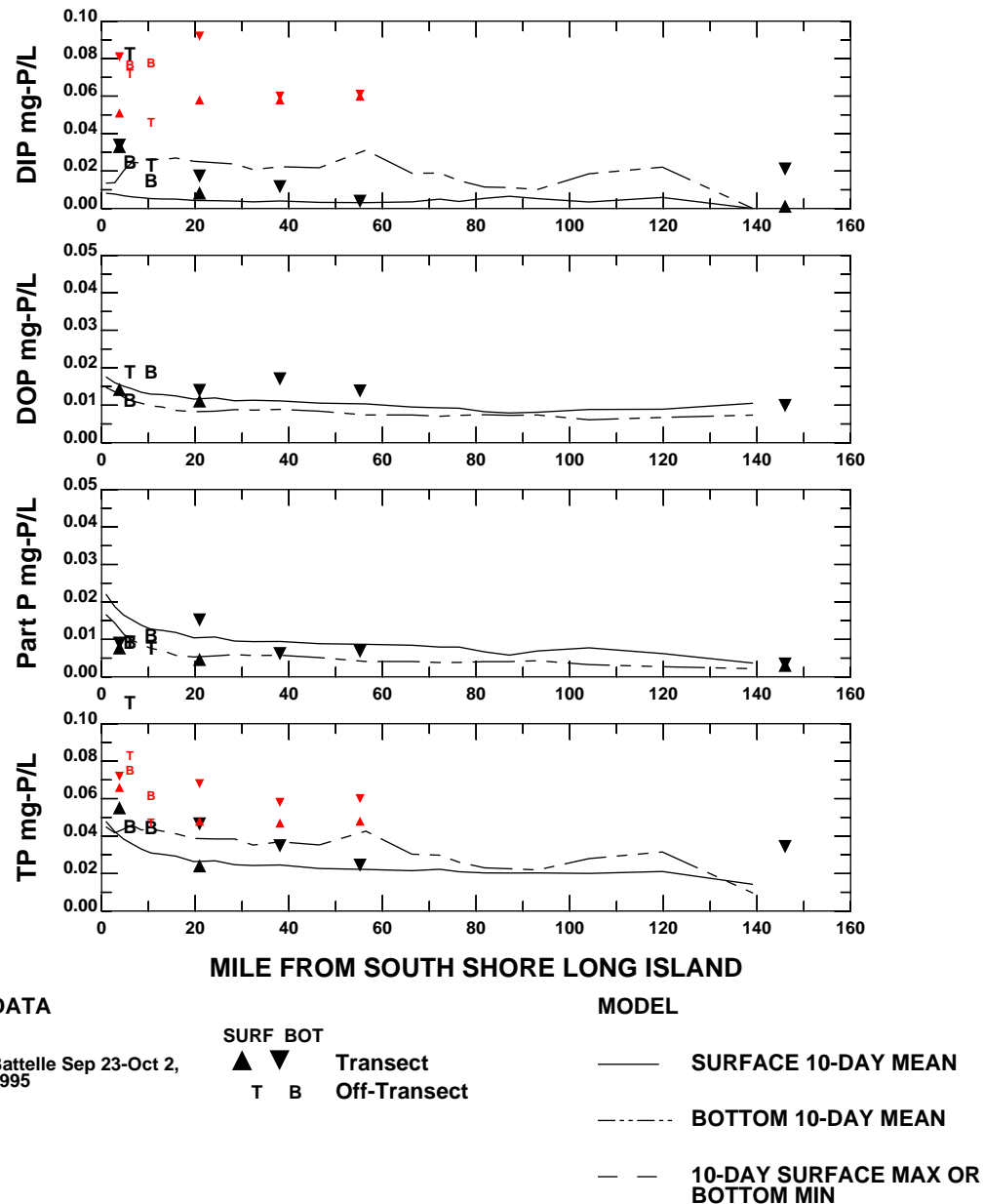
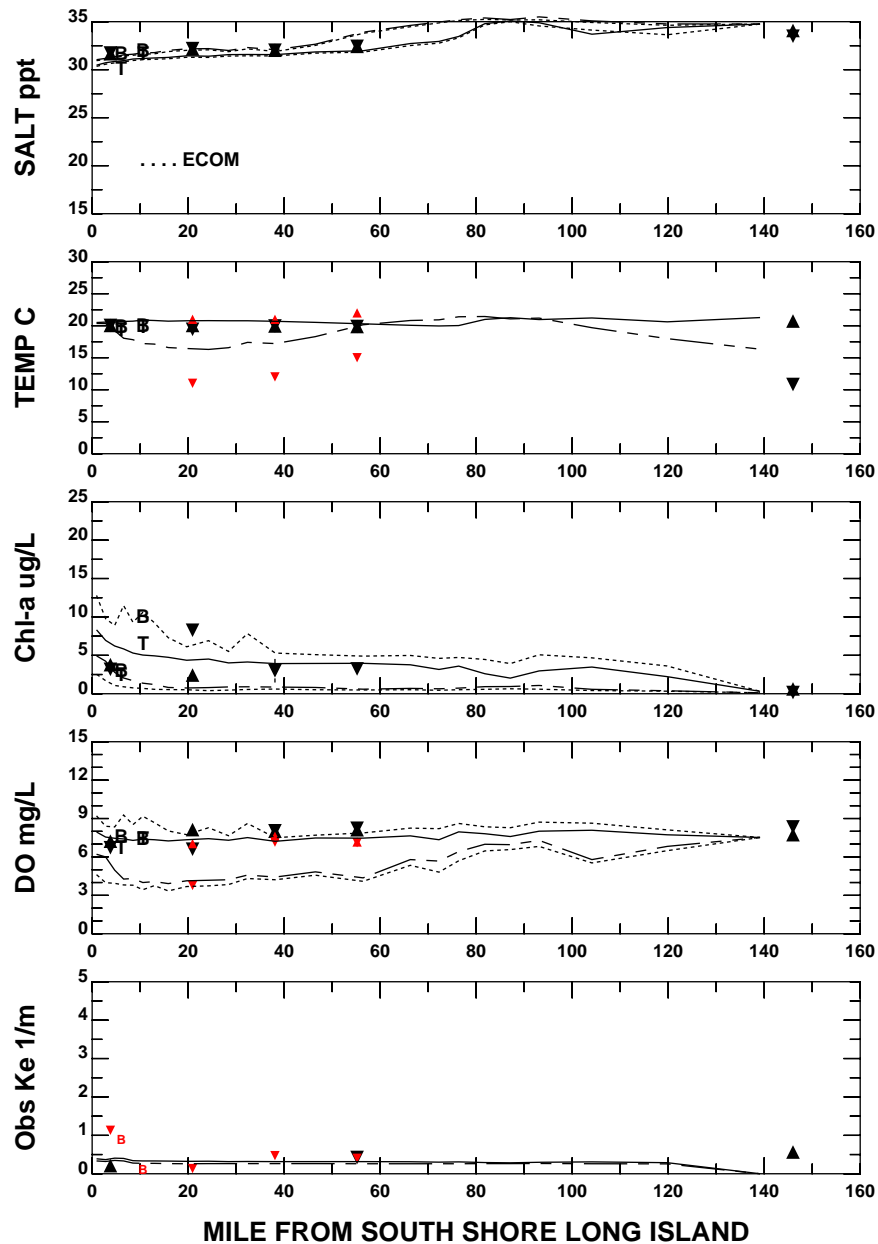


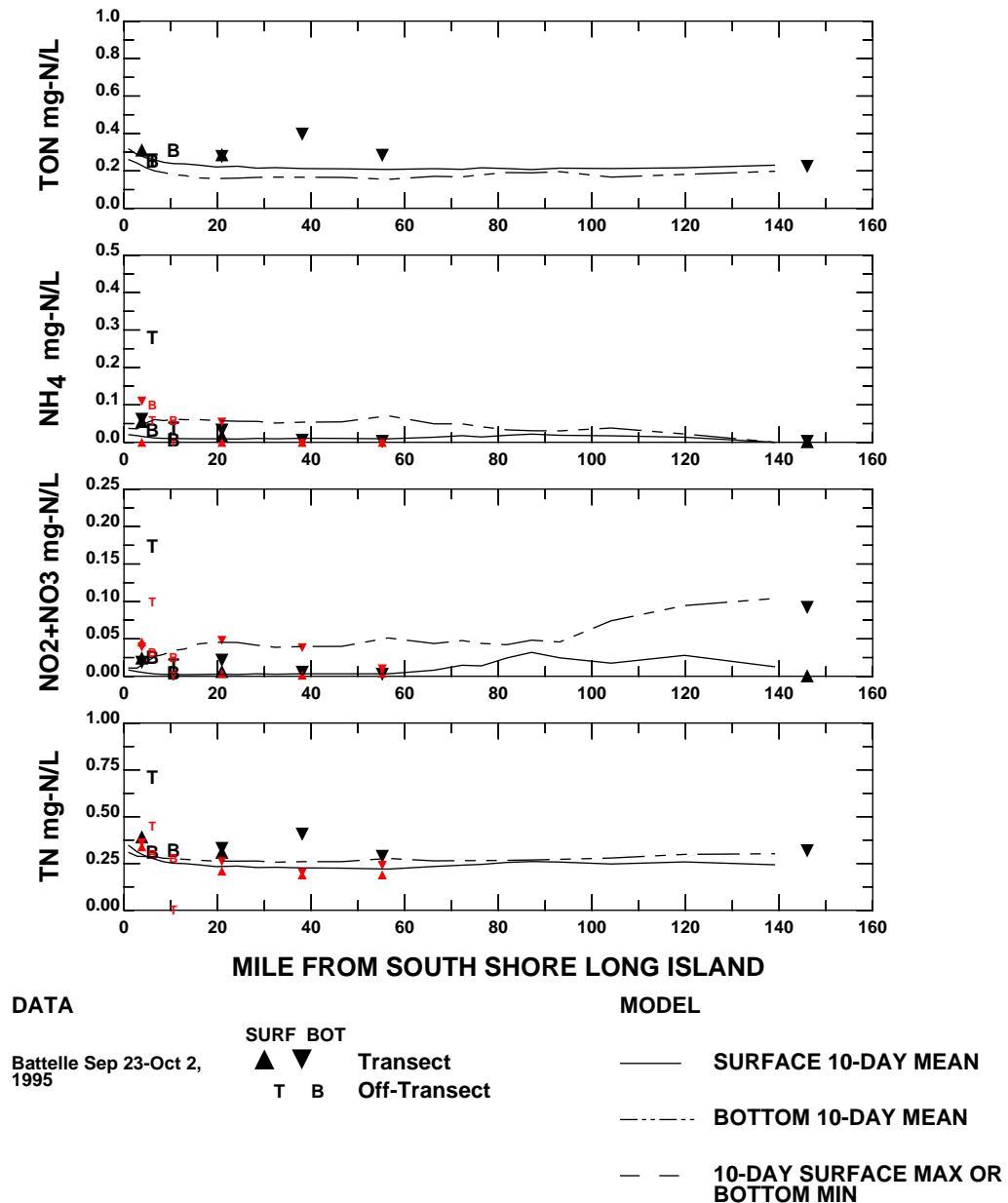
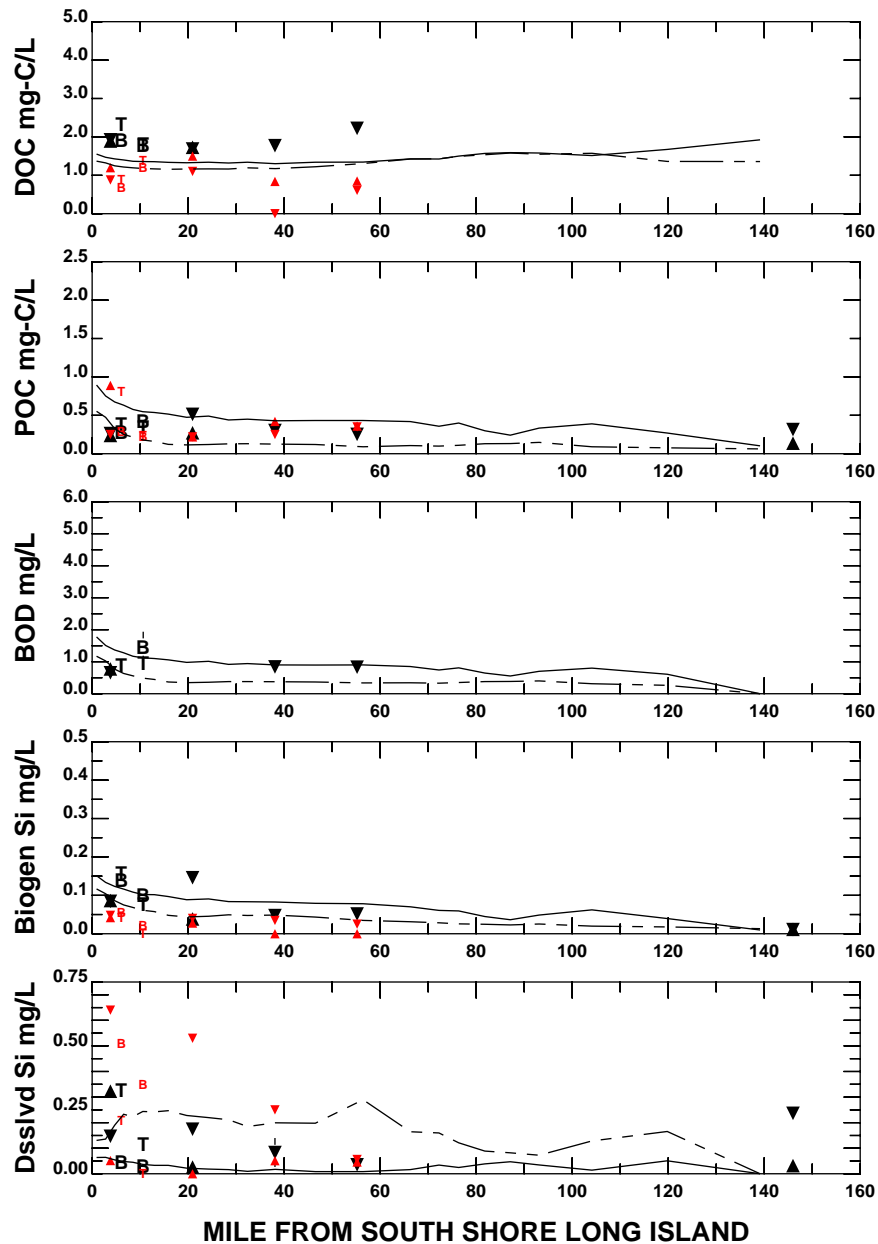


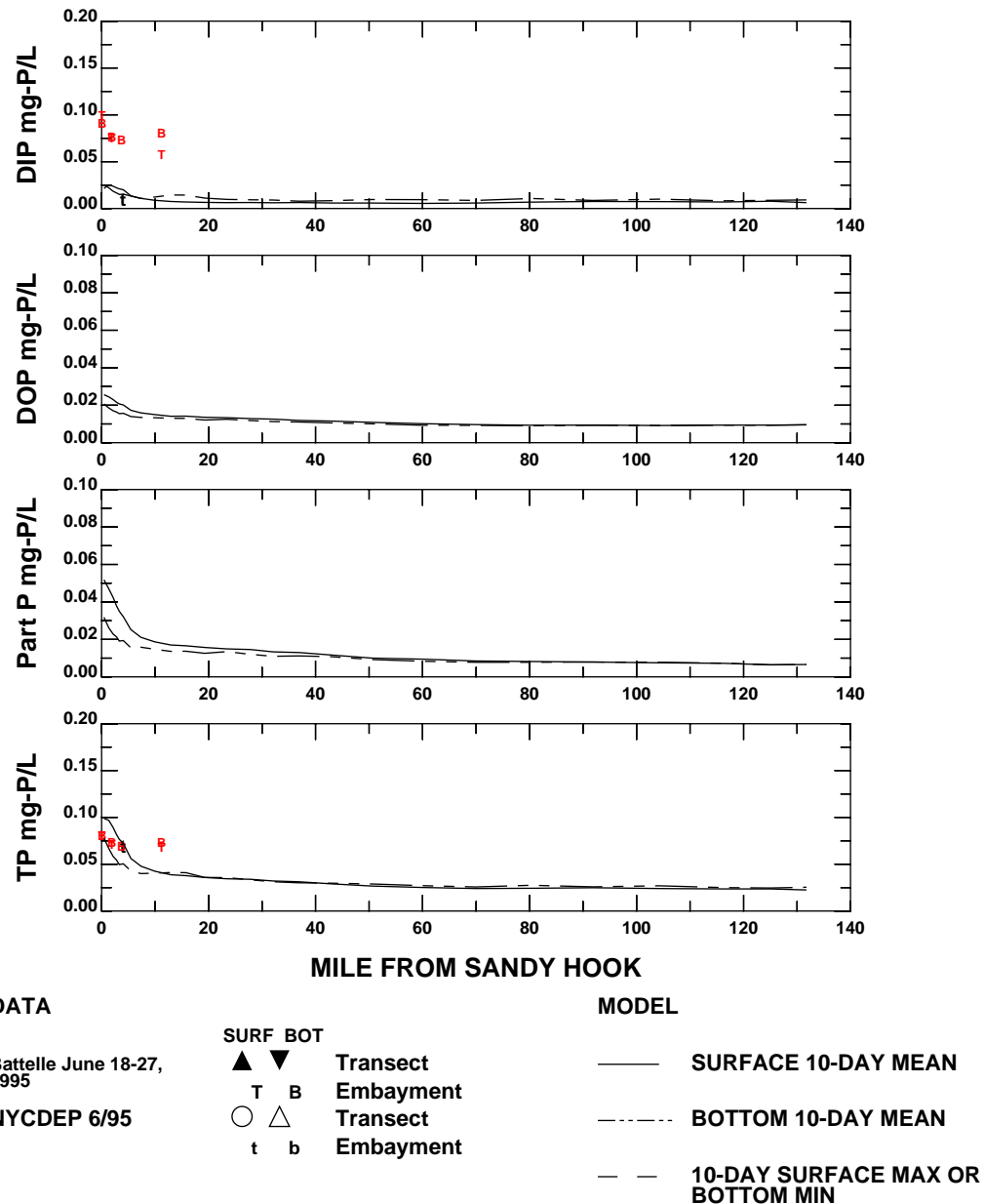
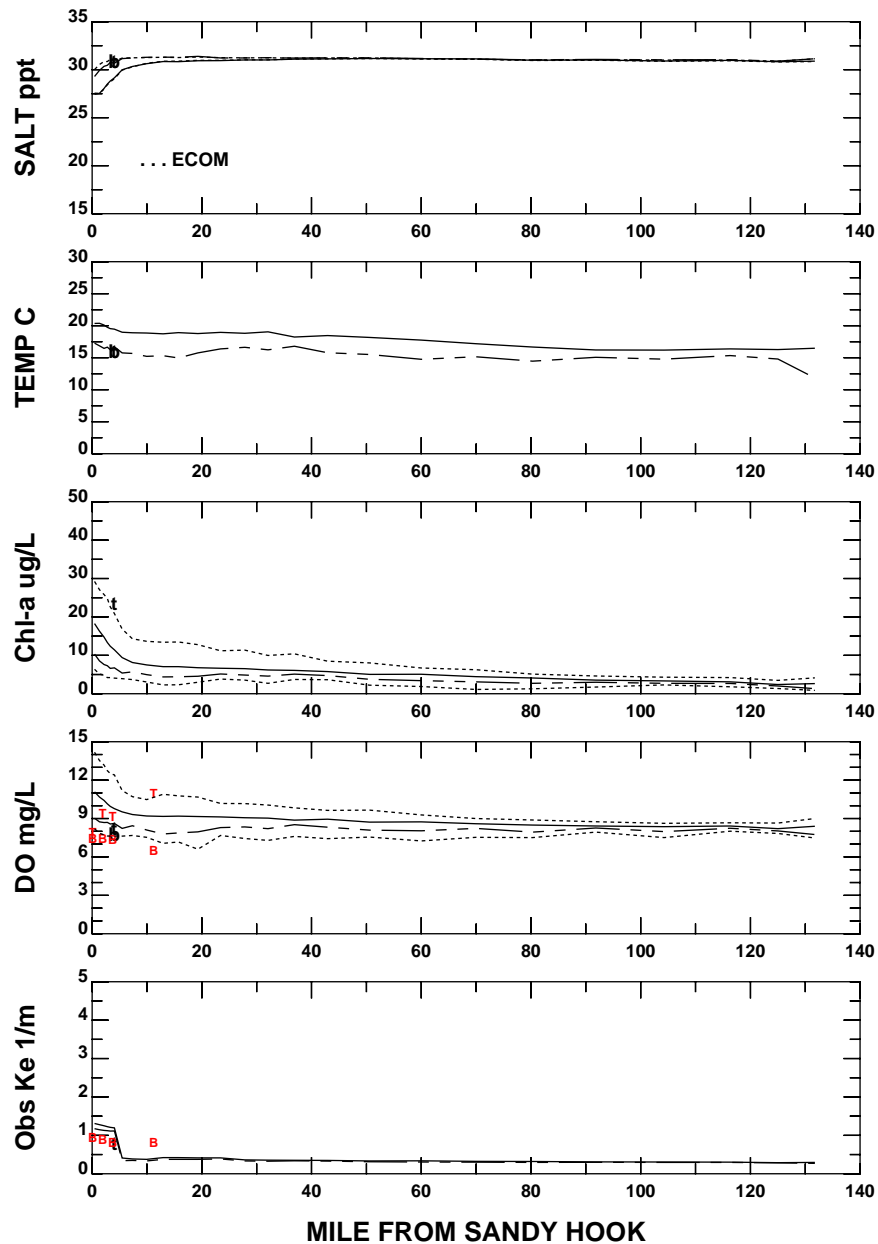


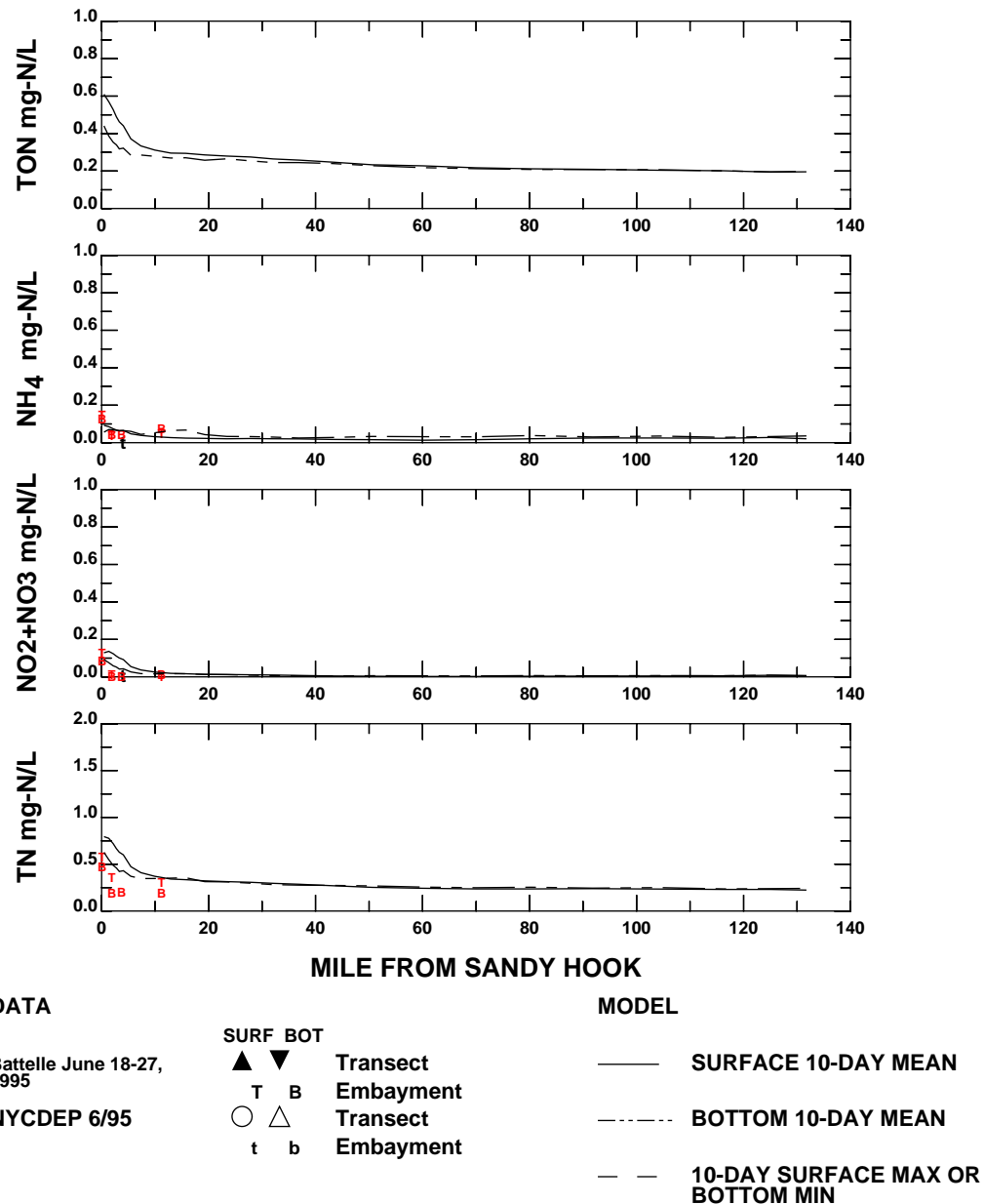
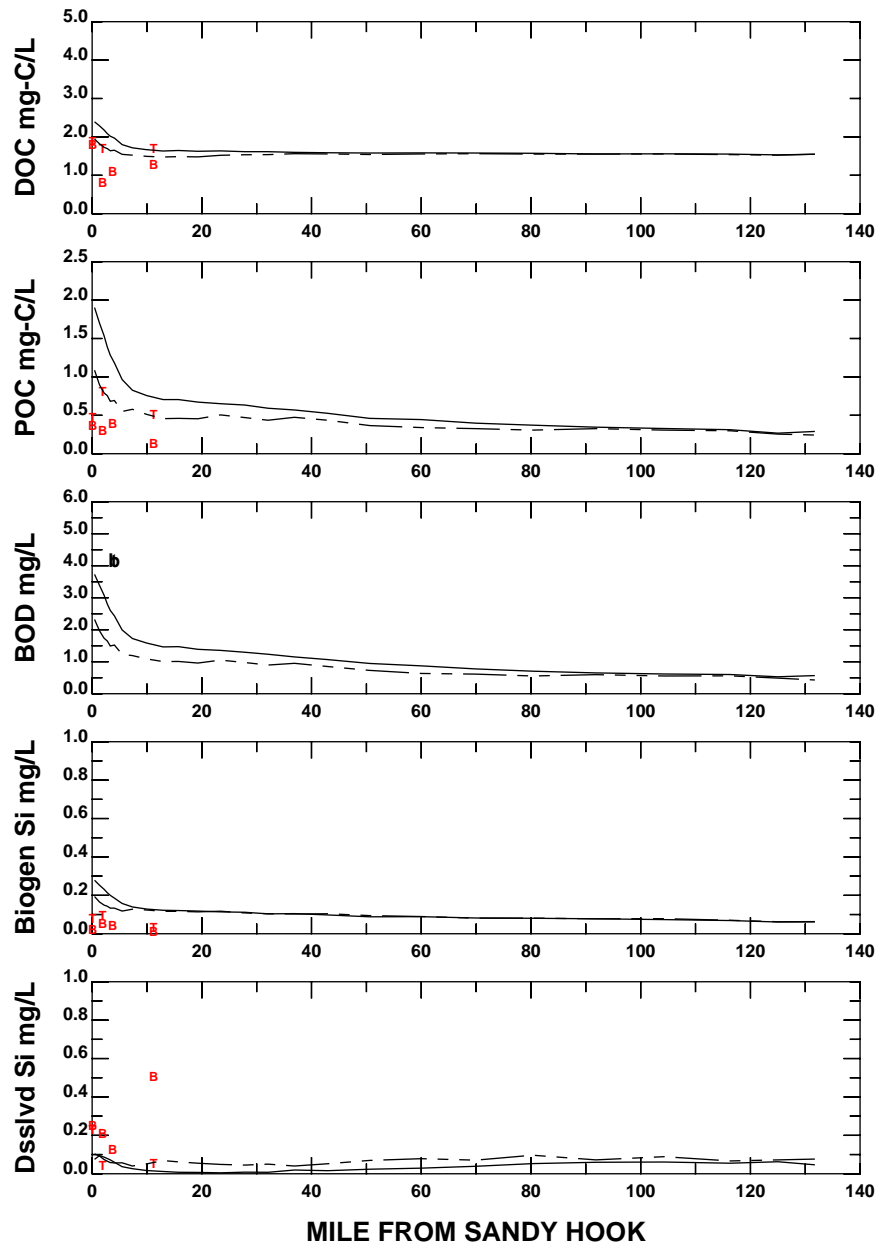


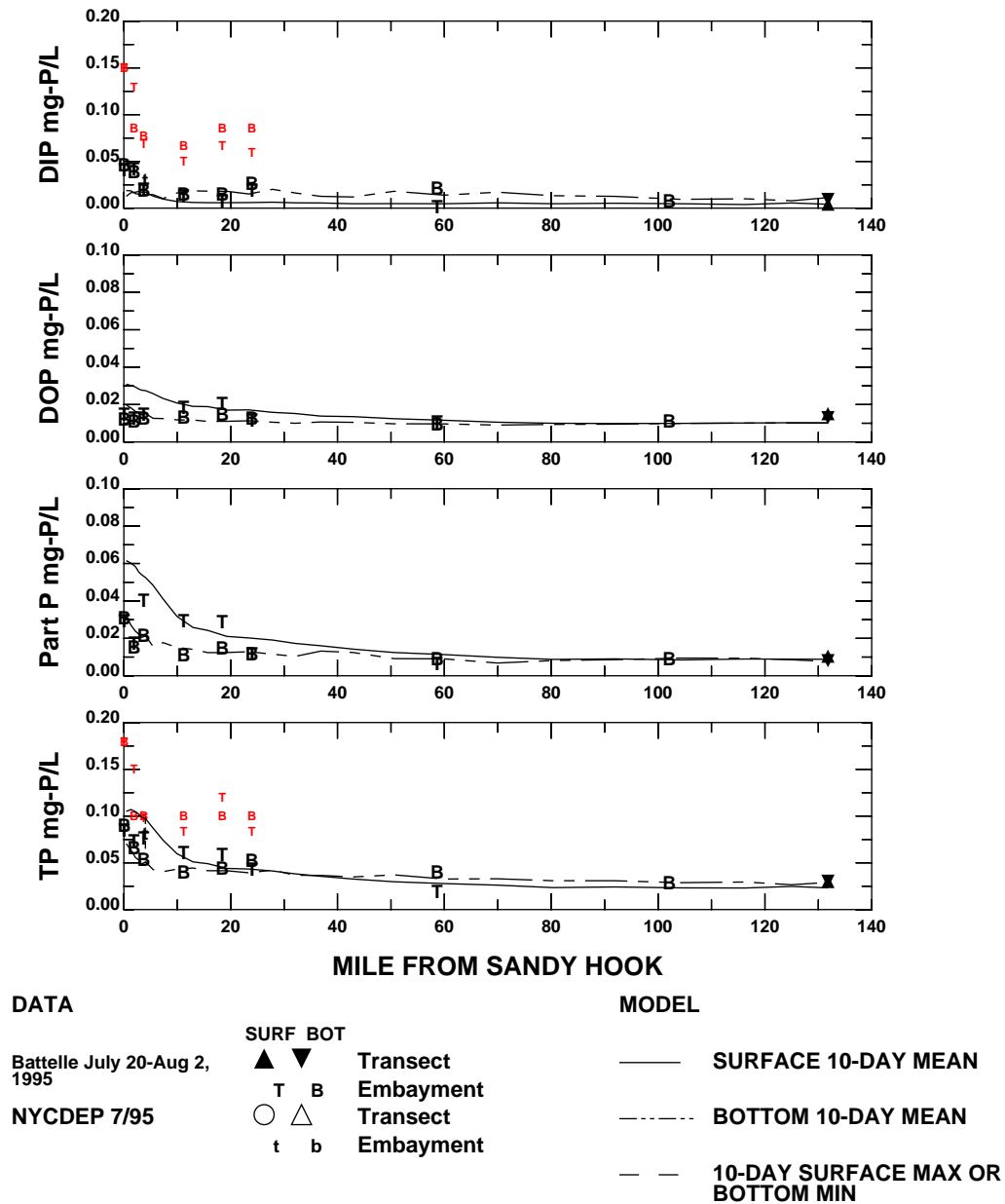
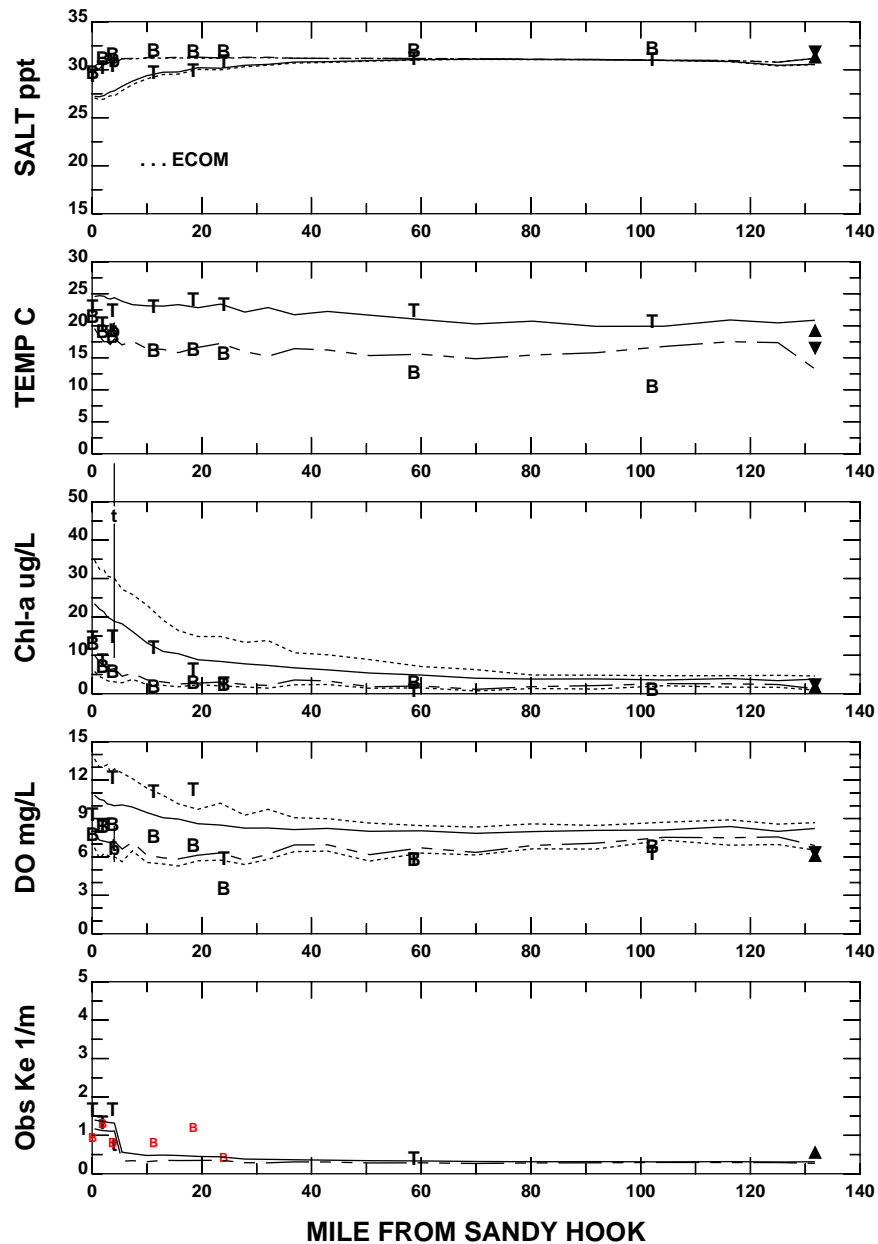


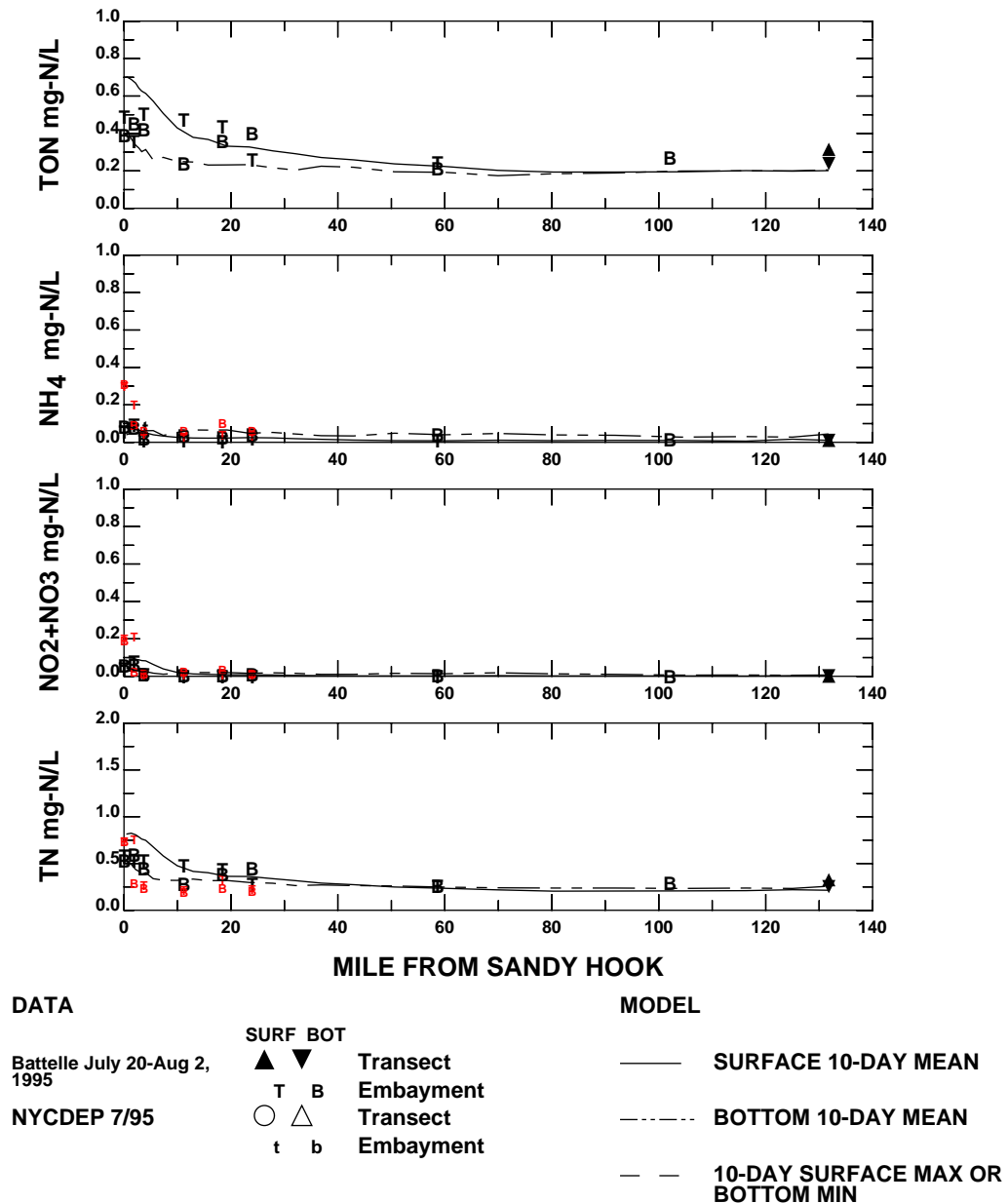
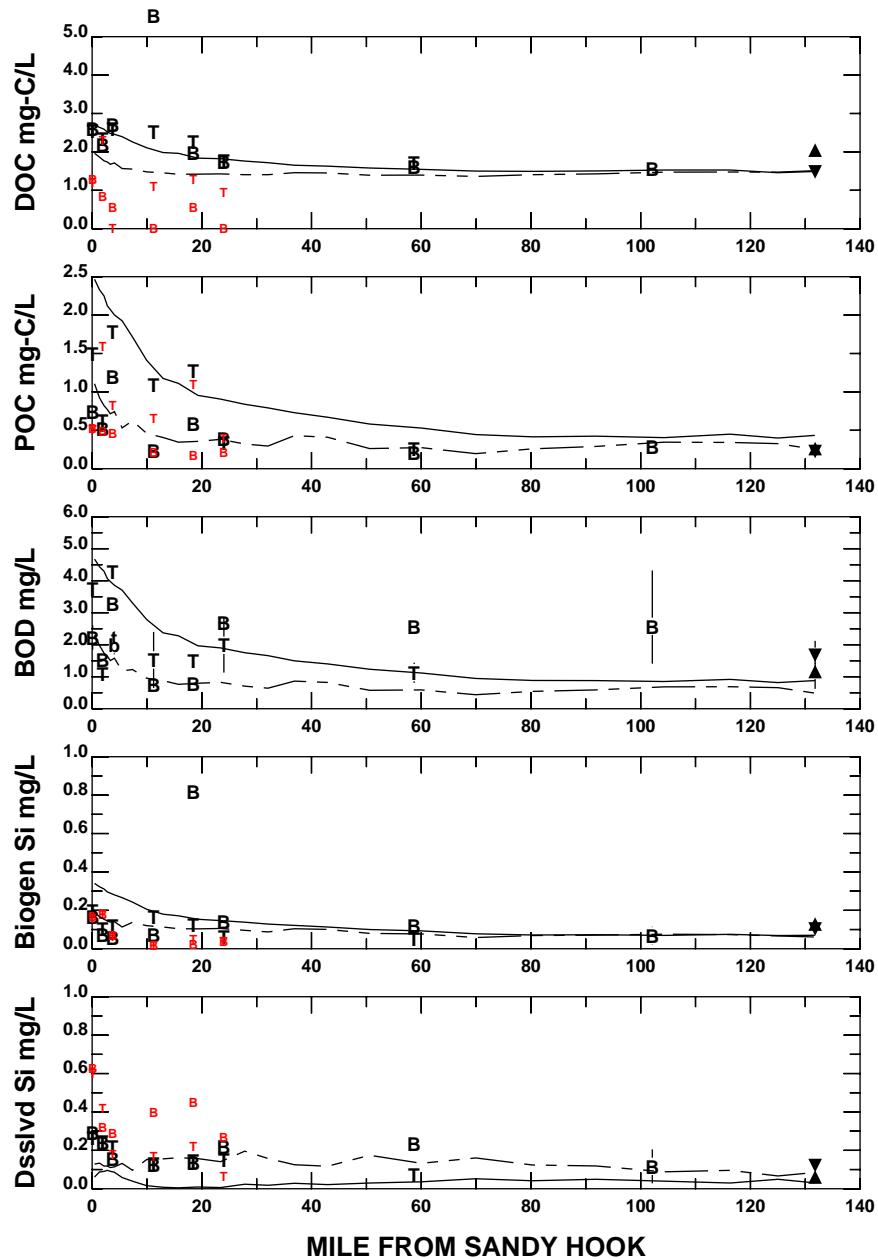


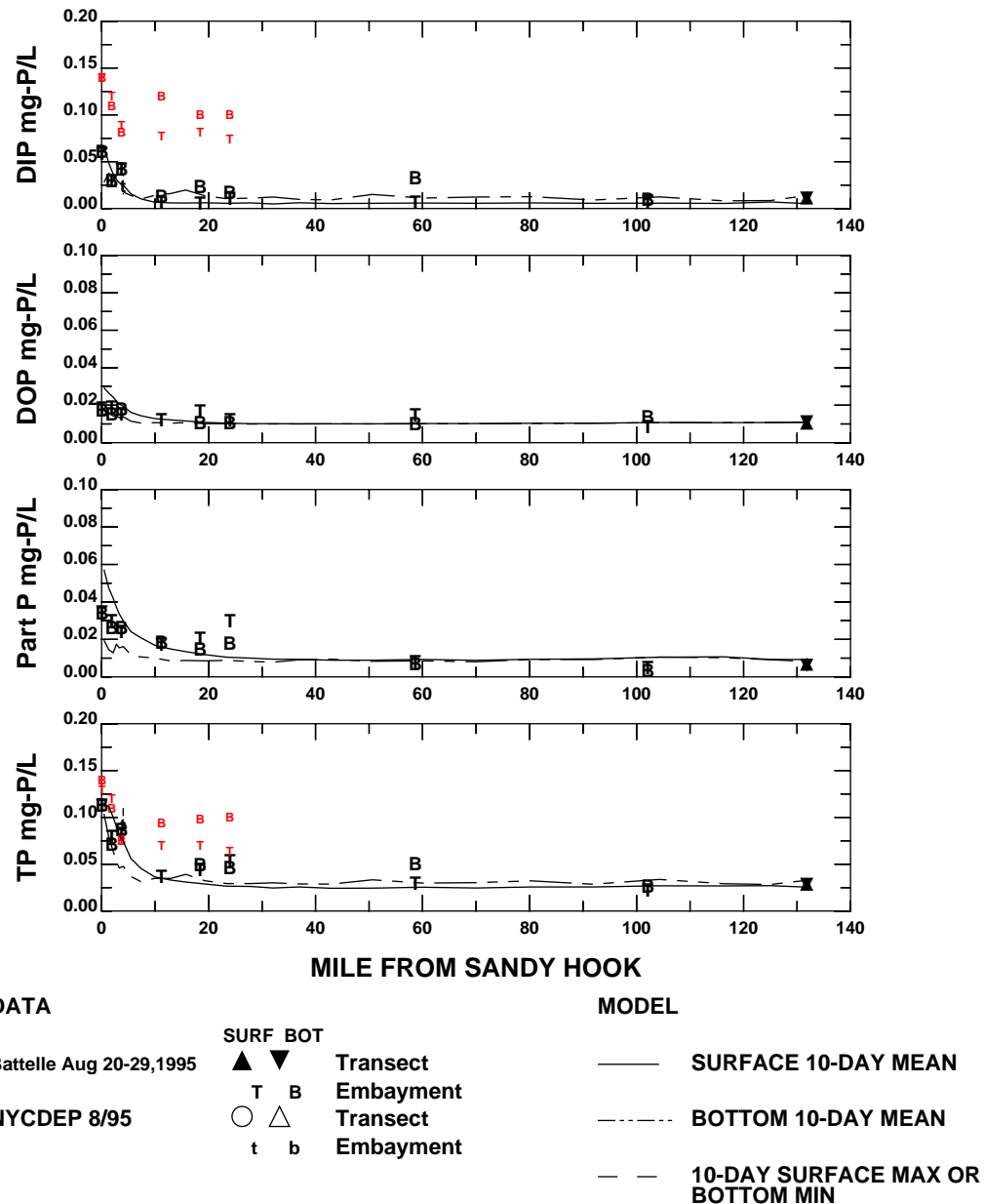
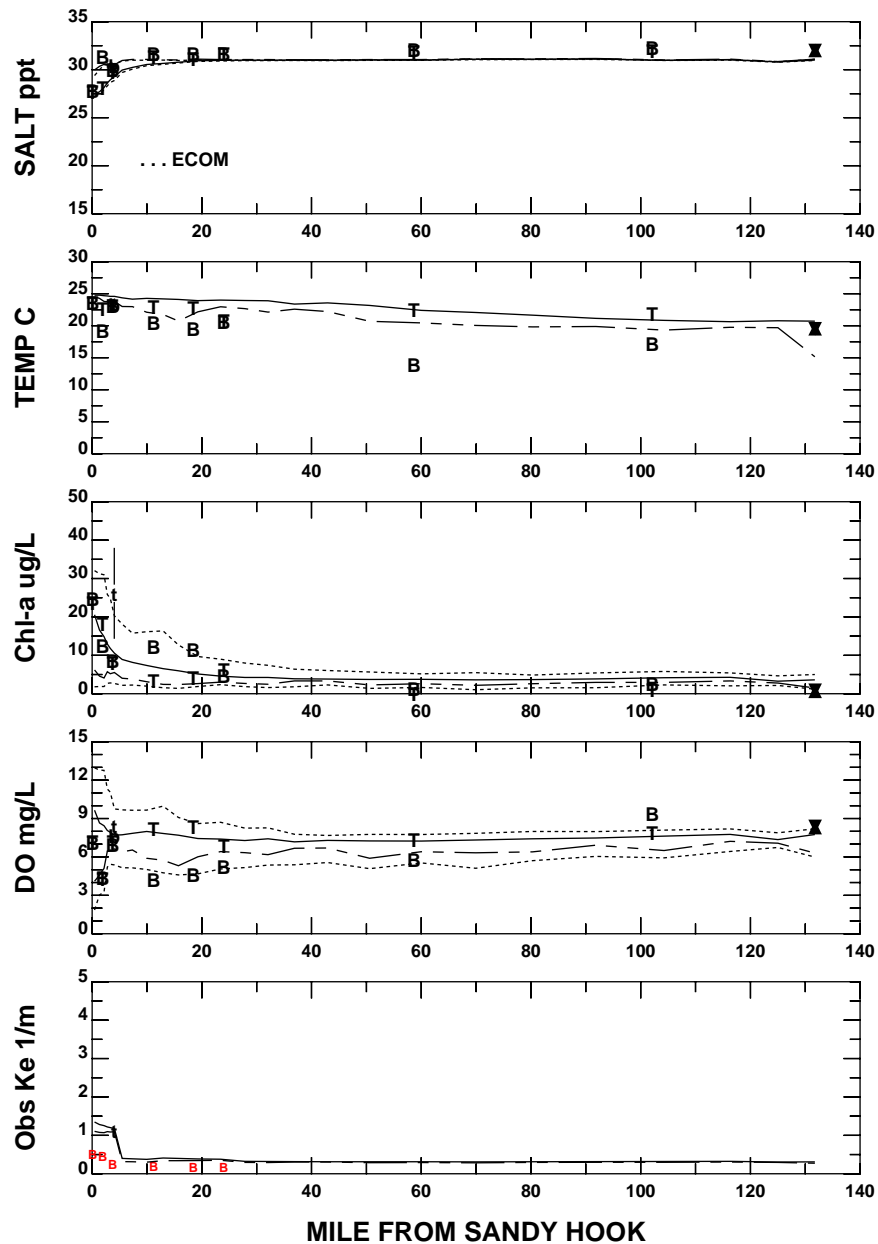


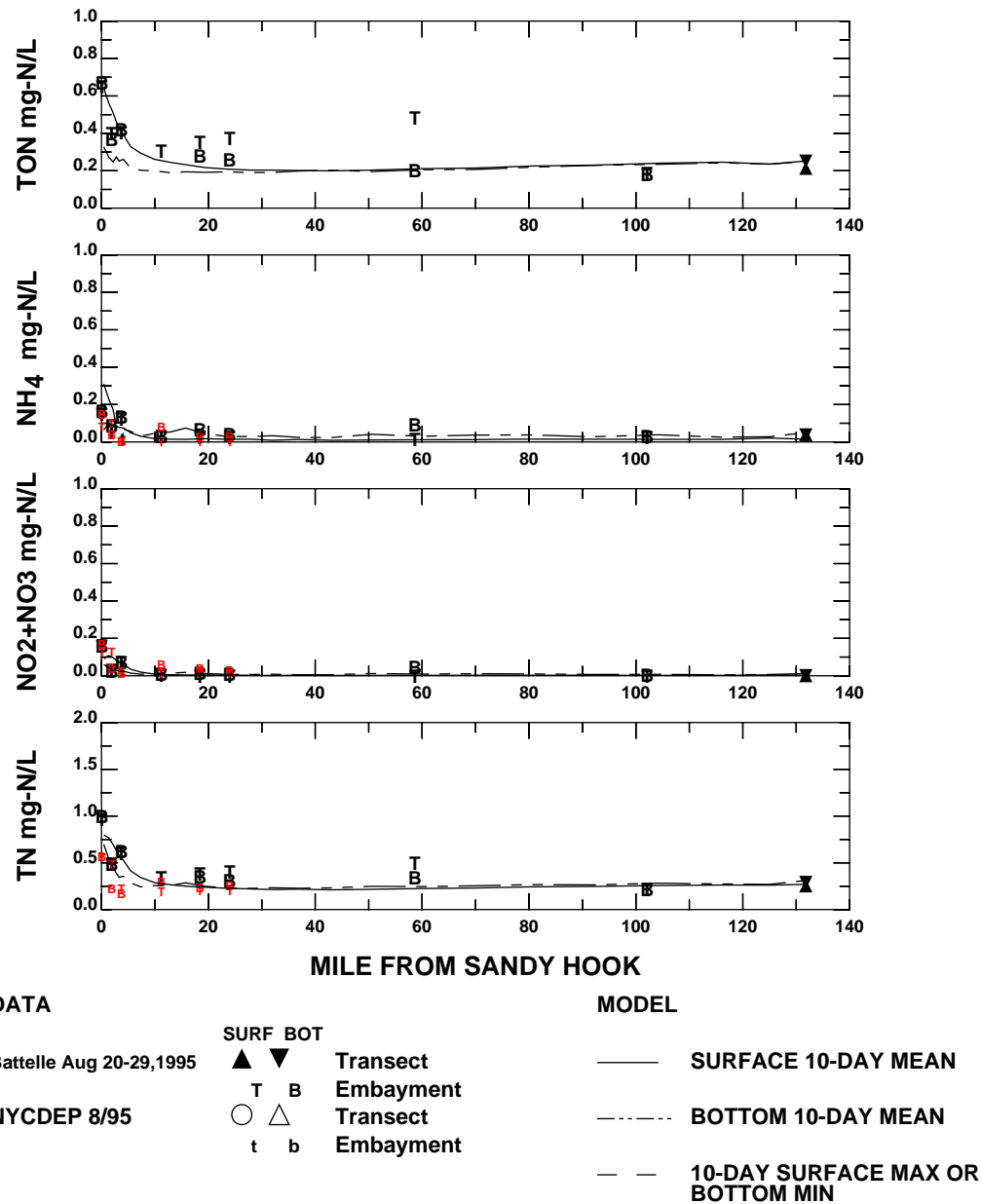
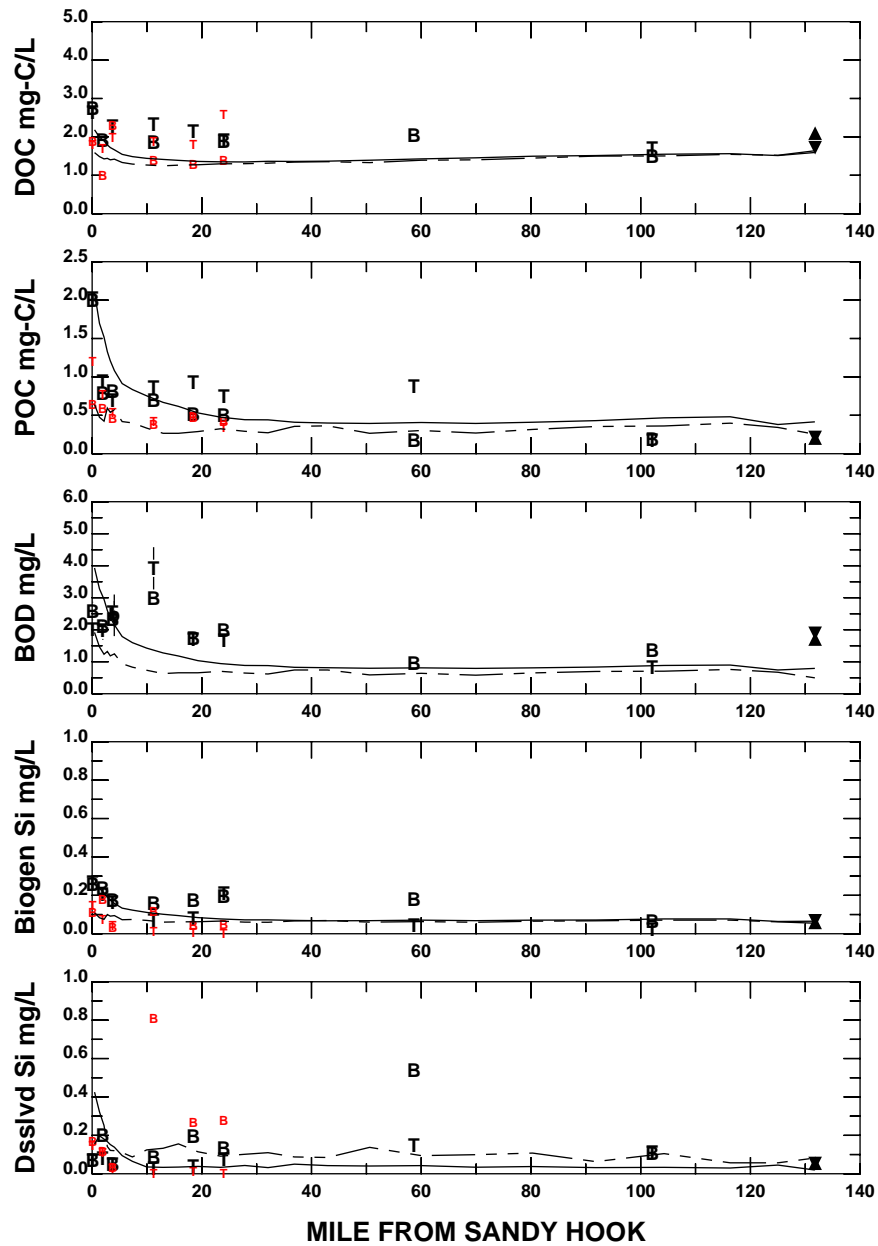


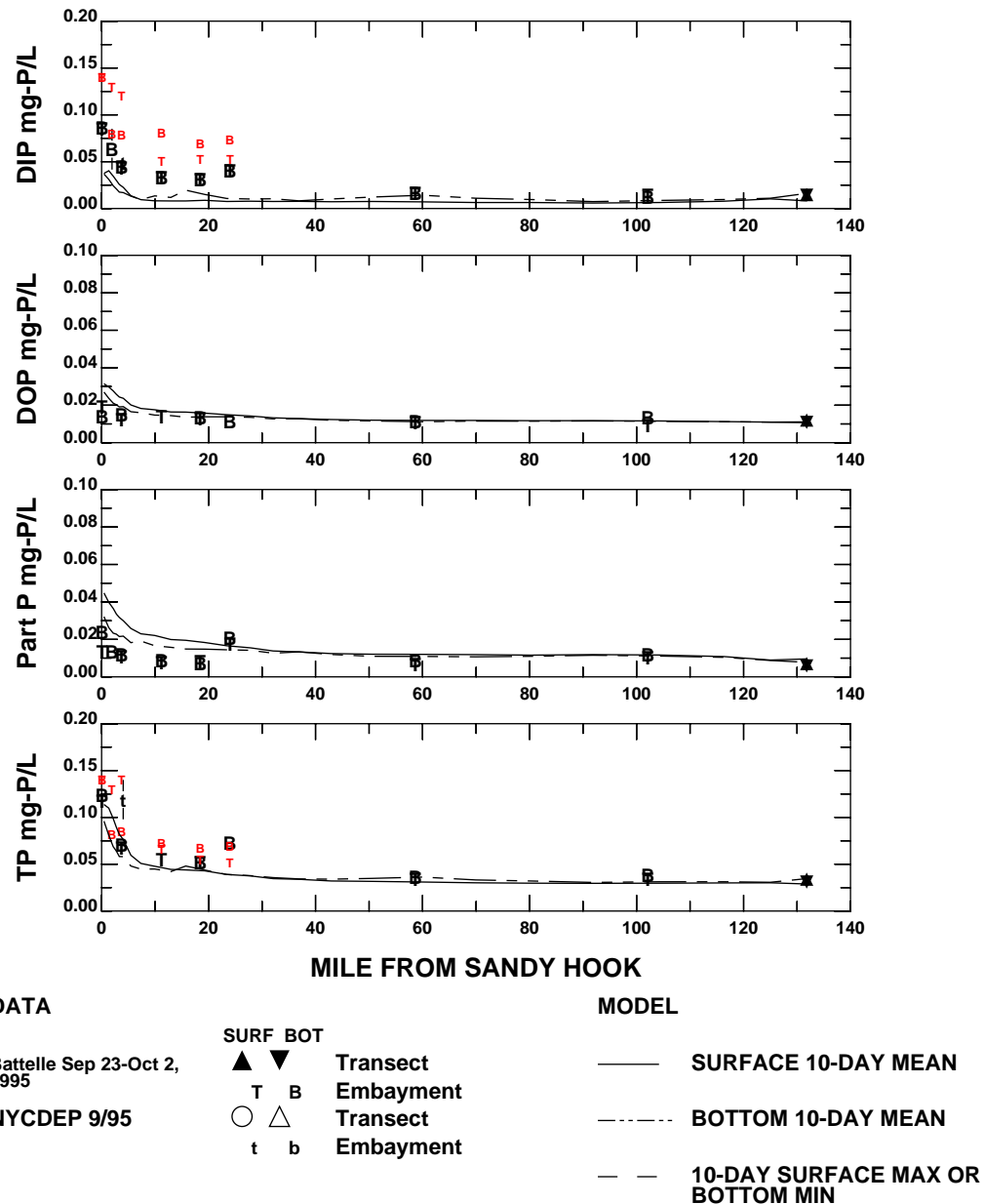
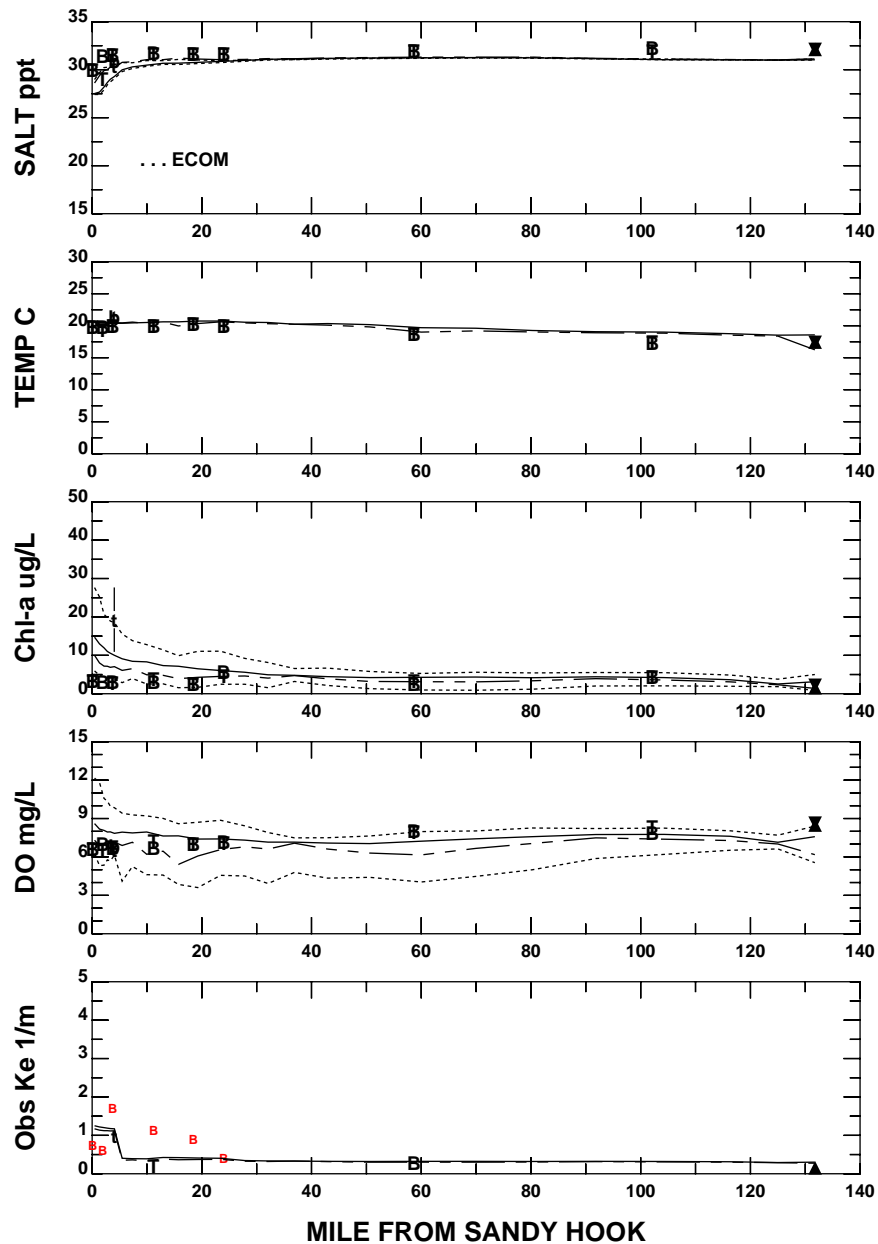


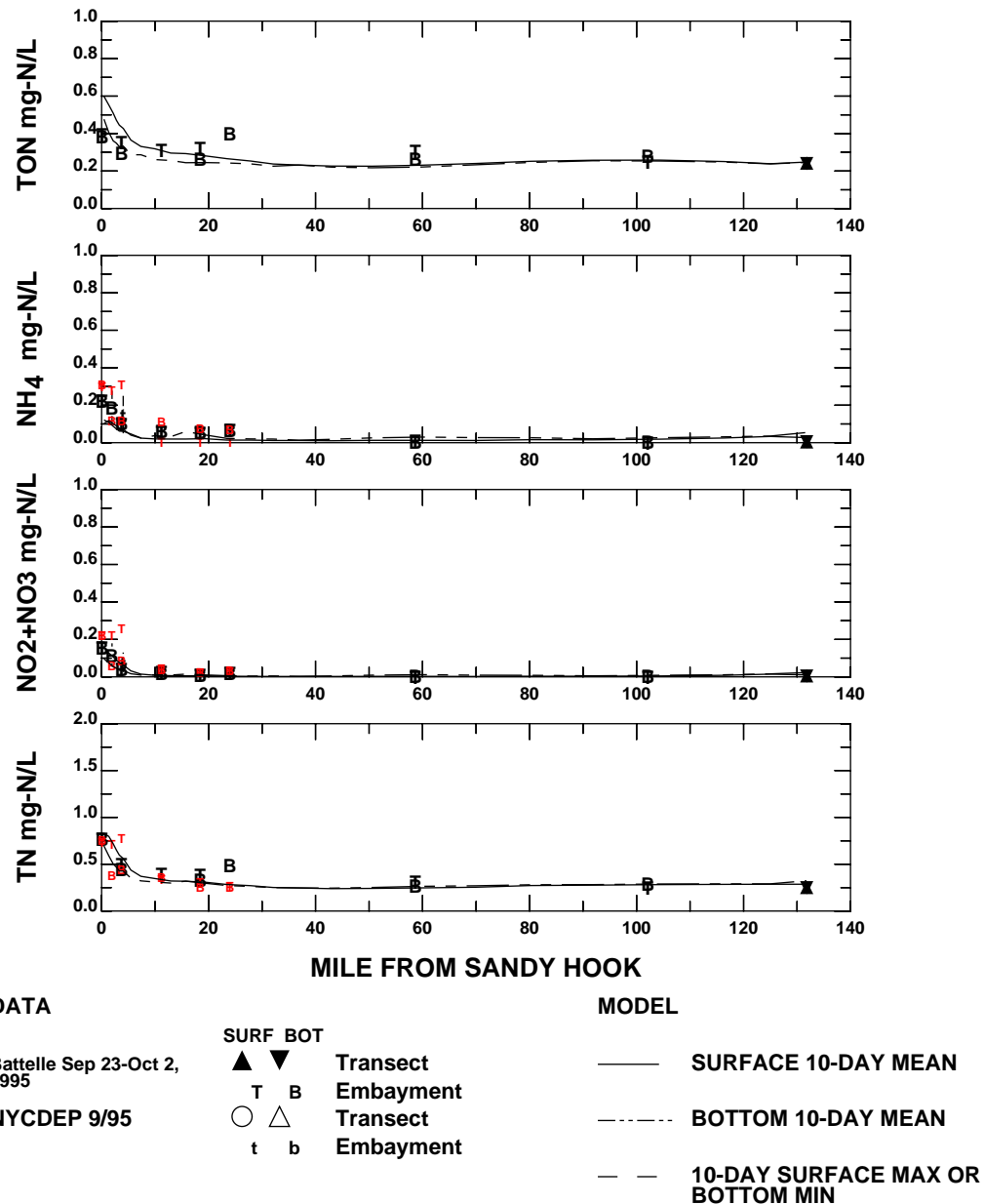
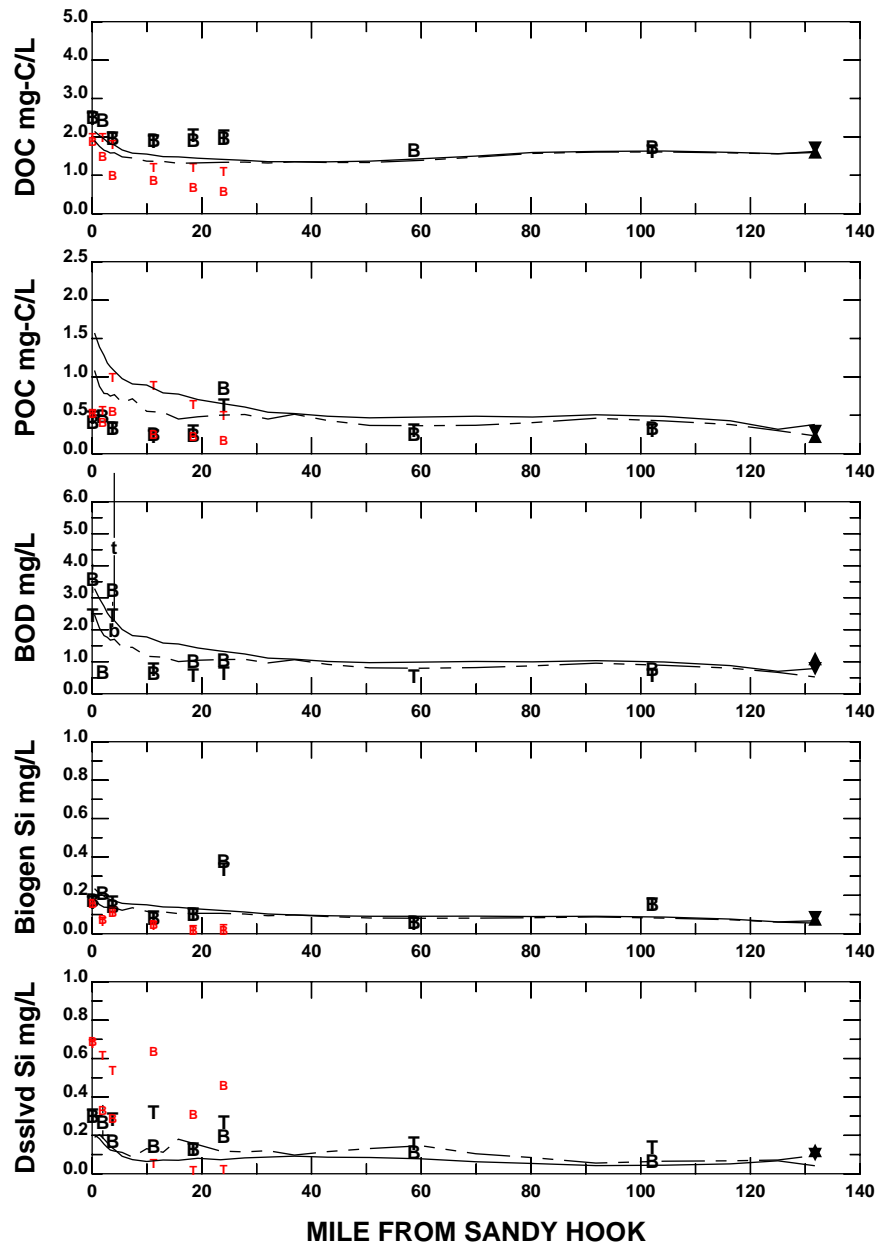


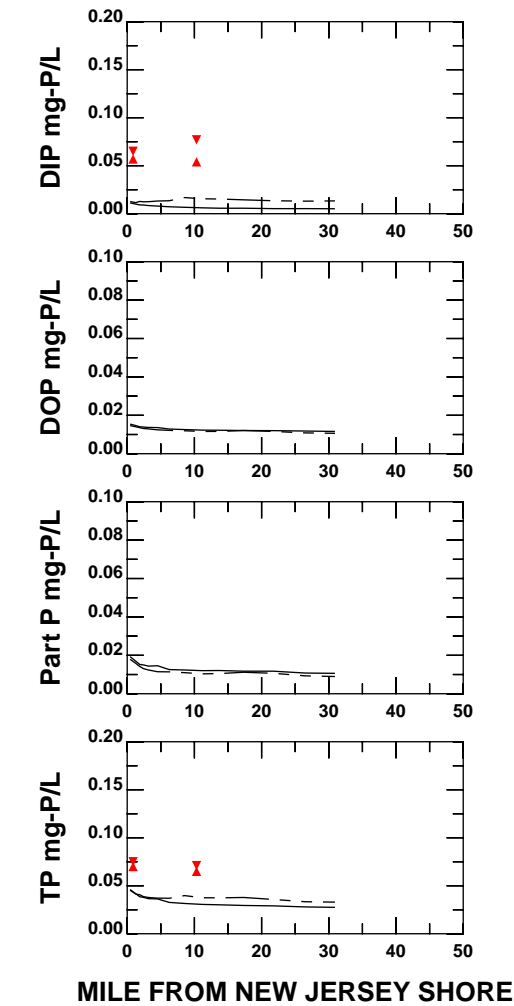
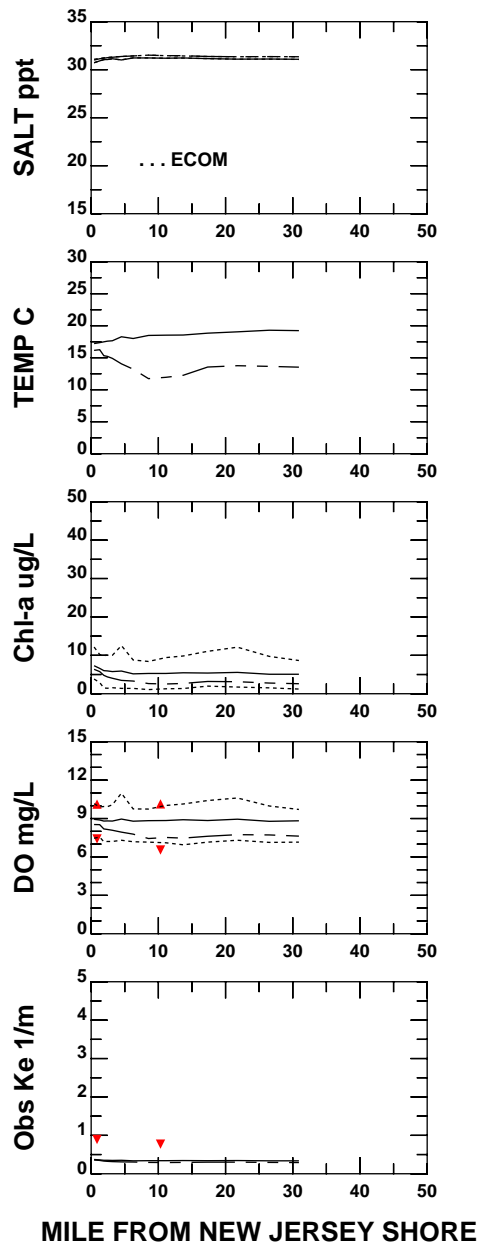












DATA

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SURF BOT

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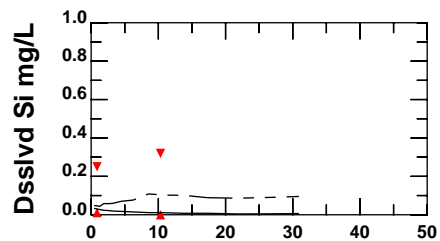
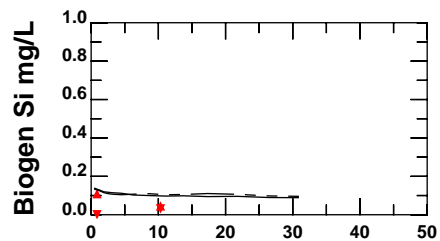
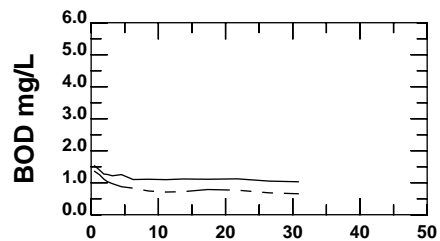
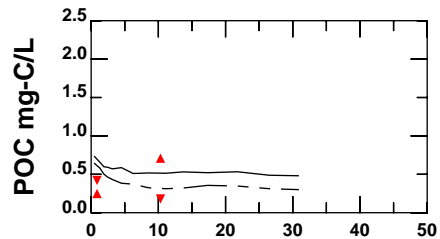
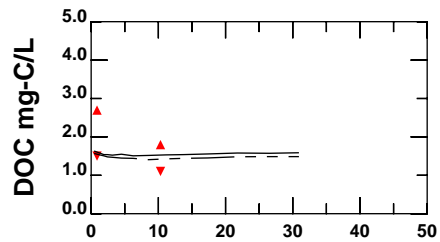
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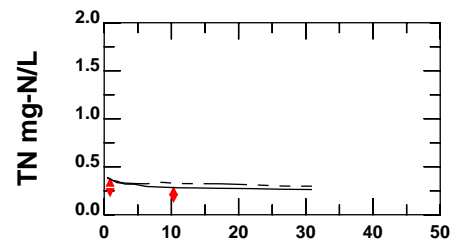
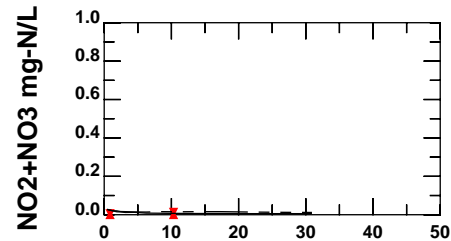
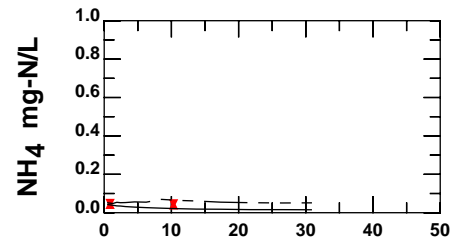
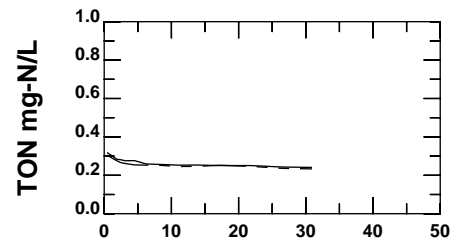
— SURFACE 10-DAY MEAN

- - - BOTTOM 10-DAY MEAN

- · - 10-DAY SURFACE MAX OR
BOTTOM MIN



MILE FROM NEW JERSEY SHORE



MILE FROM NEW JERSEY SHORE

DATA

Battelle June 18-27,
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SURF BOT

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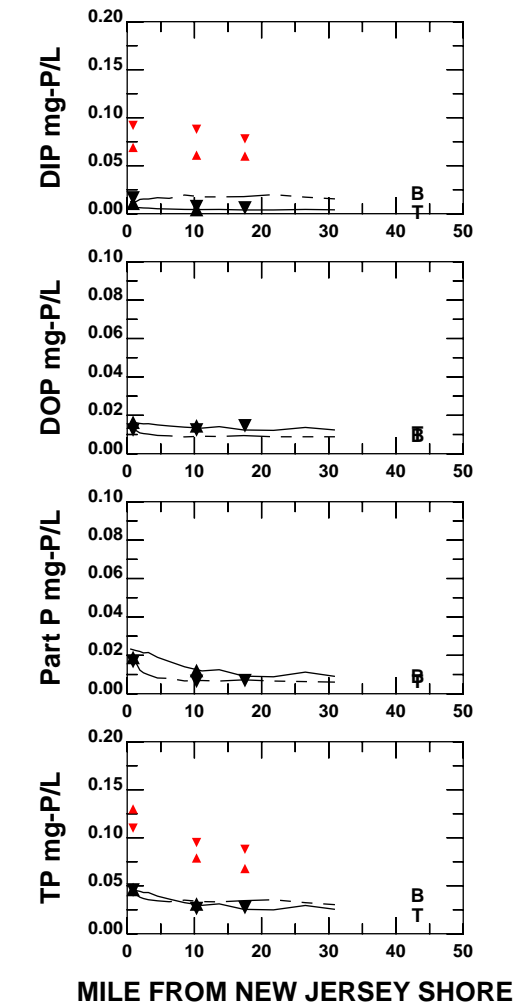
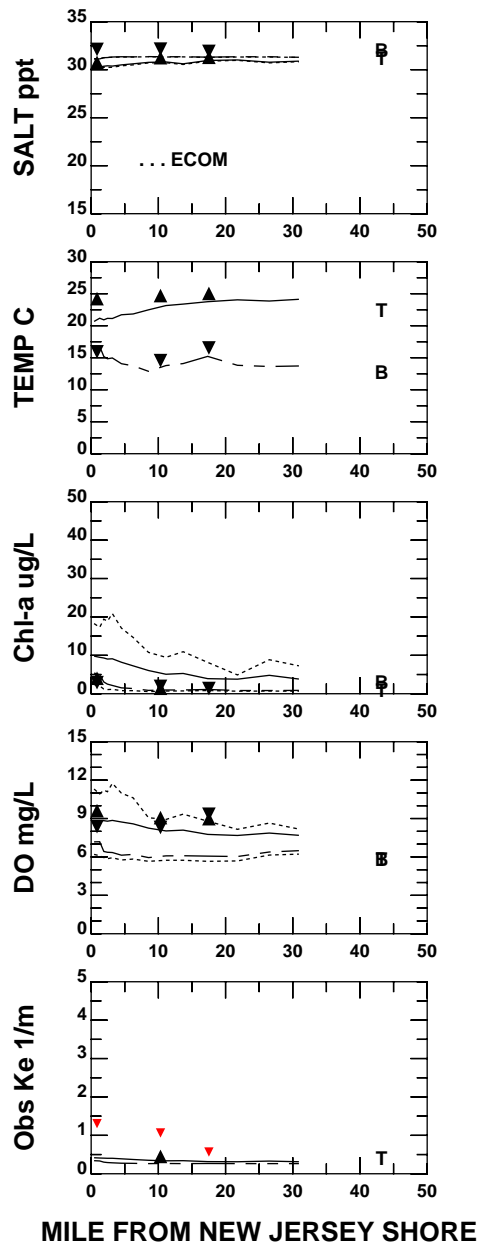
Embayment

MODEL

— SURFACE 10-DAY MEAN

- - - - - BOTTOM 10-DAY MEAN

- - - 10-DAY SURFACE MAX OR
BOTTOM MIN



DATA

Battelle July 20-Aug 2,
1995

SURF BOT

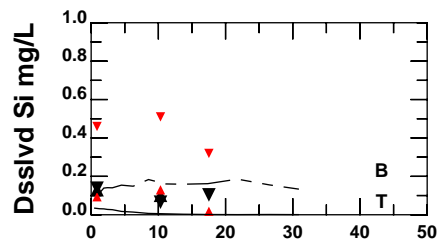
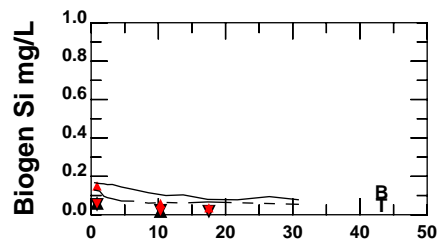
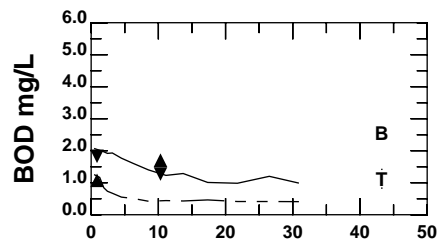
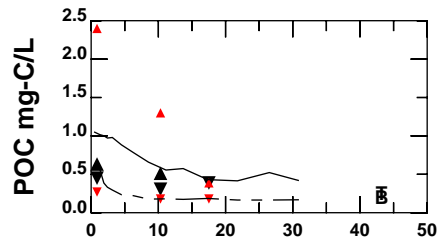
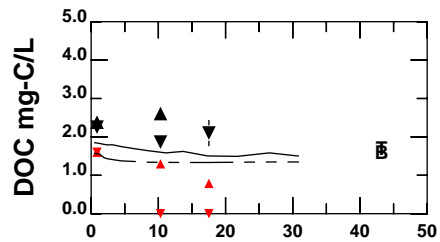
▲ ▼ Transect
T B Embayment

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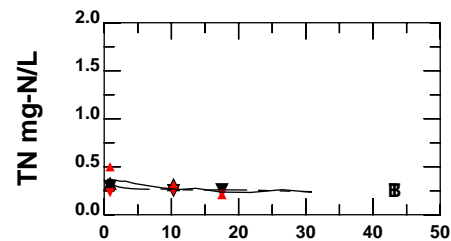
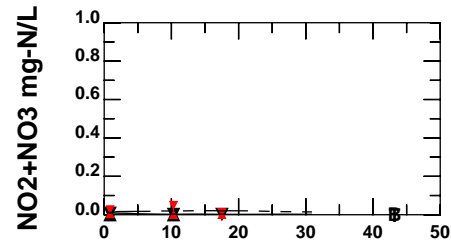
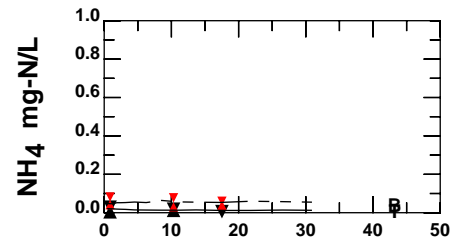
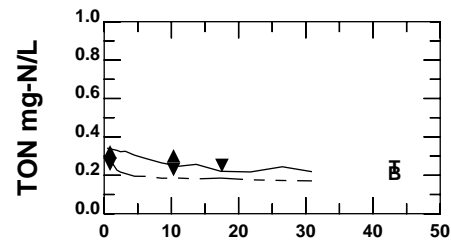
— SURFACE 10-DAY MEAN

- - - - BOTTOM 10-DAY MEAN

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BOTTOM MIN



MILE FROM NEW JERSEY SHORE



MILE FROM NEW JERSEY SHORE

DATA

Battelle July 20-Aug 2, 1995

SURF BOT

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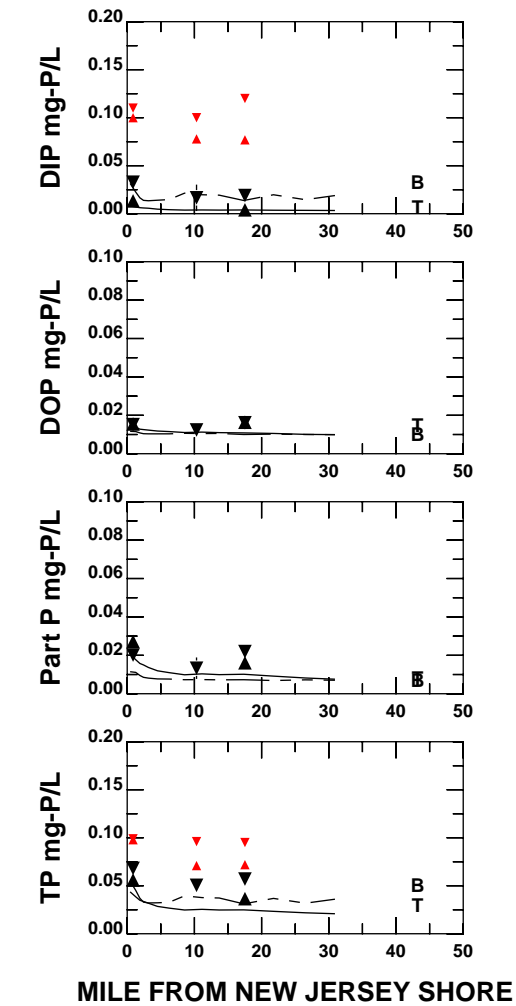
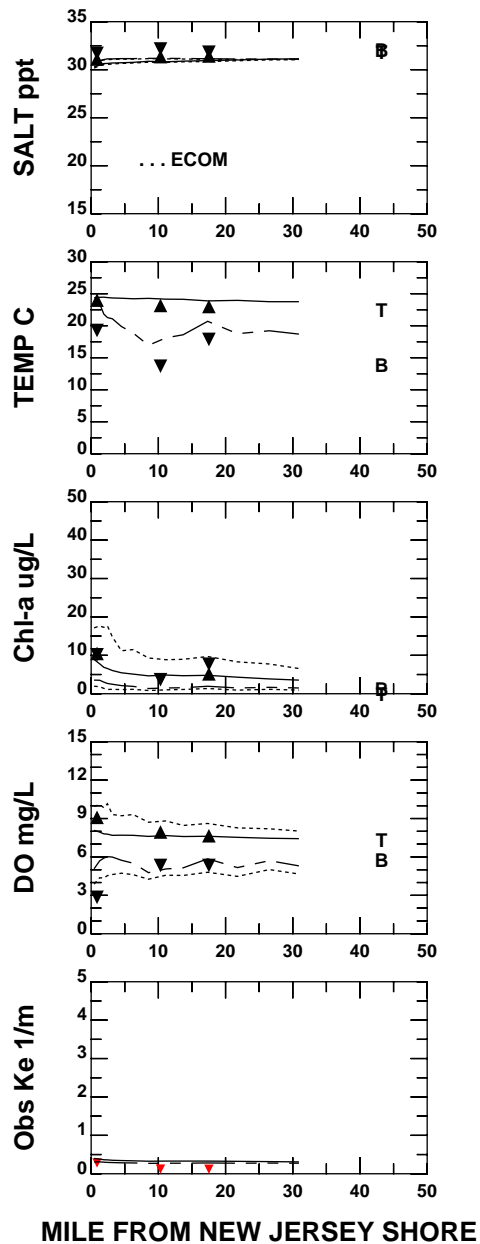
Embayment

MODEL

— SURFACE 10-DAY MEAN

- - - BOTTOM 10-DAY MEAN

- - - 10-DAY SURFACE MAX OR BOTTOM MIN



DATA

Battelle Aug 20-29, 1995

SURF BOT

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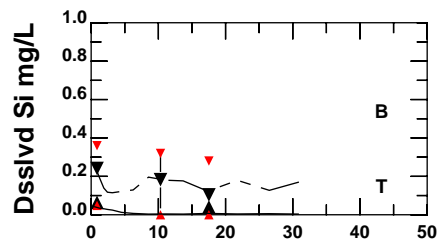
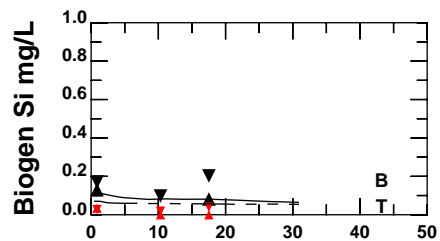
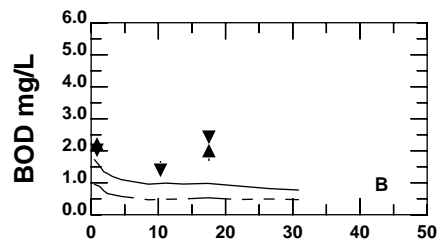
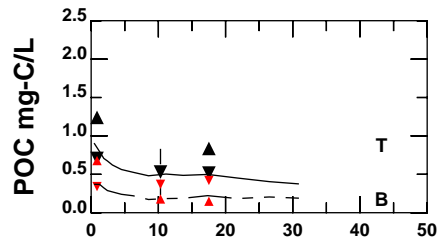
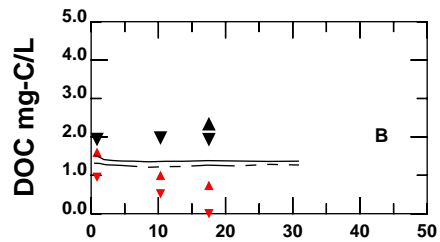
T B Embayment

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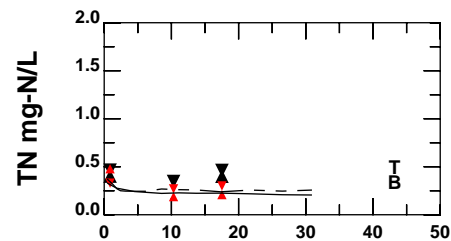
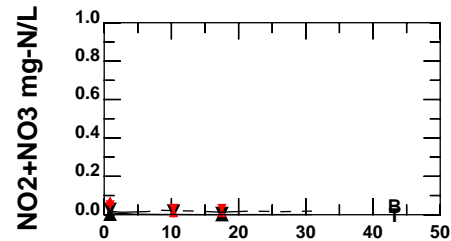
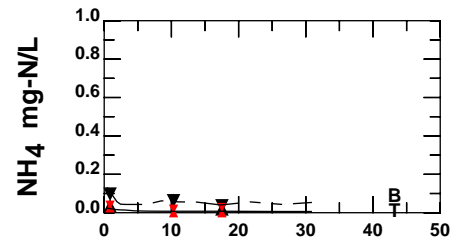
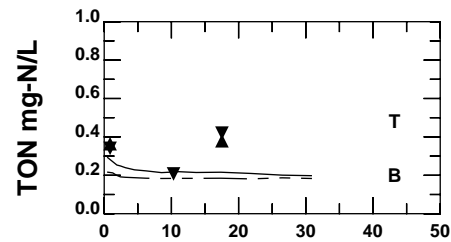
— SURFACE 10-DAY MEAN

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MILE FROM NEW JERSEY SHORE



MILE FROM NEW JERSEY SHORE

DATA

Battelle Aug 20-29, 1995

SURF BOT

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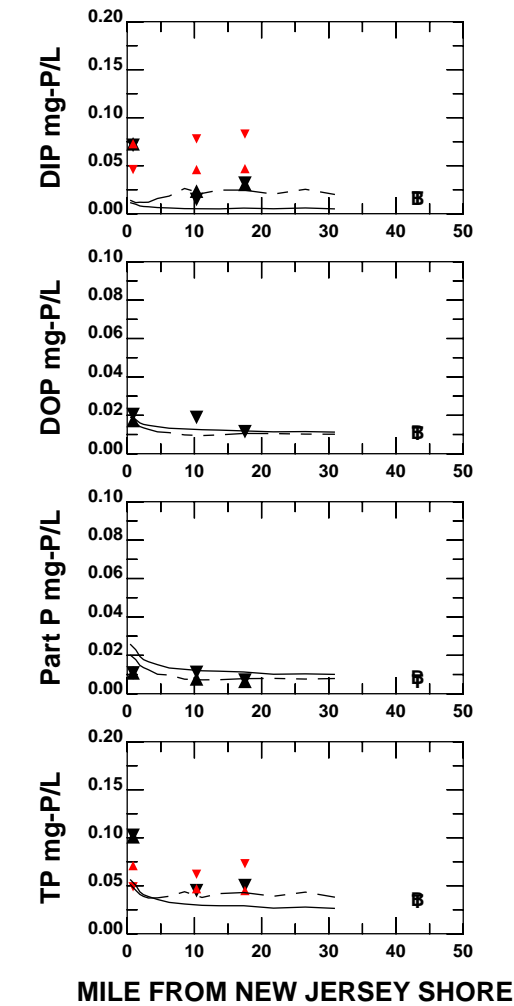
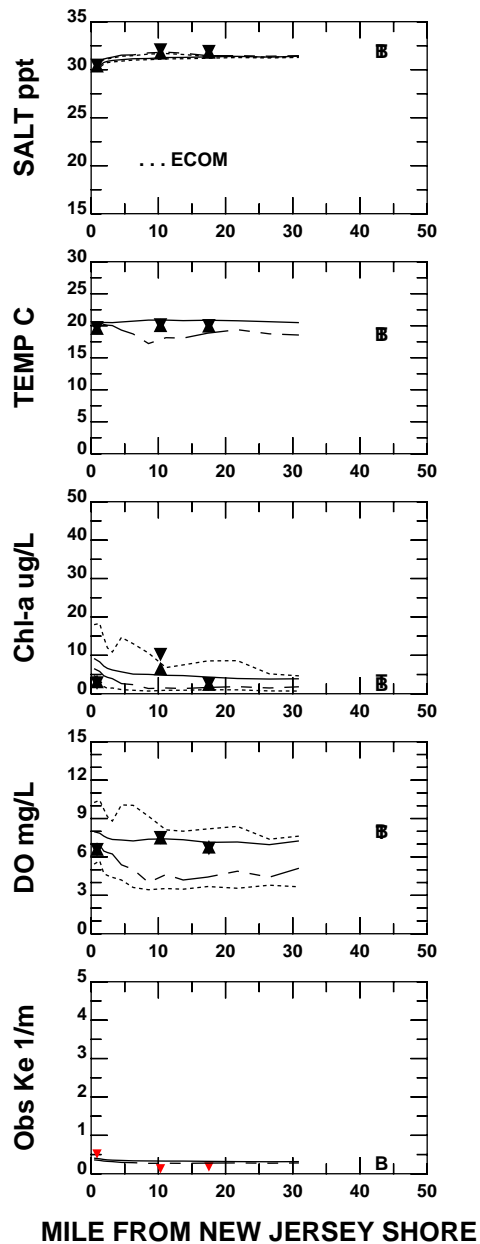
T B Embayment

MODEL

— SURFACE 10-DAY MEAN

- - - - - BOTTOM 10-DAY MEAN

- - - 10-DAY SURFACE MAX OR BOTTOM MIN



DATA

Battelle Sep 23-Oct 2,
1995

SURF BOT

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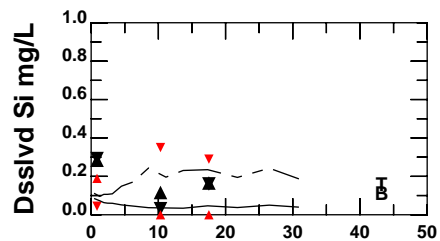
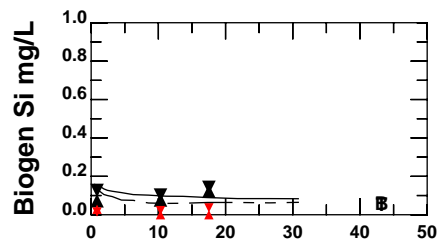
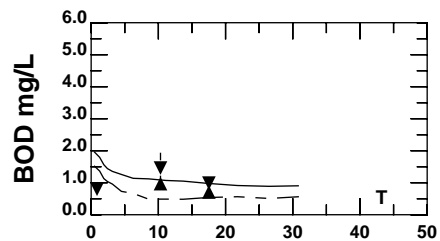
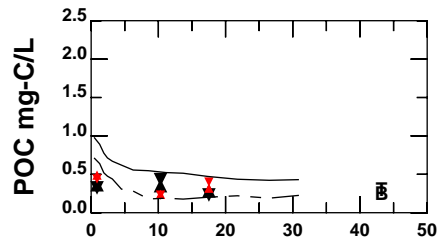
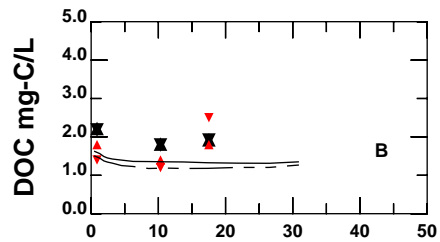
Embayment

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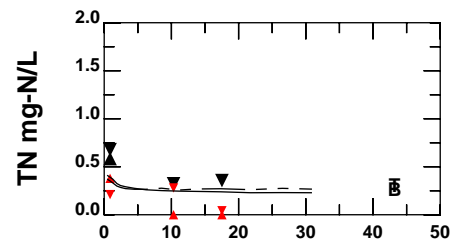
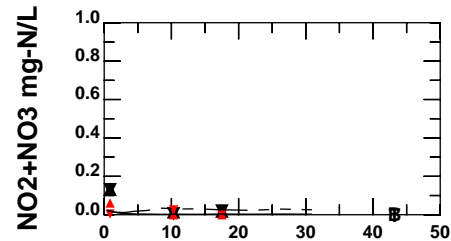
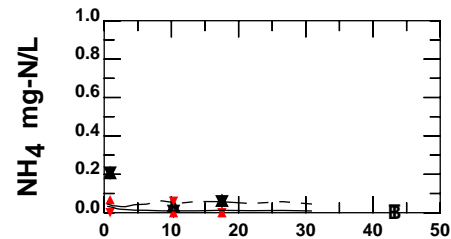
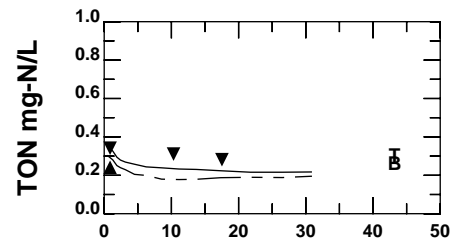
— SURFACE 10-DAY MEAN

- - - - BOTTOM 10-DAY MEAN

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MILE FROM NEW JERSEY SHORE



MILE FROM NEW JERSEY SHORE

DATA

Battelle Sep 23-Oct 2, 1995

SURF BOT

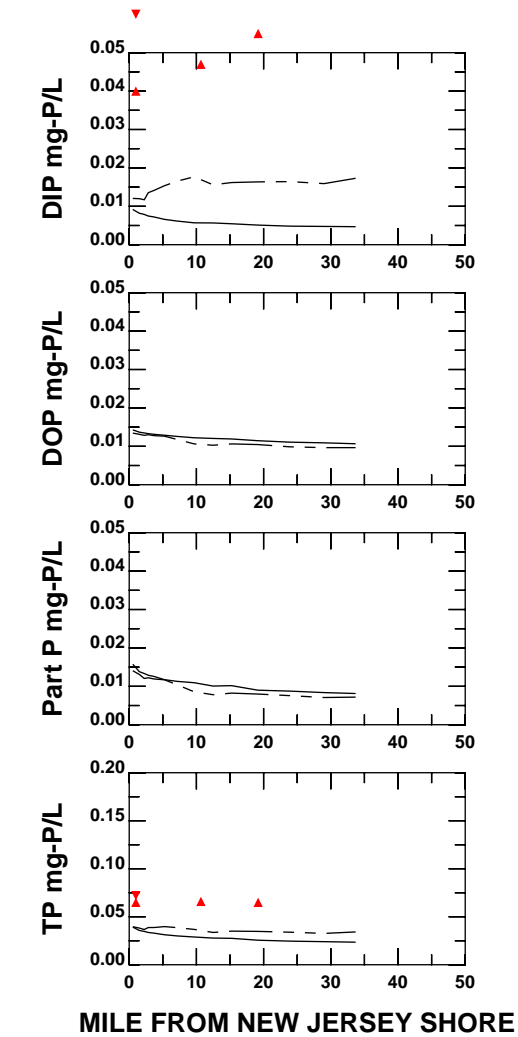
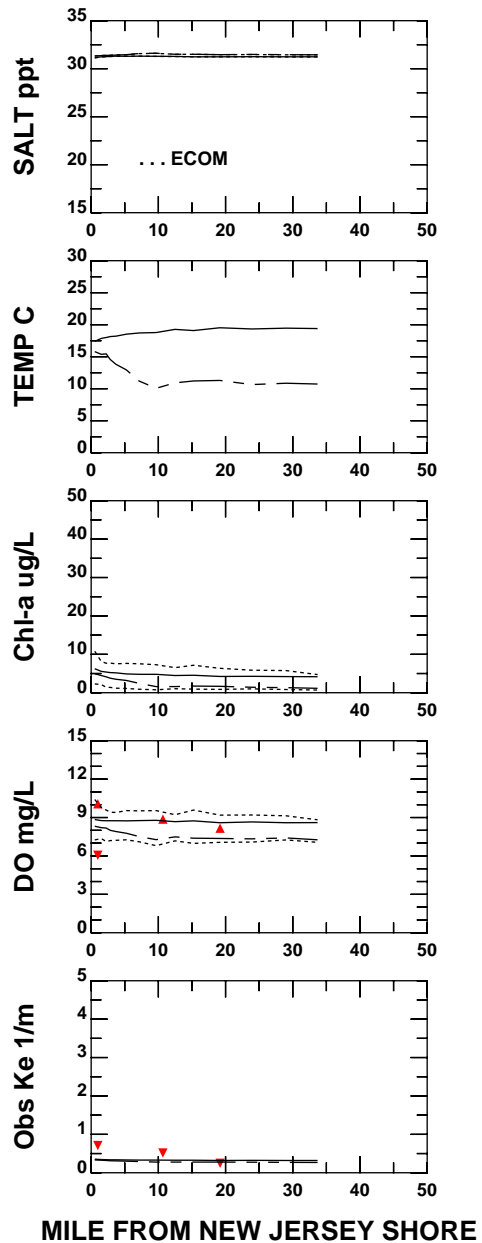
▲ ▼ Transect
T B Embayment

MODEL

— SURFACE 10-DAY MEAN

- - - - - BOTTOM 10-DAY MEAN

- - - - - 10-DAY SURFACE MAX OR BOTTOM MIN



DATA

Battelle June 18-27,
1995

SURF BOT

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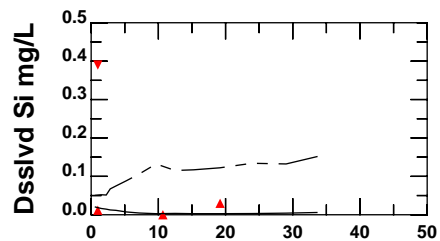
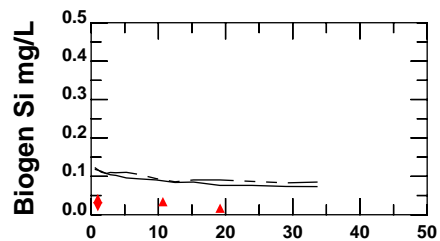
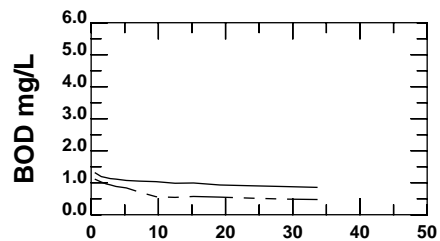
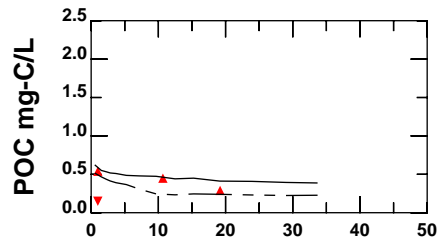
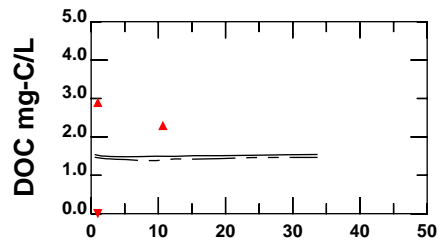
Embayment

MODEL

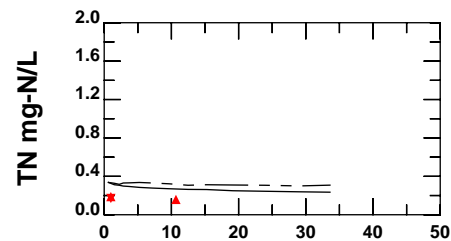
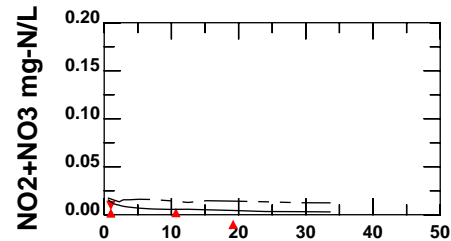
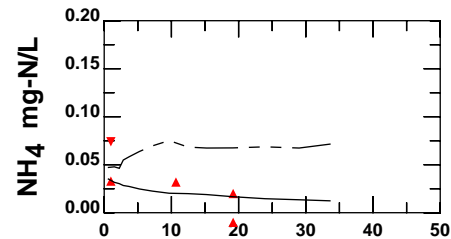
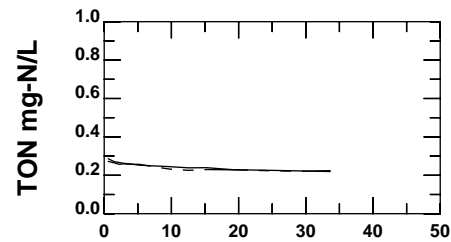
— SURFACE 10-DAY MEAN

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MILE FROM NEW JERSEY SHORE



MILE FROM NEW JERSEY SHORE

DATA

Battelle June 18-27,
1995

SURF BOT

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Transect

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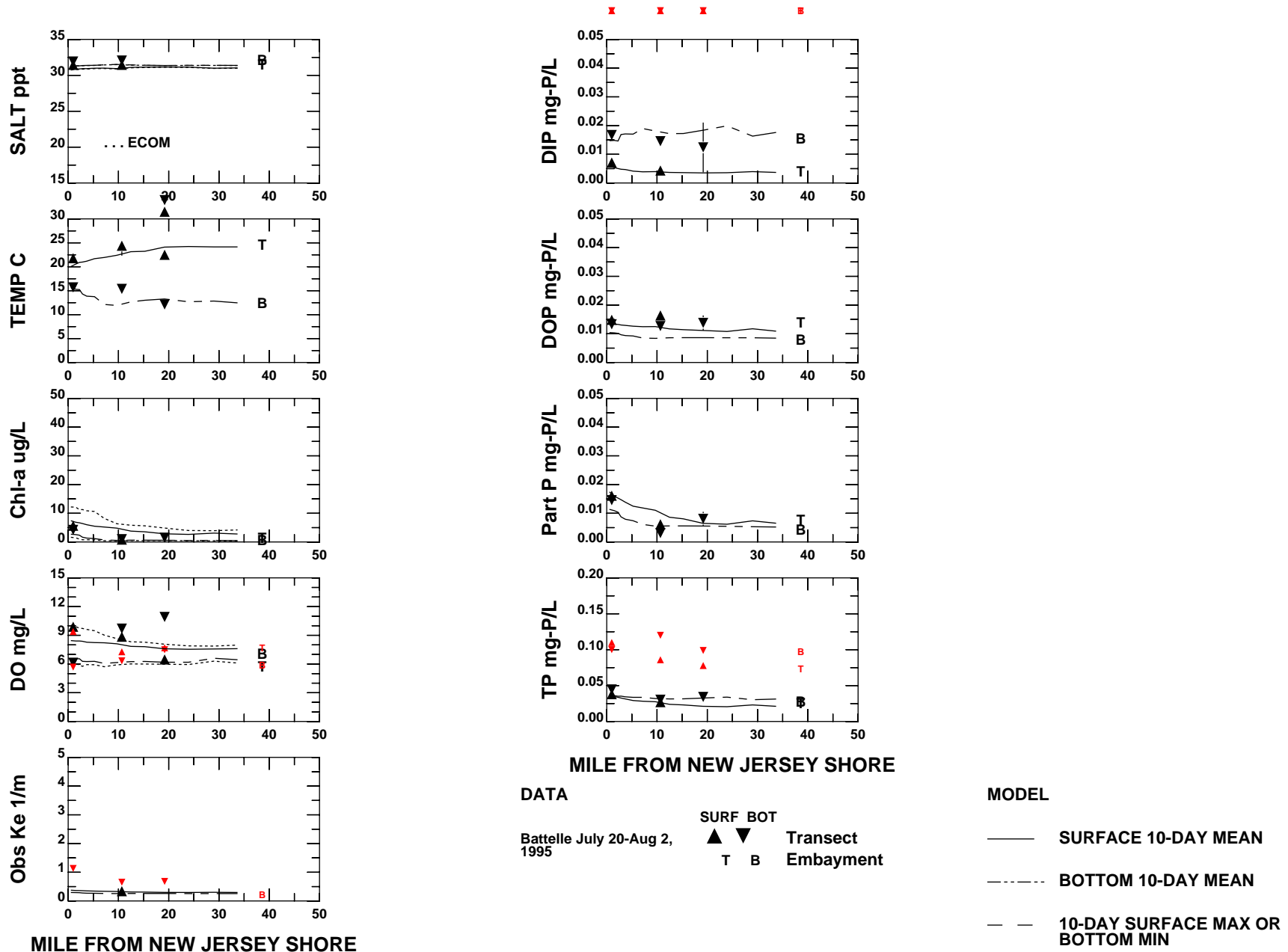
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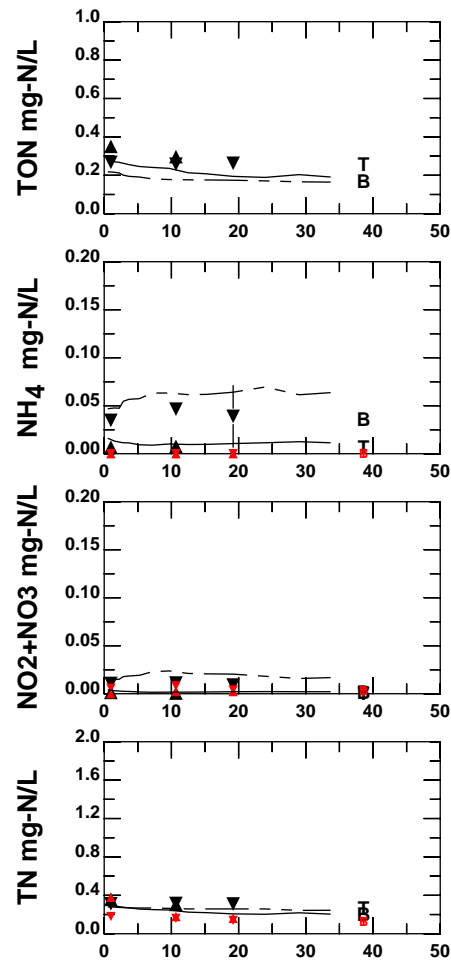
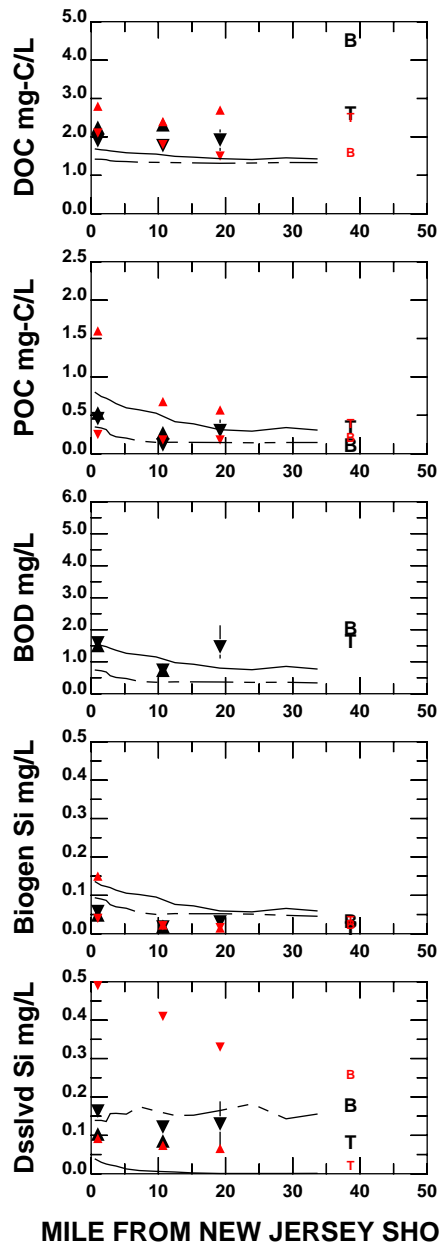
MODEL

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DATA

Battelle July 20-Aug 2,
1995

SURF BOT

▲ ▼ Transect

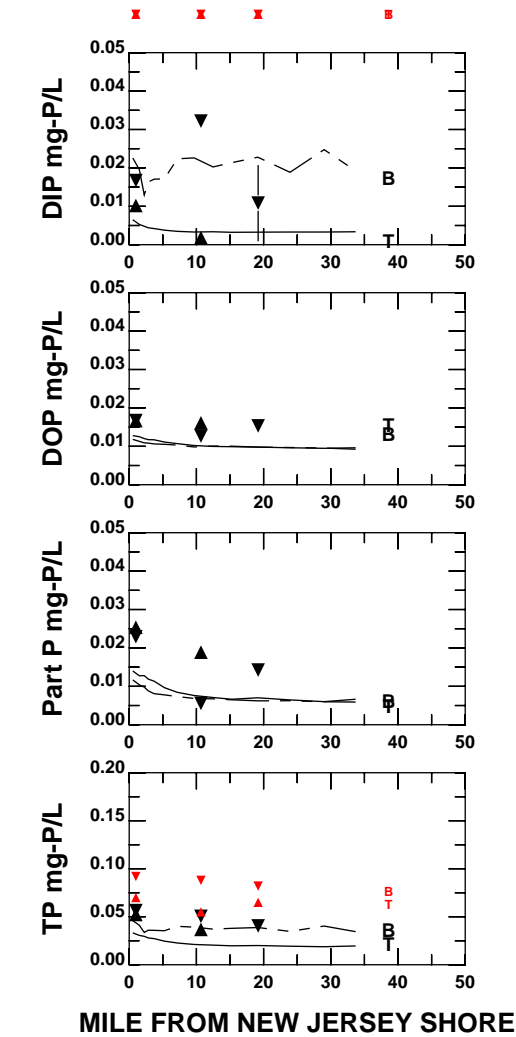
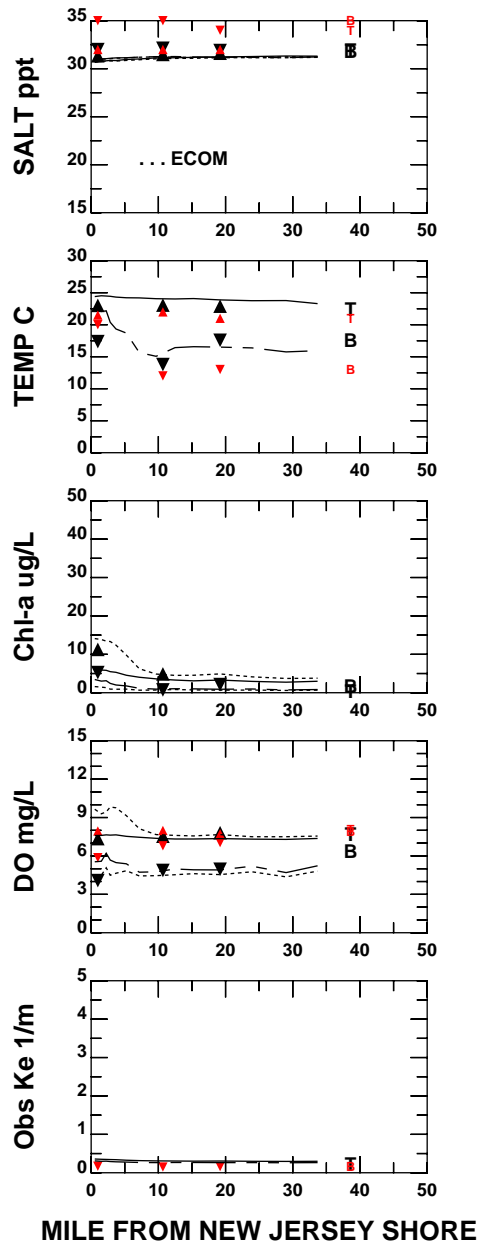
T B Embayment

MODEL

— SURFACE 10-DAY MEAN

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DATA

Battelle Aug 20-29, 1995

SURF BOT

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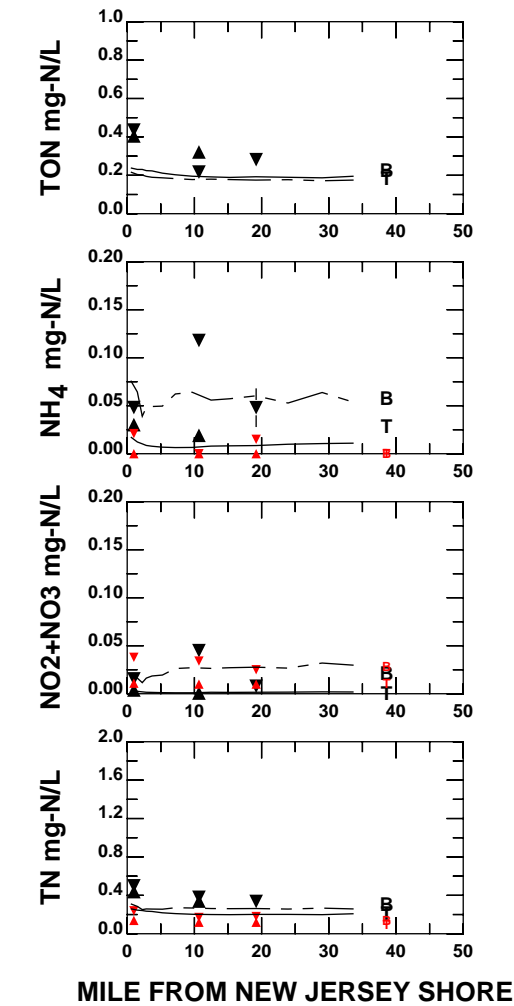
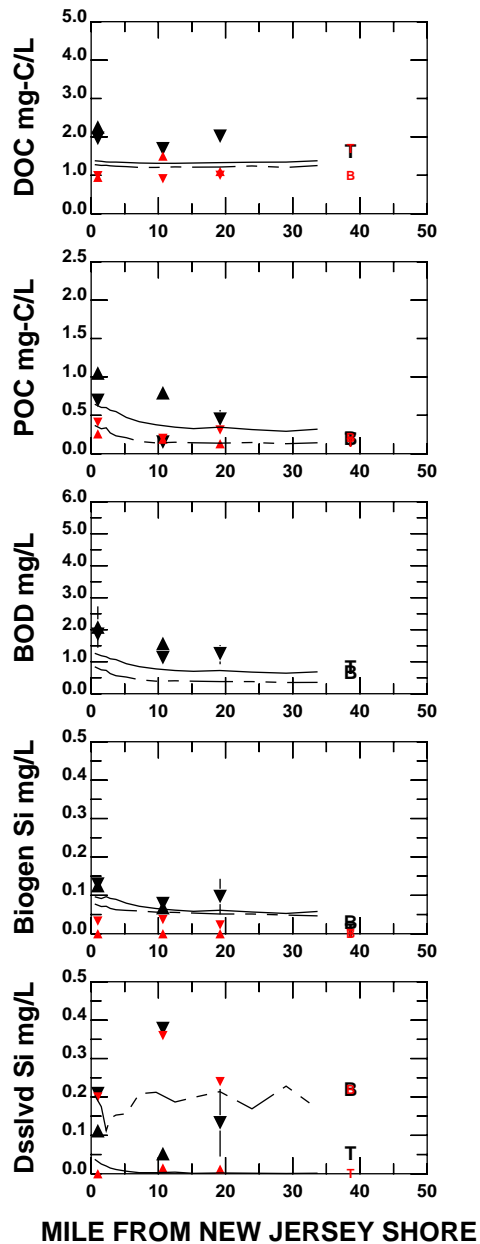
T B Embayment

MODEL

— SURFACE 10-DAY MEAN

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DATA

Battelle Aug 20-29, 1995

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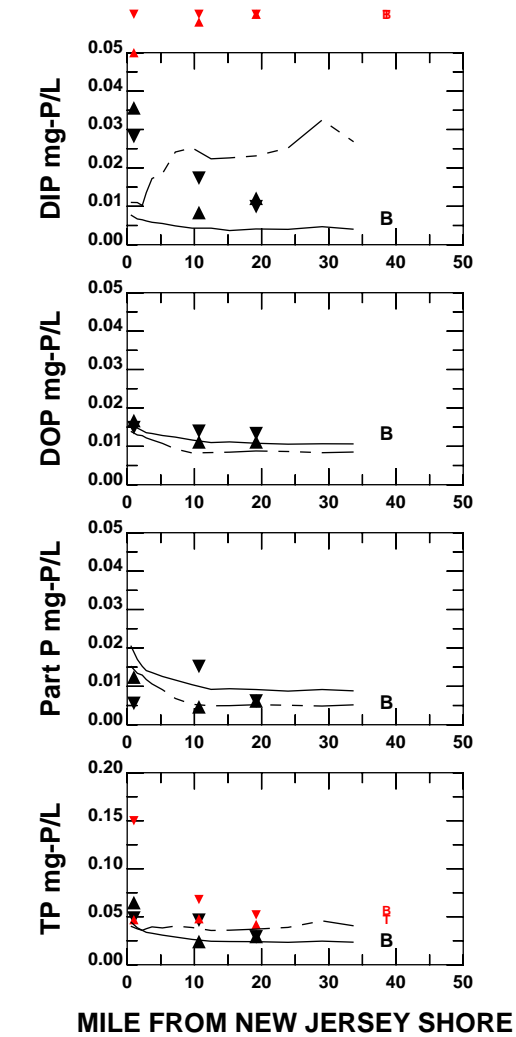
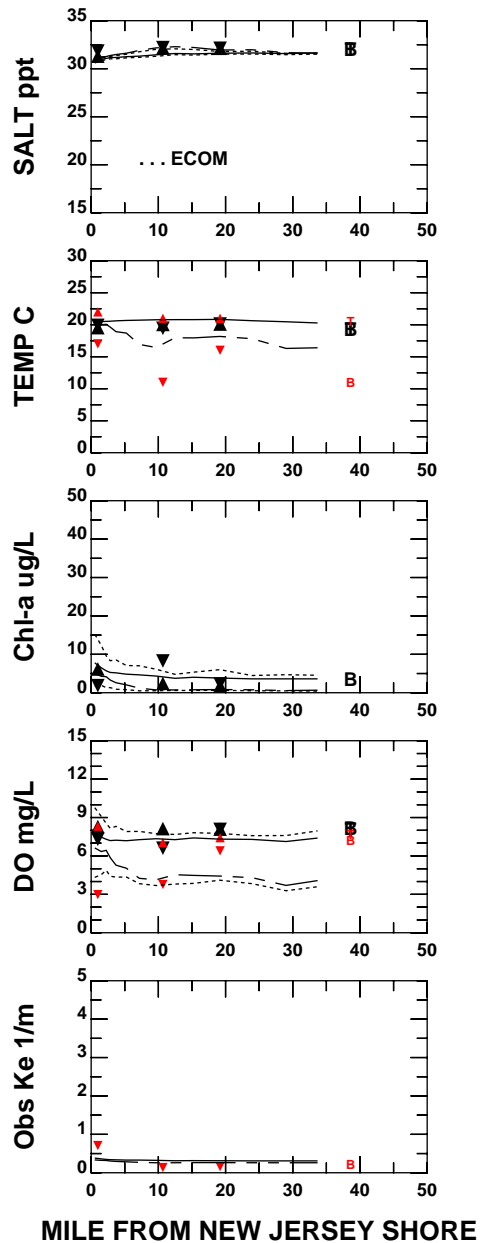
T B Embayment

MODEL

— SURFACE 10-DAY MEAN

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DATA

Battelle Sep 23-Oct 2,
1995

SURF BOT

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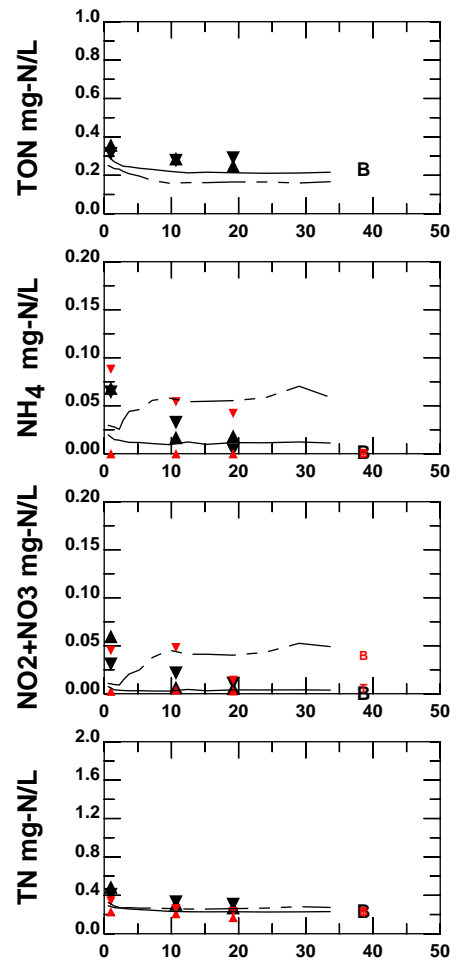
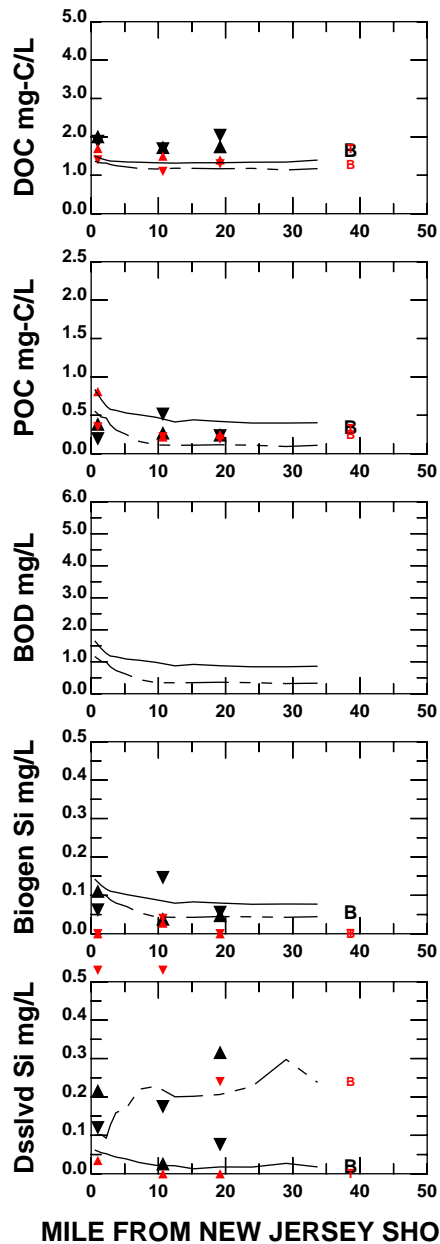
Embayment

MODEL

— SURFACE 10-DAY MEAN

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DATA

Battelle Sep 23-Oct 2,
1995

SURF BOT

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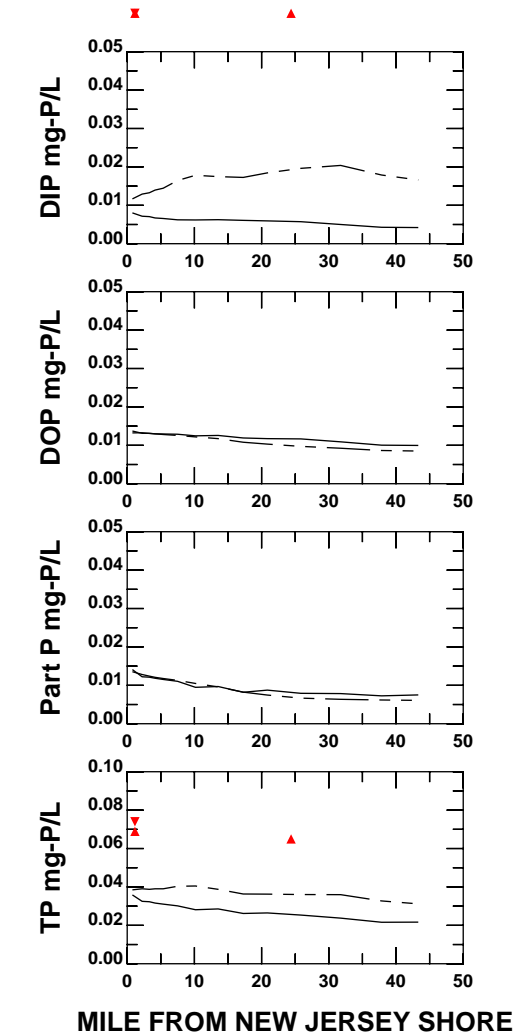
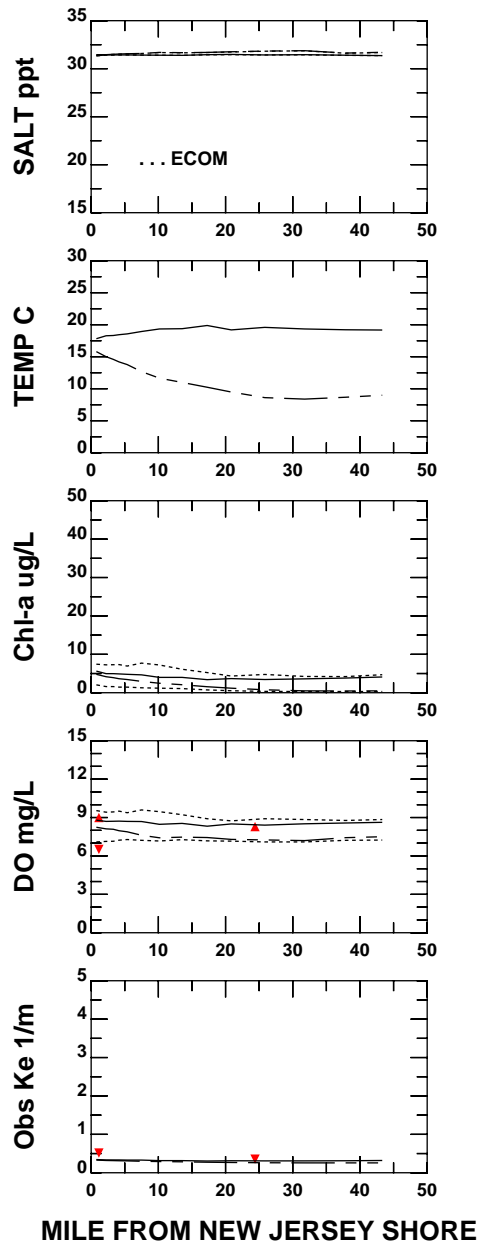
Embayment

MODEL

— SURFACE 10-DAY MEAN

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DATA

Battelle June 18-27,
1995

SURF BOT

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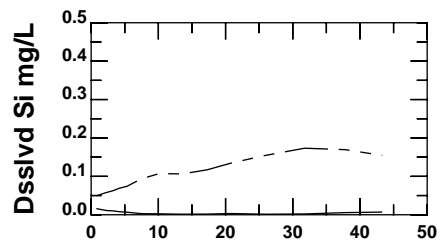
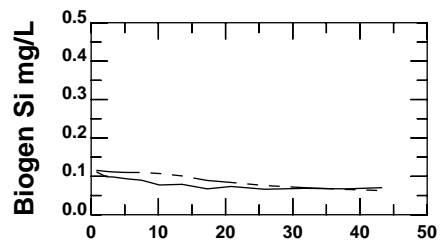
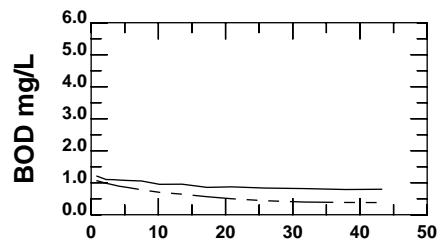
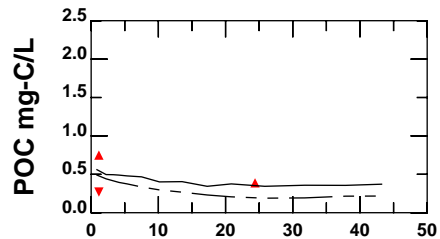
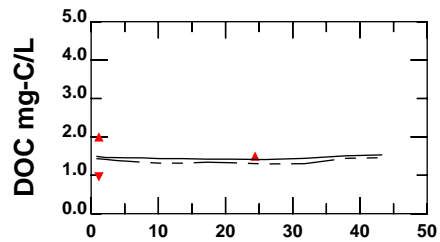
Embayment

MODEL

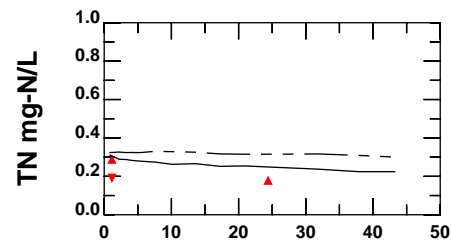
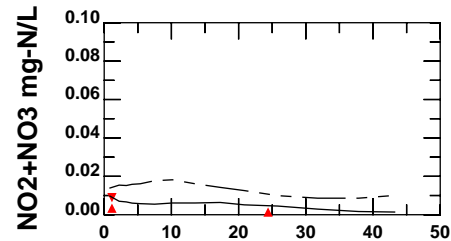
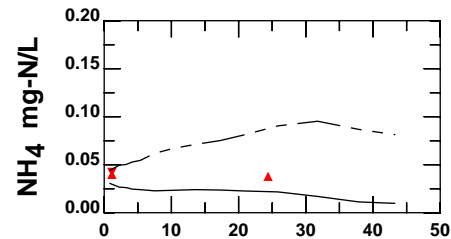
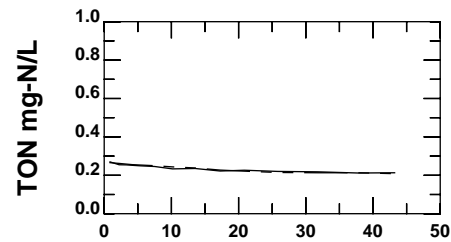
— SURFACE 10-DAY MEAN

- - - - - BOTTOM 10-DAY MEAN

- - - 10-DAY SURFACE MAX OR
BOTTOM MIN



MILE FROM NEW JERSEY SHORE



MILE FROM NEW JERSEY SHORE

DATA

Battelle June 18-27,
1995

SURF BOT

▲ ▼

Transect

T B

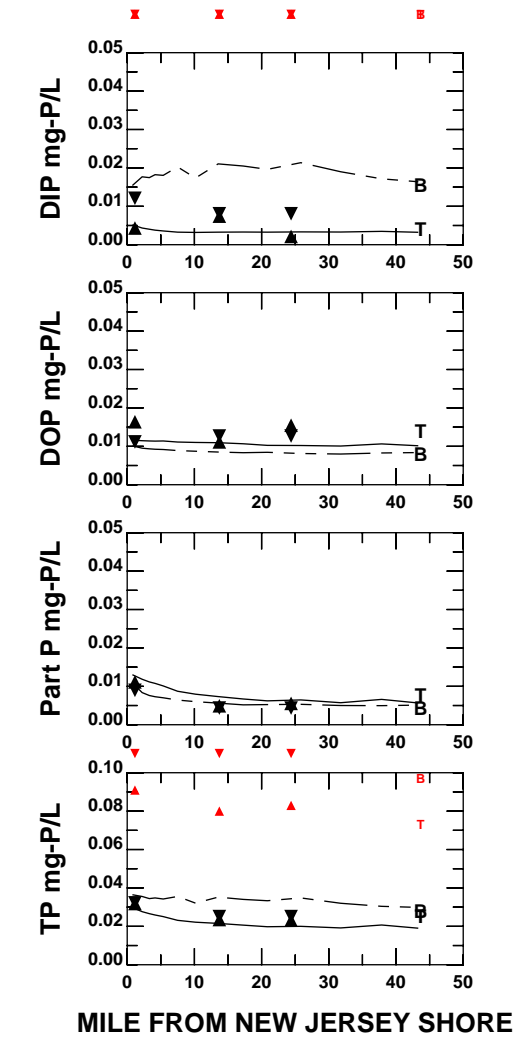
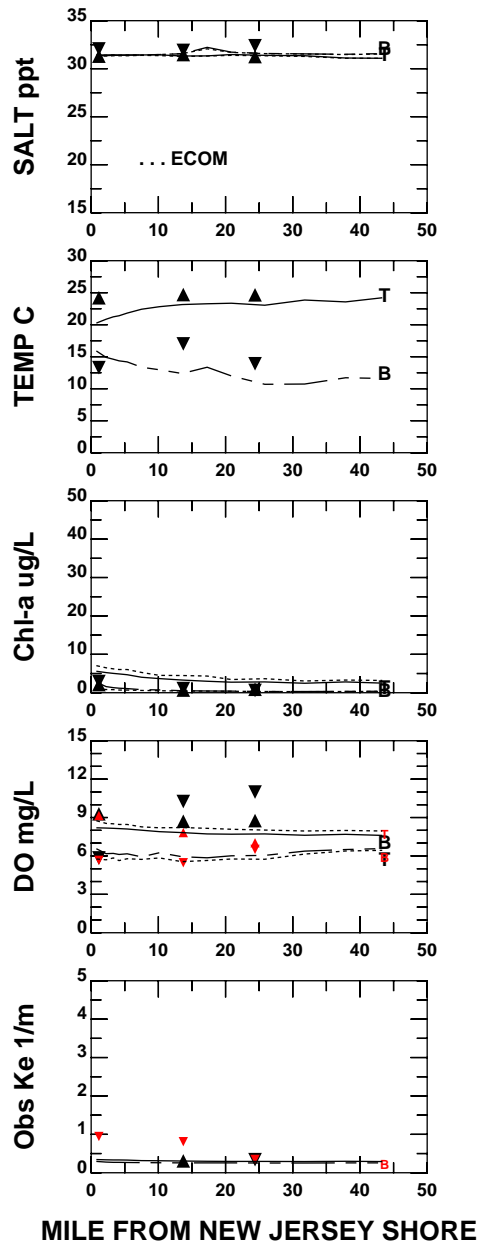
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MODEL

— SURFACE 10-DAY MEAN

- - - - - BOTTOM 10-DAY MEAN

- - - - - 10-DAY SURFACE MAX OR
BOTTOM MIN



DATA

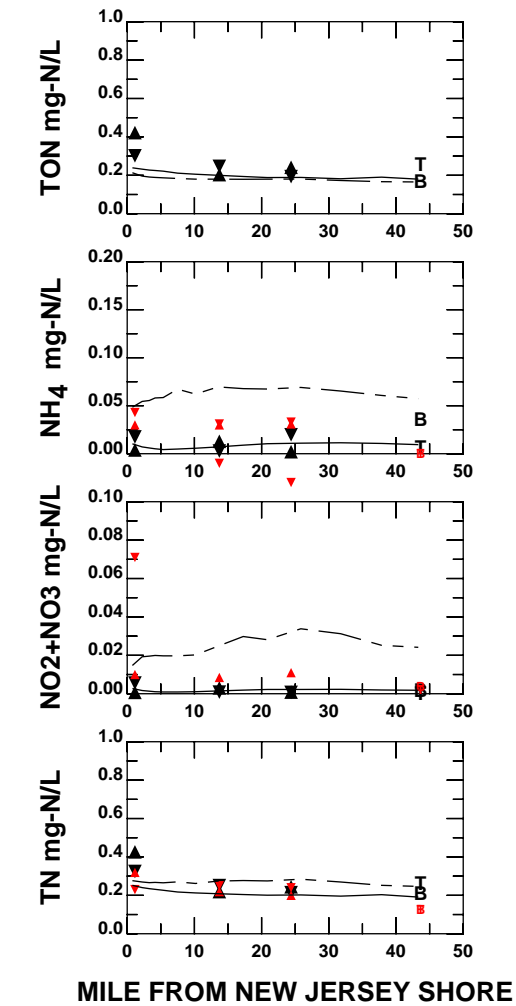
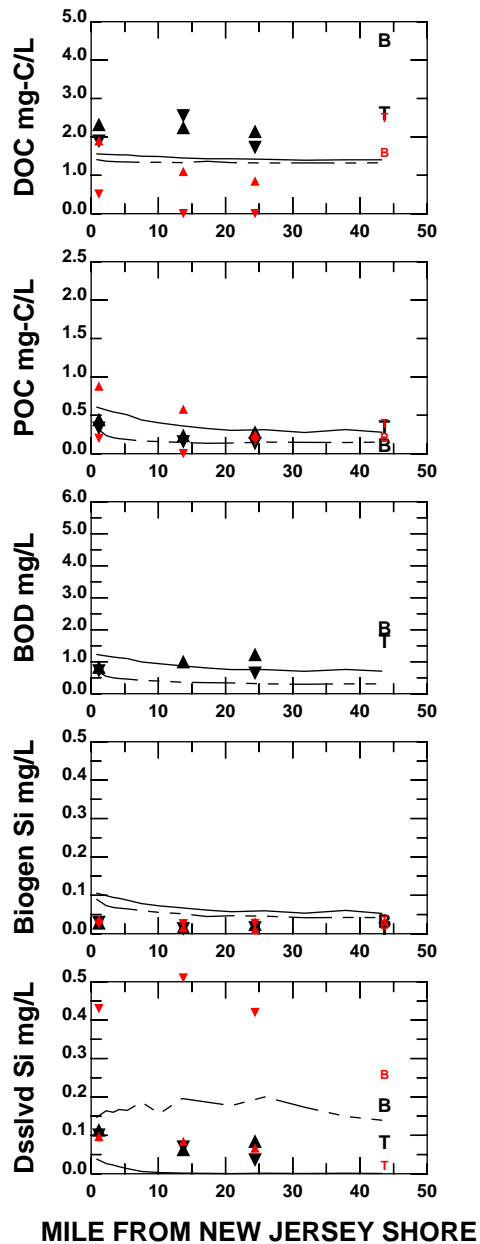
Battelle July 20-Aug 2,
1995

SURF BOT

▲ ▼ Transect
T B Embayment

MODEL

— SURFACE 10-DAY MEAN
 - - - - - BOTTOM 10-DAY MEAN
 - - - - - 10-DAY SURFACE MAX OR
 BOTTOM MIN



DATA

Battelle July 20-Aug 2,
1995

SURF BOT

▲ ▼ Transect

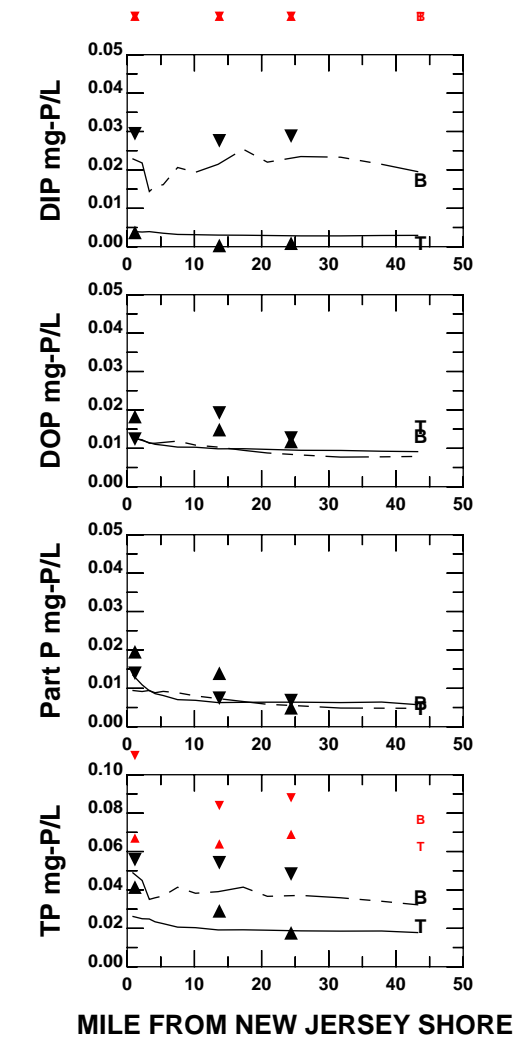
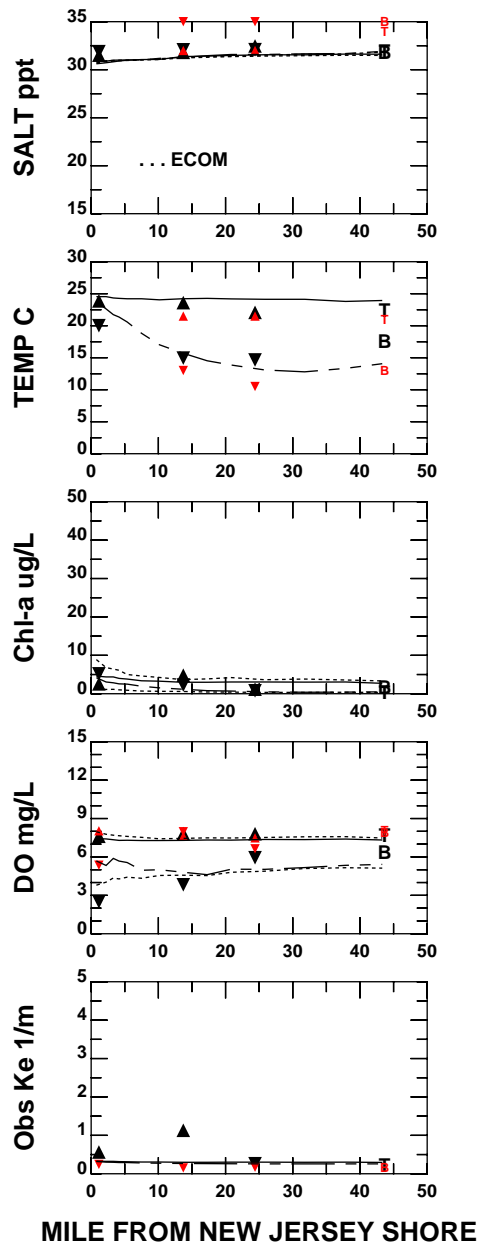
T B Embayment

MODEL

— SURFACE 10-DAY MEAN

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- - - 10-DAY SURFACE MAX OR
BOTTOM MIN



DATA

Battelle Aug 20-29, 1995

SURF BOT

▲ ▼ Transect

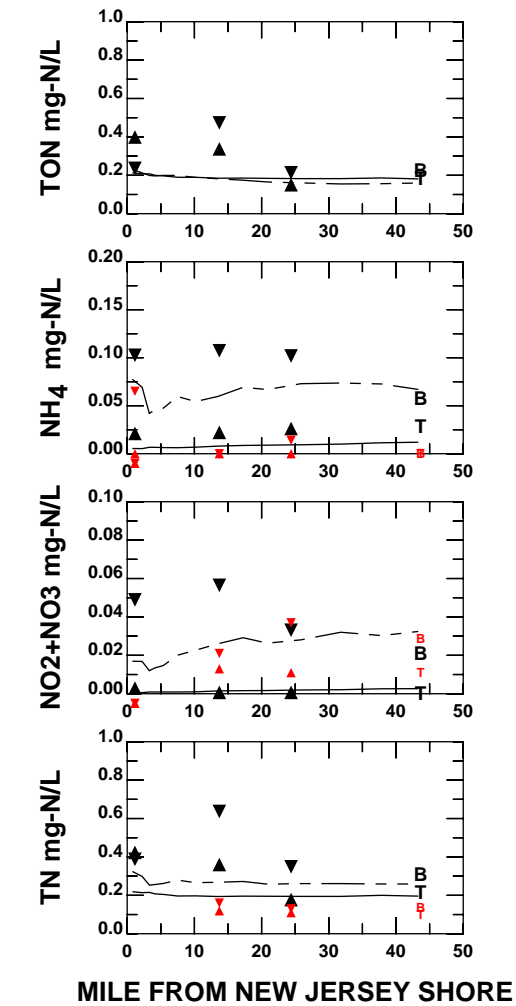
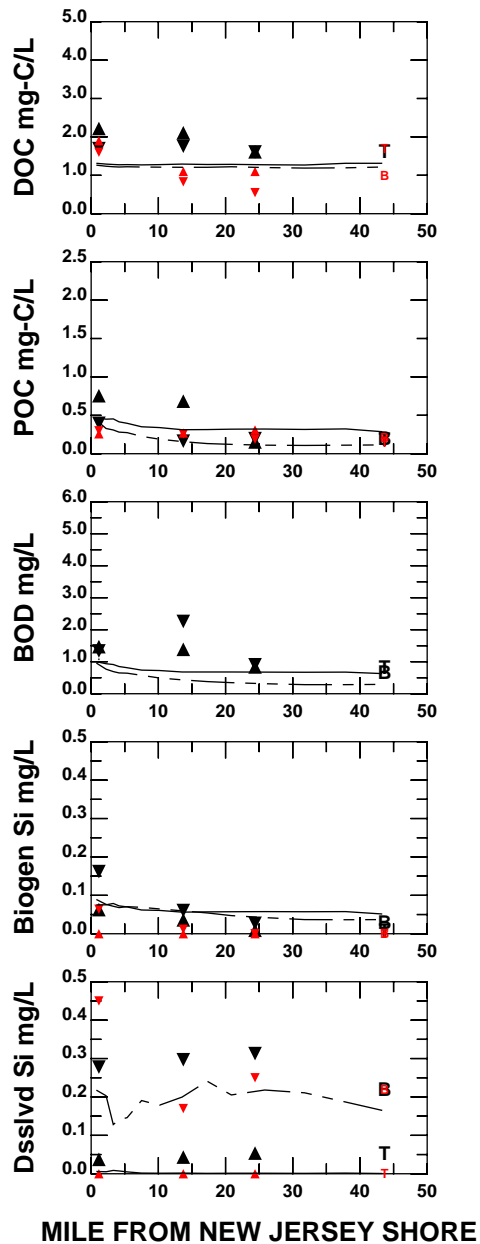
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MODEL

— SURFACE 10-DAY MEAN

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- - - 10-DAY SURFACE MAX OR BOTTOM MIN



DATA

Battelle Aug 20-29, 1995

SURF BOT

▲ ▼ Transect

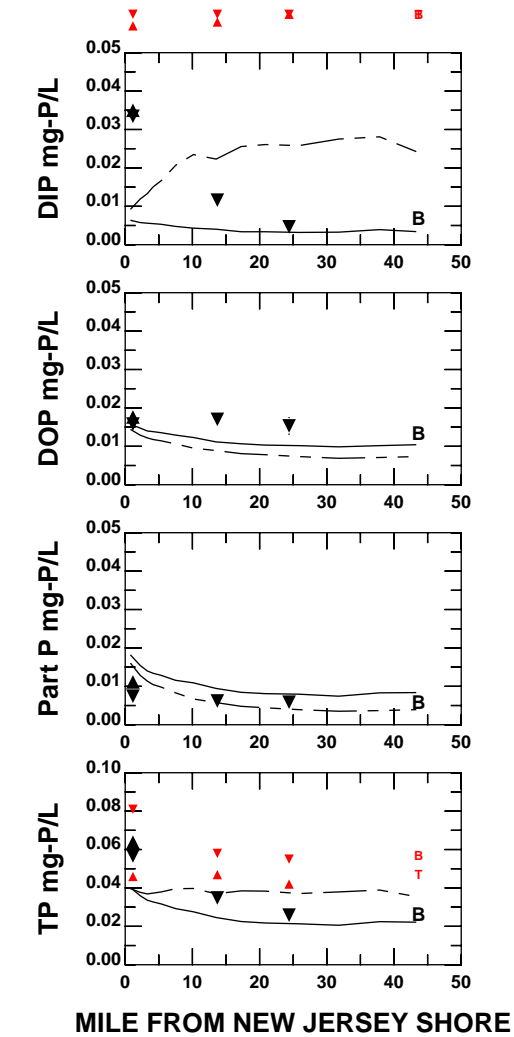
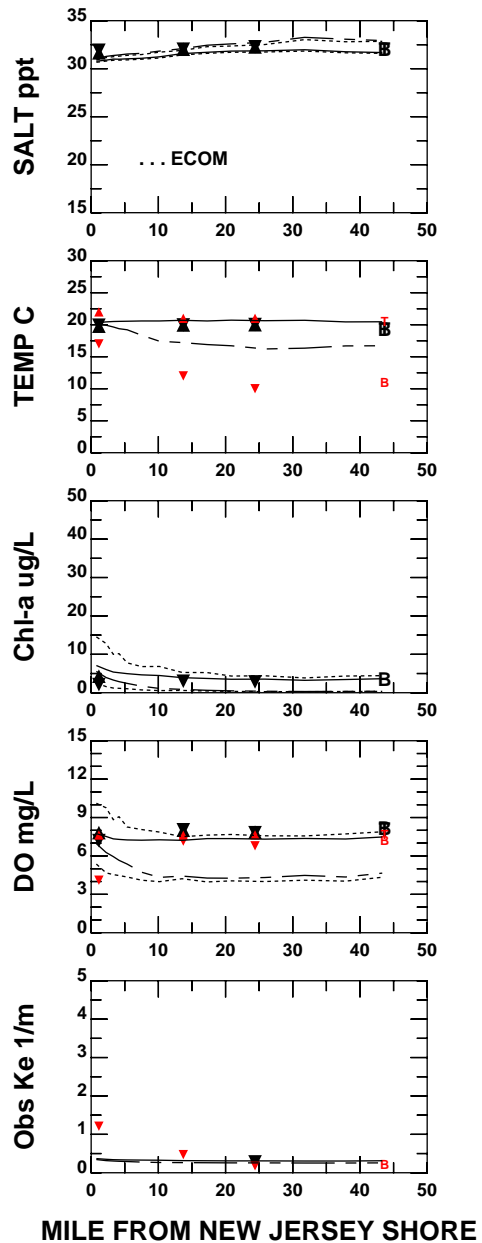
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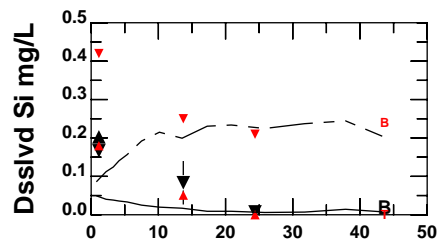
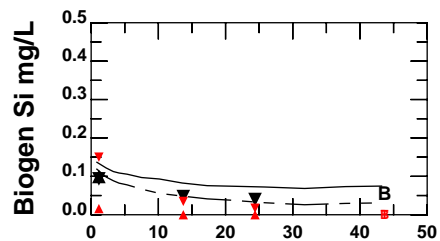
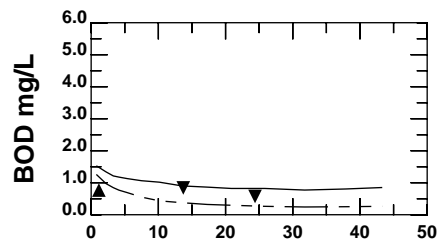
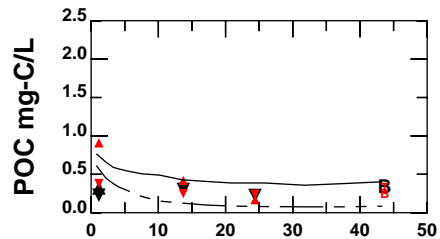
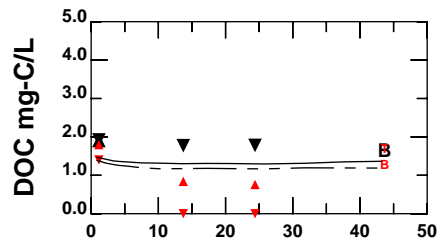
MODEL

— SURFACE 10-DAY MEAN

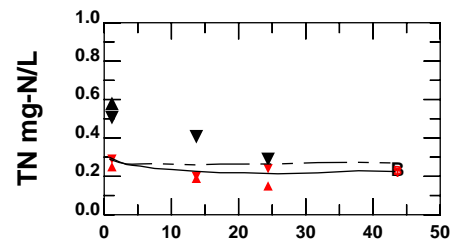
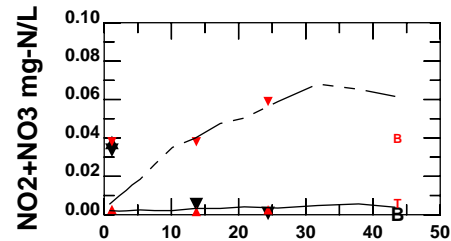
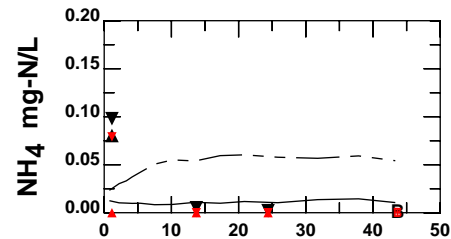
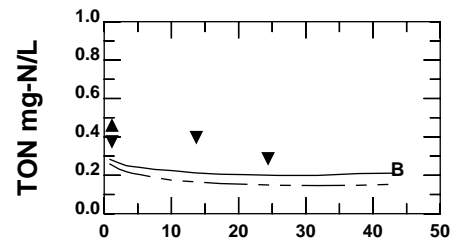
- - - - - BOTTOM 10-DAY MEAN

- - - - - 10-DAY SURFACE MAX OR
BOTTOM MIN





MILE FROM NEW JERSEY SHORE



MILE FROM NEW JERSEY SHORE

DATA

Battelle Sep 23-Oct 2, 1995

SURF BOT

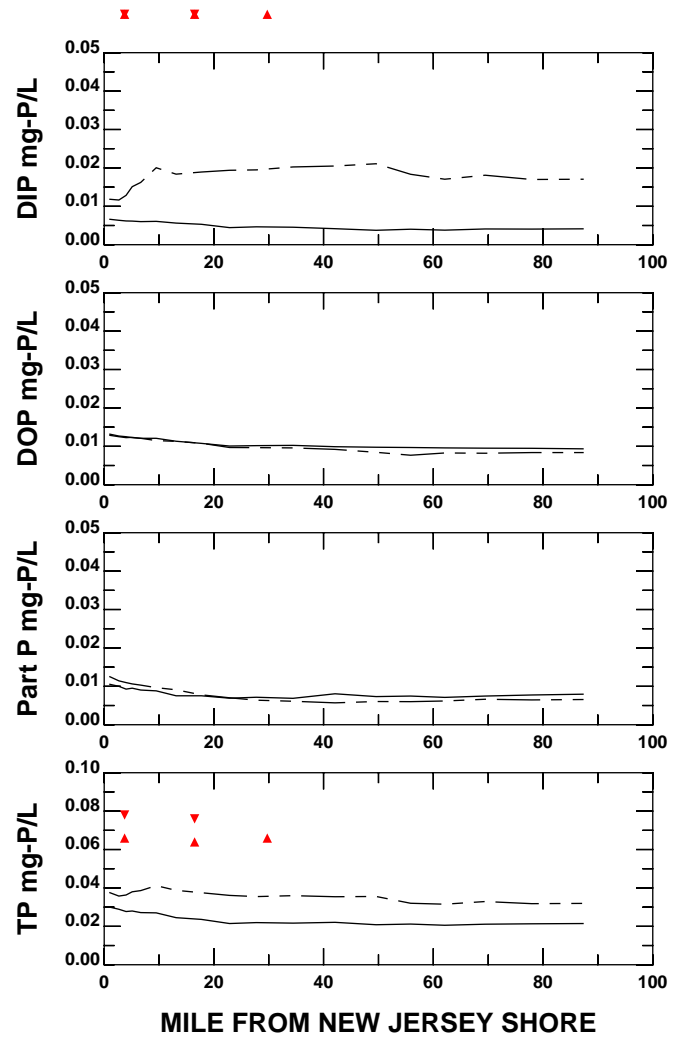
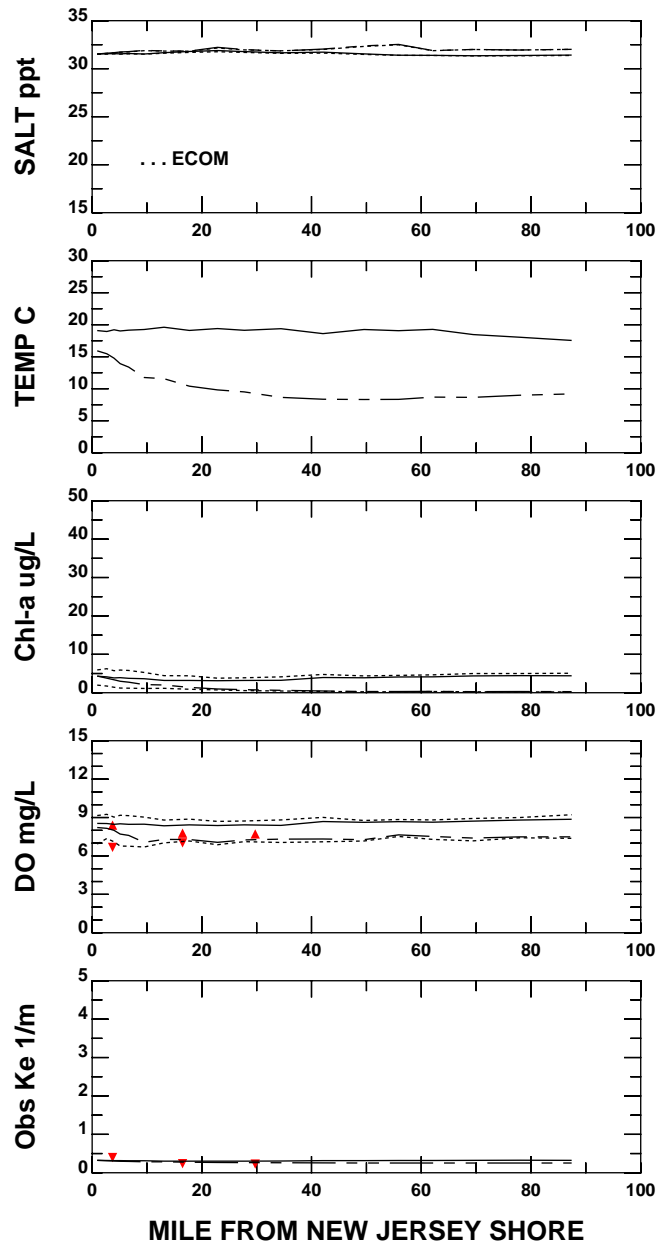
▲ ▼ Transect
T B Embayment

MODEL

— SURFACE 10-DAY MEAN

- - - - - BOTTOM 10-DAY MEAN

- . - . - . 10-DAY SURFACE MAX OR BOTTOM MIN



DATA

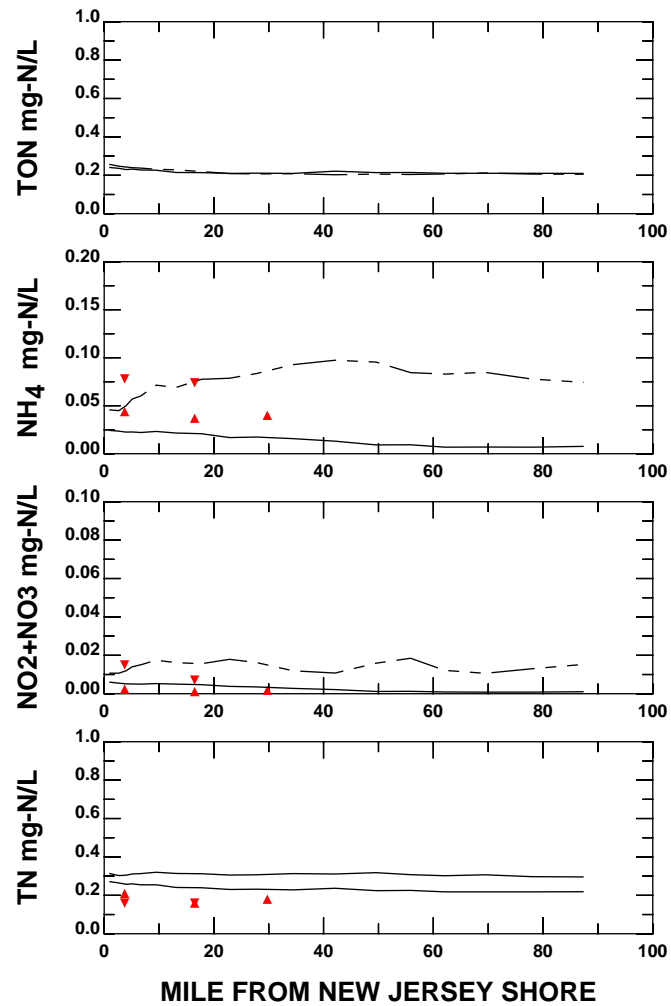
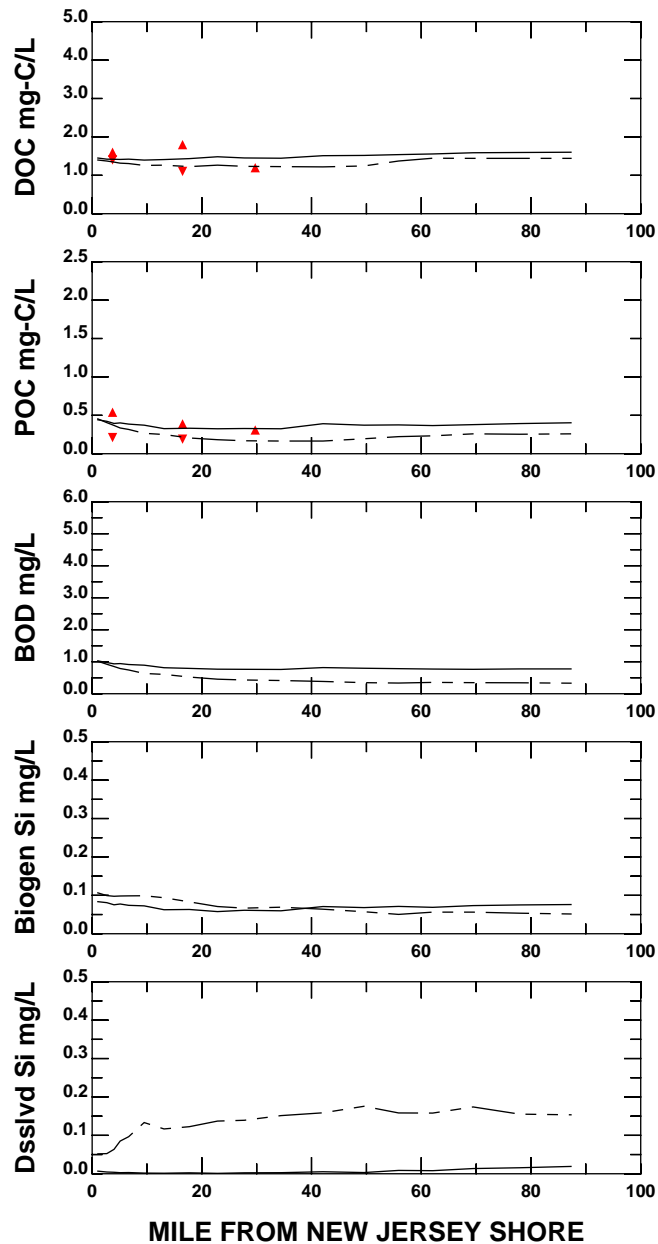
Battelle June 18-27,
1995

SURF BOT

▲ ▼ Transect
T B Embayment

MODEL

— SURFACE 10-DAY MEAN
 - - - - BOTTOM 10-DAY MEAN
 - - - 10-DAY SURFACE MAX OR
 BOTTOM MIN



DATA

Battelle June 18-27,
1995

SURF BOT

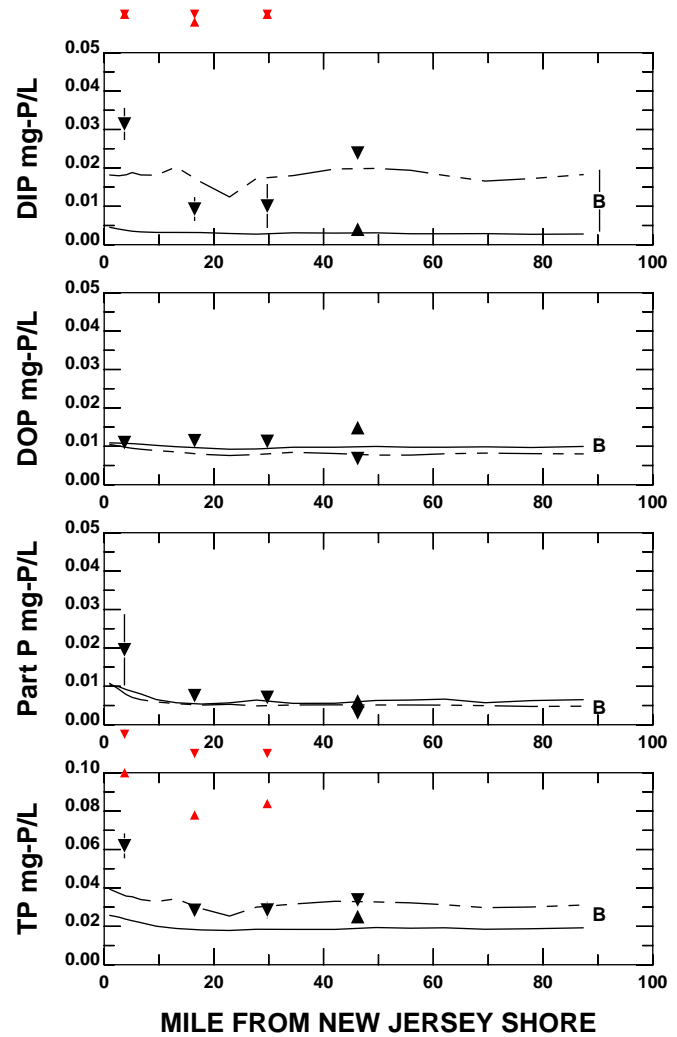
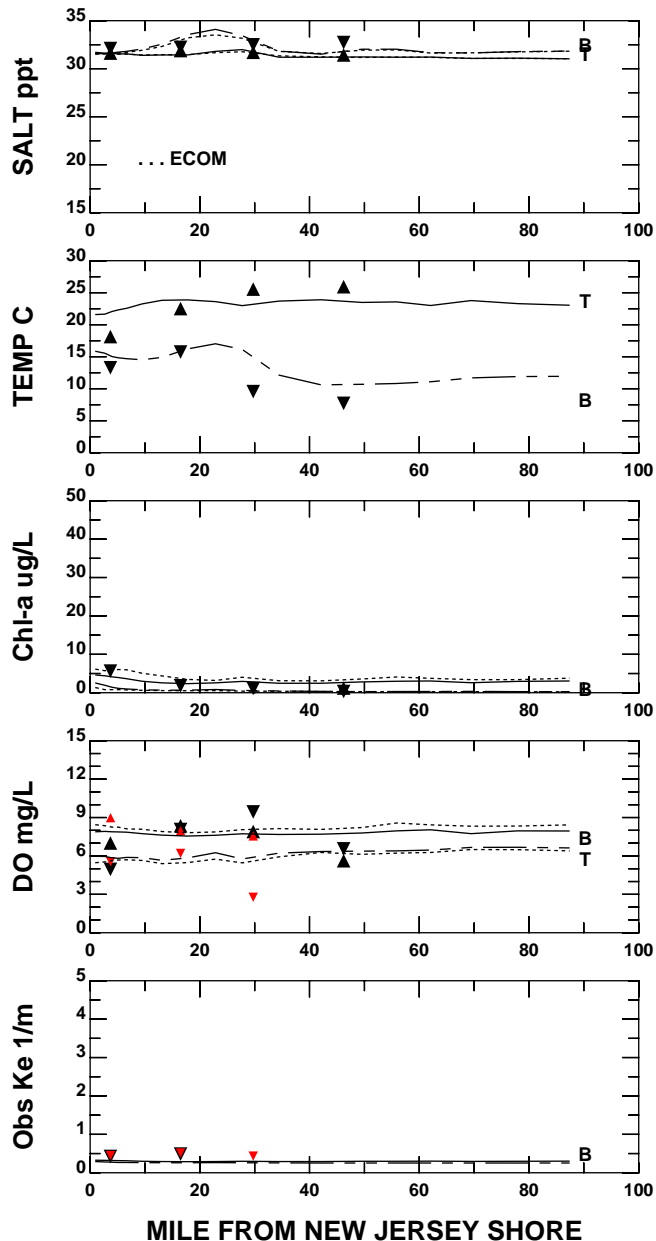
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T B Embayment

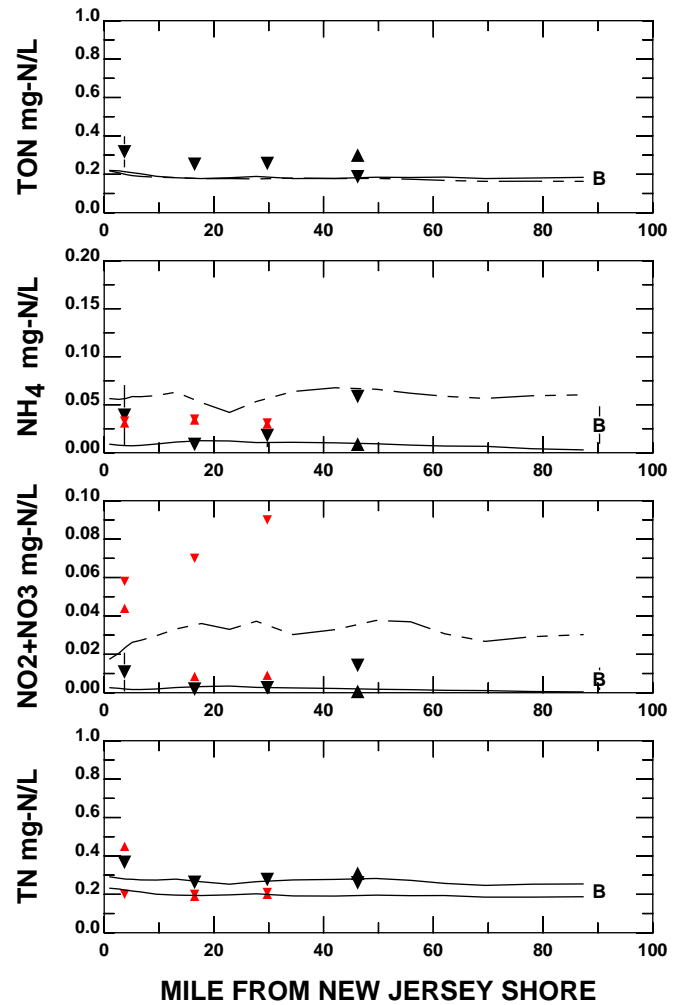
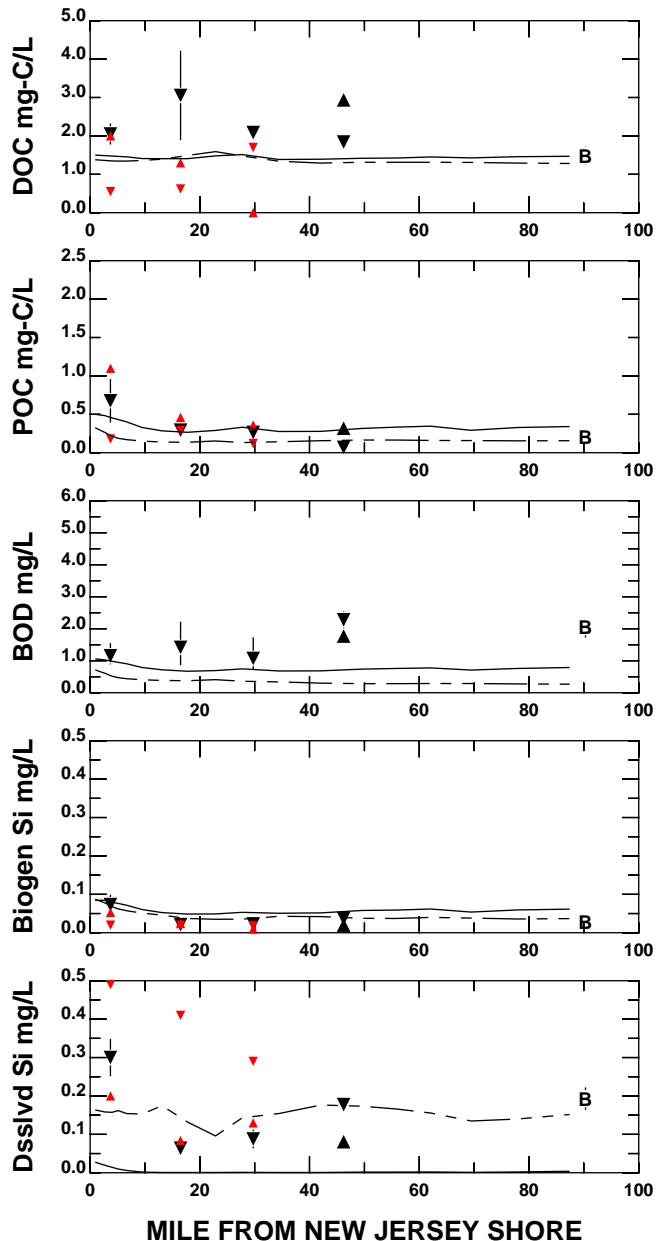
MODEL

— SURFACE 10-DAY MEAN

- - - BOTTOM 10-DAY MEAN

- - - 10-DAY SURFACE MAX OR
BOTTOM MIN

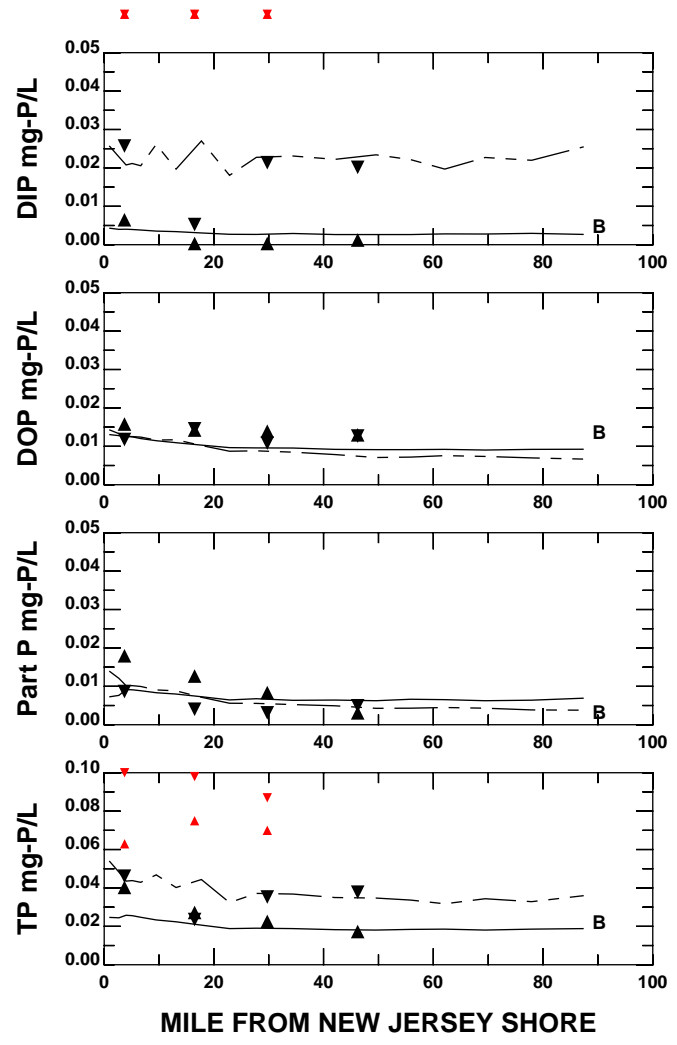
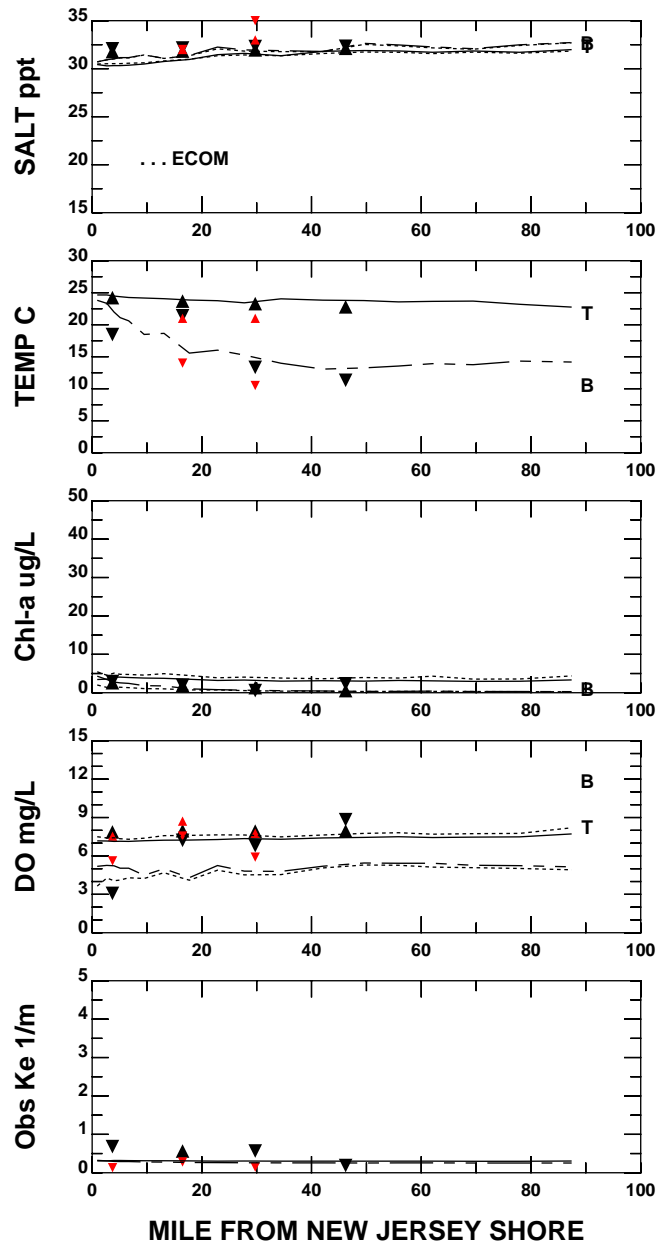


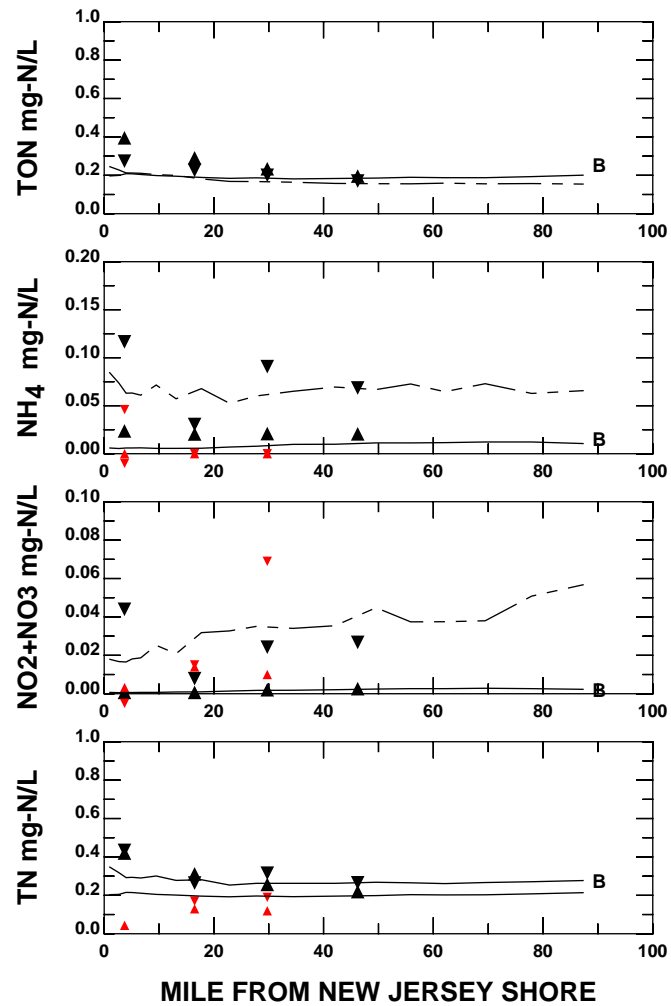
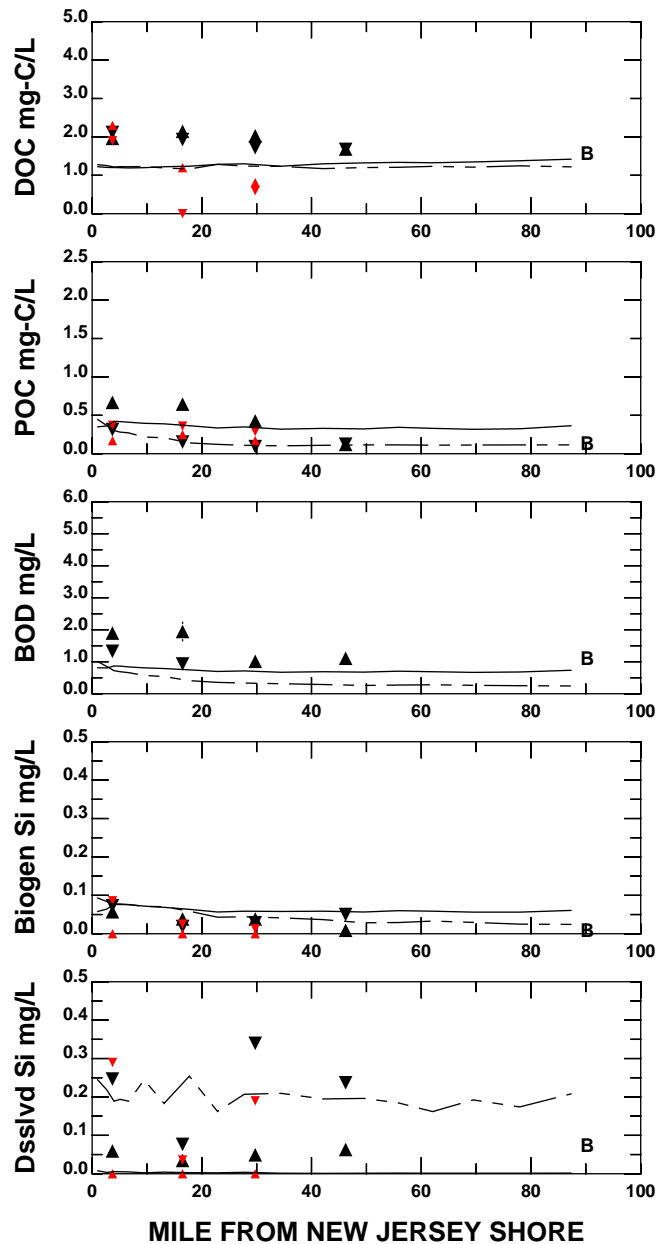


DATA
 Battelle July 20-Aug 2, 1995

SURF BOT
 ▲ ▼ Transect
 T B Embayment

MODEL
 — SURFACE 10-DAY MEAN
 BOTTOM 10-DAY MEAN
 - - - 10-DAY SURFACE MAX OR BOTTOM MIN





DATA

Battelle Aug 20-29, 1995

SURF BOT

▲ ▼ Transect

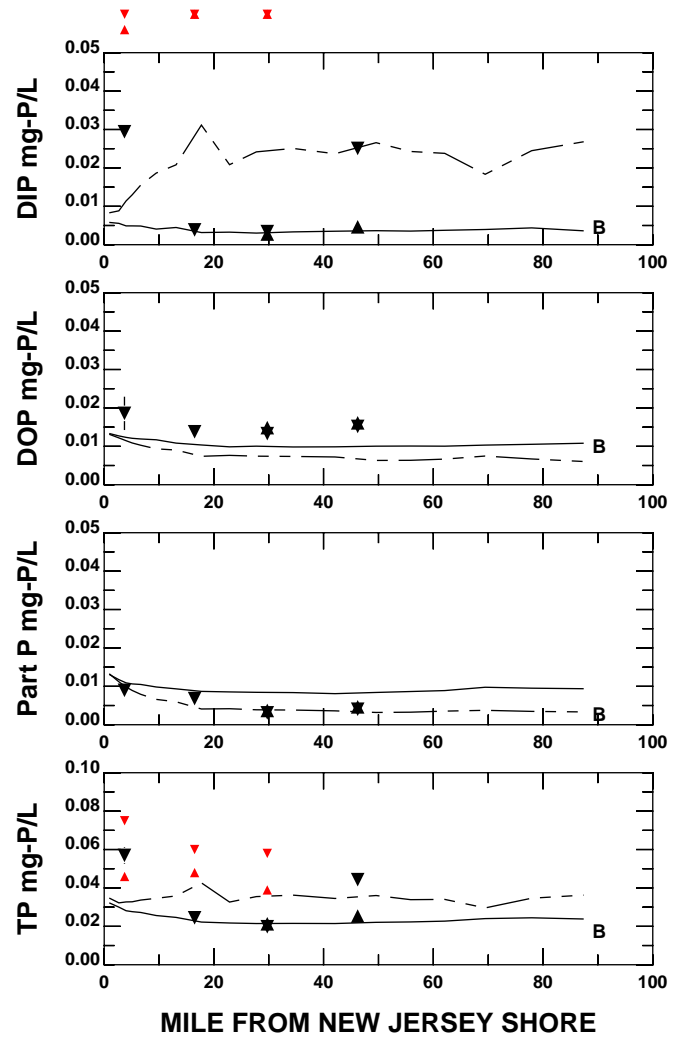
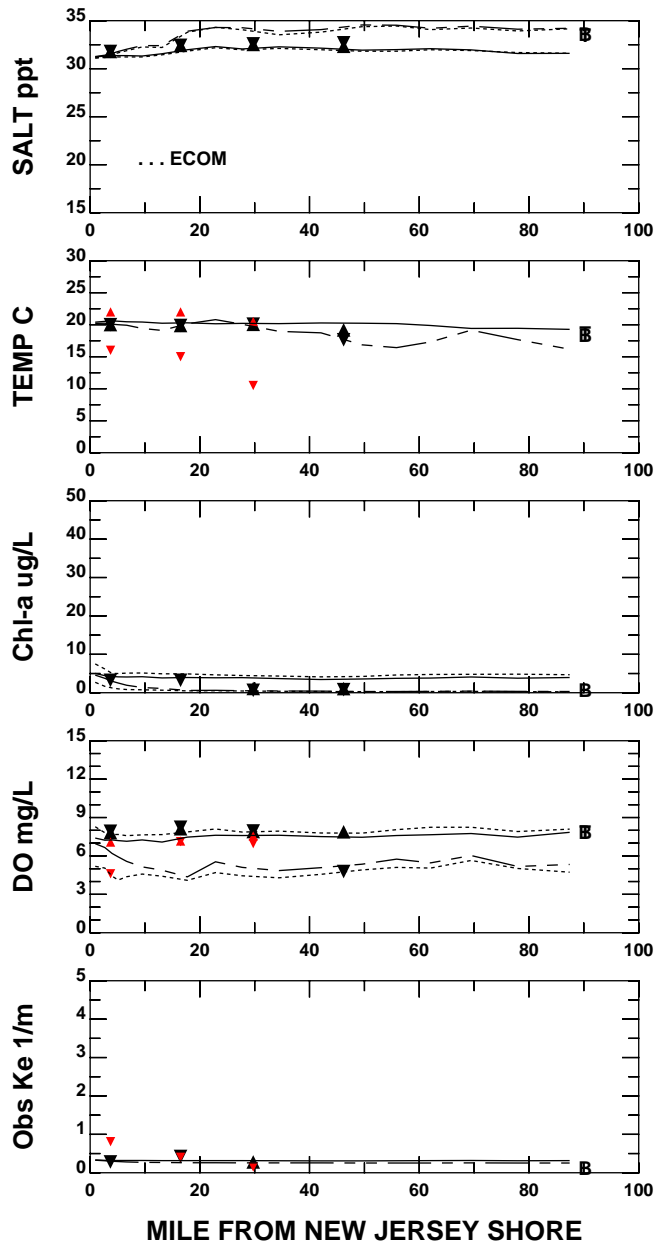
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MODEL

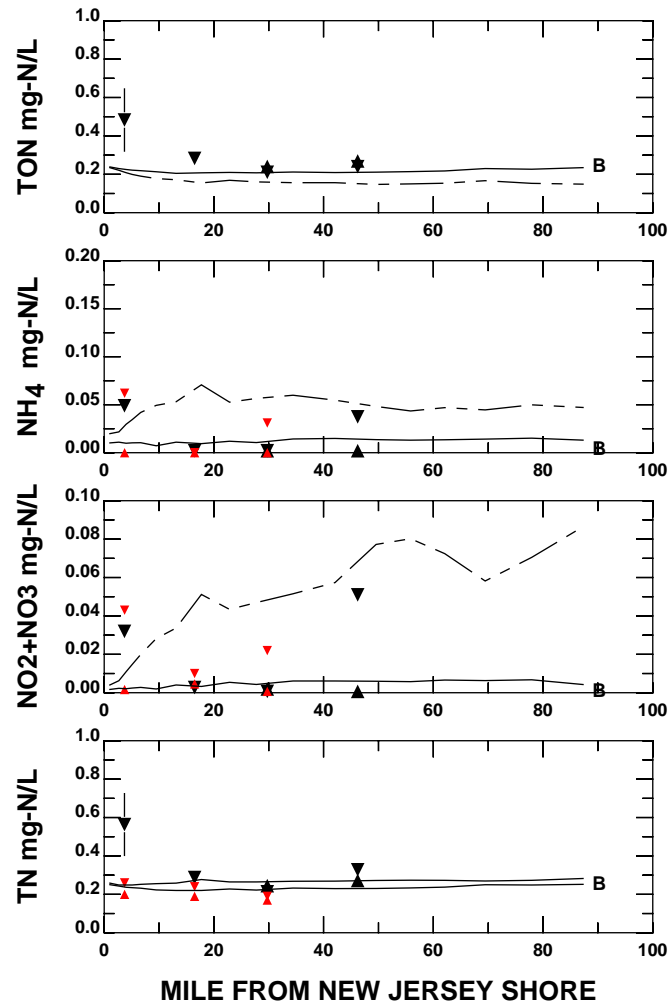
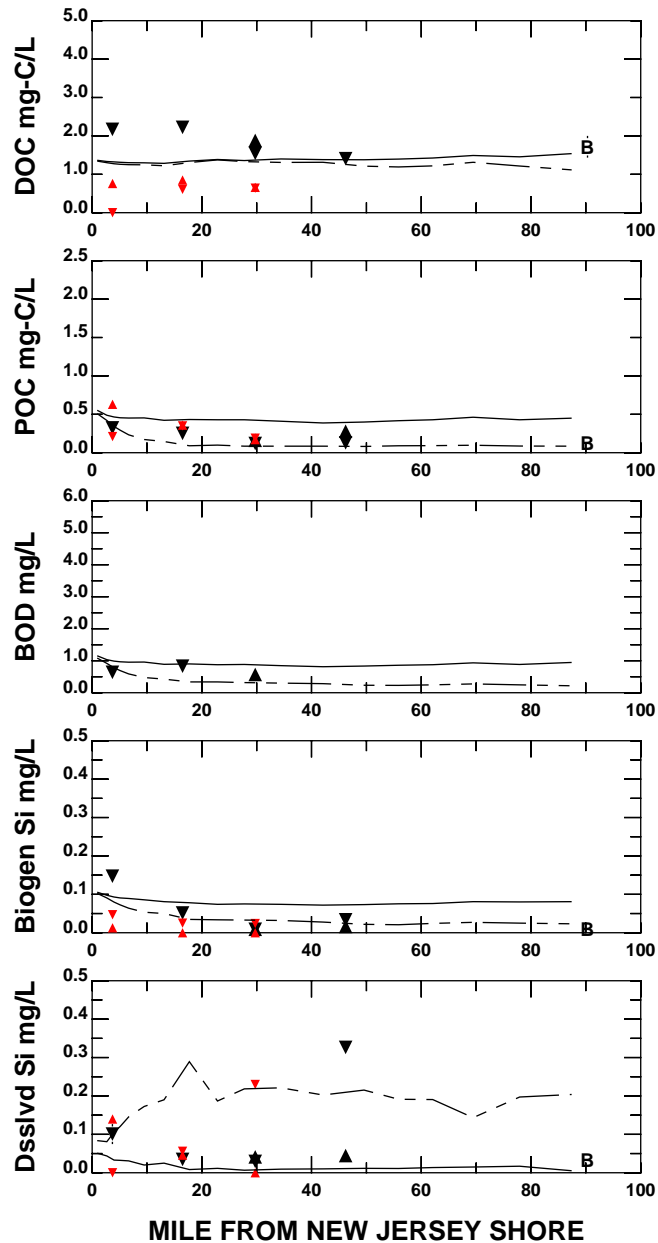
— SURFACE 10-DAY MEAN

- - - BOTTOM 10-DAY MEAN

- - - 10-DAY SURFACE MAX OR
BOTTOM MIN



| | | |
|-----------------------------|-----------------|--|
| DATA | SURF BOT | MODEL |
| Battelle Sep 23-Oct 2, 1995 | ▲ ▼ Transect | — SURFACE 10-DAY MEAN |
| | T B Embayment | - - - BOTTOM 10-DAY MEAN |
| | | - - - 10-DAY SURFACE MAX OR BOTTOM MIN |



DATA

Battelle Sep 23-Oct 2,
1995

SURF BOT

▲ ▼ Transect
T B Embayment

MODEL

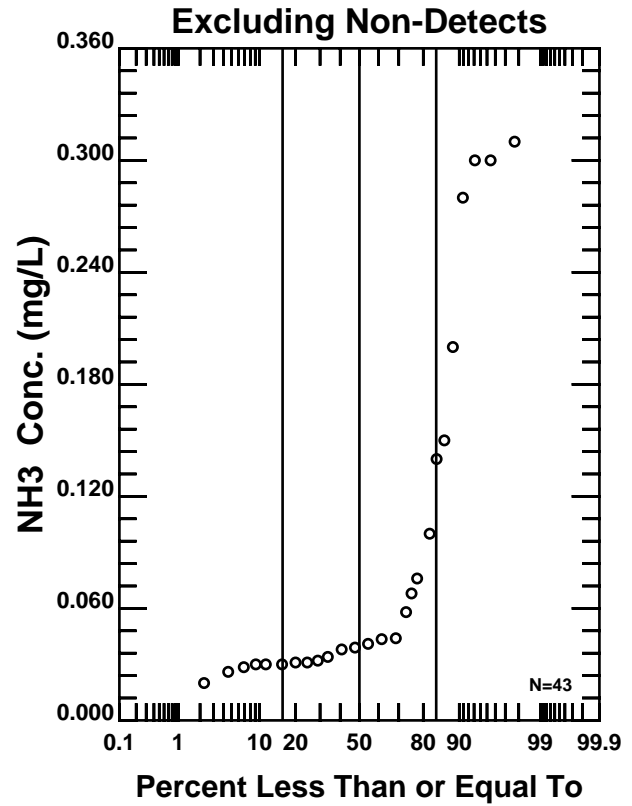
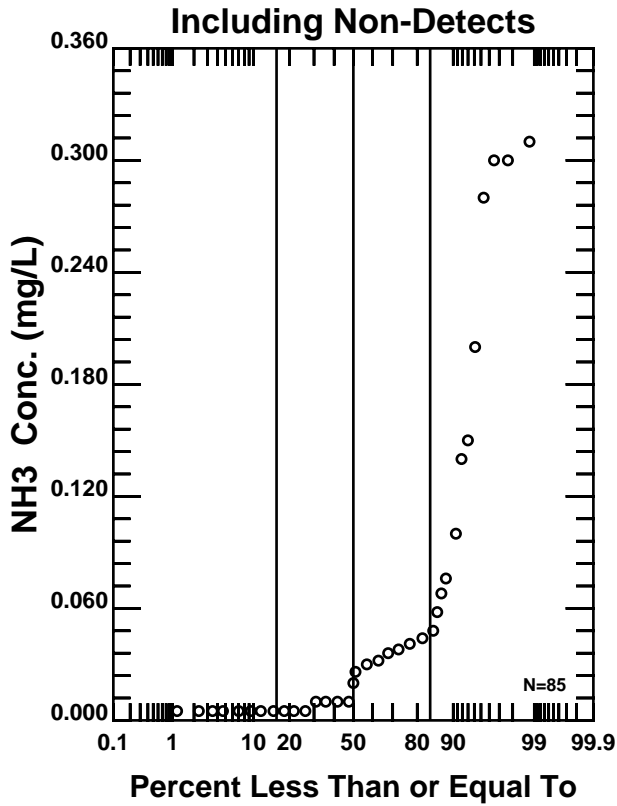
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 BOTTOM MIN

ATTACHMENT B
2008 PROBABILITY DIAGRAMS

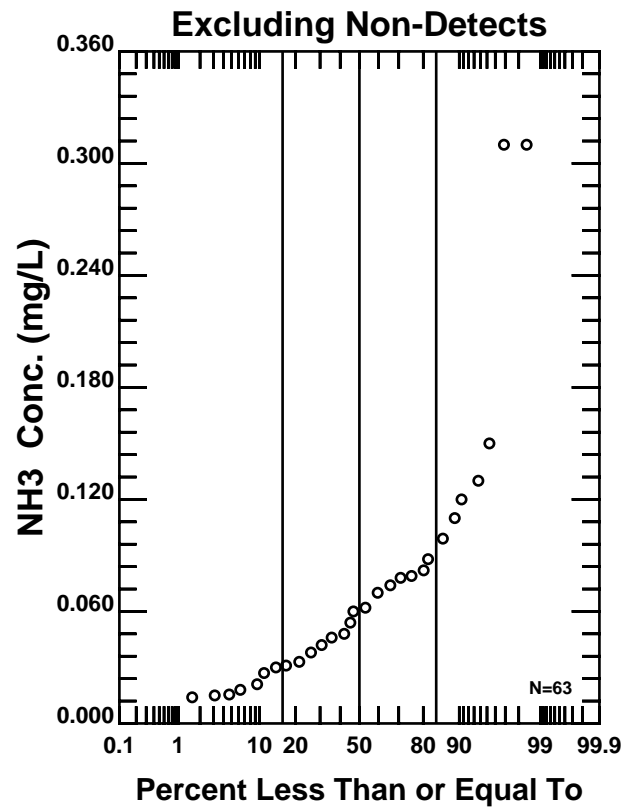
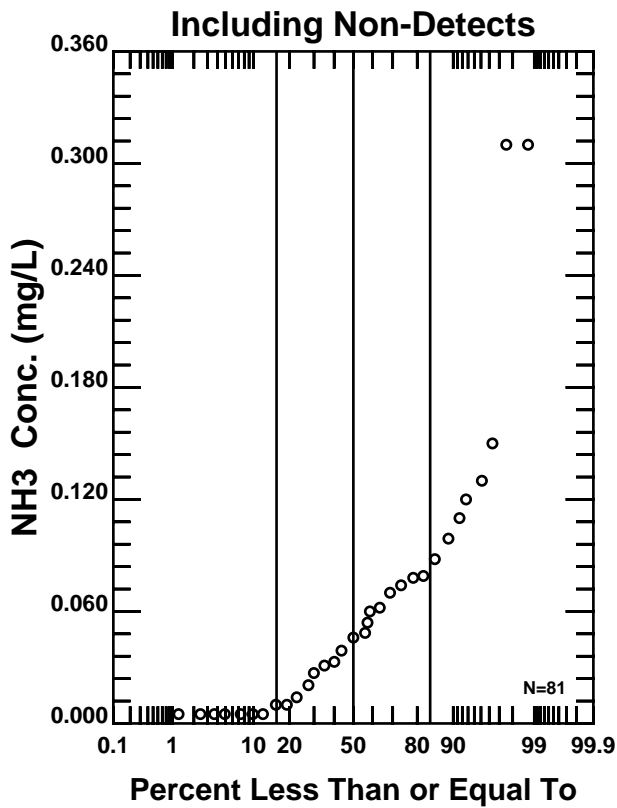
HYDROQUAL, INC.

1200 MACARTHUR BLVD., MAHWAH, NEW JERSEY 07430 T: 201-529-5151 F: 201-529-5728 WWW.HYDROQUAL.COM

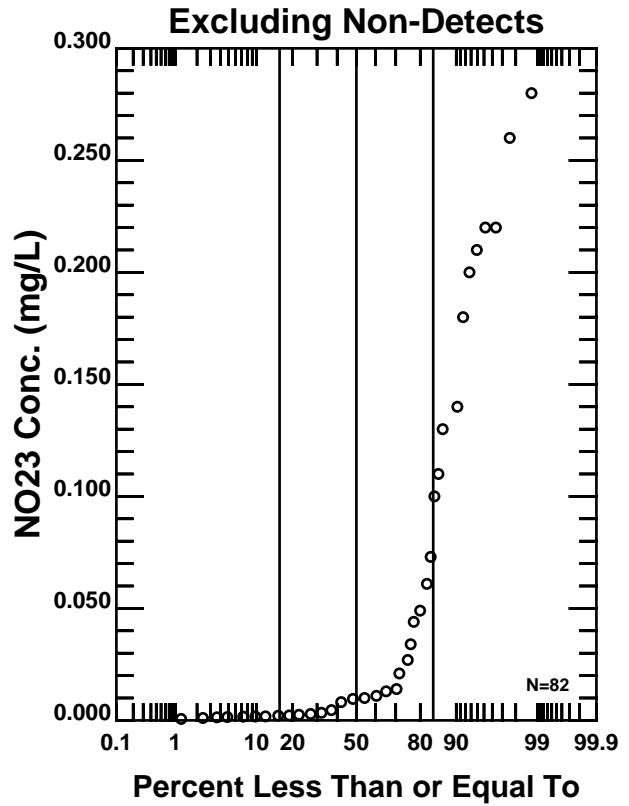
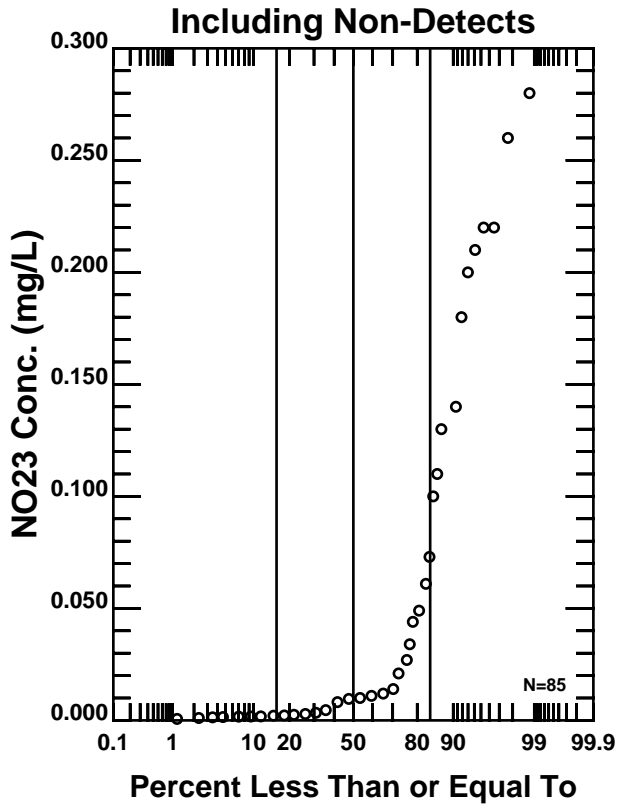
2008 NY Bight Surface Observation



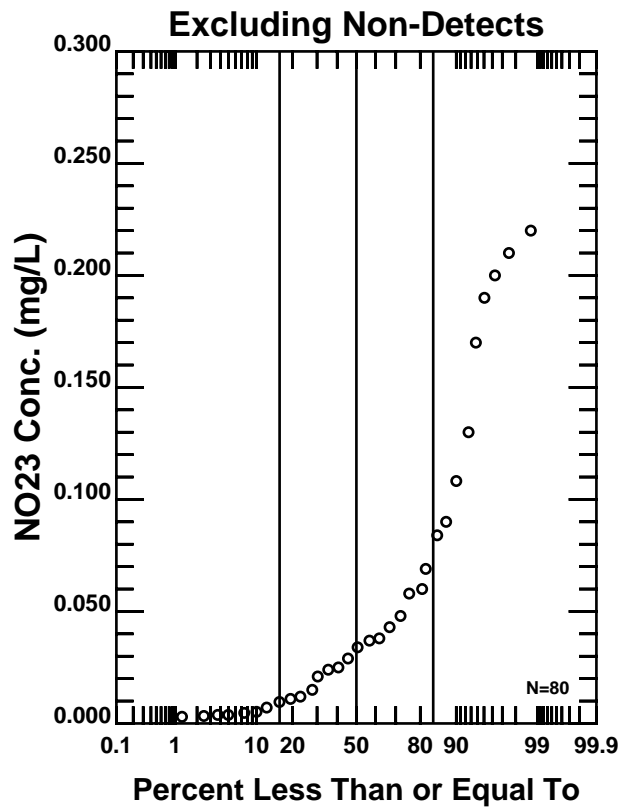
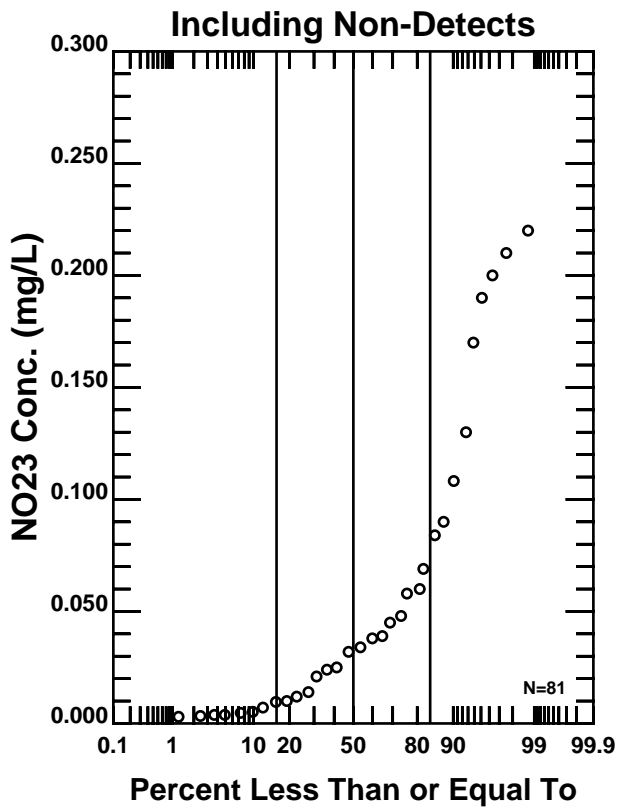
2008 NY Bight Bottom Observation



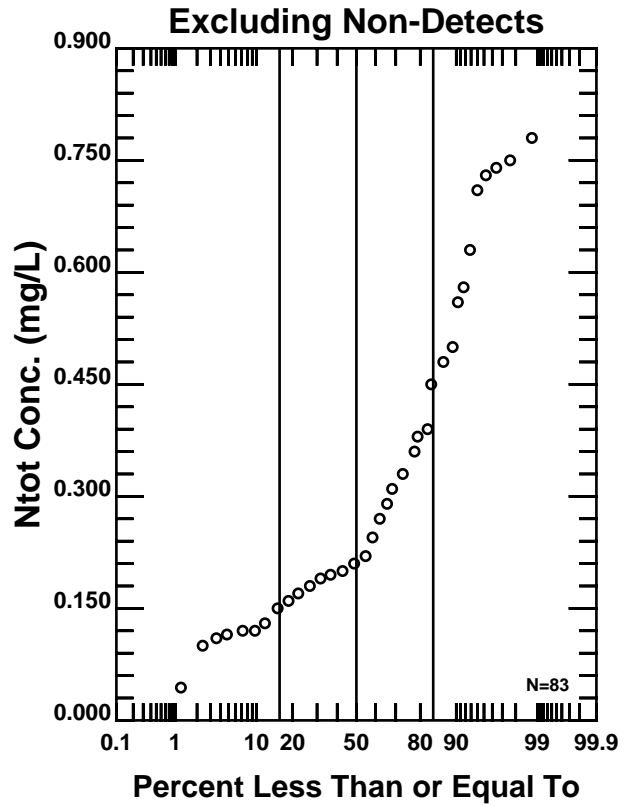
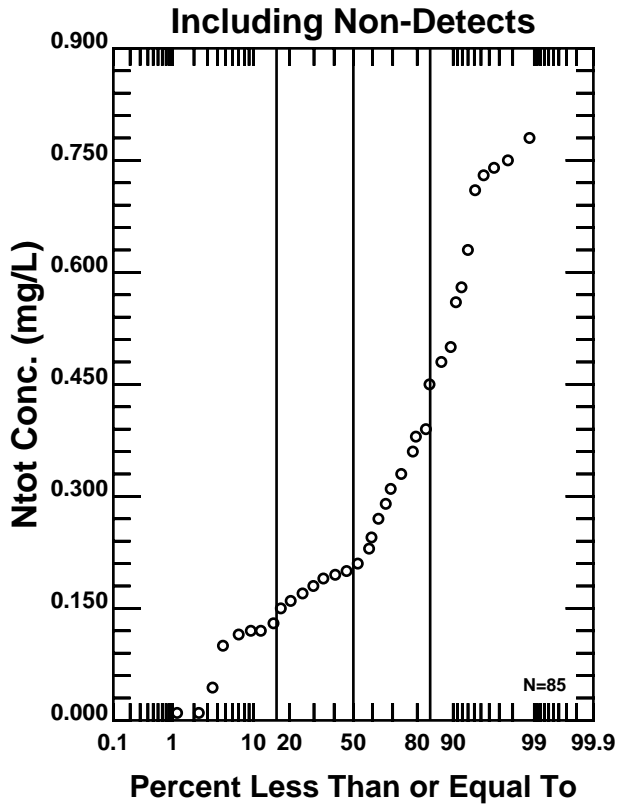
2008 NY Bight Surface Observation



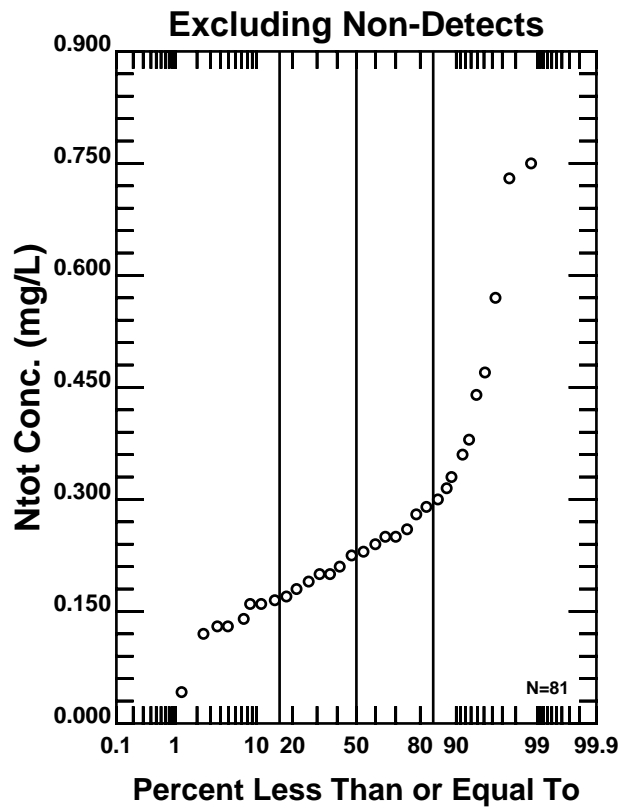
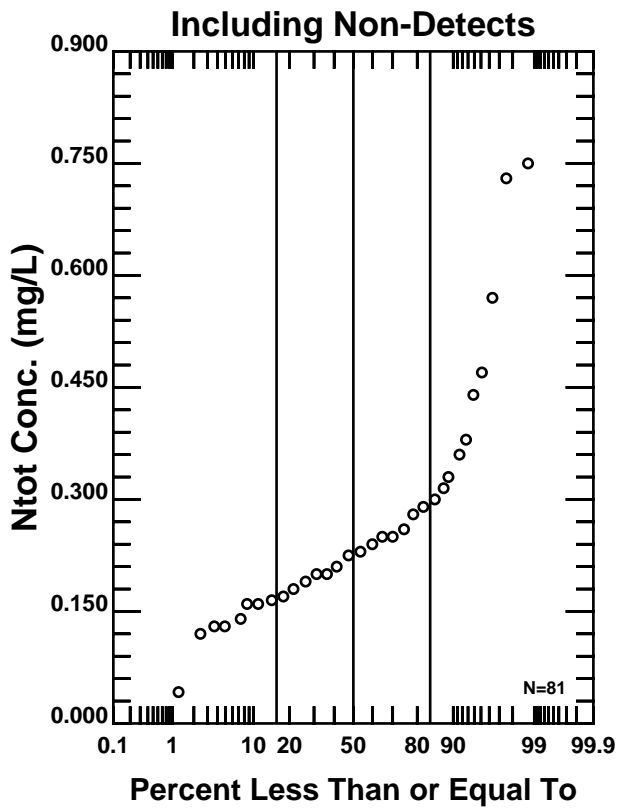
2008 NY Bight Bottom Observation



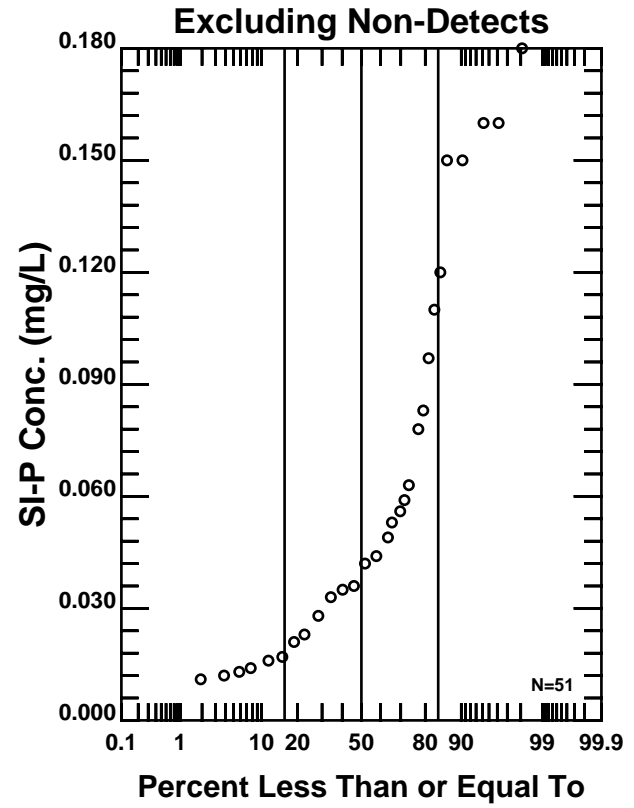
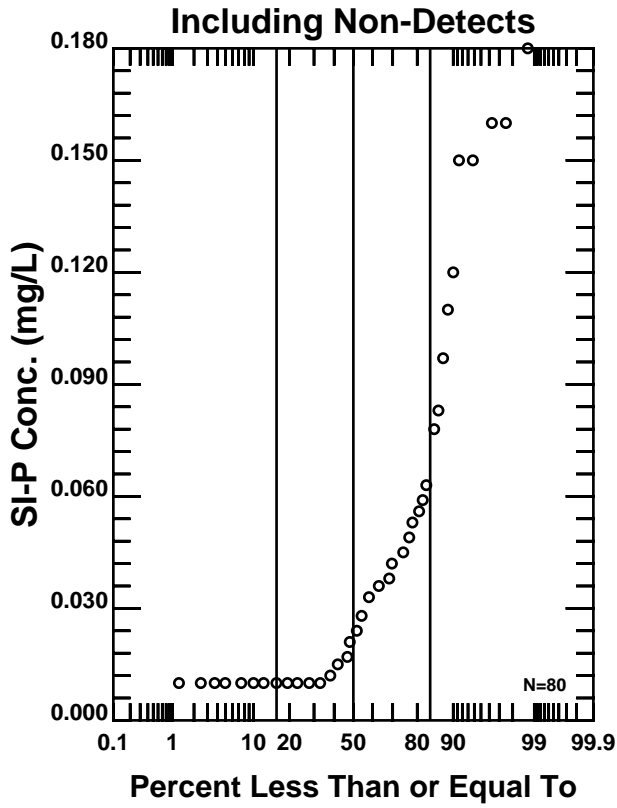
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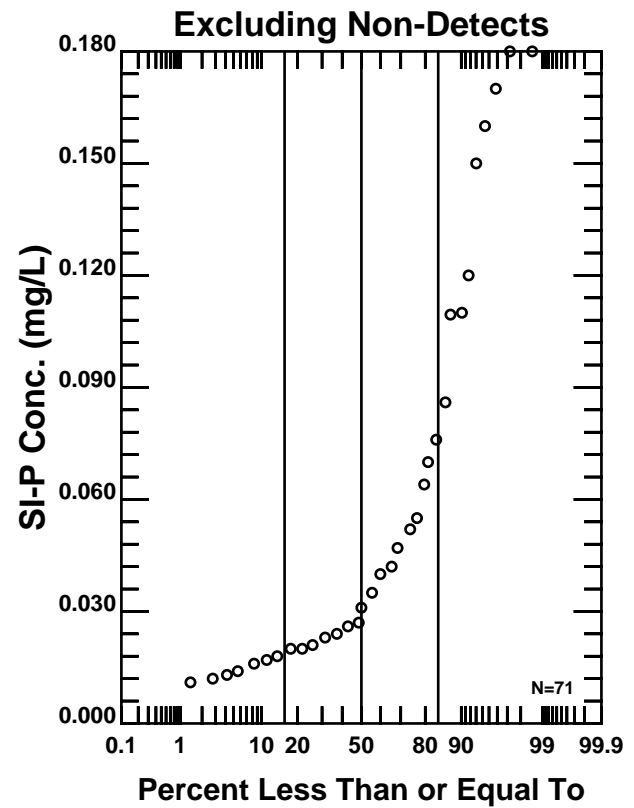
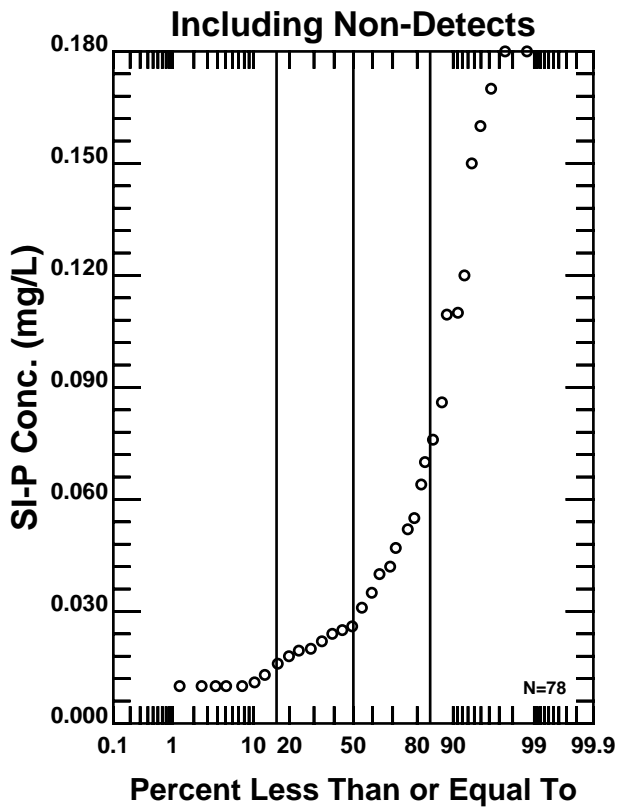
2008 NY Bight Bottom Observation



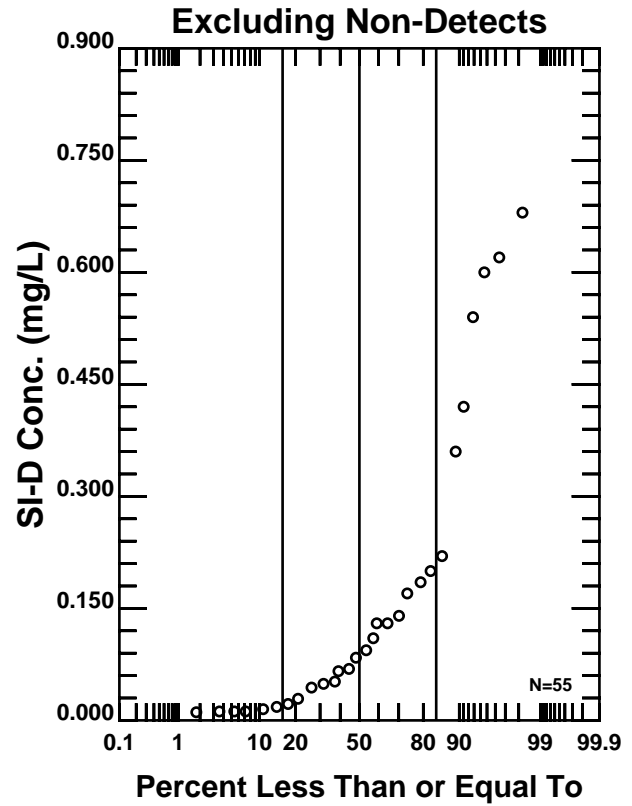
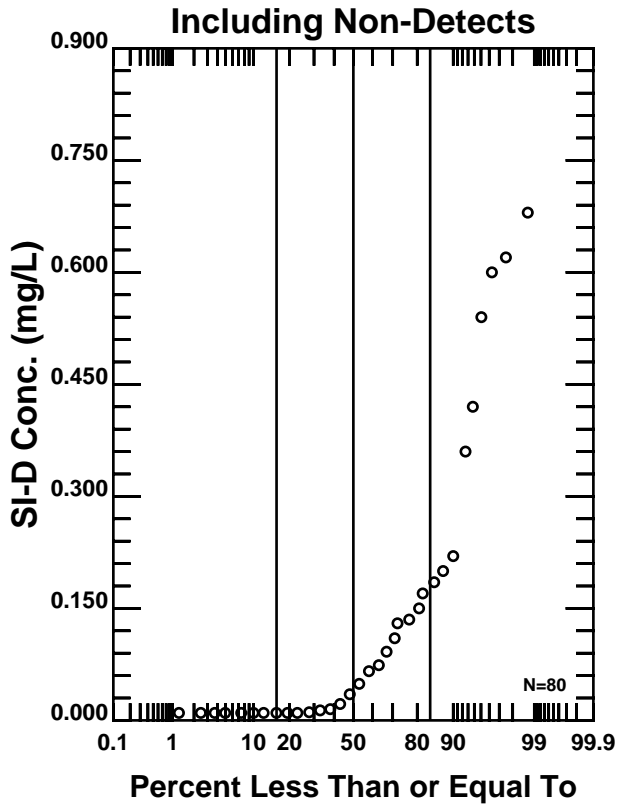
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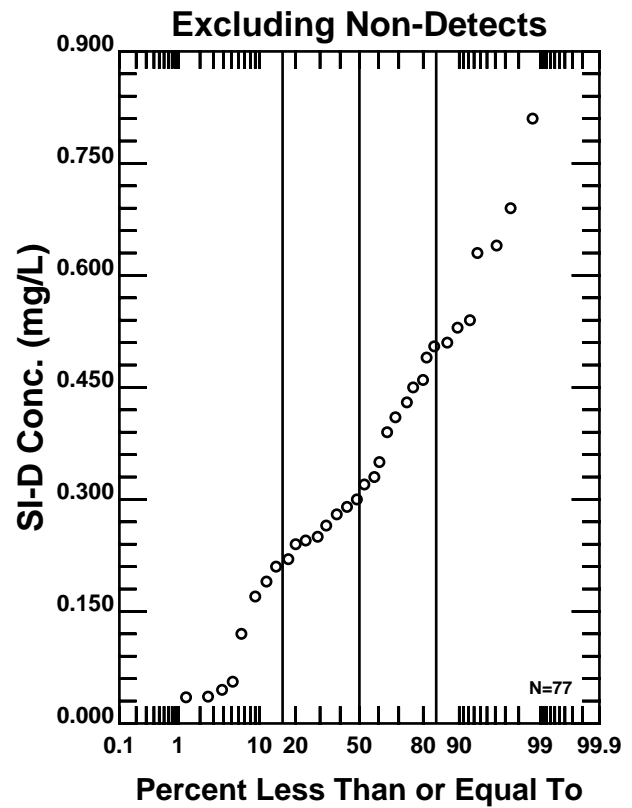
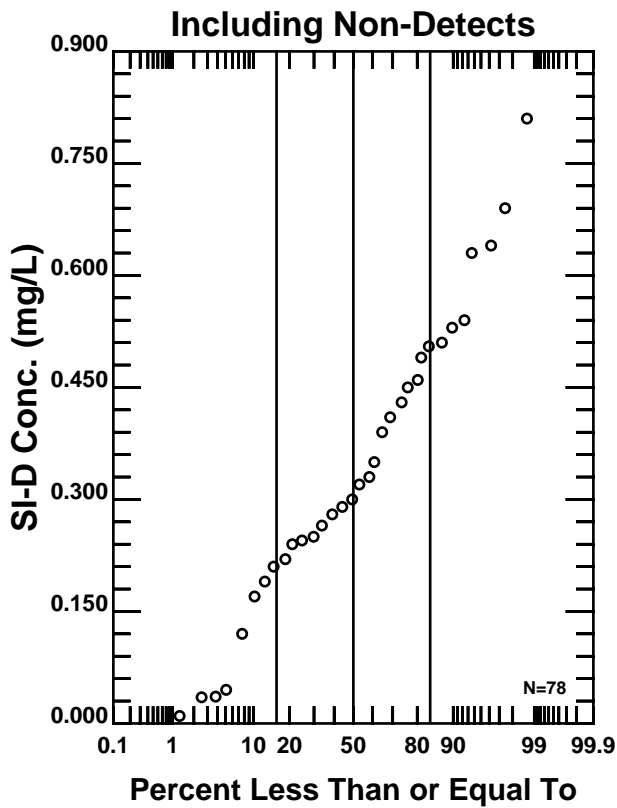
2008 NY Bight Bottom Observation



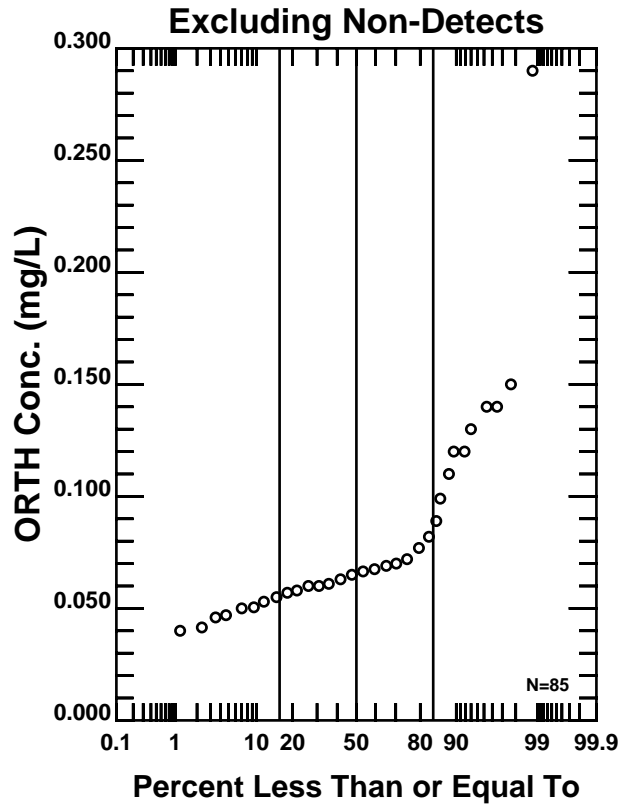
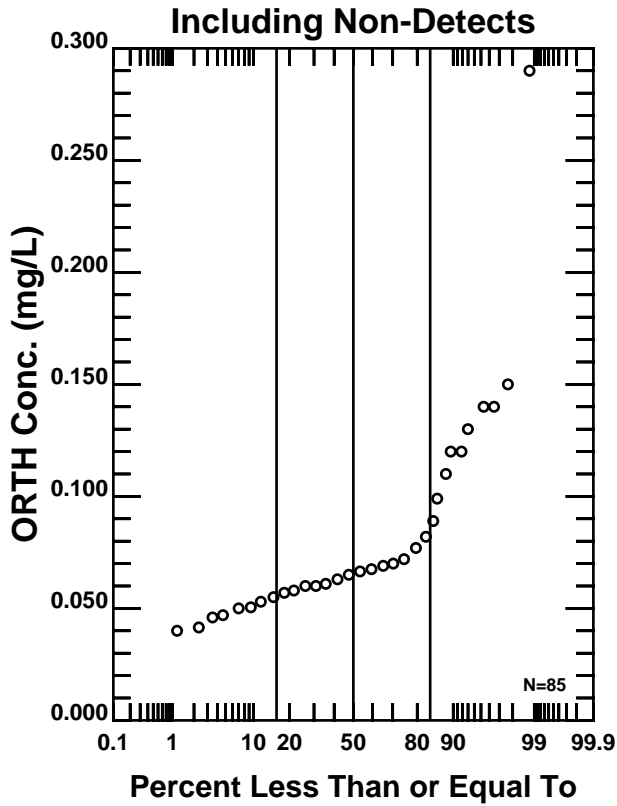
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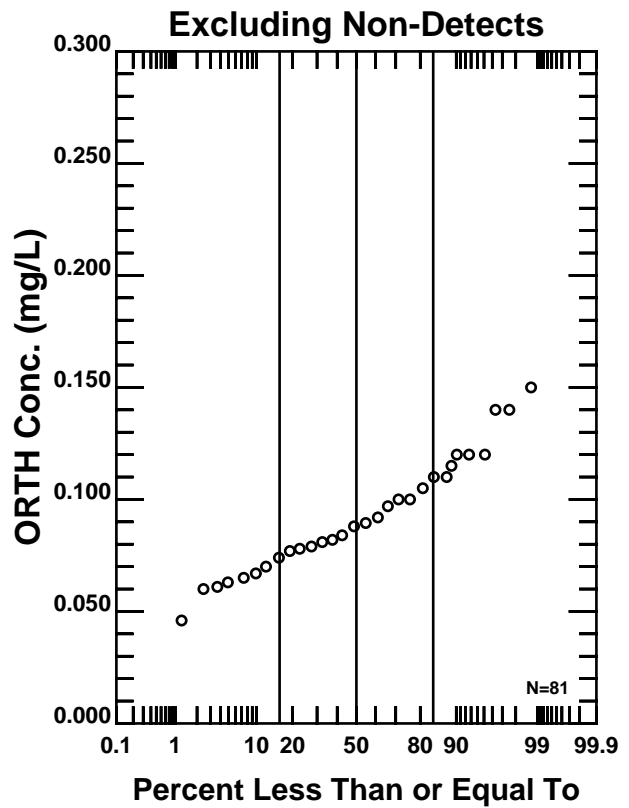
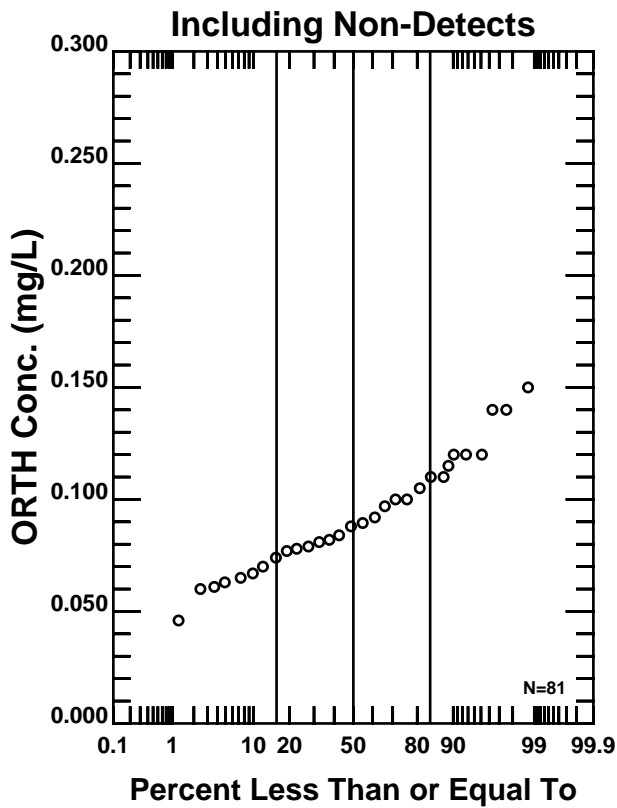
2008 NY Bight Bottom Observation



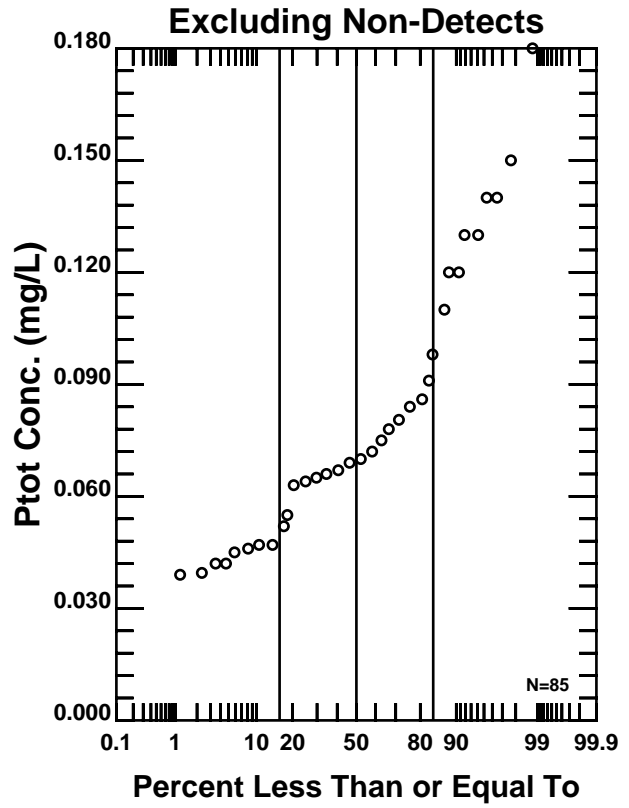
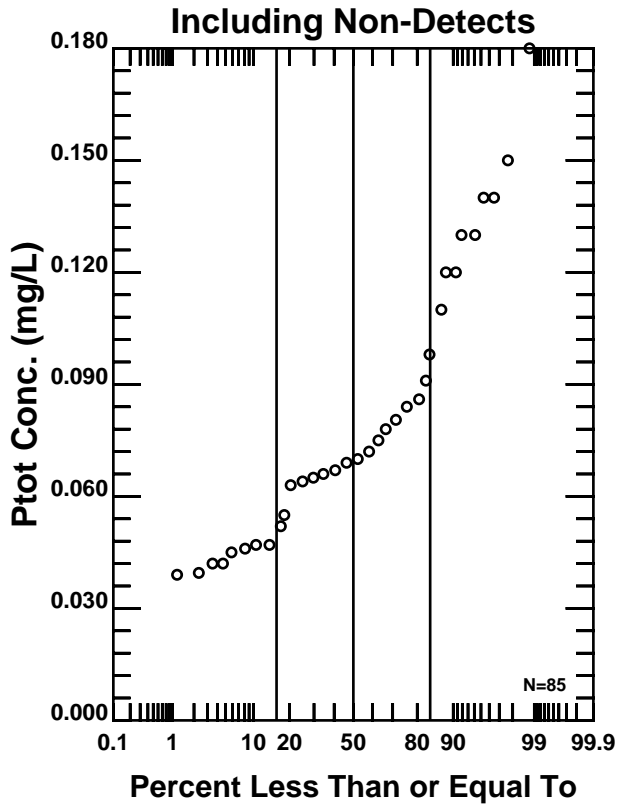
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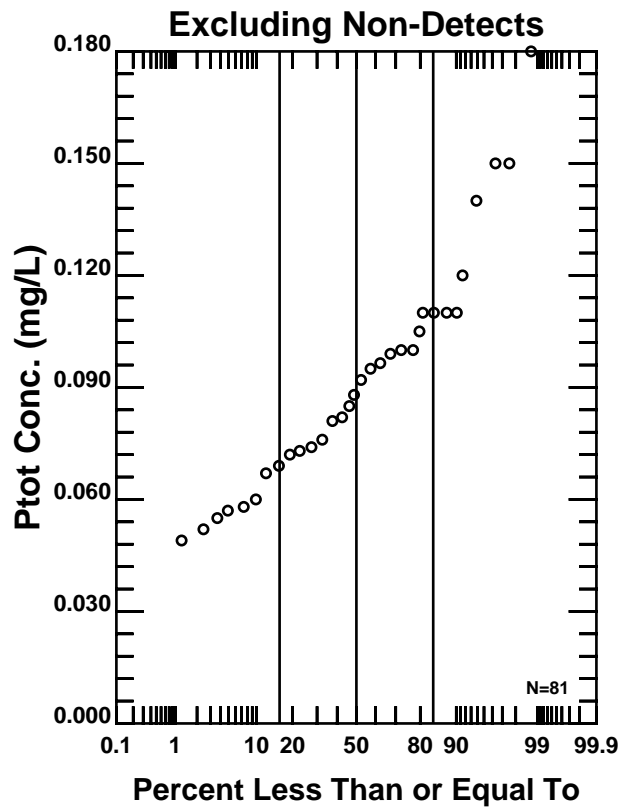
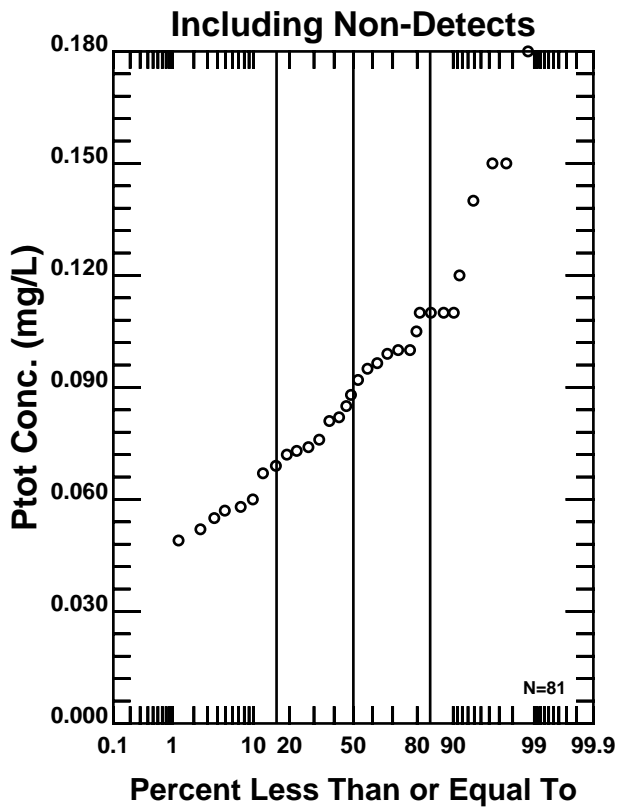
2008 NY Bight Bottom Observation



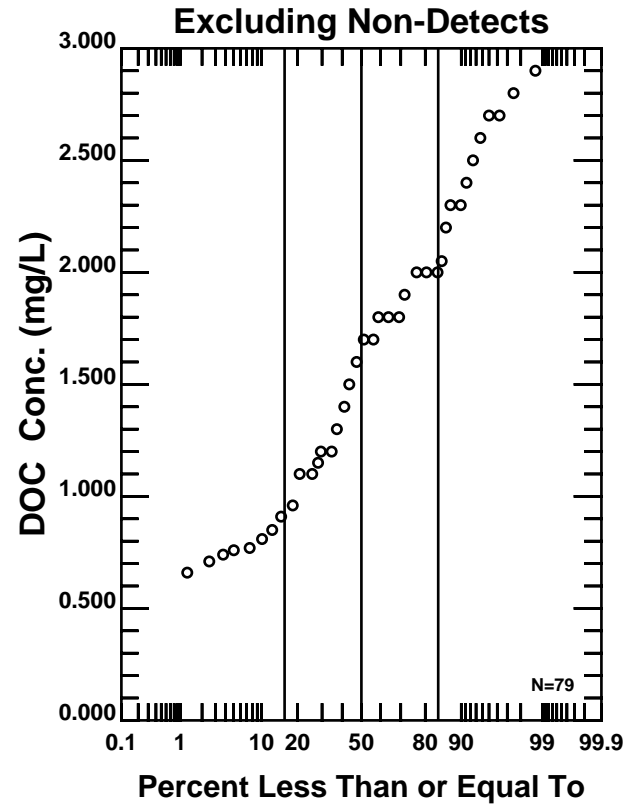
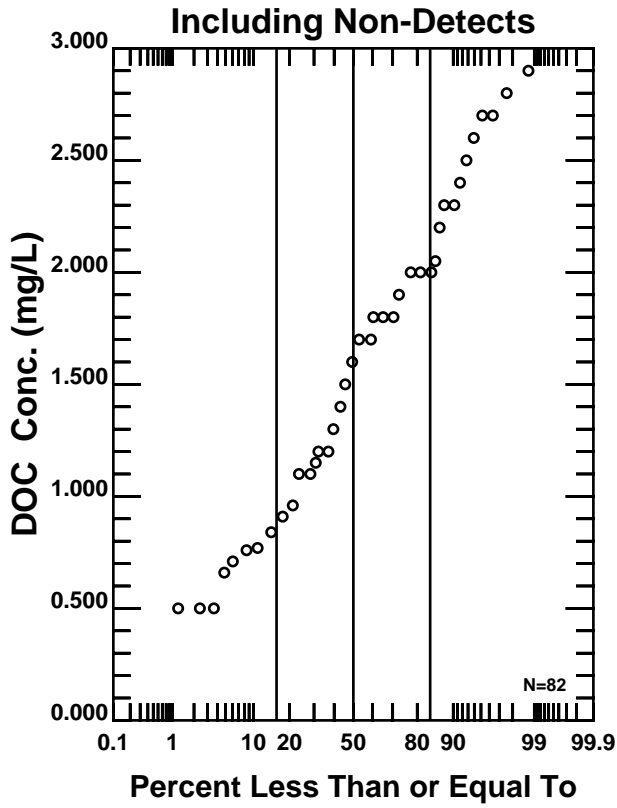
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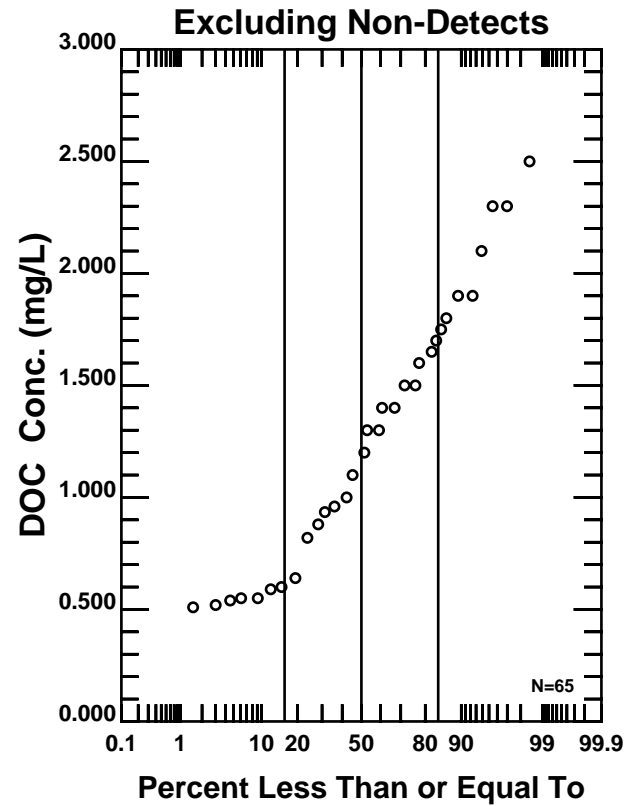
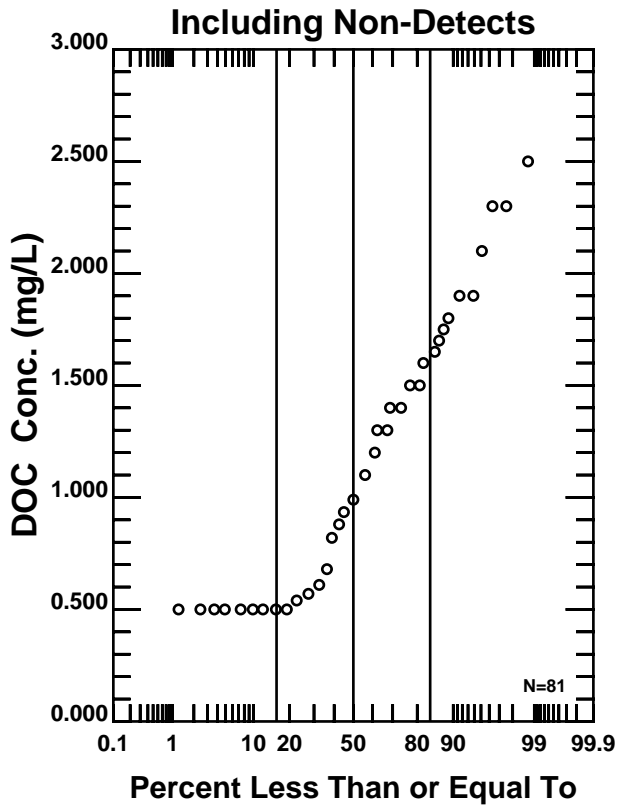
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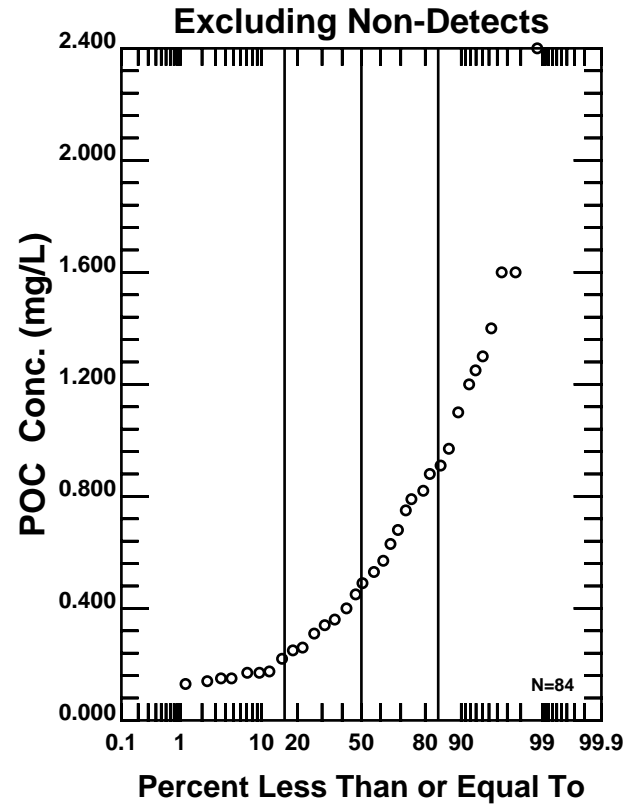
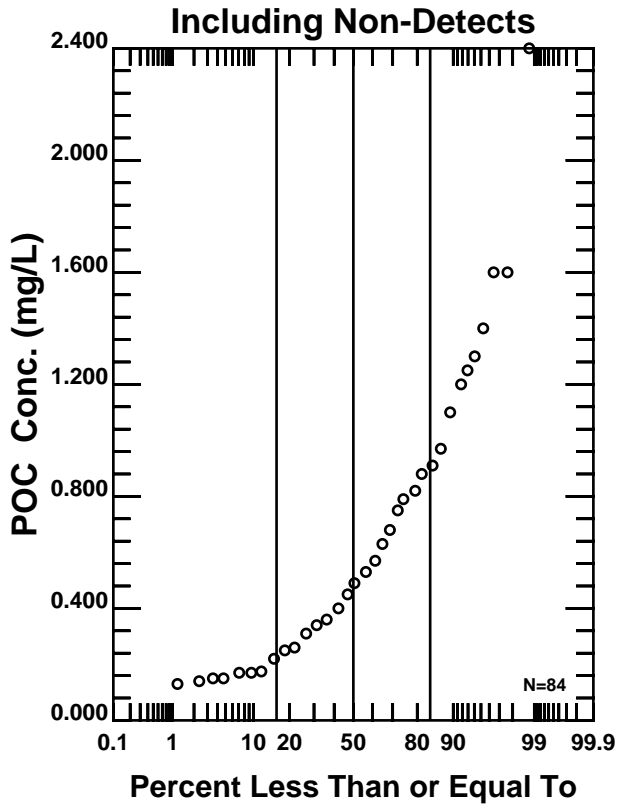
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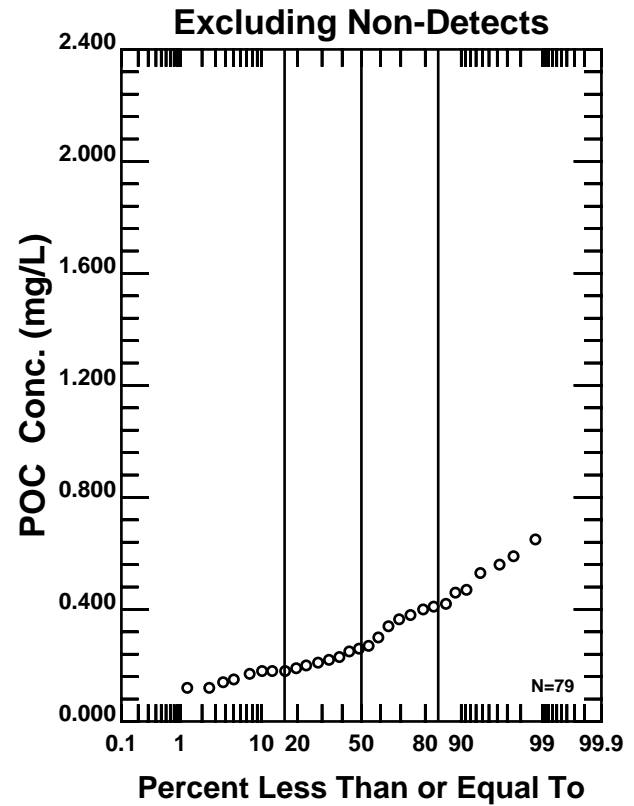
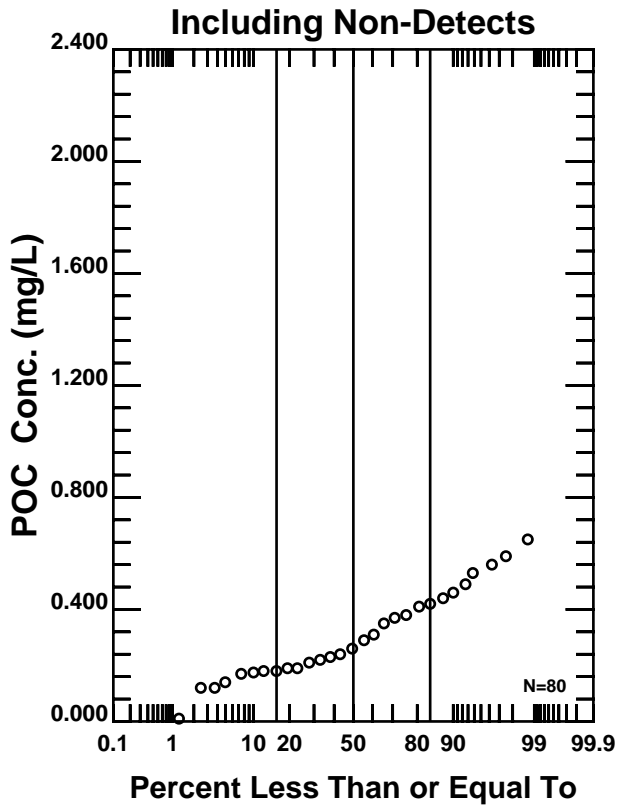
2008 NY Bight Bottom Observation



2008 NY Bight Surface Observation



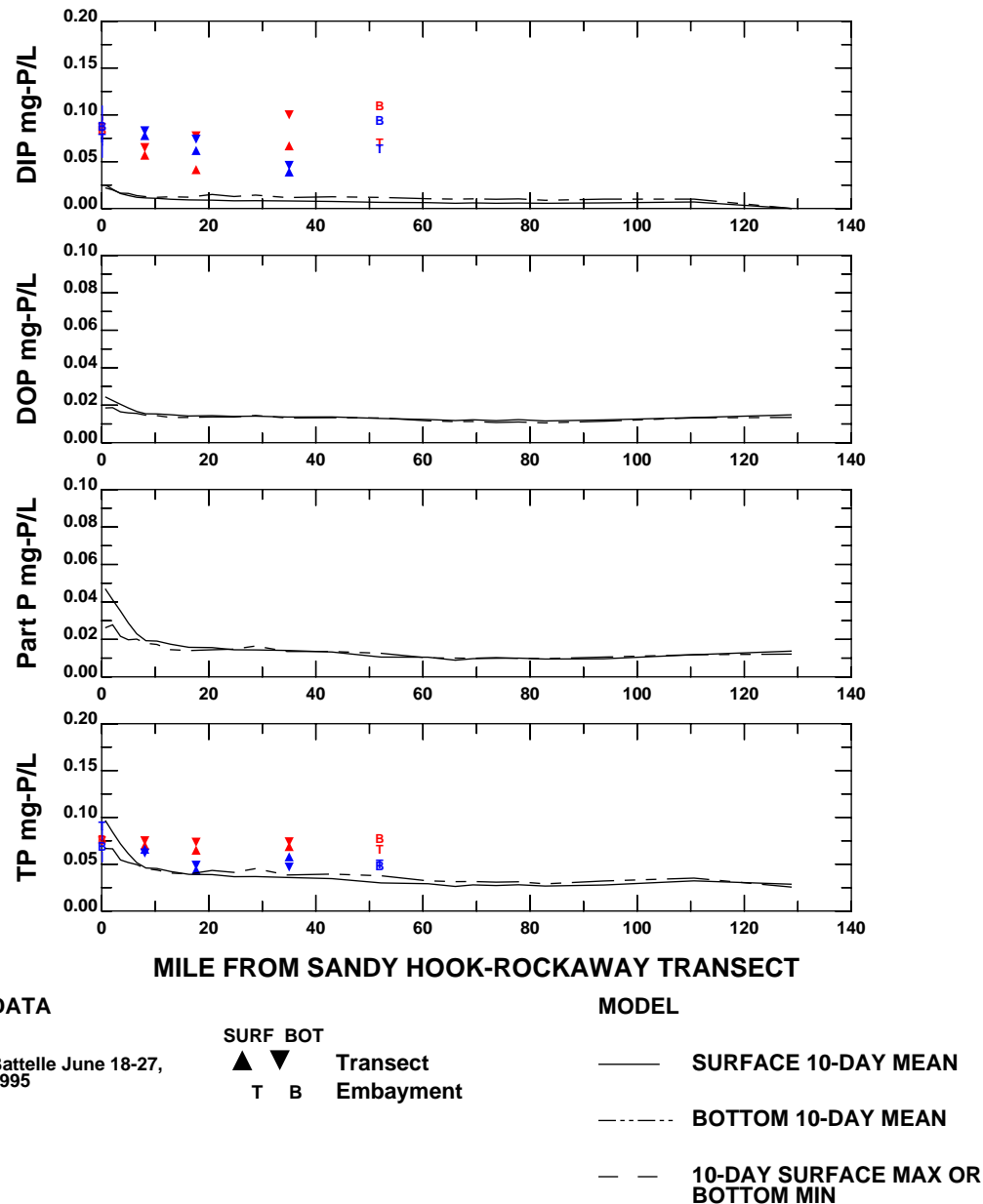
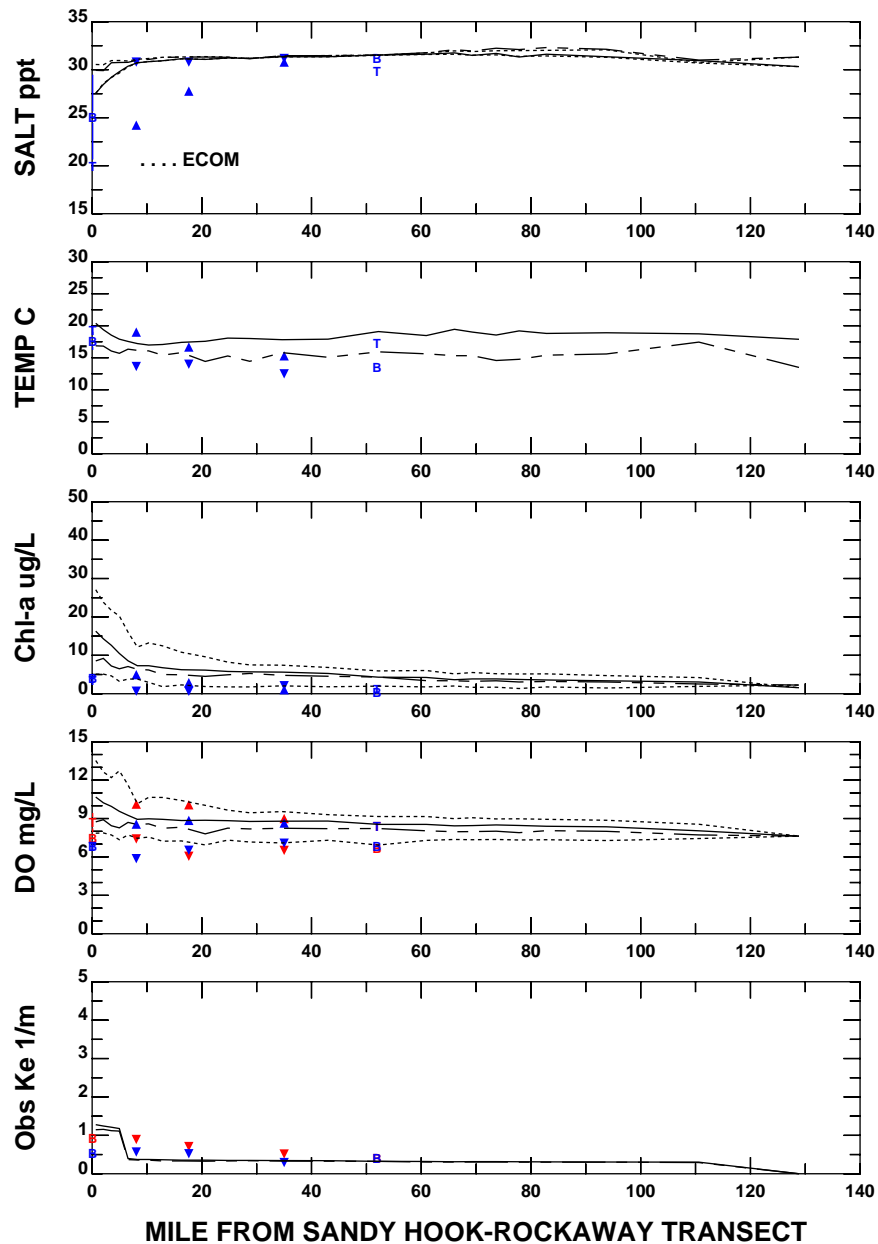
2008 NY Bight Bottom Observation

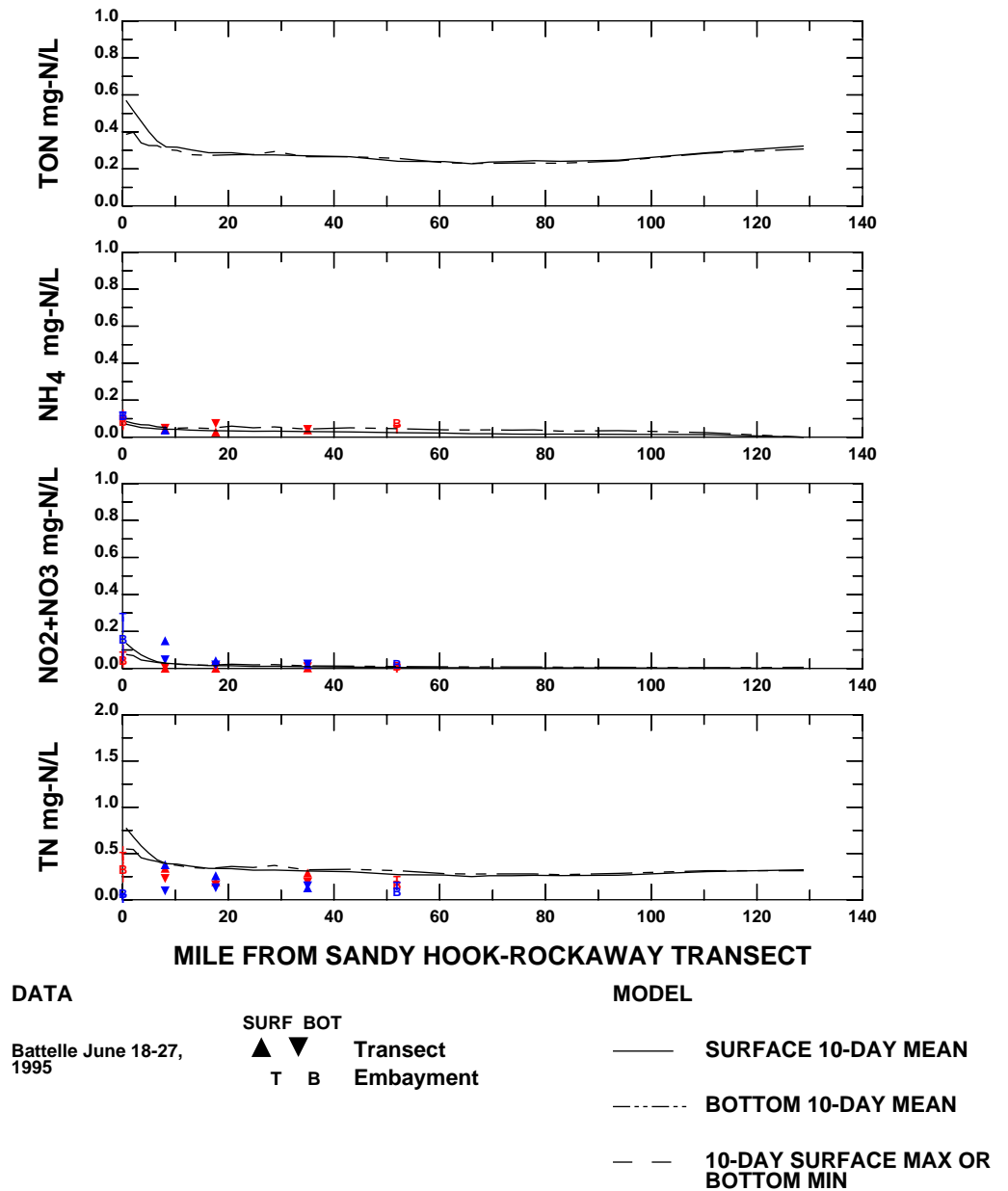
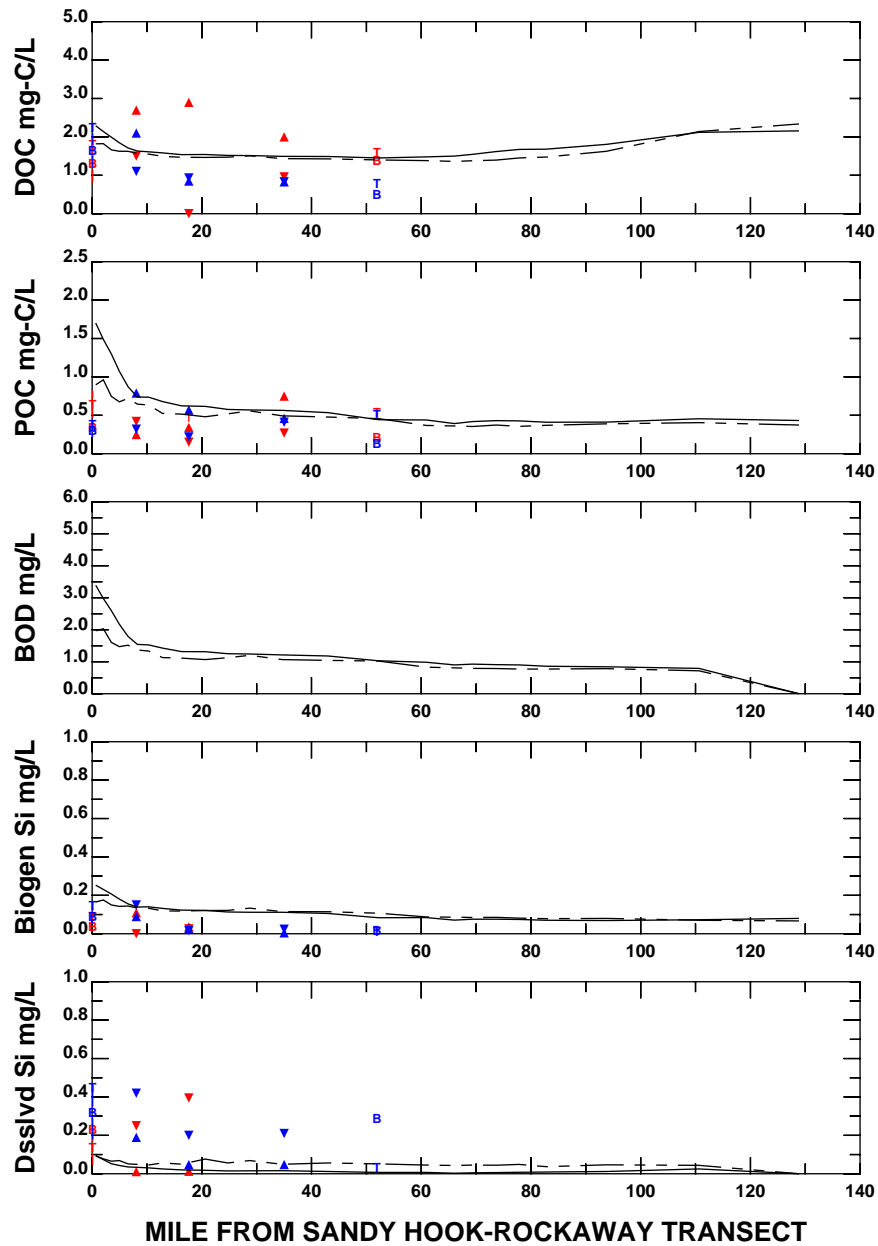


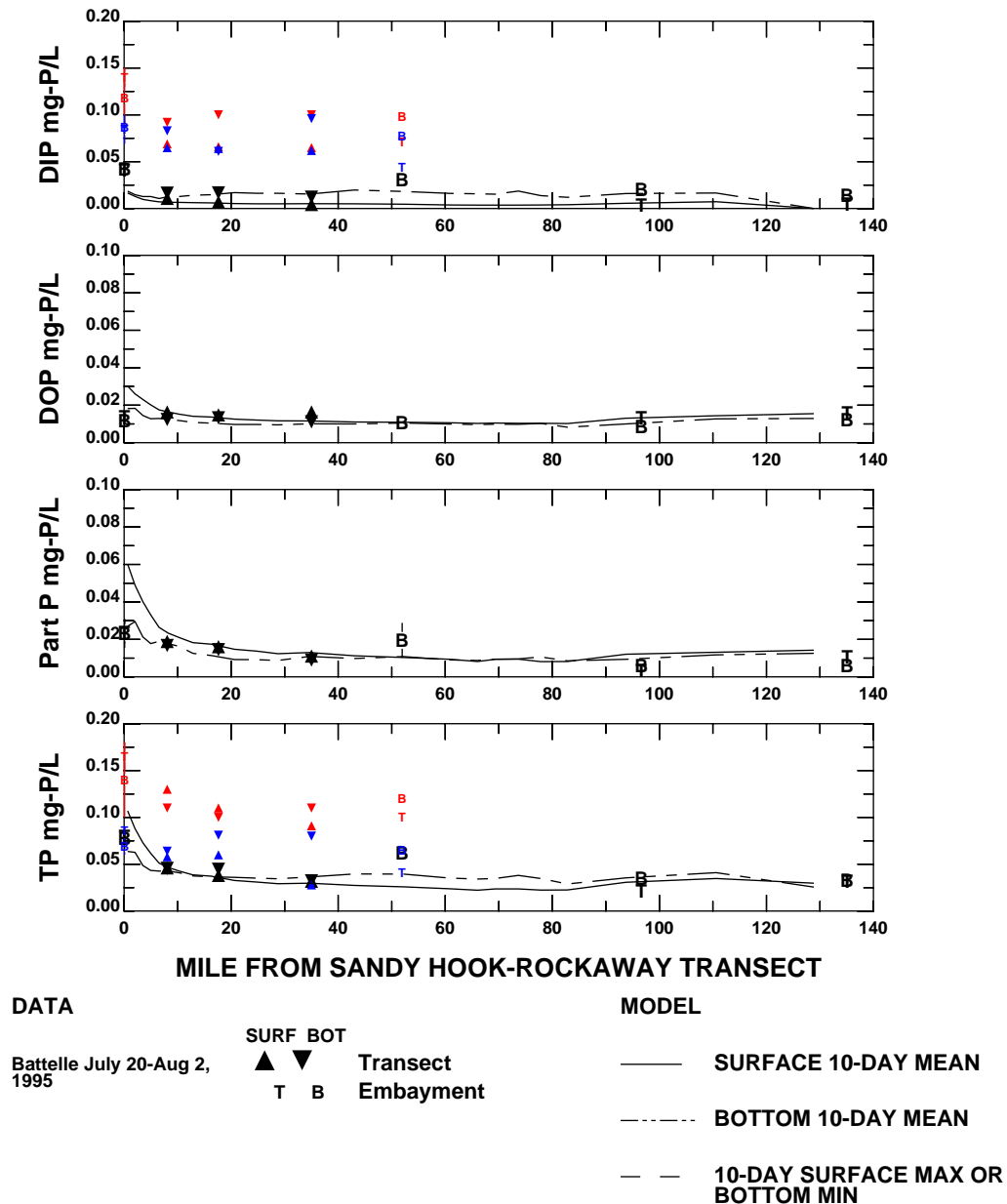
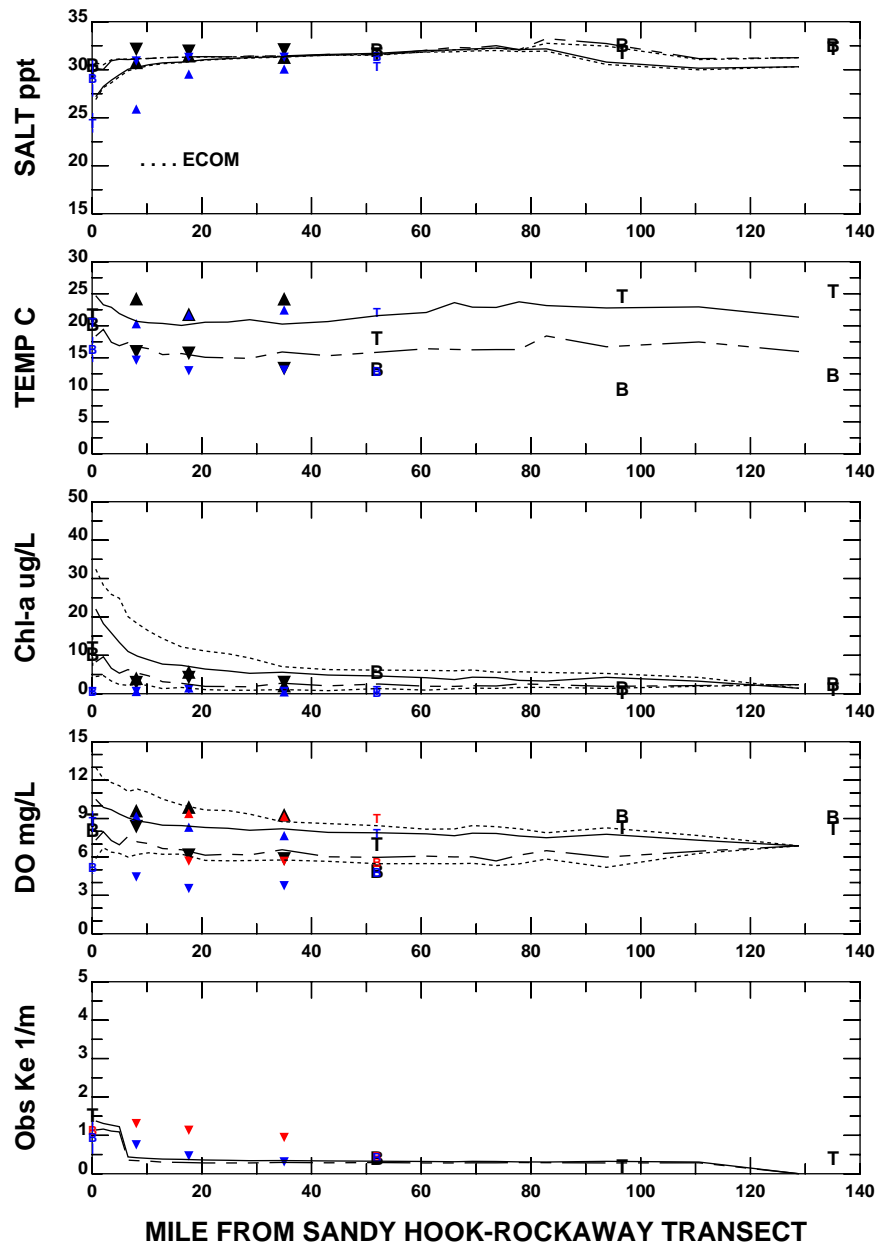
ATTACHMENT C

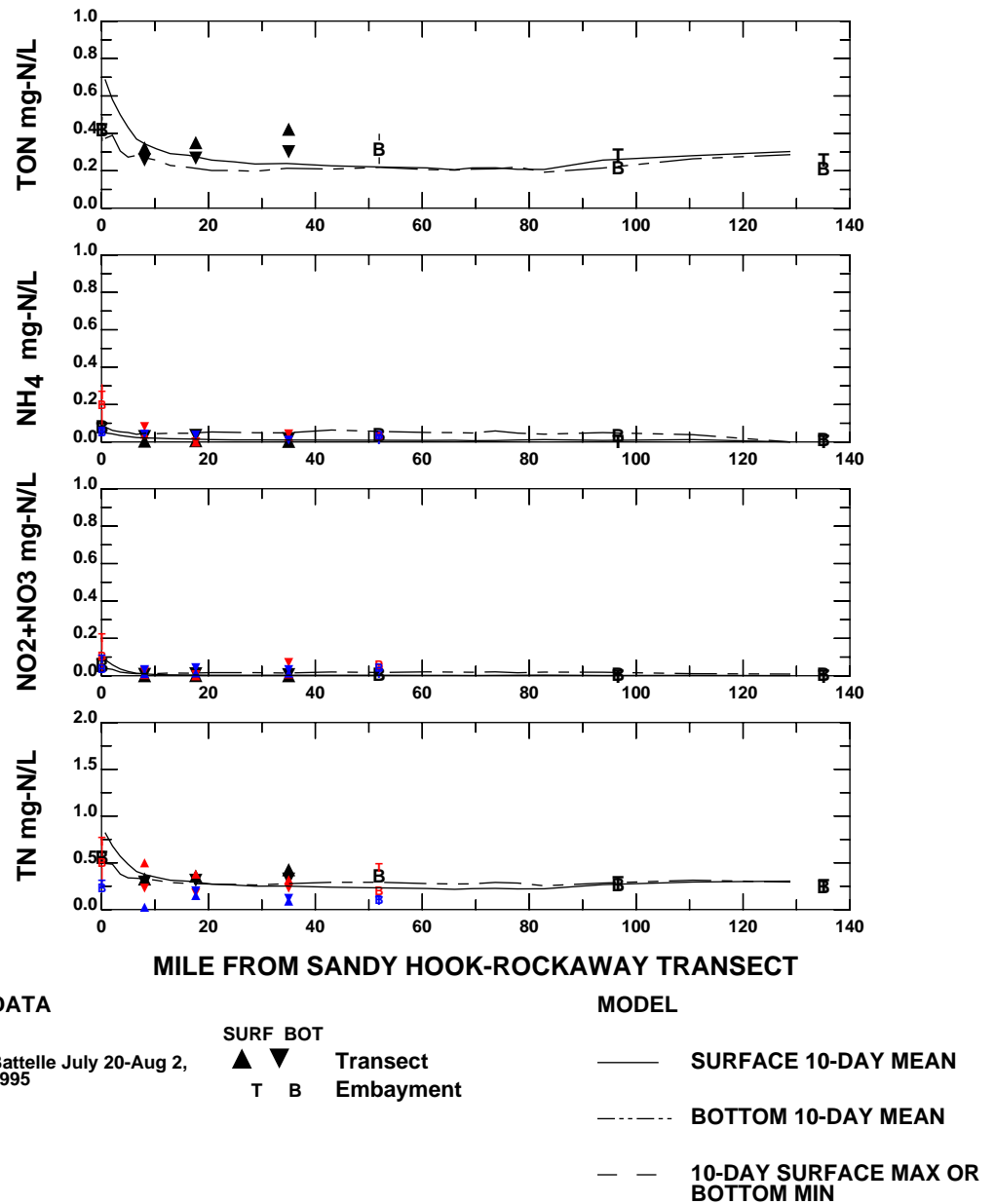
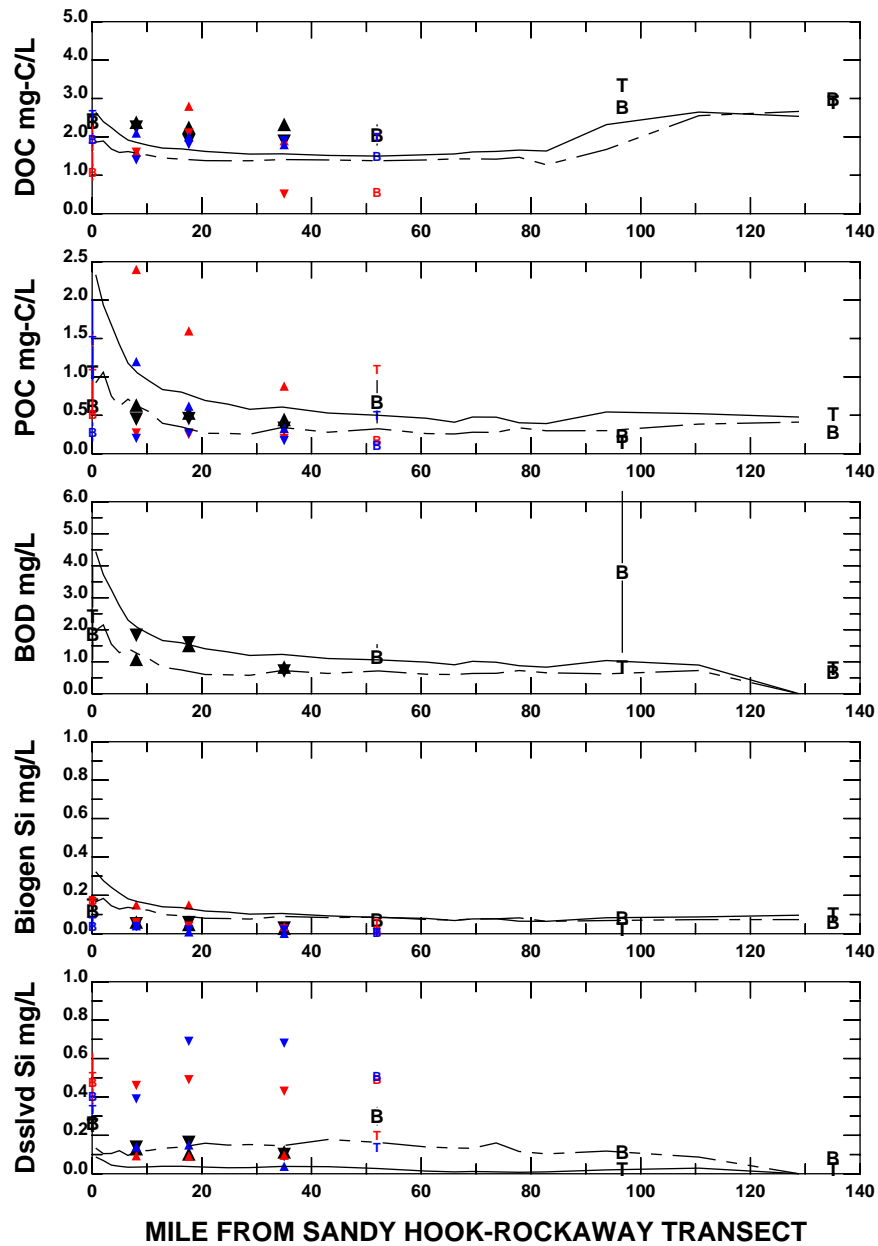
2008/2009 SPATIAL TRANSECT PLOTS

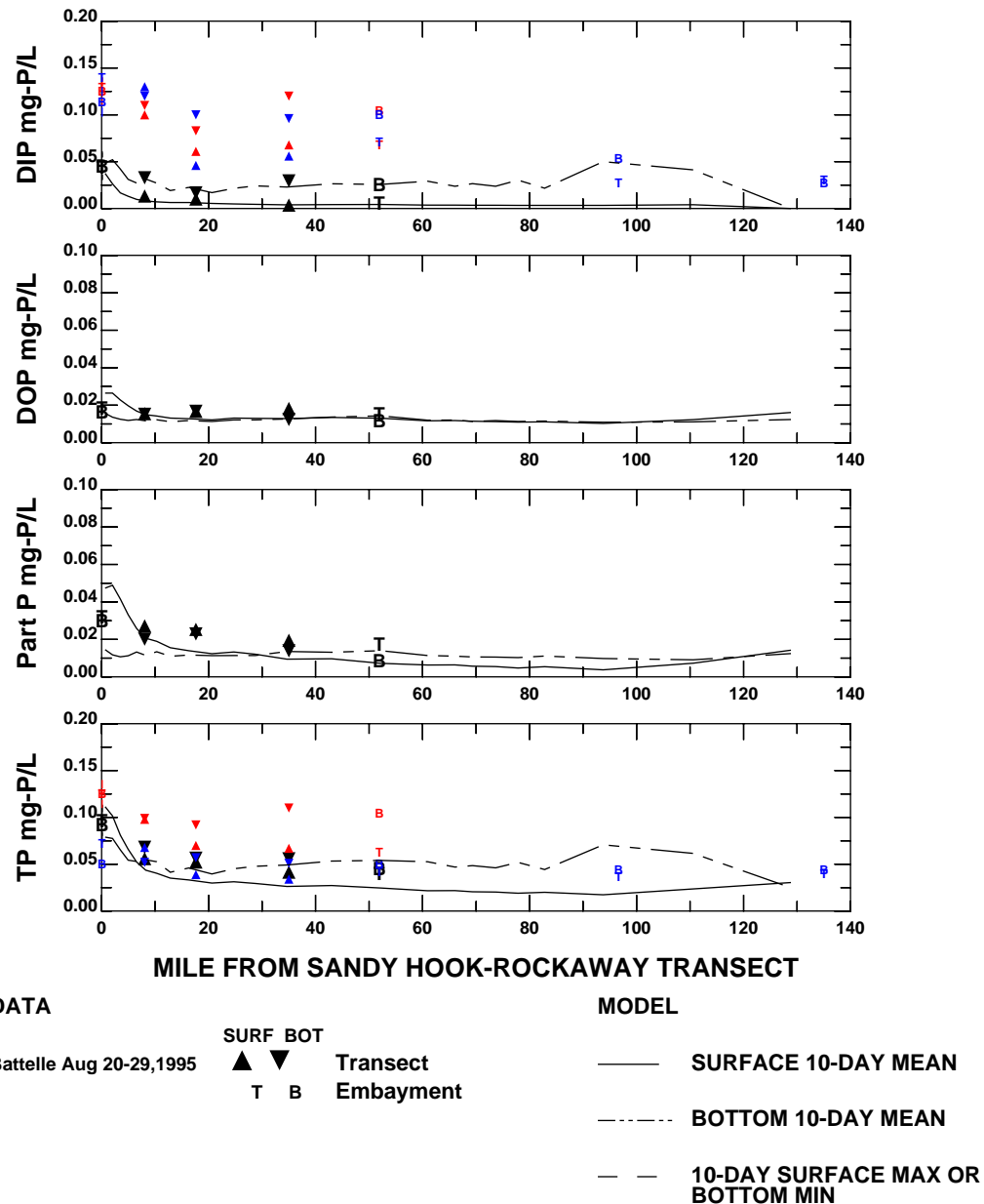
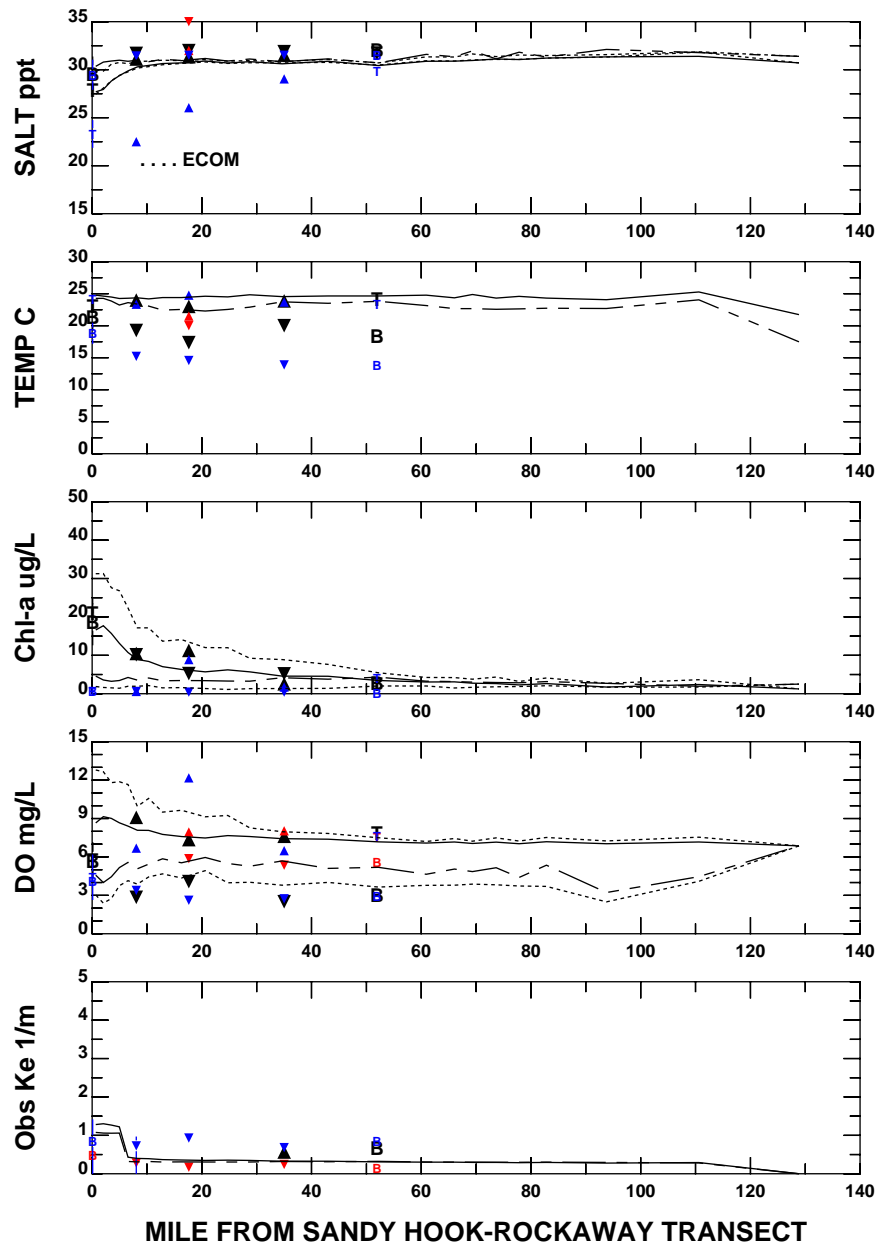
(note: 2008 data shown in red and 2009 data shown in blue)

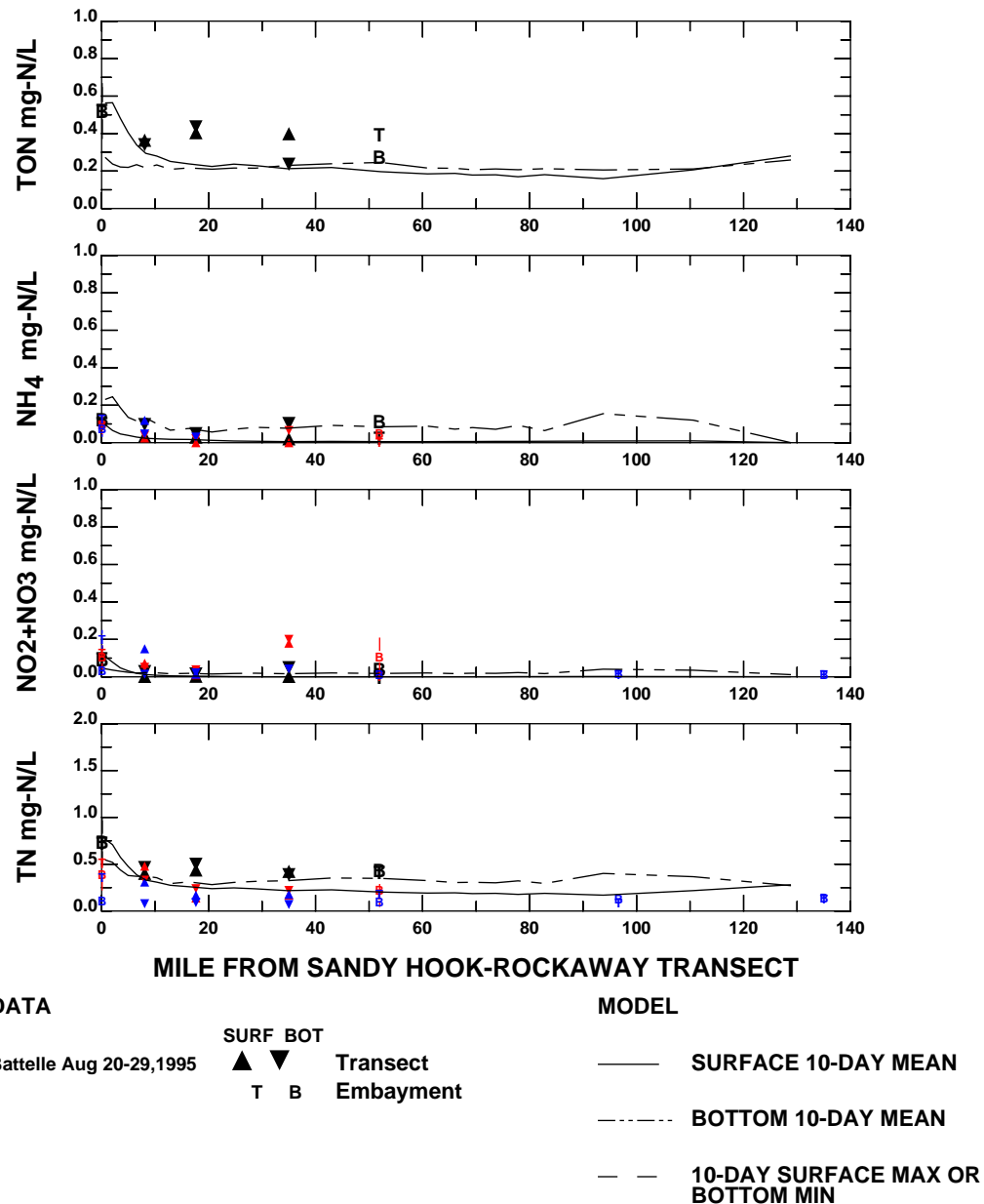
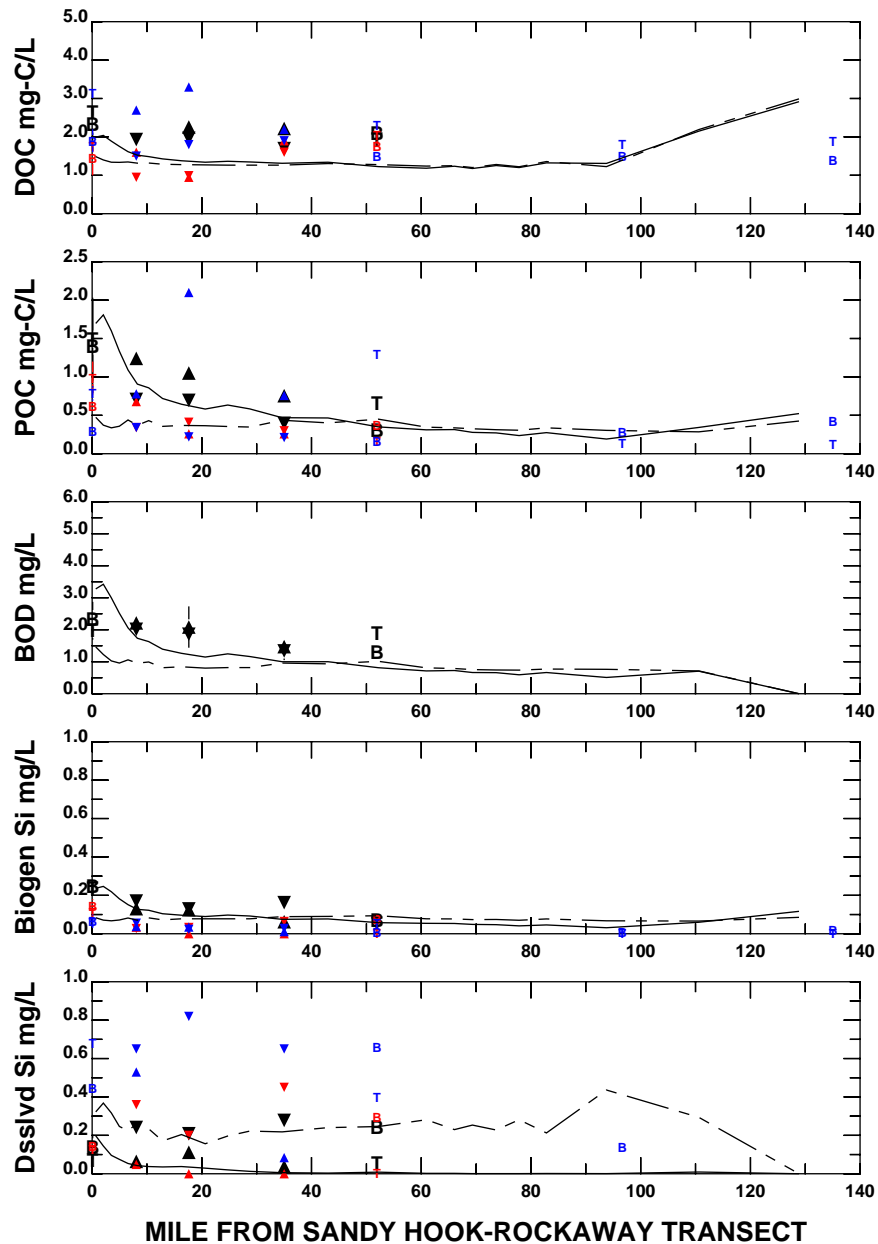


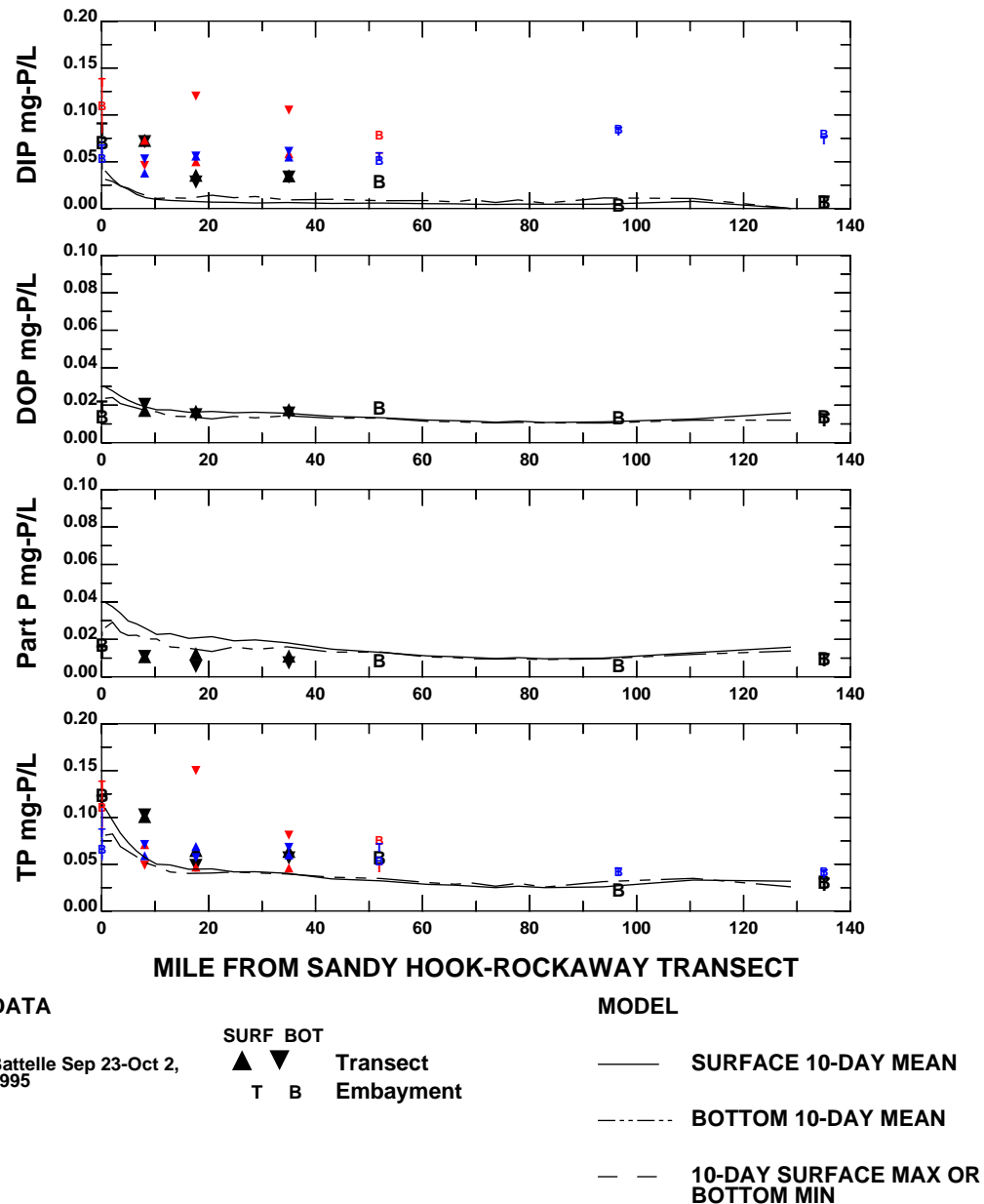
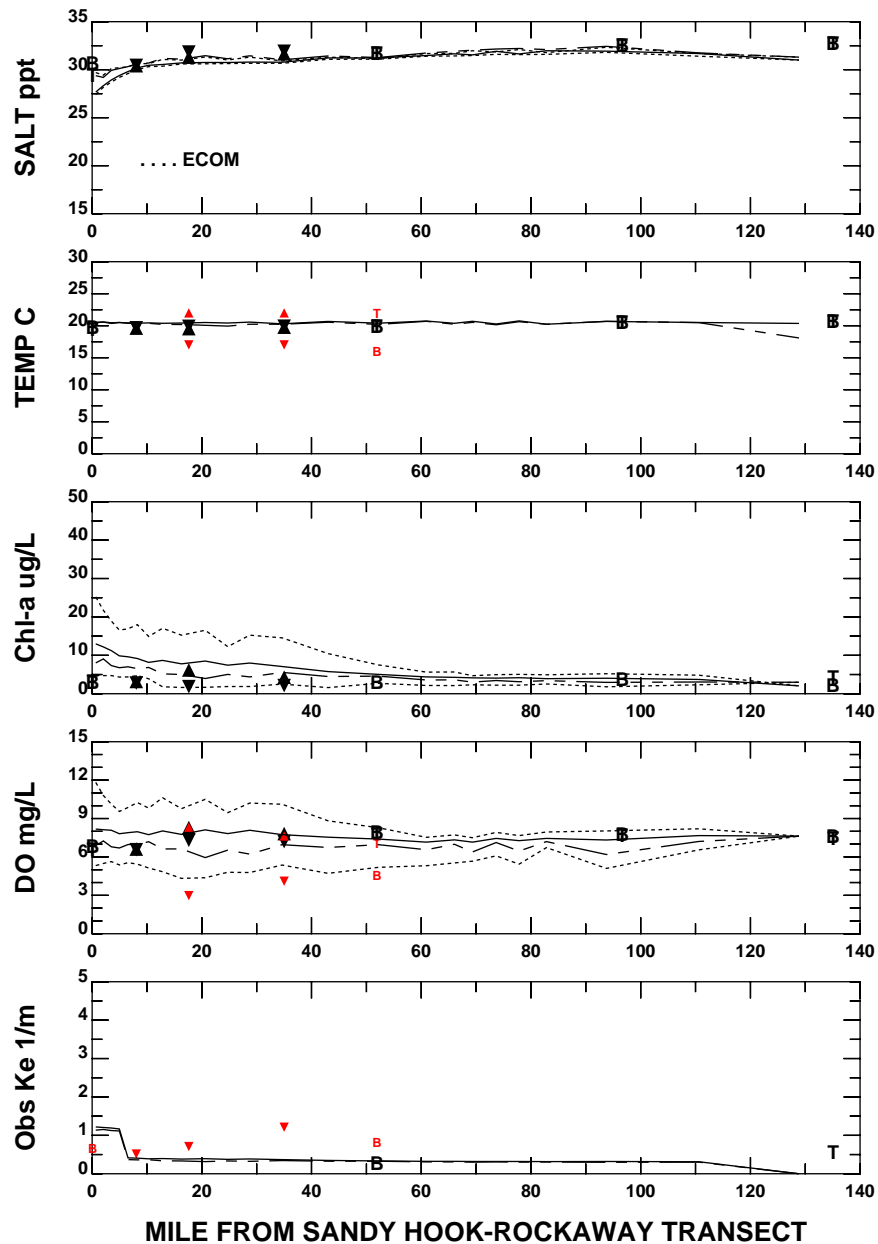


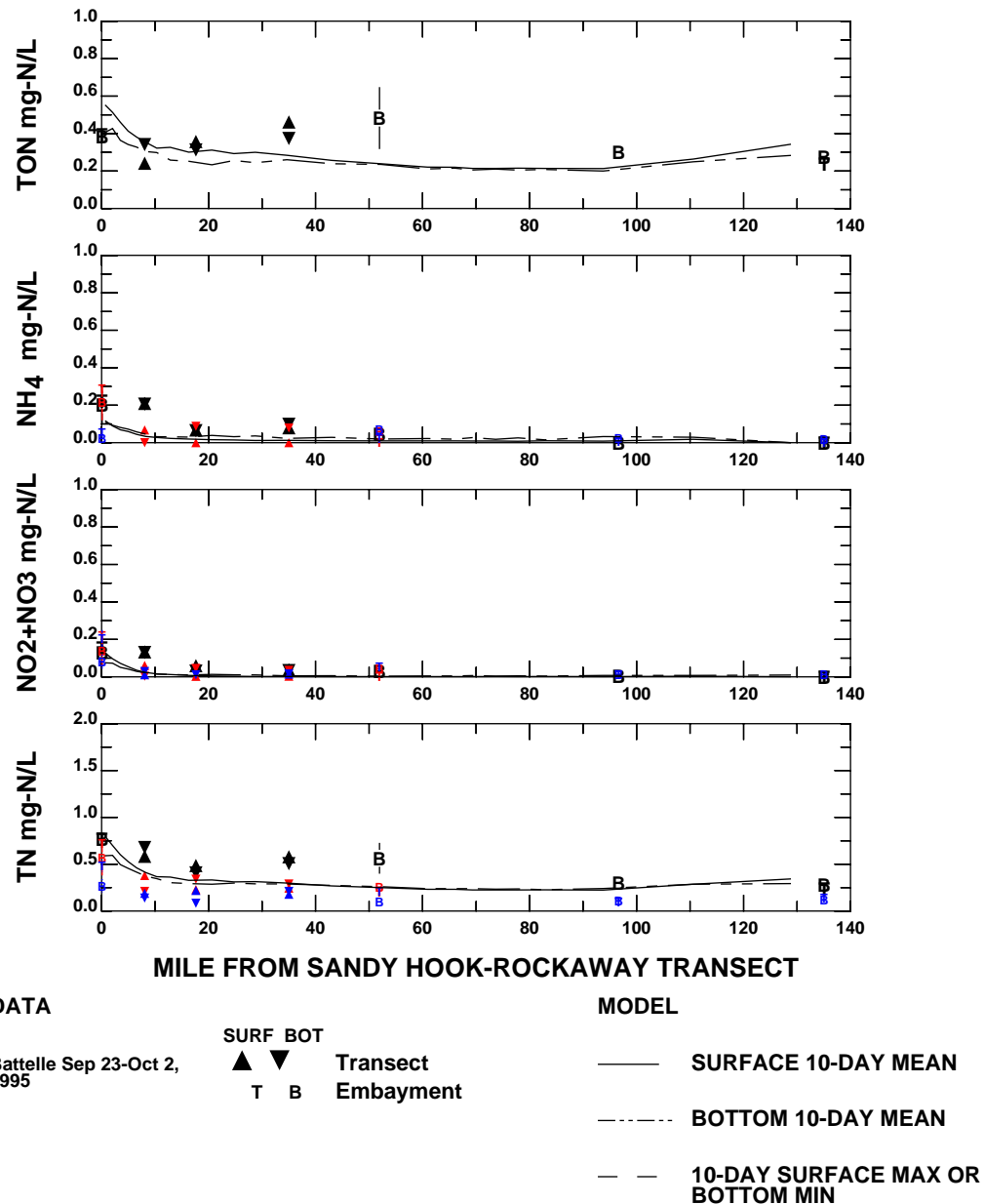
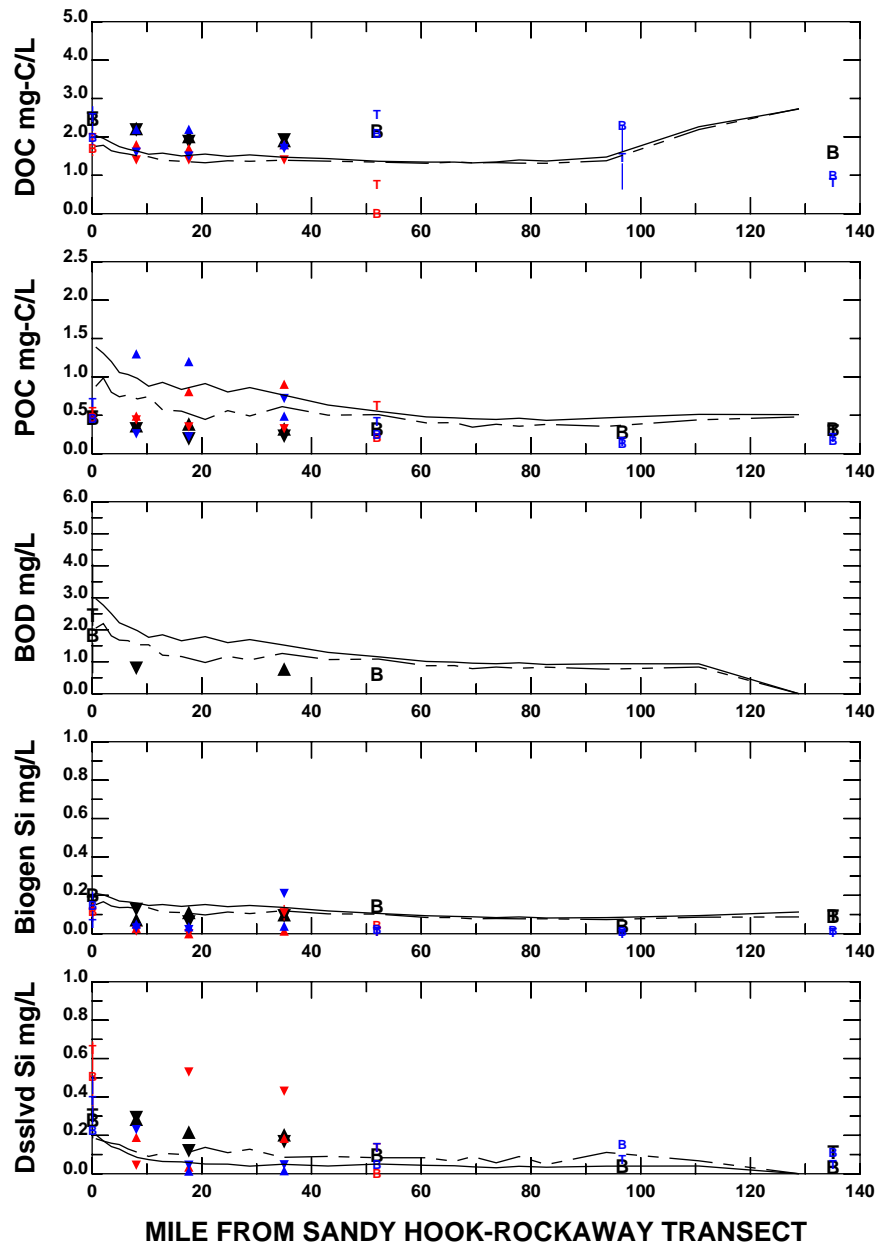


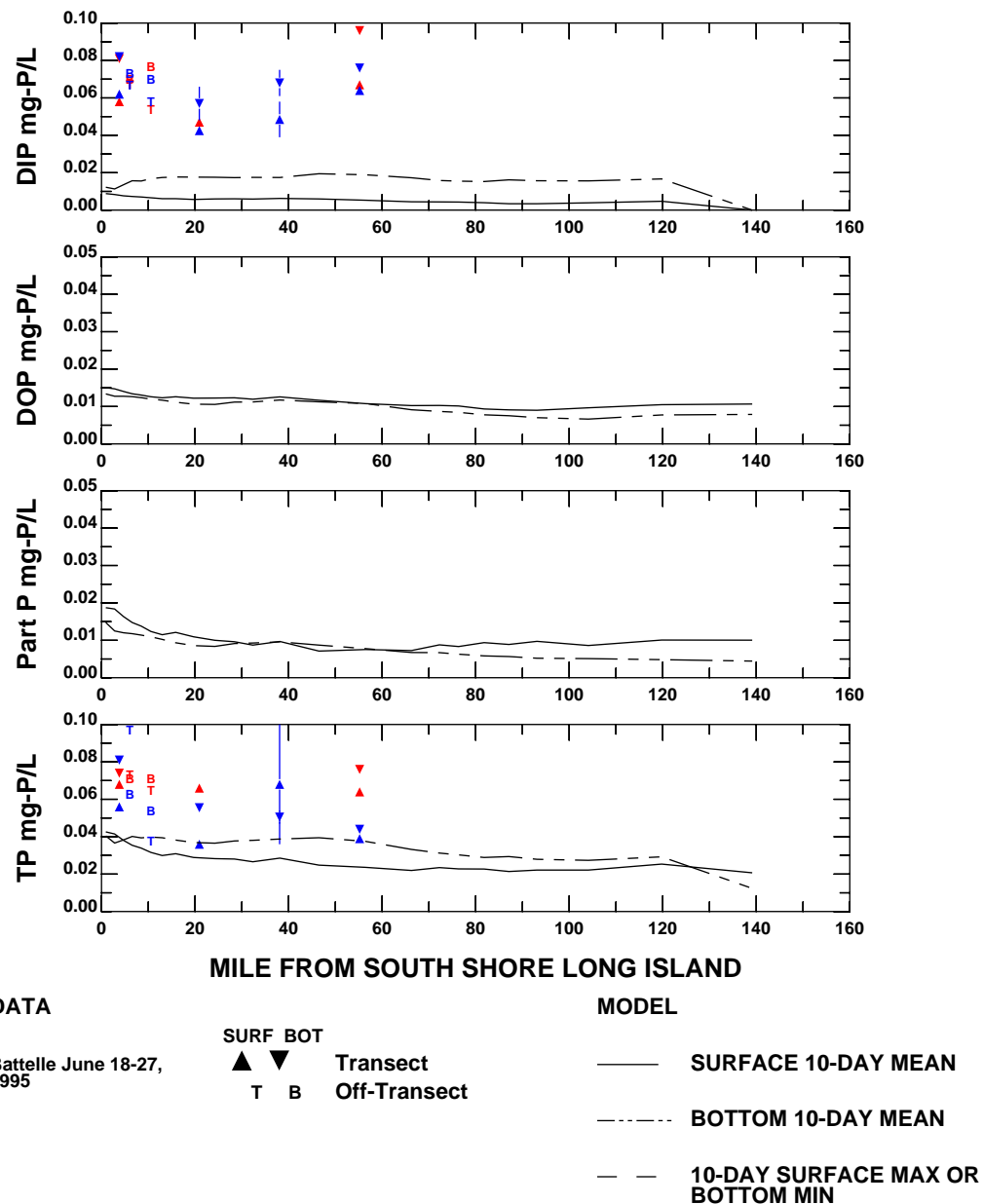
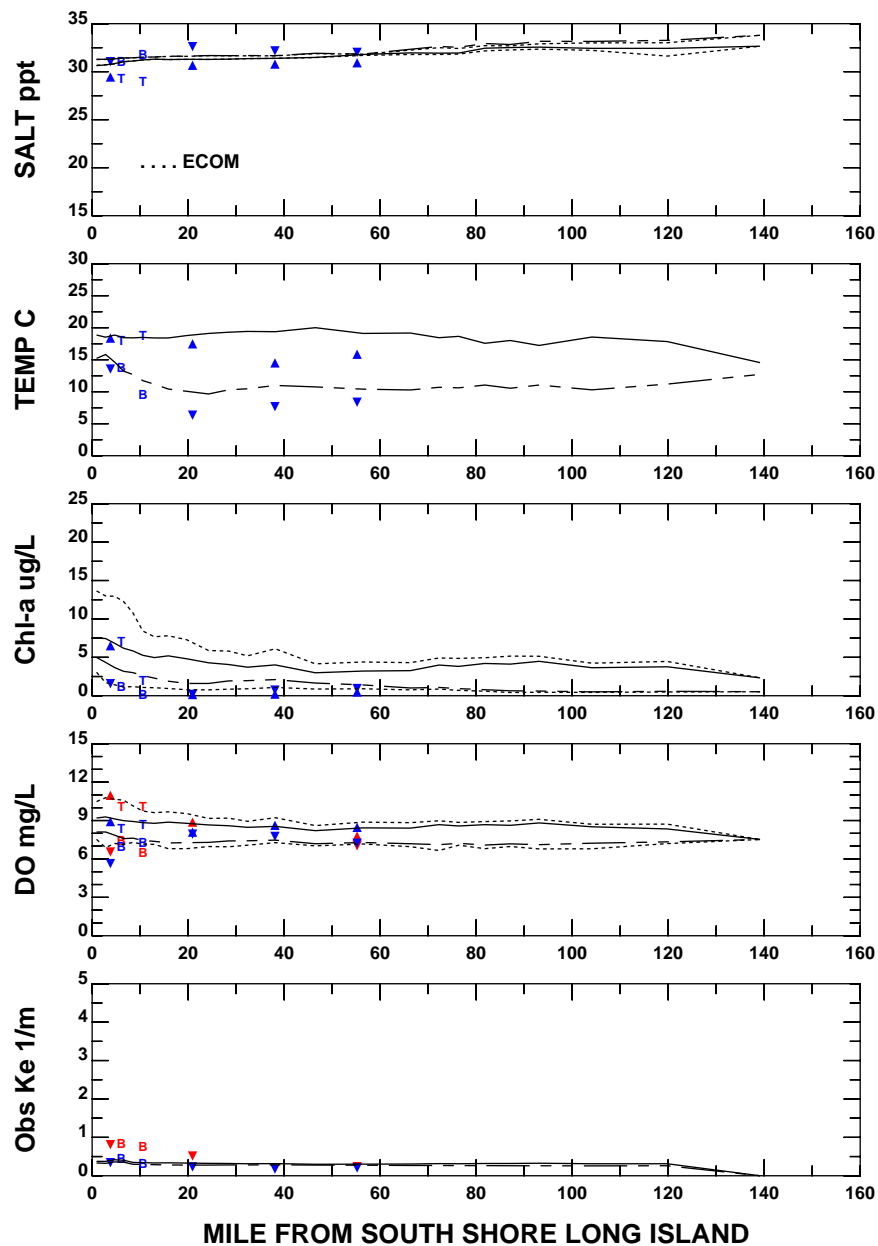


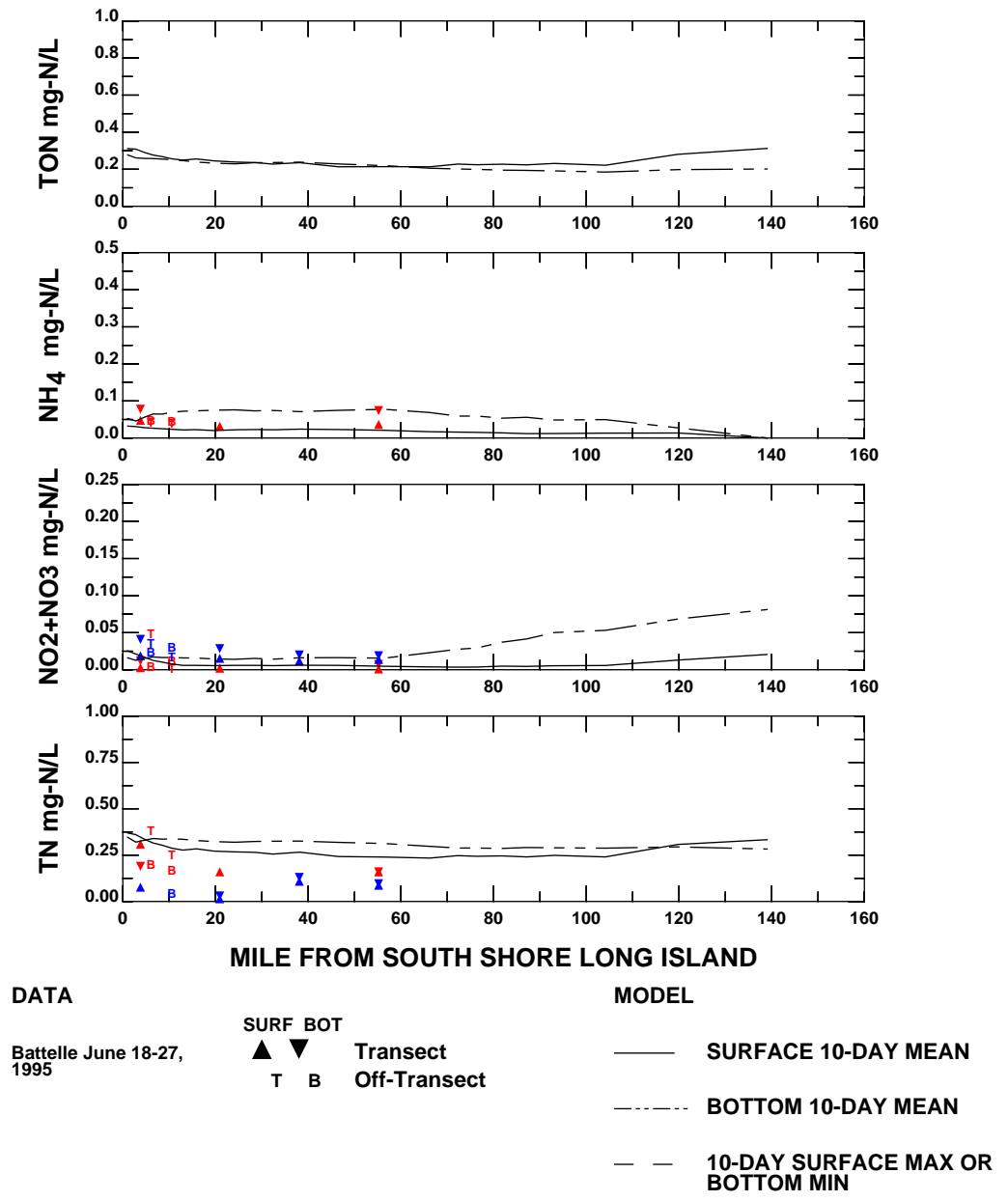
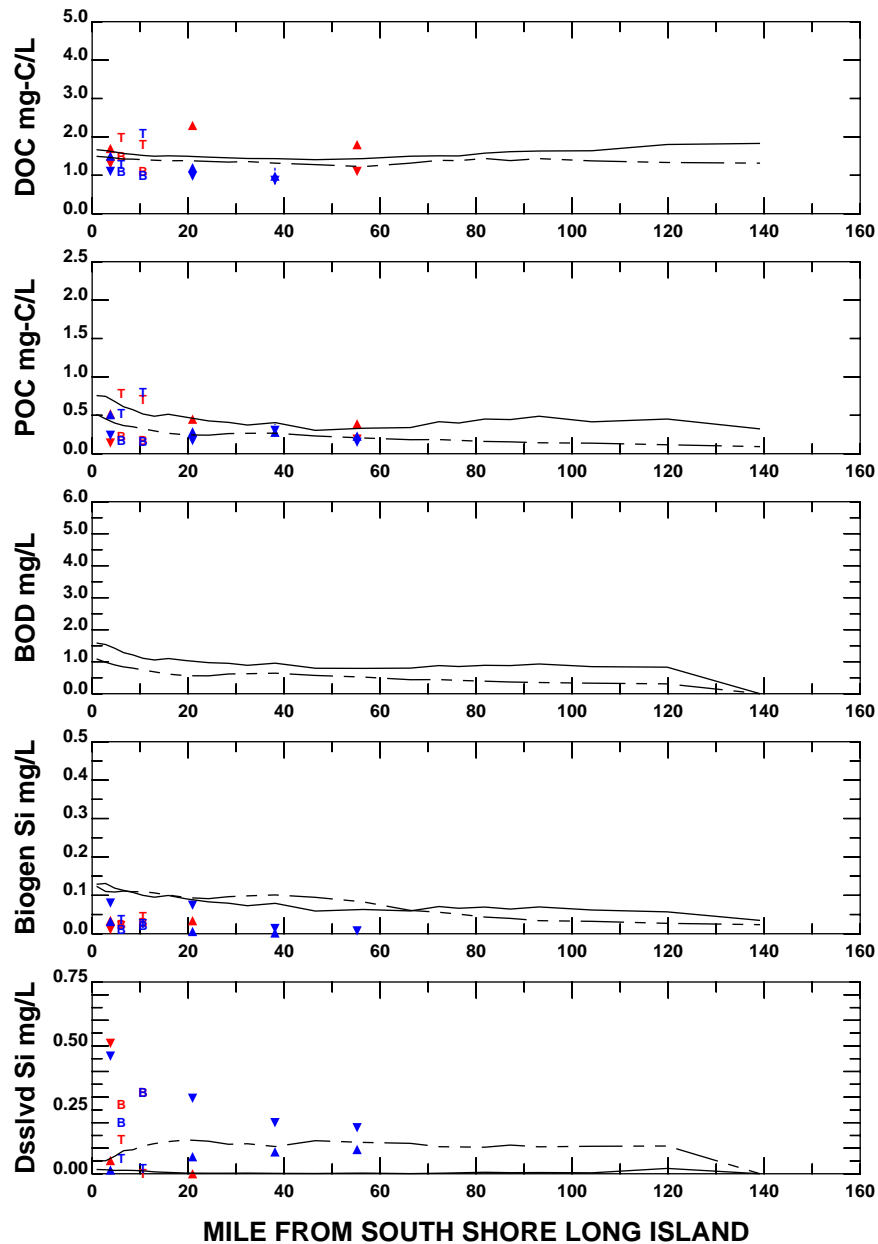


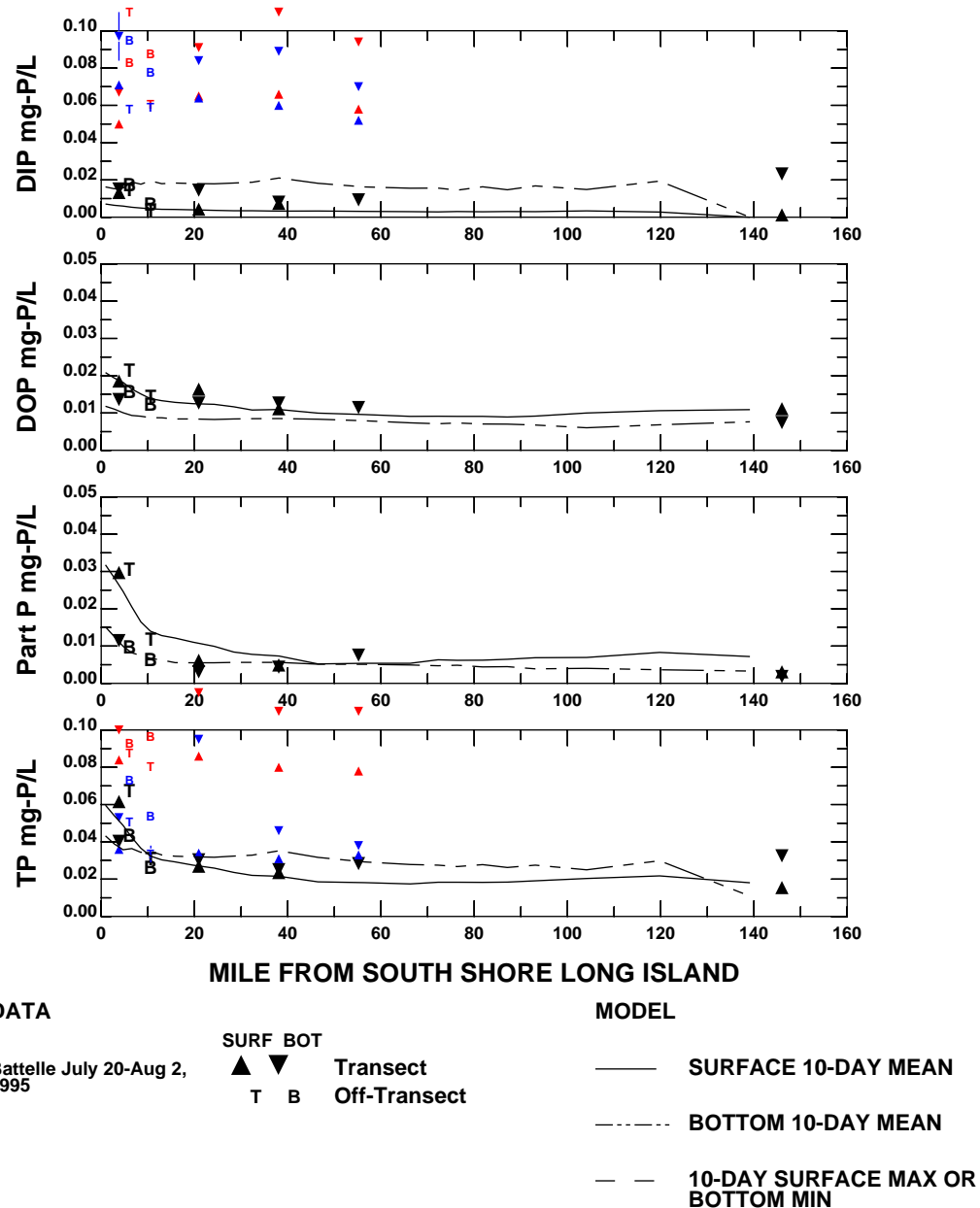
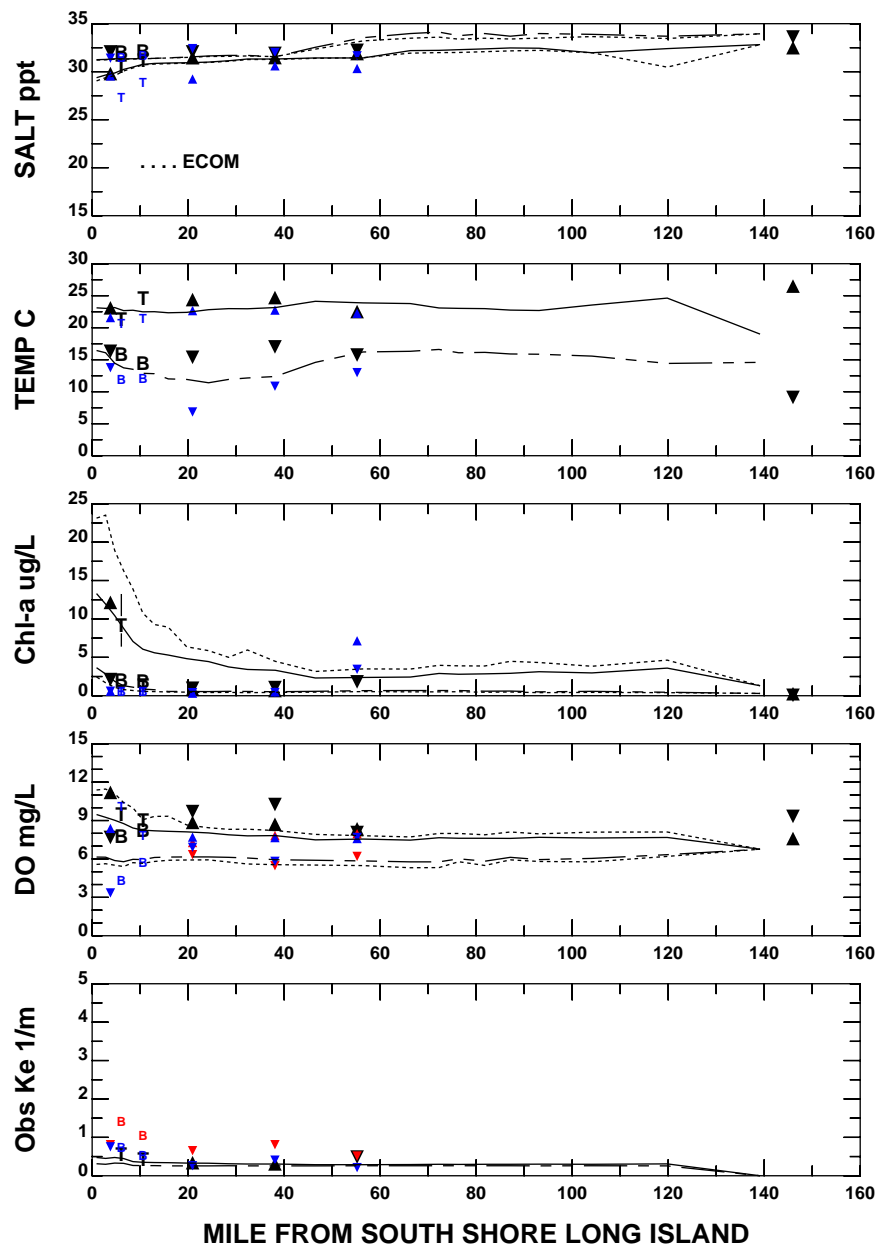


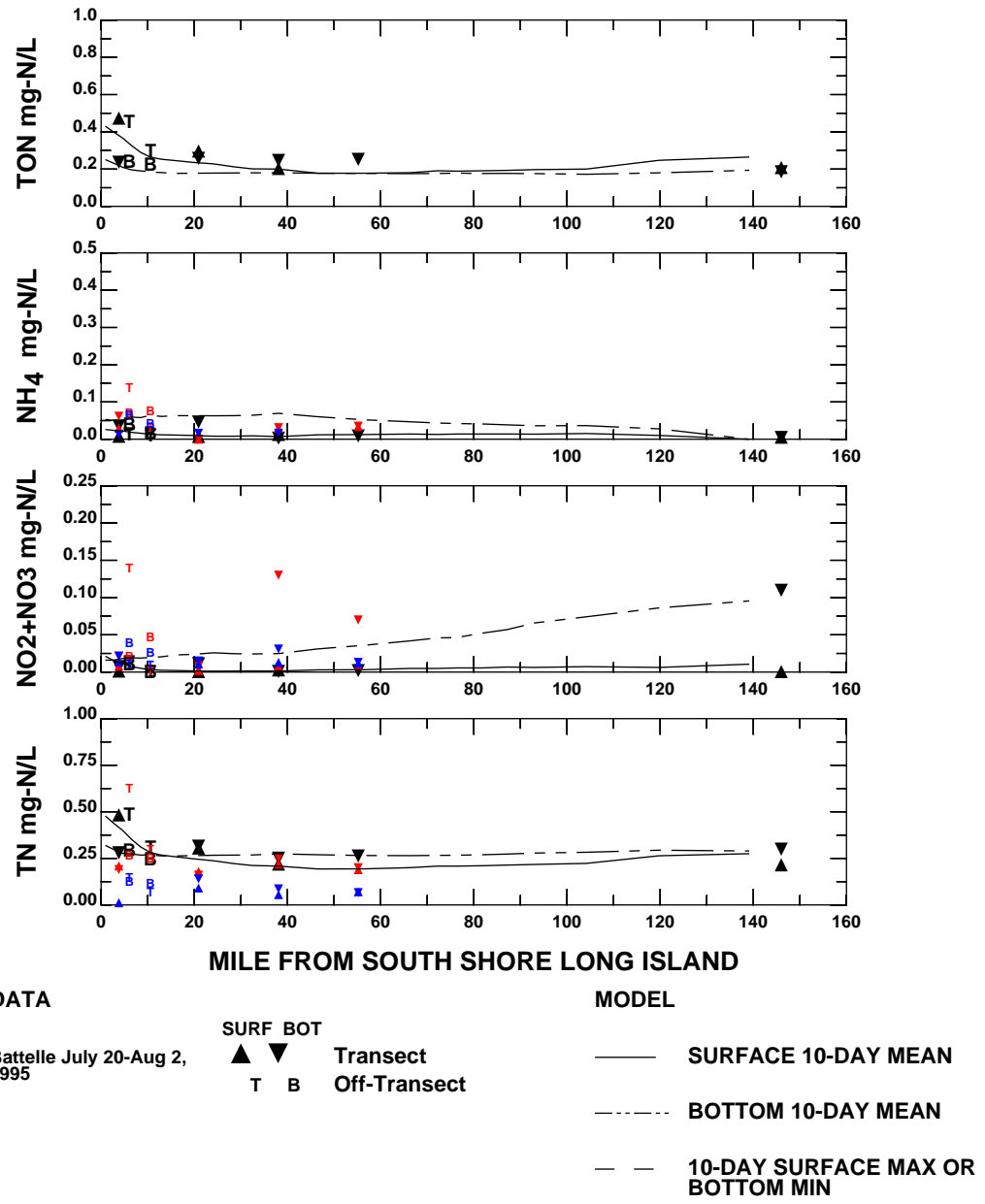
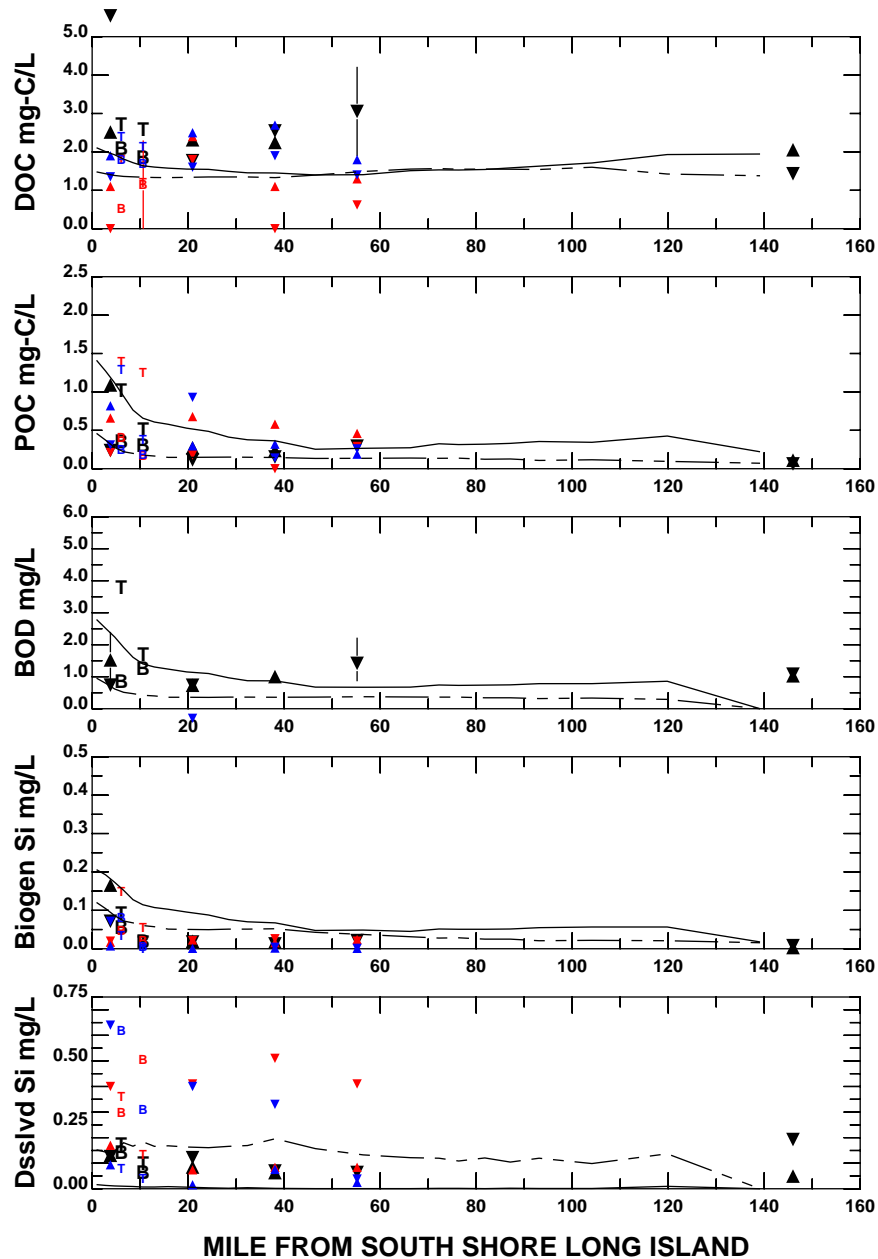


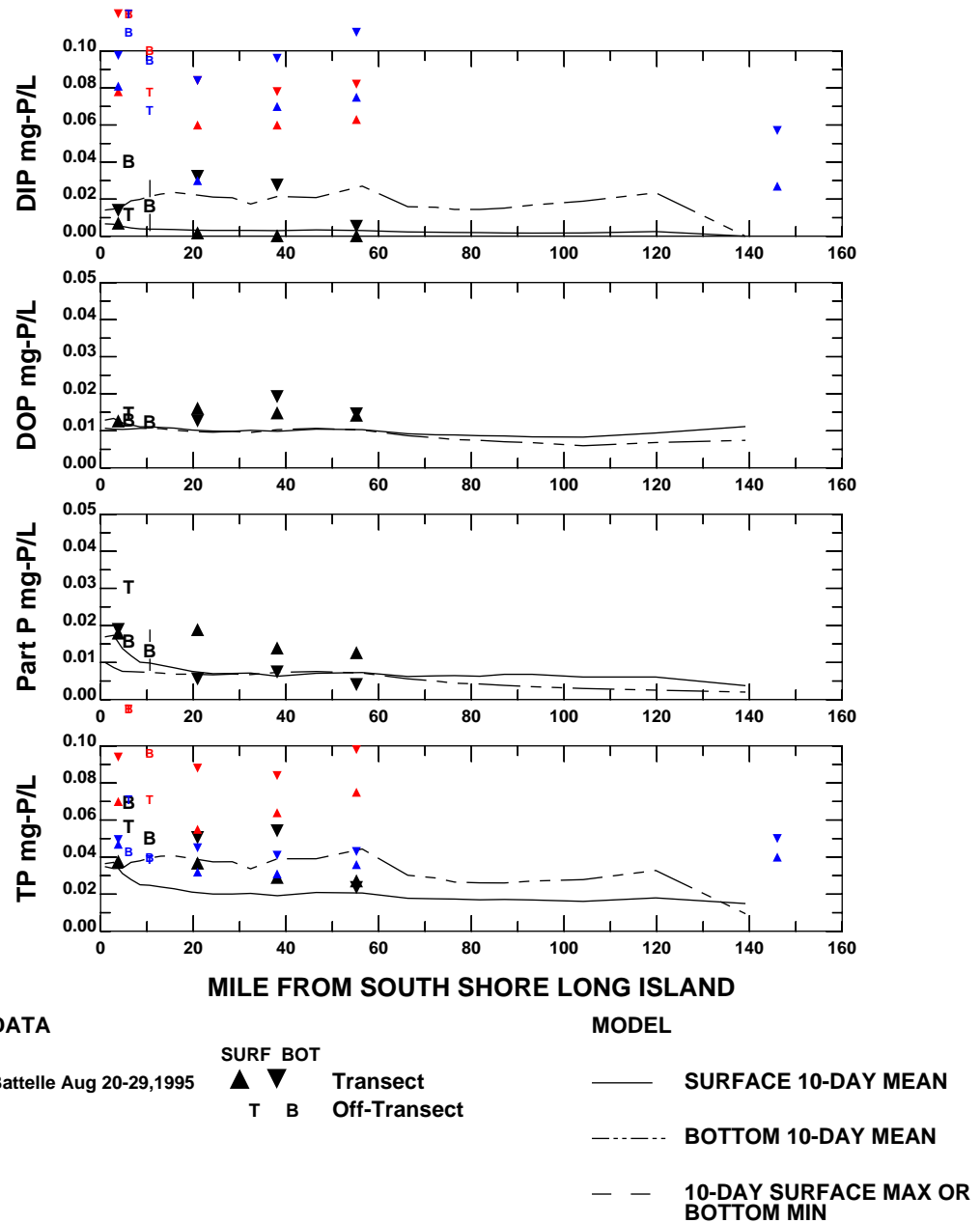
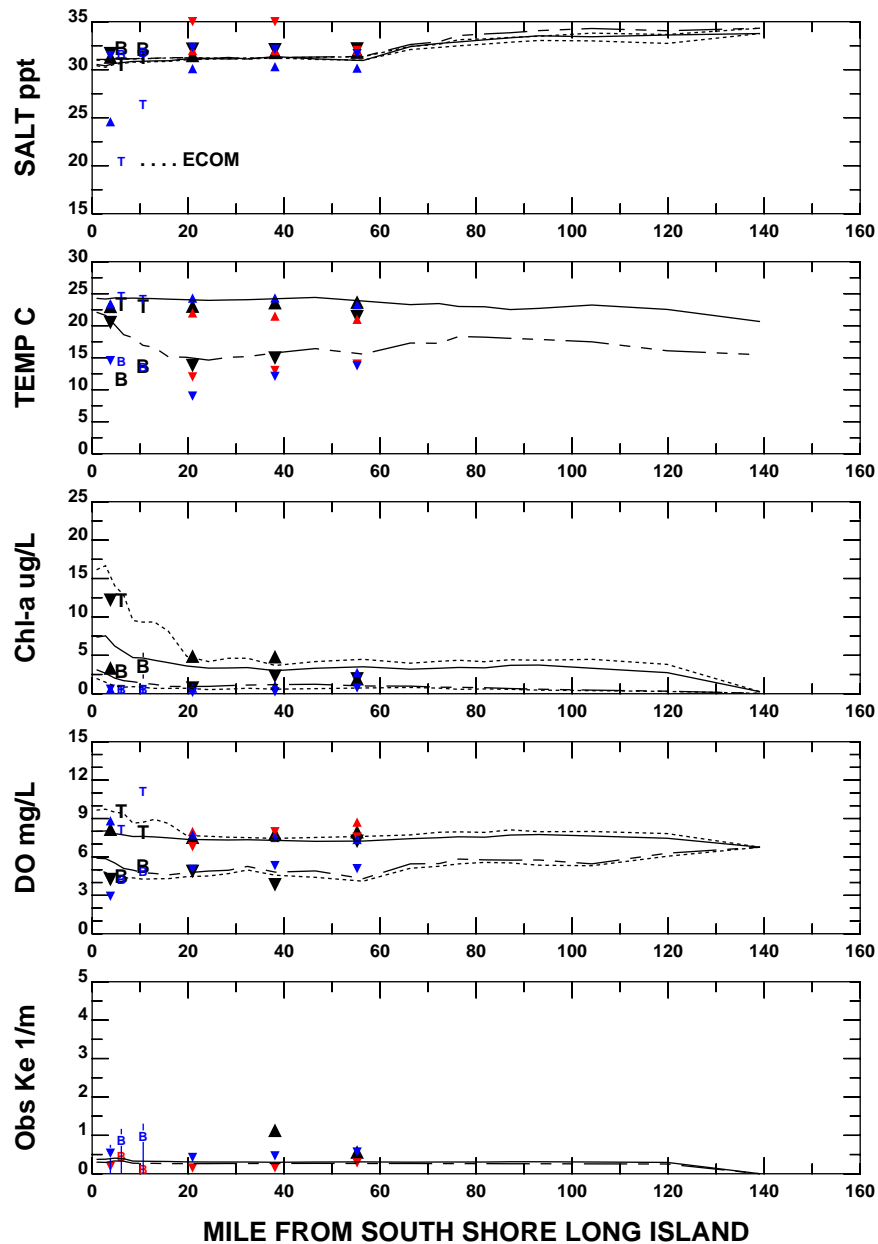


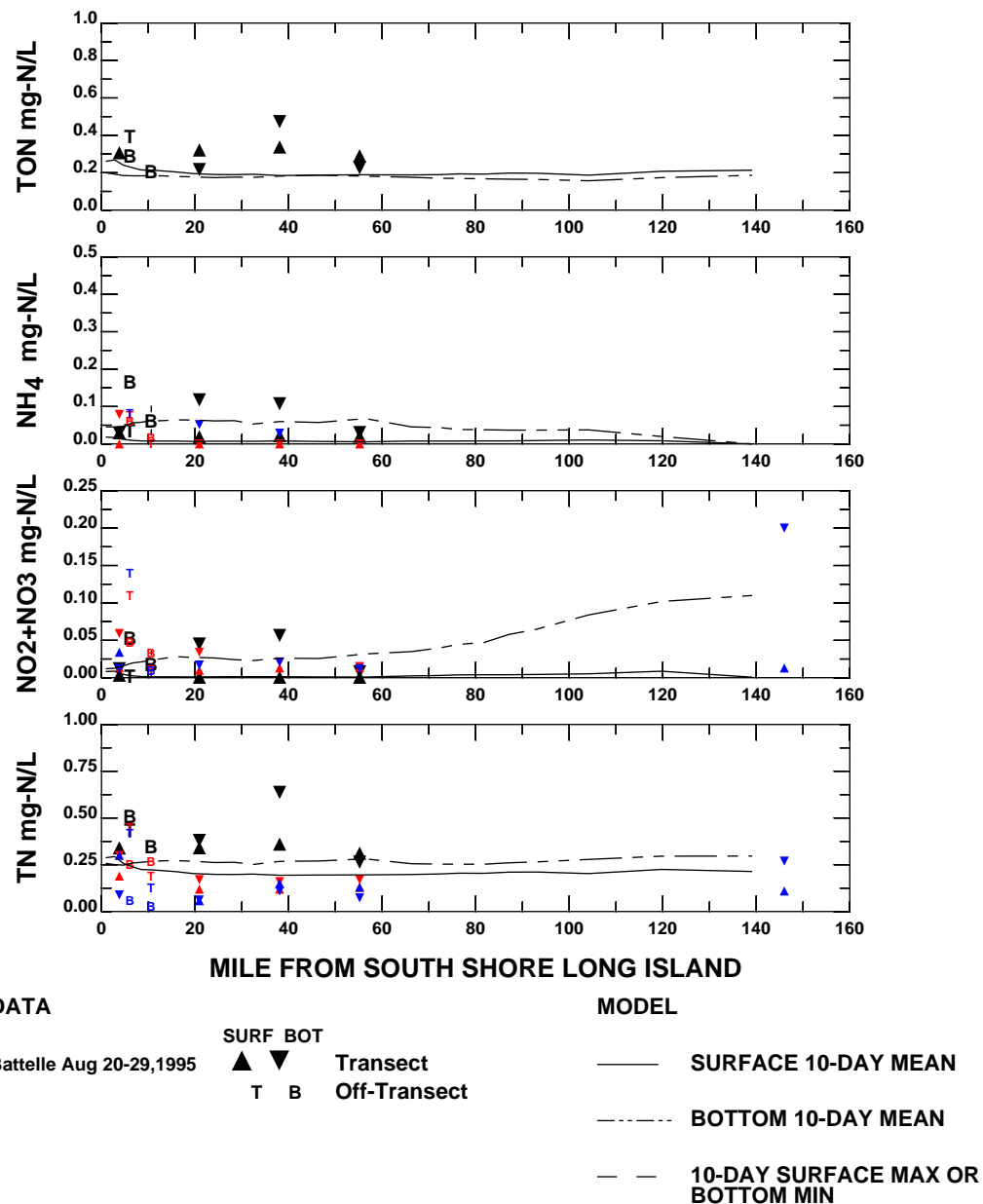
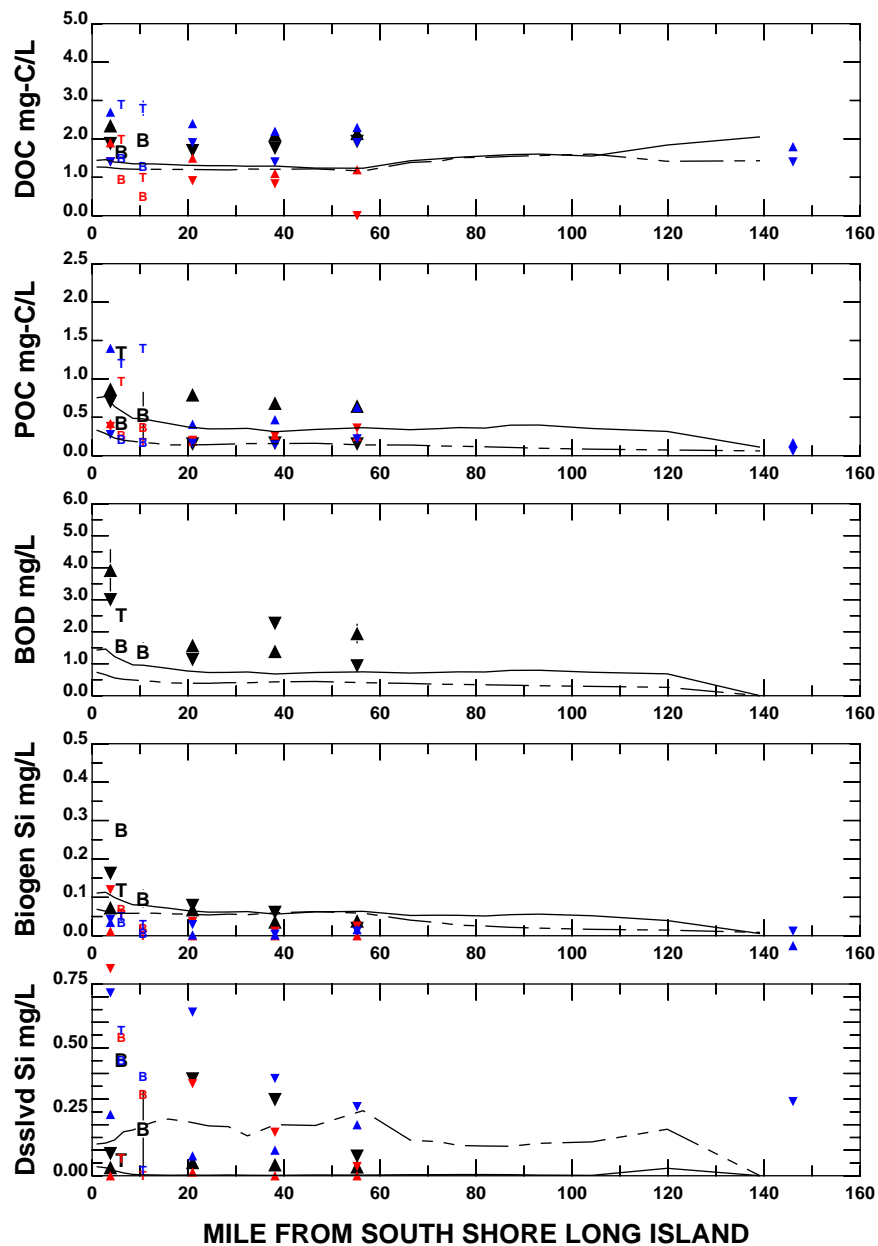


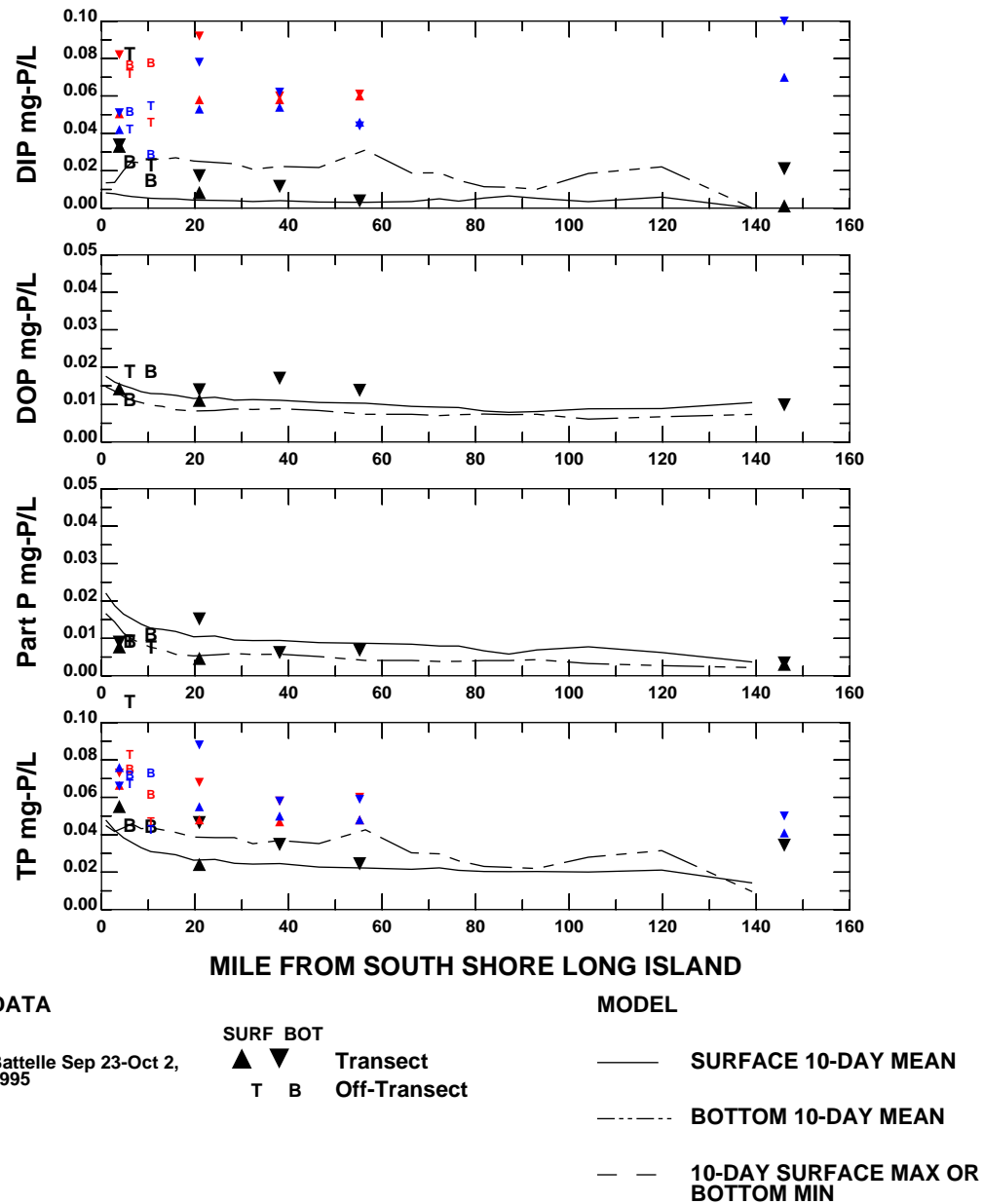
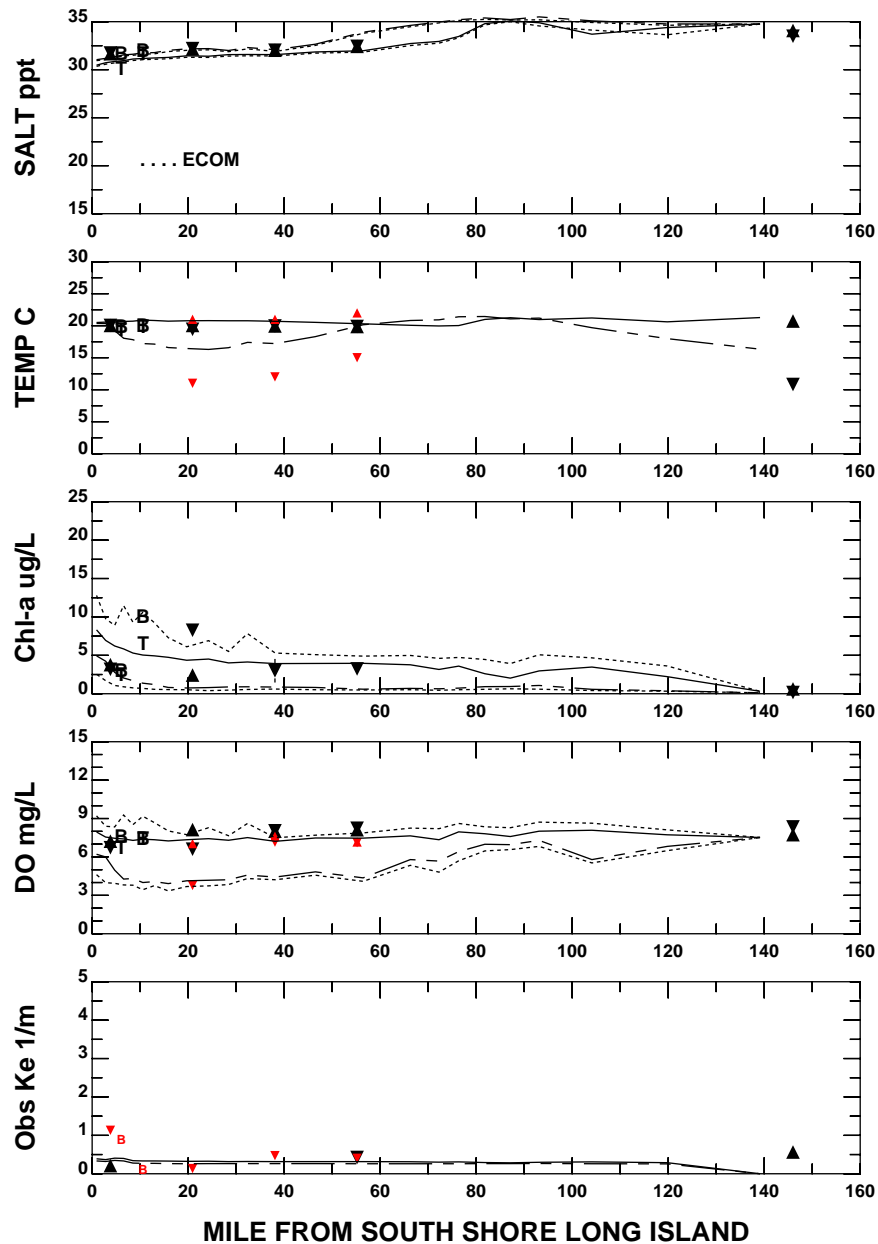


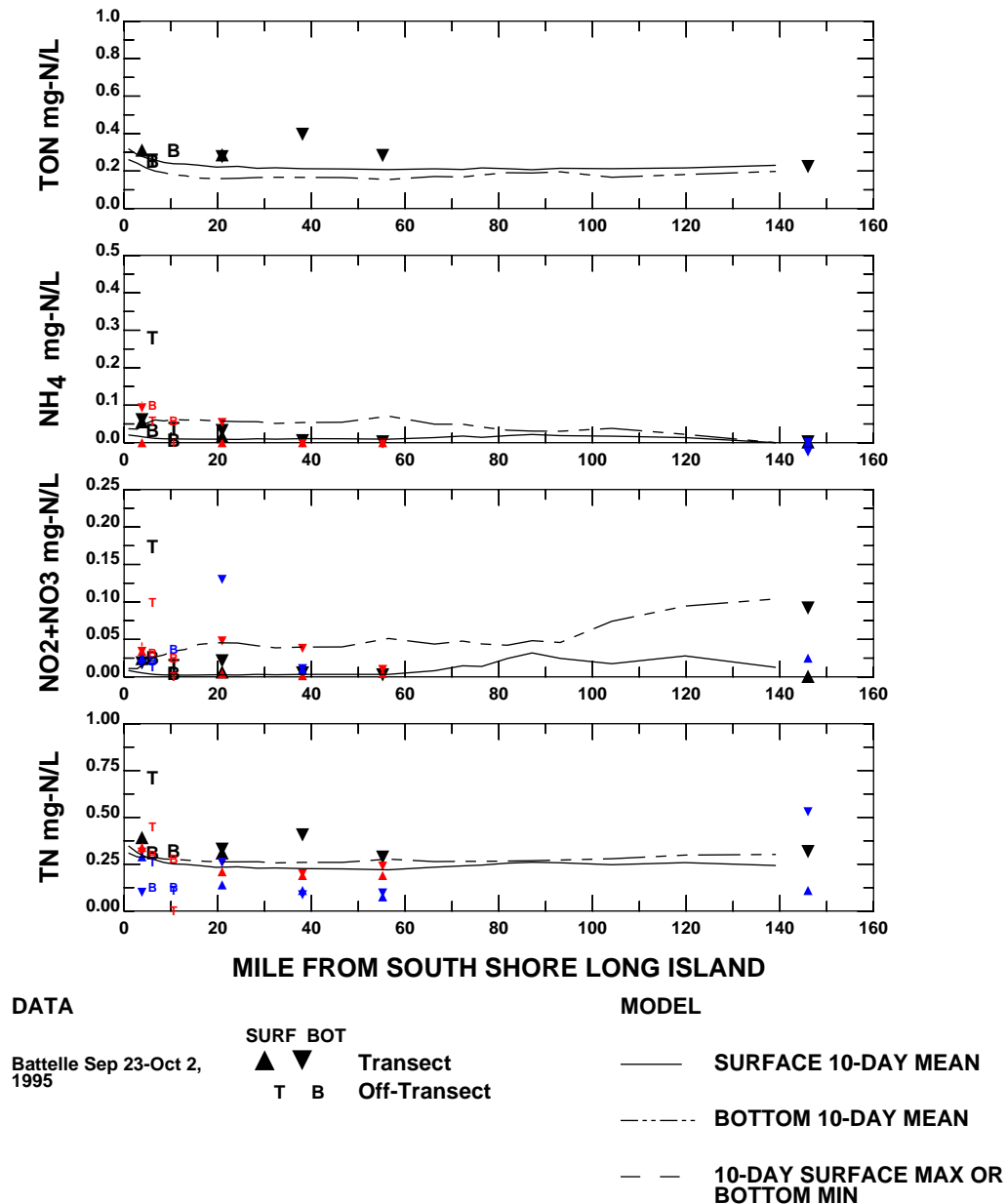
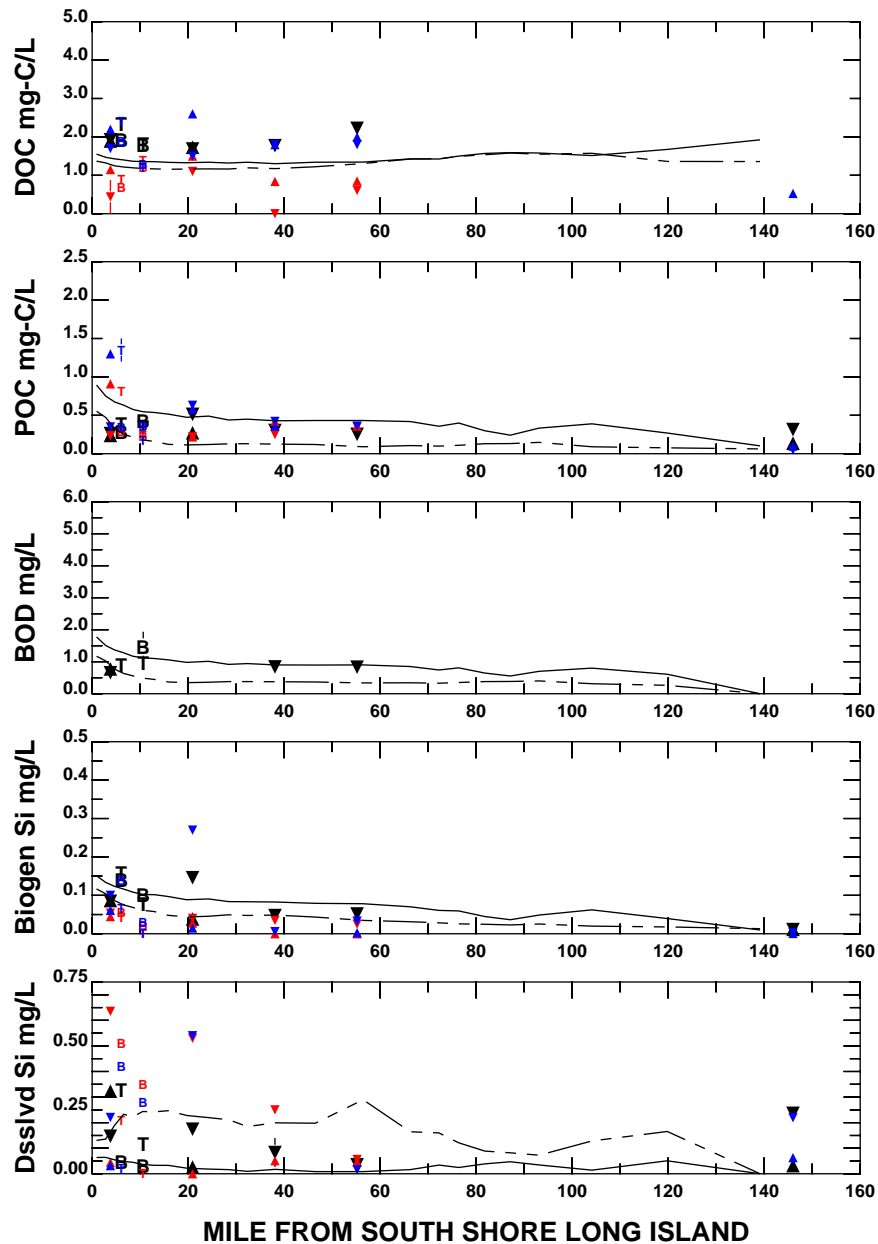


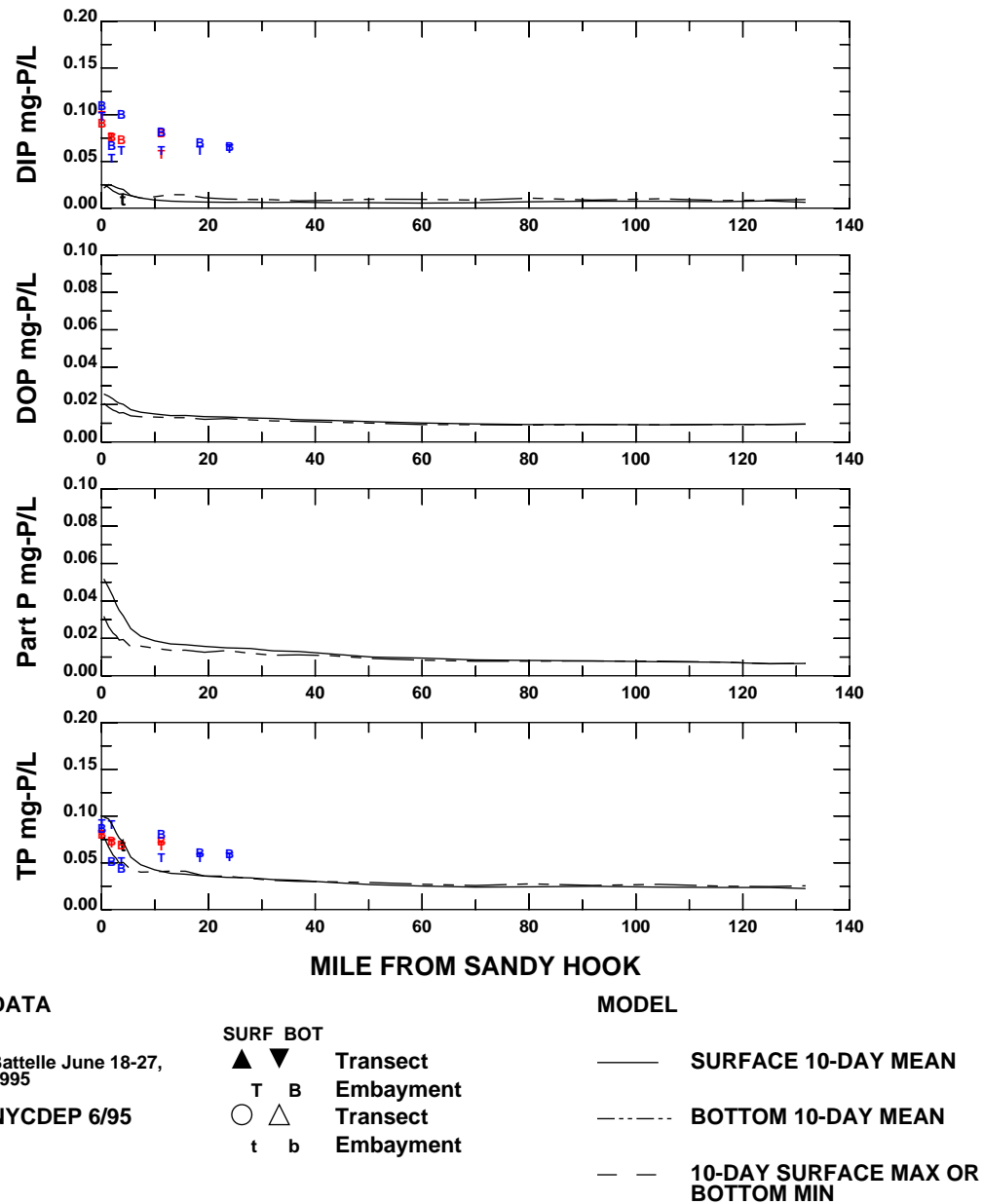
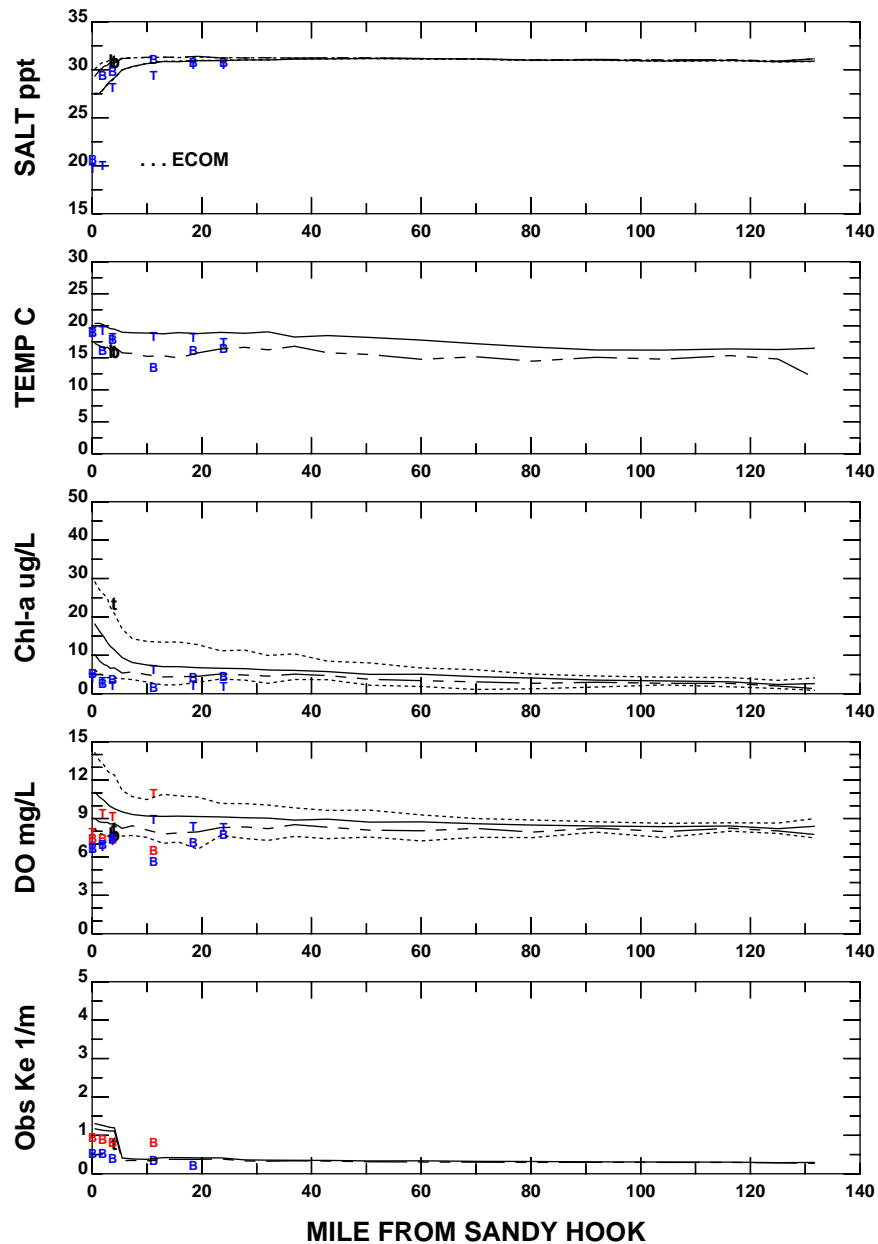


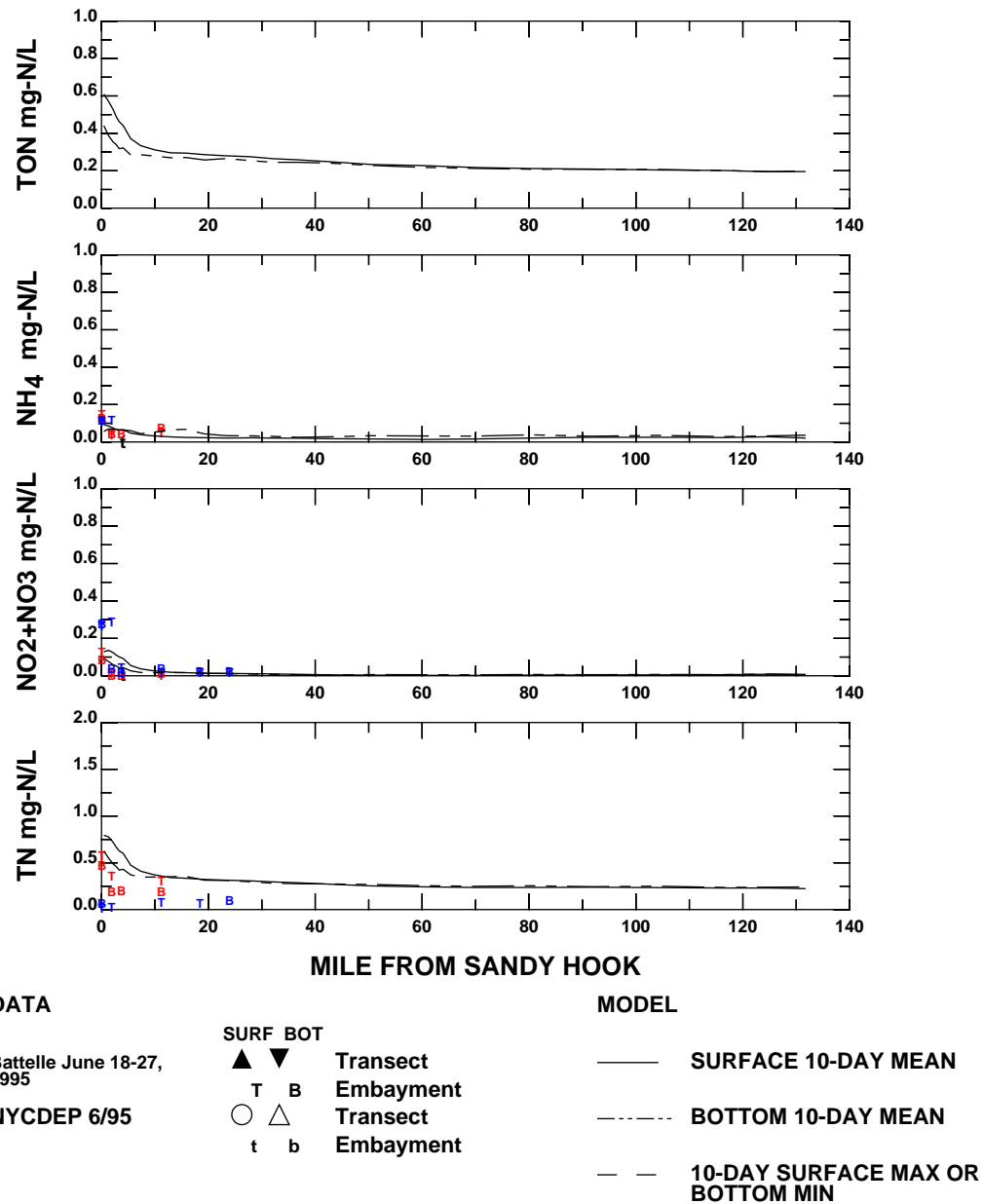
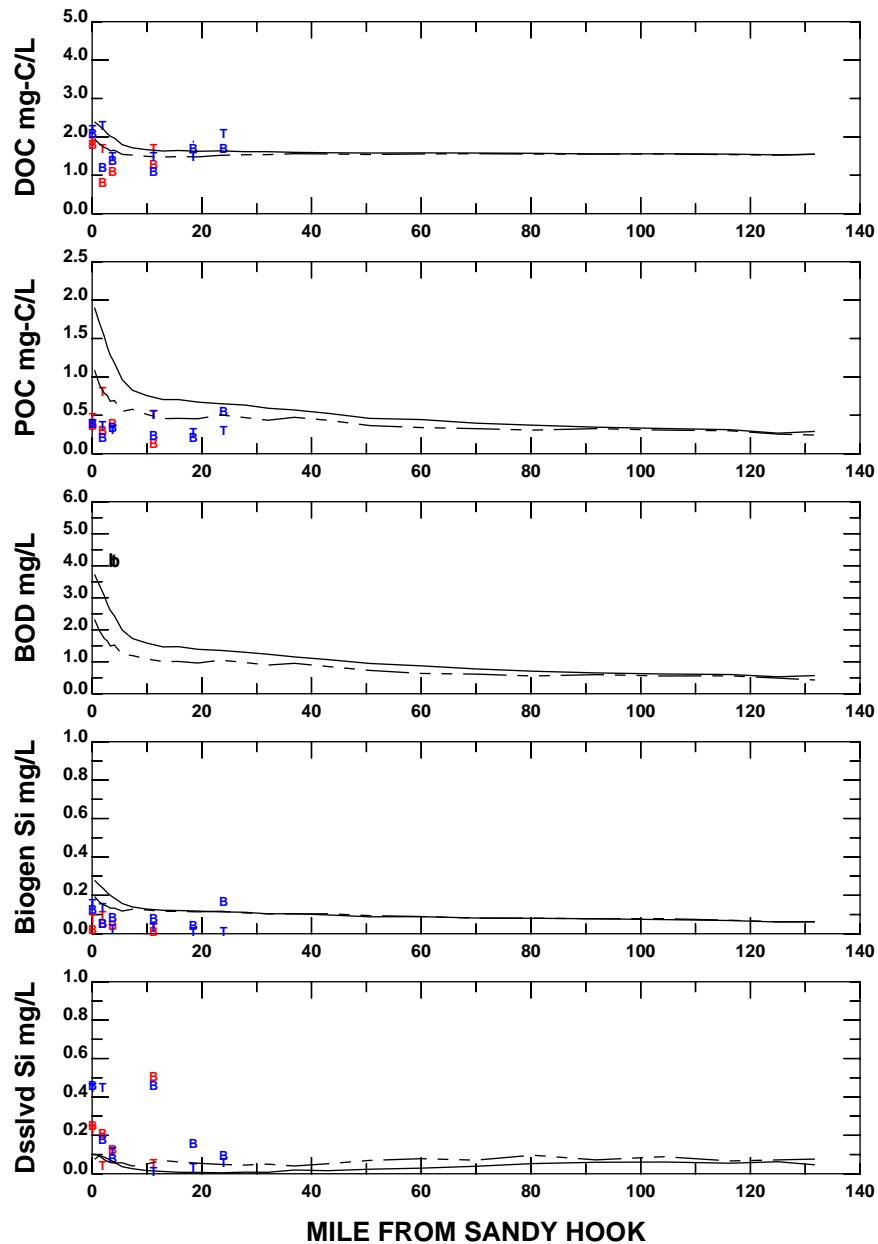


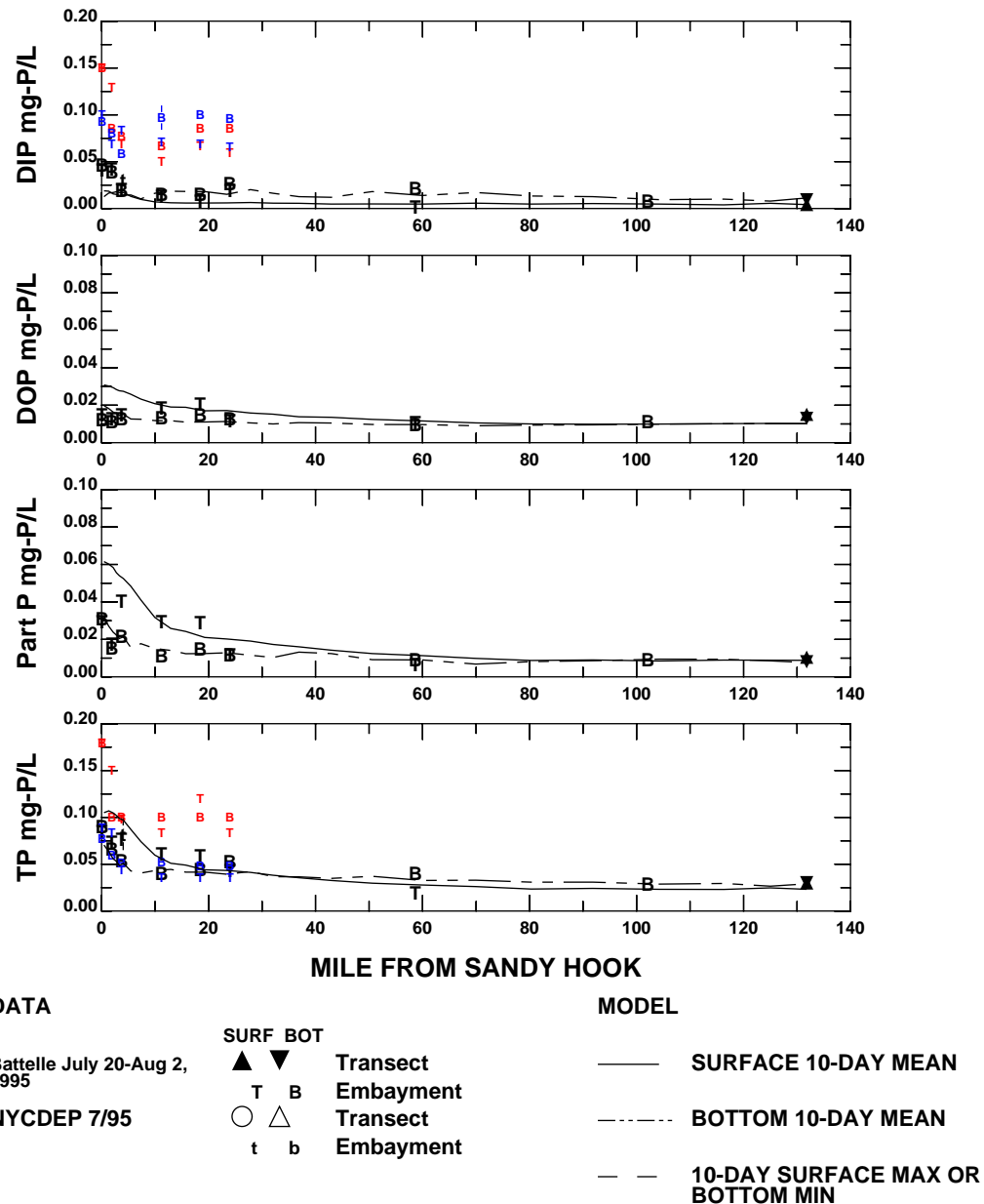
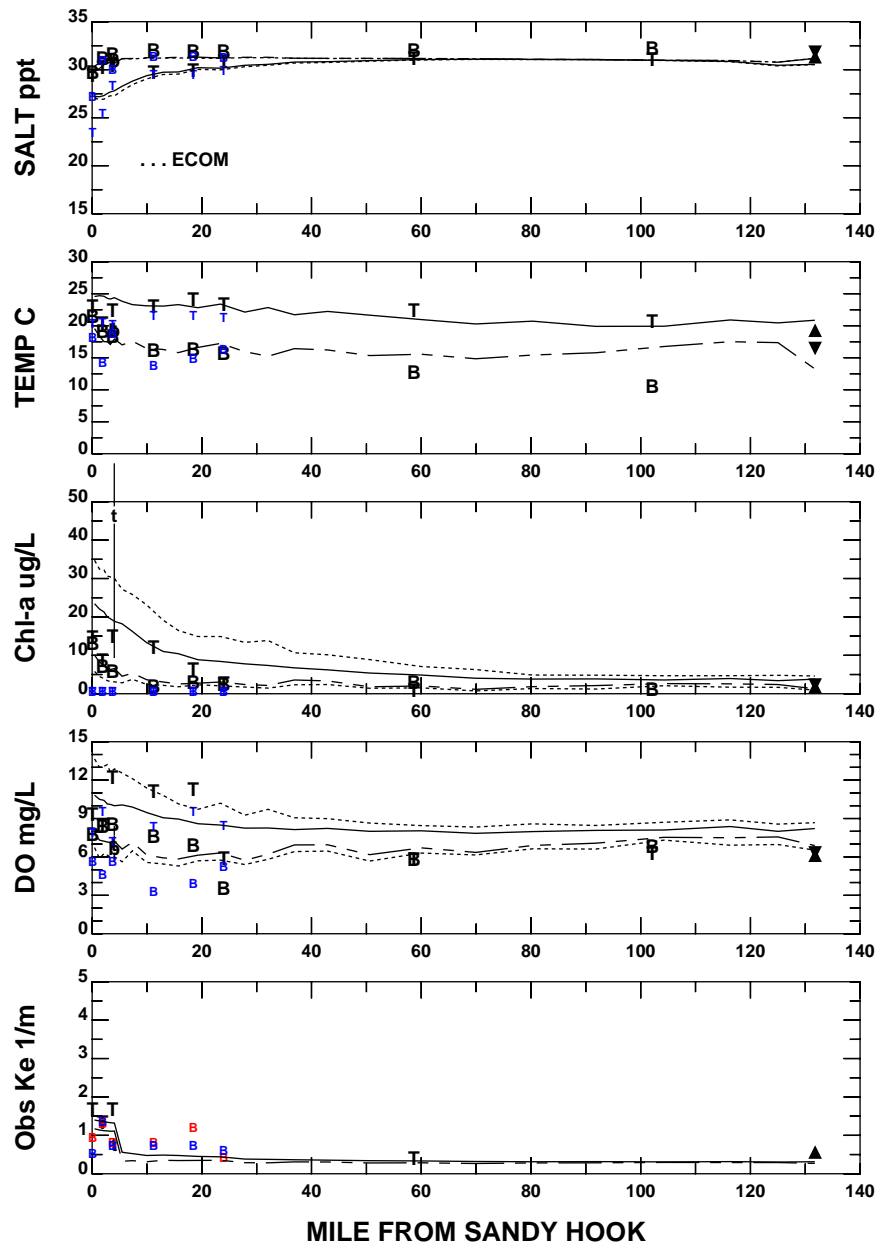


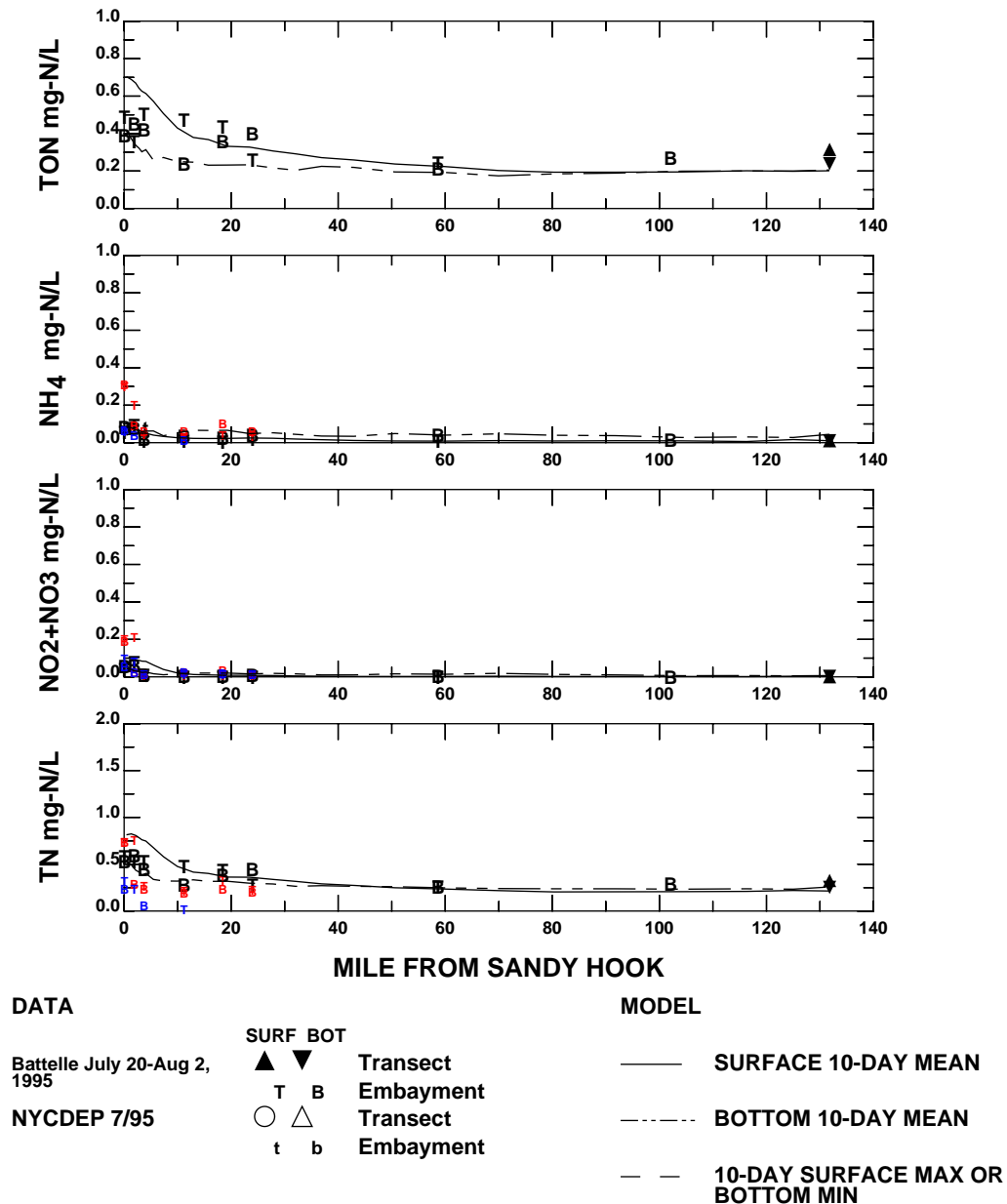
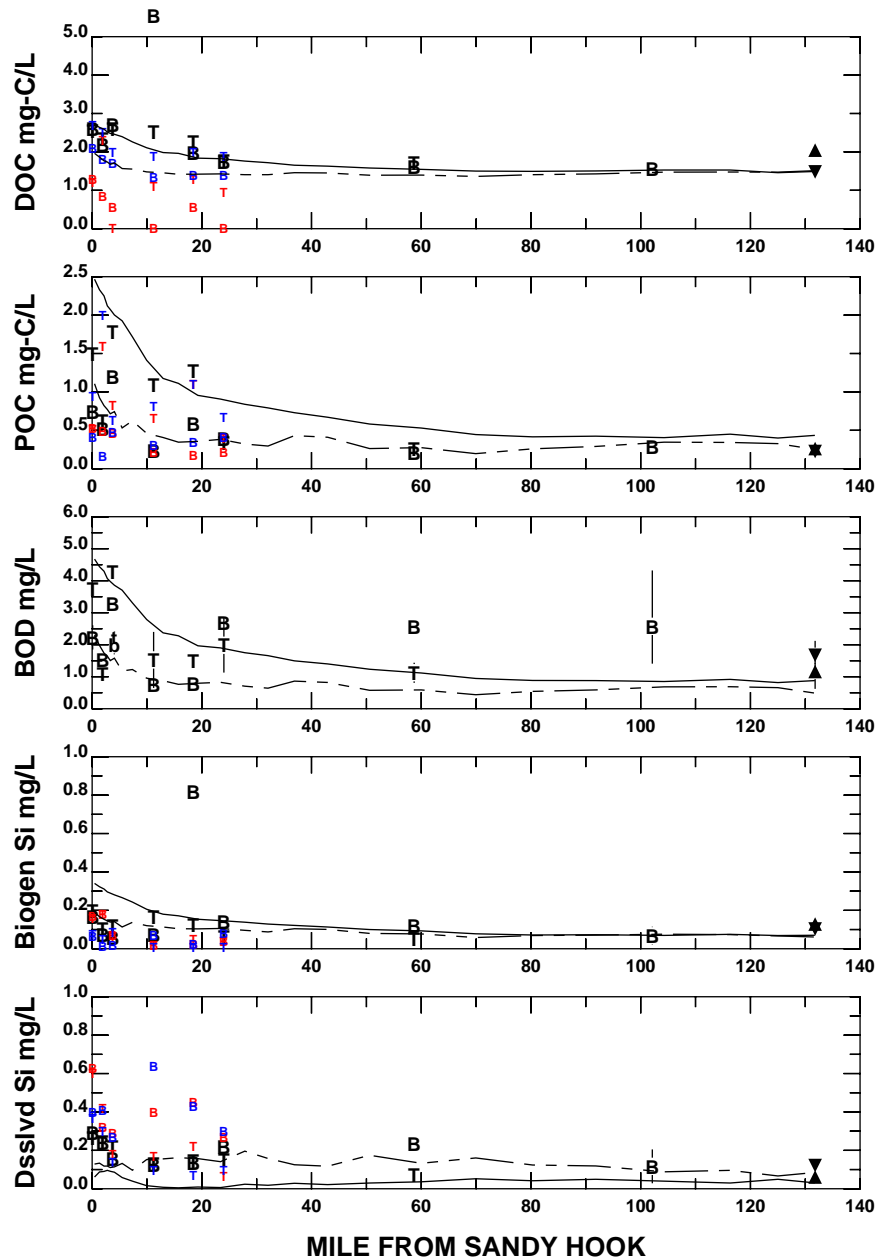


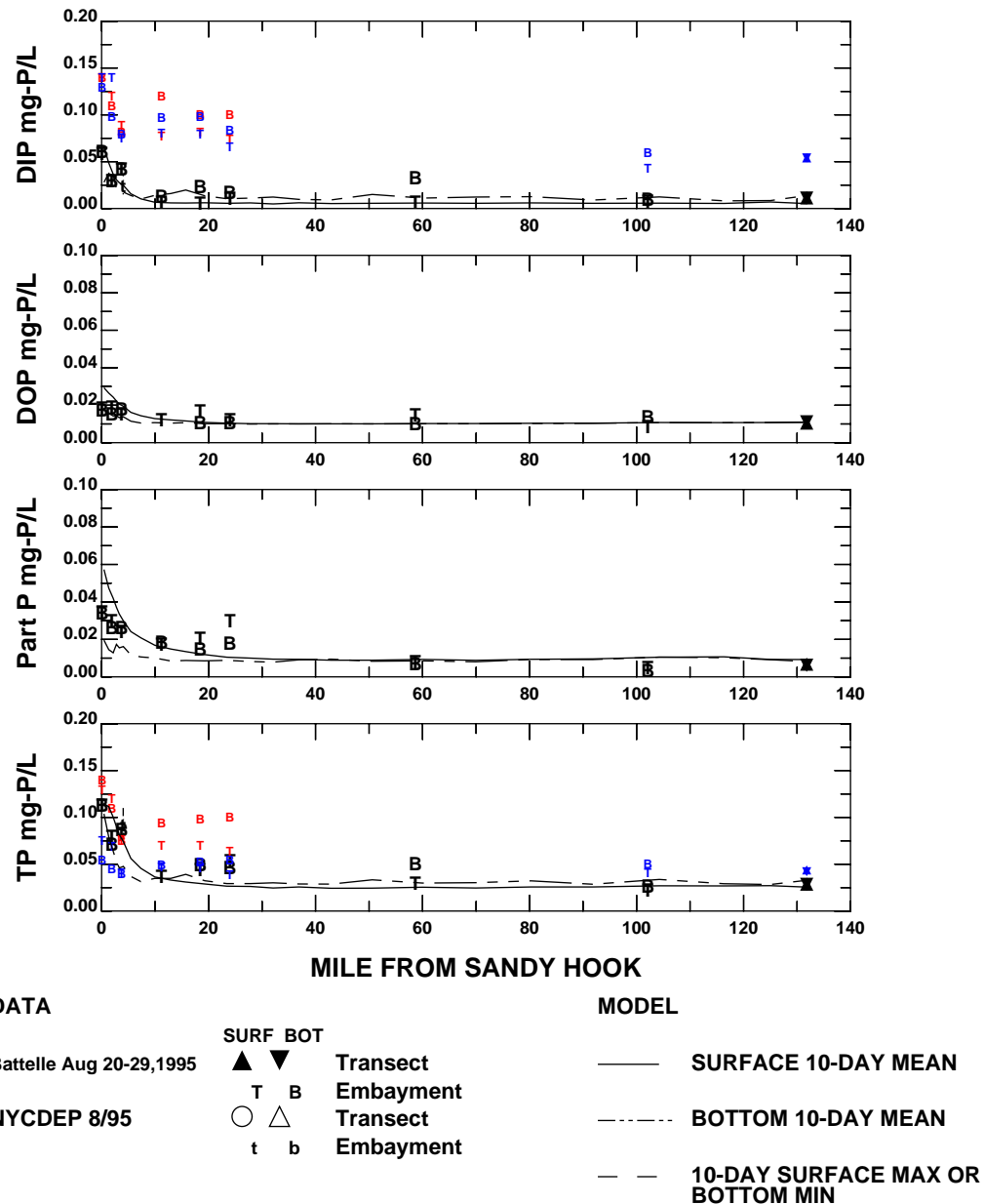
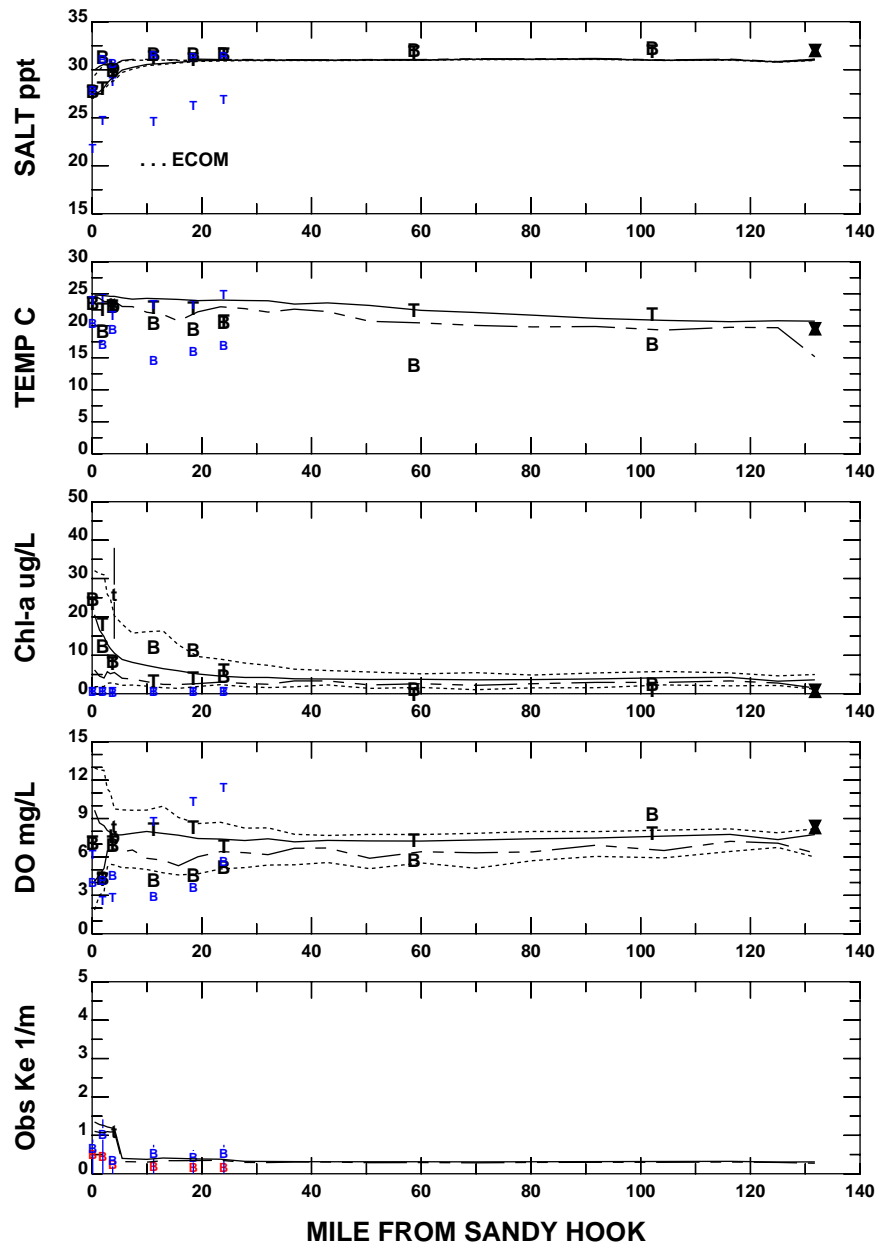


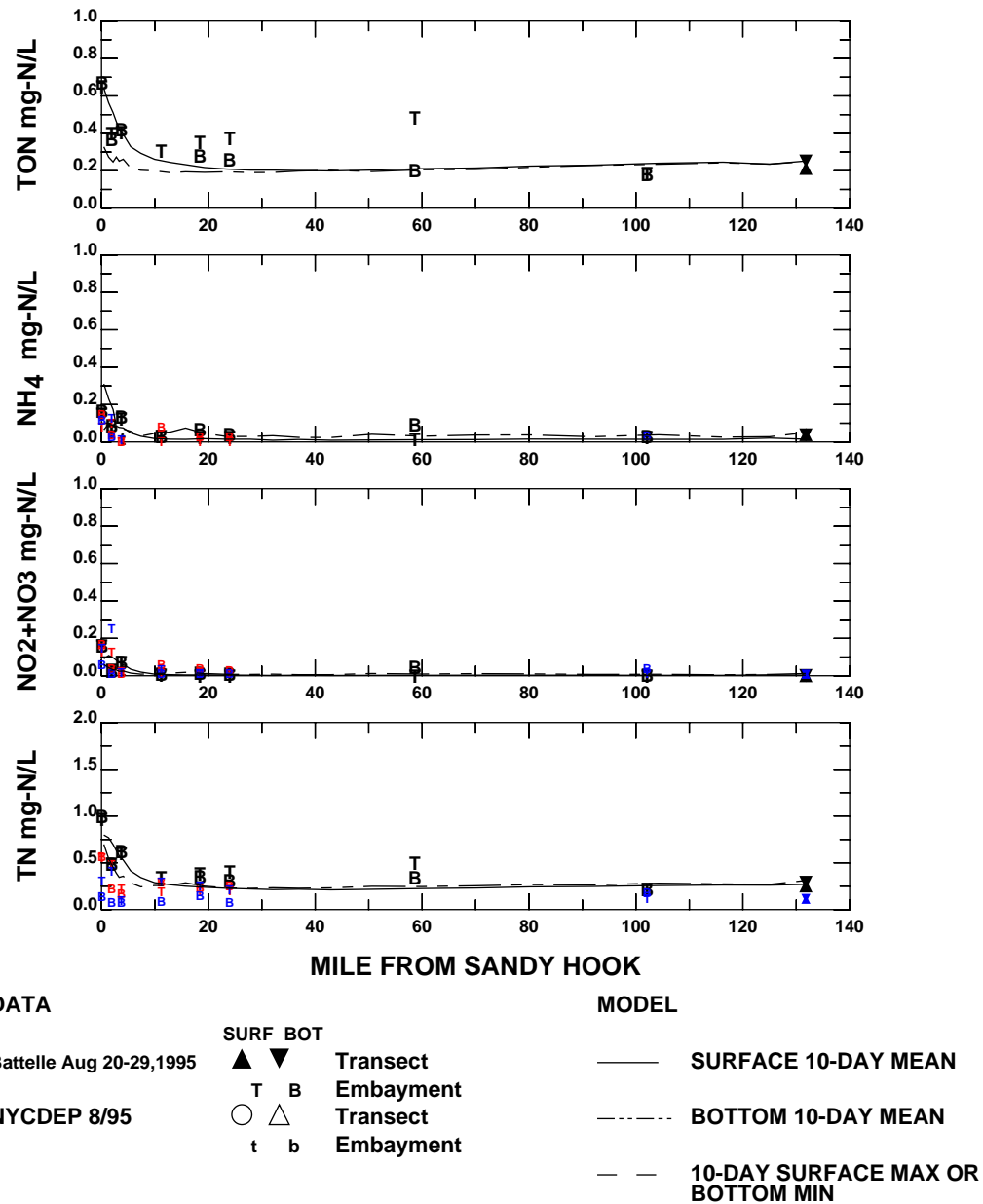
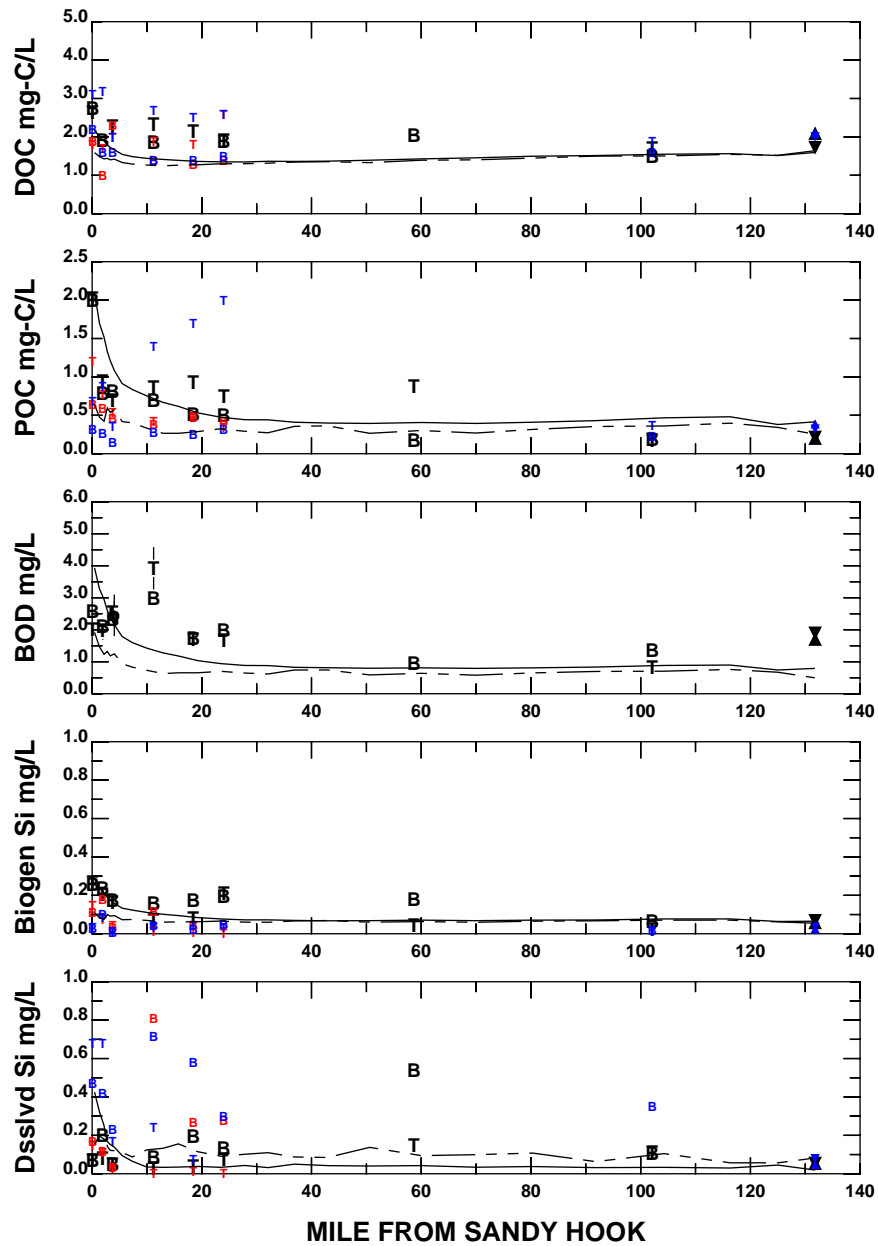


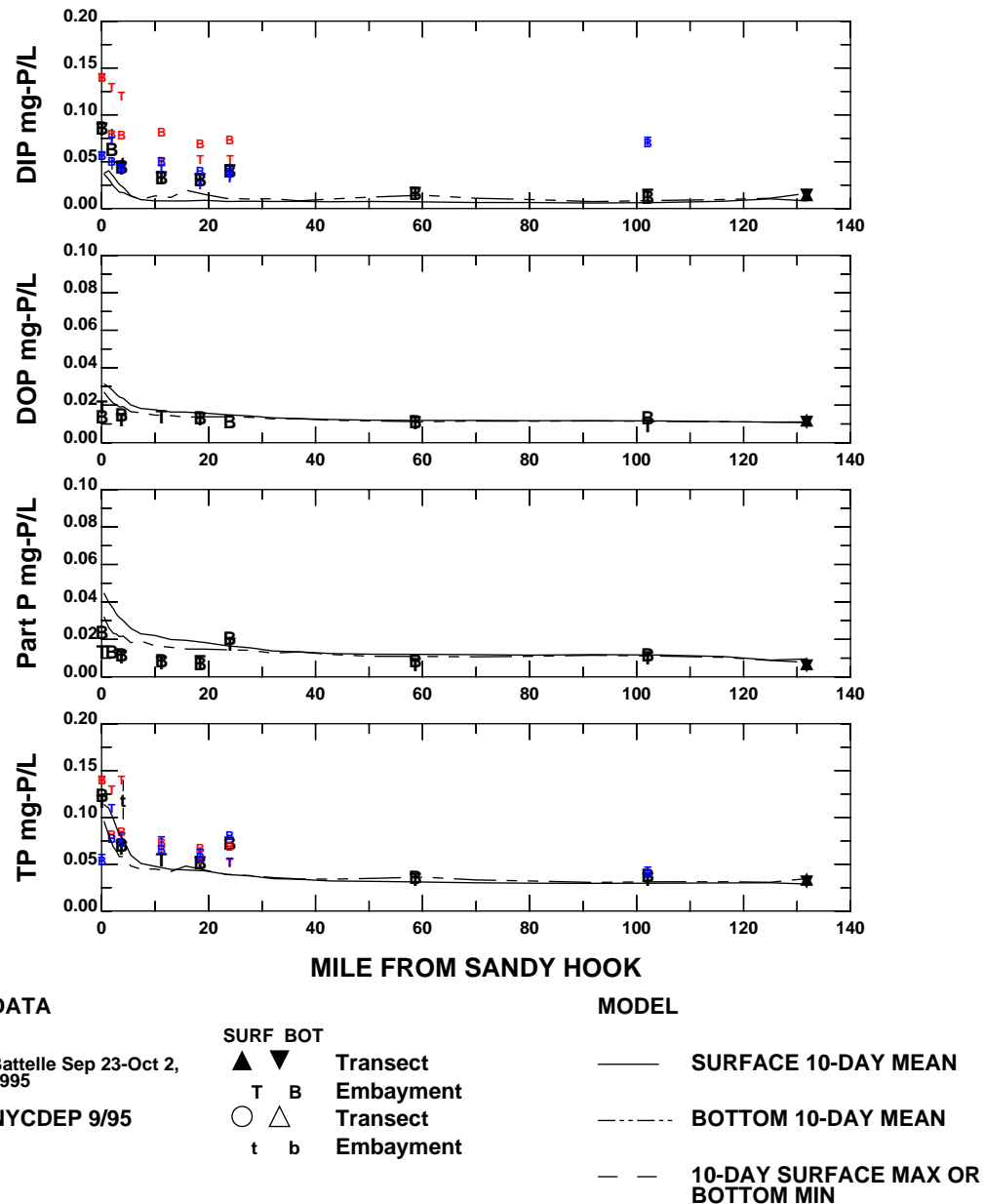
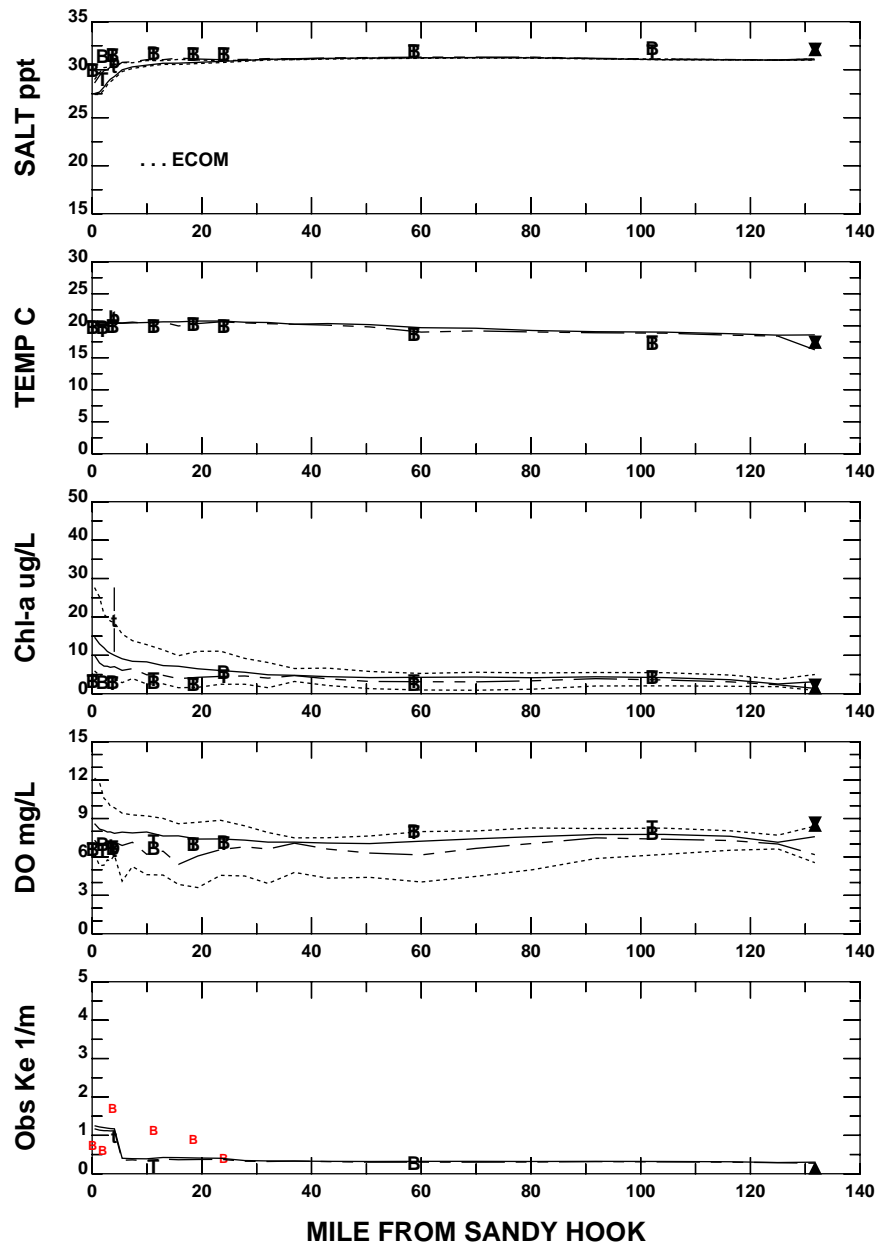


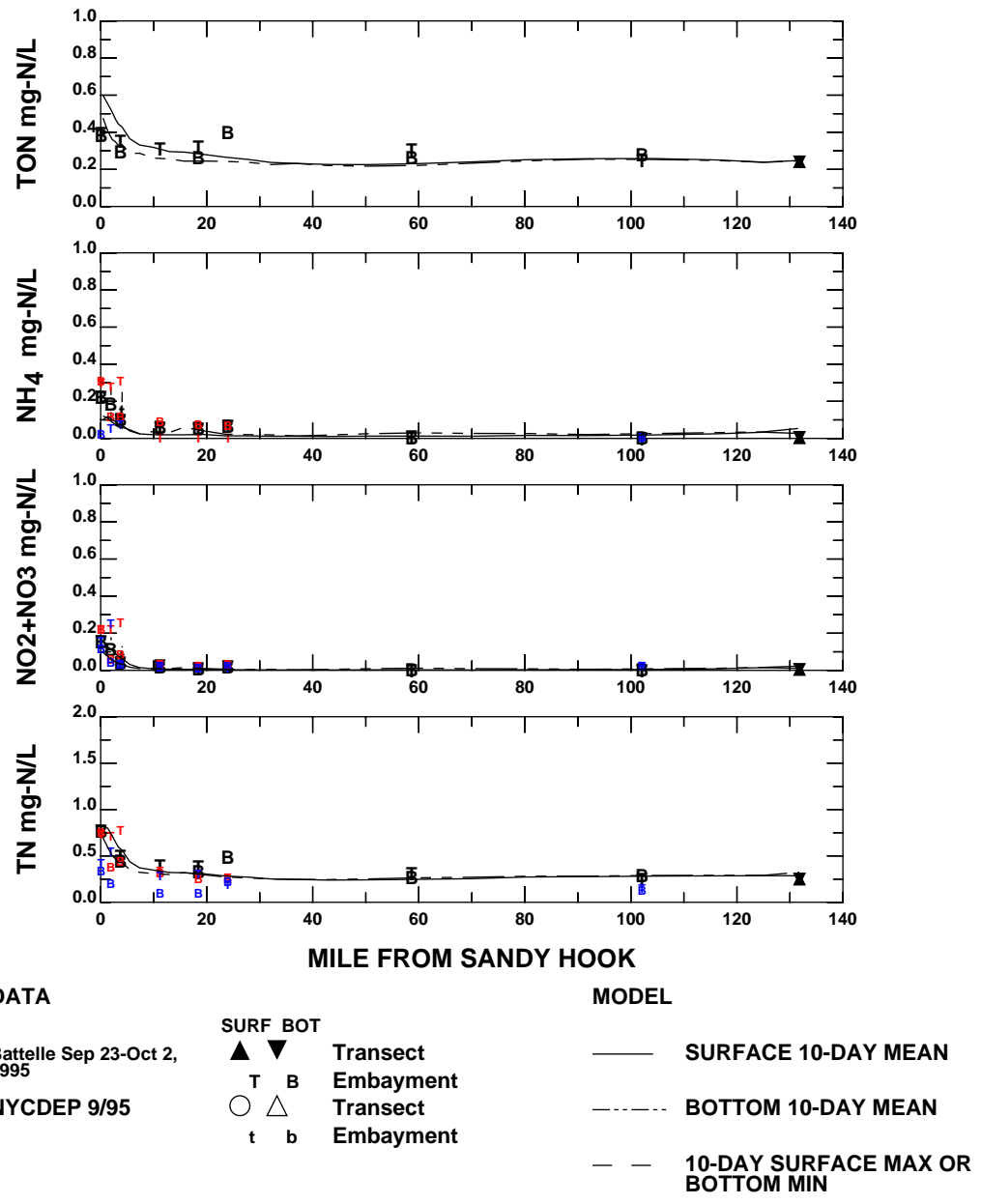
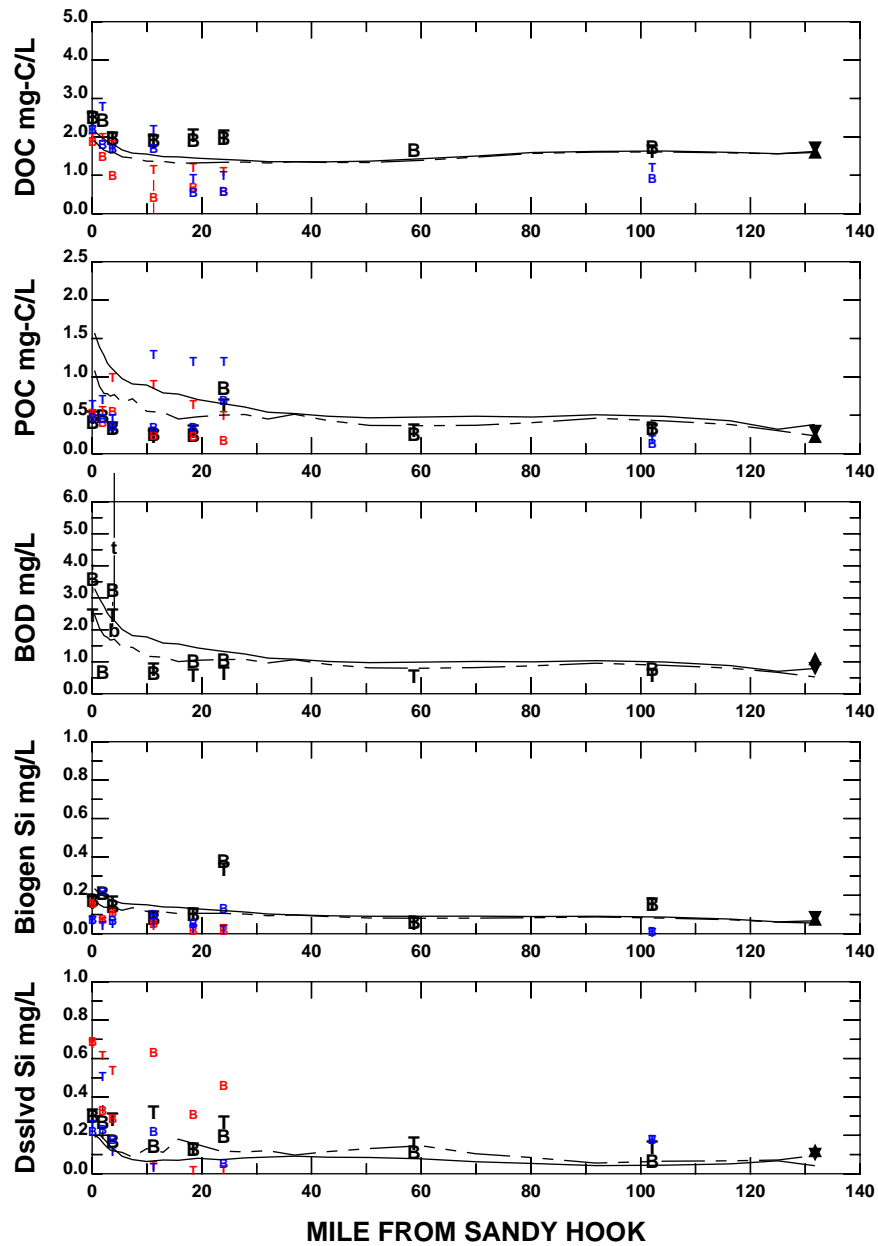


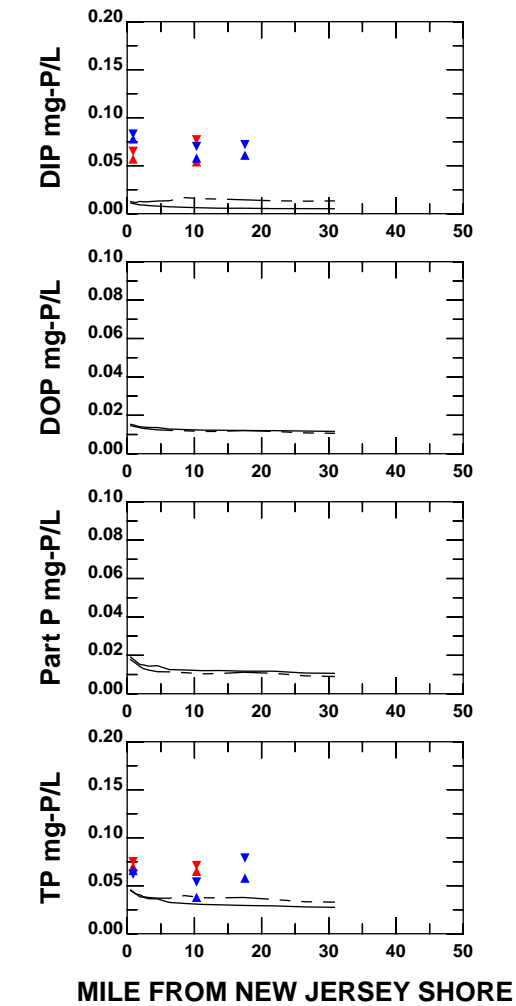
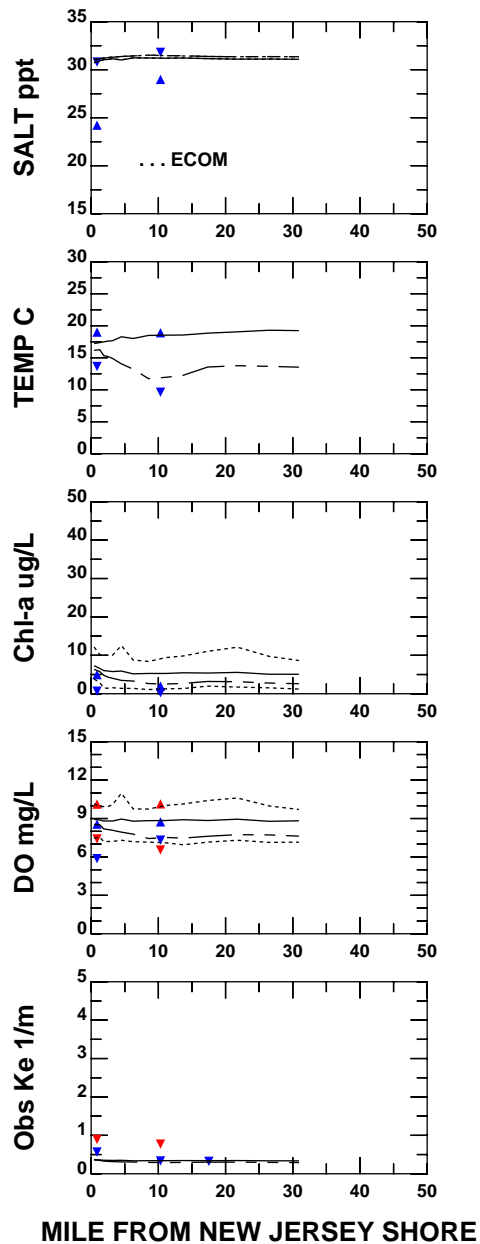












DATA

Battelle June 18-27,
1995

SURF BOT

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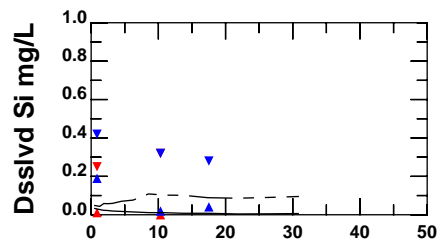
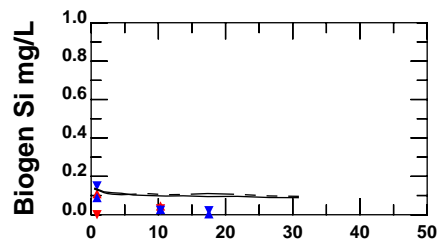
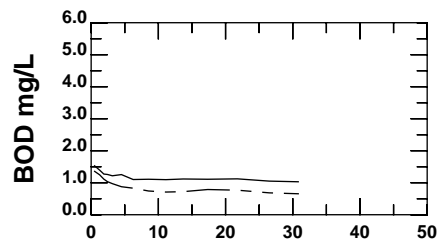
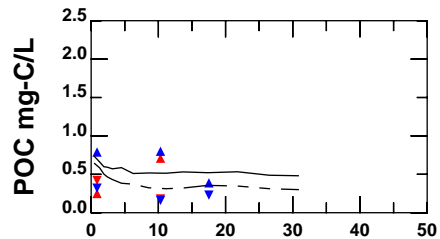
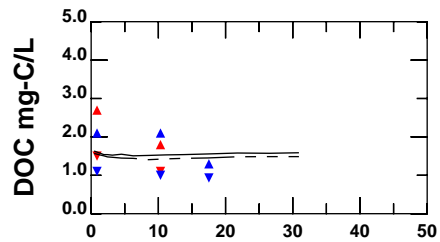
Embayment

MODEL

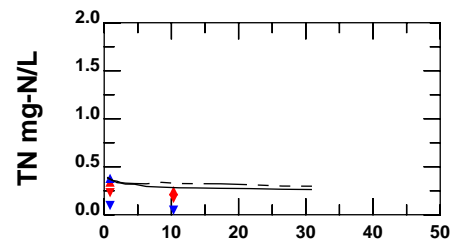
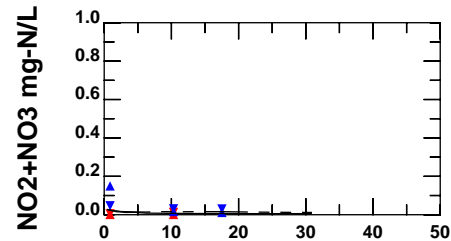
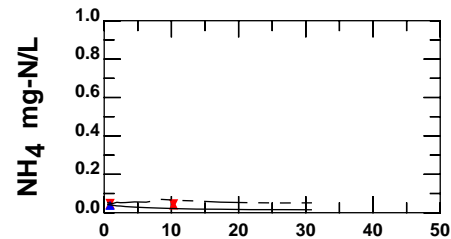
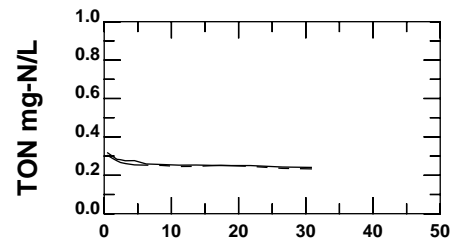
— SURFACE 10-DAY MEAN

--- BOTTOM 10-DAY MEAN

- - - 10-DAY SURFACE MAX OR
BOTTOM MIN



MILE FROM NEW JERSEY SHORE



MILE FROM NEW JERSEY SHORE

DATA

Battelle June 18-27,
1995

SURF BOT

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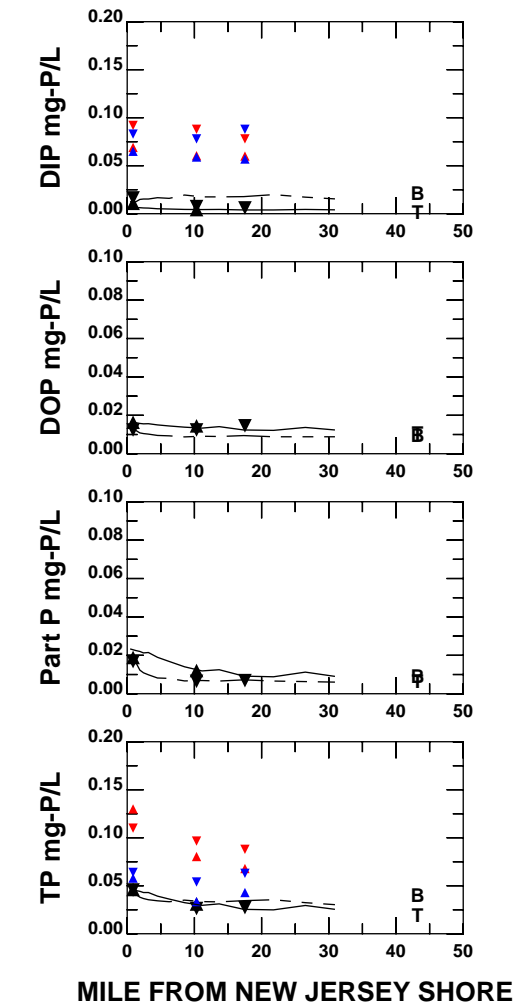
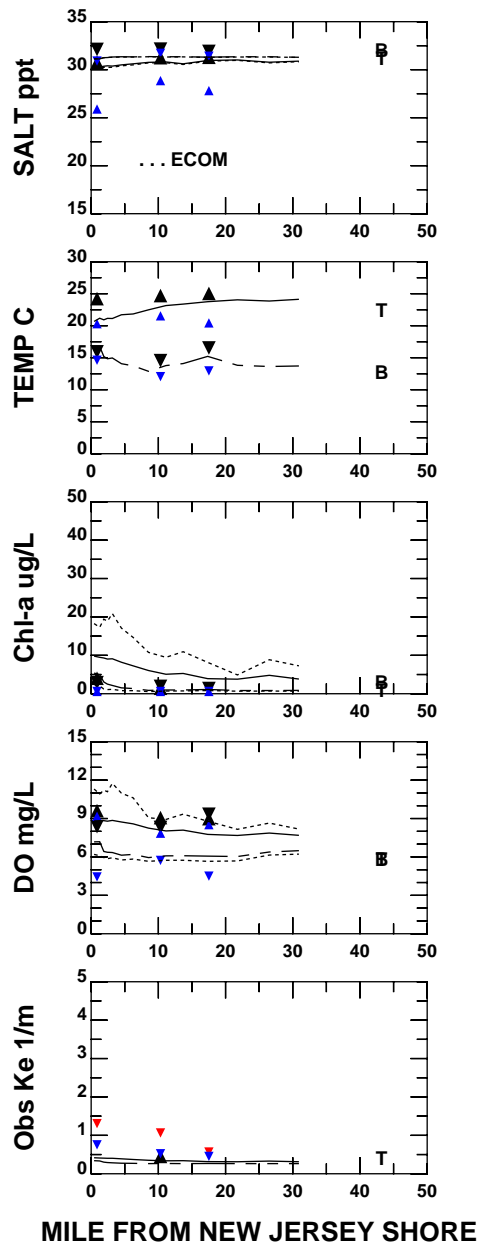
Embayment

MODEL

— SURFACE 10-DAY MEAN

- - - - - BOTTOM 10-DAY MEAN

- · - · - 10-DAY SURFACE MAX OR
BOTTOM MIN



DATA

Battelle July 20-Aug 2,
1995

SURF BOT

▲ ▼

Transect

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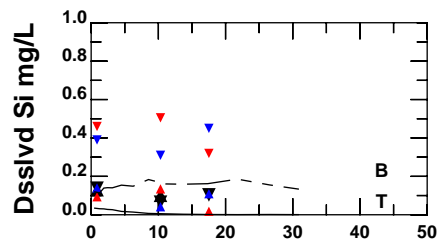
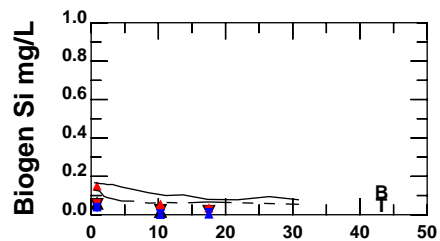
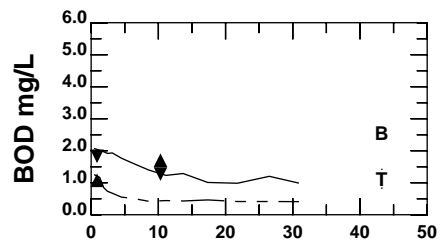
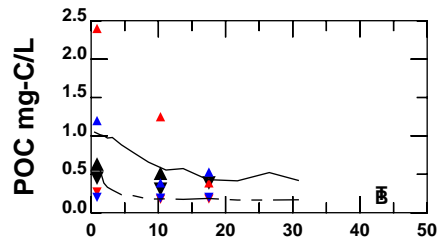
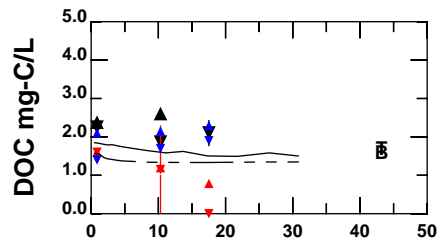
Embayment

MODEL

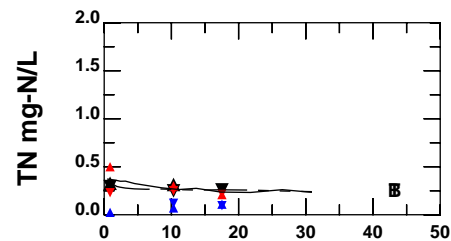
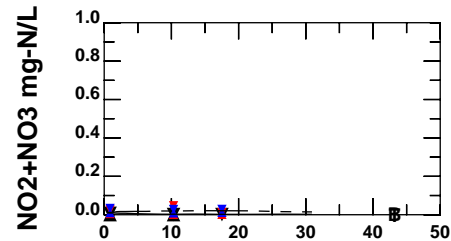
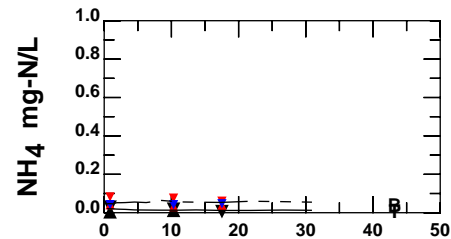
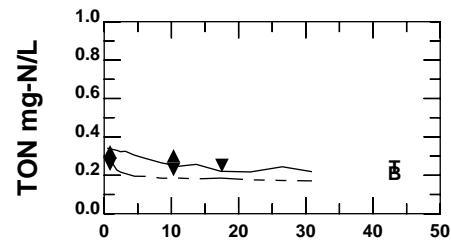
— SURFACE 10-DAY MEAN

- - - - - BOTTOM 10-DAY MEAN

- - - - - 10-DAY SURFACE MAX OR
BOTTOM MIN



MILE FROM NEW JERSEY SHORE



MILE FROM NEW JERSEY SHORE

DATA

Battelle July 20-Aug 2, 1995

SURF BOT

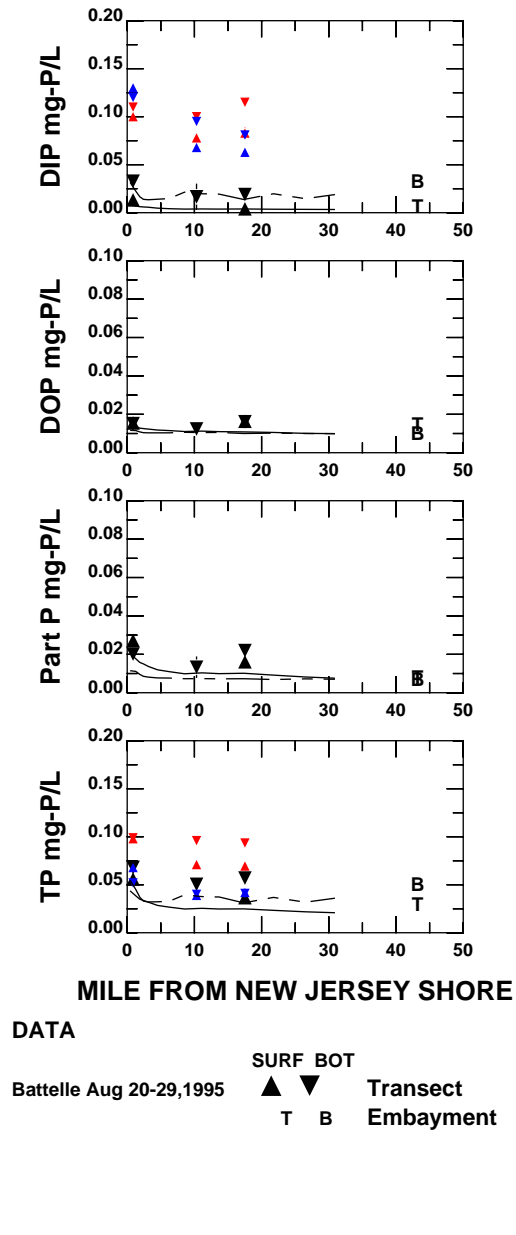
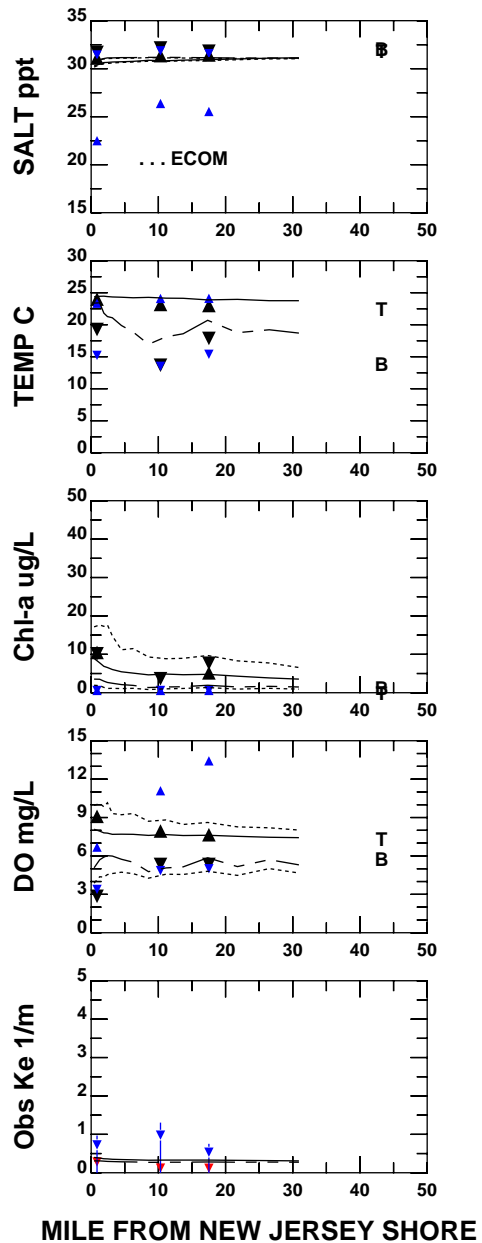
▲ ▼ Transect
T B Embayment

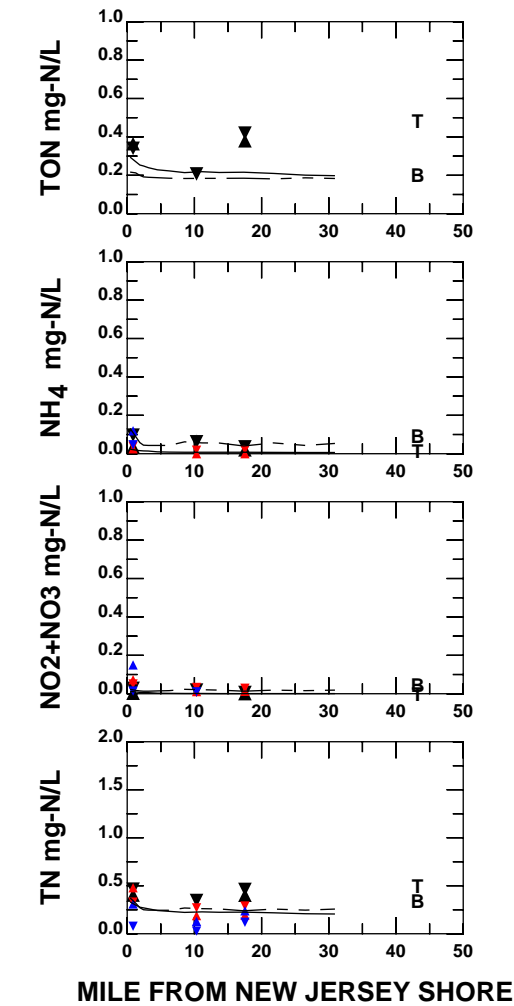
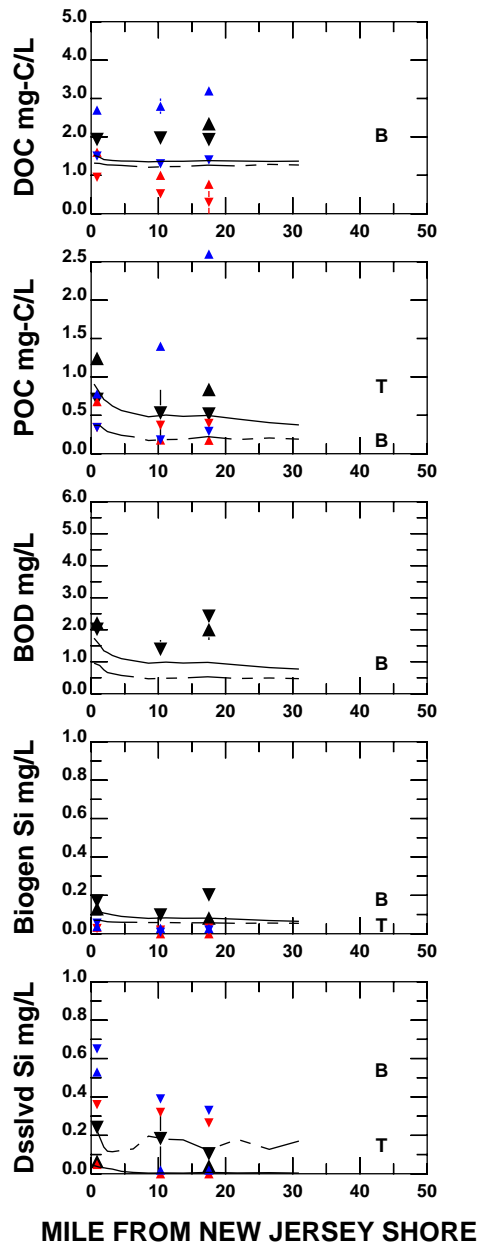
MODEL

— SURFACE 10-DAY MEAN

- - - - - BOTTOM 10-DAY MEAN

- - - - - 10-DAY SURFACE MAX OR BOTTOM MIN





DATA

Battelle Aug 20-29, 1995

SURF BOT

▲ ▼ Transect

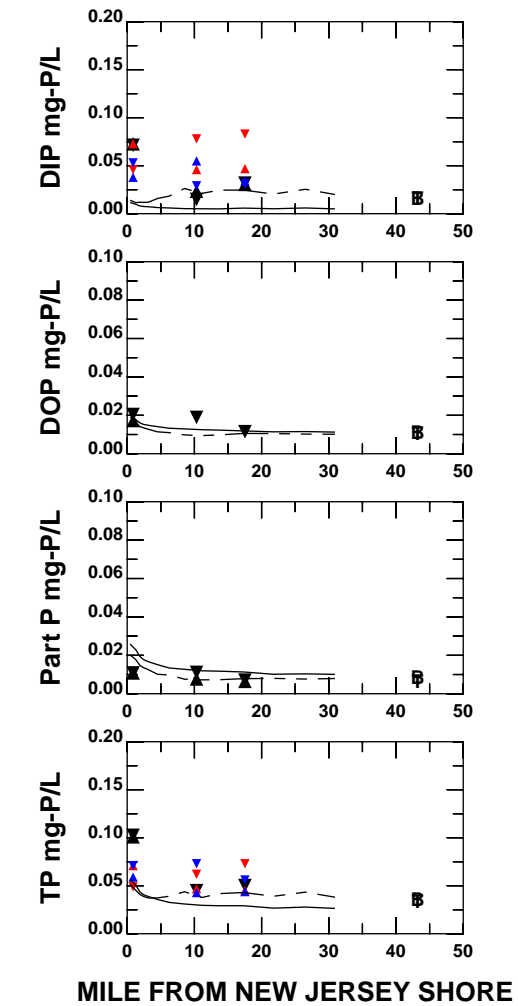
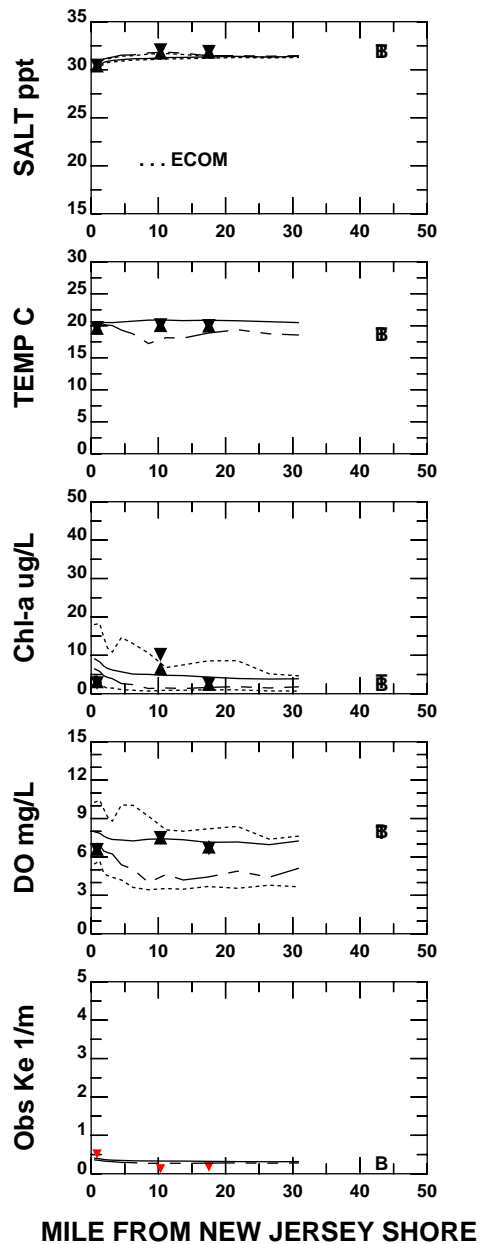
T B Embayment

MODEL

— SURFACE 10-DAY MEAN

- - - - - BOTTOM 10-DAY MEAN

- - - - - 10-DAY SURFACE MAX OR
BOTTOM MIN



DATA

Battelle Sep 23-Oct 2,
1995

SURF BOT

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Transect

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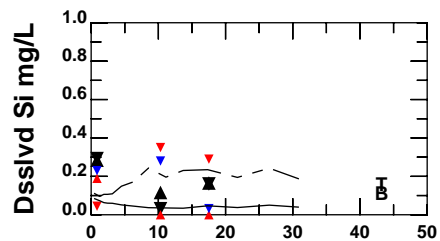
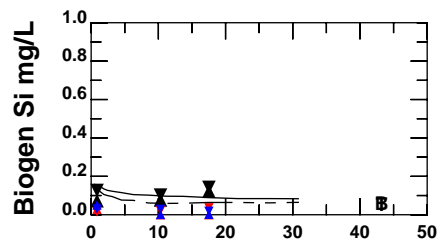
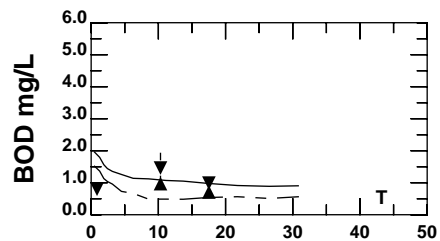
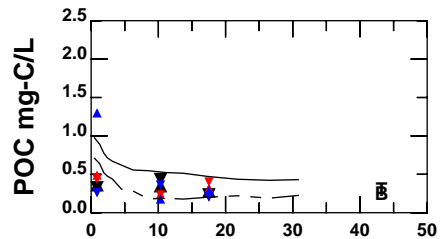
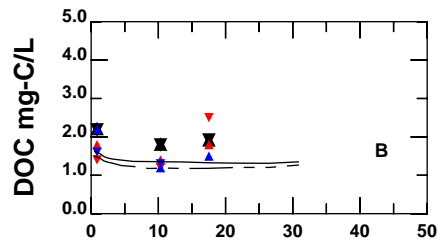
Embayment

MODEL

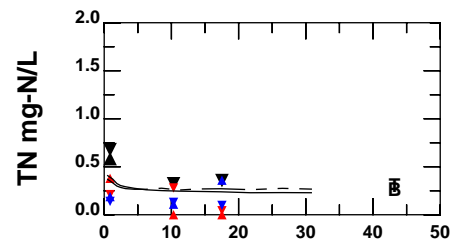
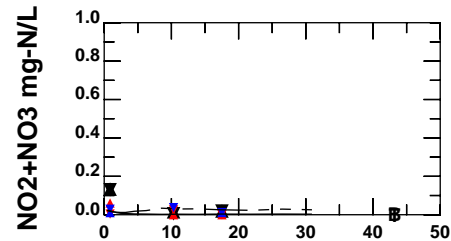
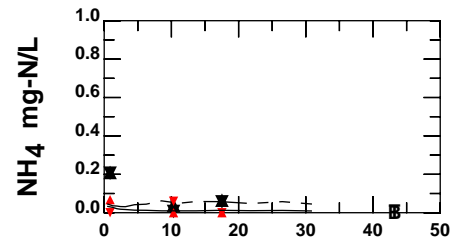
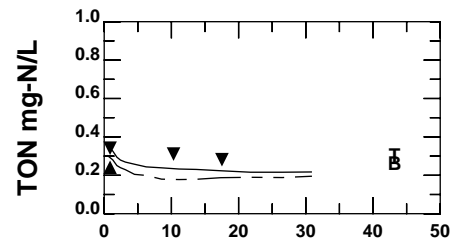
— SURFACE 10-DAY MEAN

- - - BOTTOM 10-DAY MEAN

- - - 10-DAY SURFACE MAX OR
BOTTOM MIN



MILE FROM NEW JERSEY SHORE



MILE FROM NEW JERSEY SHORE

DATA

Battelle Sep 23-Oct 2, 1995

SURF BOT

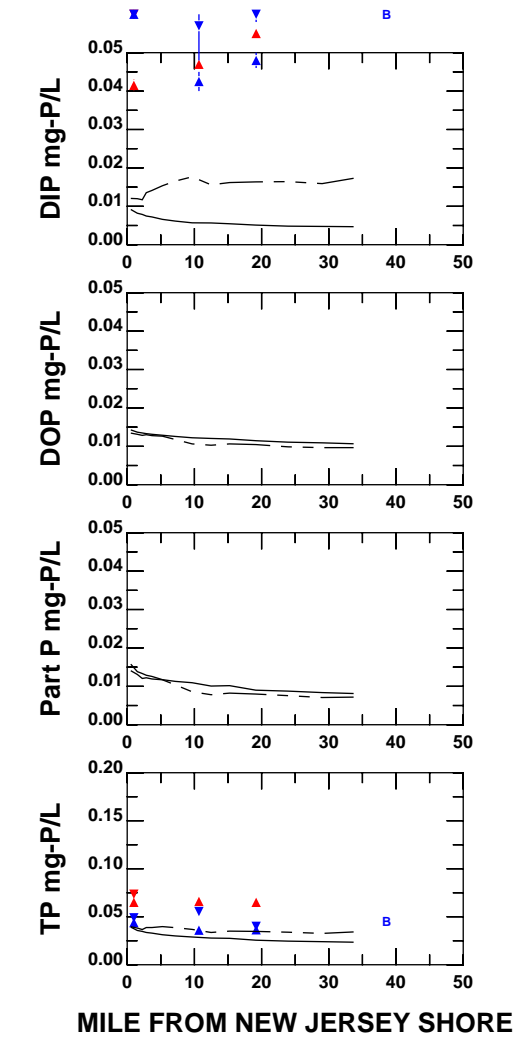
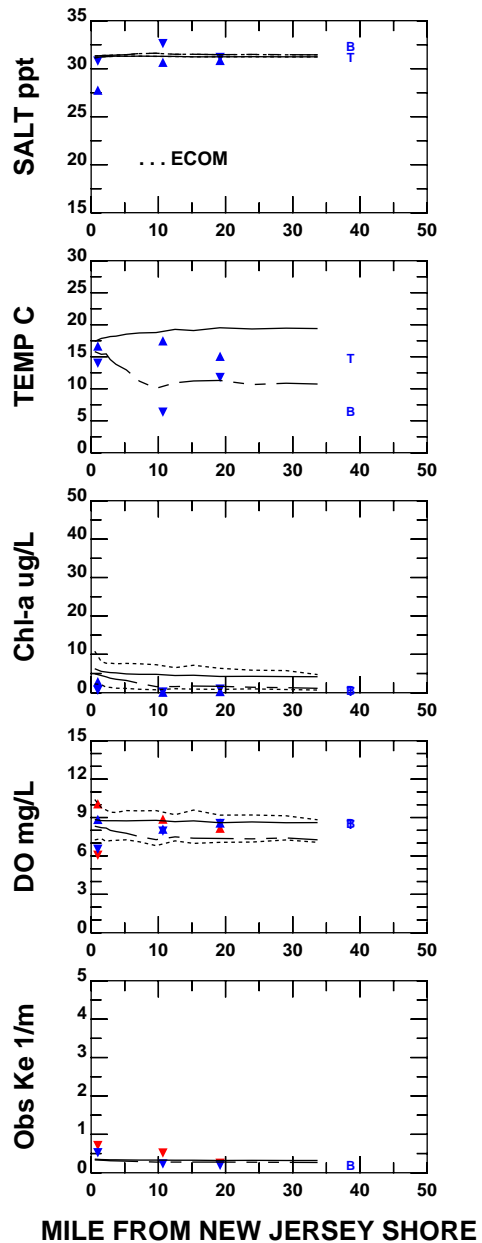
▲ ▼ Transect
T B Embayment

MODEL

— SURFACE 10-DAY MEAN

- - - BOTTOM 10-DAY MEAN

- - - 10-DAY SURFACE MAX OR BOTTOM MIN



DATA

Battelle June 18-27,
1995

SURF BOT

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Transect

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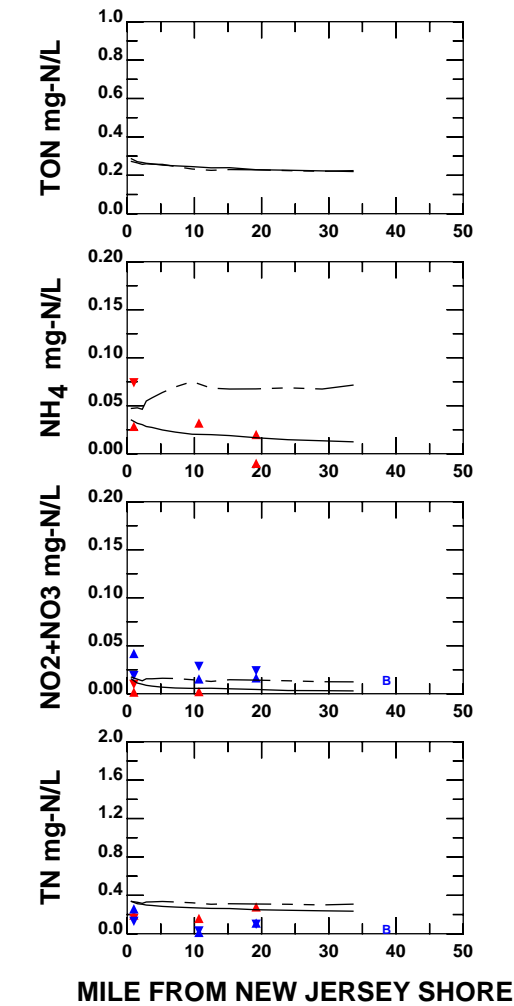
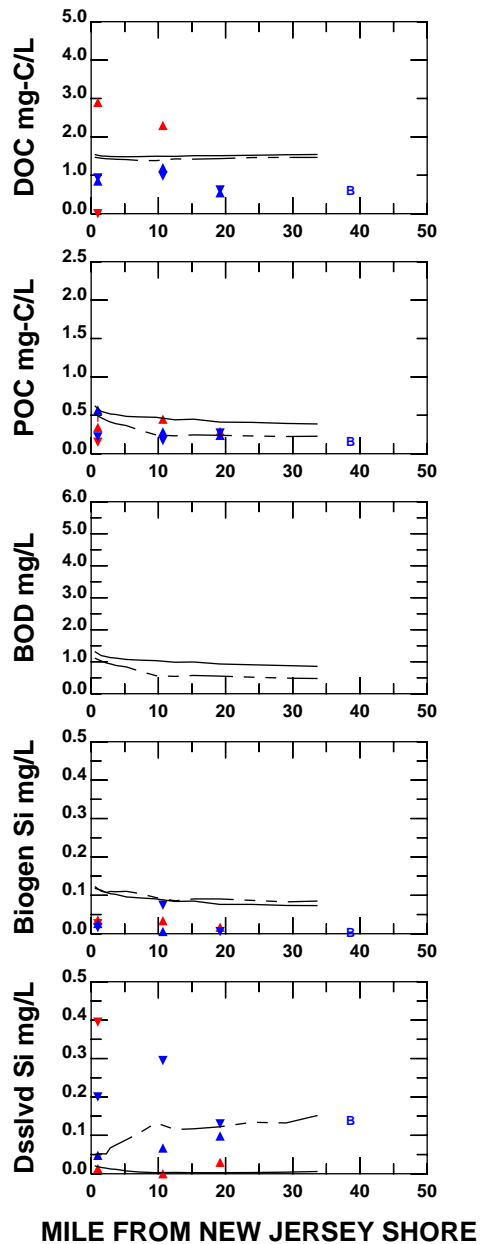
Embayment

MODEL

— SURFACE 10-DAY MEAN

- - - BOTTOM 10-DAY MEAN

- - - 10-DAY SURFACE MAX OR
BOTTOM MIN



DATA

Battelle June 18-27,
1995

SURF BOT

▲ ▼

Transect

T B

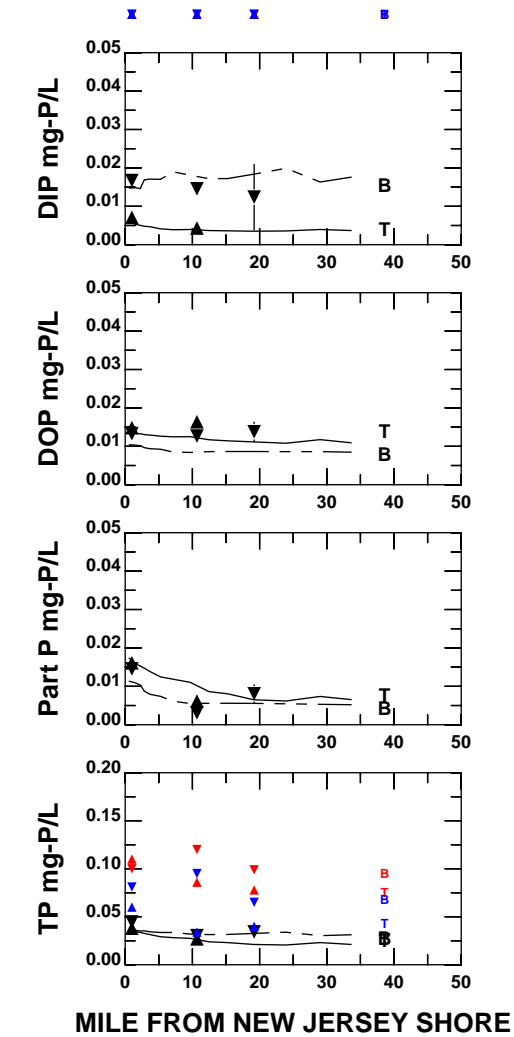
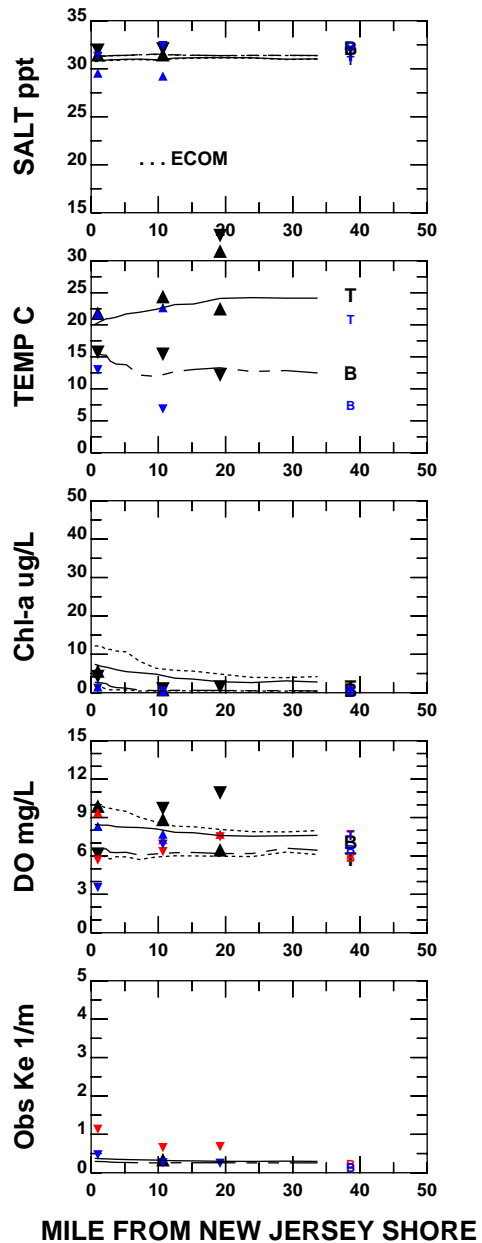
Embayment

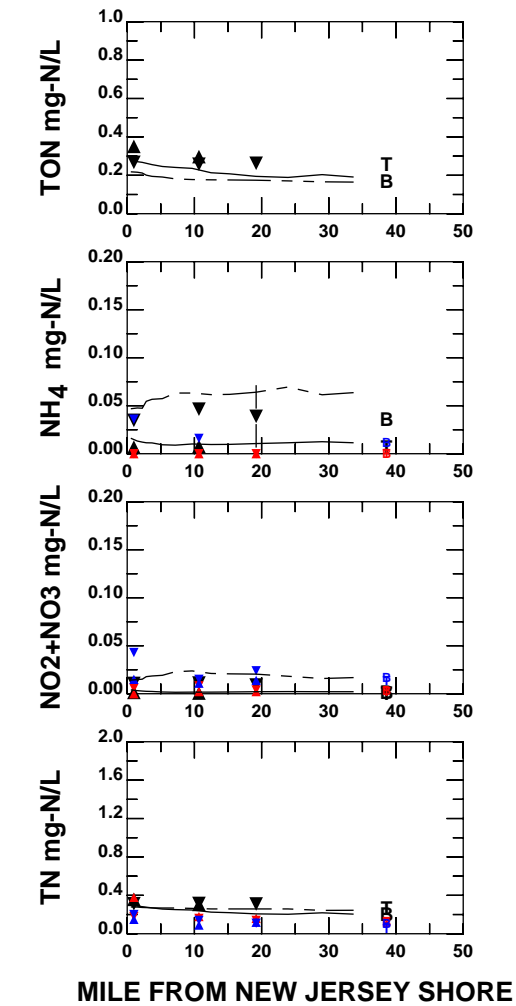
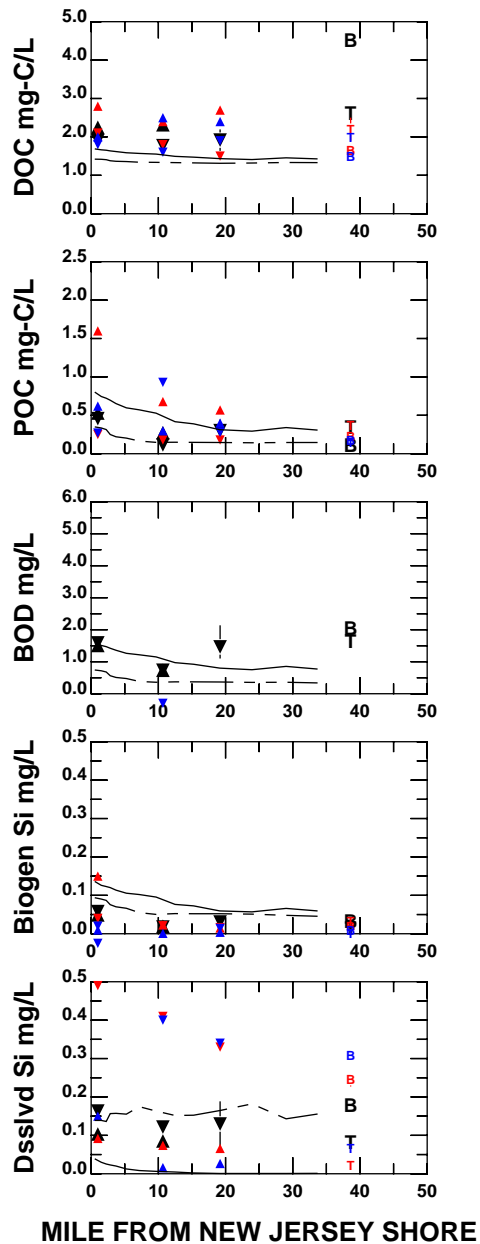
MODEL

— SURFACE 10-DAY MEAN

····· BOTTOM 10-DAY MEAN

- - - 10-DAY SURFACE MAX OR
BOTTOM MIN





DATA

Battelle July 20-Aug 2,
1995

SURF BOT

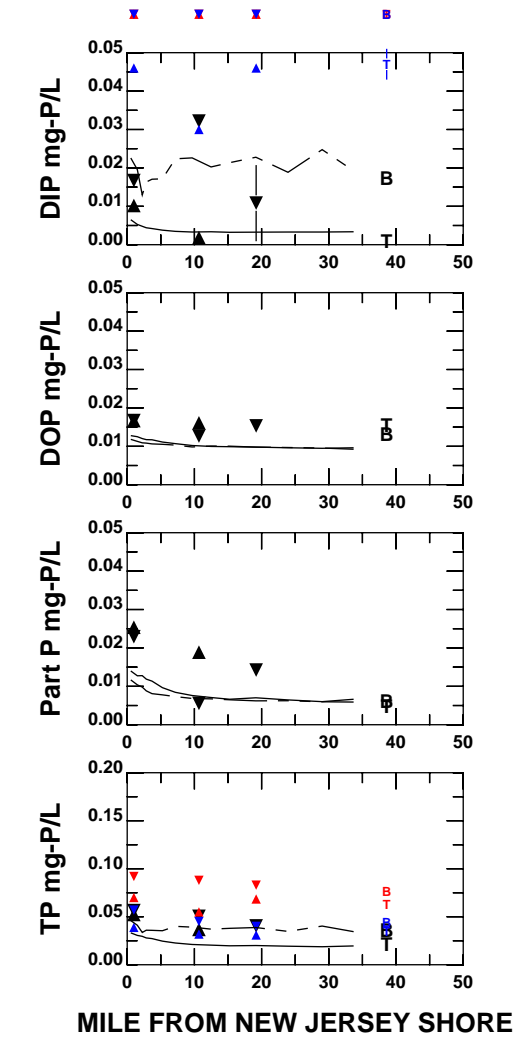
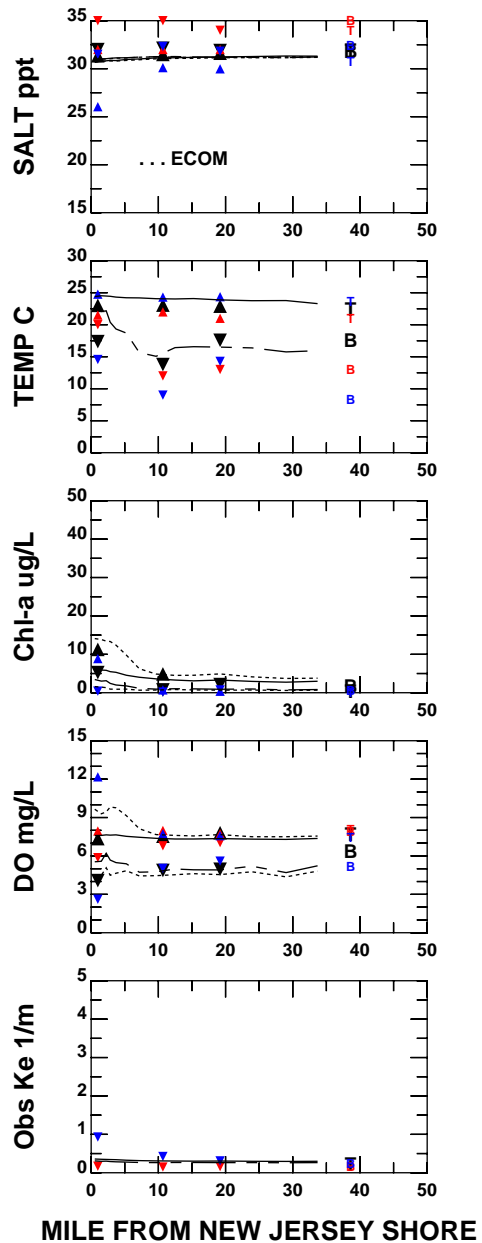
▲ ▼ Transect
T B Embayment

MODEL

— SURFACE 10-DAY MEAN

- - - - - BOTTOM 10-DAY MEAN

- · - · - 10-DAY SURFACE MAX OR
BOTTOM MIN



DATA

Battelle Aug 20-29,1995

SURF BOT

▲ ▼ Transect

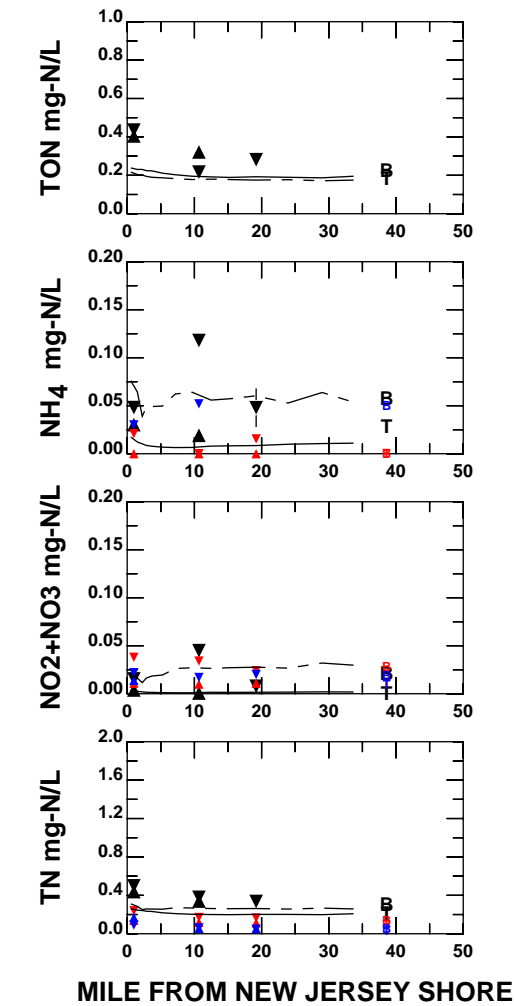
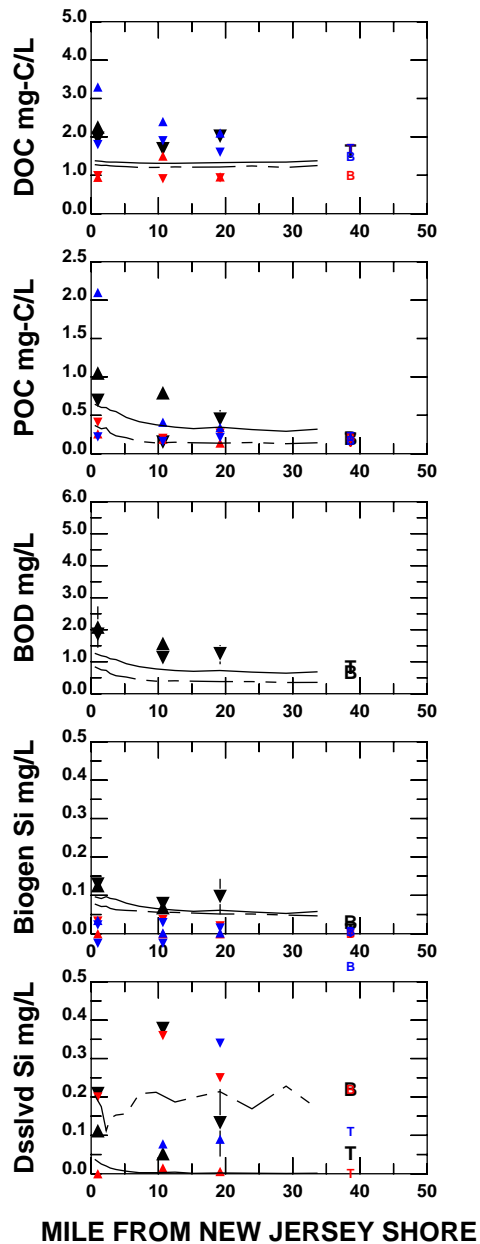
T B Embayment

MODEL

— SURFACE 10-DAY MEAN

- - - - - BOTTOM 10-DAY MEAN

- - - - - 10-DAY SURFACE MAX OR BOTTOM MIN



DATA

Battelle Aug 20-29, 1995

SURF BOT

▲ ▼ Transect

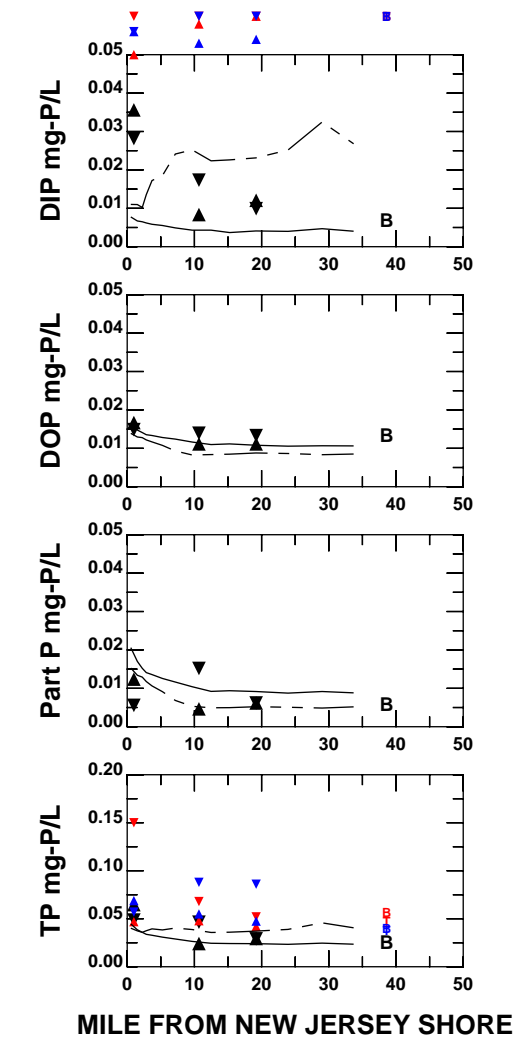
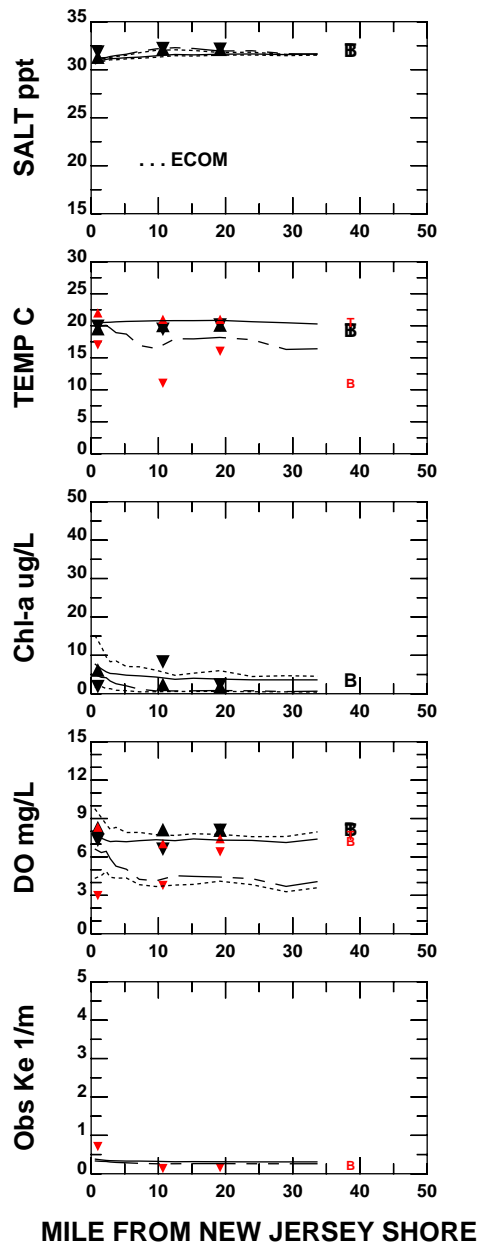
T B Embayment

MODEL

— SURFACE 10-DAY MEAN

- - - - - BOTTOM 10-DAY MEAN

- - - 10-DAY SURFACE MAX OR BOTTOM MIN



DATA

Battelle Sep 23-Oct 2,
1995

SURF BOT

▲ ▼

Transect

T B

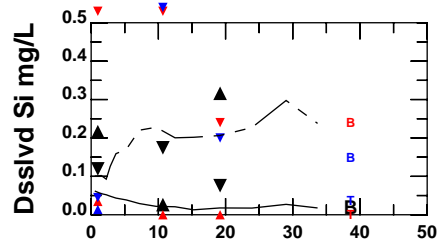
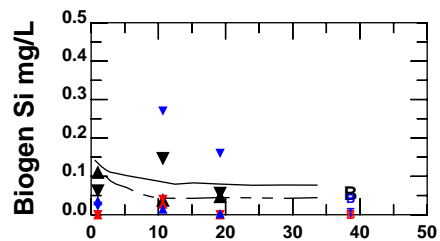
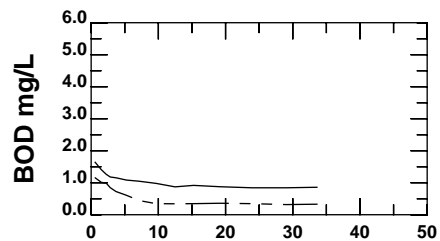
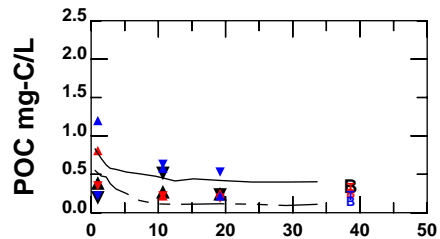
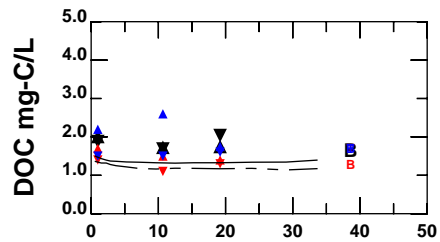
Embayment

MODEL

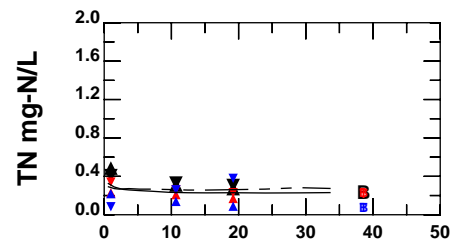
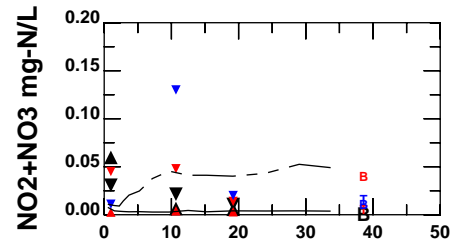
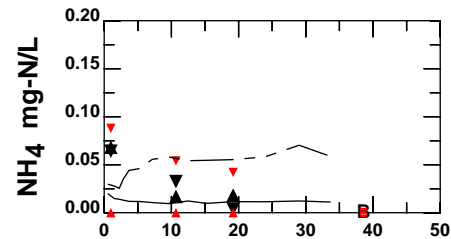
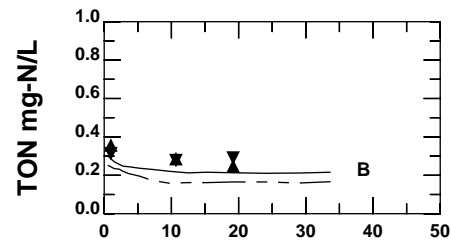
— SURFACE 10-DAY MEAN

- - - BOTTOM 10-DAY MEAN

- - - 10-DAY SURFACE MAX OR
BOTTOM MIN



MILE FROM NEW JERSEY SHORE



MILE FROM NEW JERSEY SHORE

DATA

Battelle Sep 23-Oct 2, 1995

SURF BOT

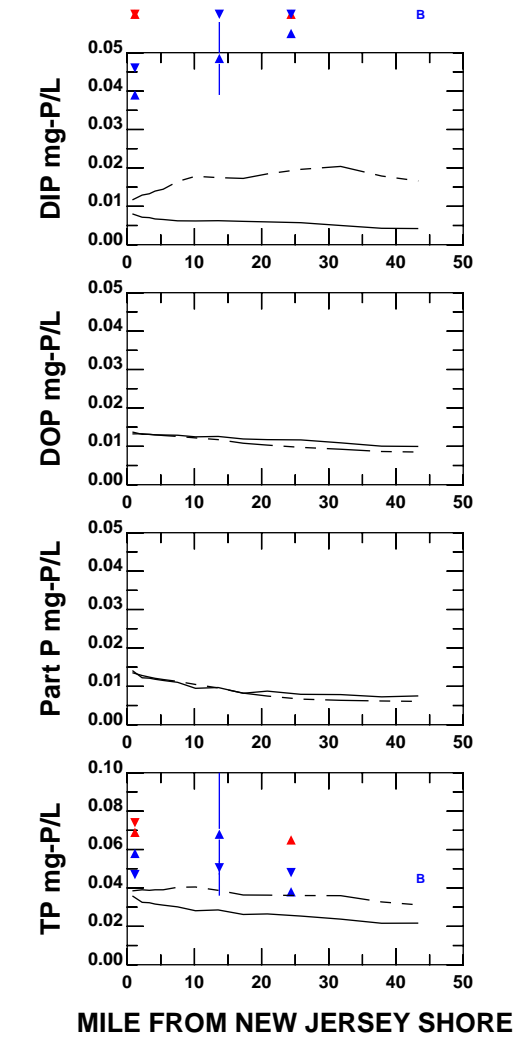
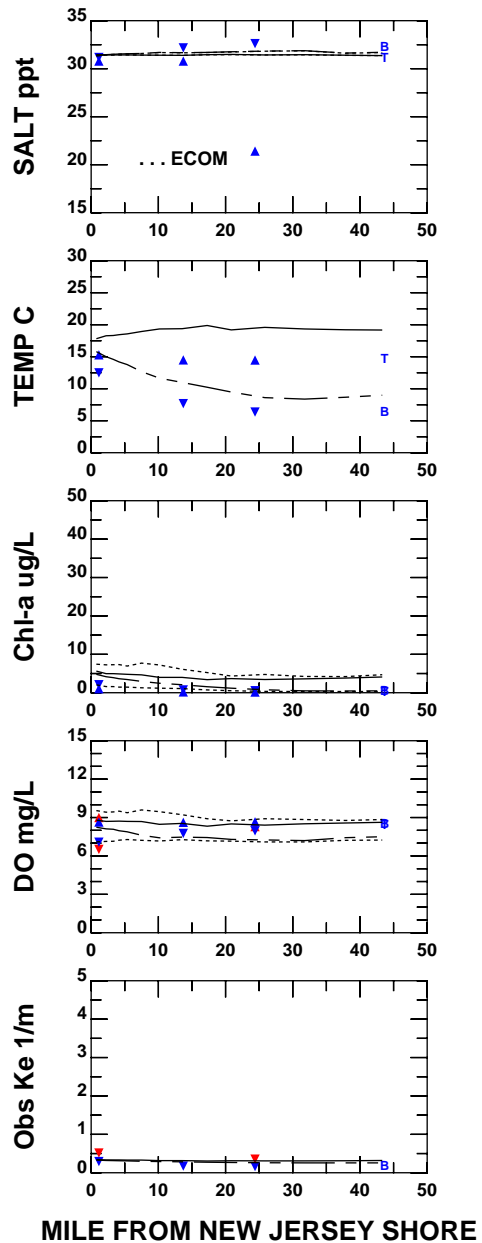
▲ ▼ Transect
T B Embayment

MODEL

— SURFACE 10-DAY MEAN

- - - - - BOTTOM 10-DAY MEAN

- - - - - 10-DAY SURFACE MAX OR BOTTOM MIN



DATA

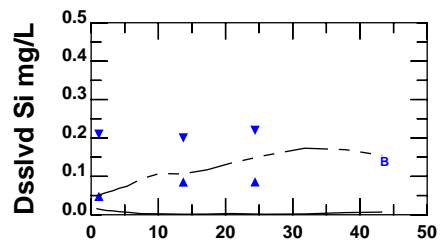
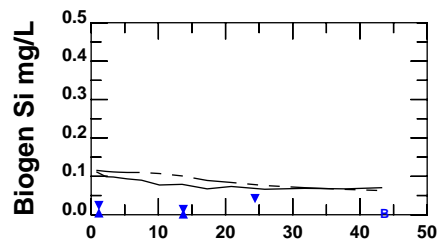
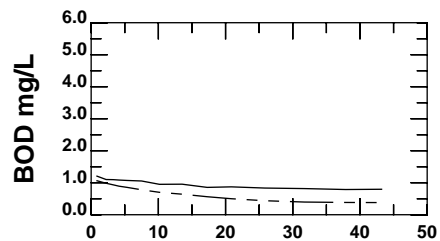
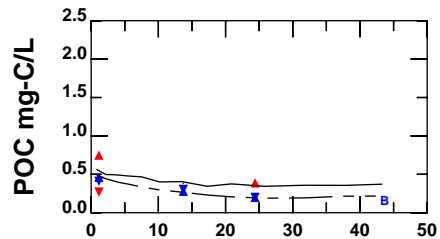
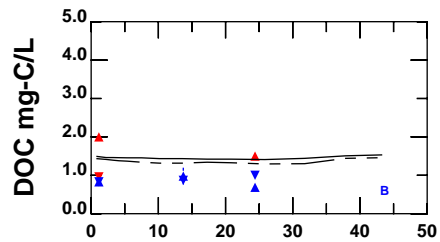
Battelle June 18-27,
1995

SURF BOT

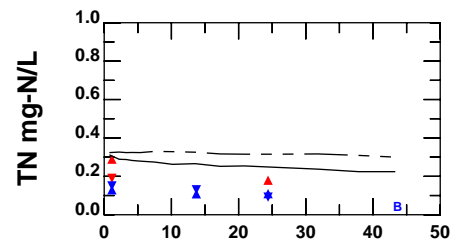
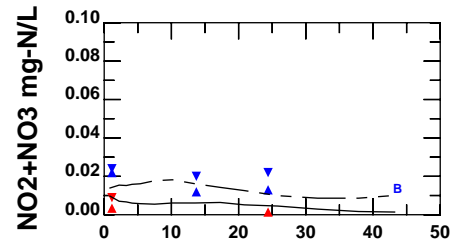
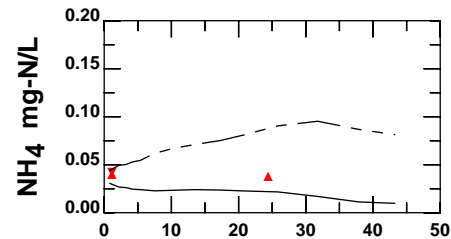
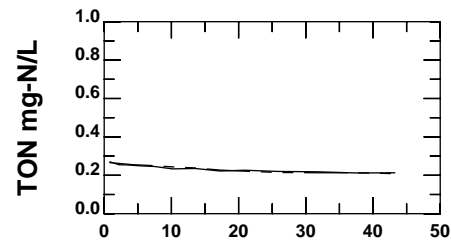
▲ ▼ Transect
T B Embayment

MODEL

— SURFACE 10-DAY MEAN
 - - - - - BOTTOM 10-DAY MEAN
 - - 10-DAY SURFACE MAX OR
 BOTTOM MIN



MILE FROM NEW JERSEY SHORE



MILE FROM NEW JERSEY SHORE

DATA

Battelle June 18-27,
1995

SURF BOT

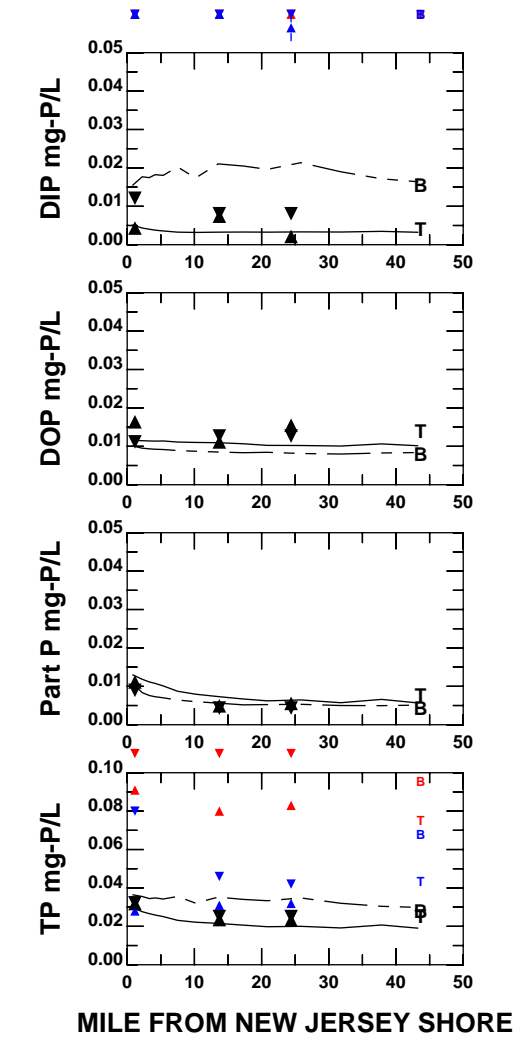
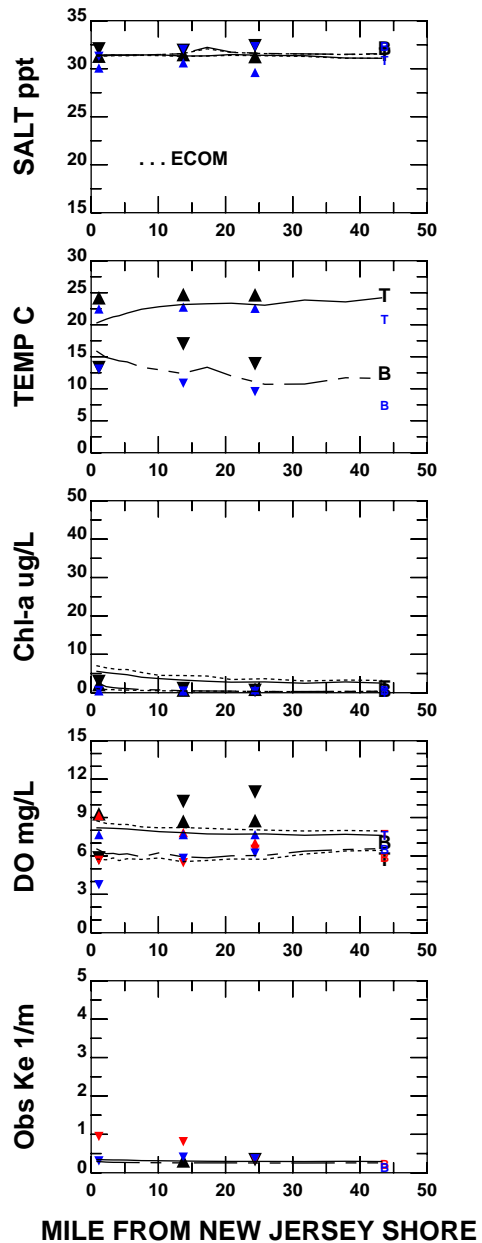
▲ ▼ Transect
T B Embayment

MODEL

— SURFACE 10-DAY MEAN

- - - - - BOTTOM 10-DAY MEAN

- . - . - . 10-DAY SURFACE MAX OR
BOTTOM MIN



DATA

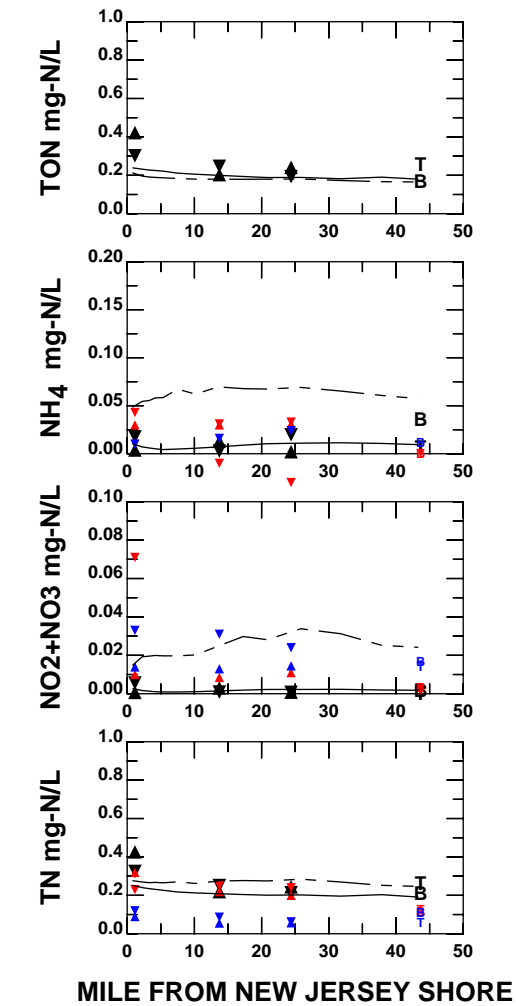
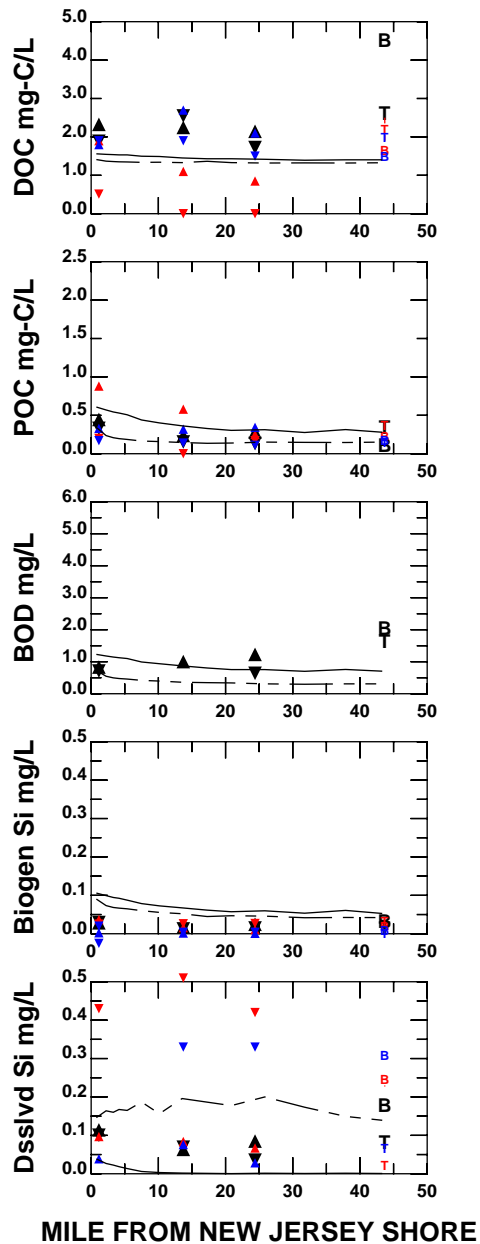
Battelle July 20-Aug 2,
1995

SURF BOT

▲ ▼ Transect
T B Embayment

MODEL

— SURFACE 10-DAY MEAN
 - - - - - BOTTOM 10-DAY MEAN
 - - - 10-DAY SURFACE MAX OR
 BOTTOM MIN



DATA

Battelle July 20-Aug 2,
1995

SURF BOT

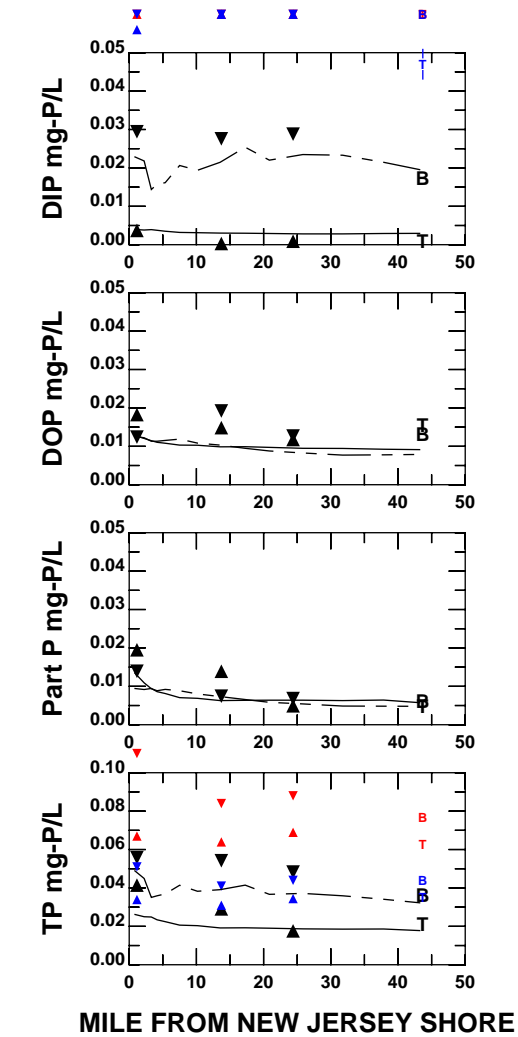
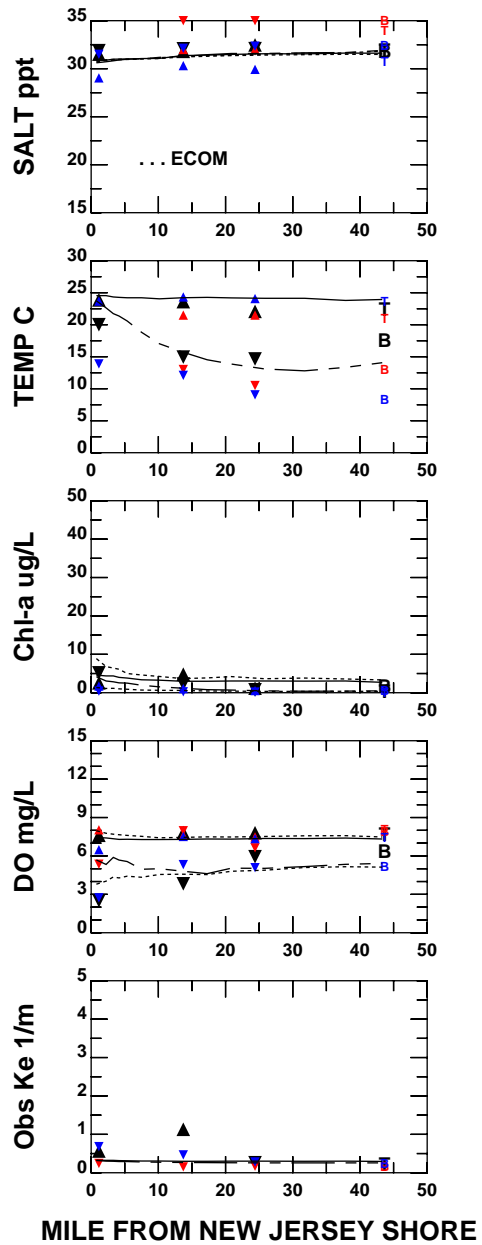
▲ ▼ Transect
T B Embayment

MODEL

—— SURFACE 10-DAY MEAN

----- BOTTOM 10-DAY MEAN

- - - 10-DAY SURFACE MAX OR
BOTTOM MIN



DATA

Battelle Aug 20-29,1995

SURF BOT

▲ ▼ Transect

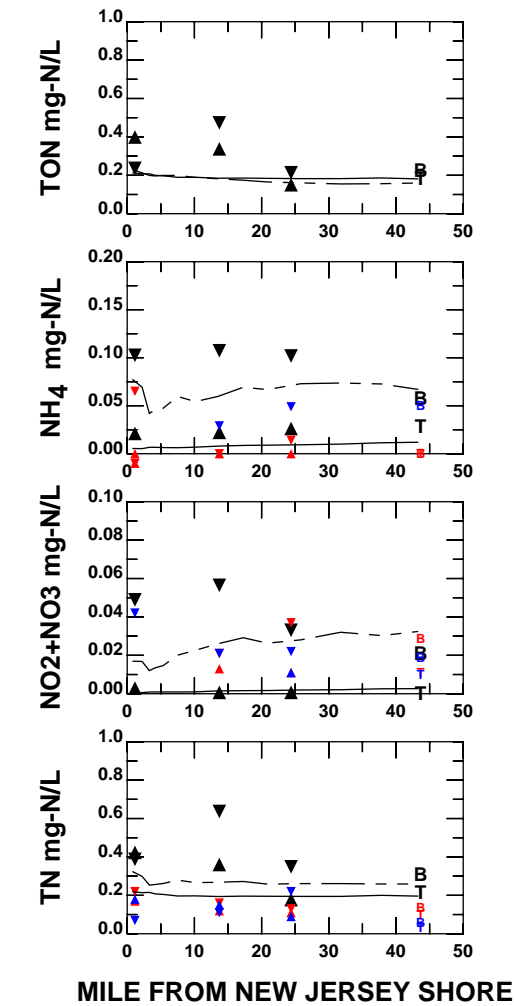
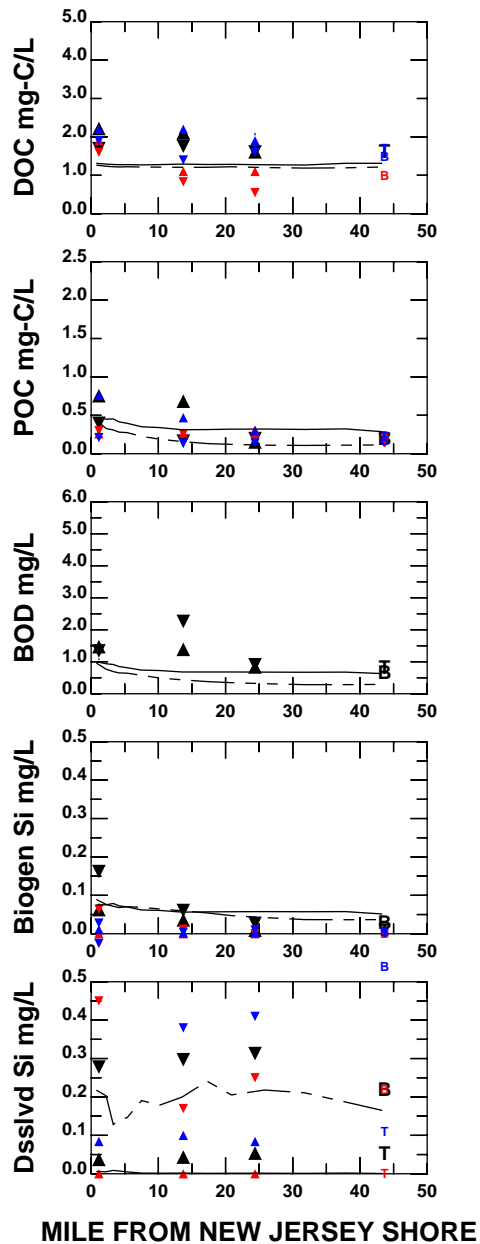
T B Embayment

MODEL

— SURFACE 10-DAY MEAN

- - - - - BOTTOM 10-DAY MEAN

- - - - - 10-DAY SURFACE MAX OR
BOTTOM MIN



DATA

Battelle Aug 20-29, 1995

SURF BOT

▲ ▼ Transect

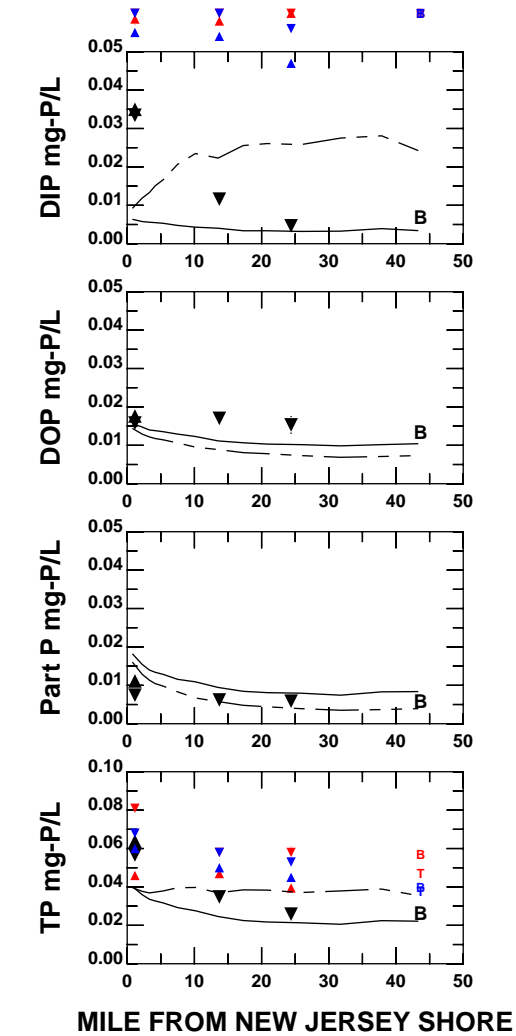
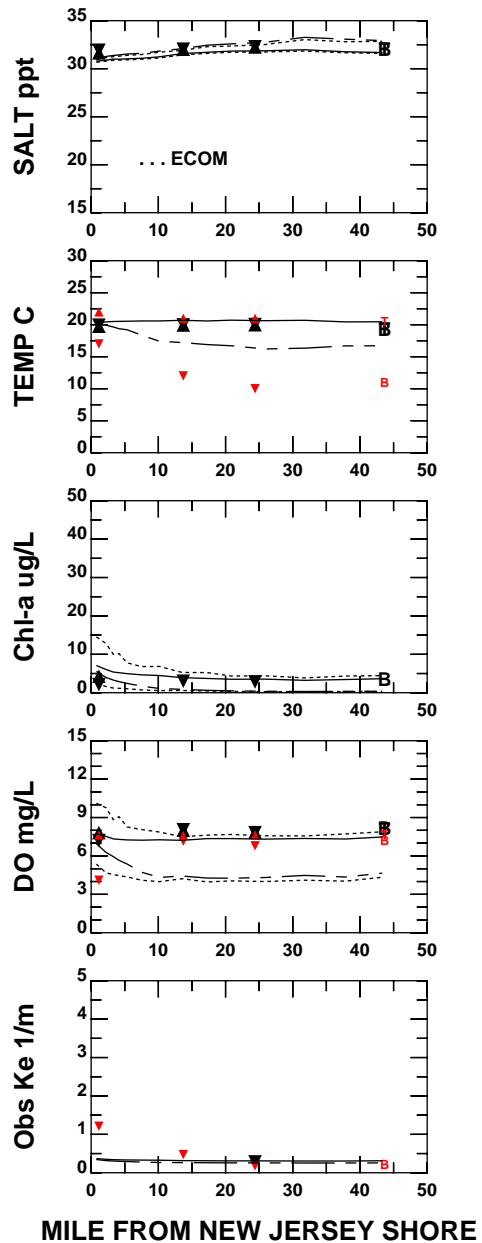
T B Embayment

MODEL

— SURFACE 10-DAY MEAN

- - - - - BOTTOM 10-DAY MEAN

- - - - - 10-DAY SURFACE MAX OR
BOTTOM MIN



DATA

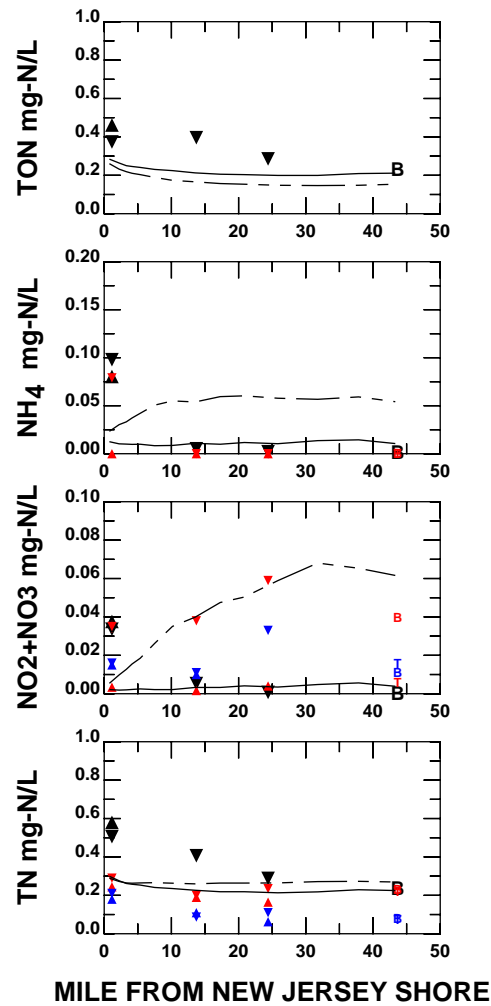
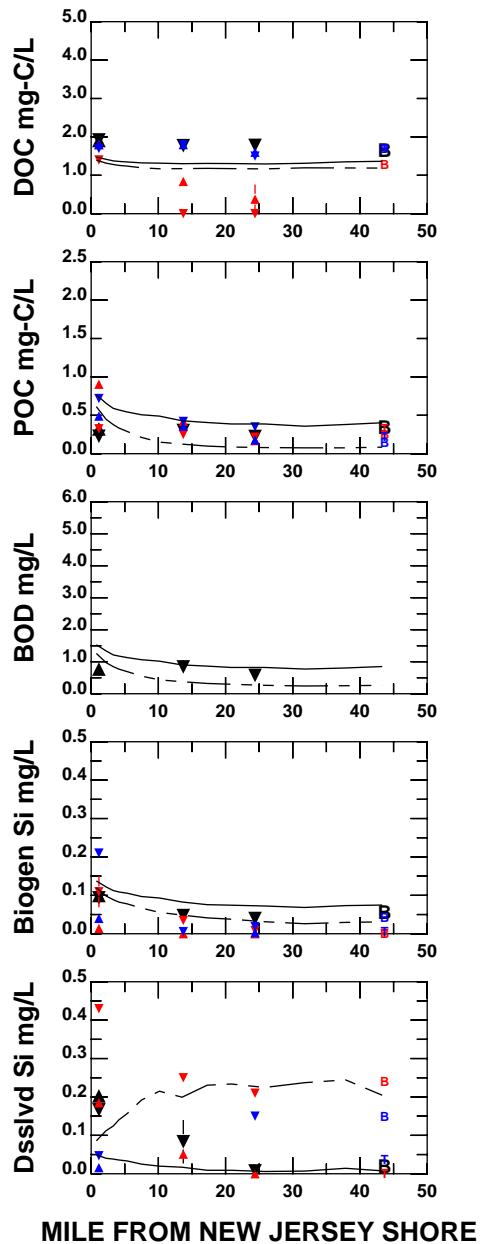
Battelle Sep 23-Oct 2,
1995

SURF BOT

▲ ▼ Transect
T B Embayment

MODEL

— SURFACE 10-DAY MEAN
 - - - - - BOTTOM 10-DAY MEAN
 - - - 10-DAY SURFACE MAX OR
 BOTTOM MIN



DATA

Battelle Sep 23-Oct 2,
1995

SURF BOT

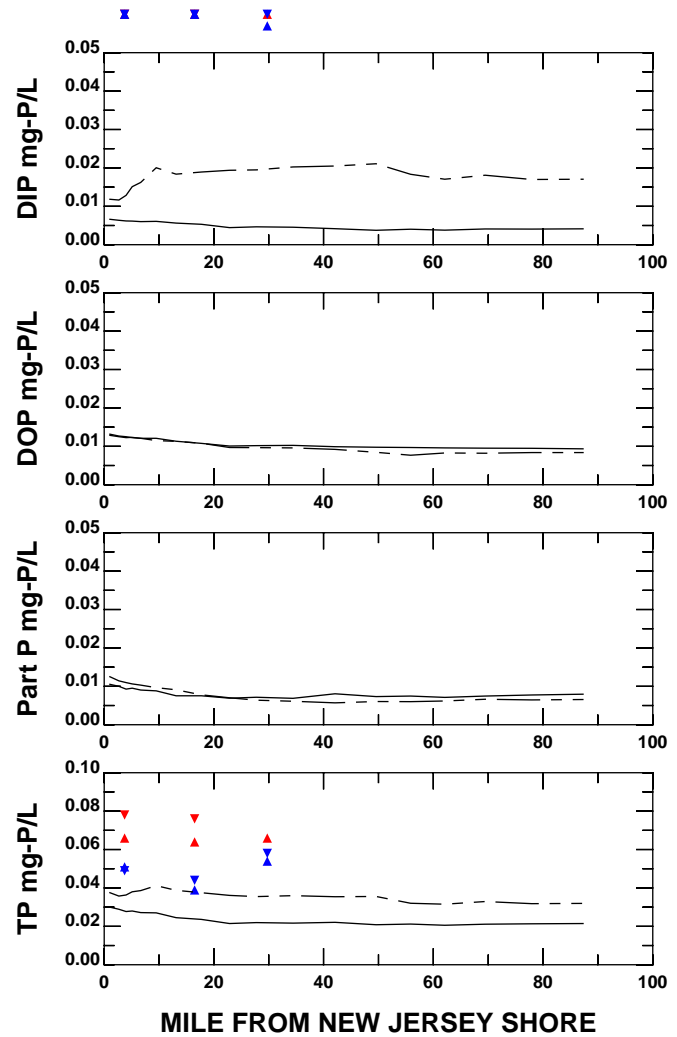
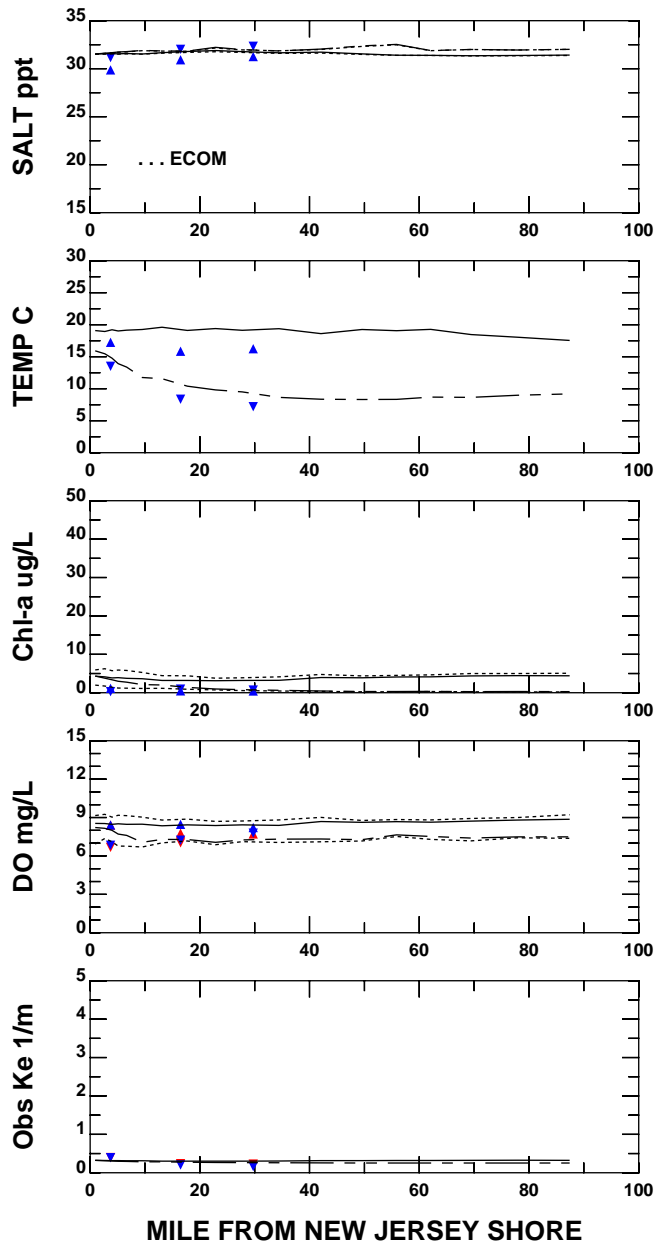
▲ ▼ Transect
T B Embayment

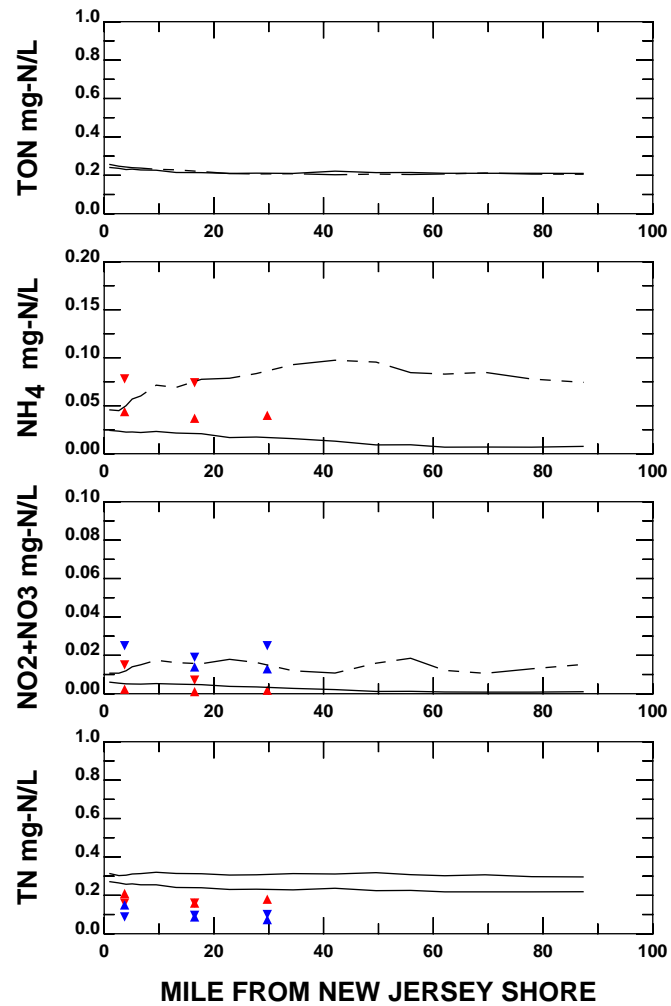
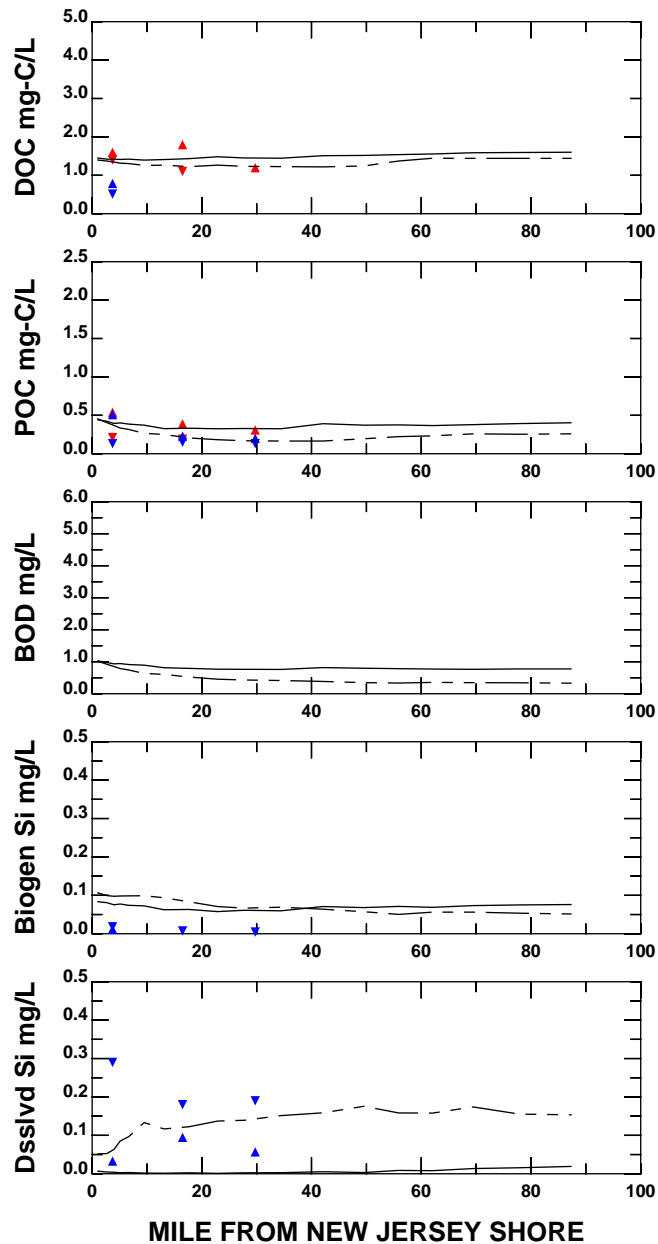
MODEL

— SURFACE 10-DAY MEAN

- - - - - BOTTOM 10-DAY MEAN

- - - - - 10-DAY SURFACE MAX OR
BOTTOM MIN





DATA

Battelle June 18-27,
1995

SURF BOT

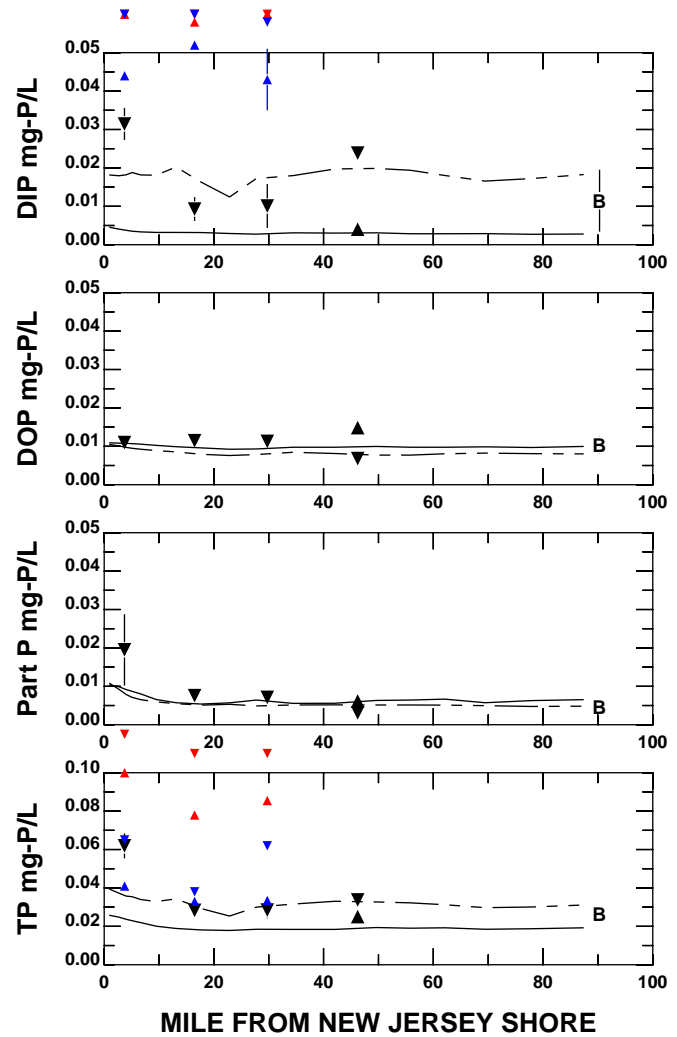
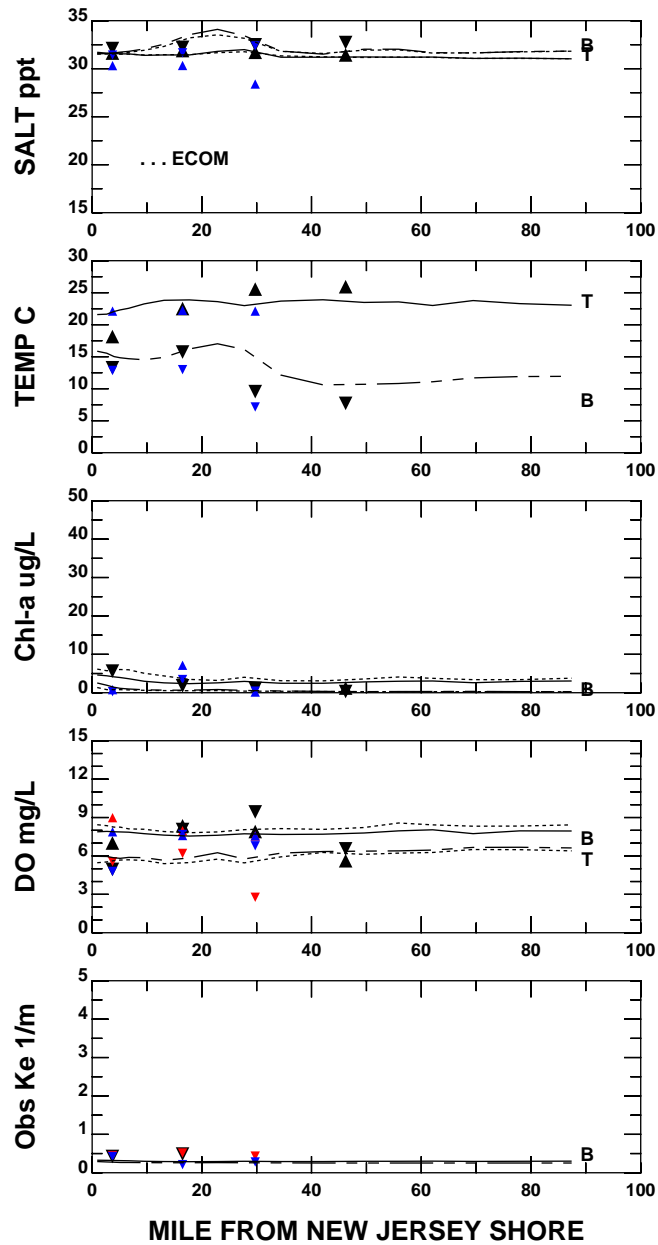
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T B Embayment

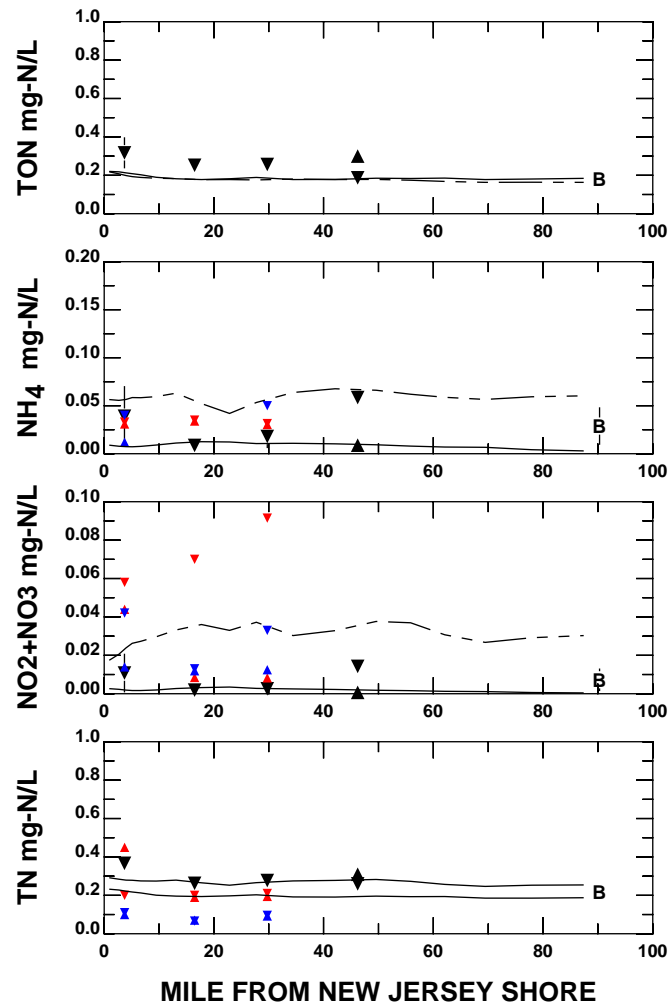
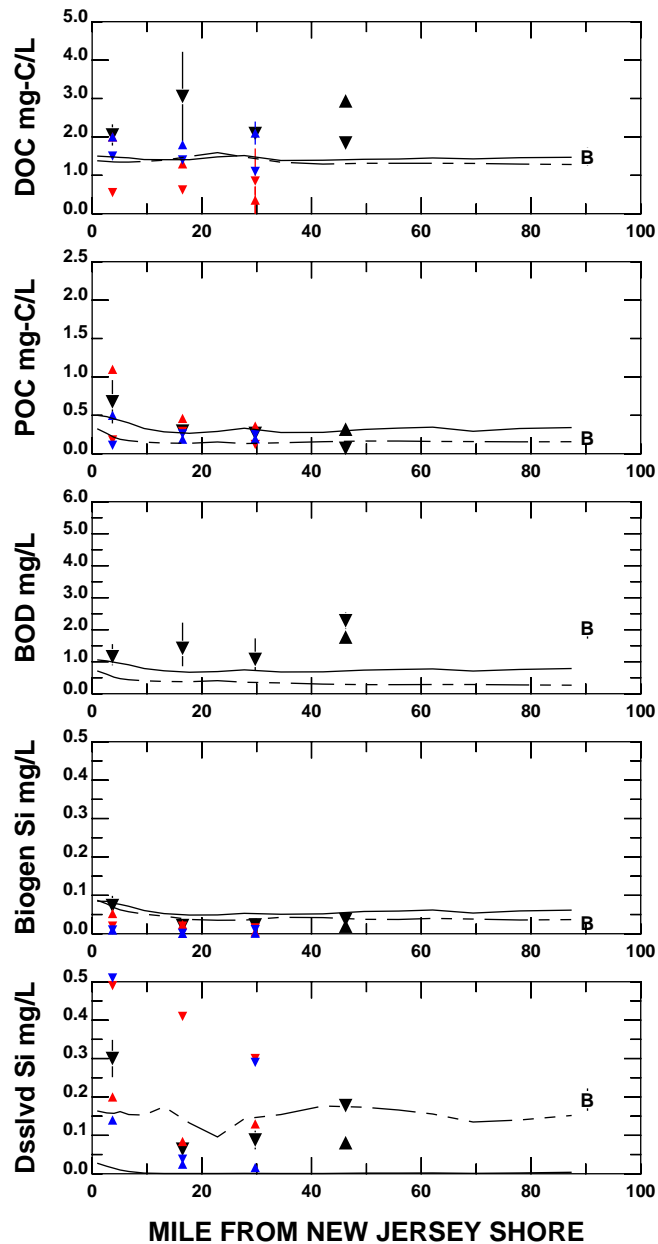
MODEL

— SURFACE 10-DAY MEAN

- - - BOTTOM 10-DAY MEAN

- · - 10-DAY SURFACE MAX OR
BOTTOM MIN





DATA

Battelle July 20-Aug 2,
1995

SURF BOT

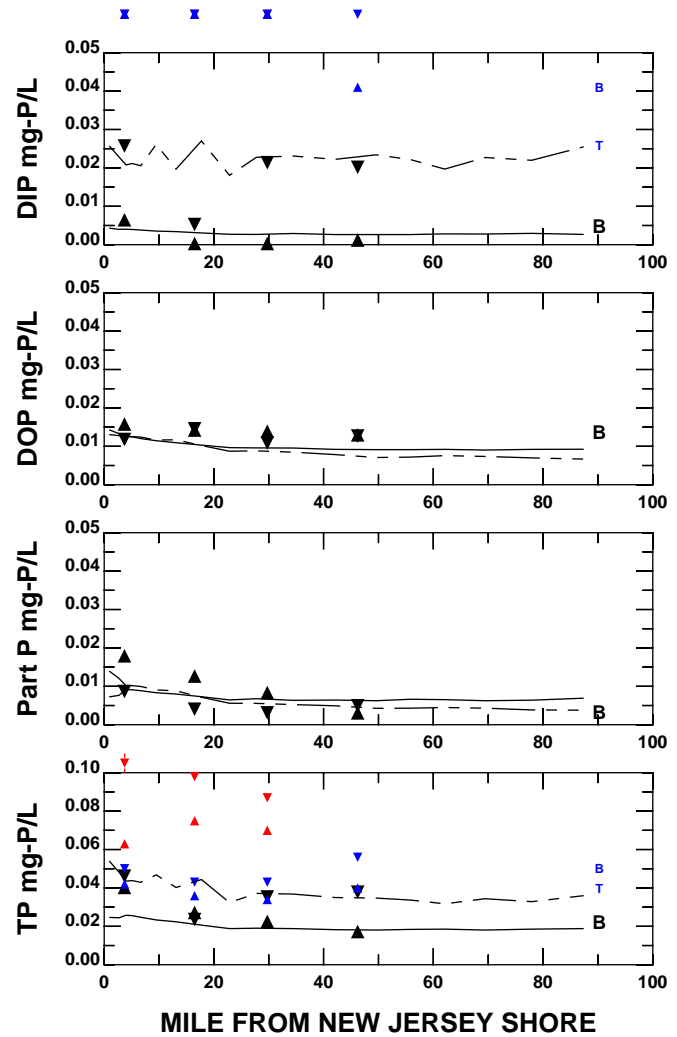
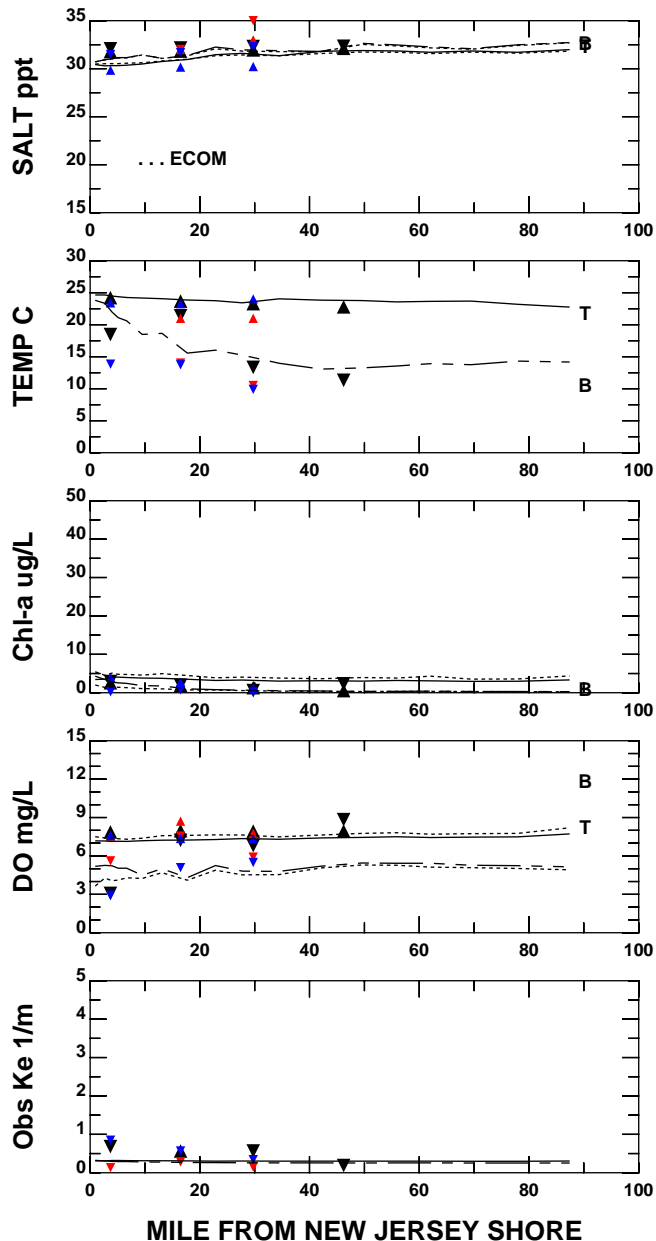
▲ ▼ Transect
T B Embayment

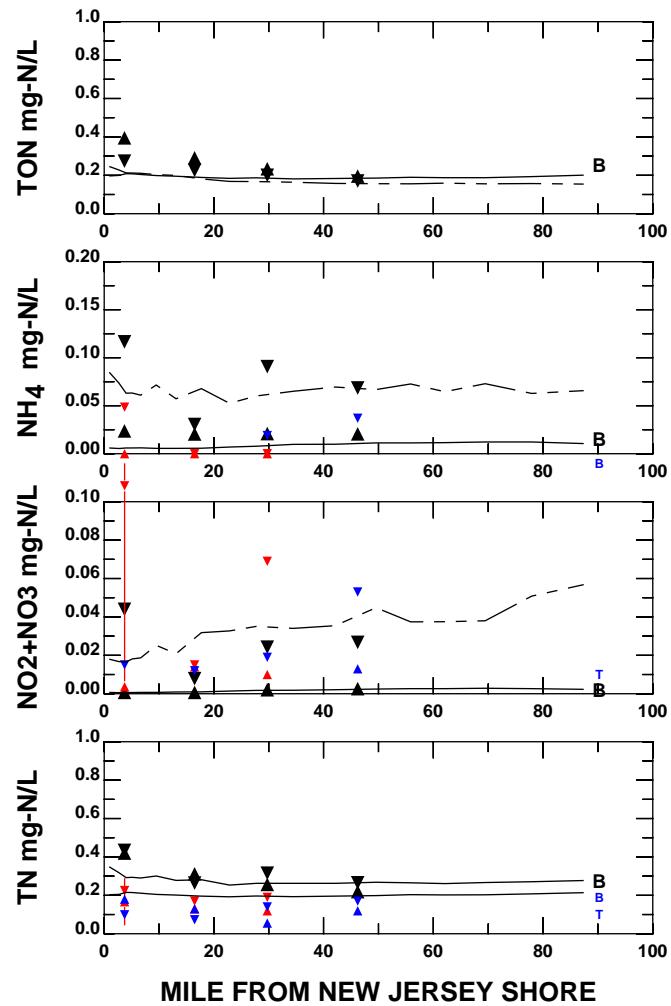
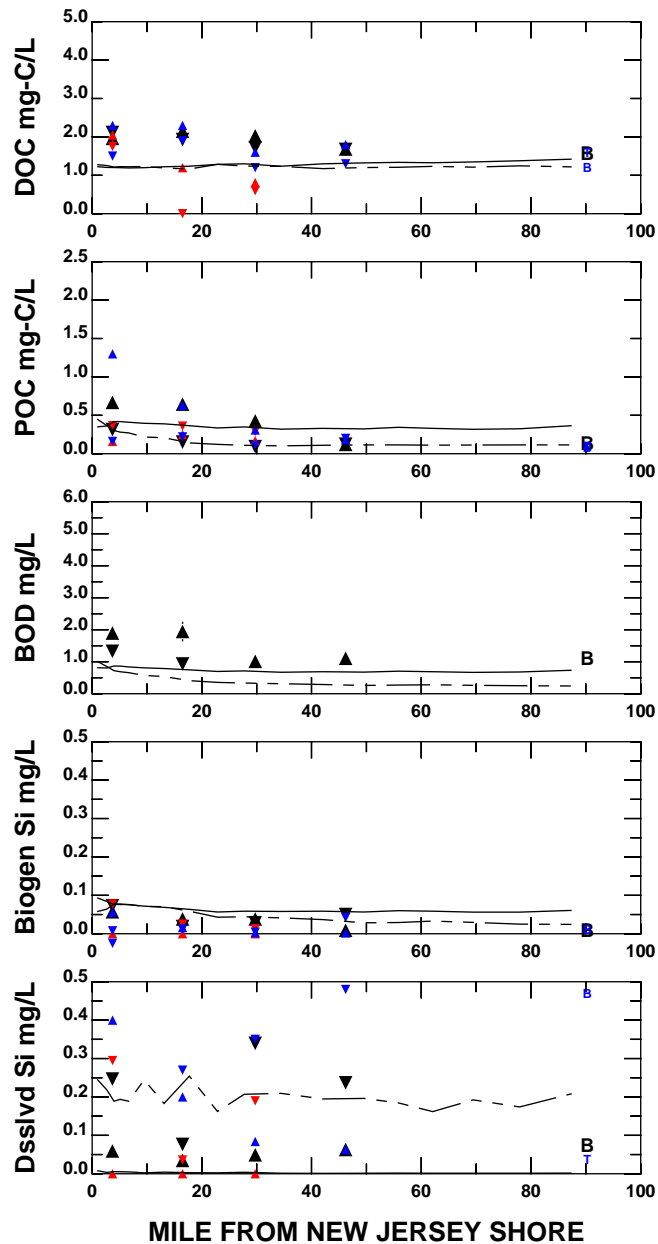
MODEL

— SURFACE 10-DAY MEAN

- - - - - BOTTOM 10-DAY MEAN

- - - - - 10-DAY SURFACE MAX OR
BOTTOM MIN





DATA

Battelle Aug 20-29, 1995

SURF BOT

▲ ▼ Transect

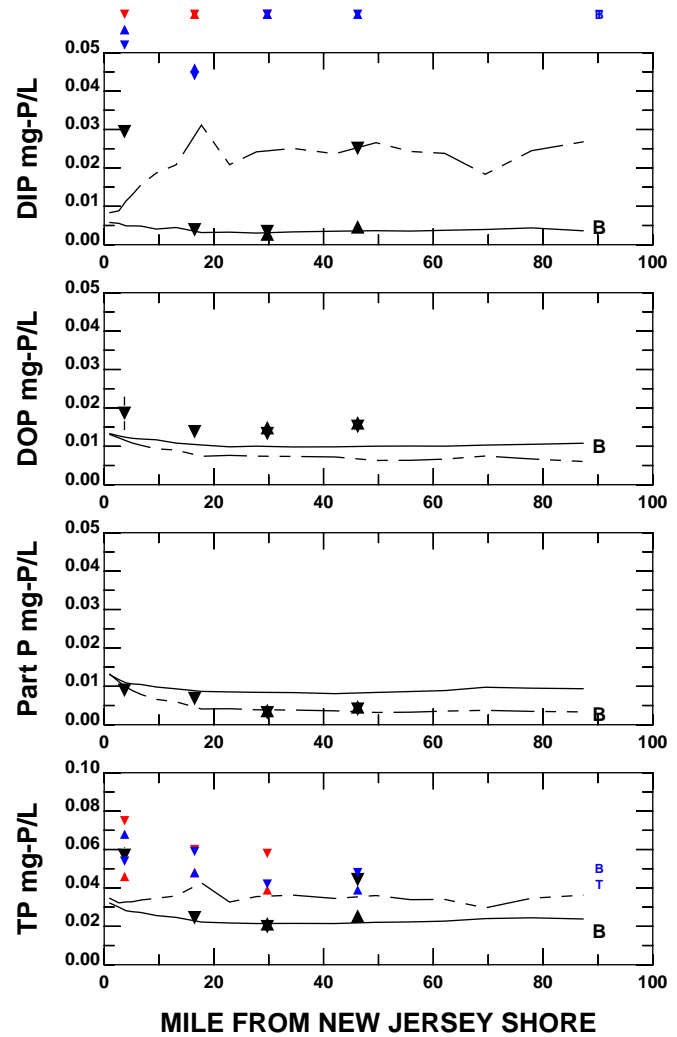
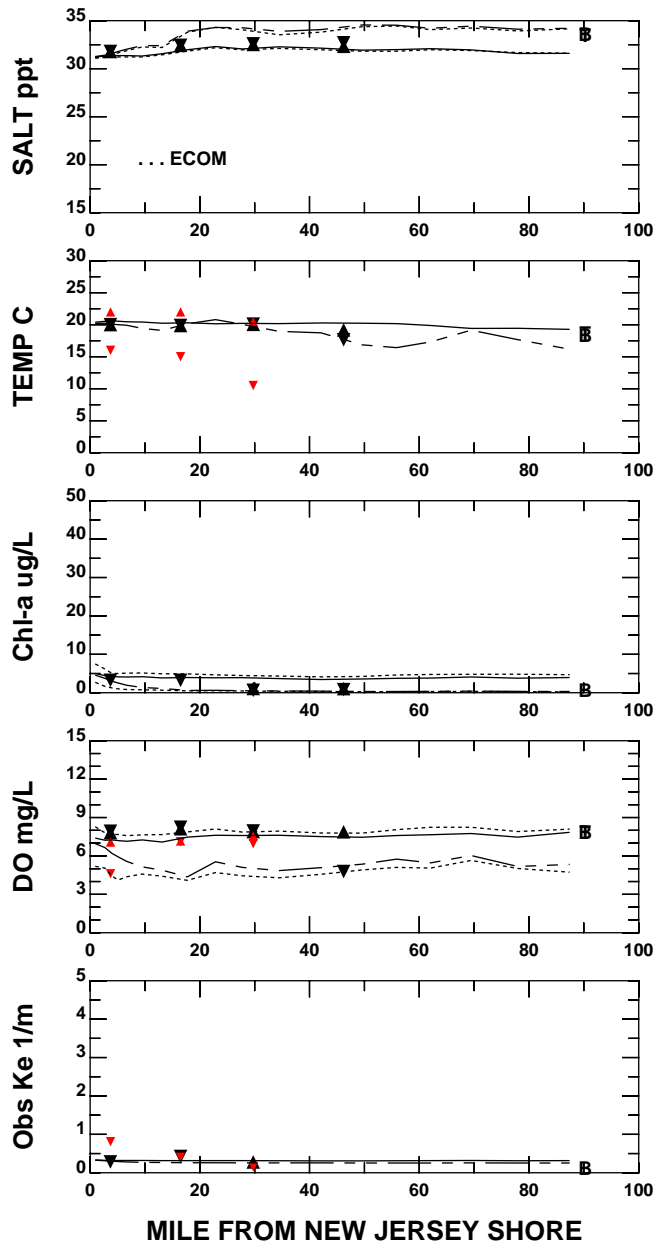
T B Embayment

MODEL

— SURFACE 10-DAY MEAN

- - - BOTTOM 10-DAY MEAN

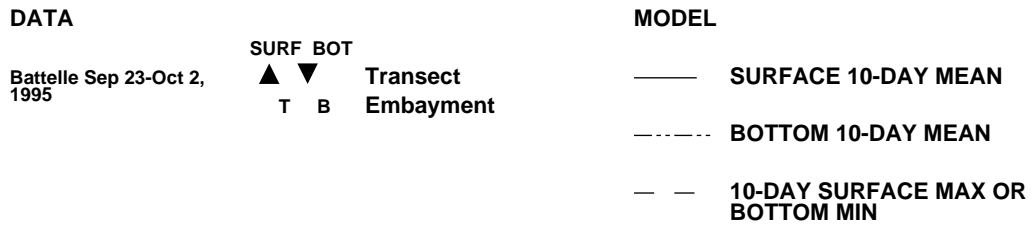
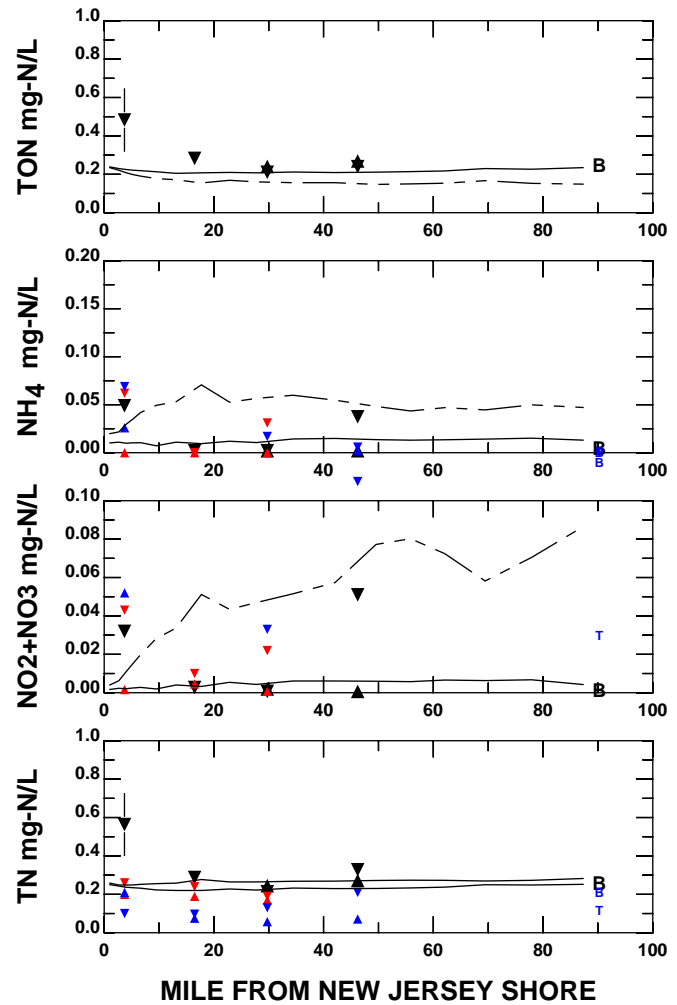
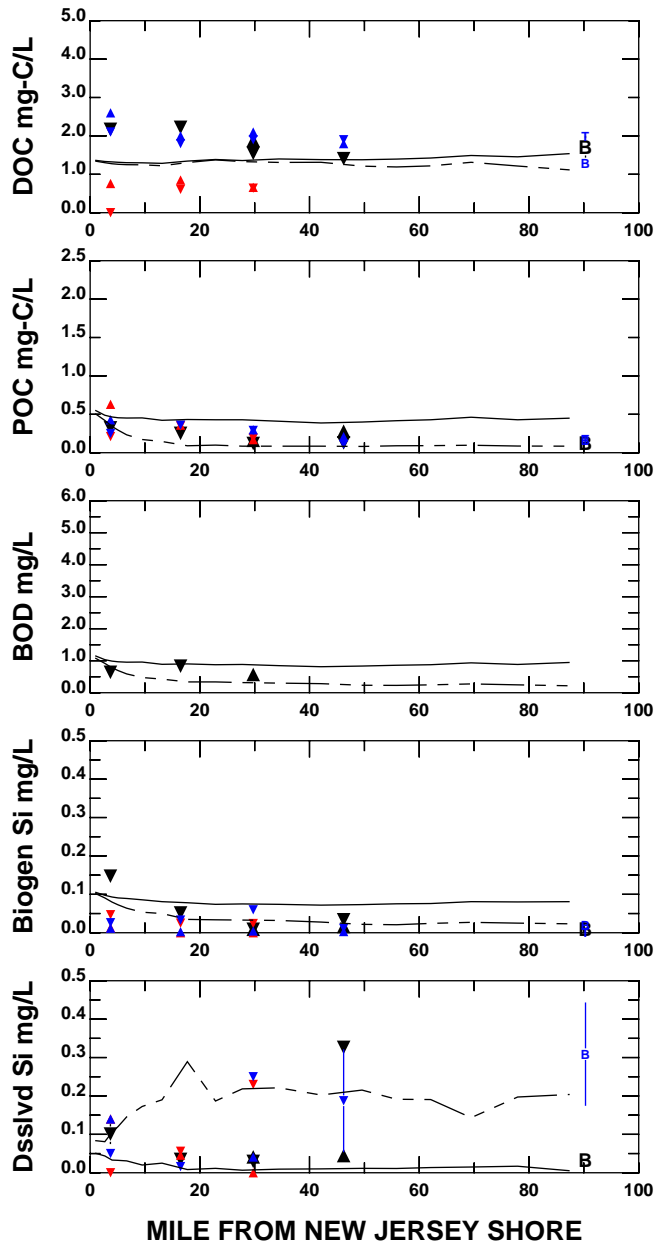
- - - 10-DAY SURFACE MAX OR
BOTTOM MIN



DATA
 Battelle Sep 23-Oct 2, 1995

SURF BOT
 ▲ ▼ Transect
 T B Embayment

MODEL
 — SURFACE 10-DAY MEAN
 - - - BOTTOM 10-DAY MEAN
 - - - 10-DAY SURFACE MAX OR BOTTOM MIN

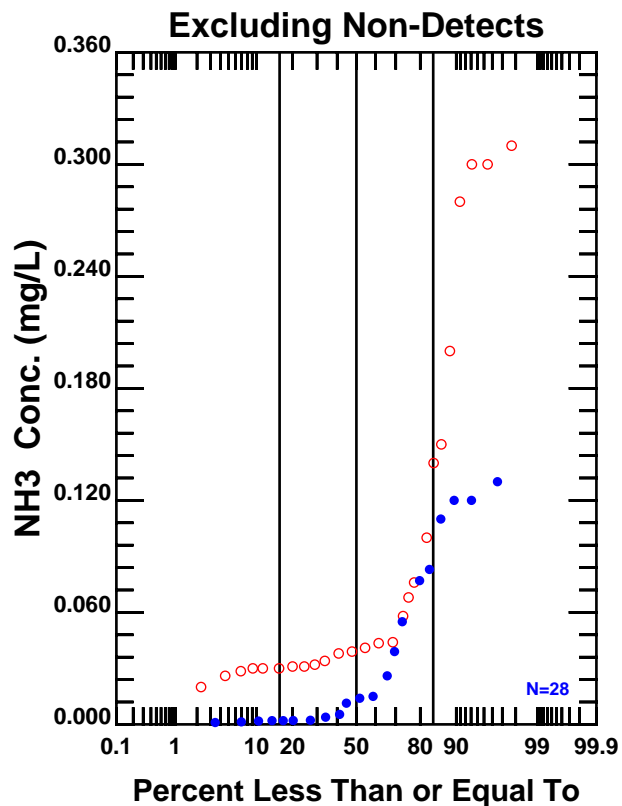
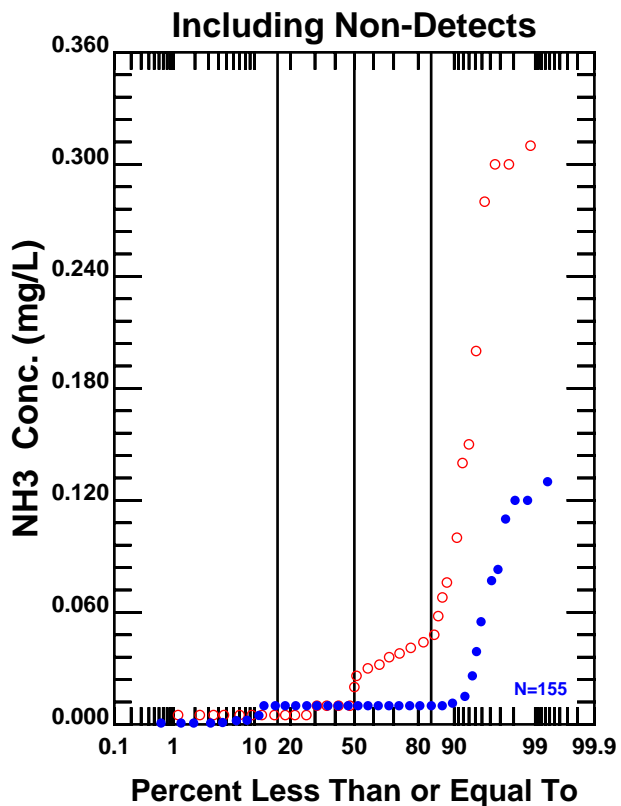


ATTACHMENT D

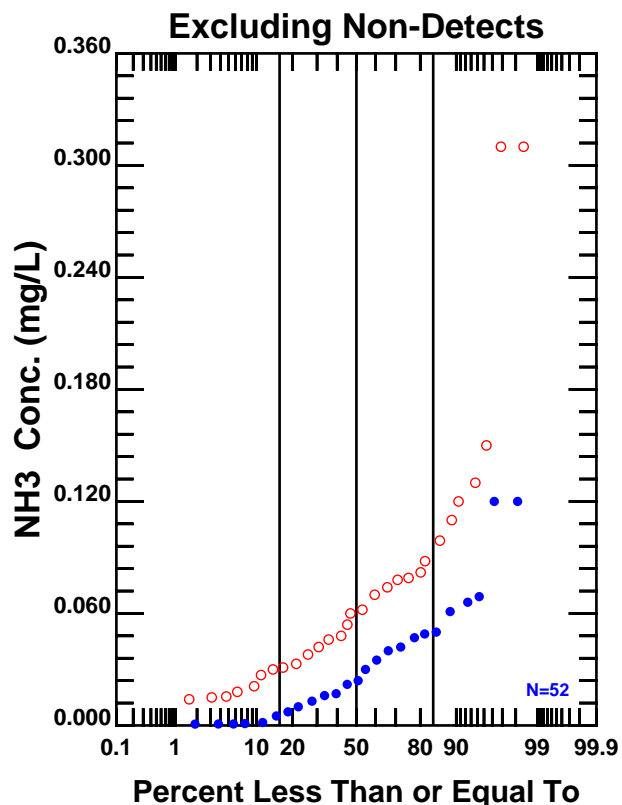
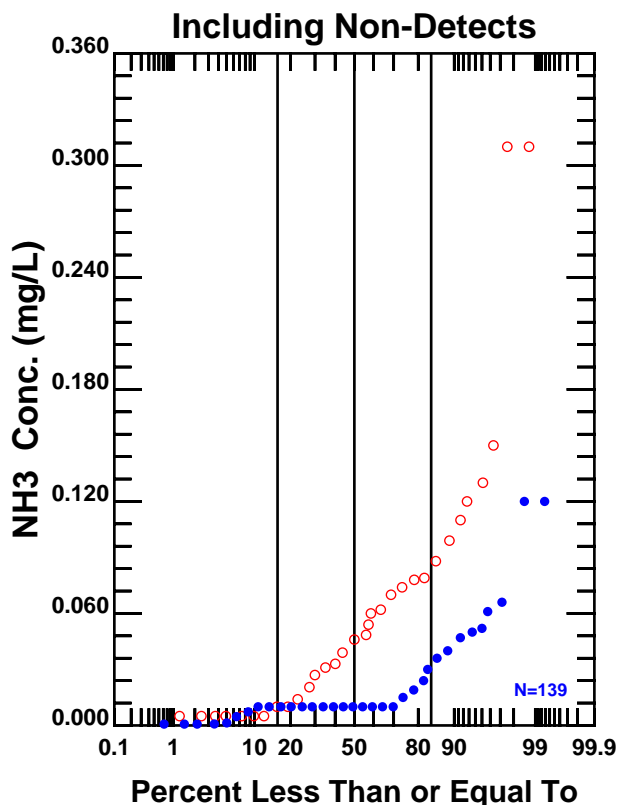
2008/2009 PROBABILITY PLOTS

(note: 2008 data shown in red and 2009 data shown in blue)

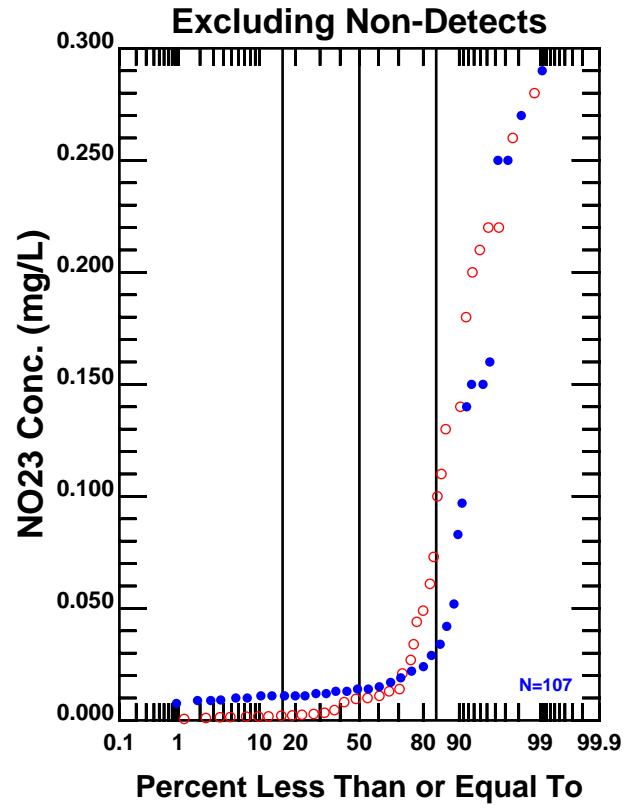
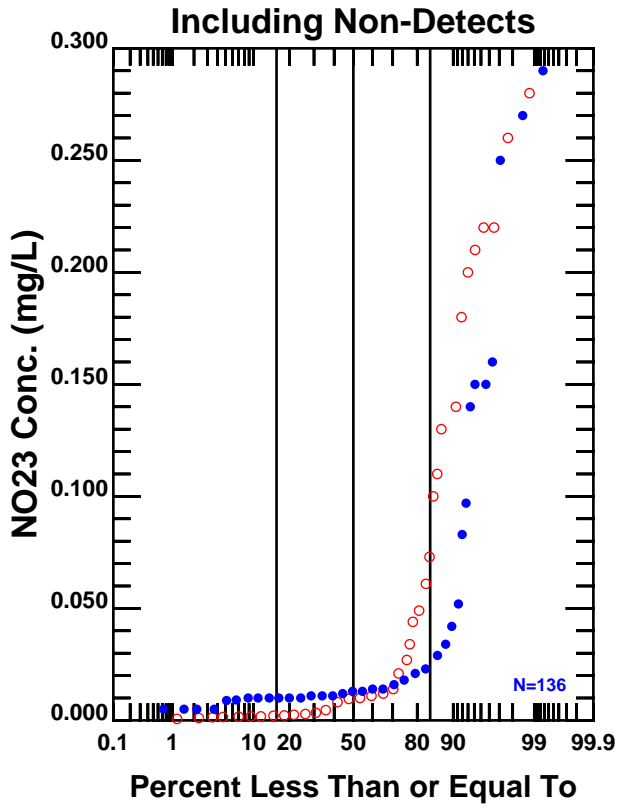
2008-2009 NY Bight Surface Observation



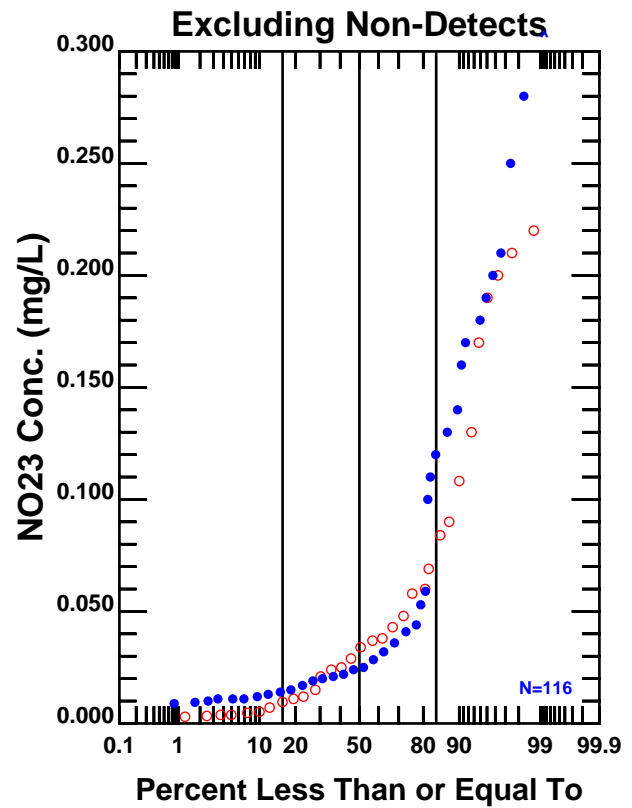
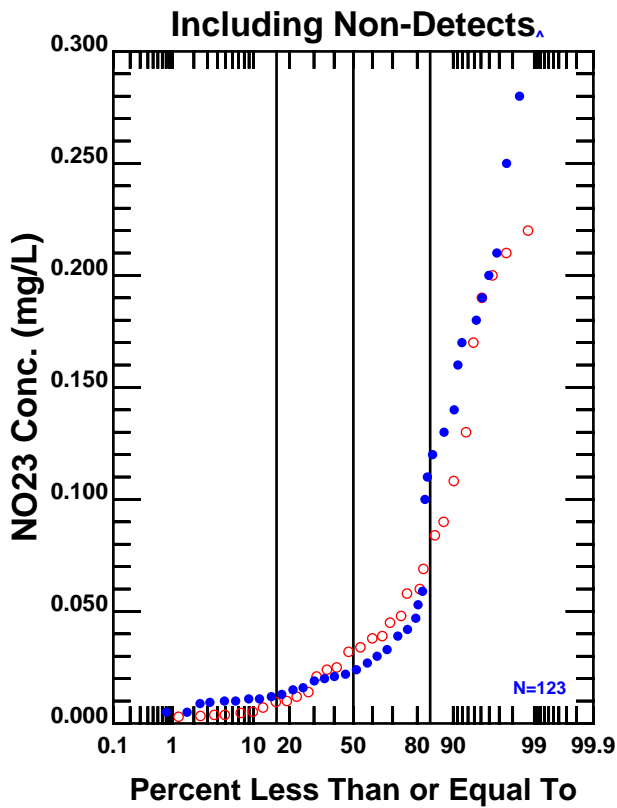
2008-2009 NY Bight Bottom Observation



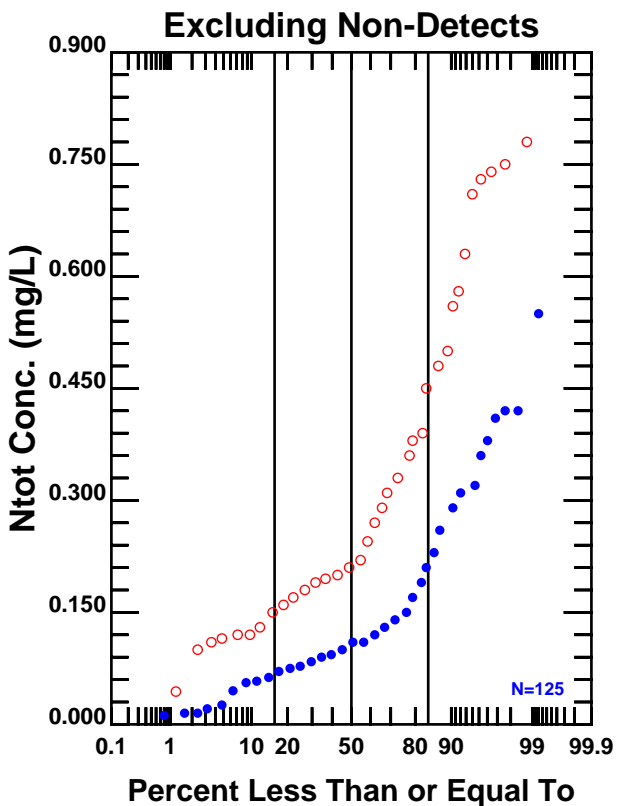
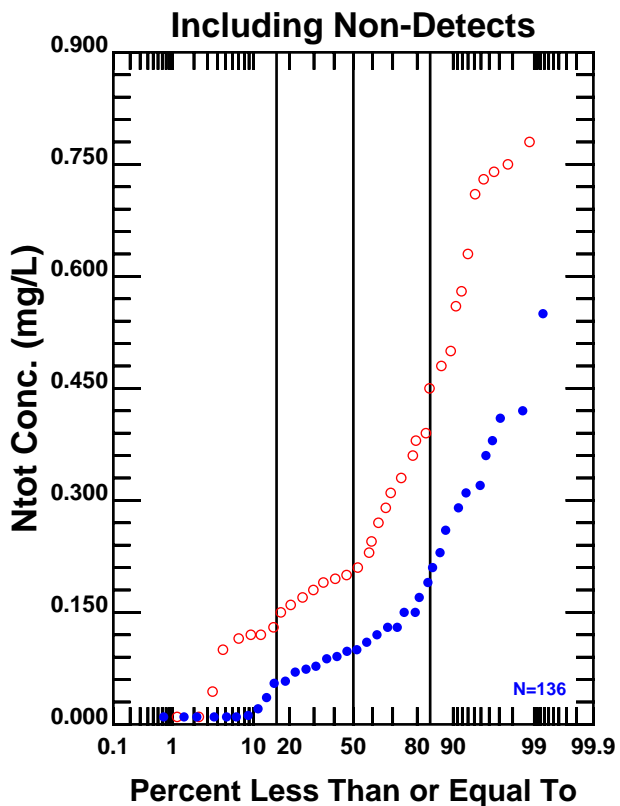
2008-2009 NY Bight Surface Observation



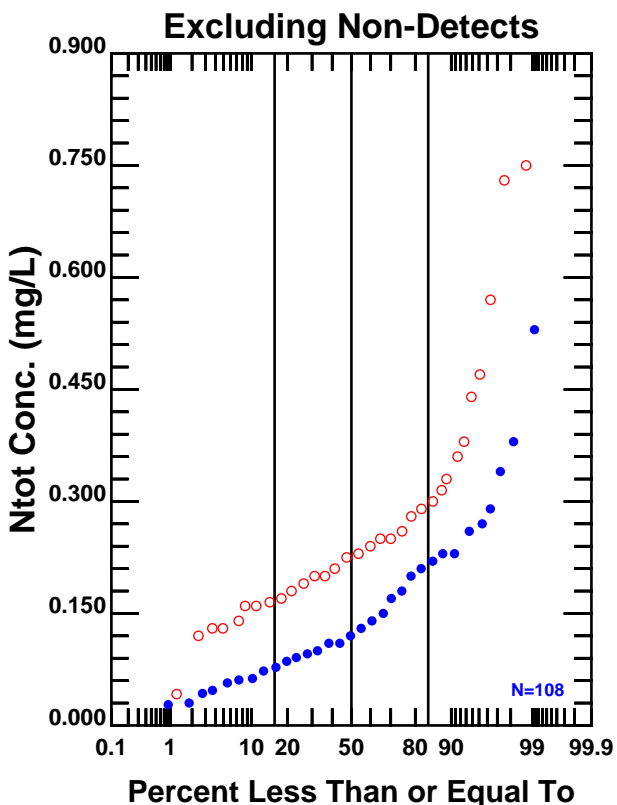
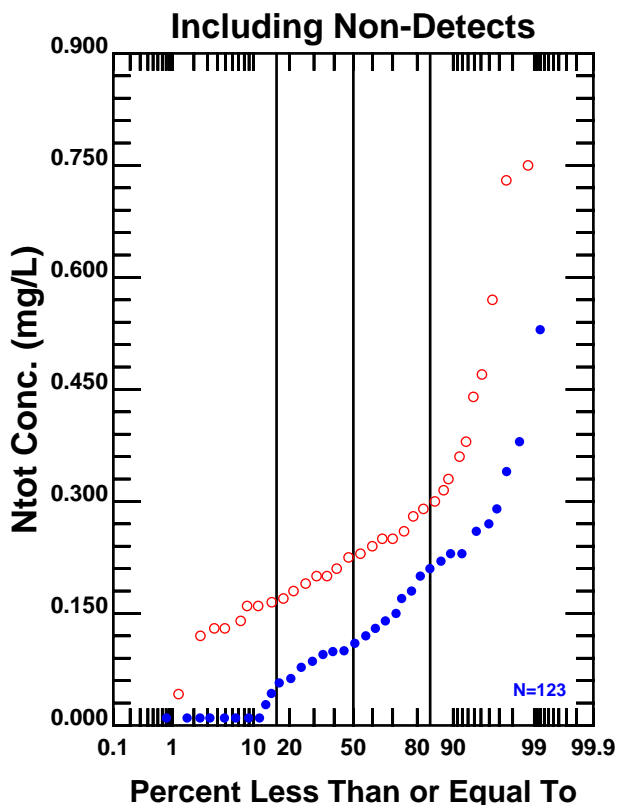
2008-2009 NY Bight Bottom Observation



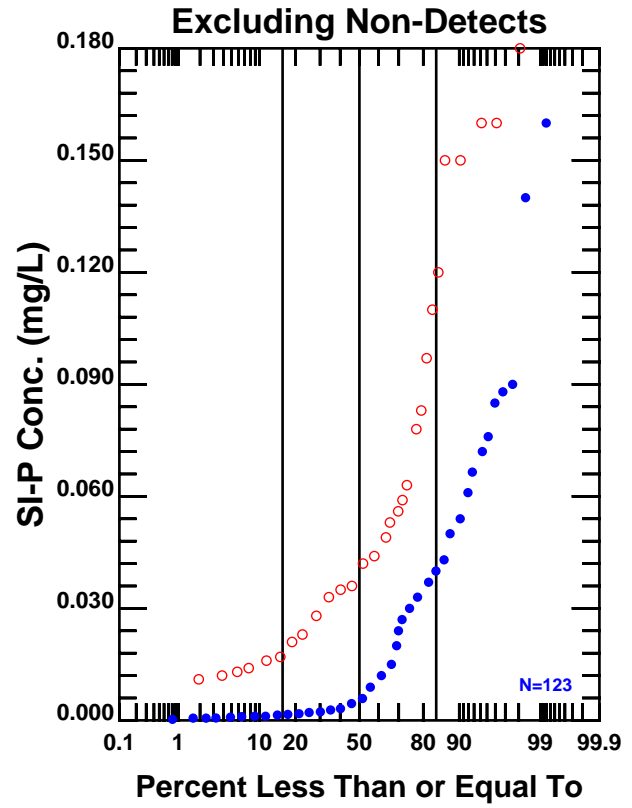
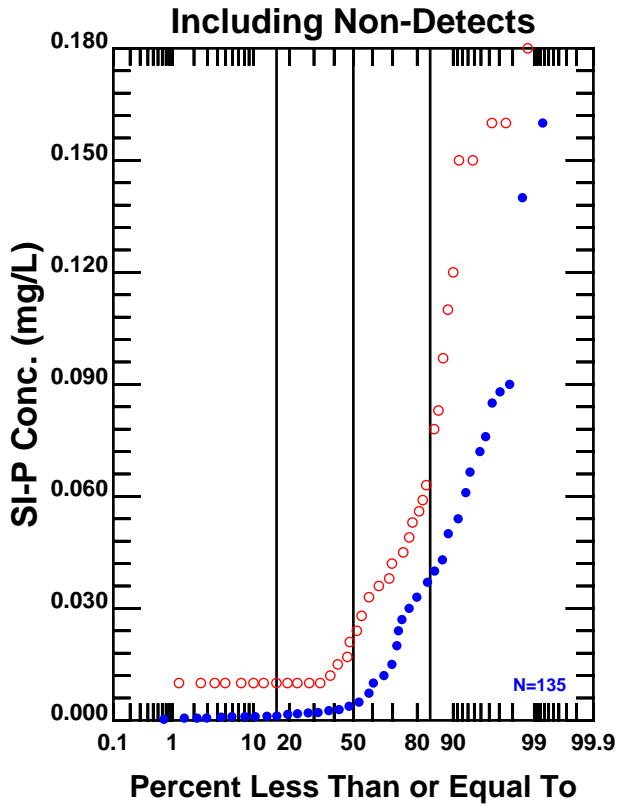
2008-2009 NY Bight Surface Observation



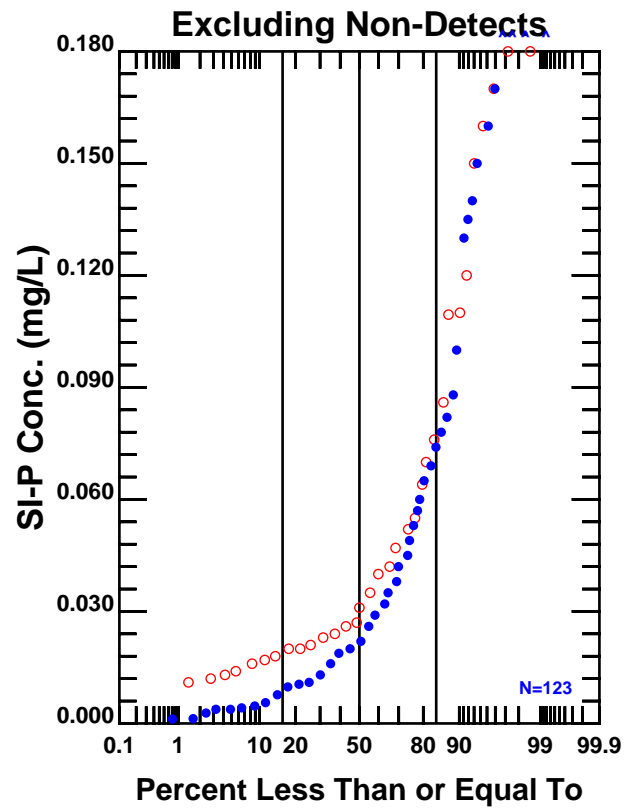
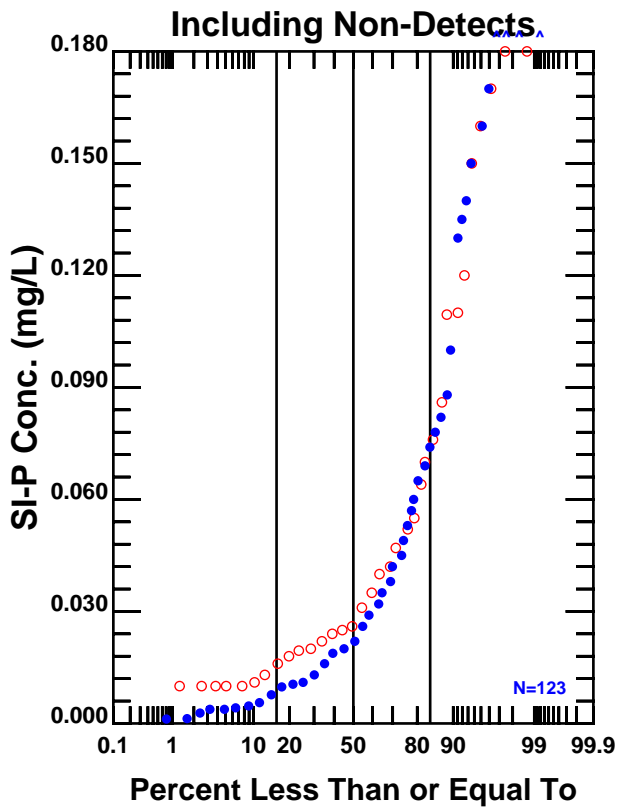
2008-2009 NY Bight Bottom Observation



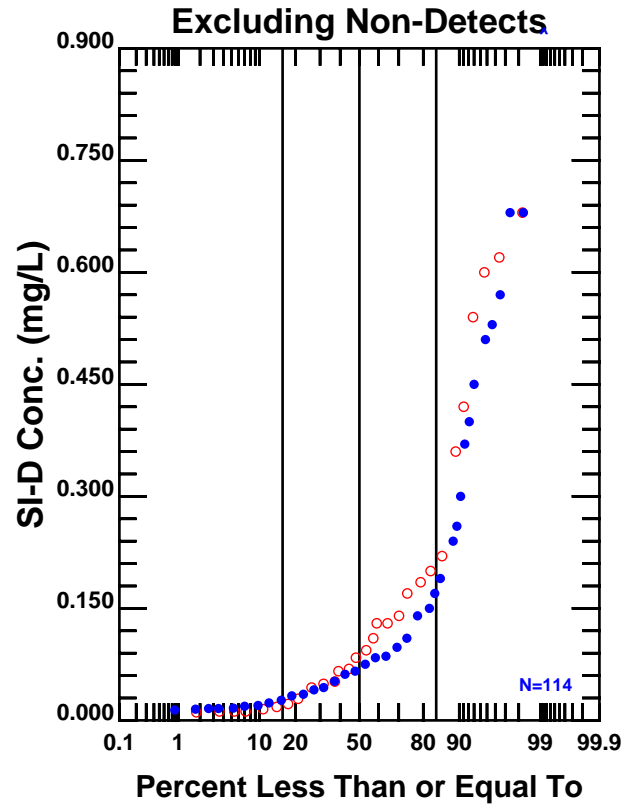
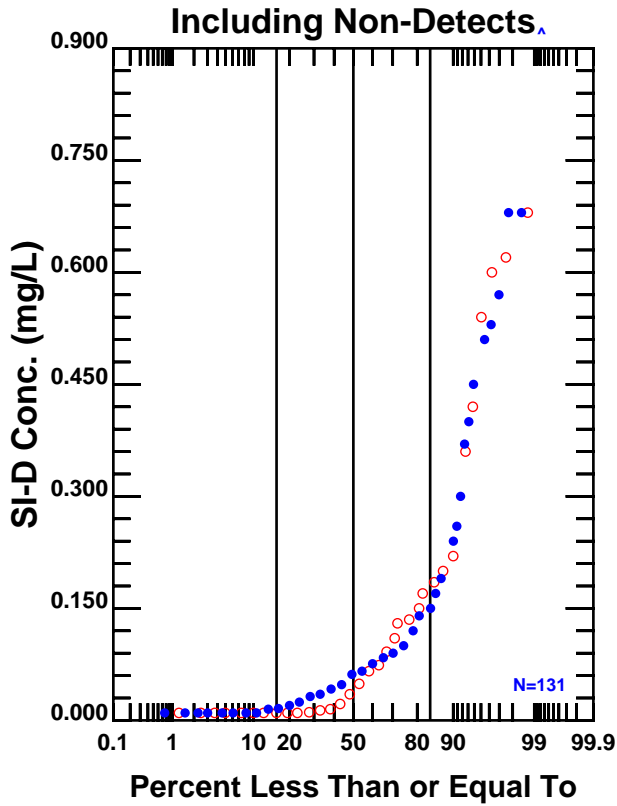
2008-2009 NY Bight Surface Observation



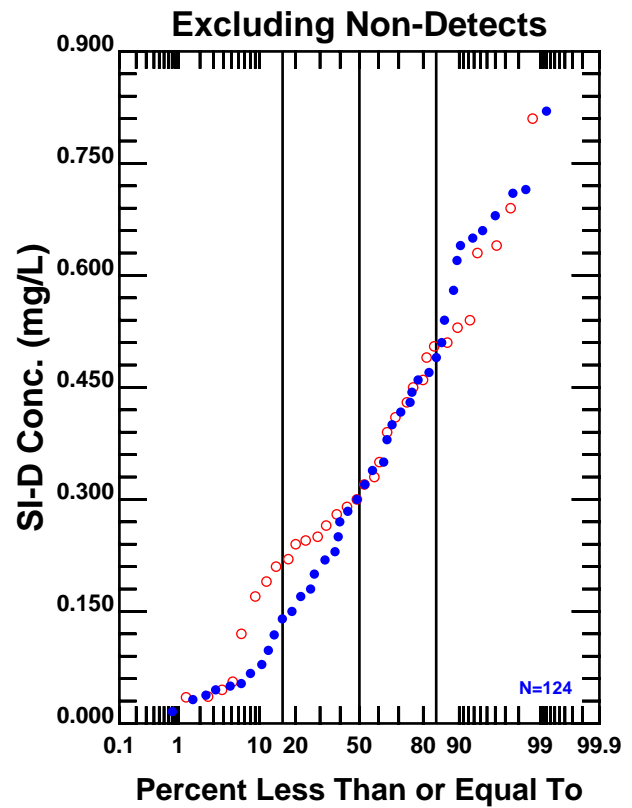
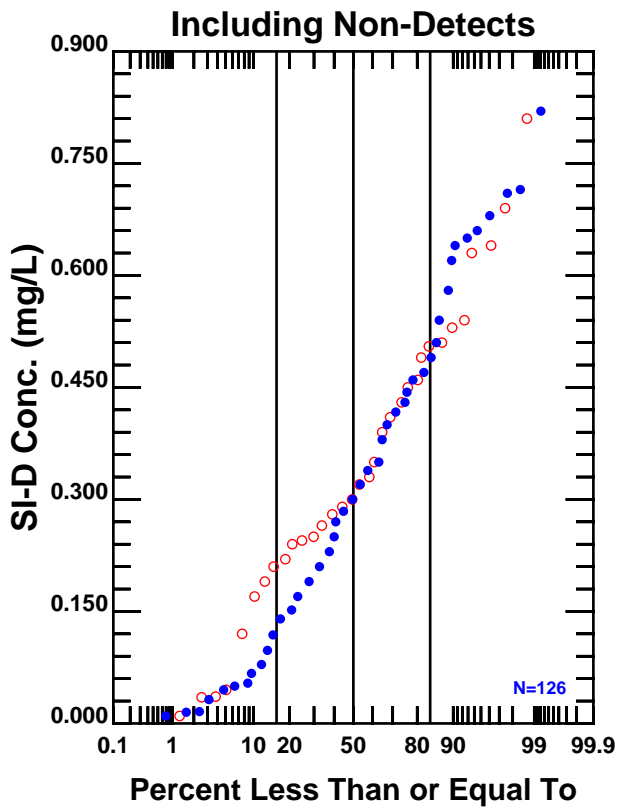
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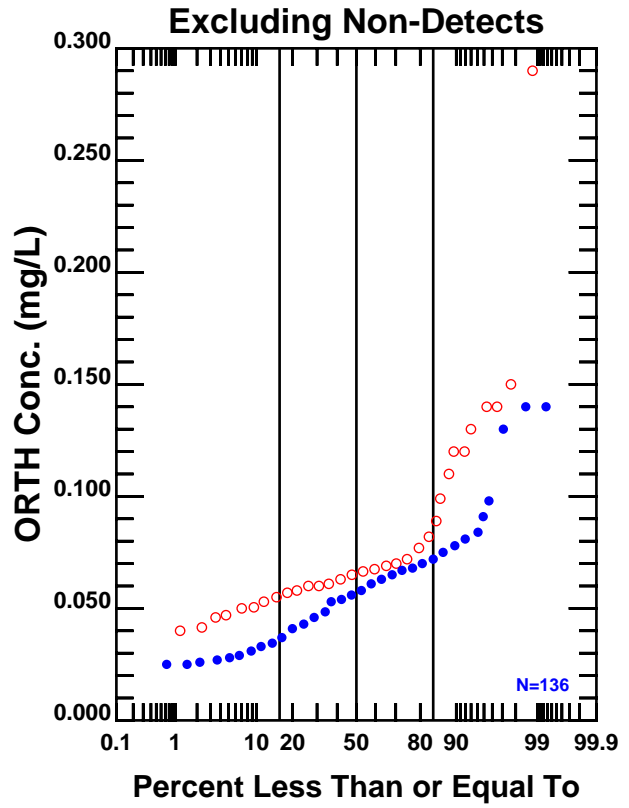
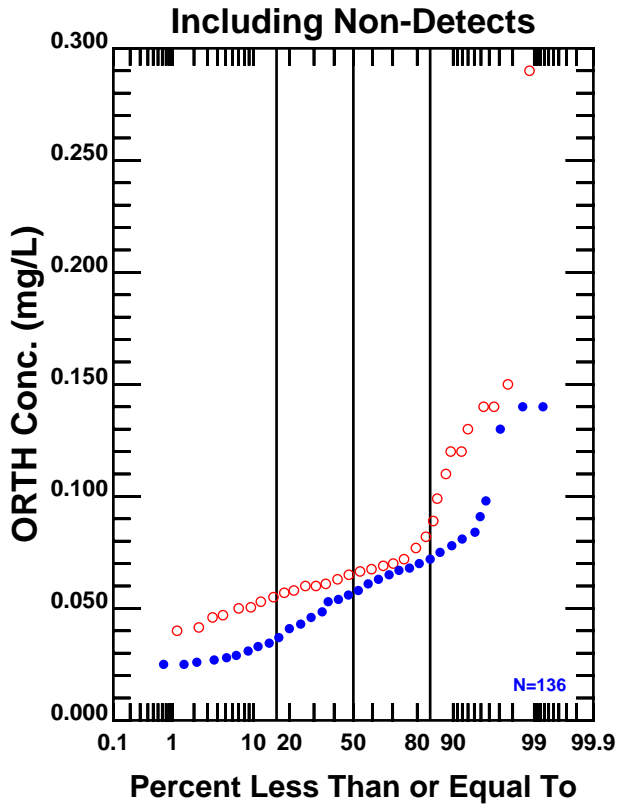
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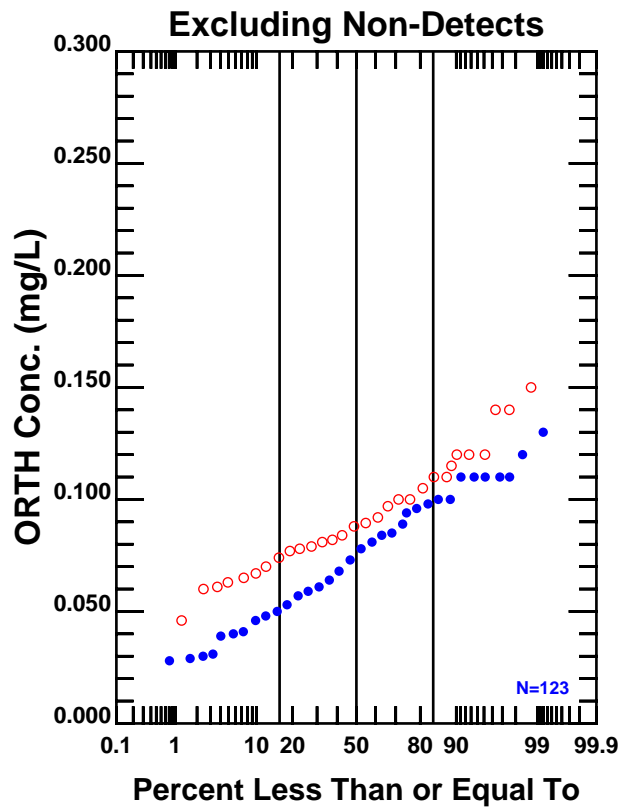
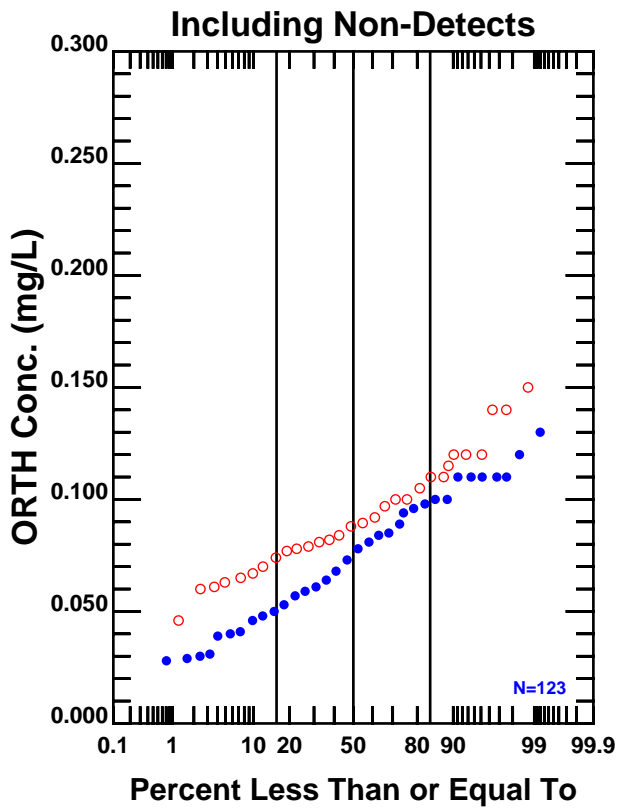
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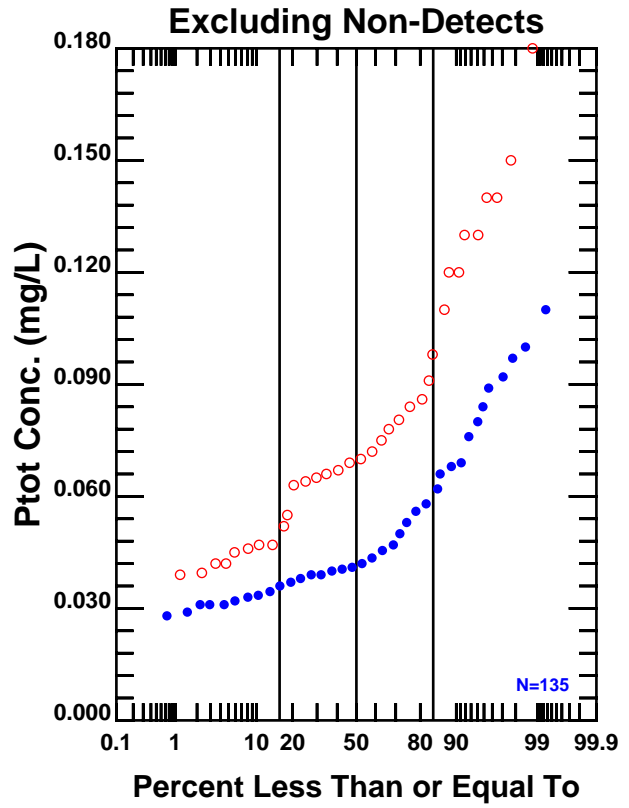
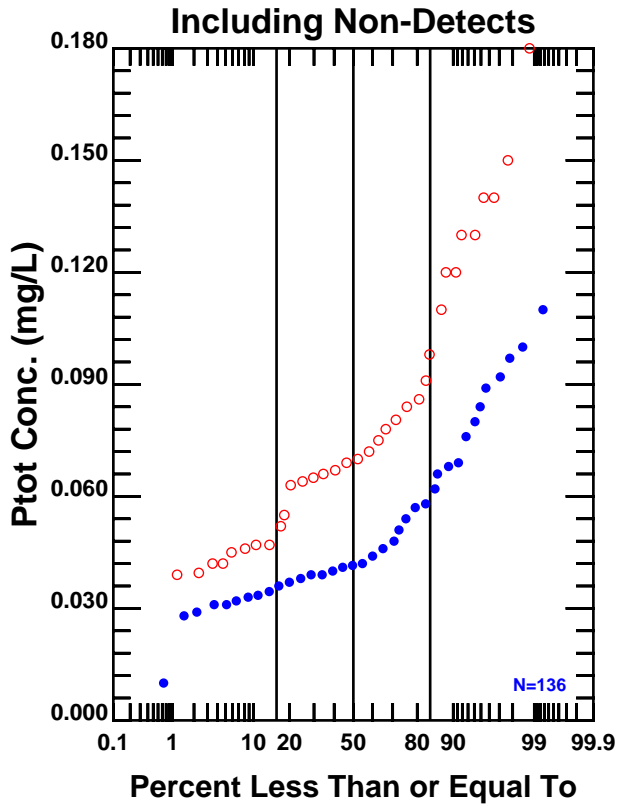
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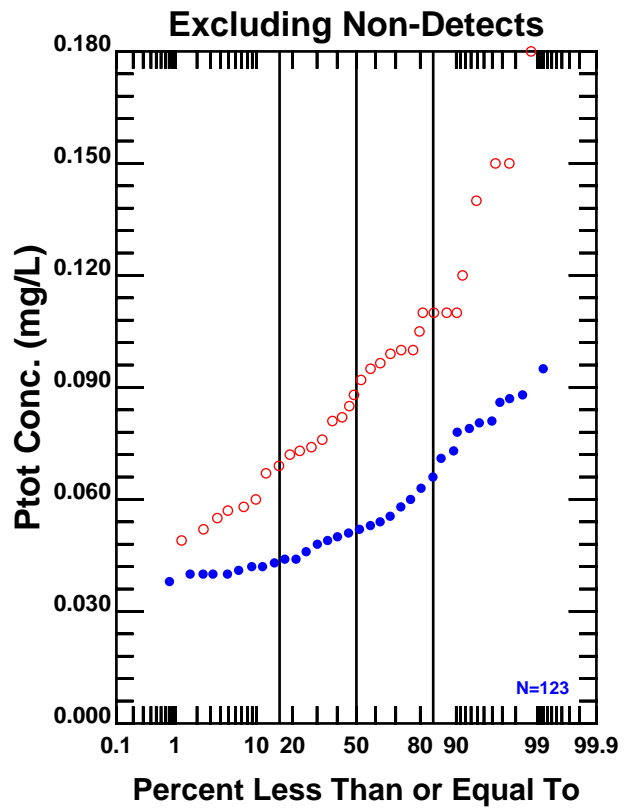
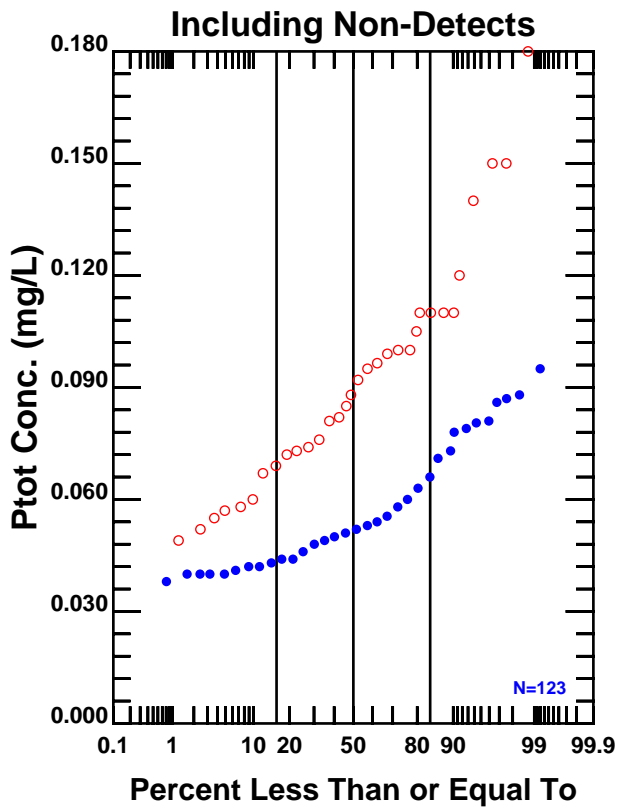
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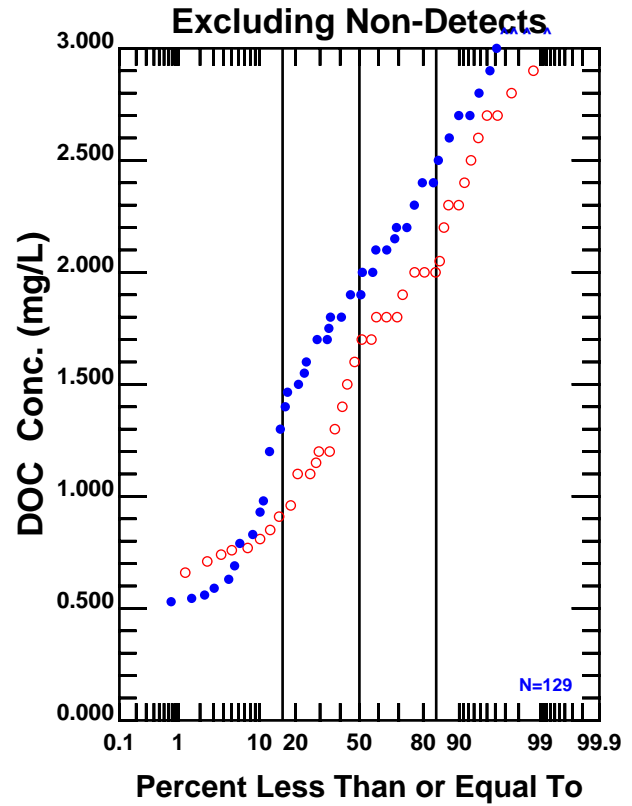
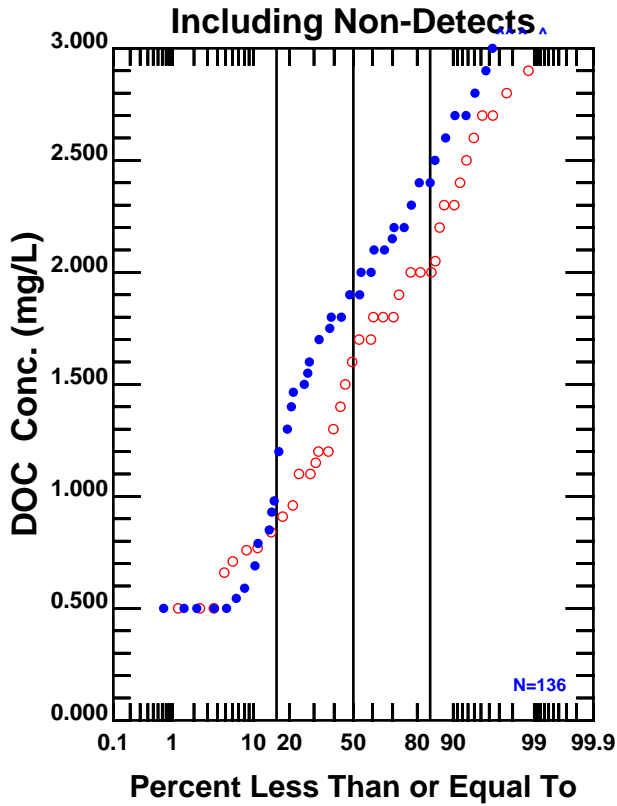
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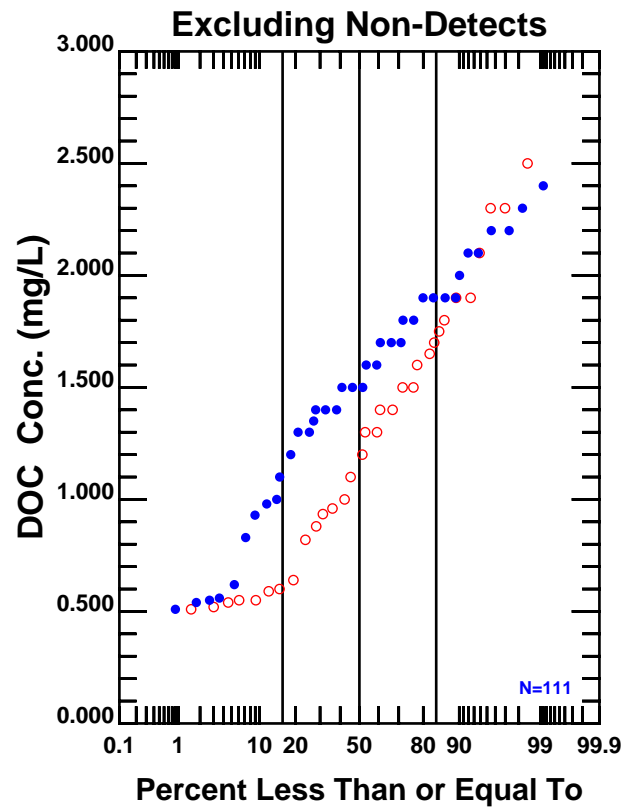
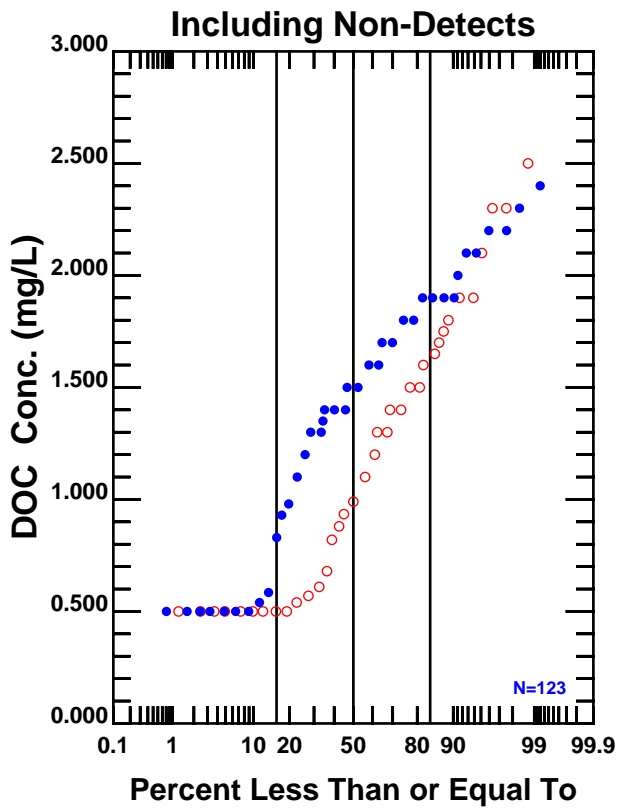
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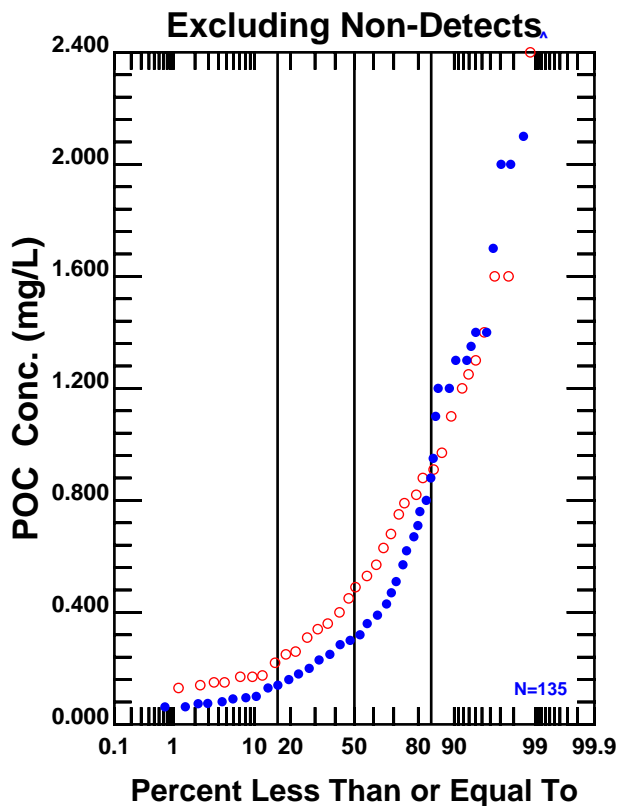
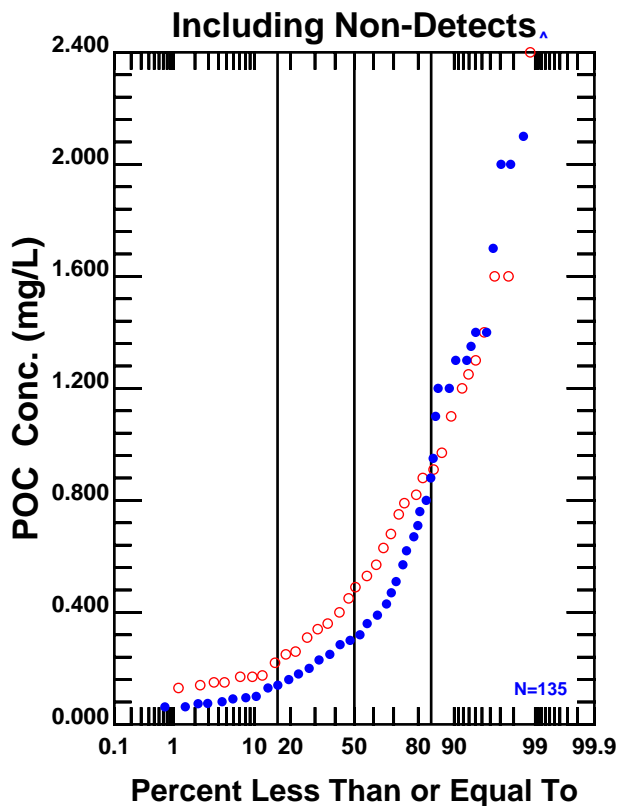
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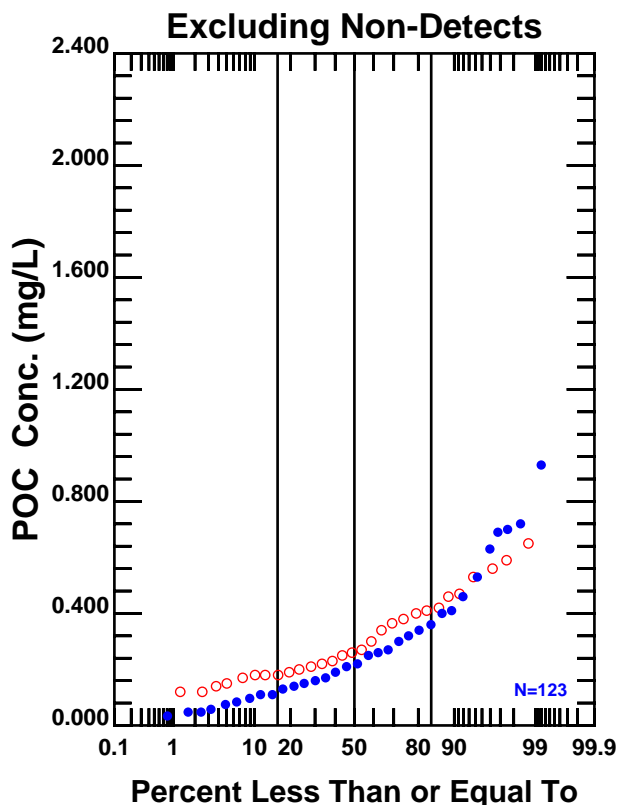
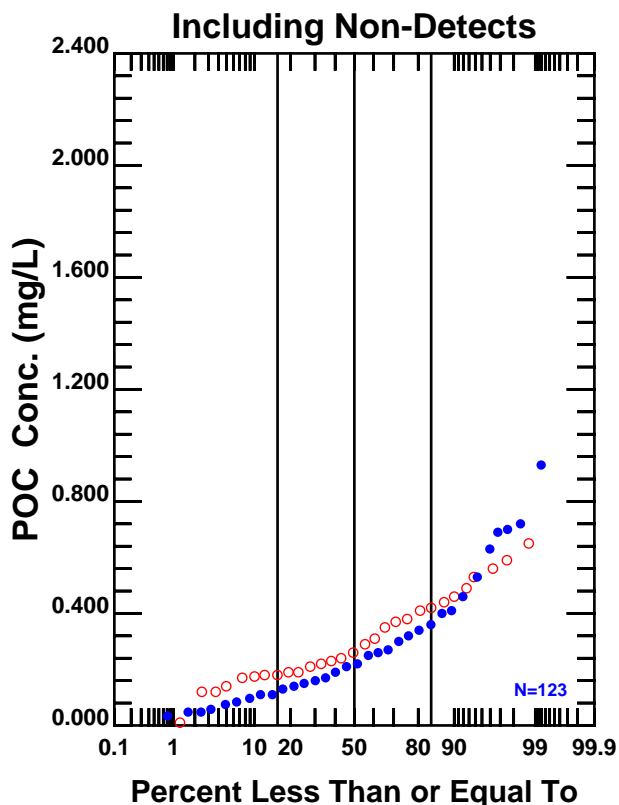
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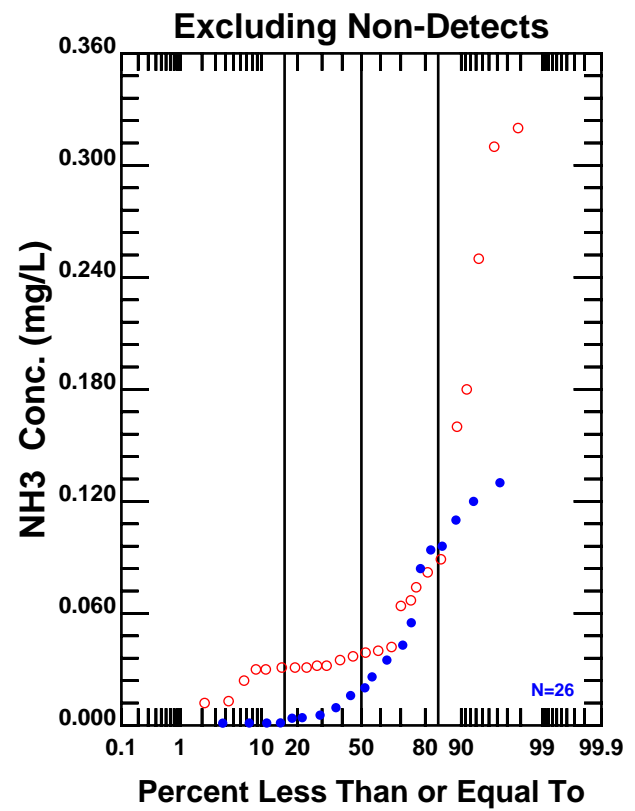
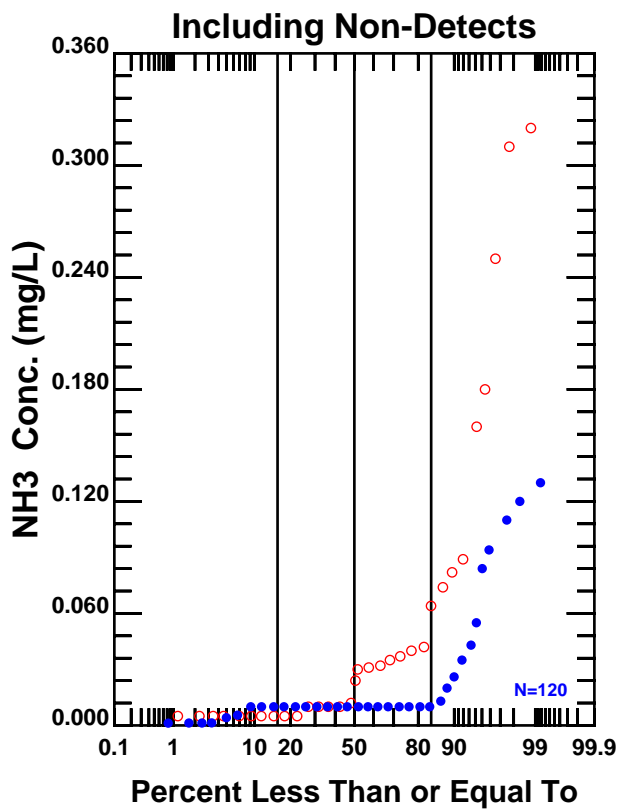
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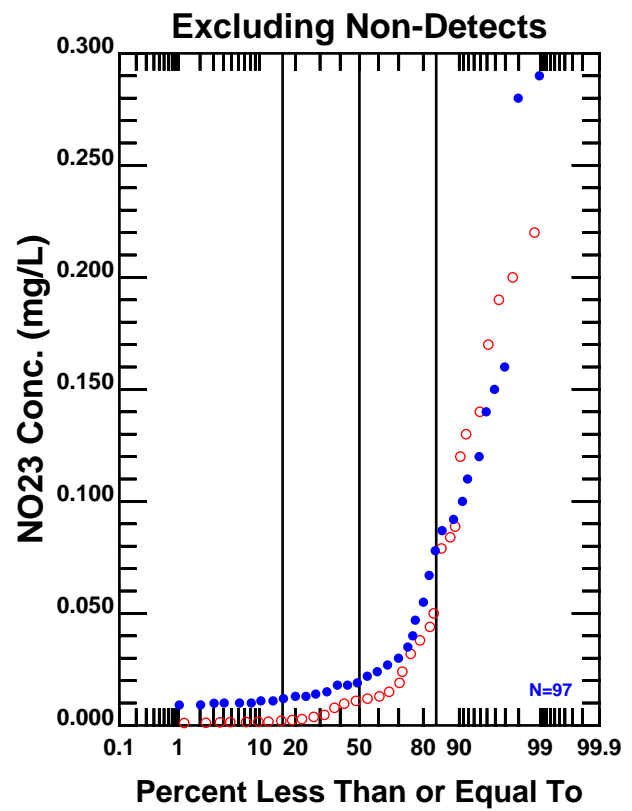
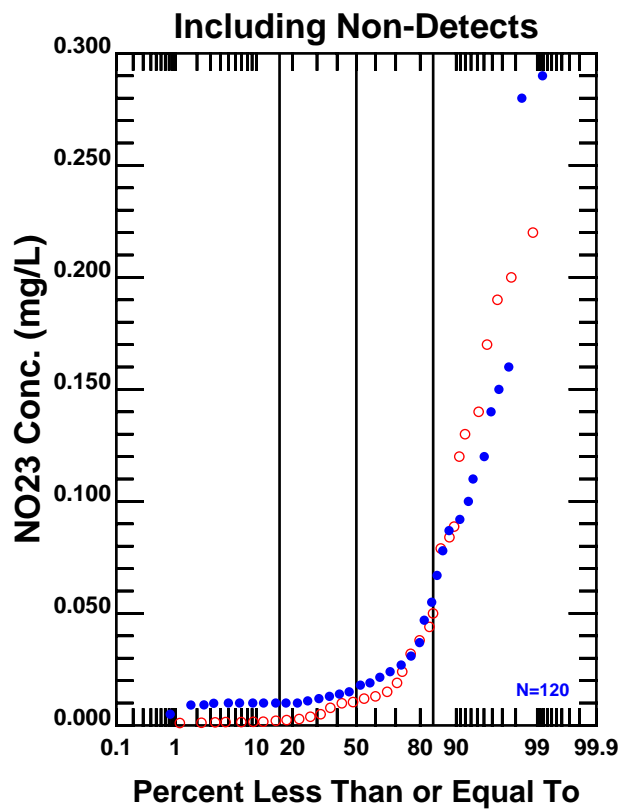
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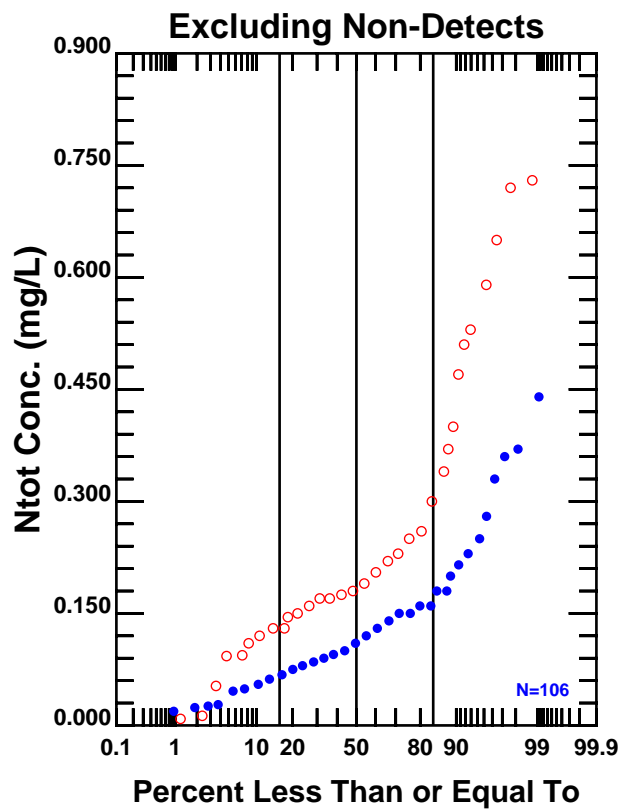
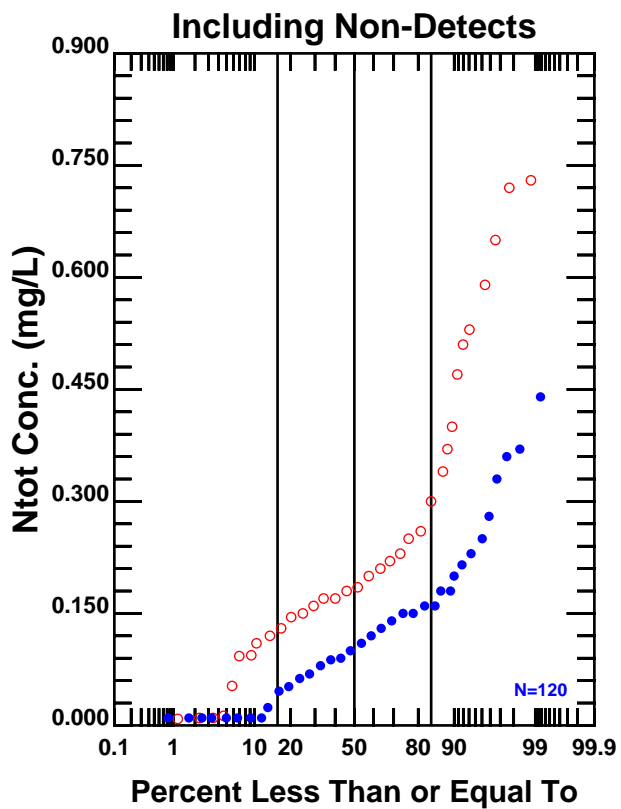
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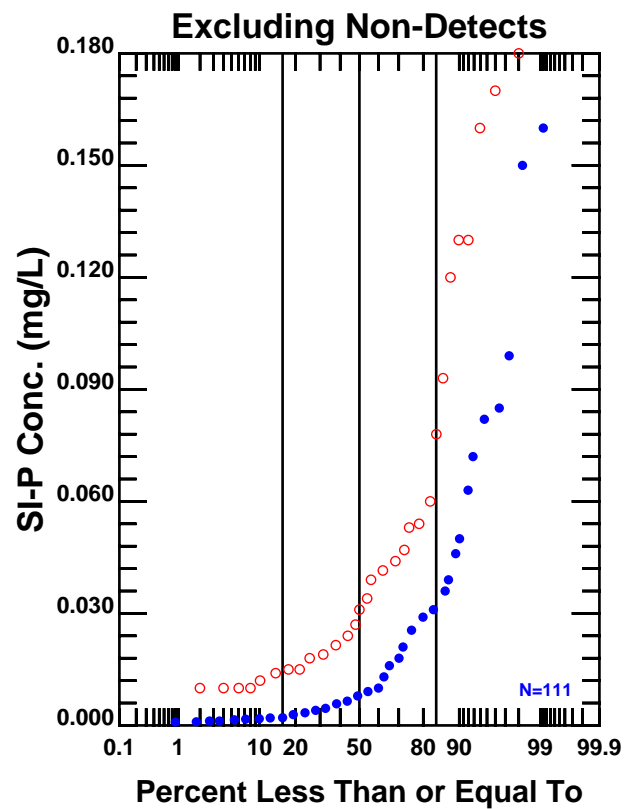
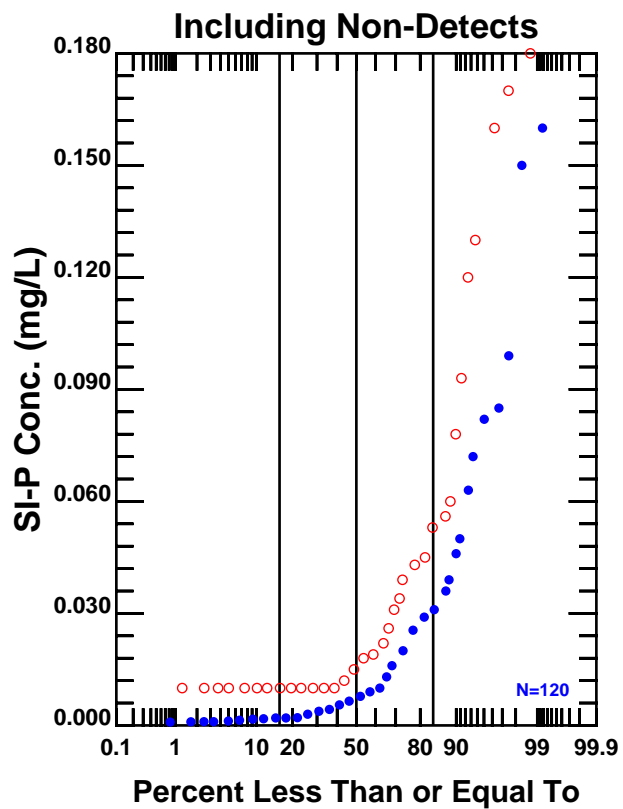
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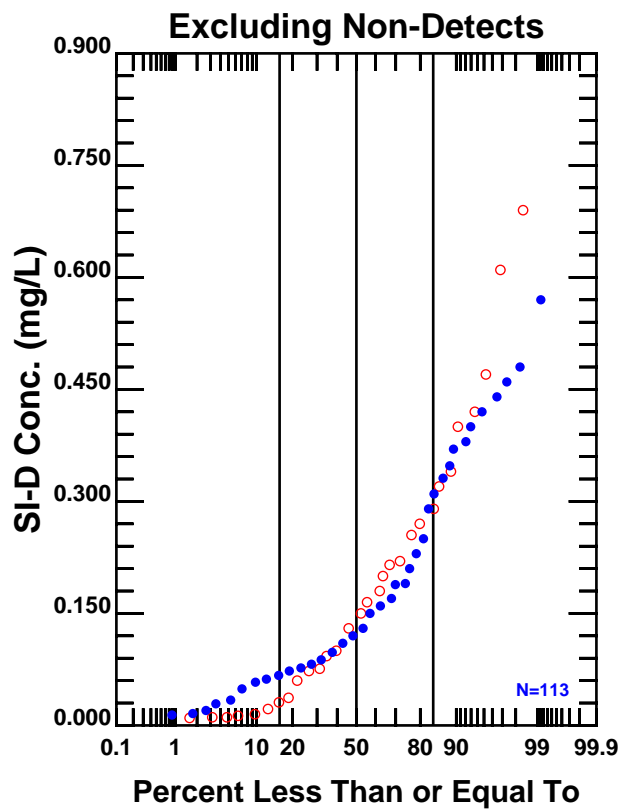
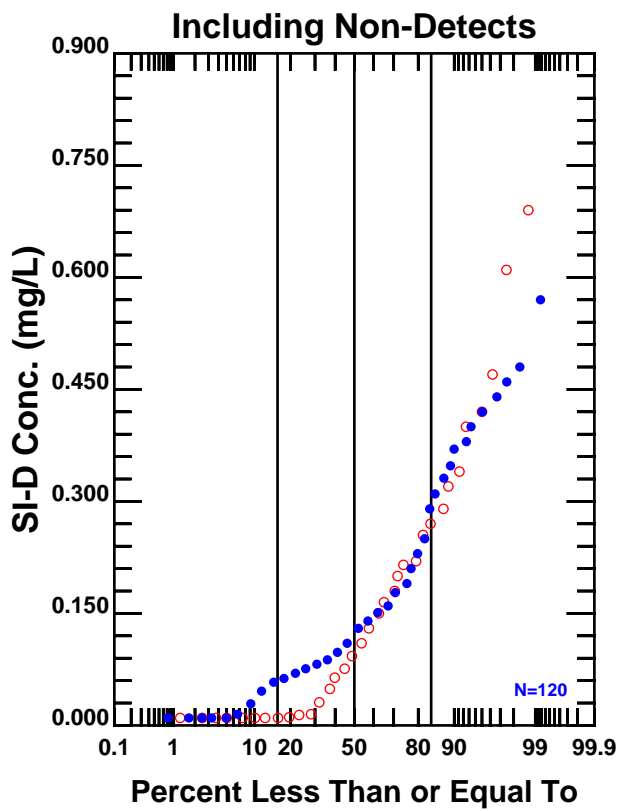
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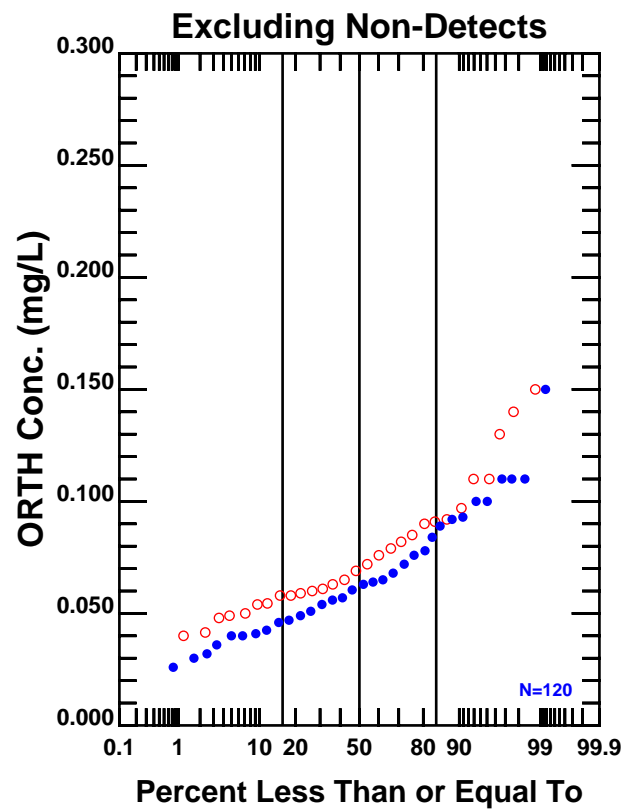
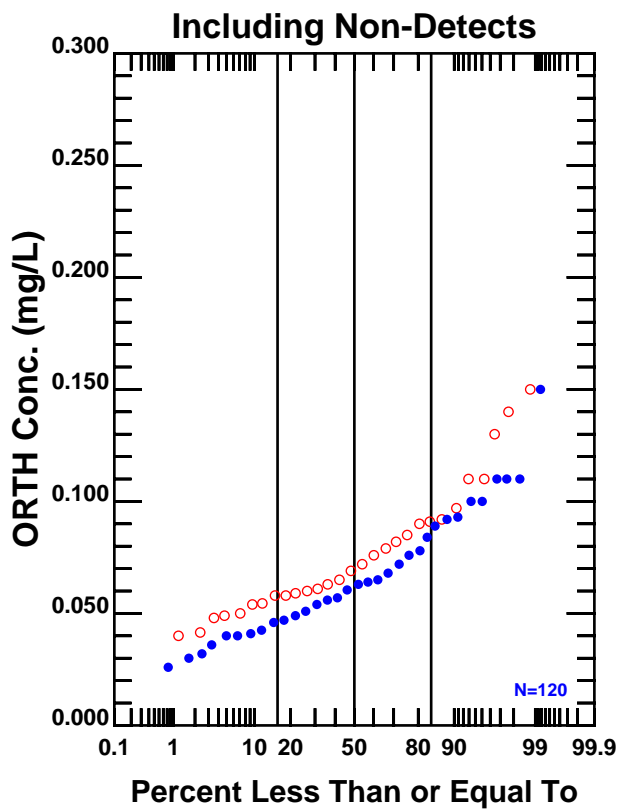
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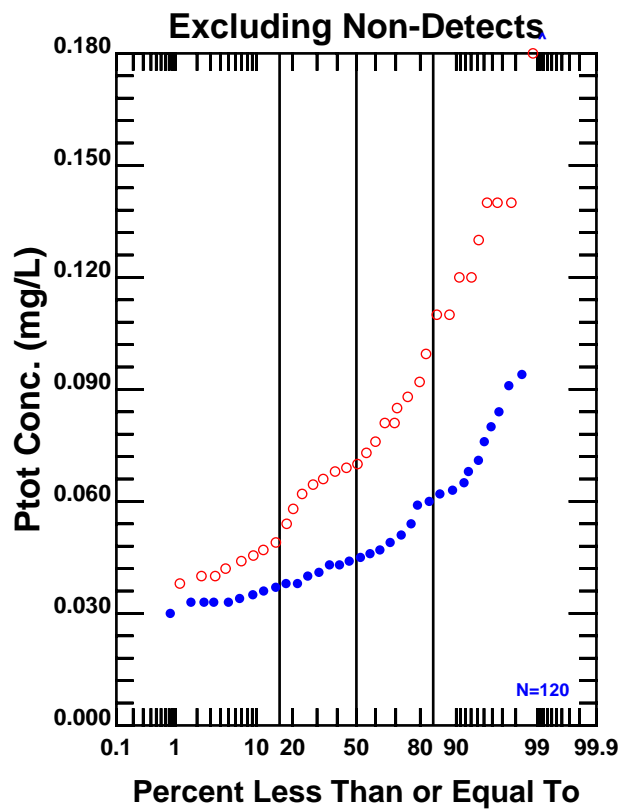
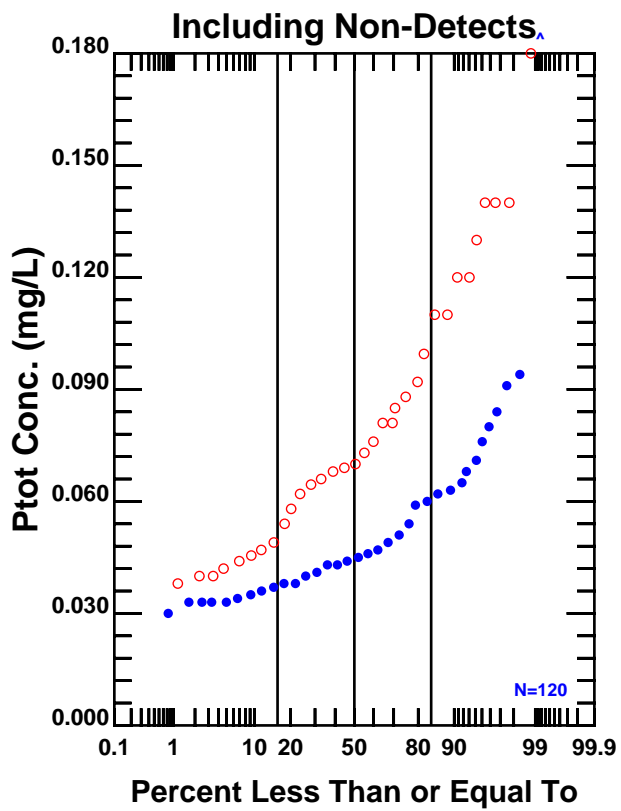
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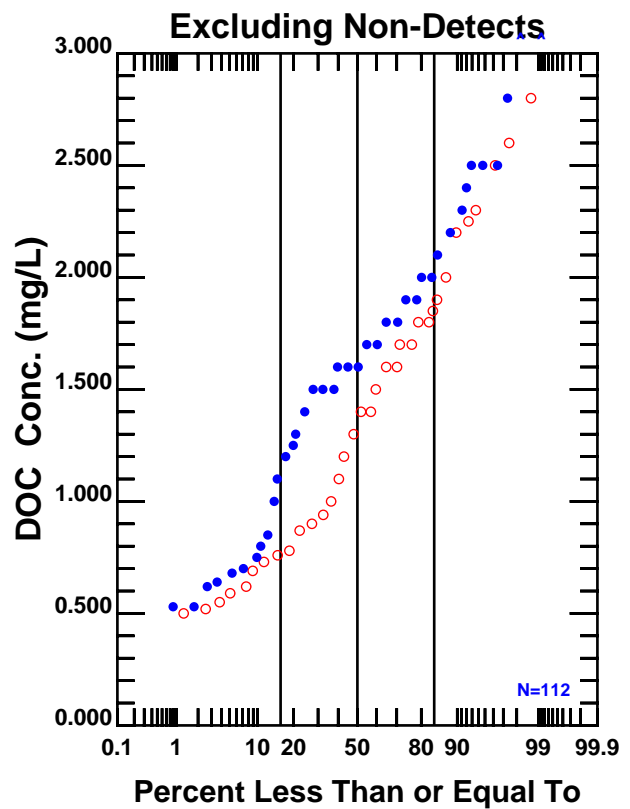
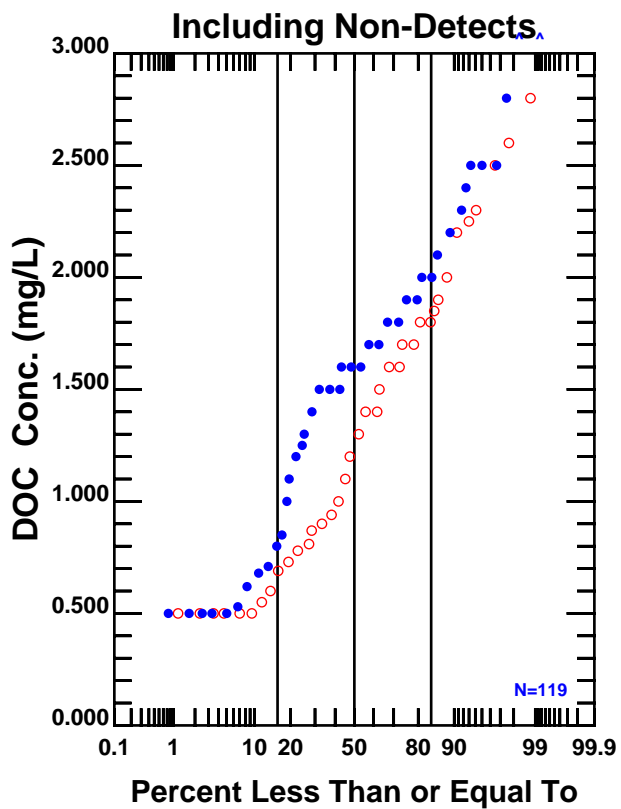
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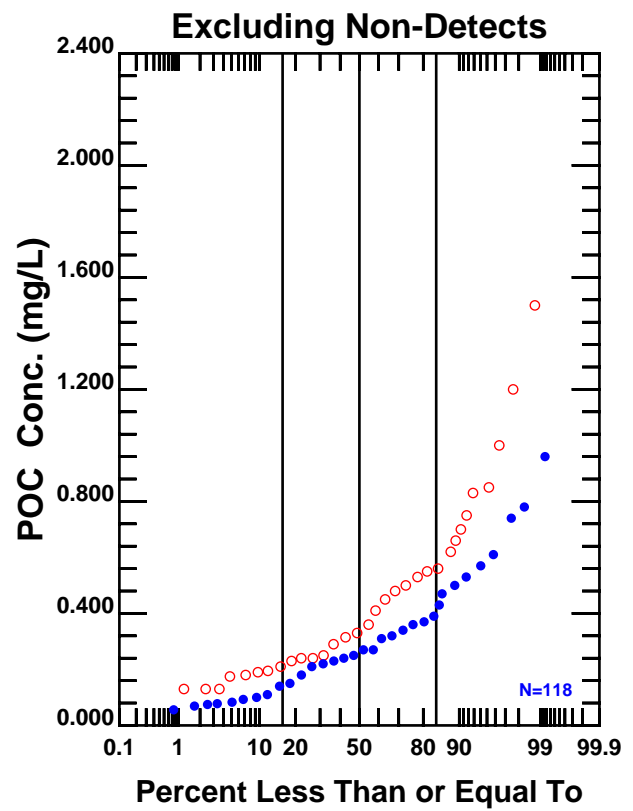
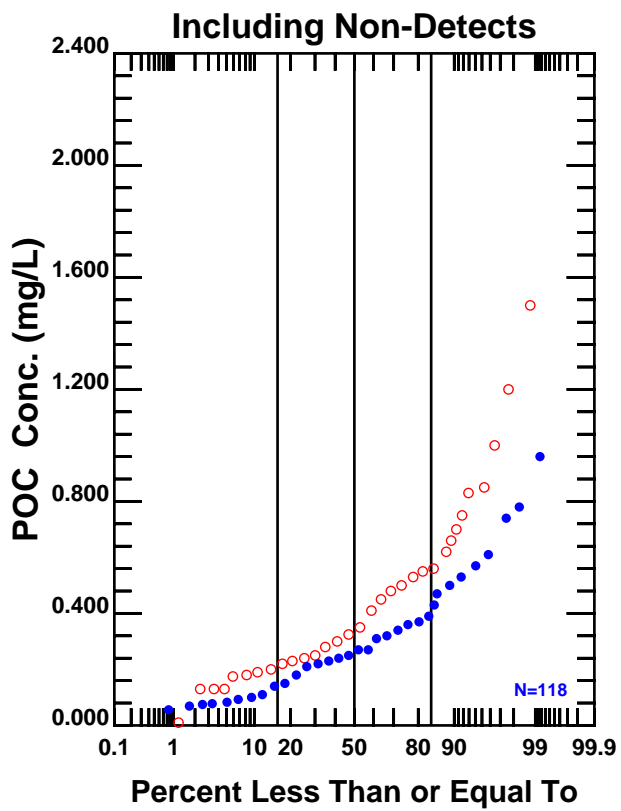
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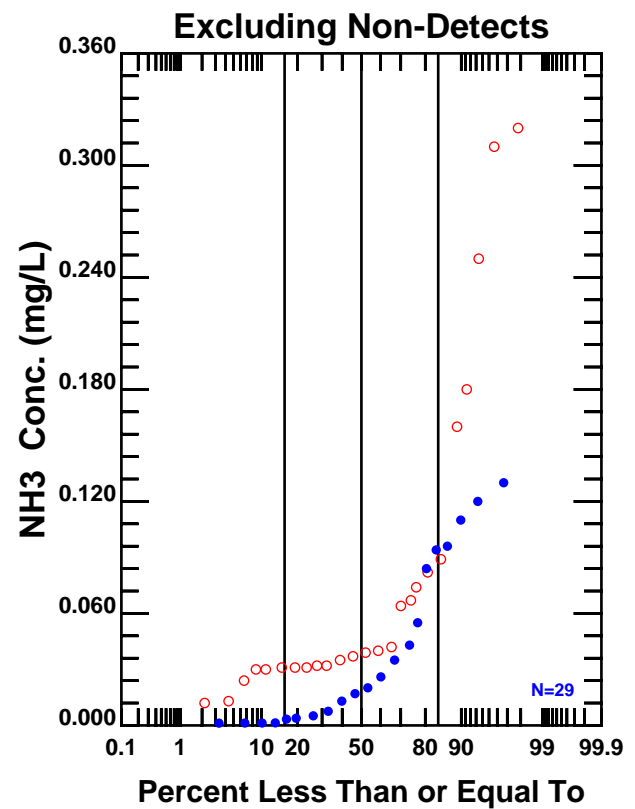
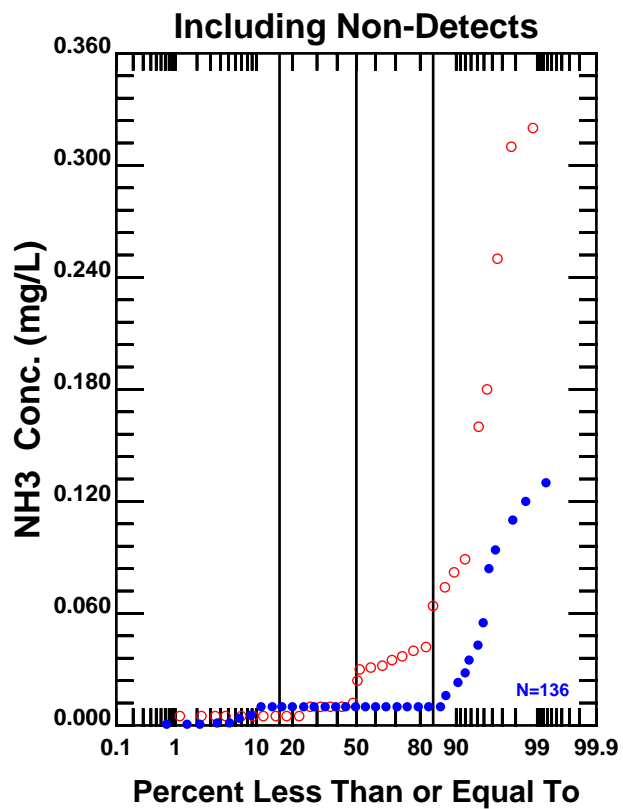
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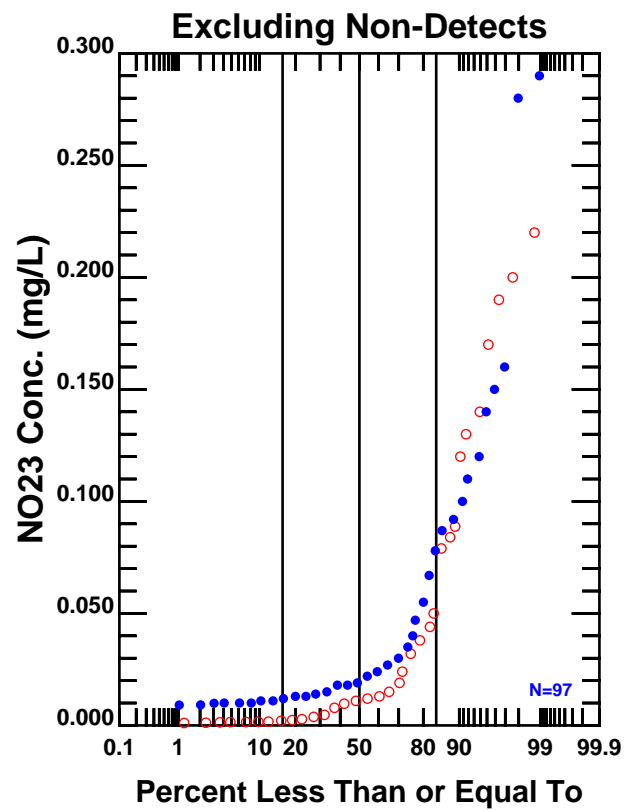
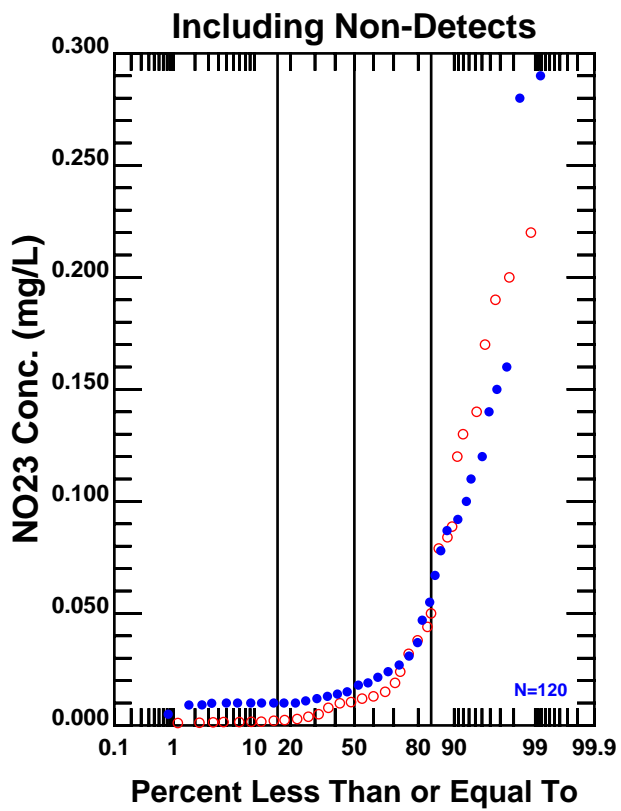
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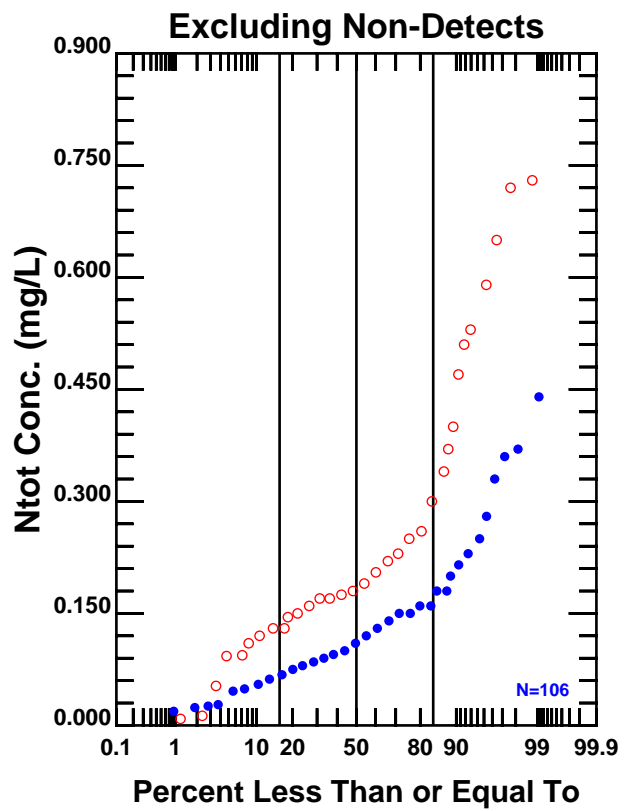
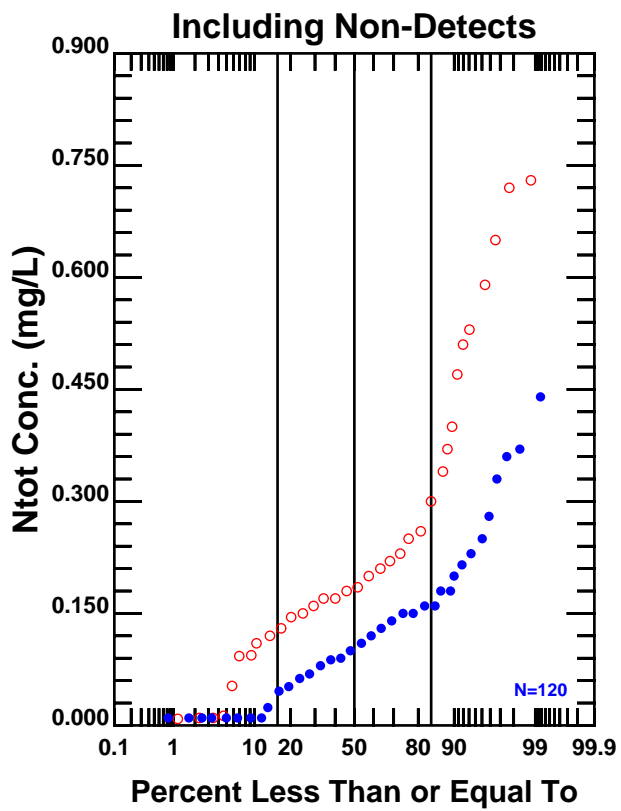
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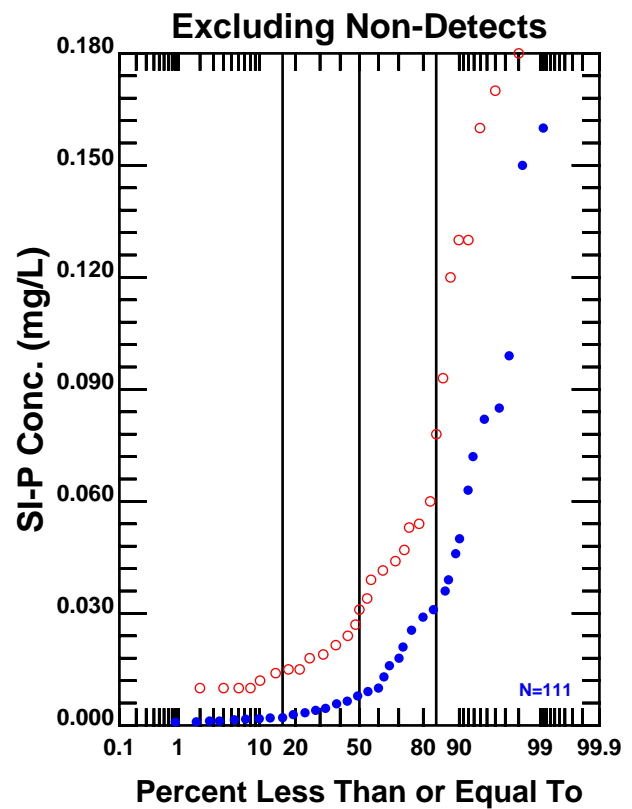
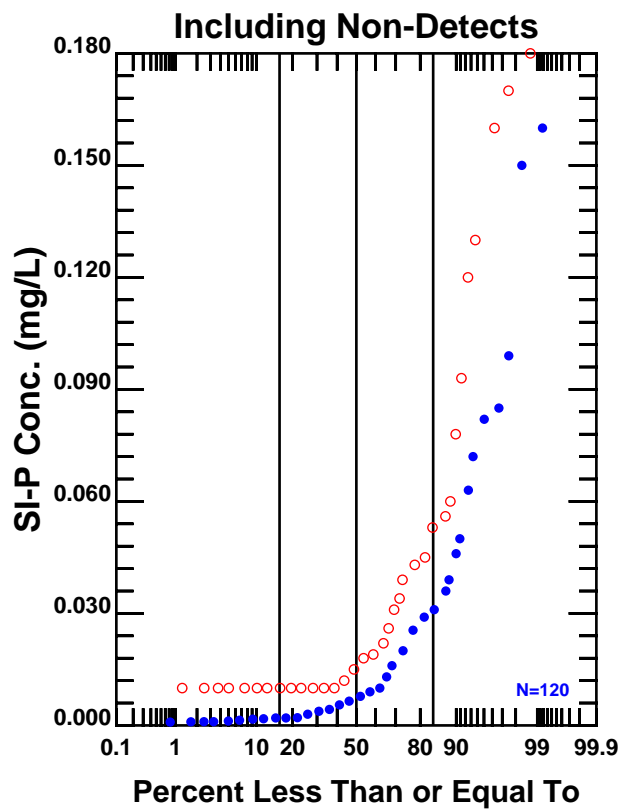
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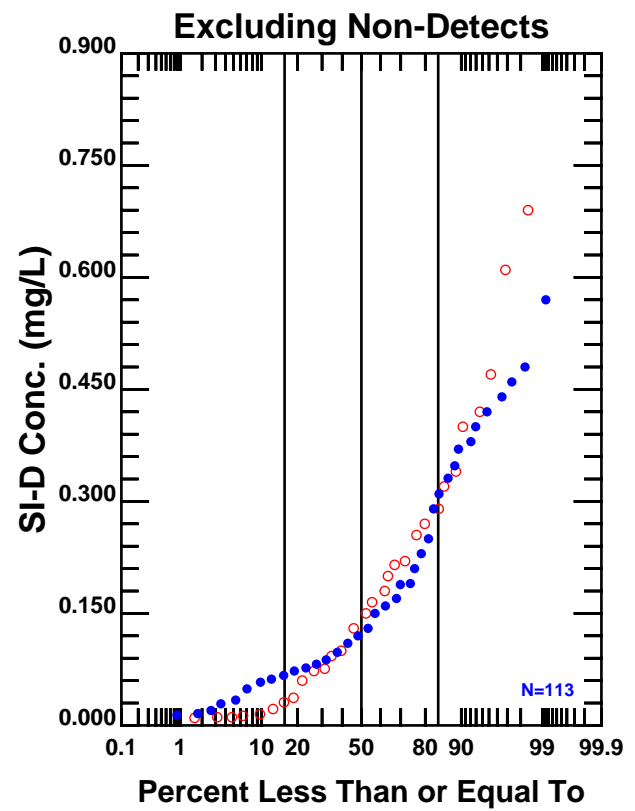
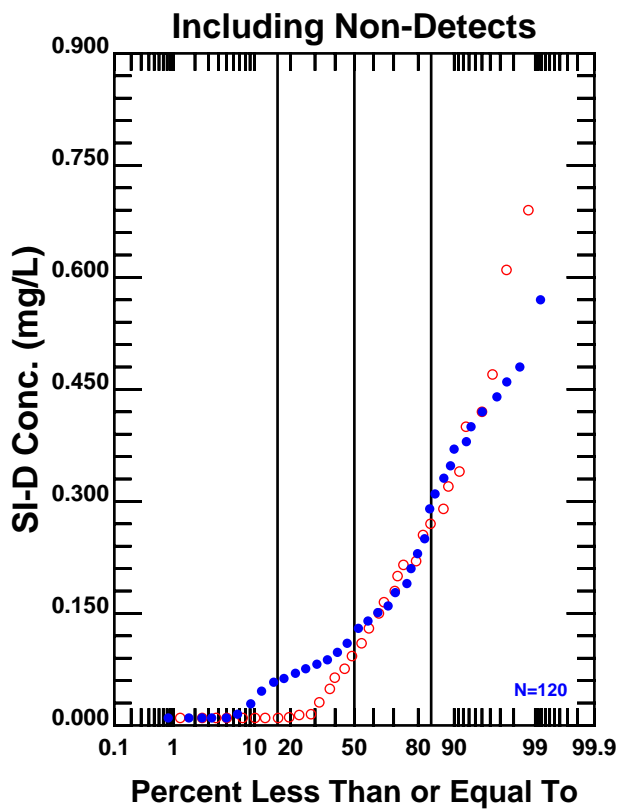
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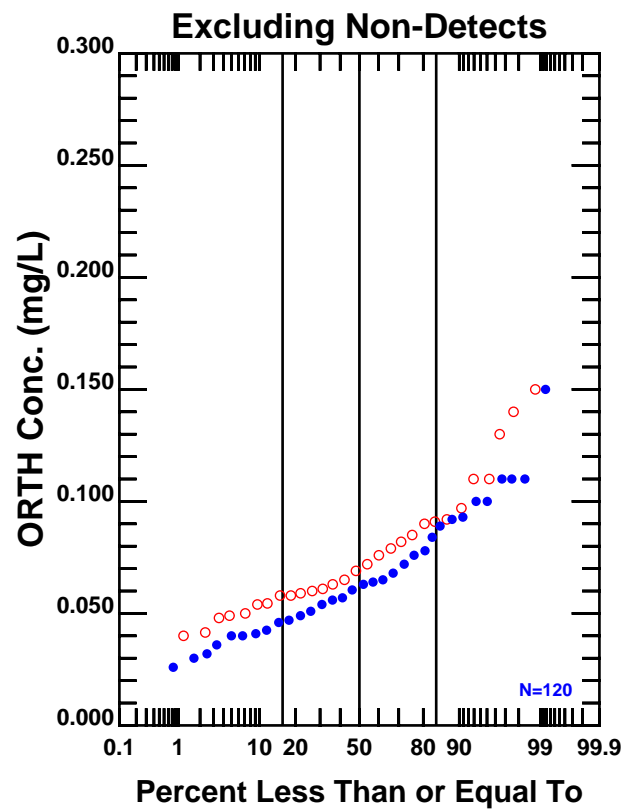
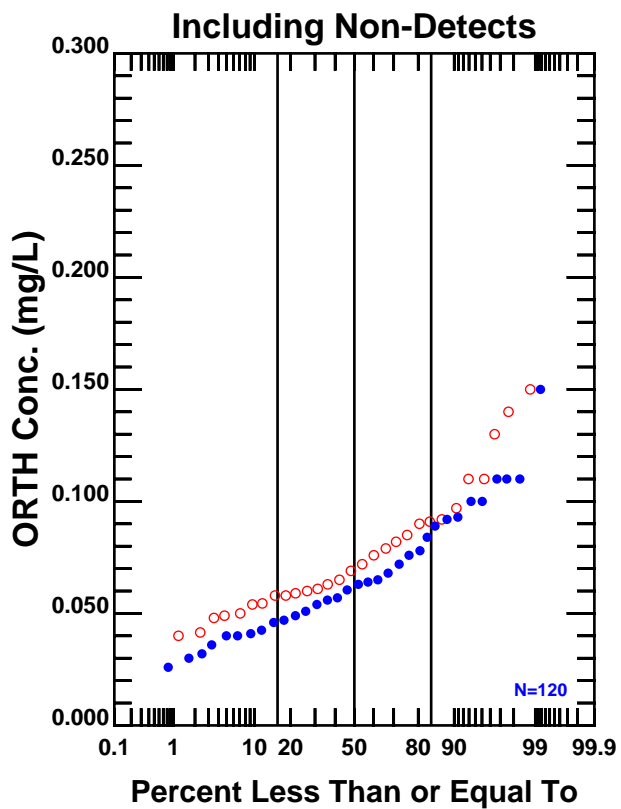
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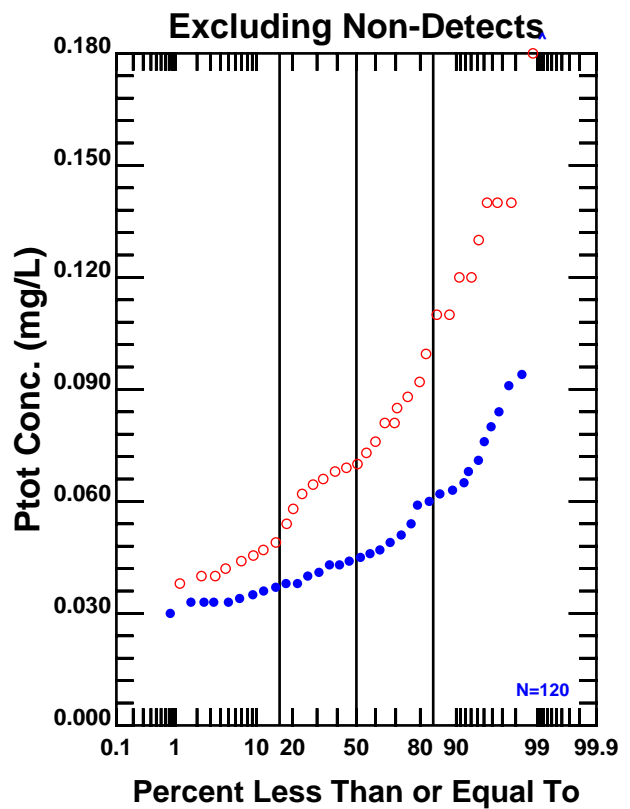
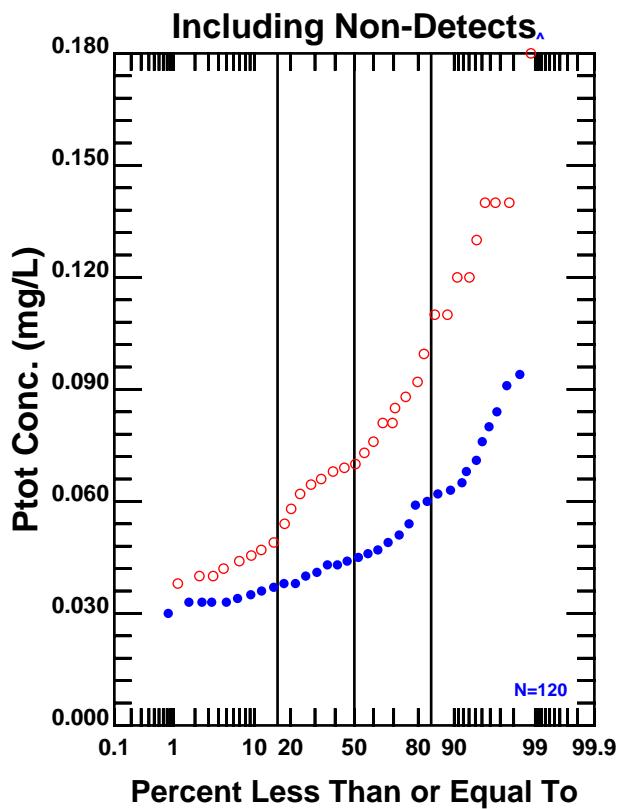
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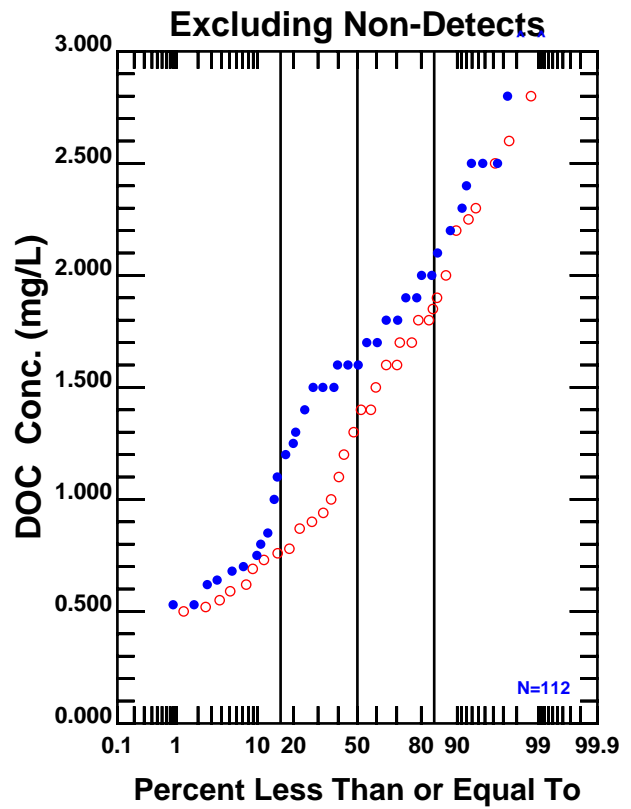
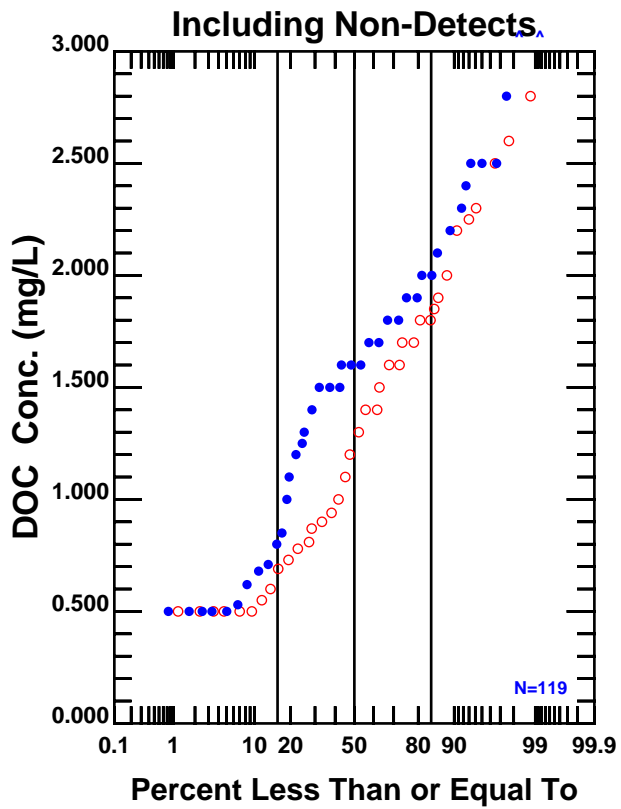
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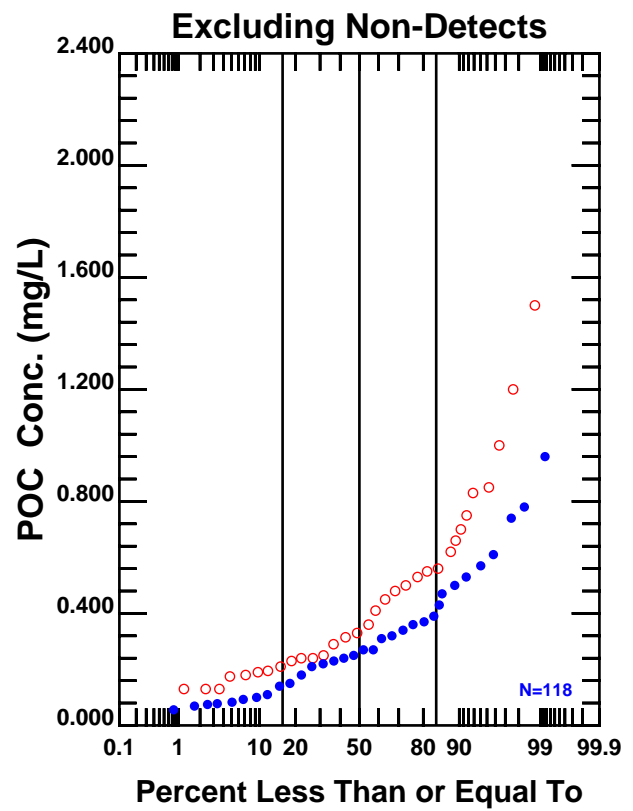
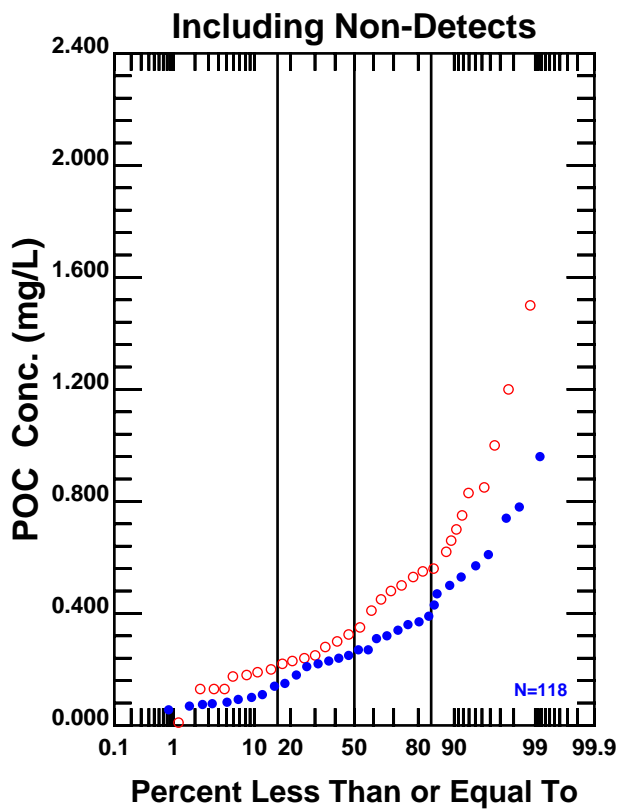
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2008-2009 NY Bight MidDepth Observation



2008-2009 NY Bight MidDepth Observation



ATTACHMENT E
PROJECTED DAYS OF STANDARDS NON-ATTAINMENT

HYDROQUAL, INC.

1200 MACARTHUR BLVD., MAHWAH, NEW JERSEY 07430 T: 201-529-5151 F: 201-529-5728 WWW.HYDROQUAL.COM

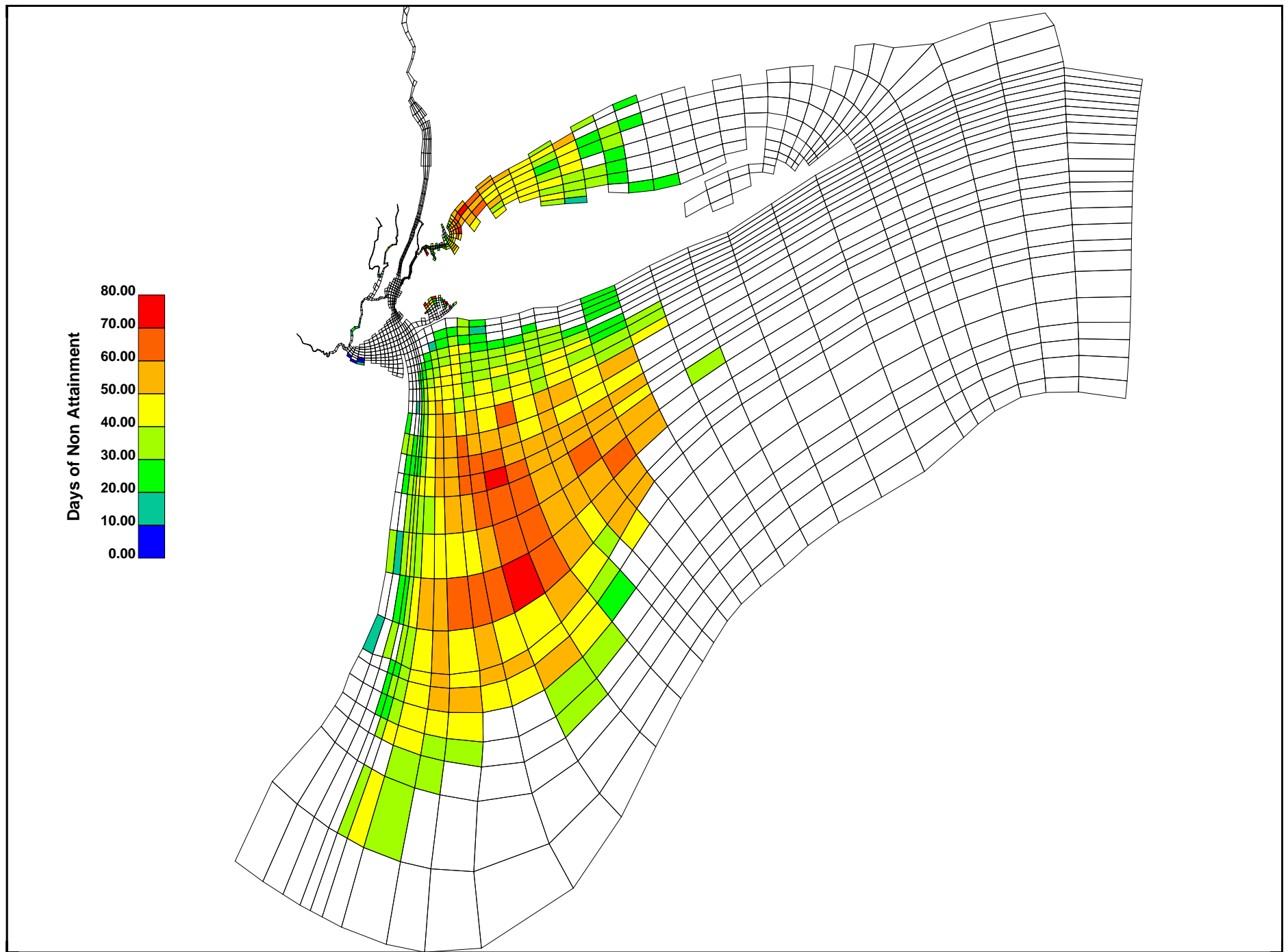


Figure E-1. Projected days of dissolved oxygen standards non-attainment after implementation of Harbor TMDLs for nitrogen and carbon. Based on preliminary Harbor sub-regional TMDL planning SWEM simulation results and NYSDEC chronic dissolved oxygen standard for marine waters. 1988 hydrodynamics.

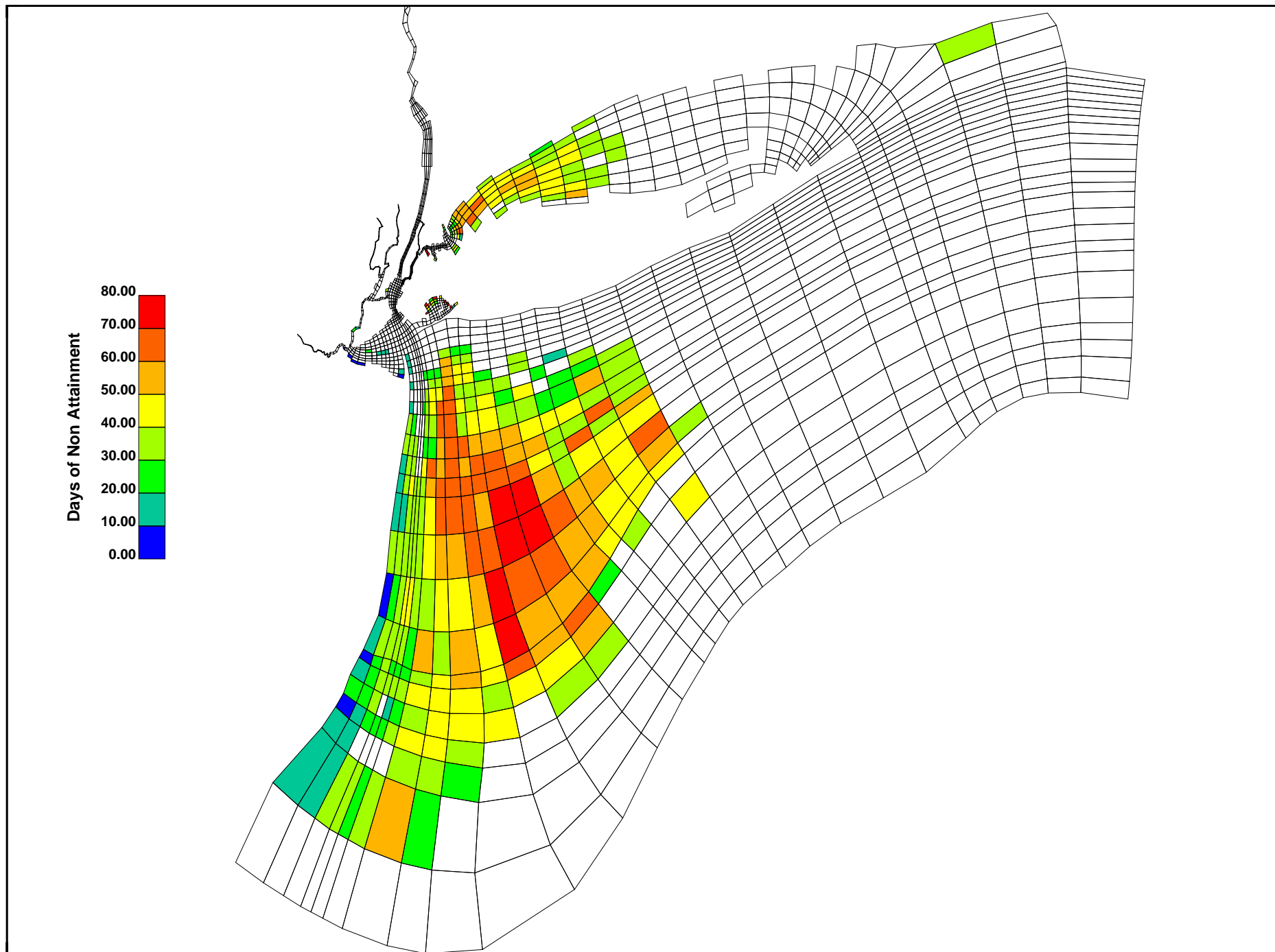


Figure E-2. Projected days of dissolved oxygen standards non-attainment after implementation of Harbor TMDLs for nitrogen and carbon. Based on preliminary Harbor sub-regional TMDL planning SWEM simulation results and NYSDEC chronic dissolved oxygen standard for marine waters. 1989 hydrodynamics.

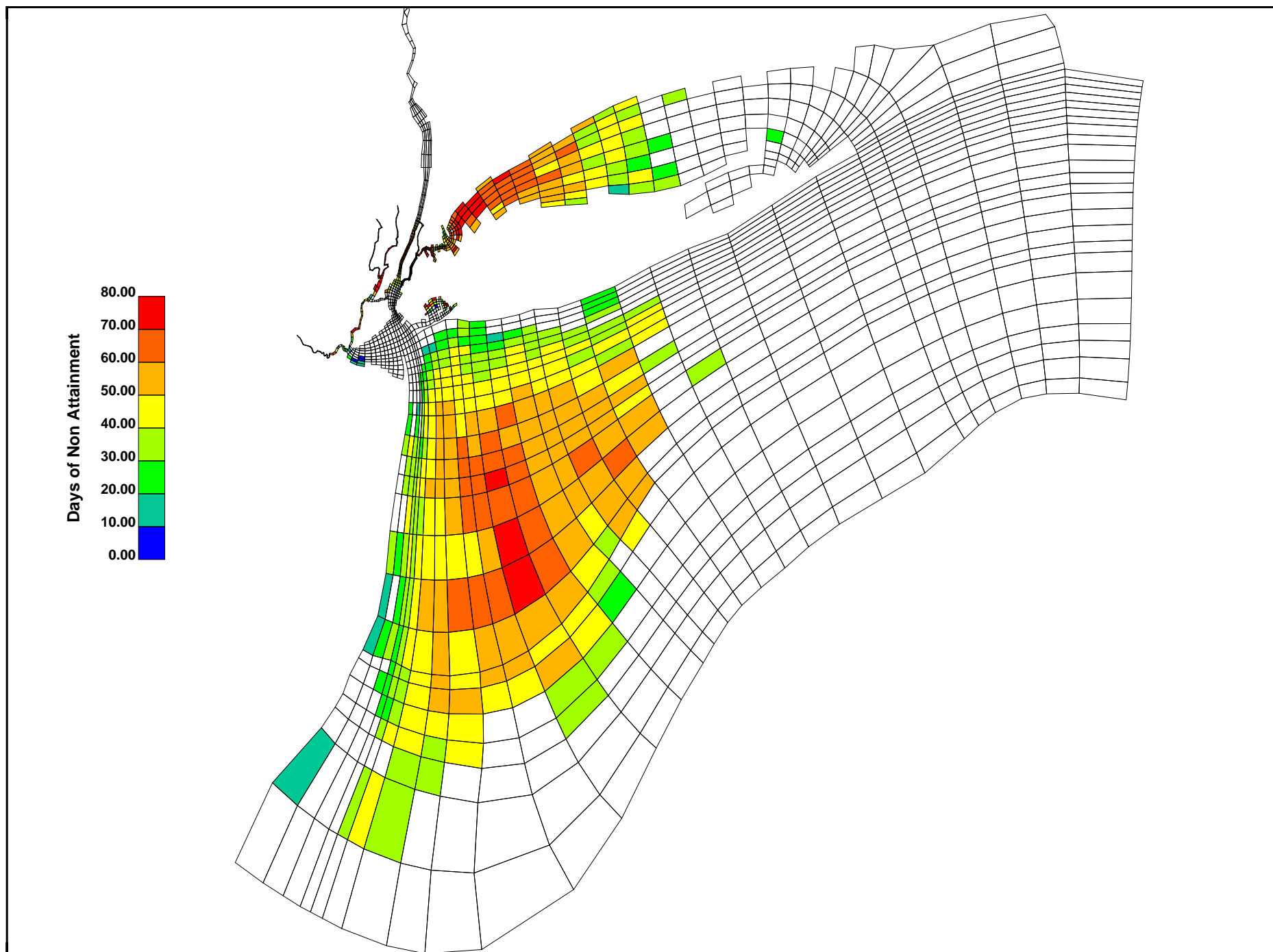


Figure E-3. Projected days of dissolved oxygen standards non-attainment under baseline conditions. Based on SWEM results and NYSDEC chronic dissolved oxygen standard for marine waters. 1988 hydrodynamics.

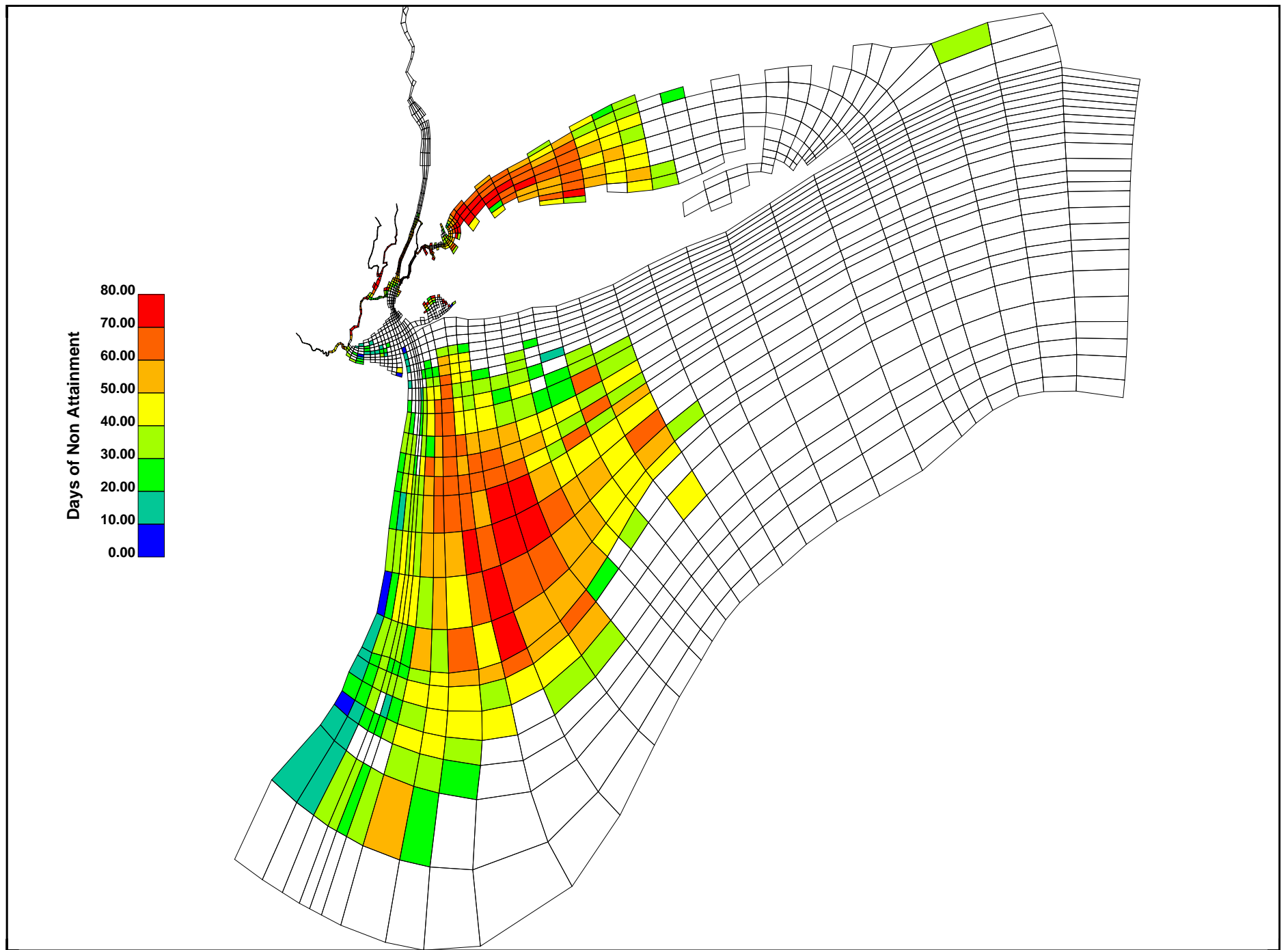


Figure E-4. Projected days of dissolved oxygen standards non-attainment under baseline conditions. Based on SWEM results and NYSDEC chronic dissolved oxygen standard for marine waters. 1989 hydrodynamics.

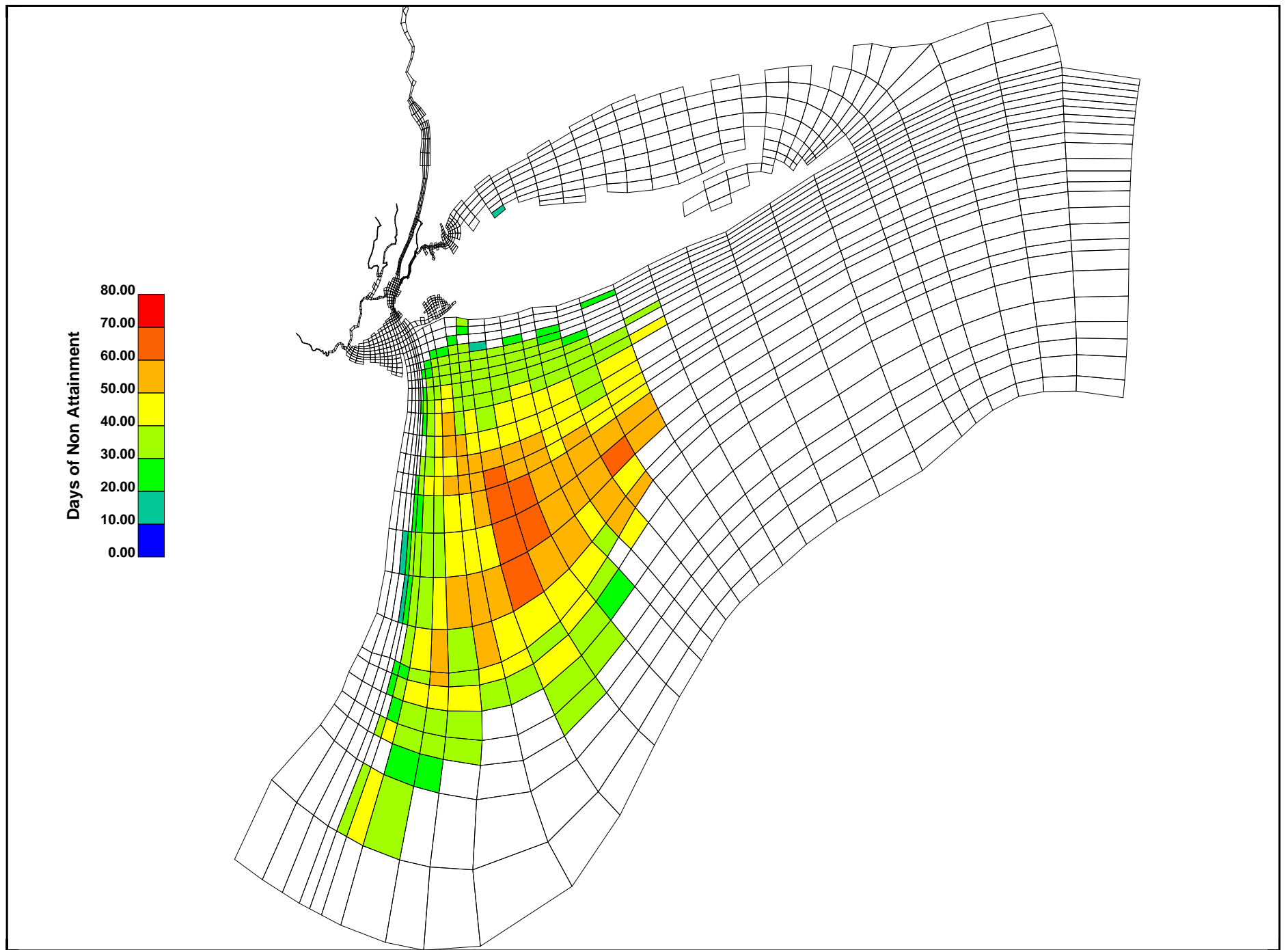


Figure E-5. Projected days of dissolved oxygen standards non-attainment with pastoral loadings. Based on SWEM results and NYSDEC chronic dissolved oxygen standard for marine waters. 1988 hydrodynamics.

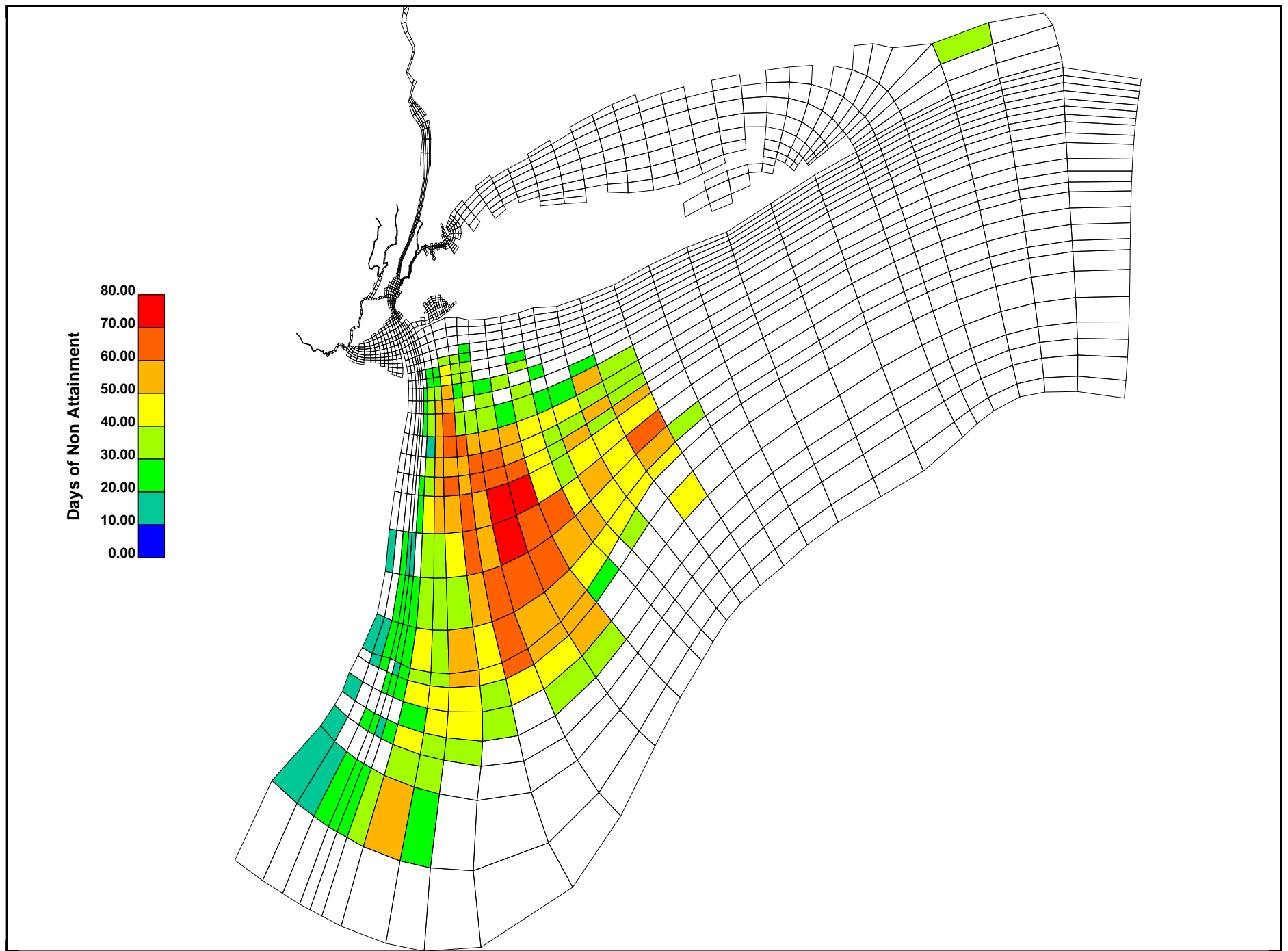


Figure E-6. Projected days of dissolved oxygen standards non-attainment with pastoral loadings. Based on SWEM results and NYSDEC chronic dissolved oxygen standard for marine waters. 1989 hydrodynamics.