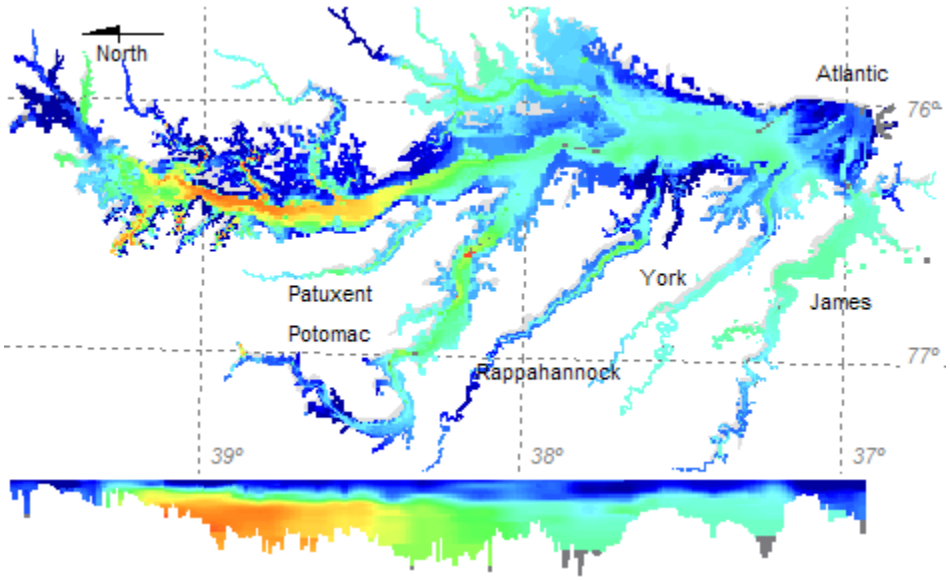
User Guide for the Chesapeake Bay and Tidal Tributary Interpolator



Software: VOL3D
Version 4.6
August, 2006

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Introduction

The Chesapeake Bay and Tidal Tributary Interpolator computes water quality concentrations throughout the Chesapeake Bay and/or tributary rivers from water quality measured at point locations. The purpose of the Interpolator is in compute water quality concentrations at all locations in the 2-dimensional plane (top or bottom depth) or throughout the 3-dimensional water volume. Results of the interpolation can then be compared over time to compute trends or individual interpolations can be overlaid with other data to visualize possible cause and effect relationships. One example is to compare water quality with living resource (fish, shellfish, aquatic vegetation) distributions. Results of the Chesapeake Bay Interpolator have been used since 1988 to determine trends in water quality for the Chesapeake Bay Program (http://www.chesapeakebay.net/).

Version 4.6 of the VOL3D software includes new code to: 1) vertically interpolate data at intermediate depths prior to volumetric interpolation; and, 2) incorporate improved point-in-polygon algorithms.

Another tool, DART, which must be run on the CIMS network at the Chesapeake Bay Program Office, creates data sets for the Interpolator for any parameter in the historical water quality data base. DART is a very powerful tool which can create many data sets in a very short time. Anyone who needs to interpolate data held by the Chesapeake Bay Program, should investigate the use of DART.

Interpolator Description

The Chesapeake Bay Interpolator is a cell-based interpolator. The mid-point (either in two dimensions or three dimensions) of each fixed cell location is computed by interpolating the nearest *n* neighboring water quality measurements, where *n* is normally 4, but this number is adjustable. The computed mid-point value represents the interpolated value for the cell. Cell size in Chesapeake Bay was chosen to be 1km (east-west) x 1km (north-south) x 1m (vertical), with columns of cells extending from surface to the bottom of the water column, thus representing the 3-dimensional volume as a group of equal sized cells extending throughout the volume. The tributaries are represented by various sized cells depending on the geometry of the tributary, since the narrow upstream portions of the rivers require smaller cells to accurately model the river's dimensions. This configuration results in a total of 51,839 cells by depth for the Main Bay

(Segments CB1TF-CB8PH), and a total of 238,669 cells by depth for all 77 segments which comprise the Main Bay and tributaries. Computation time on a Pentium 2 ghz PC running Windows XP is approximately 15 seconds for the Bay and tributary interpolator model.

The Chesapeake Bay Interpolator is unique in the way it computes values in 3-dimensions. The interpolator code is optimized to compute concentration values that closely reflect the physics of stratified water bodies, such as Chesapeake Bay. The Bay is very shallow compared to its width or length, hence water quality varies much more vertically than horizontally. The Chesapeake Bay Interpolator uses a vertical filter to select the vertical range of data that are used in each calculation. For instance, to compute a model cell value at 5m deep, monitoring data at 4.5m deep are preferred, since the centroid of the 5m cell is at 4.5m. If fewer than *n* (4) monitoring data values are found at the preferred depth, the depth window is widened to search up to *d* (normally +/-2m) meters above and below the preferred depth, with the window being widened (normally in 0.5m increments) until *n* monitoring values have been found for the computation. The user can set a minimum number of nearest neighbors that are required, for instance, the user can require at least 3 nearest neighbors to be required yet desires up to 8 nearest neighbors for a particular analysis, but if 3 (the minimum desired in this example) are not available then the computed value will result in a missing value for that cell.

The Interpolator selects the nearest data at the same depth (left diagram) to compute the value for the center of each cell in the interpolator model. The Interpolator will expand its search up and down to find data at other depths if necessary (right diagram).

In this version of the Interpolator, a vertical interpolator has been added on the Data Import screen, which allows the user to compute intermediate values from top to bottom, between existing monitoring data values. Using this technique generates data at many depths so that the volumetric interpolator can be assured to find data at optimum depths. The default settings generate data at 1m depths beginning at 0.5m, so that data are generated to coincide with the mid-point depths of the interpolator cell definition (0.5, 1.5, 2.5,… m deep). This technique has been shown to improve results of volumetric interpolation.

A search radius filter is implemented to limit the horizontal distance of monitoring data from the cell being computed. Data points outside the radius selected by the user (normally 25,000m) are excluded from calculation. This filter is included so that only data that are relatively near the location being interpolated are used.

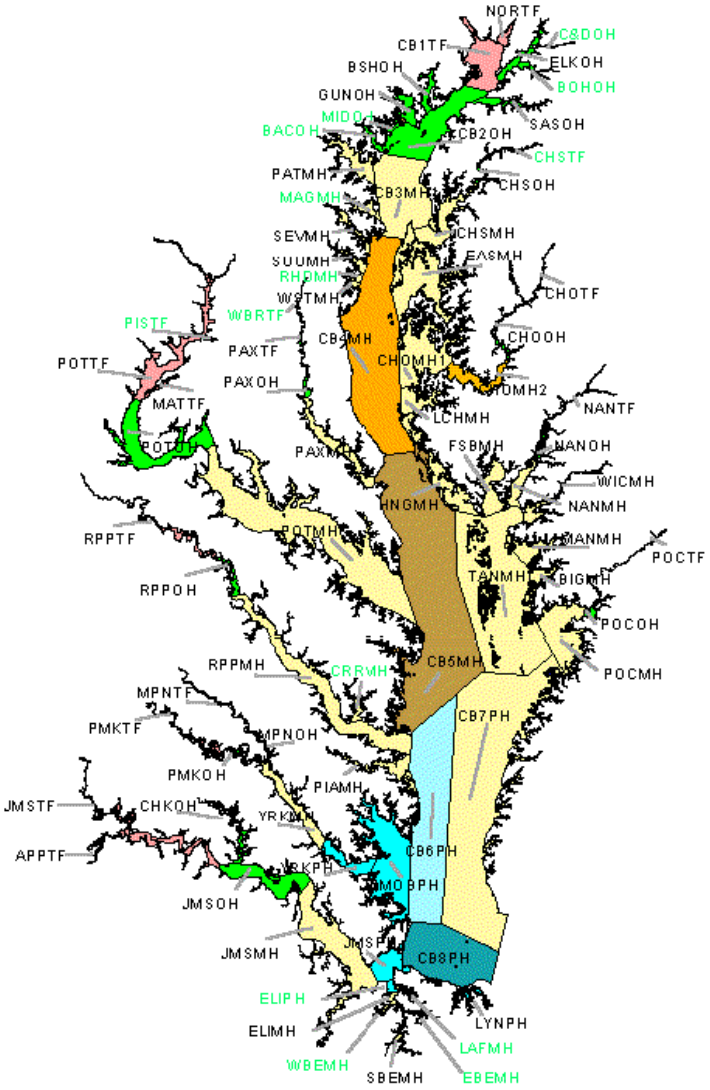
In this version of the Interpolator, Segment and Region filters have been added. Segments are geographic limits for the interpolator model. For instance, the Main Bay is composed of 8

segments (CB1TF, CB2OH, ...,CB8PH). The tributaries are composed of 69 additional segments, using the CBP 1998 segmentation scheme. These segments divide the Bay into geographic areas that have somewhat homogeneous environmental conditions. This segmentation also provides a means for reporting results on a segment basis that can show more localized changes compared to the whole Bay ecosystem. To replicate the segmentation scheme, the segment boundaries were used to cookie-cutter out the Interpolator cells that fall within each segment. Each set of these cells are then identified inside the corresponding *.bth file that contains the bathymetry definitions. The "cbay8.bth" file contains the cell locations for interpolating the 8 segments of Main Bay. A similar file, "bay_trib.bth" contains the cell definitions for all of the Main Bay and tributary segments. Other .bth files have also been created for individual river systems. Users that need specialized processing, such as finer resolution or additional segments in a particular area of interest, must create a new bathymetry file that defines the bathymetry of the area of interest at the desired cell-size.

Regions filters (cbay8.drg, bay_trib.drg, etc) are files which contain a closed polygon of x-y points that define an area larger than the corresponding bathymetry *.bth file. The region file identifies the geographic boundary that limits which monitoring station data are included in interpolation for a given segment. The purpose of the data region is to select a subset of the monitoring data from the input data file, and to then use that subset for computing the values for each cell in that segment. Use of data regions ensures that the interpolator does not "reach across land" to obtain data from an adjacent river which would give erroneous results. By using data regions, each segment of cells can be computed from their individual subset of monitoring data. Each adjacent data region should overlap by some amount so that there is a continuous gradient, and not a seam, across segment boundaries.

Installation

The Vol3D Interpolator code and auxiliary files have been bundled together into a SETUP application that will run on any standard PC running the Windows operating system. It is suggested that the application be installed in the C:\VOL3D directory.



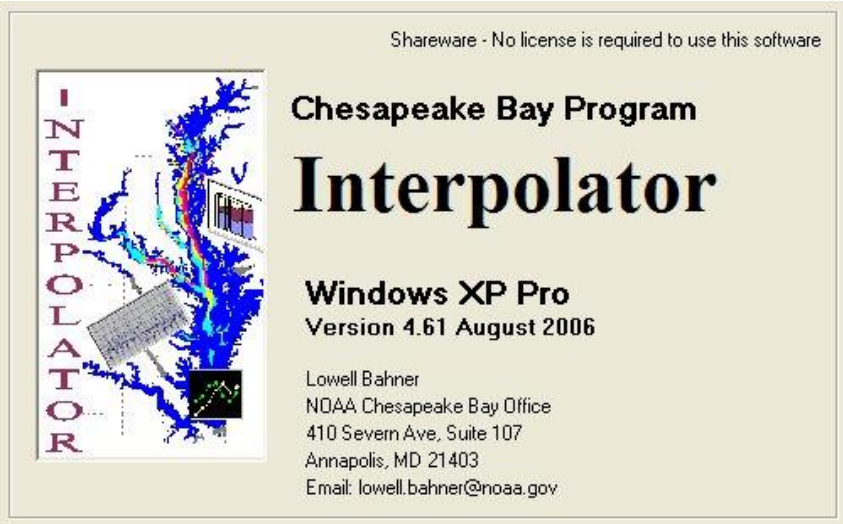
Chesapeake Bay Program 1998 segmentation design.

Using the Chesapeake Bay Interpolator

Procedure for using the VOL3D Interpolator

Begin using the VOL3D software by double clicking the VOL3D.EXE icon on the PC.

The Splash screen will provide a short welcome.



The next and subsequent screens provide 7 buttons (Geography, Parameter, Data Import, Interpolate, Math, Graphics, and Reports) that step the user through the interpolation, graphics, and reporting process. It is best to progress through each button from left to right since each button activates a page which is integral to data selection, interpolation, analysis, and reporting.

1. Geography Button

Click the **Geography Button** to select the Geography screen. Select the bathymetry that matches your requirement, such as, Chesapeake Bay or Bay and tidal tributaries (Figure 1-1).

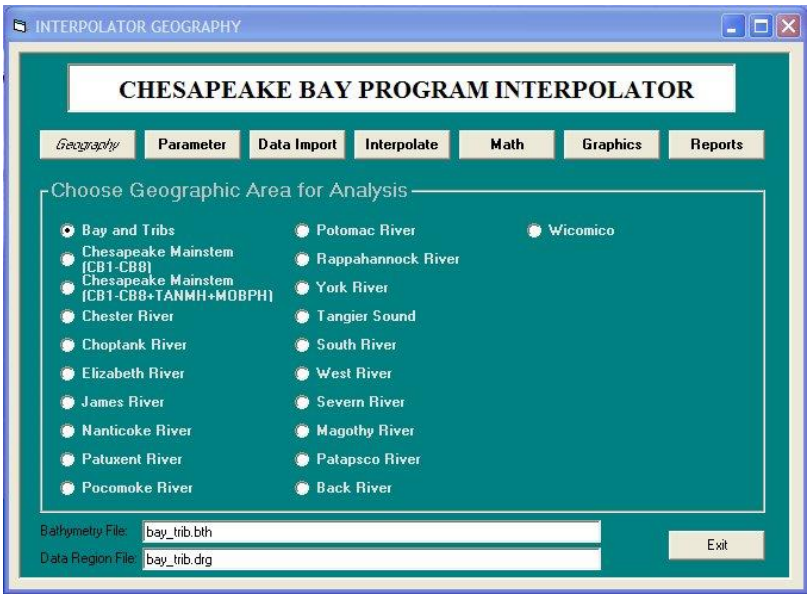


Figure 1-1. Geography screen. Select desired geographic area bathymetry.

2. Parameter Button

Click the **Parameter Button** to select the Parameter screen. Select the parameter that matches your requirement, such as, dissolved oxygen, salinity, or water temperature (Figure 2-1). The parameter name and number of significant digits of numerical precision is user defined in the "Params.ini" file, but the desired numerical precision can be temporarily changed on this screen. The number of decimals propagates through to values written to the .est interpolated data files and graphics legends.

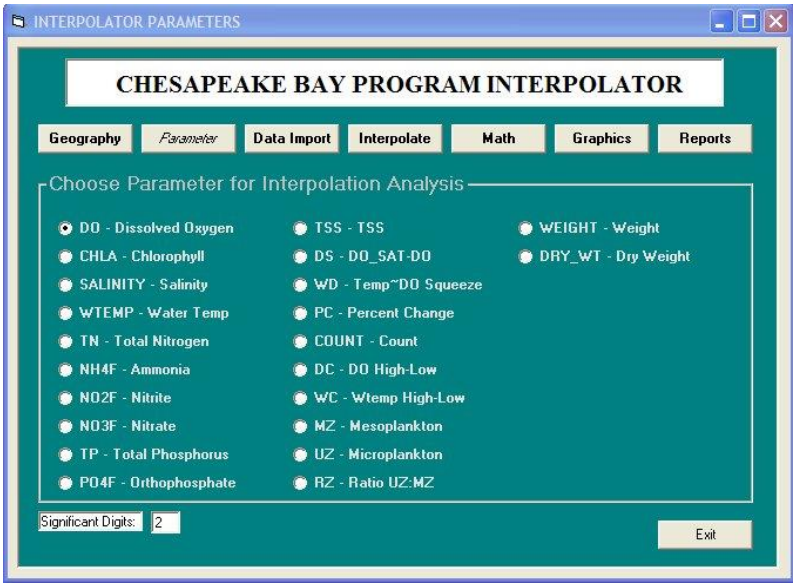


Figure 2-1. Parameter screen. Choose desired parameter for analysis.

3. Data Import Button

Click the **Data Import Button** to select the Data Import screen (Figure 3-1). On this screen, click the "Get File Name" button to select the data file that contains the data that are to be interpolated (Figure 3-2). The default file extension for data files is .d3d. d3d files include the X and Y coordinates and measured values used for interpolation. See section "8. FILE DEFINITIONS AND STRUCTURE, Input Data File (.d3d)" for details. Coordinates in UTM Zone 18, NAD83 are recommended for interpolation. UTM coordinates (Zone 18, NAD83) are also required for mapping in the interpolator graphics procedures.

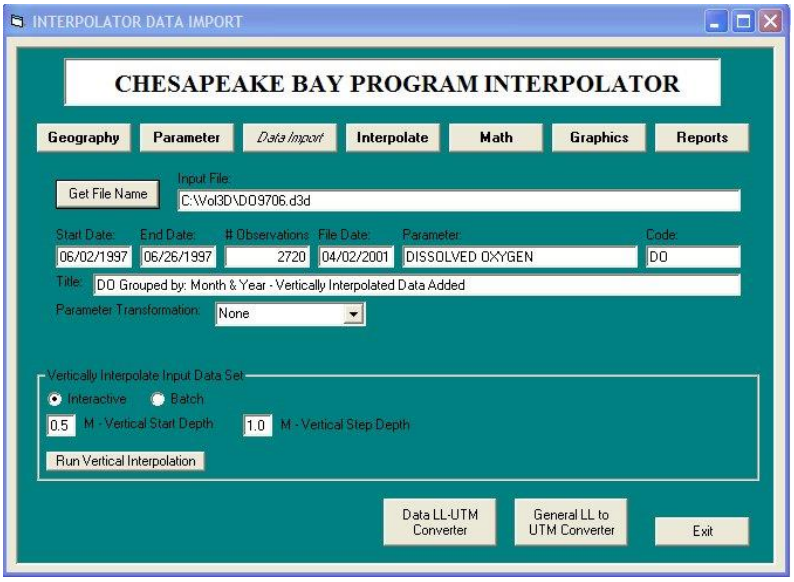


Figure 3-1. Data Import screen. Select a data file (.d3d) for analysis using the "Get File Name" button. Data files can be vertically interpolated using the "Vertically Interpolate Input Data Set" control lower on the screen.

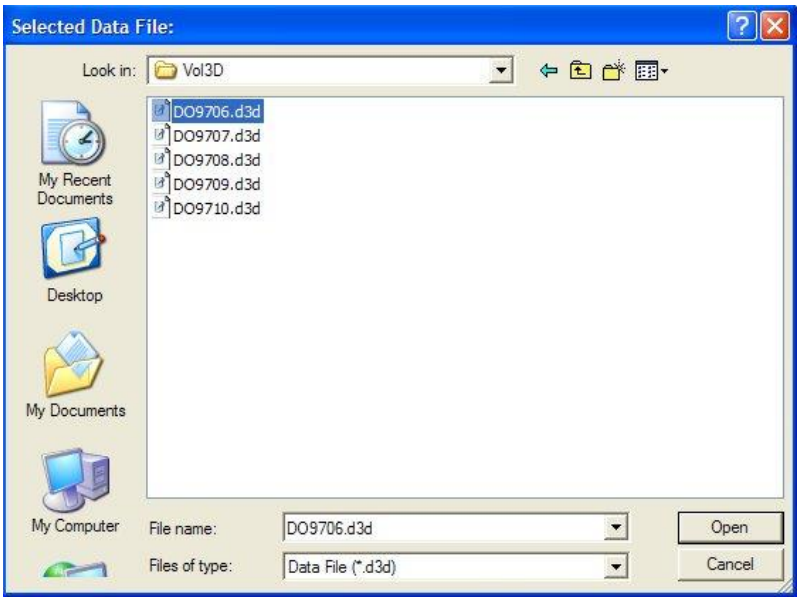


Figure 3-2. Data Import screen, "Get File Name" window. Select a data file (.d3d) for analysis.

Once a .d3d file has been selected, the other fields on this screen will populate with information about the data file, including, start and end dates of the data, the number of observations, the date the file was created, the parameter name and code, and title (Figure 3-1). Normally data do not need to be transformed, however, some data such as chlorophyll, TSS, and chemical contaminants should be transformed with the log-transform to normalize the data. The data are transformed as they are read into the interpolation computation routine and the results are back-transformed to the original units in the .est output file. In batch interpolation mode, the .job file provides an entry for controlling whether file transformation occurs. If the parameter is to be transformed by the natural log transform, any data values that are negative or zero will be set to a value of 0.0001. If the parameter is to be transformed by the square root transform, any data values that are negative will be set to 0.0.

Vertically Interpolate Input Data Set Procedure

Field monitoring data can be sampled at many depths, and often the sampling depths are not uniform among stations. The volumetric interpolator incorporates search windows to find adjacent and most relevant data, however, with vertically stratified systems, such as Chesapeake Bay, having data at uniform depths improves volumetric interpolation. The Vertical Interpolator procedure (Figure 3-3) inserts intermediate values in the data file between measured values at uniform depths. When the procedure is run, the .d3d input file is first sorted by station location, then by depth. From one depth to the next, the measured concentrations are linearly interpolated using linear regression, and new values are computed at fixed intervals and written into the .d3d file. A copy of the original .d3d file is copied to a new file and named with the extension .bck (Figure 3-4). The user is reminded to make a copy of the original .d3d files in a different directory, prior to running this procedure as a backup in case the original files will be needed. Since the original files are altered with new data, make sure to keep track of which file is the original and which has been altered. The first line (title) of the vertically interpolated file is also altered to indicate that the file has been vertically interpolated.

Figure 3-3. Data Import screen, Vertically Interpolate Input Data Set procedure. In “Interactive” mode, the “Input File” (Figure 3-1) will be vertically interpolated. In “Batch” mode, all files listed in the “Batch File” .JOB file will be processed. The .d3d input files will be copied to a new file with .bck extension, and the .d3d file will be changed to include vertically interpolated values. It is highly recommended that a copy of the original .d3d files be saved in another directory in case the original files need to be accessed.

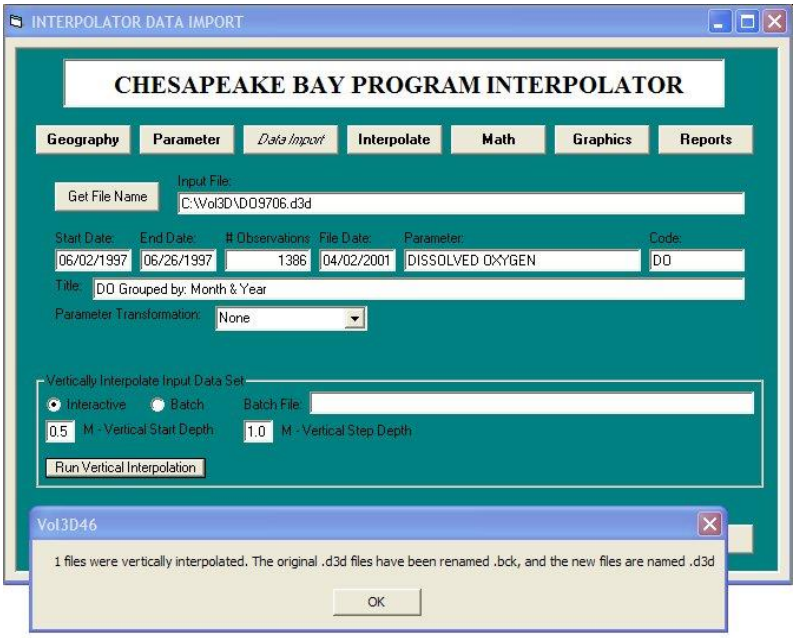


Figure 3-4. Data Import screen notice that the Vertically Interpolated file was copied to a backup (.bck) file and that the original file has been altered.

Table 3-1 shows two files as an example of this procedure. The .bck file on the left is the copy of the original data file and the .d3d file on the right is the file with intermediate values added by the procedure. In this example, the "Vertical Start Depth" was chosen as 0.5 meters, and the "Vertical Step Depth" was chosen as 1.0 meter. You will see that a value at 0.5m was calculated between the original depths of 0.1m and 1.0m. Four values were calculated between the original depths of 1m and 5m, so the resulting file has new values at depths starting at 0.5m, and plus-1m at every depth to the bottom recorded depth. If the 0.1m depth did not exist in the original file, then the 0.5 depth would not have been calculated, but rather the first added depth would have been 1.5m. Depths that might exist below the lowest measured depth are not computed, since the interpolator has no knowledge of the total depth at a monitoring station. Also notice that the first title line has a note "Vertically Interpolated Data Added" as documentation of the data alteration.

Table 3-1. Example of file before and after vertical interpolation data have been added at depths beginning at 0.5 meters and at each meter thereafter. The data record format is: station location (407086, 4377799), depth in meters, dissolved oxygen concentration, and station name.

Original File Copy (Test.d3d.bck)	Vertically Interpolated File (Test.d3d)
DO Grouped by: Month & Year DO,DISSOLVED OXYGEN 06/02/1997,06/26/1997 04/02/2001:11:17 3 407086,4377799,.1,9.9,CB1.1 407086,4377799,1,9,CB1.1 407086,4377799,5,8,CB1.1	DO Grouped by: Month & Year – Vertically Interpolated Data Added DO,DISSOLVED OXYGEN 06/02/1997,06/26/1997 04/02/2001:11:17 8 407086,4377799,.1,9.9,CB1.1 407086,4377799,.5,9.5,CB1.1 407086,4377799,1,9,CB1.1 407086,4377799,1.5,8.88,CB1.1 407086,4377799,2.5,8.62,CB1.1 407086,4377799,3.5,8.38,CB1.1 407086,4377799,4.5,8.12,CB1.1 407086,4377799,5,8,CB1.1

Longitude/Latitude to UTM Converter Procedures

Two buttons at the bottom of the **Data Import** screen can be used to convert longitude and latitude coordinates to UTM coordinates, which are recommended for interpolation (Figures 3-5, 3-6). The first converts the longitude and latitude coordinates in d3d formatted files to UTM coordinates, and vice versa. This is handy for checking data locations on maps. The second procedure converts individual longitudes and latitudes to and from UTM coordinates. NAD27 to NAD83 conversion is not supported in this code. Improper use of NAD27 or NAD83 can result in coordinate errors in the 100 to 300 meter range.

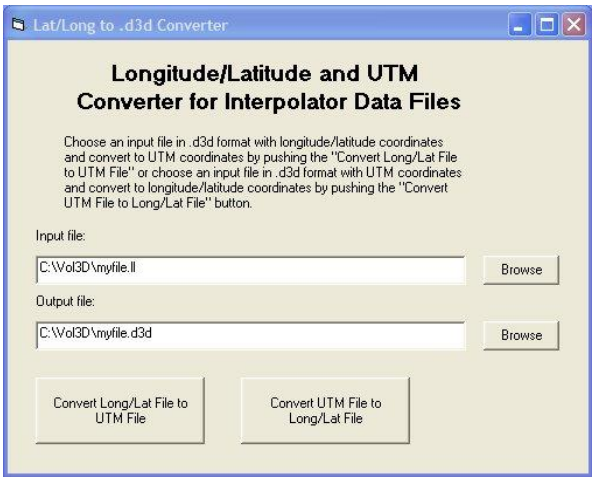


Figure 3-5. Data Import screen file converter for converting longitude and latitude coordinates to UTM coordinates and vice versa. Longitude and latitude must be entered in the input file as decimal degrees. The input file must use the standard .d3d file format. North American Datum (NAD) is assumed as NAD83 and does not convert from NAD27.

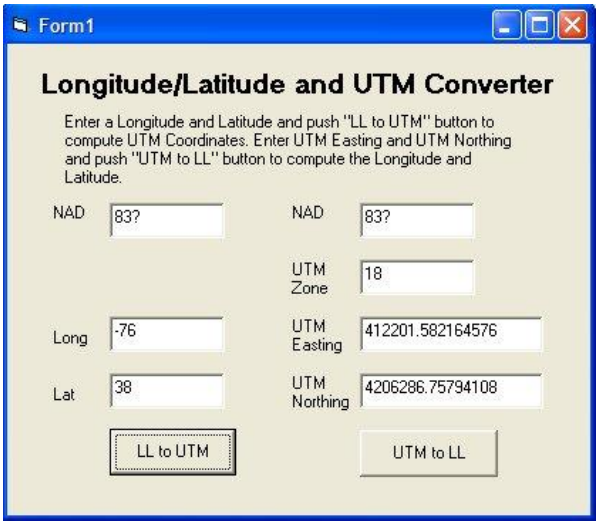


Figure 3-6. Data Import screen general purpose UTM converter for converting longitude and latitude coordinates to UTM coordinates and vice versa. North American Datum (NAD) is assumed as NAD83 and does not convert from NAD27. NAD is labeled (83?) to remind the user to use datum 83 coordinates.

4. Interpolate Button

Click the **Interpolate Button** to select the Interpolate screen (Figure 4-1). Select the interpolator settings that match your requirements. The 3D Inverse-Distance Squared model is the 3-dimensional interpolator model. The 2D Inverse-Distance Squared model uses the same code as the 3D interpolator model except that only one layer of cells are computed--cells for each depth below the surface cell are set to missing (normally -9). The 2D Octant Search model computes values for cells in only one layer, however, the data used for computing each cell value are selected from data in each surrounding octant. For instance, for a given cell, the data used for calculation would include 4 data points from each surrounding octant, or a total of 32 data points. The model will use fewer than the total data in each octant if insufficient data exist. The model uses as many data as are available for each octant, up to the maximum requested number of data points. The octant search model is used to reduce the bias from sampling schemes that collect continuous strings of data, such as aircraft monitoring that collect many data points in well defined flight tracks. The run-time for the octant search model is significantly longer due to the extensive sorting required to select data from each data octant.

The "Trace Level" selects the amount of detail written to the ".LOG" file. A "Trace Level" of "2" provides general interpolator statistics. A "Trace Level" of "3" provides information about the data values used in the computations for each region. A "Trace Level" of "4" provides information about individual cell computations. A "Trace Level" of "5", "6", or "7" provides increasing information about data values, distances, and octants. Increasing the "Trace Level" value is useful for investigating the performance of the interpolator.

The “Convert .EST to .TXT” button will create a .txt file that can be imported into Arc/Info or ArcView. The .txt files are a full matrix of values, 57 columns wide, with all missing or non-existent cell values designated as missing values (normally -9), comma delimited, and column headings and text strings are enclosed in quotes. Each row in the .txt file represents numbers from 1 column of water from top to bottom, 1 cell wide by n cells deep. Additional columns are appended to the .txt file for bottom, minimum, maximum, mean, and sum values.

The “Convert .EST to .T3D” button will create a .txt file that can be imported into other applications. The .t3d files are 4 columns wide, comma delimited, contain the x value, y value, negative z value, and the estimated value. There are no column headings. Missing values are included and are coded based on what was selected during the interpolation.

Refer to section 8. FILE DEFINITIONS AND STRUCTURE for details about file formats and definitions.

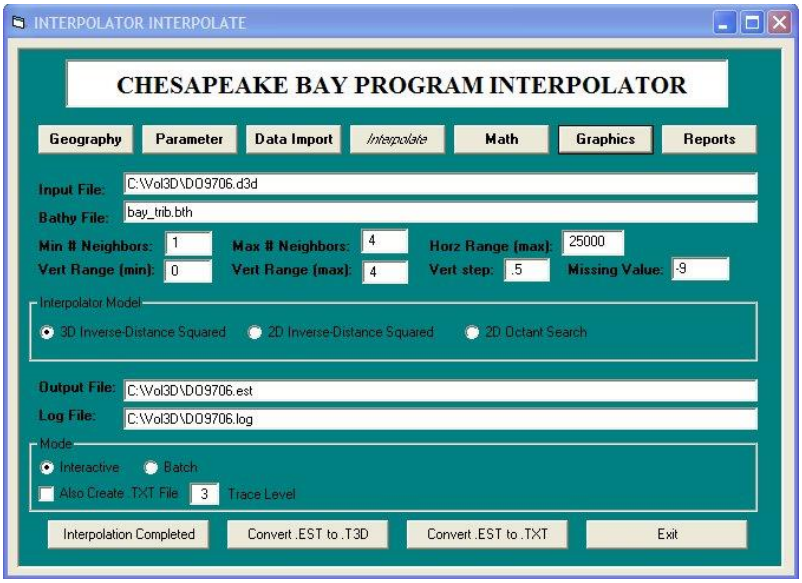


Figure 4-1. 3D Inverse-Distance Squared Interpolate screen populated with entries after having made choices on previous screens. The 2D Inverse-Distance Squared Interpolate screen uses the same format as the 3D Inverse-Distance Squared model; however, only the surface depth value has computed values. Cell values at depths below surface are set to missing (generally -9). The 2D Octant Search Interpolator does not rely only on the closest data in all directions, but rather uses data from data from surrounding octants. For example, if 4 nearest neighbors are requested in each of 8 octants surrounding the cell being computed--up to 32 nearest neighbor values will be used to compute the value. If no nearest neighbor values are available, a missing value will be computed. Other buttons are available for creating data using specific formats for various GIS (.txt files) and graphics applications (.t3d files).

The interpolator mode can be set to “Interactive” or “Batch”. In interactive mode, the chosen file is interpolated as defined in Figure 4-1. In “Batch” mode, a job file is selected which provides the information needed to interpolate a series of files under machine control (Figure 4-2). The “.job” file can be built interactively by pressing the “Save to Batch Job” button after selecting the run parameters for each desired file (Figure 4-3). The “Batch Job” can be executed by pushing the “Run Batch Job” button.

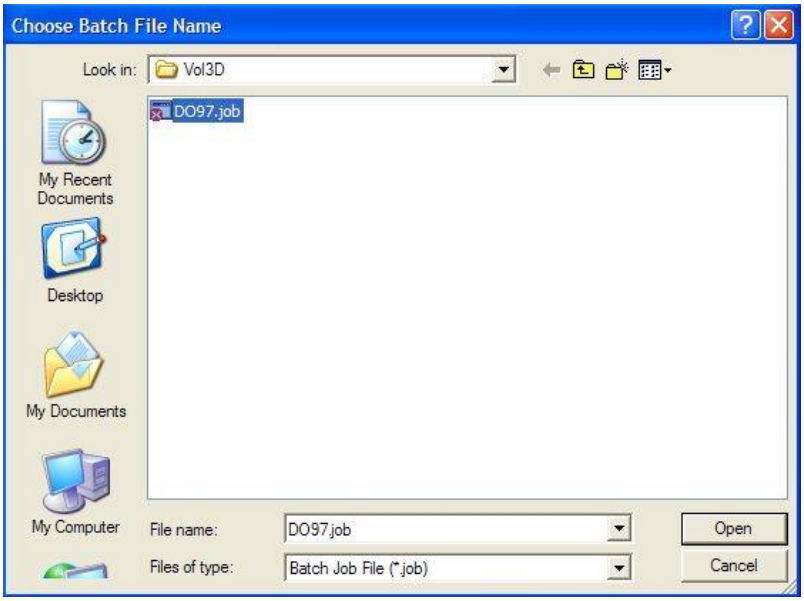


Figure 4-2. Batch Job File Name selection window that displays after choosing "Batch" radio button on the Interpolation screen.

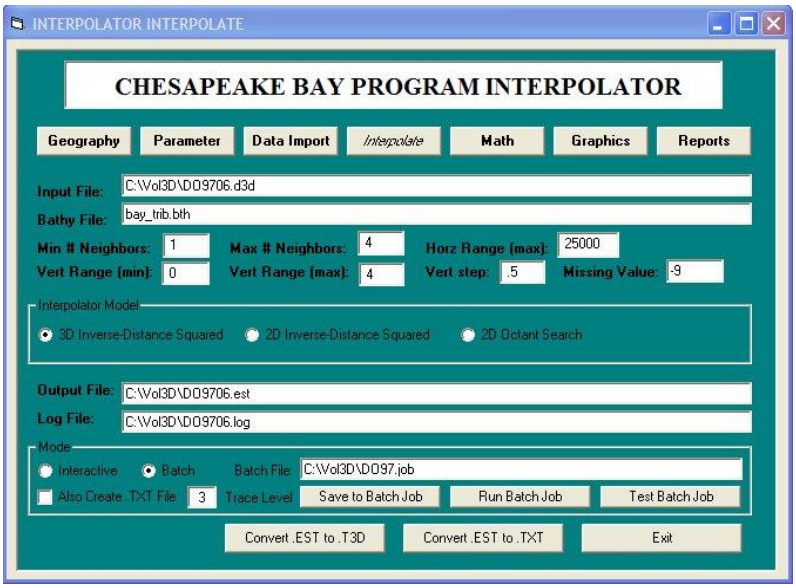


Figure 4-3. Saving or running a batch job through the Interpolate screen. "Save to Batch Job" saves the values that have been entered in the fields on this screen into the "Batch File ('filename'.job)". If the 'filename'.job file already exists, the new entry is appended to the existing file. If it does not exist, a new file is created. The "Output File" file name entry is also

written to a file (‘filename’.fls) for use in creating volume and mass estimates by running batch jobs. The .fls file is simply a list of interpolated (.est) file names that can be processed sequentially. The “Test Batch Job” button executes a batch job but does not run the interpolator. This button can be used to test whether the needed files exist and the batch job is sound prior to execution of the interpolator.

5. Math Button

Click the **Math Button** if you need to conduct special operations on one or more files. Four functions are provided: 1) Math operations which include adding, subtracting, multiplying, or dividing one interpolated file by another, or by a constant; 2) Recoding values to new values; 3) Conducting a change analysis over time; and, 4) Calculating the minimum or maximum values from a set of files.

Math functionality is provided so that special parameters can be calculated. Math is conducted on a cell by cell basis. For instance, to add two interpolated files, Cell 1 of input file A is added to Cell 1 of input file B and the sum is stored in Cell 1 of output file C, and so forth. Subtracting one file from another can be used to show change from one time to another (Figure 5-1). Missing values are handled as in regular math—a non-missing value becomes missing if a math operation attempts to compare a real value with a missing value. Division by zero or other illegal math operation will cause the operation to stop.

The "Derive New Parameter" math operations can be performed sequentially to provide additional capability. For instance, five interpolated files (.est files) could be sequentially added together, then the resulting file could be divided by 5 to compute the mean for the five files. Another example would be to subtract interpolated dissolved oxygen data from an interpolated saturated dissolved oxygen file to compute the oxygen deficit.

The code checks whether the input files have the same number of segments. If the input files ("Input .est File 1" and "Input .est File 2") do not have the same number of segments, they were generated from different bathymetry files, and the cell values in the two files can not be properly combined. An error message will be displayed if this condition occurs.

The "Recode Parameter Value" radio button provides the means to convert calculated values to new values (Figure 5-2). The input file is not changed, but a new output file is created with new values in each cell which classify the data into new values or categories. For example, to compute the interaction of dissolved oxygen and water temperature:
1) Recode the dissolved oxygen .est file so that oxygen below 3 mg/l is set to "1" and oxygen above 3 is set to "0" (also set missing to -9).
2) Recode the water temperature .est file so that temperature below 25C is set to "0" and temperature above 25C is set to "10" (also set missing to -9).
3) Derive a new parameter "WD" by adding the recoded dissolved oxygen and water temperature .est files. The result is a wd.est file where: "0"=acceptable oxygen and temperature; "1"=unacceptable oxygen; "10"=unacceptable temperature; and "11"= unacceptable oxygen and unacceptable temperature (missing cells will = -9). This file can be graphed to show the distribution of these categories. The water column volume of these categories can also be computed to show critical ranges for habitat analysis.

Missing values are handled in a special way. Since missing values have no real value, they are not used in math operations. If a cell in either "Input File 1" or "Input File 2" are flagged as missing (normally –9), then no math is done, and the "Output File" value for that cell is set to

missing (The "Missing Value" is set on the Interpolate screen).

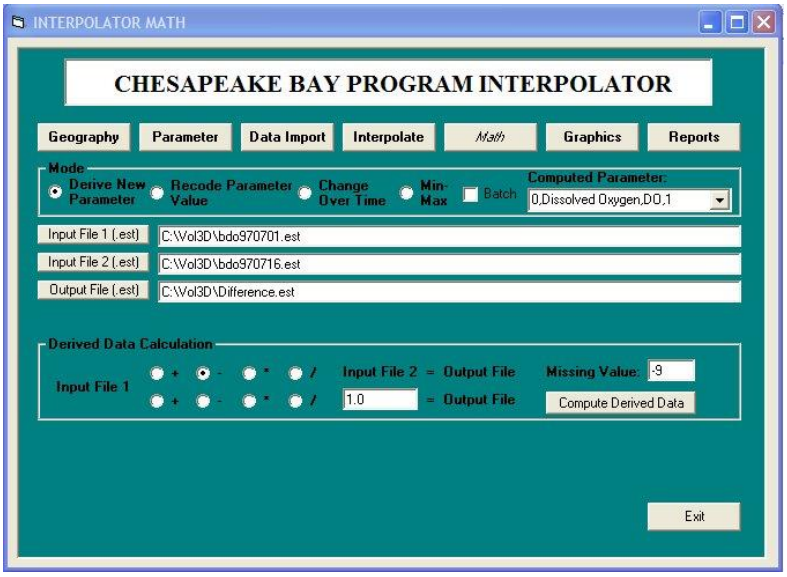


Figure 5-1. Math screen with files chosen to "Derive New Parameter" of Dissolved Oxygen by subtracting File 2 from File 1 to create the output file.

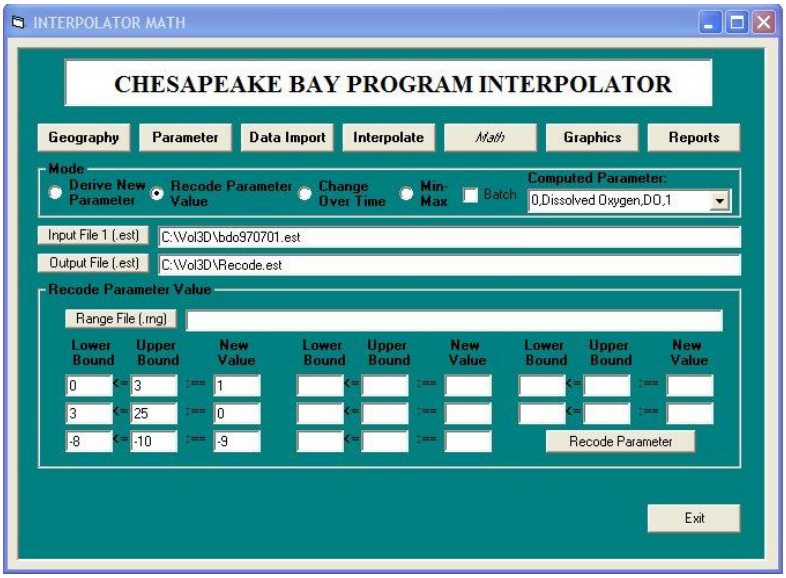


Figure 5-2. Math screen with files chosen to "Recode Parameter Value" of Dissolved Oxygen by recoding values from 0-3 to the new value of "1", recoding values of above 3 to the new value of "0" and retaining missing values as –9, to create the new output file. Choosing a Range File is provided to load an existing set of ranges, which can then be modified on this screen for specialized analyses.

Trends Analysis

Interpolated values can be analyzed for trends. The "Change Over Time" button allows the user to create a 3-dimensional (.est) file with linear percentage changes over time for each cell in the bathymetry (Figures 5-3 and 5-4).

As a simple example, a station may be sampled several times over a period of time. The Monitoring data can be plotted with time on the x-axis and the measured value on the y-axis. The resulting linear regression line can be plotted through these points and the slope and intercept can be used to compute the percentage increase or decrease between the beginning and end of the time series.

This same technique can be used with the interpolator to generate a 3D map of trends, which can be used to visualize spatial and temporal change in a single graphic. Each cell value from a series of .est files can be used to compute a linear regression, so that each cell has its own regression and resulting percentage change, either up or down, over time. By coding the result as the percent change, an interpolated .est file can be created that has a percentage change value for each cell. This .est file represents a 3D file of "Change Over Time". A plot of this file provides a graphical representation of the change. The categories used to display the changes graphically are defined in the pc.rng file. The default pc.rng file provides categories of: >+10%, +5 to +10%, 0 to +5%, -5 to 0%, -10 to -5 %, and >–10 % change. These categories should be modified to reflect the needs of the analysis.

Missing values in the analysis can be treated in two ways: 1) included, meaning they are propagated through the analysis; or, 2) ignored. The default is to include missing values. The result of including missing values is that if one value for a specific cell is missing anytime in the times series, then that cell is set to missing. A single missing value forces the whole series of values at that cell location to be missing and no percentage change is calculated. The percentage change value is set to missing (-9 by default).

If missing values are set to be ignored, then each missing value in a time series for a given cell is ignored and the rest of the time series observations are used to compute the percentage change over time. The potential problem with this approach is that the trend may be skewed by the lack of having all of the desired data.

At least two points are required to compute a time series change. If the number of observations for any cell is less than 2, the resulting value for the percentage change is set to missing.

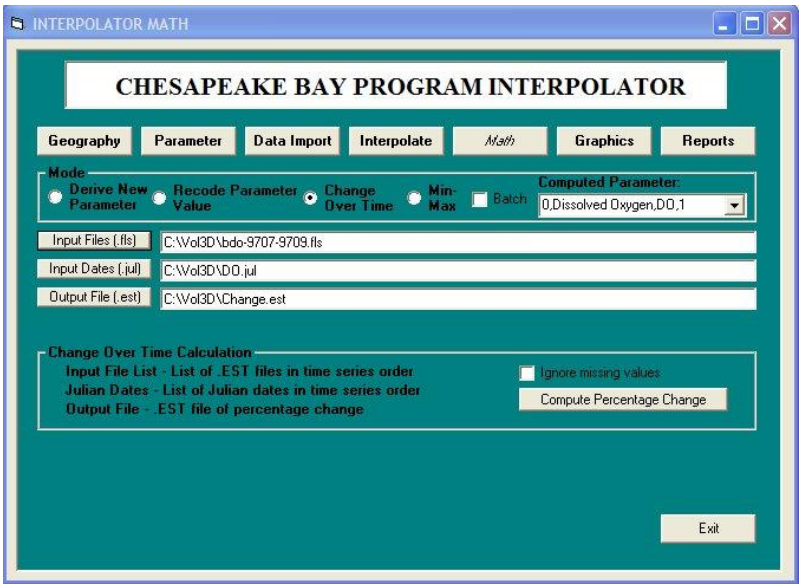


Figure 5-3. Math screen with files chosen to "Change Over Time". The bdo-9707-9709.fls file contains file names of dissolved oxygen .EST files. The corresponding Julian dates for these .EST files are read from the do.jul file. The .jul file, which provides the date or time variable for the regression, must have one date for each .est file. In this example, a new .EST file – Change.est – is created which contains the linear trend for each cell over the time interval of the bdo-9707-9709.fls file. The Change.est cell values are percentage change over time, categorized by the selection criteria identified in the pc.rng file. In this example, "Ignore missing values" has not been selected.

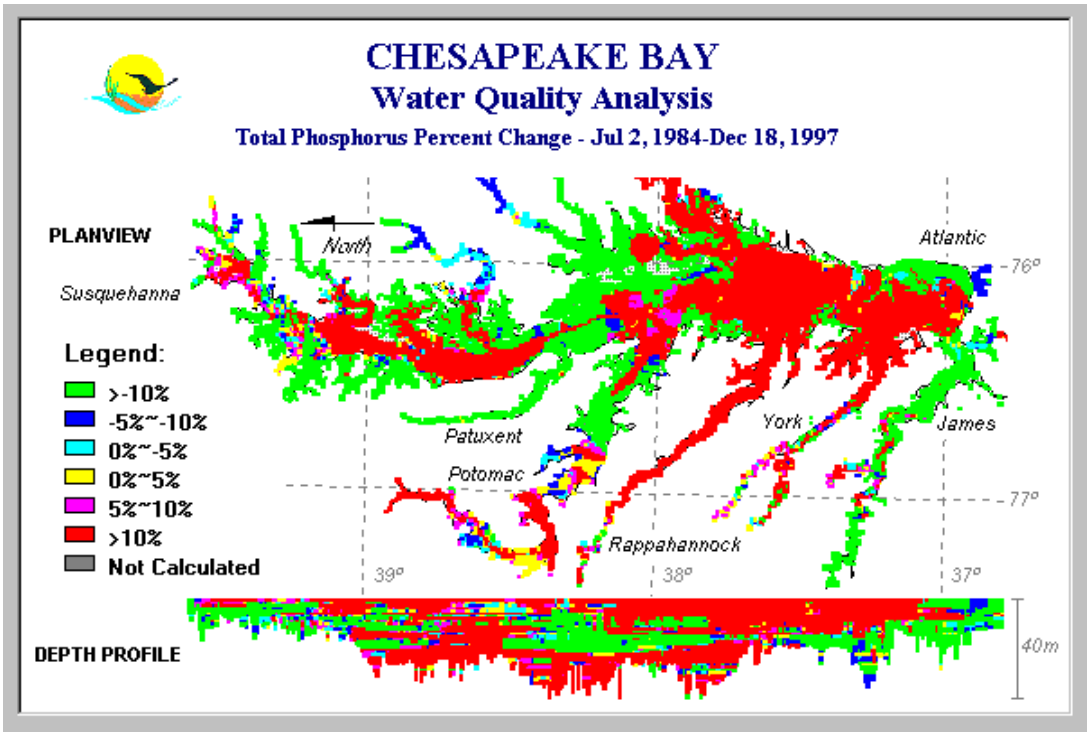


Figure 5-4. Plot of total phosphorus as a "Change Over Time". In this example, a new .EST file – tp8497.est – was created which contains the linear trend for each cell over the time interval (July 1984 through December 1997) of the tp8497.fls file. The tp8497.est cell values are percentage change over time, categorized by the selection criteria identified in the pc.rng file. The percentage change categories for total phosphorus mass (kg) are: >10% increase (red); 5 to 10% increase (pink); 0 to 5% increase (yellow); 0 to 5% decrease (light blue); 5 to 10% decrease (dark blue); and greater than 10% decrease (green). In this example, "Ignore missing values" was selected so that a trend on any available data was calculated.

Minimum-Maximum Analysis

The "Min-Max" button can be selected to locate the minimum or maximum values in a series of interpolated values. For instance, this function could be used to read ten interpolated files, and find for Cell 1 the minimum value and write that minimum value to the output file Cell 1. This process would be repeated for each cell, so the resulting output file would contain the minimum value for each cell in the series. The Maximum function could be chosen if desired to find the maximum cell values in a series of files. These functions are useful for determining, for example, the lowest salinity over a 10-year period, or the highest temperature over a year period, for each cell in the interpolated files (Figure 5-5).

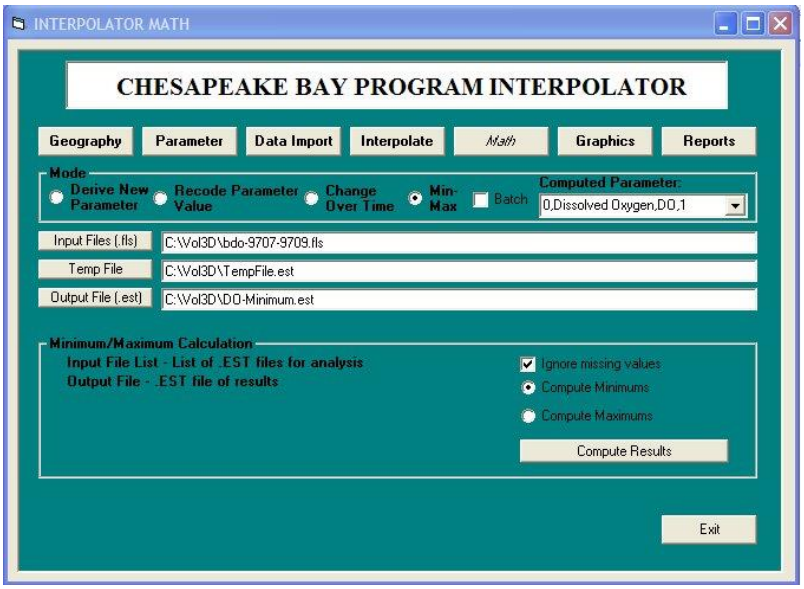


Figure 5-5. Min-Max screen to capture the minimum oxygen values in each cell over the July-September timeframe in 1997. The bdo-9707-9709.fls file contains file names of interpolated dissolved oxygen .EST files. The Temp file is an intermediate working file that can be deleted after the job is completed. In this example, a new .EST file – do-minimum.est – is created which contains the minimum value for each cell over the time interval of the bdo-9707-9709.fls file. In this example, "Ignore missing values" has been selected.

6. Graphics Button

Click the **Graphics Button** to select the Graphics screen. In this version, interpolated data can be displayed in Plan View (looking down on the Bay and tidal tributary rivers) and a Side View (looking at the vertical dimension of the Bay and tidal tributaries from the West), for the Bay and tributary rivers, or just specific rivers.

The Graphics screen provides a means to choose all of the variables needed to create the Bay/Trib graphic. Most of the choices are driven by the files being graphed, to help minimize typing all of the required information. The graphic can be printed or saved to a .BMP file (Figures, 6-1, 6-2, and 6-3).

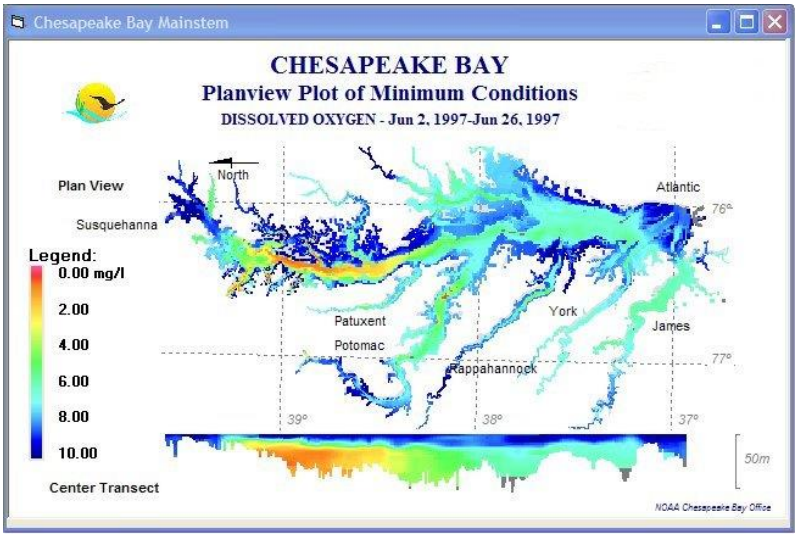


Figure 6-1. Example of Bay and Tributaries graphic of interpolated dissolved oxygen using a continuous color gradient to represent concentrations on the surface (Plan View) and Center Transect of the mainstem.

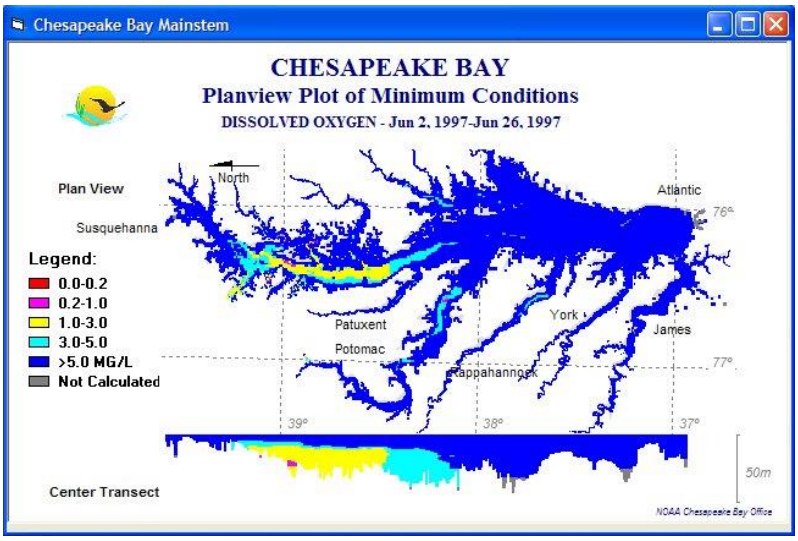


Figure 6-2. Example of Bay and Tributaries graphic of interpolated dissolved oxygen using Concentration Ranges to represent concentrations on the surface (Plan View) and Center Transect of the mainstem. This graphic is derived from the same data as Figure 6-1, but concentrations have been grouped by ranges which can be useful in determining visually if criteria have been met.

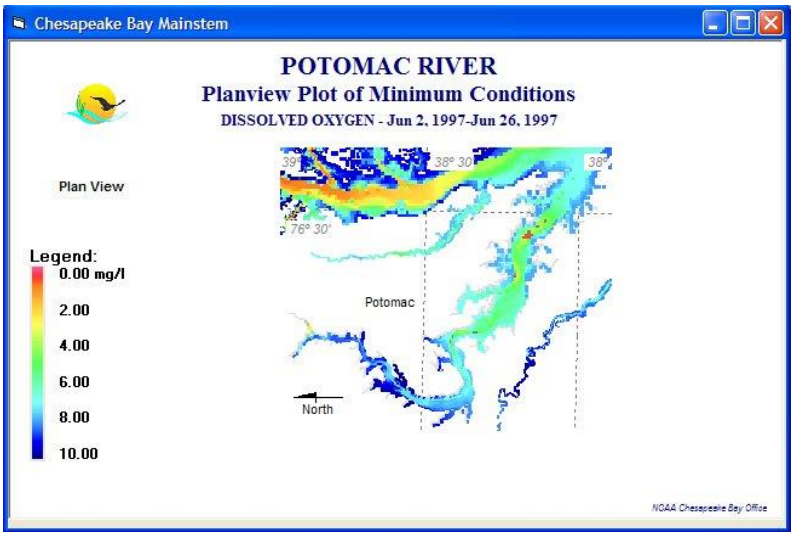


Figure 6-3. Example of Potomac River graphic of interpolated dissolved oxygen. This graphic was prepared using the same interpolated data file as Figures 6-1 and 6-2, but using a Potomac River map layout. Note that the cell sizes are smaller in the narrow northern reaches of the Potomac (500m x 500m) than the cell sizes near the Bay (1km x 1km).

Graphics Production

The first graphics screen (Figure 6-4) displays a list of base maps that can be selected by clicking. Figure 6-1 was created by selecting the "Bay and Tribs" Graphic Area, "Color Gradient" Colors, and "Top and Side View" View. Figure 6-2 was created by selecting the "Bay and Tribs" Graphic Area, "Color Categories" Colors, and "Top and Side View" View. Figure 6-3 was created by selecting the "Potomac River" Graphic Area, "Color Gradient" Colors, and "Top" View.

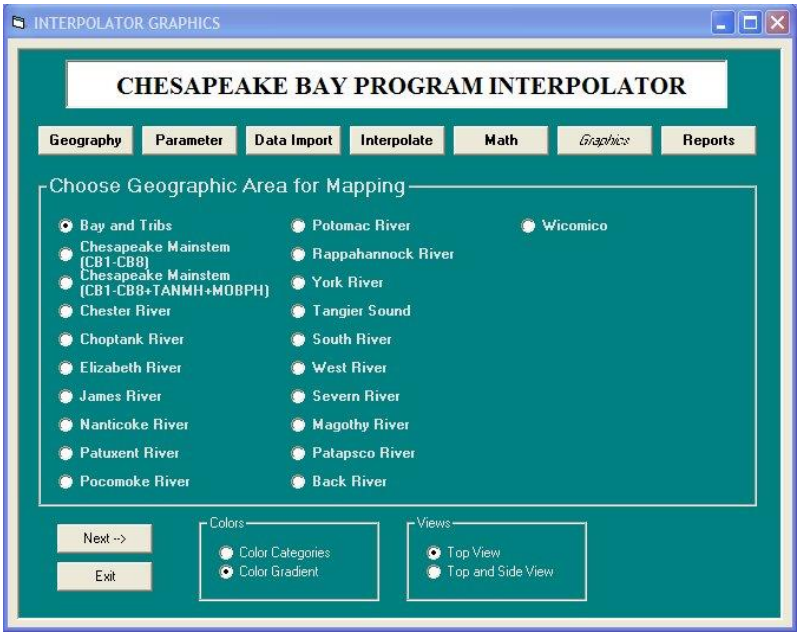


Figure 6-4. The first Interpolator Graphics screen provides several preprogrammed geographic areas as base maps for displaying interpolated data. This screen also provides a choice of colors displayed as a continuous gradient or by color categories.

Color Gradient Graphics Production

Graphics using color gradients are created on a subsequent, but fairly busy graphics design screen (Figures 6-5 and 6-6).

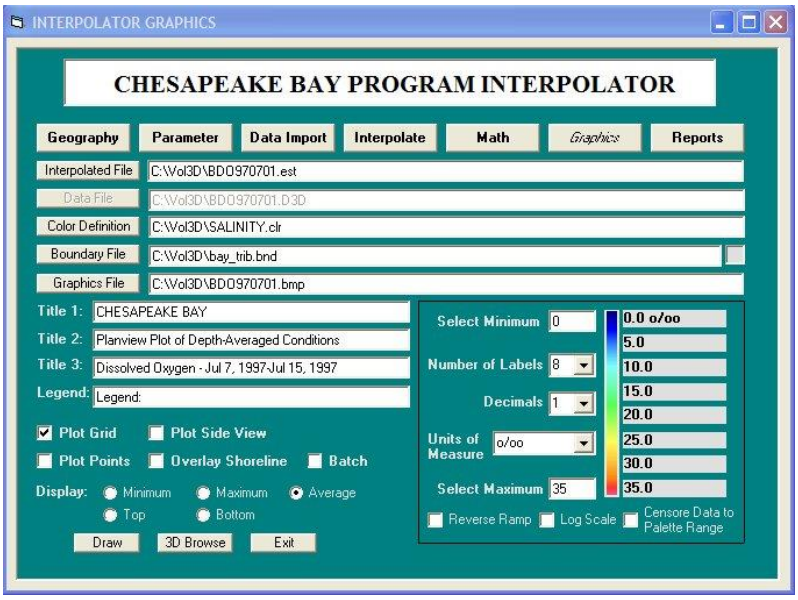


Figure 6-5. The Color Gradient graphics design screen allows the user to customize graphics of an interpolated (.est) data file. The color gradient control is initially programmed by information stored in the "Color Definition" .clr file. The "Boundary File" defines the base map, for instance, "Bay and Tribs" or "Potomac River". The small gray box on the right sets the background color of the interior of the map. The "Graphics File" is the name used for saving the graphic. Title 1, 2, and 3 are the title lines displayed at the top of the graphic. These titles have default entries that can be altered by typing in whatever is desired. The "Legend" is an additional title line on the graphic to give a title to the legend block. "Plot Grid" when checked causes a longitude/latitude grid to be displayed. "Plot Side View" selects whether a center transect depth view is displayed. Not all tributary graphics have a center transect file. "Plot Points" selects whether circles are drawn where data in the .d3d file exist. The circles are filled with the color of the data point. "Overlay Shorelines" selects whether the shoreline is plotted over the graphic. "Batch" selects whether a whole series of graphics are prepared. "Display" selects what data are represented in the graphic, i.e., minimum, maximum, or average (mean), or top layer or bottom layer. The chosen data strongly influence what the graphic displays as a communication technique. Title 2 changes to reflect what data are being mapped.

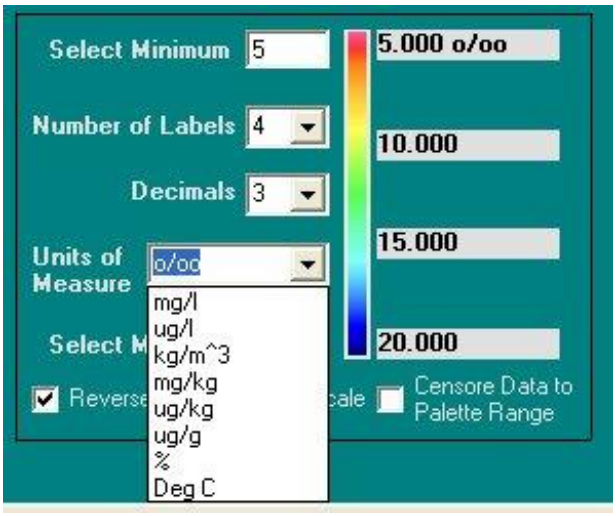


Figure 6-6. The Color Gradient control allows programming of the range of colors representing the data, the units of measure, and the number of labels. The number of decimals displayed can also be chosen. The gradient can be reversed and can be scaled as logarithms. Units of measure can be chosen from a pull down list. "Censore (truncate) Data to Palette Range" selects only those data that fall within the range to be displayed.

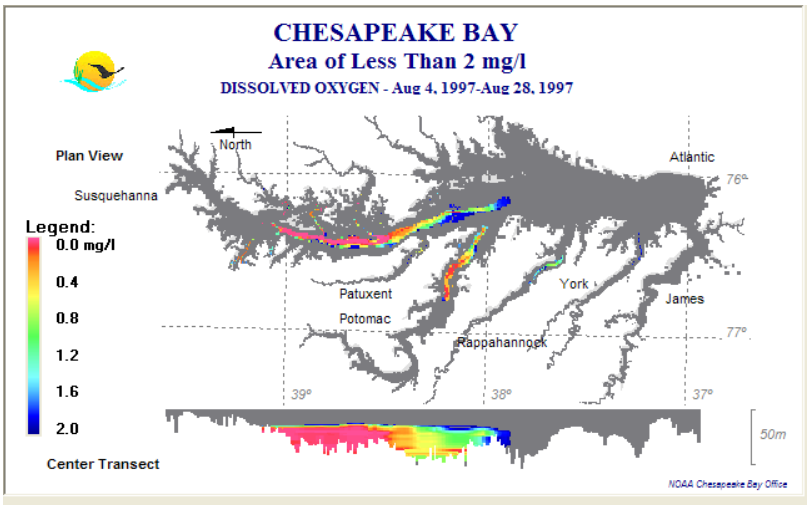


Figure 6-7. This graphic resulted from setting the Color Gradient range from 0 to 2 mg/l and selecting "Censore Data to Palette Range". Only those cells with concentrations of 0 to 2 are displayed.

Color Categories Graphics Production

Graphics using color categories are created using a graphics design screen tailored to defining color ranges and associating colors to those ranges (Figure 6-8). See section "**8. File Definitions**

and Structure, Parameter Range Files (.rng)" for a full description of how to define color ranges and associated colors. During data selection, data of the minimum value of the range are included in the range, but data within the range must be less than the upper value of the range-- in mathematical notation the decision criteria are "lower range value <= data value < upper range value"

The **Batch** checkbox can be selected to process a group of files (.est file names are read from a *.fls file). If **Batch** is chosen, the program prompts the user to choose a *.fls file. **Title 3** and **Graphics File** will automatically change for each plot based on the information contained in the .est file. Other titles and legends will display based on what is displayed when the **DRAW** button is pushed. Each graphic will automatically be saved to a unique .bmp graphics file.

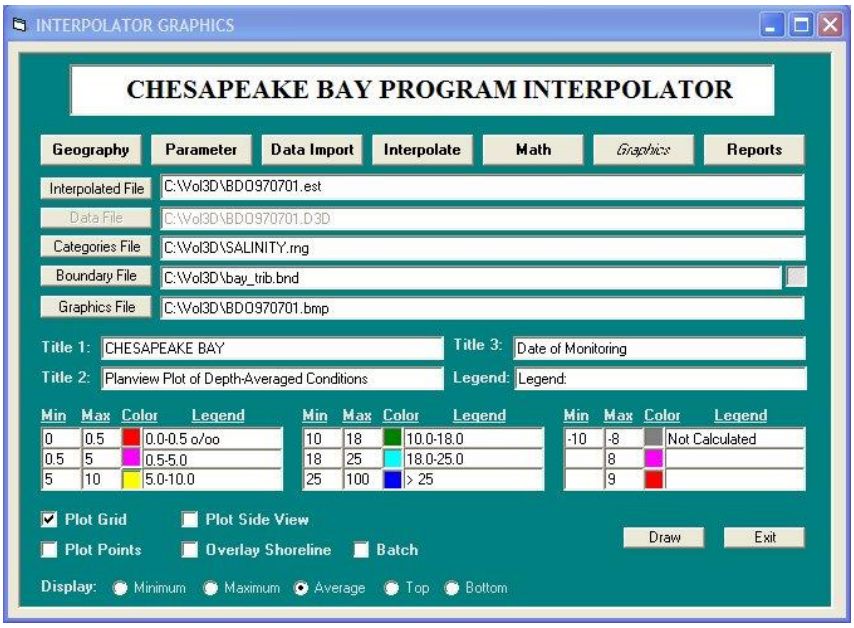


Figure 6-8. The Color Categories graphics design screen allows the user to customize graphics of an interpolated (.est) data file. The color categories control is initially programmed by information stored in the "Categories File" (.rng file), which includes the minimum for the range, the maximum for the range, the color code, and a legend for the range. The "Boundary File" defines the base map, for instance, "Bay and Tribs" or "Potomac River". The small gray box on the right sets the background color of the interior of the map. The "Graphics File" is the name used for saving the graphic. Title 1, 2, and 3 are the title lines displayed at the top of the graphic. These titles have default entries that can be altered by typing in whatever is desired. The "Legend" is an additional title line on the graphic to give a title to the legend block. "Plot Grid" when checked causes a longitude/latitude grid to be displayed. "Plot Side View" selects whether a center transect depth view is displayed. Not all tributary graphics have a center transect file. "Plot Points" selects whether circles are drawn where data in the .d3d file exist. The circles are filled with the color of the data point. "Overlay Shorelines" selects whether the shoreline is

plotted over the graphic. “Batch” selects whether a whole series of graphics are prepared. “Display” selects what data are represented in the graphic, i.e., minimum, maximum, or average (mean), or top layer or bottom layer. The chosen data strongly influence what the graphic displays as a communication technique. Title 2 changes to reflect what data are being mapped.

7. Reports Button

Click the **Reports Button** to generate files for volumetric and mass analysis.

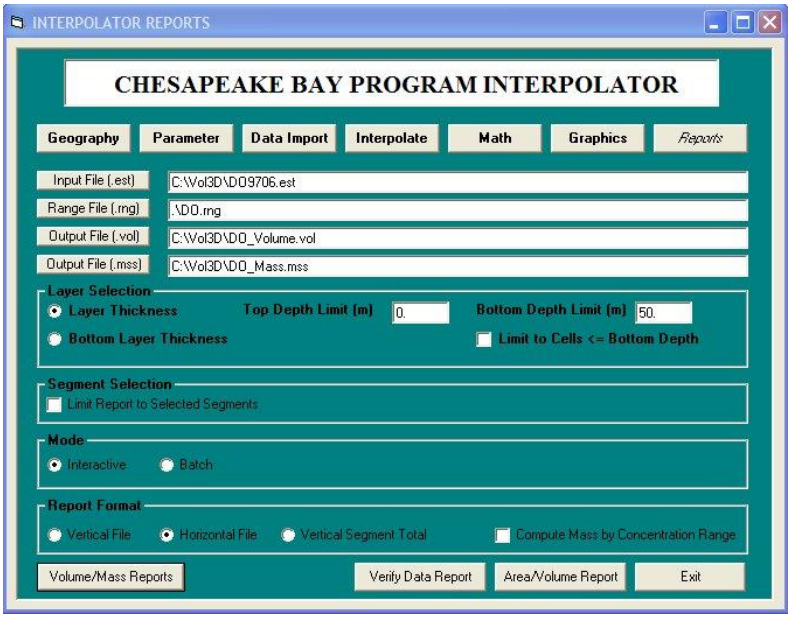


Figure 7-1. The Reports screen is used to compute volume and mass. In Interactive mode, an interpolated file (.est) is processed to create a file of water volumes by parameter range category by segment. A file of parameter mass is also computed by segment. If the "Compute Mass by Concentration Range" is checked on, then the mass calculations are also separated by the same category ranges as the volume calculations.

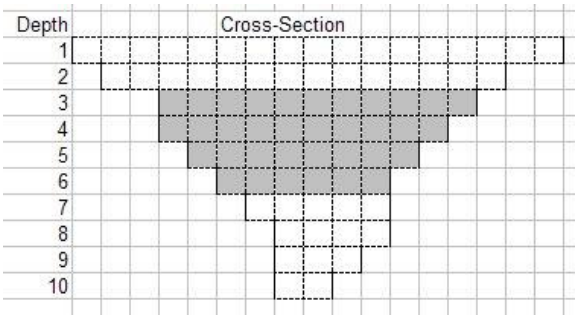


Figure 7-1a. Graphical example of choosing a "Layer Thickness" of 3m through 6m. Gray cells of 3-6m will be included in this hypothetical analysis.

The "Layer Thickness" is set by default to 0-50 meters deep to include all cells in the interpolated file. This thickness could be set, for example, to 3-6 meters to calculate the volume and mass for the desired parameter in water 3 through 6 meters deep (Figure 7.1a). Cells to be included in the analysis are selected for depths between and including the top and bottom limits. Selecting "Limit to Cells <= Bottom Depth" limits the analysis to those columns of cells where

the bottom cell has a depth less than or equal to the "Bottom Depth Limit" and has the practical purpose of rejecting deep water areas from a shallow water analysis. The effect of this decision rejects all water depths from the analysis where the total depth is greater than the "Bottom Depth Limit". For example, if the "Bottom Depth Limit" is set to 3m and the "Limit to Cells <= Bottom Depth" is checked on, then only those locations where total depth is less than or equal to 3m will be counted (Figure 7-1c). This feature could be used to calculate the volume of shallow water that might support submerged aquatic vegetation growth, or to calculate the mass of chlorophyll in that shallow water area. Not checking the "Limit to Cells <= Bottom Depth" checkbox, will include all water depths to be included where data exist at depths within the lower to upper depth range. The effect this choice would have on the previous example would be that cells with depths less than 3m would be included from deep water areas (Figure 7-1b).

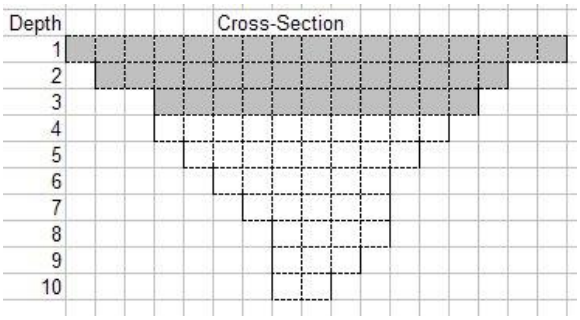


Figure 7-1b. Graphical example of choosing a "Layer Thickness" with "Top Depth Limit" = 0m and "Bottom Depth Limit" = 3m, and "Limit to Cells <= Bottom Depth" checkbox off. Gray cells will be included in this hypothetical analysis.

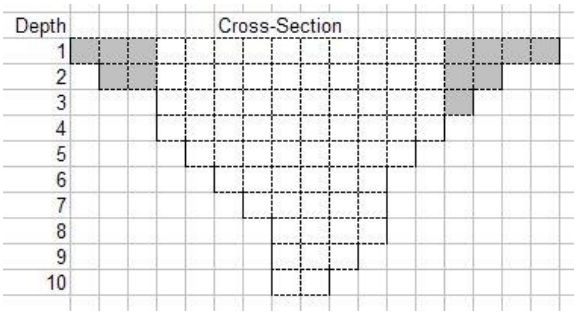


Figure 7-1c. Graphical example of choosing a "Layer Thickness" with "Top Depth Limit" = 0m and "Bottom Depth Limit" = 3m, and "Limit to Cells <= Bottom Depth" checkbox on. Gray cells will be included in this hypothetical analysis.

The resulting volume (.vol) and mass (.mss) files can be used for creating numerical or graphical reports, such as trends plots (Figure 7-6). Volume is reported in liters. Mass (or counts of organisms) is reported relative to the values from the monitoring data, ie, whether mg/l, ug/l, or counts/l. See Section 8 for a full discussion.

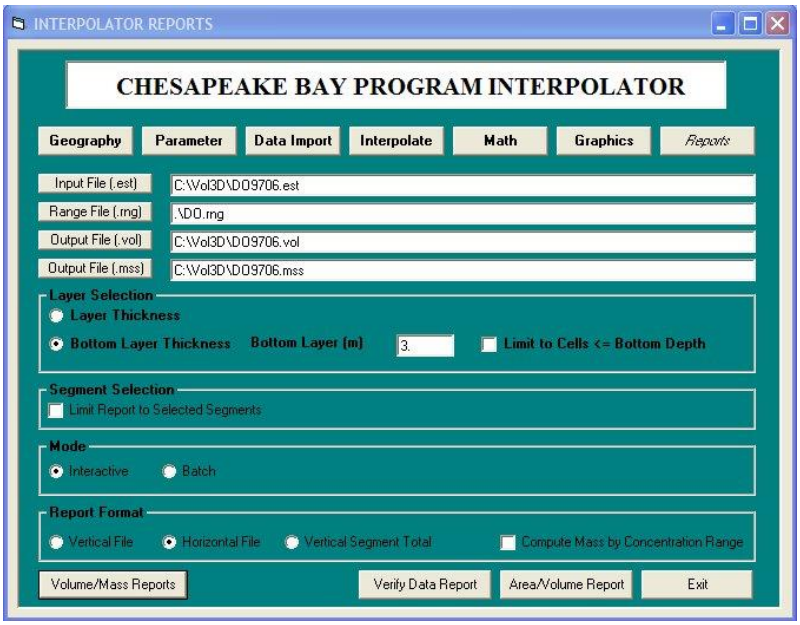


Figure 7-2. The Reports screen with "Bottom Layer Thickness" selected and set to the bottom 3 meters of water column depth. Only the cells in the selected bottom 3m layer will be processed for volume and mass calculations; cells above the bottom 3m layer will be excluded from the analysis. Where total depths are less than 3m, all of that water will be included in the analysis for this example.

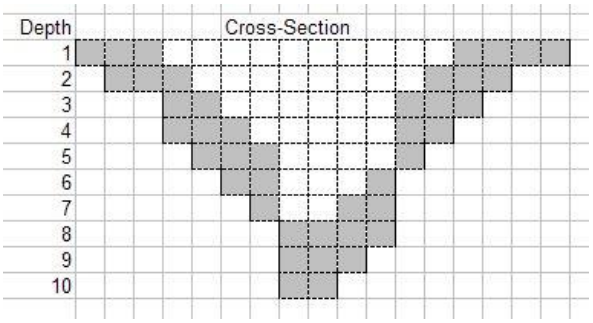


Figure 7-2a. Graphical example of choosing a 3m Bottom Layer Thickness, and "Limit to Cells <= Bottom Depth" checkbox off. Gray cells will be included in this hypothetical analysis.

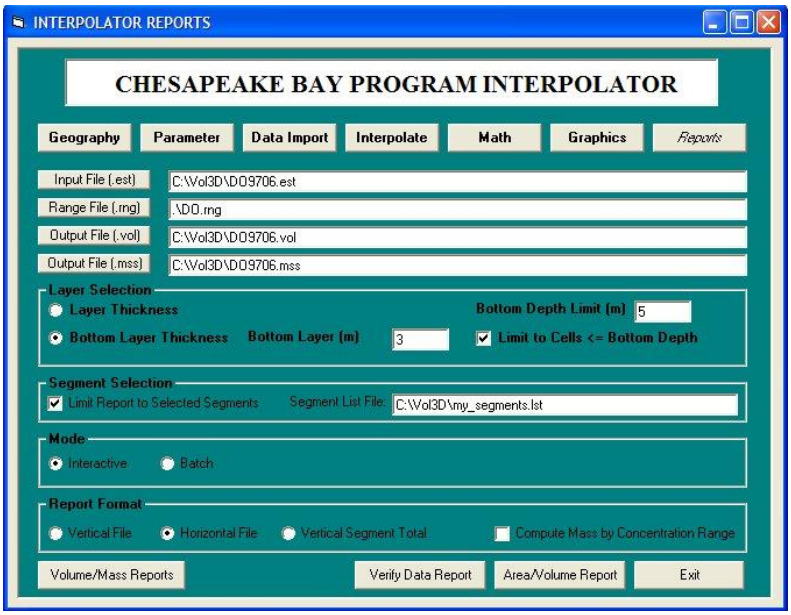


Figure 7-3. The Reports screen with "Bottom Layer Thickness" selected and set to the bottom 3 meters of water column depth. Selecting "Limit to Cells <= Bottom Depth" limits the analysis to those columns of cells where the bottom cell has a depth less than or equal to the "Bottom Depth Limit" (5 in this example, so that only shallow water that has a total depth equal to or less than 5m is selected). Then, only the cells in the bottom 3m layer of that shallow water will be processed for volume and mass calculations. Where total depths are less than 3m, all of that water will be included in the analysis for this example.

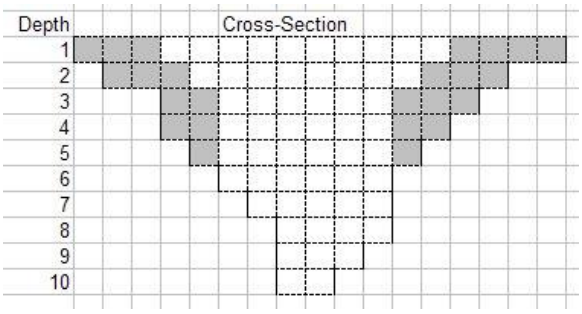


Figure 7-3a. Graphical example of choosing a 3m Bottom Layer Thickness, "Limit to Cells <= Bottom Depth" checkbox on, and "Bottom Depth Limit" = 5m. Gray cells will be included in this hypothetical analysis.

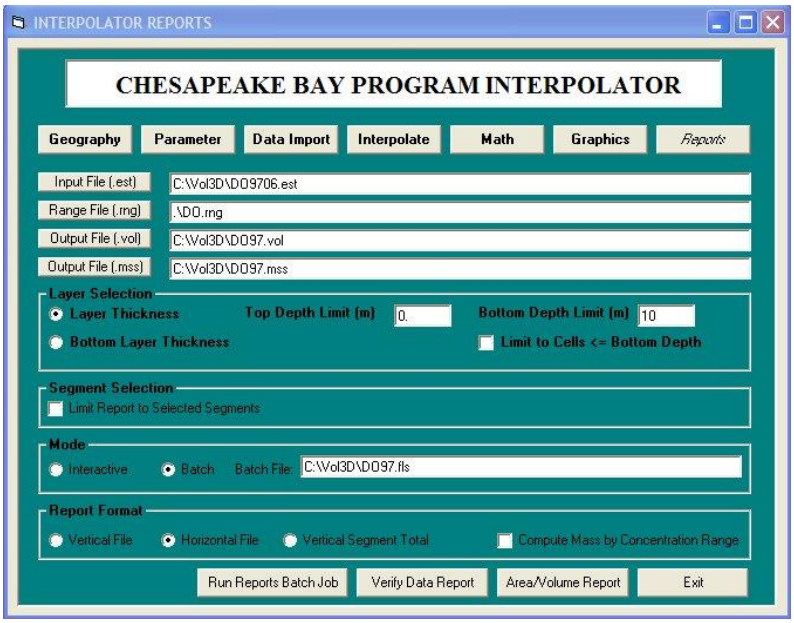


Figure 7-4. The Reports screen with "Batch" mode selected. In Batch mode, a list of interpolated file names (.est filenames stored in the file DO97.fls for this example) are processed sequentially to create a file (DO97.vol) of water volumes by parameter range category by segment. A file of parameter mass (DO97.mss) is also computed by segment. If the "Compute Mass by Concentration Range" is checked on, then the mass calculations are also separated by the same category ranges as the volume calculations. This example calculates volume and mass for DO in the top 10 meters of the water column. Each successive set of computed numbers are appended to the same specified "Output File" (.vol and .mss).

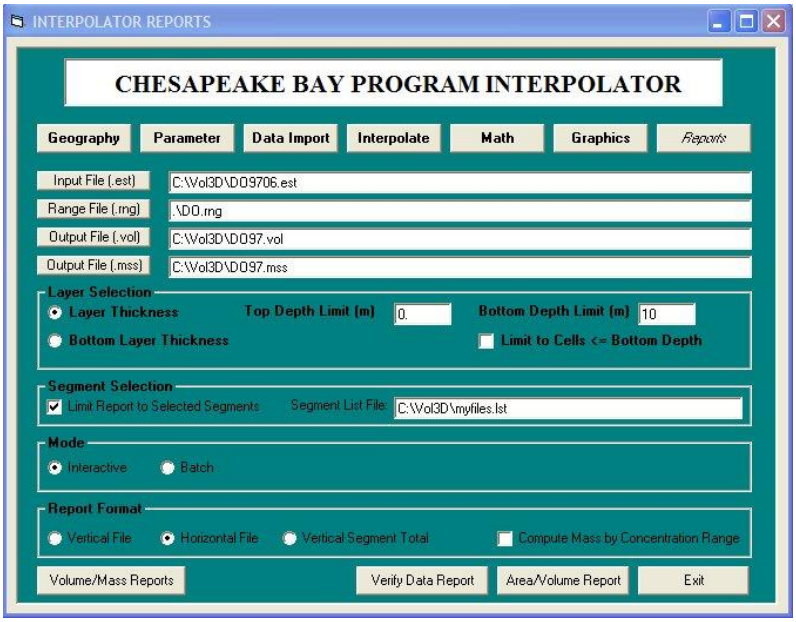


Figure 7-5. The Reports screen is used to compute volume and mass. In Interactive mode, an interpolated file (.est) is processed to create a file of water volumes by parameter range category by segment. A file of parameter mass is also computed by segment. If the "Limit Report to Selected Segments" is checked on, then the volume and mass calculations are computed only for the segments identified in the "filename".lst file. Each successive set of computed numbers are appended to the same specified "Output File" (.vol and .mas).

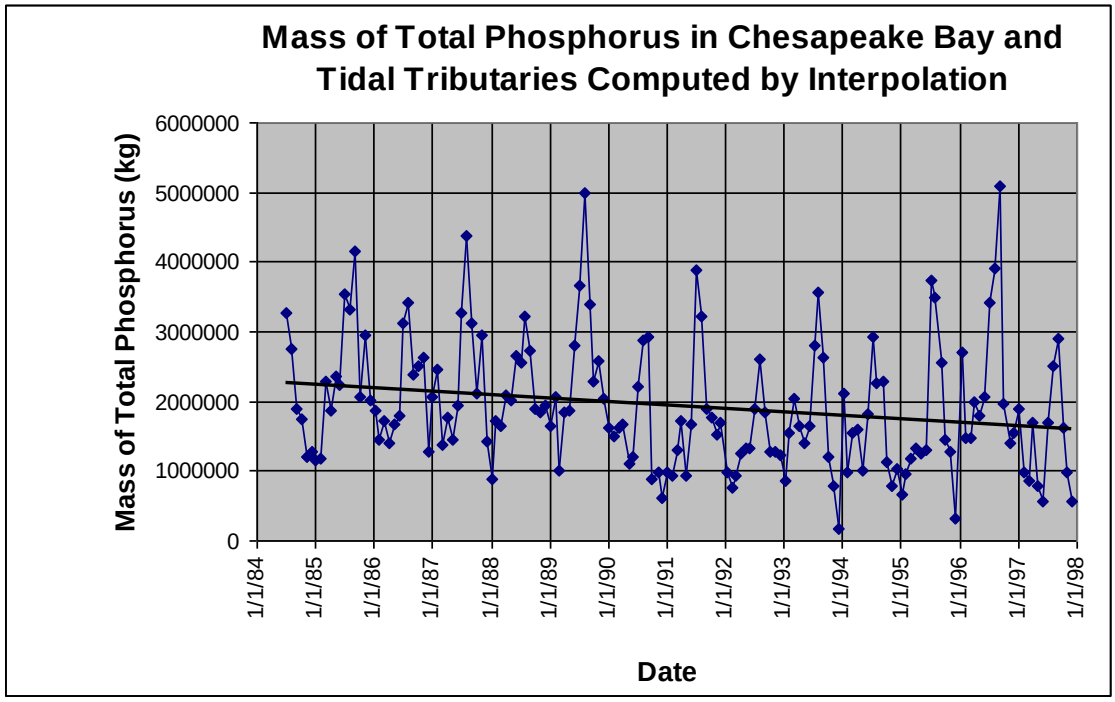


Figure 7-6. Time series plot of the mass of total phosphorus computed by the batch procedure described in Figure 7-3. The mass of total phosphorus was computed for Chesapeake Bay and tidal tributary rivers using monthly mean data for each station at each depth for the period of record. The "Date" and "Total" (sum of all columns in mass file) columns were used from the mass file ("filename".mss) to make this plot. The linear trend line is superimposed to show the general rate of decline. This plot was created by opening the tp8497.mss file in Excel, selecting the line chart button, selecting the "Start_Date" and "Total" columns, and adjusting the legends and titles as necessary to create the time series plot. The linear trend was added by selecting the time series followed by "Chart: Add Linear Trendline".

8. File Definitions and Structure

8.a Input Data File (.d3d)

Monitoring data are required for the Interpolator to compute values. The file should contain one value per depth per station for which data exist. If replicate values were measured at some or all stations, they should be averaged at each station depth so that only one value exists per depth per station. The overall data can represent one cruise, a season of cruises, or a decade of data--there are no limitations on what the data represent--that is up to the user to determine. It is best, statistically, to provide as many data as possible. One method is to linearly interpolate values from surface to bottom before creating the data file for the Interpolator. This will provide more data for the Interpolator if it is valid to do so for the desired data. For the 2D interpolation models, only one value per station should be used, since the depth value is ignored. The file naming convention for the input file is 'filename'.d3d. The input file has the following structure:

Line 1> contains a title that is meaningful to the user that identifies the contents of this dataset.
Line 2> contains a 2-digit parameter code, comma, and the spelled-out parameter name
Line 3> contains the start date, comma, and end date of the data
Line 4> contains the date and time the data were compiled
Line 5> contains the number of observations that follow
Lines 6+> contain the easting in UTM Zone 18 meters NAD83, comma, the northing in UTM Zone 18 meters NAD83, comma, the sample depth in meters, comma, the measured value of the parameter, comma, and the station ID

==========

```
CHESAPEAKE BAY AND TRIBS - Dissolved Oxygen - Measured Data - 06JUL1993-15JUL1993
DO,Dissolved Oxygen
07/06/1993,07/15/1993
08/11/1997:15:11
1128
407056,4377577, 0.5,   7.7000,CB1.1
407056,4377577, 1.0,   6.8000,CB1.1
407056,4377577, 2.0,   6.2000,CB1.1
407056,4377577, 3.0,   5.7000,CB1.1
...
407056,4377577, 4.0,   5.5000,CB1.1
407056,4377577, 5.0,   5.2000,CB1.1
411793,4365898, 0.5,   5.9000,CB2.1
411793,4365898, 1.0,   5.7000,CB2.1
411793,4365898, 2.0,   5.7000,CB2.1
411793,4365898, 3.0,   5.7000,CB2.1
...
366939,4301041, 0.5,   7.5000,WT8.3
366939,4301041, 1.0,   7.3000,WT8.3
```

==========

8.b Log File (.log)

A log (documentation) file is created during the job. The default filename is 'filename'.log. Check this file (using the Notepad editor) to see what calculations were performed during the job.

```
==========================================
Statistics Report for C:\Vol3D\BDO930701.est

Title: CHESAPEAKE BAY AND TRIBS - Dissolved Oxygen - Measured Data - 06JUL1993-15JUL1993
Parameter: Dissolved Oxygen  Parameter Code: DO
Data Period: 07/06/1993-07/15/1993
Data File Date: 08/11/1997:15:11
Observations: 1128
Maximum Number of Nearest Neighbors: 4
Minimum Number of Nearest Neighbors: 1
Maximum Vertical Search Window: 4
Minimum Vertical Search Window: 0
Vertical Search Window Step Size: .5
Maximum Horizontal Search Radius: 25000
Missing Value: -9
Interpolator Model: Depth-Radius-Interpolator
Interpolation Date: 10/6/97 10:55:55 AM
Bathymetry File: bay_trib.bth
Number of Bathymetry Regions: 68
Data Region File: bay_trib.reg
Number of Data Regions: 68
 - Bathymetry Region ID: 1001  Region Name: CB1TF  Data Points: 28 in data region 1001
 -- Cell Size  E-W: 1000  N-S: 1000  Vertical: 1
 --- 360 cells were interpolated in region CB1TF  Subtotal: 360 total cells
 ---- Region was calculated in 4 seconds.
 - Bathymetry Region ID: 1002  Region Name: CB2OH  Data Points: 48 in data region 1002
 -- Cell Size  E-W: 1000  N-S: 1000  Vertical: 1
 --- 1237 cells were interpolated in region CB2OH  Subtotal: 1597 total cells
 ---- Region was calculated in 1 seconds.

...
...

Total Number of Cells Interpolated: 173805
Total Number of Non-Missing Value Cells Interpolated: 160558
Total Number of Missing Value Cells Interpolated: 13247

Nearest Neighbors: 4    # of Cells: 101978
Nearest Neighbors: 3    # of Cells: 12358
Nearest Neighbors: 2    # of Cells: 33517
Nearest Neighbors: 1    # of Cells: 12705

173805 cells were calculated in 244 seconds.
==========================================
```

8.c Interpolated Estimates File (.est)

An interpolated estimates file is created during the job. The default filename is 'filename'.est. For the 3D interpolator model, this file contains the values for each cell interpolated during the job, from surface to bottom for each cell location. For the 2D interpolator models, this file contains the values for the top cell at each cell location. While the interpolated value is written to the surface cell location in this file, its value might represent the bottom value--i.e., the value might represent bottom layer dissolved oxygen. All cell values below the top value will be set to

missing (usually -9). The file contents include:

Line 1>Input data file name
Line 2>Data file description
Line 3> 2 digit parameter code and parameter name
Line 4>Start and end dates of data
Line 5>Date and time data file was compiled
Line 6>Number of data points, nearest neighbors, minimum neighbors, maximum vertical window, minimum vertical window, vertical window step increase size, maximum search radius, missing value
Line 7>Name of interpolator used
Line 8>Date and time of job
Line 9>Bathymetry file used
Line 10>Data region file used
Line 11>Number of segments to interpolate
Line 12>Cell description for this segment:number of surface cells in segment, segment id, segment name, cell e-w dimension in meters, cell n-s dimension in meters, cell vertical depth in meters
Line 13+>cell easting, cell northing, cells deep, interpolated values from surface to bottom.

==========

C:\VOL3D\BDO970601.D3D
CHESAPEAKE BAY BY CRUISE - Dissolved Oxygen - Linear Interpolated Data - 03JUN1997-12JUN1997
DO,Dissolved Oxygen
06/03/1997,06/12/1997
06/10/1998:8:55
1254,4,1,4,0,.5,25000,-9
Interpolator Model: Depth-Radius-Interpolator
6/17/98 10:24:26 AM
cbay8.bth
cbay8.reg
8
132,1001,CB1TF,1000,1000,1
403000,4384000,2,9.1,8.9
404000,4384000,5,9.1,8.9,8.8,8.8,8.8
404000,4383000,3,9.1,8.9,8.8
405000,4383000,8,10.3,9.9,9.5,8.8,8.8,8.8,8.8,8.8
405000,4382000,3,10.3,9.9,9.5
406000,4382000,1,9.9
...
...
405000,4082000,1,10.5
410000,4082000,4,10.5,10.5,10.4,10.3
404000,4081000,1,10.6
410000,4081000,3,10.5,10.5,10.4
405000,4079000,1,10.6

==========

8.d TXT File Created from Estimates File (.txt)

Interpolated estimates files ('filename'.est) can be reformatted as 'filename'.txt files which can be readily imported into other applications, including Arc/Info and ArcView. The .TXT file contains the values for each cell in the original Estimates file, from surface to bottom for each cell location. In addition, each line in the file is padded with –9 values. So the file is a rectangular matrix of data with all values having a value. The file is comma delimited, and all extraneous blanks have been removed. The precision of the reported parameter values are assigned by the values set in the 'parameter.sys' file. The .TXT file contents include:

Line 1>Column Headings
Line 2+>cell easting, cell northing, segment name, cell e-w dimension in meters, cell n-s dimension in meters, cell vertical depth in meters, bathymetry depth in meters, interpolated values from surface to bottom, additional depths padded with –9 down to layer_45, then bottom, minimum, maximum, mean, and sum values for non-missing cells in this water column.

```
UTM_X,UTM_Y,Segment,EW_dim,NS_dim,Vert_dim,n,layer_1,layer_2,layer_3,layer_4,layer_5,layer_6,layer_7,layer_8,layer_9,layer_10,layer
_11,layer_12,layer_13,layer_14,layer_15,layer_16,layer_17,layer_18,layer_19,layer_20,layer_21,layer_22,layer_23,layer_24,layer_25,layer_26,l
ayer_27,layer_28,layer_29,layer_30,layer_31,layer_32,layer_33,layer_34,layer_35,layer_36,layer_37,layer_38,layer_39,layer_40,layer_41,layer_
42,layer_43,layer_44,layer_45,Bottom,Minimum,Maximum,Mean,Sum
403000,4384000,CB1TF,1000,1000,1,2,-9.0,-9.0,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-
9,-9,-9,-9,-9,-9,-9,-9.0,-9.0,-9.0,-9.0,-9.0
404000,4384000,CB1TF,1000,1000,1,5,-9.0,-9.0,-9.0,-9.0,-9.0,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-
9,-9,-9,-9,-9,-9,-9,-9,-9,-9.0,-9.0,-9.0,-9.0,-9.0
...
383000,4338000,CB3MH,1000,1000,1,6,8.7,8.2,8.0,7.4,6.2,4.7,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-
9,-9,-9,-9,-9,-9,-9,-9,-9,4.7,4.7,8.7,7.2,43.2
384000,4338000,CB3MH,1000,1000,1,5,8.7,8.2,8.0,7.4,6.2,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-
9,-9,-9,-9,-9,-9,-9,-9,-9,6.2,6.2,8.7,7.7,38.5
385000,4338000,CB3MH,1000,1000,1,6,8.7,8.2,7.9,7.3,6.2,4.8,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-
9,-9,-9,-9,-9,-9,-9,-9,-9,4.8,4.8,8.7,7.2,43.1
386000,4338000,CB3MH,1000,1000,1,6,8.7,8.1,7.9,7.3,6.2,4.9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-9,-
9,-9,-9,-9,-9,-9,-9,-9,-9,4.9,4.9,8.7,7.2,43.1
```

==

8.e T3D File Created from Estimates File (.t3d)

Interpolated estimates files ('filename'.est) can be reformatted as 'filename'.t3d files which can be readily imported into other applications, such as, NoeSys and T3D. The .T3D file contains the values for each cell in the original Estimates file, with one cell value per line in the output file. The file is comma delimited, and all extraneous blanks have been removed. The precision of the reported parameter values are assigned by the values set in the 'parameter.sys' file. The .T3D file contents include:

Line 1+>cell centroid easting, cell centroid northing, negative cell centroid depth in meters, interpolated value for parameter

```
403000,4384000,-0.5,-9.0
403000,4384000,-1.5,-9.0
404000,4384000,-0.5,-9.0
404000,4384000,-1.5,-9.0
...
391500,4304000,-9.5,0.8
391500,4304000,-10.5,0.2
391500,4304000,-11.5,0.1
391500,4304000,-12.5,0.1
```

==========

8.f Bathymetry File (.bth)

Each interpolator job requires a bathymetry file which defines the cell structure of the desired body of water that is being interpolated. The following shows the contents of the *cbay8.bth* file:

Line 1>Number of segments to interpolate
Line 2>Number of surface cells in segment 1, segment id, segment name, e-w cell size in meters, n-s cell size in meters, cell depth in meters
Line 3>Cell centroid easting in meters, cell centroid northing in meters, number of cells (>0) from surface to bottom, cell centroid depths from surface to bottom. The Interpolator computes a value for each cell centroid identified in the .bth file which is output to the .est file.
(Repeat 2 & 3 for each segment.)

==========

```
8
132,1001,CB1TF,1000,1000,1
403000,4384000,2,0.5,1.5
404000,4384000,5,0.5,1.5,2.5,3.5,4.5
404000,4383000,3,0.5,1.5,2.5
405000,4383000,8,0.5,1.5,2.5,3.5,4.5,5.5,6.5,7.5
405000,4382000,3,0.5,1.5,2.5
...
410000,4363000,6,0.5,1.5,2.5,3.5,4.5,5.5
411000,4363000,10,0.5,1.5,2.5,3.5,4.5,5.5,6.5,7.5,8.5,9.5
412000,4363000,4,0.5,1.5,2.5,3.5
270,1002,CB2OH,1000,1000,1
403000,4363000,3,0.5,1.5,2.5
404000,4363000,4,0.5,1.5,2.5,3.5
405000,4363000,3,0.5,1.5,2.5
406000,4363000,3,0.5,1.5,2.5
400000,4362000,1,0.5
...
385000,4107000,1,0.5
381000,4106000,2,0.5,1.5
381000,4105000,2,0.5,1.5
381000,4104000,1,0.5
```

==========

8.g Data Regions Files (regions.sys, .rgn)

Each interpolator job requires a data regions file which defines the geographic boundary of the **data** for the body of water that is being interpolated. 77 data regions have been created, one for each CBP segment. The data region is used to clip off data that fall outside the desired geographic area that is being interpolated. A data regions file includes one or more data region definitions that must match the bathymetry being interpolated. These data region file names are stored in a file, *regions.sys*, which is required by the Interpolator. This file can contain 25 defined regions files. The order of the entries in this file define the order presented to the user in the GEOGRAPHY screen during the job. The structure of the regions.sys file is:

Line 1+>Item identifier (sequential number of 1 to 25), comma, data region name, comma, corresponding bathymetry file name, comma, corresponding data region file name.
Repeat for each defined data region.

```
==========================================
1,Bay and Tribs,bay_trib.bth,bay_trib.drg
2,Chesapeake Mainstem (CB1-CB8),cbay8.bth,cbay8.drg
==========================================
```

Each .drg file defined in the *regions.sys* file must have the following structure. The following shows the contents of the *cbay8.drg* file:

Line 1>Bathymetry file name
Line 2>Data region file name
Line 3>Number of segments to interpolate
Line 4>First segment ID and name
Line 5> Data region ID
Line 6>Number of x-y points in this data region
Line 7+>Data region x-y points. First and last in each polygon must be the same to close the polygon.
Repeat for each data region.

```
==========================================
cbay8.bth
cbay8.drg
 8
1001,CB1TF
1001
8
398699,4385013
421073,4384159
413328,4355973
397839,4344869
383210,4352557
401281,4367077
398699,4385013
398699,4385013
…
…
1008,CB8PH
1008
13
410677,4131611
418631,4108780
422019,4095375
415538,4079614
408467,4086243
396978,4083150
384016,4087569
372968,4087569
372968,4095817
385194,4104508
374588,4117618
386372,4131464
410677,4131611

==========================================
```

8.h Parameter Names File (params.sys)

Each parameter is identified by a 2-digit parameter code and spelled out parameter name. These codes and names are stored in the *params.sys* file. This file can accommodate 25 parameters. The order of the codes and names in this file determines the order of the parameters in the PARAMETERS screen (Figure 2-1). This file can be edited as necessary by the user. The file structure is:

Line 1>Item number (up to 25 lines), comma, spelled out parameter name, comma, 2-digit parameter code, comma, number of digits precision to the right of the decimal in output file.

==========

1,Dissolved Oxygen,DO,2
2,Chlorophyll,CH,1
3,Salinity,SA,1
4,Water Temperature,WT,1
5,Total Nitrogen,TN,2
6,Ammonia,NH,3
7,Nitrite,N2,3
8,Nitrate,N3,3
9,Total Phosphorus,TP,2

==========

8.i **Parameter Range Files (.rng)**

Several files are required to compute report files of volume and mass and to graphically portray the interpolated results. These include:
1) the "filename".est file of estimated values;
2) the cbpotiny.bmp which is a small CBP logo file;
3) the aro.bmp which is a small north arrow;
4) shore_18.bnd which is a shoreline boundary file; and,
5) the "parameter_code".rng file. The range file is used by the volume and mass report procedures to subset the computed results into categories for reporting. For graphics, the .rng file defines how the graphics program assigns colors to each cell value in the "filename".est file. For drawing purposes, the first range in the .rng table has drawing priority over the second range, which has priority over the third range, etc, so the first range color will paint over ranges lower in the table. This order determines which colors have priority in the final graphic. The do.rng file serves as an example:

Line 1>For dissolved oxygen values of 0.0 to but less than 0.2, color 12, pattern 0, title 0.0-0.2
Line 2>For dissolved oxygen values of 0.2 to but less than 1.0, color 13, pattern 2, title 0.2-1.0
Line 3>For dissolved oxygen values of 1.0 to but less than 3.0, color 14, pattern 12, title 1.0-3.0
Line 4>For dissolved oxygen values of 3.0 to but less than 5.0, color 11, pattern 12, title 3.0-5.0
Line 5>For dissolved oxygen values of 5.0 to but less than 25.0, color 19, pattern 21, title >5.0 MG/L
Line 6>For dissolved oxygen values of -10.0 to but less than -8.0 (-9=missing value), color 8, pattern 8, title Not Calculated
Pattern is currently ignored in this version.

To categorize integer value ranges, it is best to bracket the range, for instance, to assign color 12 to the range of 2 (lower bound) to 2 (upper bound), set the lower bound to 1.9 and the upper bound to 2.1. Set the title to "2" to convey the intent that "2" is the range being presented. This bracketing is required to allow the code to select values equal to or greater than the lower bound and less than the upper bound.

Acceptable color codes are:

0	Black
1	Blue
2	Green
3	Cyan
4	Red
5	Magenta
6	Yellow
7	White
8	Gray
9	Light Blue
10	Light Green
11	Light Cyan
12	Light Red
13	Light Magenta
14	Light Yellow
15	Bright White

```
==========================================
0.0,0.2,12,0,0.0-0.2
0.2,1.0,13,2,0.2-1.0
1.0,3.0,14,12,1.0-3.0
3.0,5.0,11,12,3.0-5.0
5.0,25.0,9,21,>5.0 MG/L
-10.0,-8.0,8,8,Not Calculated

==========================================
```

8.j Batch Job File (.job)

Individual interpolator runs can be computed sequentially by saving the necessary information for the run in a "Batch File" ('filename'.job). This "Batch File" is then used to calculate each of the files identified in the .job file. This file can be edited as necessary by the user. The file structure is:

```
Line 1>bathymetry file
Line 2>regions file
Line 3>input data file
Line 4> output interpolated (.est) file
Line 5> output log (.log) file
Line 6>parameter transformation
Line 7>minimum number of neighbors
Line 8>maximum number of neighbors
Line 9>horizontal range (m)
Line 10>vertical range minimum
Line 11>vertical range maximum
Line 12>Vertical step size
Line 13>missing value
Line 14>interactive/batch flag
Repeat lines 1-14 for each file to be interpolated

==========================================
cbay8.bth
cbay8.drg
C:\Vol3D\BDO970601.d3d
C:\Vol3D\BDO970601.est
C:\Vol3D\BDO970601.log
None
 1
 4
 25000
 0
 4
 .5
-9
1
cbay8.bth
cbay8.drg
C:\Vol3D\BDO970701.d3d
C:\Vol3D\BDO970701.est
C:\Vol3D\BDO970701.log
None
 1
 4
 25000
 0
 4
 .5
-9
```

1

==========

8.k Batch Job File List (.fls)

Calculations on individual interpolator .est files can be computed sequentially by reading the .est file names from a "batch file list" ('filename'.fls). This file is created when the Batch Job File ('filename'.job) is created. This file can be edited as necessary by the user. The file structure is:

Line 1>interpolator (.est) file name
Repeat for each file to be processed.

==========

C:\Vol3D\DO970601.est
C:\Vol3D\DO970701.est
…
…

==========

8.l Julian Date File (.jul)

Calculations of "Change Over Time" require a julian date file which contains the dates which relate to the .est files identified in the .fls file. For this analysis, the julian dates are the X variable of the time series and the .est files are the Y variables of the time series. The julian dates represent dates and times that are based on the decimal numbering system, rather than years, months, and days (and time). The julian (or any linearly numbered scheme) date file must be created by the user. The following example was created by opening the appropriate .mss file in Excel, converting the "Start_Date" from mm/dd/yy format to decimal format, and cutting and pasting the reformatted date column into a .jul flat file. The file structure is:

Line 1>julian date
Repeat for each file to be processed.

```
                    ==========================================
30865.00
30895.00
30929.00
30956.00
…
…
                    ==========================================
```

8.m Segments List File (.lst)

Reports on individual segments can be computed sequentially by reading the .est file names from a "segments list file" ('filename'.lst). This file is created manually by the user. The file structure is:

Line 1>Number of segments to process
Line 2+>Segment name (spelling must match those in Appendix A).
Repeat for each segment to be processed.

```
                    ==========================================
3
POCTF
POCOH
POCMH
                    ==========================================
```

8.n Volume Report File (.vol)

The volume of water that contains a specified range of concentrations of a parameter can be computed and saved to a volume report file ('filename'.vol). Volume estimates are reported in liters. The entire Bay and tributary volume based on the "Bay and Tributary" 77 segment bathymetry is 75,199,817,500 m^3, or 75.2x10^12 liters. The volume of Main Bay segments CB1TF-CB8PH totals 51.839x10^12 liters. Data from one job to another may be appended to the

same output file so that a time series file is created that can be opened in a spreadsheet or database program for further graphing or analysis. The first line of the file is composed of 'column headings' contained within quotes. This file can be edited as necessary by the user. The file structure is:

Line 1>Column headings defined by the 'Report' job that is run, including data start date, data end date, depth of top layer analyzed, depth of bottom layer analyzed, volume for segment, volume by concentration range for that segment,…,…, repeat for each segment,…,grand total volume
Line 2>data accumulated from the input interpolated file (.est) for each column in line 1
Repeat for each interpolated file processed.

Note: Since data that are calculated may be appended to an existing file, there is a risk that the user may append data from different bathymetry jobs. The user must be careful not to mix 8 segment mainstem data with 77 segment mainstem and tributary data in this report, or else the column headings will not represent the data.

==========

"Start Date","End Date","Layer Top","Layer Bottom","CB1TF","CB1TF_0.0_0.2","CB1TF_0.2_1.0","CB1TF_1.0_3.0","CB1TF_3.0_5.0","CB1TF_5.0_25.0","CB1TF_-10.0_-8.0","CB2OH","CB2OH_0.0_0.2","CB2OH_0.2_1.0","CB2OH_1.0_3.0","CB2OH_3.0_5.0","CB2OH_5.0_25.0","CB2OH_-10.0_-8.0","CB3MH","CB3MH_0.0_0.2","CB3MH_0.2_1.0","CB3MH_1.0_3.0","CB3MH_3.0_5.0","CB3MH_5.0_25.0","CB3MH_-10.0_-8.0","CB4MH","CB4MH_0.0_0.2","CB4MH_0.2_1.0","CB4MH_1.0_3.0","CB4MH_3.0_5.0","CB4MH_5.0_25.0","CB4MH_-10.0_-8.0","CB5MH","CB5MH_0.0_0.2","CB5MH_0.2_1.0","CB5MH_1.0_3.0","CB5MH_3.0_5.0","CB5MH_5.0_25.0","CB5MH_-10.0_-8.0","CB6PH","CB6PH_0.0_0.2","CB6PH_0.2_1.0","CB6PH_1.0_3.0","CB6PH_3.0_5.0","CB6PH_5.0_25.0","CB6PH_-10.0_-8.0","CB7PH","CB7PH_0.0_0.2","CB7PH_0.2_1.0","CB7PH_1.0_3.0","CB7PH_3.0_5.0","CB7PH_5.0_25.0","CB7PH_-10.0_-8.0","CB8PH","CB8PH_0.0_0.2","CB8PH_0.2_1.0","CB8PH_1.0_3.0","CB8PH_3.0_5.0","CB8PH_5.0_25.0","CB8PH_-10.0_-8.0","Total"
"06/03/1997","06/12/1997",0.,50.,359000000000.,0.,0.,0.,0.,359000000000.,0.,1237000000000.,0.,0.,0.,56000000000.,1181000000000.,0.,2391000000000.,0.,2000000000.,366000000000.,361000000000.,1662000000000.,0.,9237000000000.,0.,19000000000.,19740000000000.,1104000000000.,6140000000000.,0.,15377000000000.,0.,0.,0.,851000000000.,14526000000000.,0.,6503000000000.,0.,0.,0.,0.,6503000000000.,0.,13488000000000.,0.,0.,0.,0.,13488000000000.,0.,3150000000000.,0.,0.,0.,0.,3150000000000.,0.,51742000000000.,0.,21000000000.,2340000000000.,2372000000000.,47090000000000.,0.
"07/07/1997","07/15/1997",0.,50.,0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,2391000000000.,134000000000.,51000000000.,150000000000.,168000000000.,1888000000000.,0.,9237000000000.,1937000000000.,1253000000000.,933000000000.,620000000000.,4494000000000.,0.,15395000000000.,1391000000000.,2236000000000.,1909000000000.,1069000000000.,8790000000000.,0.,6503000000000.,0.,0.,524000000000.,1063000000000.,4916000000000.,0.,13482000000000.,0.,0.,661000000000.,2978000000000.,9843000000000.,0.,2474000000000.,0.,0.,0.,114000000000.,2360000000000.,0.,49482000000000.,3462000000000.,3540000000000.,4177000000000.,6012000000000.,32291000000000.,0.
"07/16/1997","07/31/1997",0.,50.,360000000000.,0.,0.,0.,0.,360000000000.,0.,1237000000000.,0.,0.,7000000000.,24000000000.,1206000000000.,0.,2391000000000.,0.,133000000000.,159000000000.,282000000000.,1817000000000.,0.,9237000000000.,0.,16200000000000.,1644000000000.,942000000000.,5031000000000.,0.,15388000000000.,0.,1453000000000.,2710000000000.,2005000000000.,9220000000000.,0.,6503000000000.,0.,0.,55000000000.,1231000000000.,5217000000000.,0.,13491000000000.,0.,0.,9000000000.,1793000000000.,11689000000000.,0.,3160000000000.,0.,0.,0.,0.,3160000000000.,0.,51767000000000.,0.,32060000000000.,4584000000000.,6277000000000.,37700000000000.,0.

==========

8.o Mass Report File (.mss)

The mass file report contains the mass of a parameter computed for each cell in the interpolated (.est) file then summed in one of two ways. The default method (below example) is to sum the mass by segment and total for all segments in the bathymetry.

The second method follows the format of the volume report and computes the mass by concentration range for each segment.

The mass that is computed and summed is saved to a mass report file ('filename'.mss). It is assumed the input data are measured in [units]/[liter], such as mg/l or ug/l or counts/liter. In the mass report, the resulting mass estimates are computed by multiplying the [estimated concentration in the cell (often in mg/l)] * [the volume of the cell in m^3 (for instance, 1000m east-west x 1000m north-south x 1m deep)] * [1000 l/m^3 to convert from m^3 to liters]. Hence, if the input data were in mg/l and then the concentration is estimated to be 6mg/l in a cell, the resulting mass will be 6*10^9 mg for a 1km x 1km x 1 m cell. As a second example, if the input data were in mg/m^3, which is equivalent to ug/l, then the reported mass values would be in micrograms to account for the volume being reported in m^3 rather than liters. If the input data are counts (such as organism counts) per liter, then the mass report units would be total counts. If the input data are counts (such as organism counts) per cubic meter, then the total counts in the mass report must be divided by 1000 to account for the conversion from cubic meters to liters between the input data and the interpolated counts. The mass (or counts) for each cell is then summed for a total mass (or count) in the segment and also a grand sum of mass (or count) for the total for all segments under analysis. For instance, if the input data for CHLA were measured as ug/l and the resulting mass in Segment CB2OH was reported after interpolation as 13,000,000,000,000, that represents 1.3^13 ug CHLA for Segment CB2OH—i.e 1.3^13ug / 1.237^12 liters in CB2OH=10.5 ug/l average. As a second example, if the input data were for mg biomass of organisms per cubic meter and the resulting mass in Segment CB2OH was reported as 132,627,709,873,200, that represents 1.326^14 / 1000 mg for Segment CB2OH, since an adjustment for the input data must be made for the per cubic meter to per liter basis. A quick check can be made by multiplying the average input data value by the volume of a segment to determine if the results are within reason. For instance, if there were approximately 150 mg biomass per cubic meter in the monitoring data for CB2OH, that would be [150 mg/m^3] * [1,237,000,000 cubic meters in Segment CB2OH] = 1.86^11 mg biomass in the Segment CB2OH, which is close to the interpolated value of 1.326^11 mg, above.

Data from one job to another may be appended to the same output file so that a time series file is created that can be opened in a spreadsheet or database program for further graphing or analysis. The first line of the file is composed of 'column headings' contained within quotes. This file can be edited as necessary by the user. The file structure is:

Line 1>Column headings defined by the 'Report' job that is run, including data start date, data end date, depth of top layer analyzed, depth of bottom layer analyzed, mass of parameter by segment,…,…, repeat for each segment,…,grand total mass
Line 2>data accumulated from the input interpolated file (.est) for each column in line 1
Repeat for each interpolated file processed.

Note: Since data that are calculated may be appended to an existing file, there is a risk that the user may append data from different bathymetry jobs. The user must be careful not to mix 8 segment mainstem data with 77 segment mainstem and tributary data in this report, or else the column headings will not represent the data.

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"Start Date","End Date","Layer Top","Layer Bottom","CB1TF","CB2OH","CB3MH","CB4MH","CB5MH","CB6PH","CB7PH","CB8PH","Total"
"06/03/1997","06/12/1997",0.,50.,33956000.,99418000.,165733000.,602087001.,1229455000.,563523000.,1121378003.,301820000.,4117370004.

"07/07/1997","07/15/1997",0.,50.,0.,0.,149745000.,378545000.,726926999.,429706000.,871456001.,173612000.,2729991001.
"07/16/1997","07/31/1997",0.,50.,21746000.,82626000.,150816000.,438919000.,795246002.,428770000.,917109001.,243880000.,3079112003.
"08/04/1997","08/14/1997",0.,50.,22096000.,73961000.,128601000.,465053000.,824646000.,456154001.,940162001.,236345001.,3147018002.
"08/18/1997","08/28/1997",0.,50.,19932000.,82306000.,158793000.,460818001.,885485001.,470413001.,1010405001.,231651001.,3319803005.
"09/02/1997","09/15/1997",0.,50.,19748000.,76169000.,128181000.,517683000.,1009546002.,459632001.,949621002.,227962000.,3388542005.
"10/06/1997","10/15/1997",0.,50.,0.,0.,173127001.,576579000.,1004260004.,482547000.,963827000.,200433996.,3400774001.

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8.p Example Interpolator Job

1) Double click the Vol3D.exe icon to run the Interpolator program.
2) Click the GEOGRAPHY button to display the GEOGRAPHY screen.
3) Choose “Chesapeake Mainstem (CB1-CB8)” to interpolate the Main Bay.
4) Click the PARAMETER button to display the PARAMETER screen.
5) Choose “DO- Dissolved Oxygen” as the parameter.
6) Click the DATA IMPORT button to display the DATA IMPORT screen.
7) Click Get File Name button and select the “C:\Vol3D\DO9706.D3D” data file. The file name, start and end dates, number of observations, file date, parameter, code, and title should appear in the Data Import screen. If not, you selected an incorrect file.
8) Click the INTERPOLATE button to display the INTERPOLATE screen. The input file should read “C:\Vol3D\DO9706.D3D”, the output file should read “C:\Vol3D\DO9706.est”, Bathy file should read “cbay8.bth”, and log file should read “C:\Vol3D\DO9706.log”.
9) Click the “Run Interpolation” button to create the standard *.est file or click the “Also Create TXT File” to create a “filename”.txt file that can be imported into Arc/Info or ArcView as a table. The text ArcView file will be approximately 2.3 mb in size.
10) If you created an interpolated .est file, you can view the results by clicking the GRAPHICS button to display the GRAPHICS screen. If you created a .txt file to load into an ArcView table, you can quit the Interpolator program and continue working with the output file in ArcView.
11) At the GRAPHICS screen, the Interpolated file should read “C:\Vol3D\DO9706.est”. Click the Interpolated File button to load titles and dates for the graphic.
12) The Bathymetry file should read “cbay8.bth”, and the Categories File should read “.\DO.rng”. Click the Categories File button to load the categories for the graphic. The Boundary File should read “.\shore_18.bnd”, the output Graphics File name should read “C:\Vol3D\DO9706.bmp”. The titles and legends were loaded by pushing the Interpolated File and Categories File buttons. The background color of the boundary file is set by clicking the small grey box to the right of the Boundary File name. Click “Plot Points” ON if you want to display the location of the monitoring stations. Choose “Minimum” if you wish to display the minimum color value (where minimum is the worst case, such as dissolved oxygen), or choose “Maximum” if you wish to display the maximum color value (where maximum is the worst case, such as temperature), or choose the “Top/West” edge or “Bottom/East” edge to display the desired side.

Titles, categories, colors, and legends can be modified on this screen and will be reflected in the resulting drawing. Clicking the “DRAW” button will draw the image in a graphics window. The graphics window can be saved to a file or printed. The Interpolator does not allow graphical

editing. The saved “filename”.bmp file can be edited in a commercial graphics editing package, such as, Paint Shop Pro. The .bmp file can be converted to gif or jpeg format (single files or groups of files in batch mode) for publication on the web.

Appendix A.

Segment Name, EW-Dimension, NS-Dimension, Depth Dimension, Number Cells in Segment, Volume (m^3)
CB1TF,1000,1000,1,360,360000000
CB2OH,1000,1000,1,1237,1237000000
CB3MH,1000,1000,1,2391,2391000000
CB4MH,1000,1000,1,9237,9237000000
CB5MH,1000,1000,1,15416,15416000000
CB6PH,1000,1000,1,6503,6503000000
CB7PH,1000,1000,1,13523,13523000000
CB8PH,1000,1000,1,3172,3172000000
NORTF,500,500,1,106,26500000
C&DOH,100,100,1,2413,24130000
ELKOH,500,500,1,405,101250000
BOHOH,250,250,1,272,17000000
SASOH,250,250,1,1347,84187500
CHSTF,50,50,1,1345,3362500
CHSOH,250,250,1,462,28875000
CHSMH,500,500,1,1821,455250000
EASMH,500,500,1,3987,996750000
CHOTF,50,50,1,6129,15322500
CHOOH,250,250,1,722,45125000
CHOMH2,500,500,1,1067,266750000
CHOMH1,1000,1000,1,945,945000000
LCHMH,500,500,1,833,208250000
HNGMH,100,100,1,18568,185680000
FSBMH,1000,1000,1,143,143000000
NANTF,50,50,1,2646,6615000
NANOH,50,50,1,18000,45000000
NANMH,500,500,1,389,97250000
WICMH,100,100,1,5642,56420000
MANMH,500,500,1,358,89500000
BIGMH,250,250,1,698,43625000
POCTF,50,50,1,1788,4470000
POCOH,50,50,1,7200,18000000
POCMH,500,500,1,1418,354500000
TANMH,1000,1000,1,4019,4019000000
BSHOH,500,500,1,197,49250000
GUNOH,500,500,1,257,64250000
MIDOH,250,250,1,400,25000000
BACOH,250,250,1,358,22375000
PATMH,500,500,1,1806,451500000
MAGMH,250,250,1,1224,76500000
SEVMH,250,250,1,1815,113437500
SOUMH,250,250,1,1072,67000000
RHDMH,250,250,1,325,20312500
WSTMH,250,250,1,326,20375000
PAXTF,50,50,1,4410,11025000
PAXOH,100,100,1,2718,27180000
PAXMH,500,500,1,2244,561000000
PISTF,100,100,1,285,2850000
MATTF,250,250,1,152,9500000

POTTF,500,500,1,1939,484750000
POTOH,500,500,1,3409,852250000
POTMH,1000,1000,1,5792,5792000000
RPPTF,250,250,1,1719,107437500
RPPOH,100,100,1,5358,53580000
RPPMH,500,500,1,5929,1482250000
CRRMH,250,250,1,1051,65687500
PIAMH,250,250,1,3223,201437500
MPNTF,50,50,1,6135,15337500
MPNOH,100,100,1,3539,35390000
PMKTF,50,50,1,11452,28630000
PMKOH,100,100,1,6668,66680000
YRKMH,500,500,1,1102,275500000
YRKPH,500,500,1,1603,400750000
MOBPH,500,500,1,5370,1342500000
APPTF,100,100,1,151,1510000
CHKOH,250,250,1,777,48562500
JMSTF,250,250,1,4579,286187500
JMSOH,500,500,1,1726,431500000
JMSMH,1000,1000,1,977,977000000
JMSPH,1000,1000,1,434,434000000
WBEMH,100,100,1,631,6310000
SBEMH,100,100,1,2773,27730000
EBEMH,50,50,1,2584,6460000
ELIMH,100,100,1,5339,53390000
LAFMH,100,100,1,339,3390000
ELIPH,500,500,1,246,61500000
LYNPH,100,100,1,1673,16730000
Total Volume (m^3) = 75199817500