Example of an Aquatic Ecological Assessment Using the Environmental Residue-Effects Database and the RECOVERY, TBP, and WEAP Models (Example No. 1)

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Introduction

The U.S. Army Engineer Research and Development Center (ERDC) is developing the Army Risk Assessment Modeling System (ARAMS) to provide the Army with the capability to perform human and ecologically based risk/hazard assessments associated with past practice and current activities at military installations. The intent of the system is to provide a platform from which a variety of assessments can be performed. The system is envisioned to help a risk analyst visualize an assessment from source, through multiple environmental media (e.g., groundwater, surface water, air, and land), to sensitive receptors of concern (e.g., humans and ecological endpoints).

ARAMS uses the Framework for Risk Analysis in Multimedia Environmental Systems (FRAMES) developed by the Pacific Northwest National Laboratory (PNNL) for linking disparate objects, such as environmental fate/transport models, databases, spreadsheets, etc. FRAMES is a Windows-based software platform that provides an interactive user interface and, more importantly, specifications to allow a variety of DOS and Windows-based environmental codes to be integrated within a single framework.

This document is intended to serve as a tutorial for helping new users with the application of ARAMS/FRAMES and the components within this system. This example does not include the steps for project planning and the use of associated tools under the "File" menu. These tools help the user plan the risk assessment including development of the conceptual site model and the Risk Assessment Guidelines for Superfund (RAGS) Part D Table 1 for human health risk assessment. There are several Help files within ARAMS that explain these tools.

Example Description

This example uses the Wildlife Ecological Assessment Program (WEAP), the RECOVERY model, the Theoretical Bioaccumulation Potential (TBP) model, the Environmental Residue-Effects Database (ERED), the Aquatic Organism Selector (AOS), and the Biota-Sediment Accumulation Factors (BSAF) Database. RECOVERY is a surface water model that assumes a fully mixed water column for simplicity, but includes layered bed sediments. This model computes time-varying sediment and water constituent concentrations/fluxes. TBP converts contaminated sediment concentrations to organism body burden, or residue (tissue concentration), based on a theoretical bioaccumulation potential. WEAP is a software package that summarizes ecological health impacts to various organisms from exposures to constituents. WEAP is a statistical package that 1) correlates duration of exposure to constituent levels to help determine the impacts of the exposure to organisms, and 2) bridges the gap between simulated chemical transport and fate modeling and ecological-risk assessment data that are available from laboratory studies. ERED is an aquatic ecological toxicity database, containing ecological benchmark data of effects as related to tissue residues by chemical and organism species.

This example begins with contaminated water column and sediments (such as a lake) and computes time-varying surface water and sediment concentrations with RECOVERY. Previous versions required a source term module to feed loadings to the RECOVERY lake model, but RECOVERY has been streamlined, and the source term module is no longer needed since all inputs are submitted directly in the RECOVERY user interface. Sediment concentrations are used by the TBP model to produce time-varying body burdens. WEAP uses the time-varying body burdens coupled with Toxicity Reference Values (TRV), e.g., No Observable Effects Dose, NOED, from the ERED toxicity benchmark database to

compute Ecological Hazard Quotients (EHQs). Time-varying EHQs are reported. Probabilities of Exceedence (i.e., equal to or greater than), based upon time series results, are calculated for body-burden levels and EHQs. The constituent that will be evaluated is "Aroclor 1254," and "Oncorhynchus mykiss" will be the target species. Each of the components required for this analysis is shown by an object in the FRAMES object workspace, as shown in Figure 1.

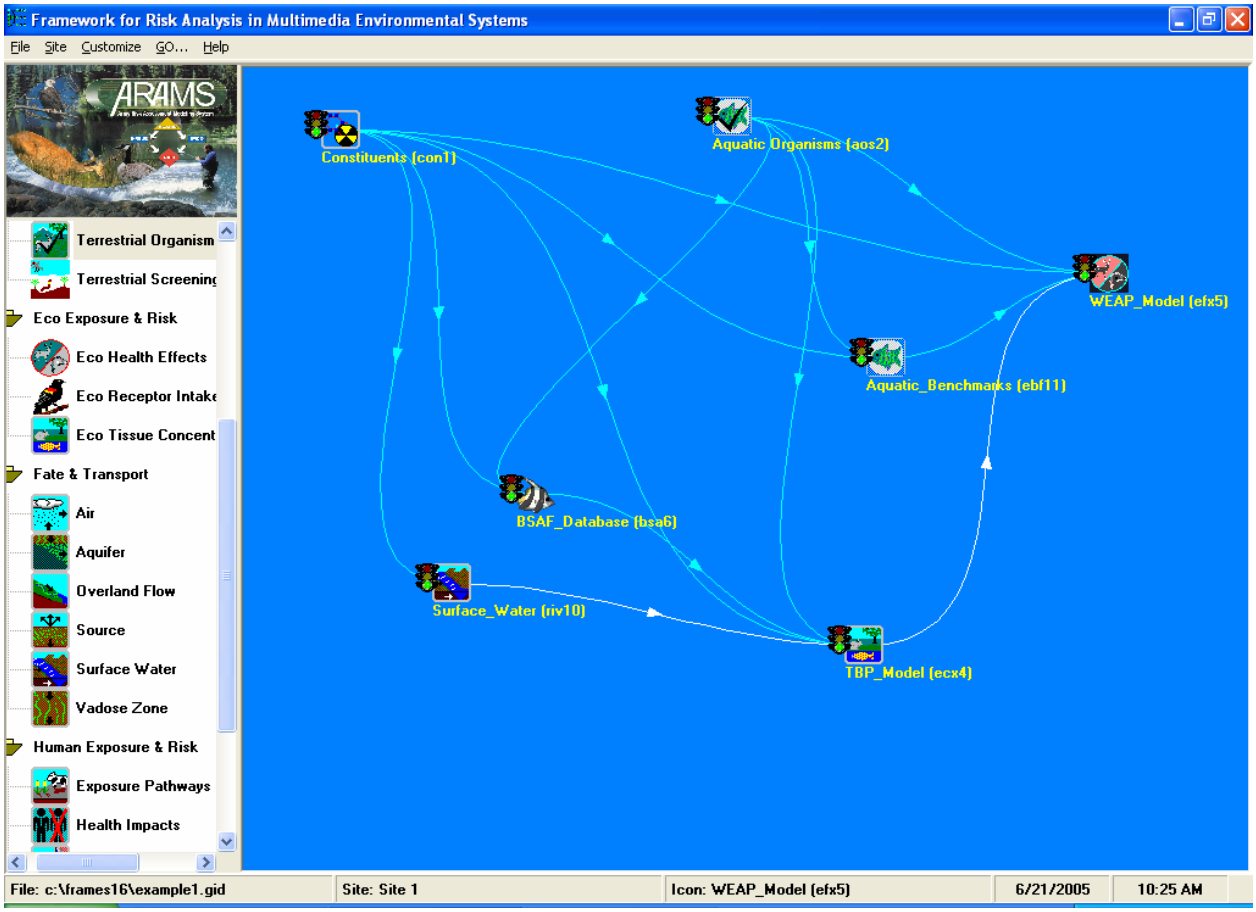

Figure 1. Object workspace for example application

Input Data

- Double-click on "ARAMS Icon" to open "ARAMS info and Disclaimer" window and then select "Accept" to continue.

- Choose "FRAMES" in the ARAMS toolbar to launch FRAMES. (Note: If this is the first time you have used ARAMS, you will need to configure it for FRAMES by selecting "**File,**" then "*****Must Configure Path to FRAMES*****" and supplying the path to the "**fui.exe**" file).

- While ARAMS/FRAMES is running, click "File" from the FRAMES menu and choose "New." A window titled "Global Input Data Open New" will appear (see Figure 2). In the "File Name" box enter the project name (type: "Sample*1*," maximum of eight characters) and click "Open" (see Figure 3). **Do not name the new file "Example1" because it will write over the existing "Example1" file that was distributed with the tutorial.** A window titled "Create New Site" will appear. Next, type the project site name (type: Site 1) and click "OK" (see Figure 4).

Double-Click on the **Constituent** icon so that the icon appears on the upper left corner of the main screen. Repeat this operation to place the following additional icons into the workspace:

"Surface Water"
"Eco Tissue Concentrations"
"Aquatic Benchmarks"
"Eco Health Effects"
"Biota-Sediment Accumulation Factor"
"Aquatic Organism Selector"

Click on and drag each icon to its respective position on the workspace. Connect the Constituent icon and Surface Water icons by holding down SHIFT, clicking on the Constituent Icon, dragging the cursor to the Source icon, and releasing the mouse button (Note: To remove this line, repeat the steps used to connect it. To remove an icon from the screen, right-click, and a menu will appear with different options. Click "Delete" and the icon will be taken out.).

In the same fashion, connect the following pairs of icons:

Constituent	→	*Surface Water (already done)*
Constituent	→	*Eco Tissue Concentrations*
Constituent	→	*Eco Health Effects*
Constituent	→	*Aquatic Benchmarks*
Constituent	→	*Biota-Sediment Accumulation Factor*
Surface Water	→	*Eco Tissue Concentrations*
Eco Tissue Concentrations	→	*Eco Health Effects*
Aquatic Organism Selector	→	*Eco Tissue Concentrations*
Aquatic Organism Selector	→	*Biota-Sediment Accumulation Factor*
Aquatic Organism Selector	→	*Aquatic Benchmarks*

Aquatic Organism Selector	→	*Eco Health Effects*
Biota-Sediment Accumulation Factor	→	*Eco Tissue Concentrations*
Aquatic Benchmarks	→	*Eco Health Effects*

FRAMES should now look something like Figure 1.

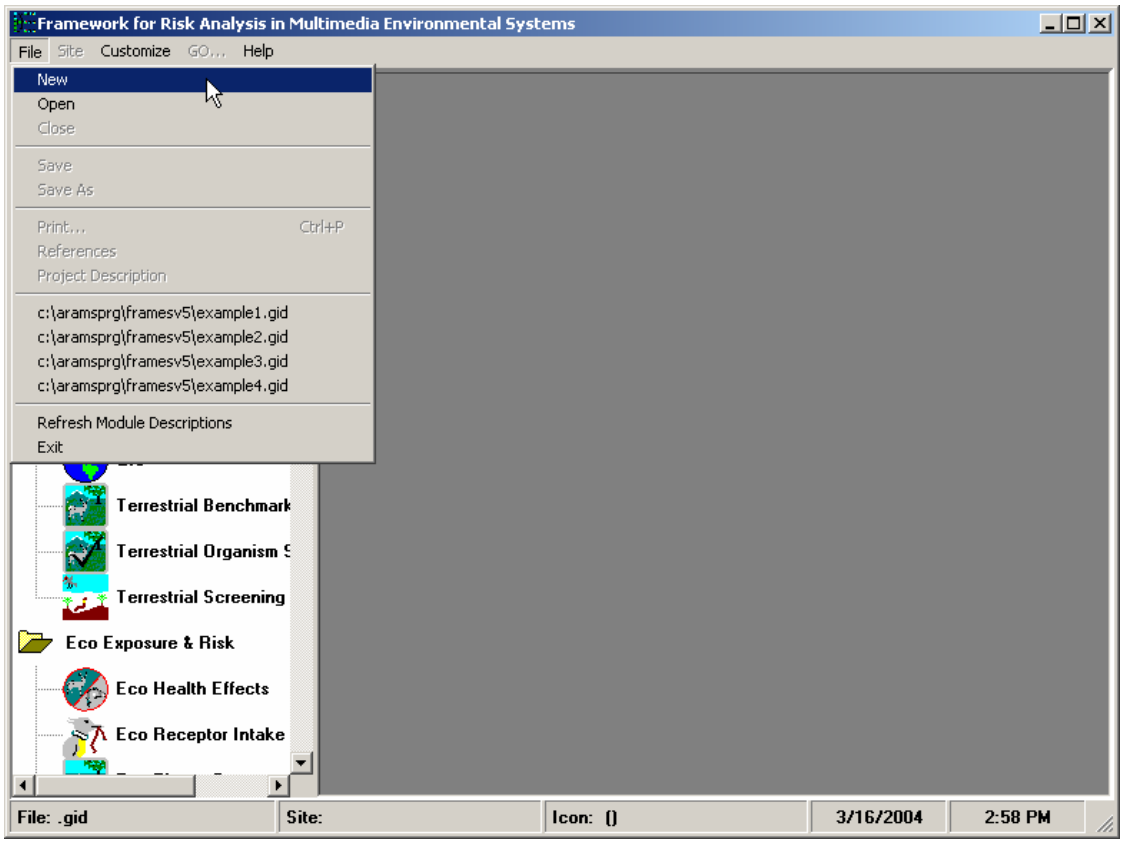

Figure 2. Opening a new file

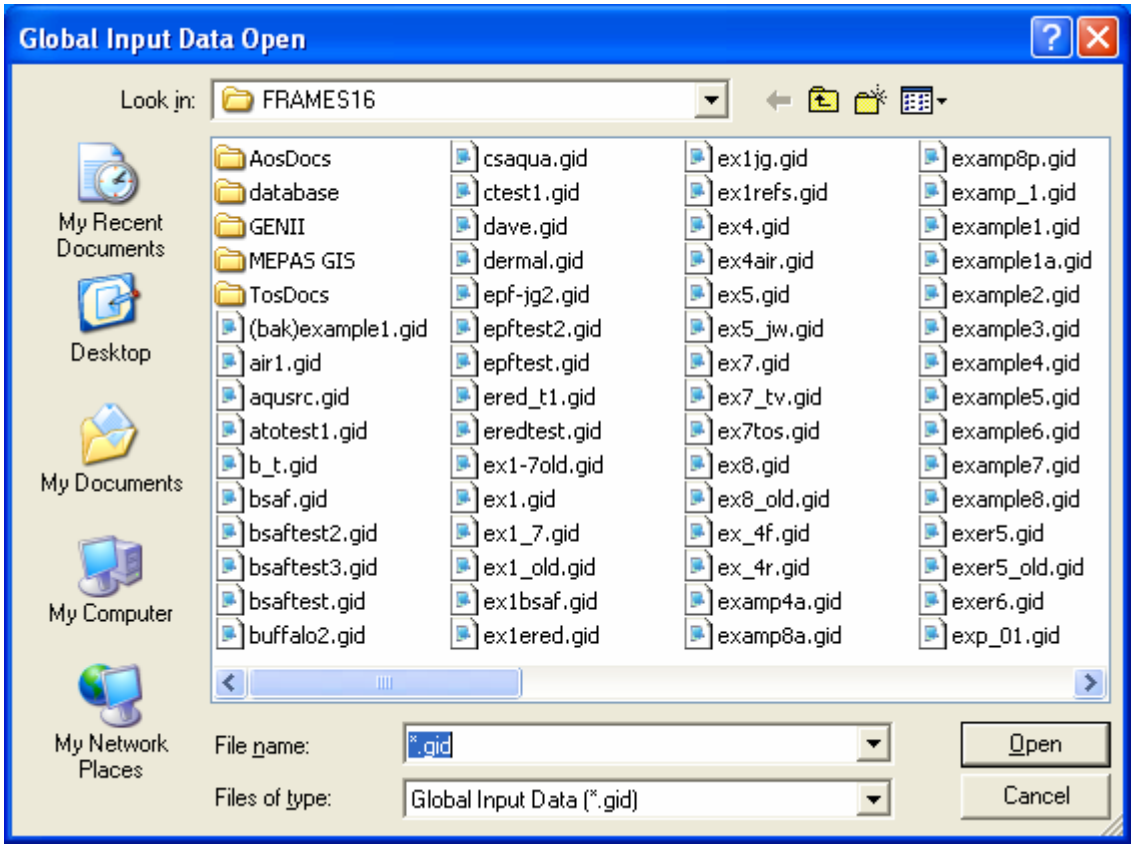

Figure 3. Global Input Data Open New screen (new file window)

Figure 4. Create New Site screen (Input "Site name" box)

CONSTITUENT DATABASE MODULE

Right-click the Constituent icon and choose "General Info" (see Figure 5). When the General Info screen opens, enter "Constituents" in the "User Label" text box and select "FRAMES Constituent Database Selection" in the "Select from applicable models" text box (see Figure 6). Click OK at the bottom of the screen to return to the workspace area. The Constituent icon's status indicator will now display a red light. Right-click on the constituent icon in the main screen and choose "User Input." The Constituent Selection screen will open (see Figure 7). The constituent used in this case is Aroclor 1254. Scroll to select the constituent from the constituents list or use the "Find" option to search for it. Click the "Add

>>>" button to add the constituent to the selected constituents list. Click "File" and choose "Save and Exit" to return to the workspace screen. The Constituent icon's status light will change from red to green.

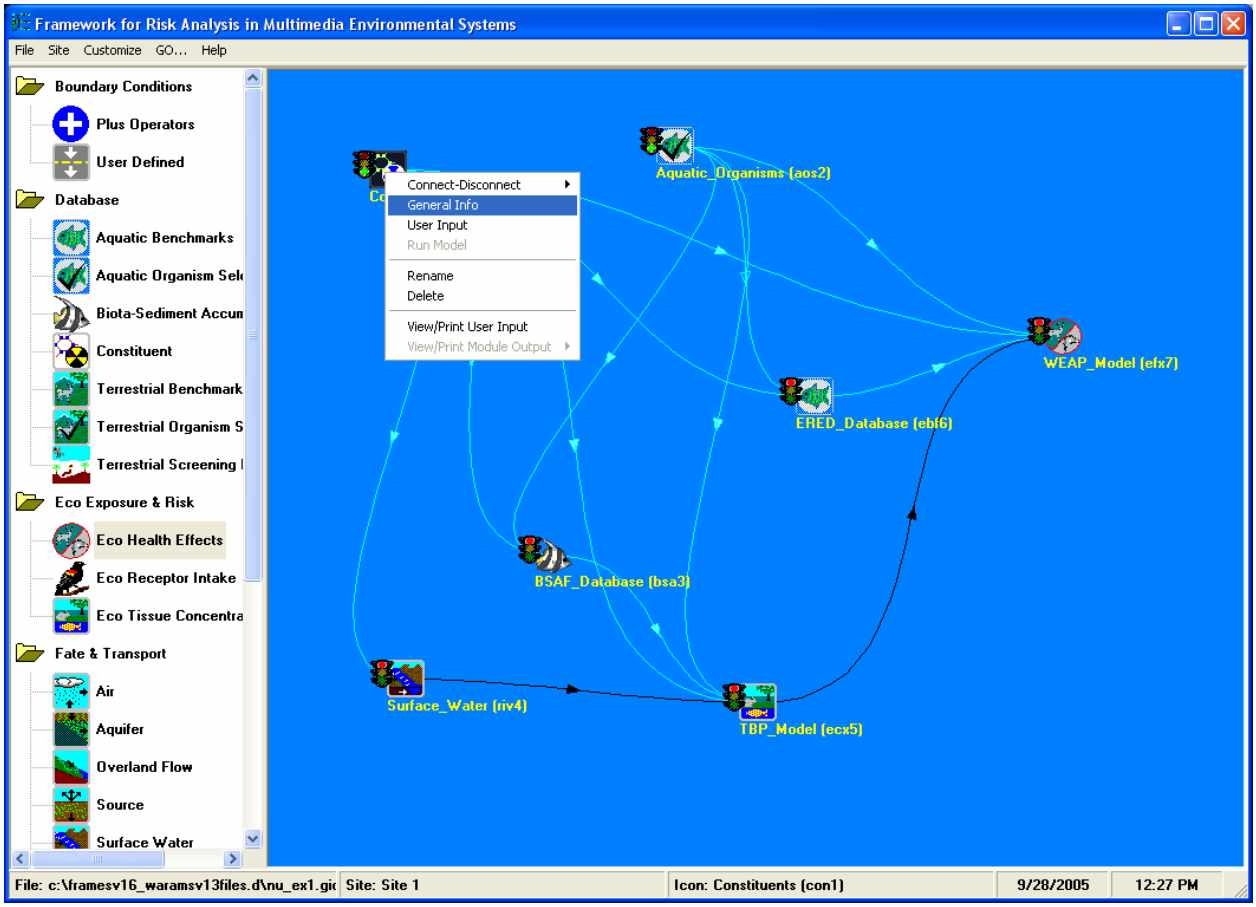

Figure 5. Workspace screen (right-click in the Constituent icon)

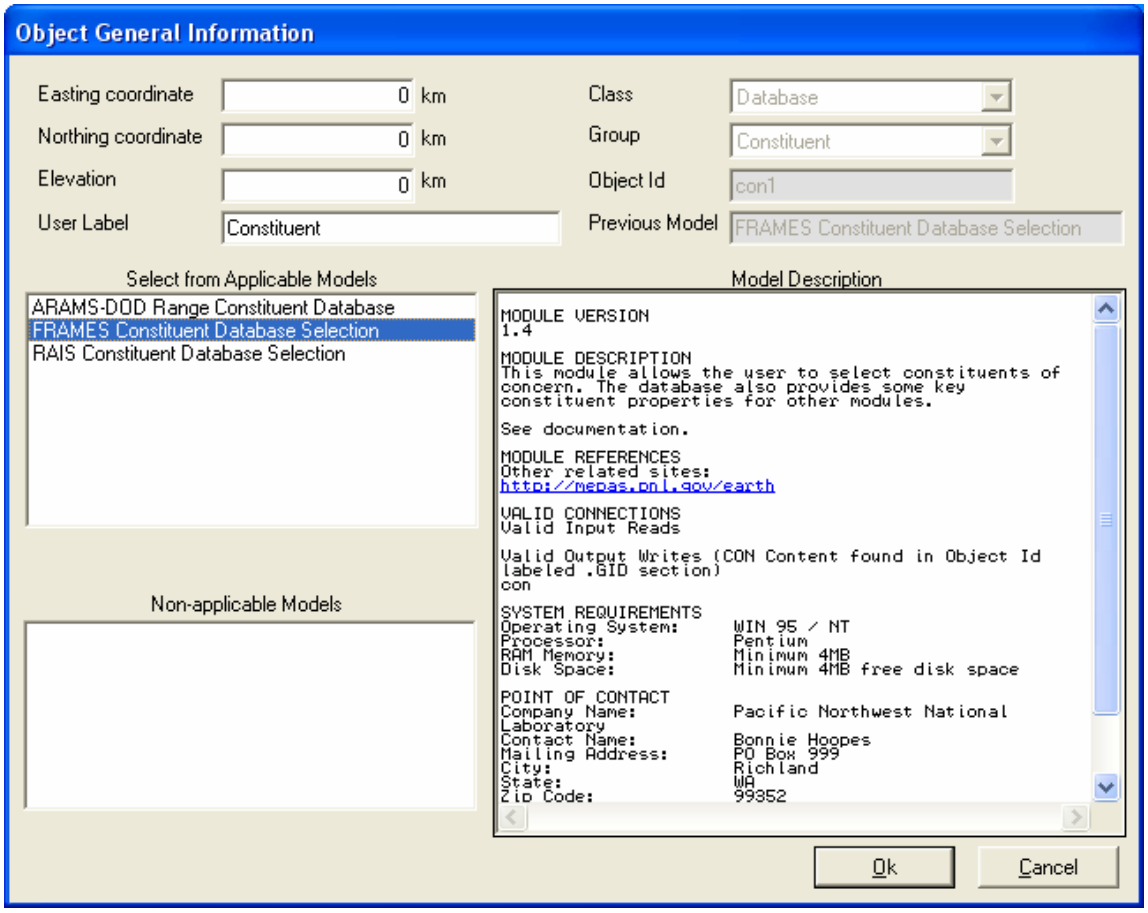

Figure 6. Object General Information screen

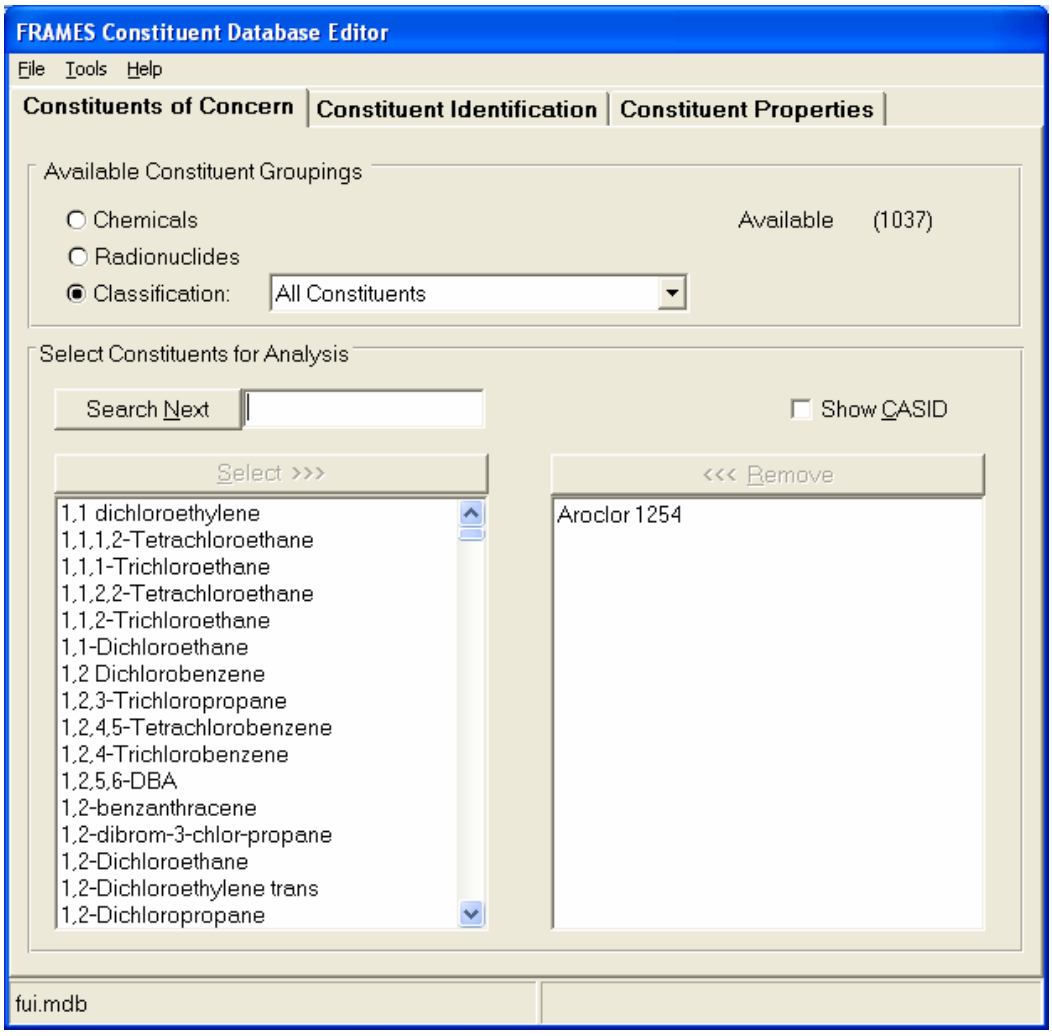

Figure 7. FRAMES Constituent Selection screen ("Constituents of Concern" tab)

The following is a listing of all data input required by the remaining modules used in this example. *Names of module icons* are in bold, italics, and underlined headings. *Menu items* (displayed by right-clicking on the icon) are shown below the module in bold and indented to the right of the icon names. Explanations of data required by each menu item are indented further to the right. To save information for your scenario, select "File" and then "Save" from the FRAMES main menu.

AQUATIC ORGANISM SELECTOR

General Info

A window titled "Object General Information" will appear. Put "Aquatic Organisms" in the Label text box. In "Select from Applicable Models," choose "Aquatic Organism Selector" and click "Ok." The status light next to the Aquatic Organism Selector icon should turn red.

The user should first choose each module for each object before entering any data; thus, enter the "General Info" on each remaining module and make a selection before selecting the "User Input." After selecting modules, User Input should be performed, and the modules run, starting with the modules at the upper end of the chain and working down the chain.

User Input

A window titled "ARAMS Aquatic Organism Selector" will appear. Select "Oncorhynchus mykiss" as shown in Figure 8. Choose "Save and Exit" from the File menu. The status light next to the Aquatic Organism Selector icon should turn green.

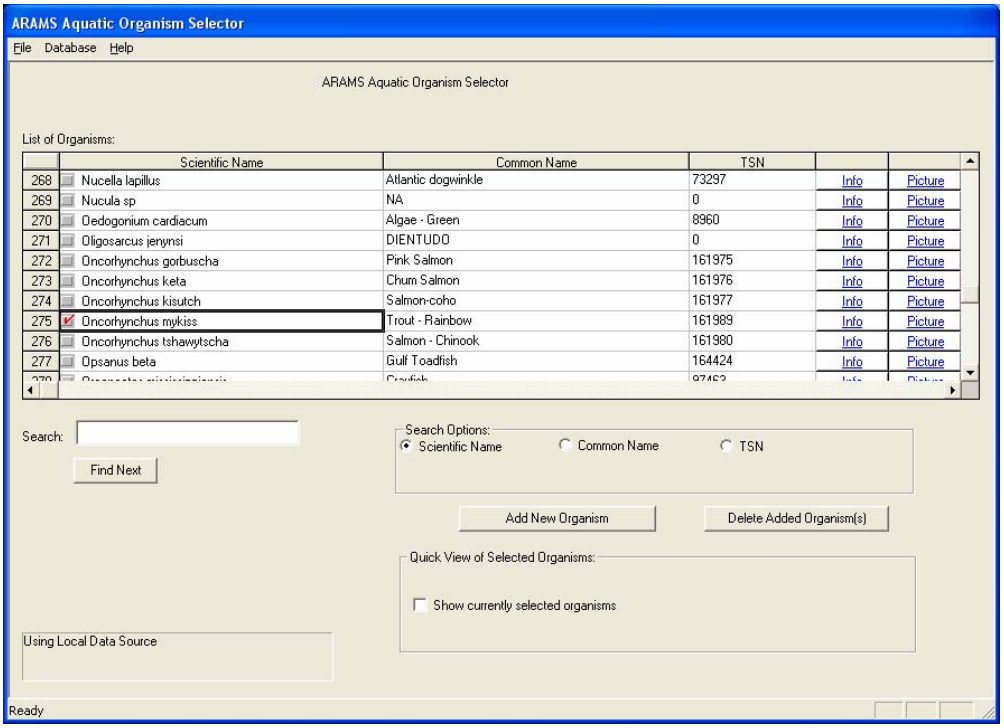

Figure 8. Aquatic Organism Selector main screen

BIOTA-SEDIMENT ACCUMULATION FACTOR

General Info

A window titled "Object General Information" will appear. Put "BSAF Database" in the Label text box. In "Select from Applicable Models," choose "BSAF Database" and click "Ok." The status light next to the BSAF icon should turn red.

User Input

A window titled "BSAFClient" will appear. There were no data in the BSAF database for the constituent of concern and target organism, so the organism is aliased to Dover Sole

(Microstomus Pacificus). While under the *Select Alias* tab, click the target organism in the far left box, then scroll the organism aliases until Microstomus Pacificus is found and click it. Next click the *Lipid and BSAF Values* tab, then click the *Retrieve Lipid/BSAF Values* button. The BSAF database did not compute a grand mean from the values in the database for lipid and BSAF, so the user must examine the available values under *Detail Report* and estimate or select a representative value from the available list or enter their own values by clicking into the data fields on the *Lipid/BSAF Values* screen. For this case, values from the BSAF database will be used. Click the *Detail Re*port screen, click the lipid value of 1.34, and then click *copy to clipboard*. Next click OK, which returns to the *Lipid/BSAF Values* screen, and click into the lipid data field, which will open the *References* screen with the cursor in the *Cell Value* position. Next click *paste from clipboard*. Note that the value of 1.36 for lipid is pasted into the *Cell Value* field, and the lipid database reference for this value is added to the short and long reference fields as shown in Figure 10. Next click *Add*, and then click *OK*, which will assign the reference to the cell value. Alternatively, users can enter their own value for lipid after clicking into the lipid field; a reference must then be added for that value. Follow the same steps for entering a value of 0.96 for BSAF by *copying and pasting* the BSAF database value. Note that the lipid and BSAF values correspond to lipid BSAF reference number 13, which can be viewed by clicking the "Reference" column for either of the values in the "Detail Report" screen. When complete, the values of 1.34 and 0.96 are shown in the lipid and BSAF fields (see Figure 11). Choose "Save and Exit" from the File menu. The status light next to the BSAF icon should turn green.

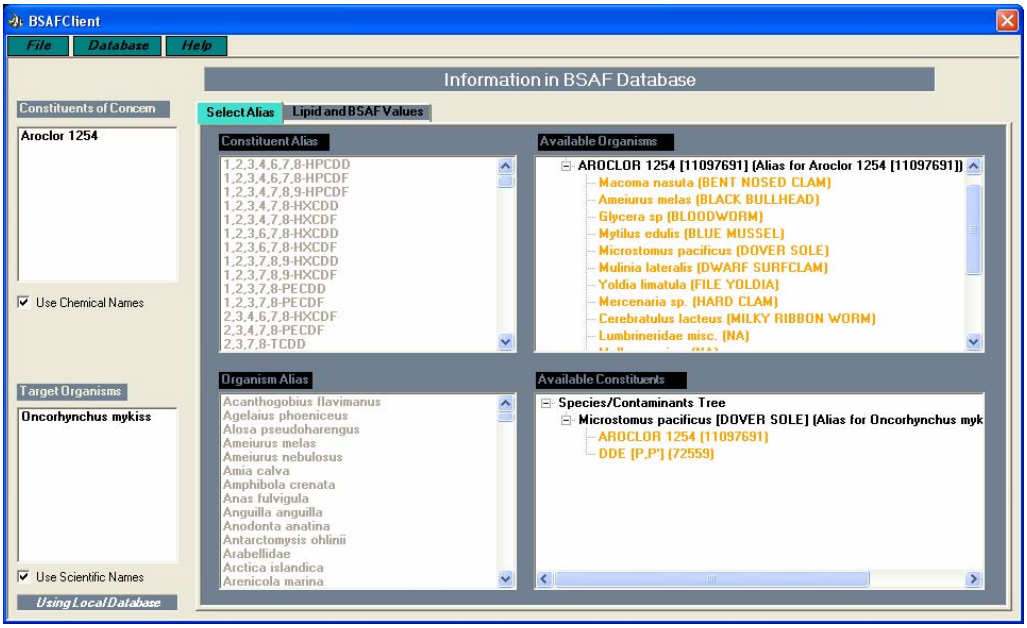

Figure 9. BSAF Database Alias Selection screen

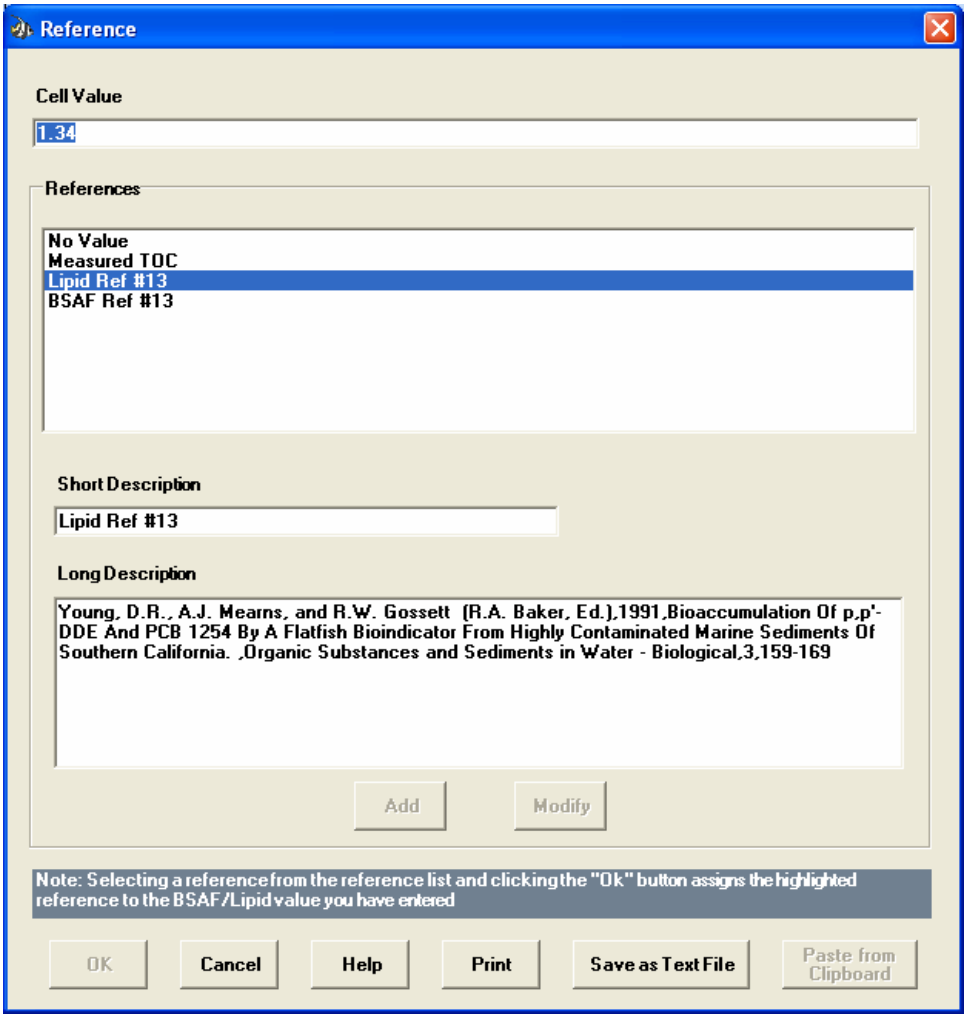

Figure 10. Input screen for entering cell values and references for lipid and BSAF

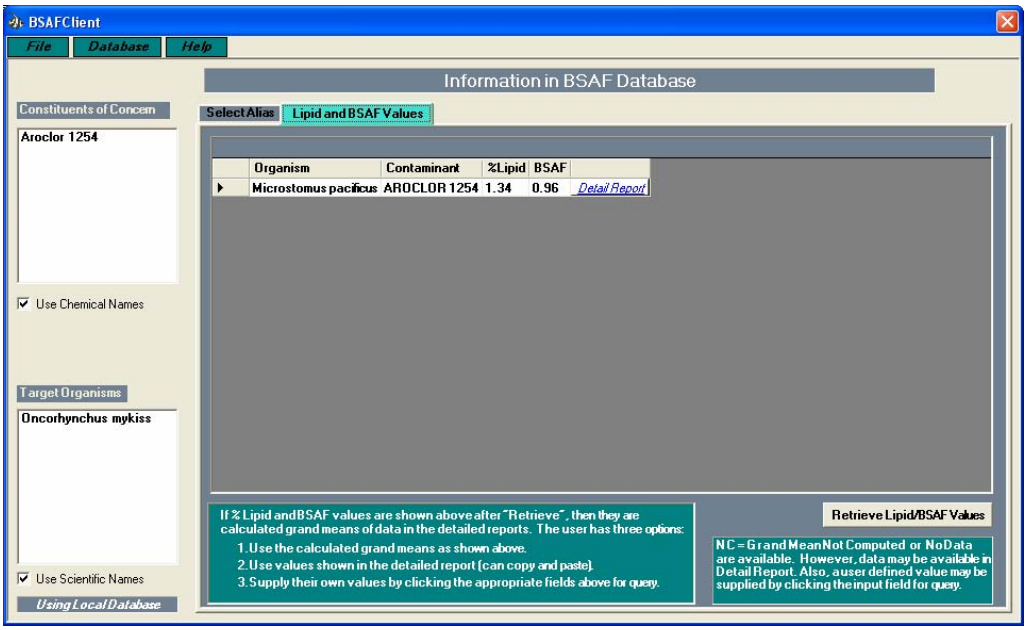

Figure 11. BSAF Database Lipid and BSAF Values screen

AQUATIC BENCHMARKS

General Info

A window titled "Object General Information" will appear. In the Label text box, input "ERED Database." In "Select from Applicable Models," choose "ERED Database" and click "Ok." The status light next to the Aquatic Benchmarks icon should turn red.

User Input

A window titled "EREDClient" will appear. Click the tab labelled "Constituent/Organism Aliasing" at the top of the screen (see Figure 12). Lists containing the target constituents and organisms will appear at the left side of the screen. Click the check boxes labelled "Use Constituent Name" and "Use Common Names" to work with constituent and organism names instead of constituent CAS numbers and organism scientific names. If the selected organisms and constituents of concern are found in the ERED database, the aliases will automatically be chosen as they are in this case. If they were not automatically selected, the alias would need to be chosen by clicking on either the constituent name or the organism name and then choosing the alias from the appropriate box labelled "Constituent Alias" or "Organism Alias." See Figure 12 to verify that the selections are correct. Aliases should be selected such that there are data in the database for the selected constituent-organism pair. The panels on the right-hand side of Figure 12 are provided so that the user can easily see the list of organisms for which there are data for the target constituents (i.e., "Available Organisms"), and vice versa, "Available Constituents." There is also a button at the top of the screen (see Figure 12) labelled "Database" where the user can choose between using the Web-based "Remote" database or a copy of

this database downloaded to the client machine called “Local” database. The local database is used when the user cannot get to the Web database for various reasons.

Select the tab labelled “Select Data for Downstream Modules” at the top of the screen and then click the button labelled “Retrieve Data” in the top right corner of the screen. After the database has been queried, a list of available effects data will be displayed in a list by constituent-organisms pairs as shown in Figure 13. The two filter combo boxes at the top of the screen allow the user to see only specific combinations of constituent-organism pairs or “All” of them. The user then must select which data to send to other modules by clicking the appropriate check boxes under “Send Data.” For this application, we are going to use only the whole body-mortality endpoint with a value of 8.2 mg/kg. After checking this endpoint, click “Save and Exit” under the File menu. The Aquatic Benchmarks icon’s status light will change from red to green. If the user goes back into the user input screens, the send data screen will look like Figure 14, where only the one benchmark of 8.2 mg/kg is shown.

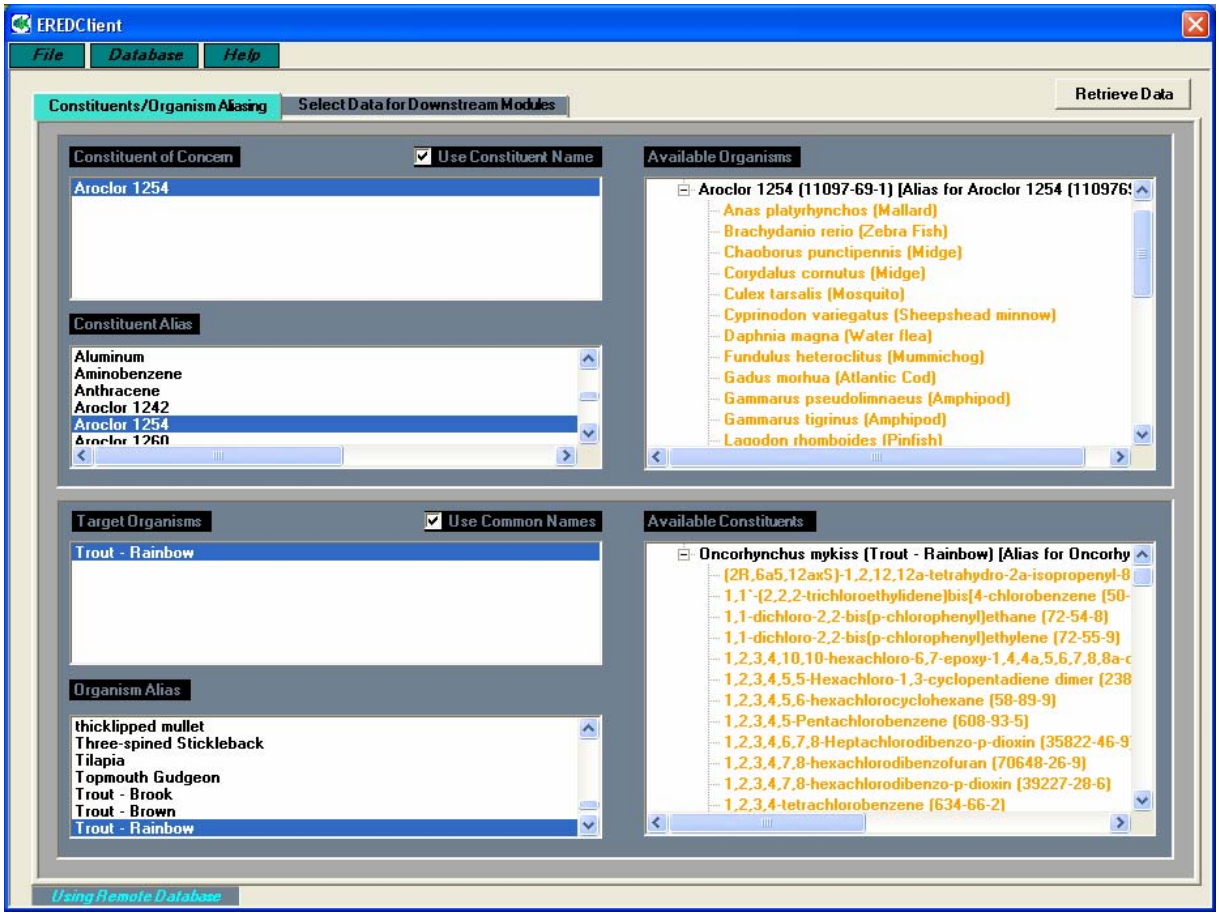

Figure 12. Constituent and Organism Aliasing in the ERED database client

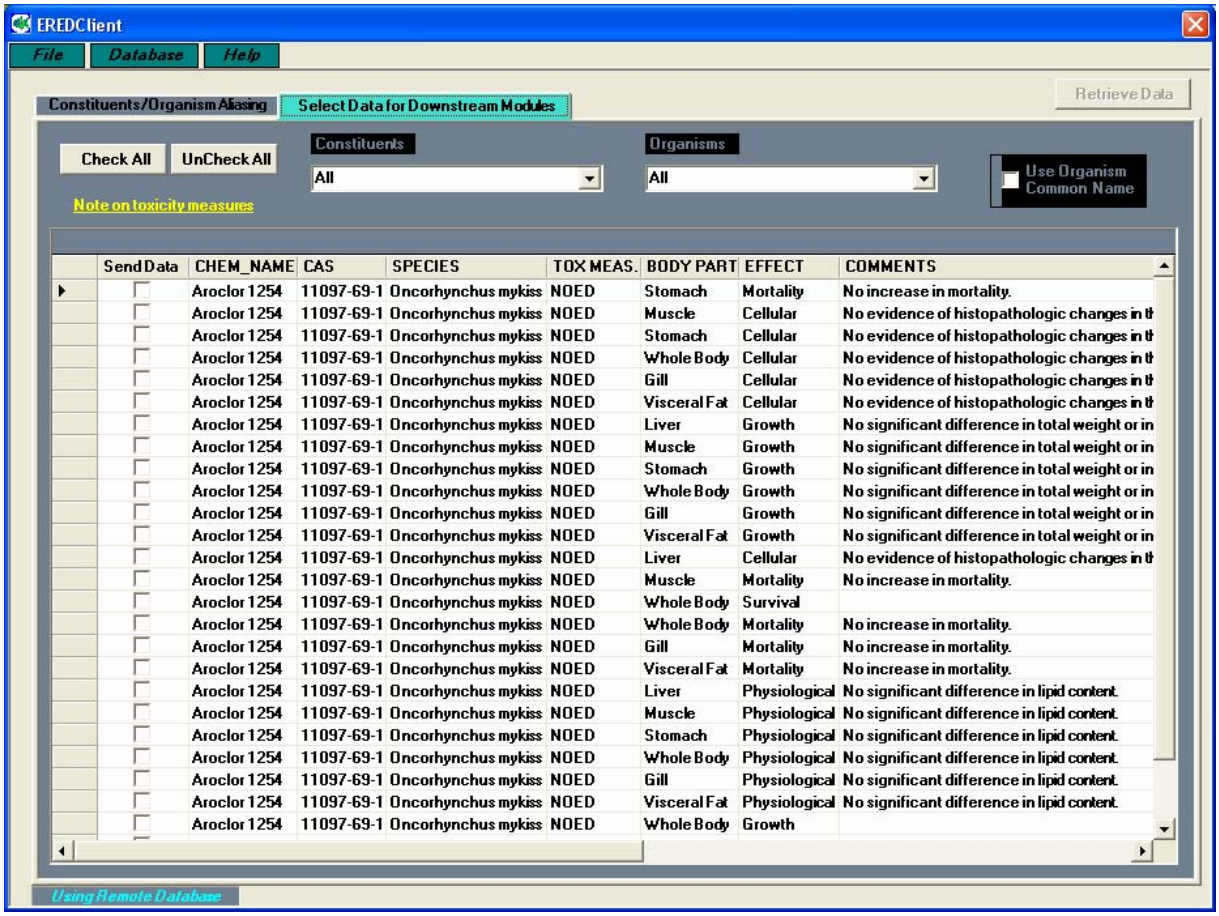

Figure 13. "Select Data for Downstream Modules" tab in the ERED DCE

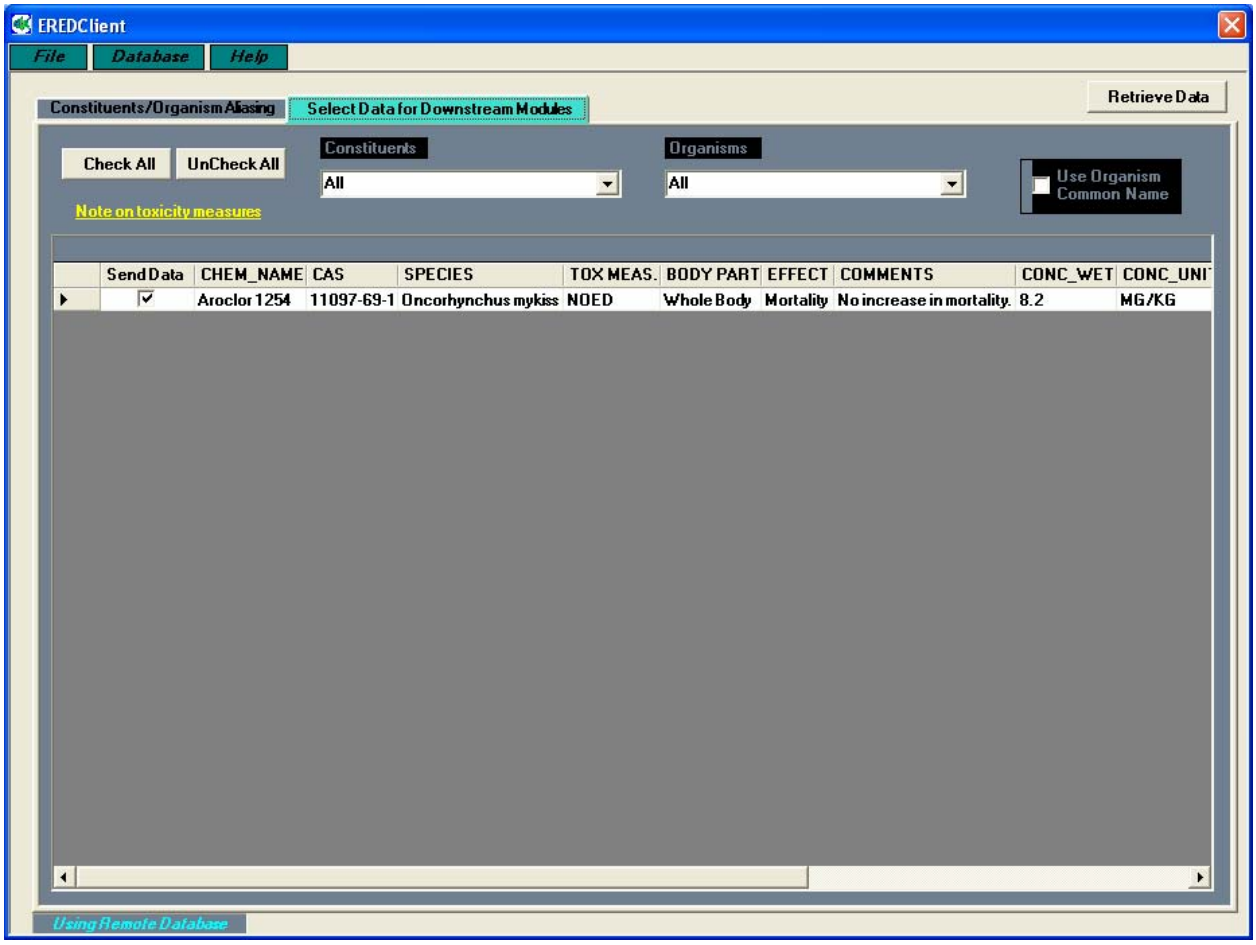

Figure 14. Send data screen of ERED DCE after choosing endpoints, save/exit, and upon reentering the user input screens

SURFACE WATER

General Info

A window titled "Object General Information" will appear. In the Label text box, put in "Surface Water." In "Select from Applicable Models," choose "RECOVERY 4.3 Surface Water Module" and click "Ok." The status light next to the Surface Water icon should turn red.

User Input

A window titled "ADDAMS Applications - RECOVERY Version 4.3" and "Morphometry and Hydrology" will come into view. All inputs should be entered sequentially as each screen appears, i.e., do not pass to the next screen until the previous screen values have been entered. The first input screen allows the user to select an existing RECOVERY input file for use in their application. Note that the Water "Steady State" and "Time Varying" buttons are dimmed out when RECOVERY is running within FRAMES since all flux input and output files in FRAMES (e.g., water flux files, or

WFF) are assumed to be time varying even if the values are constant over time. RECOVERY can accept WFF from other modules as loading inputs. For example, WFF output from an overland flow module (e.g., watershed runoff) can be accepted as loading input by RECOVERY within FRAMES. Fill out the first screen as shown in Figure 15 and click "Recalculate," then choose "Save" and select "Next."

A screen like Figure 16 will appear (mixed sediments layer). Fill it out according to the data shown, click "Save," and select "Next." Another window like Figure 17 will appear (deep contaminated sediments layer). Fill it out according to the data shown, click "Save," and select "Next." A window like Figure 18 will appear; make sure that the system properties shown in the figure coincide with your screen values. Click on "Recalculate," choose "Save," and select "Next." A screen like Figure 19 will appear next; ensure that the Aroclor 1254 properties and decay coefficients shown coincide with your screen values, click "Save," and "Next." A window like Figure 20 will appear next (model parameters). Fill it out according to the data shown, click "Save," and "Next." A window like Figure 21 will appear. Click on "Save Input," then click "Exit." The status light next to the Surface Water icon should turn yellow.

Run Model

The model runs in the background. The status light next to the Surface Water icon should turn green.

View/Print Module output

Choose "SCF Graphical View to view sediment concentrations versus time in Excel (see Figure 22).

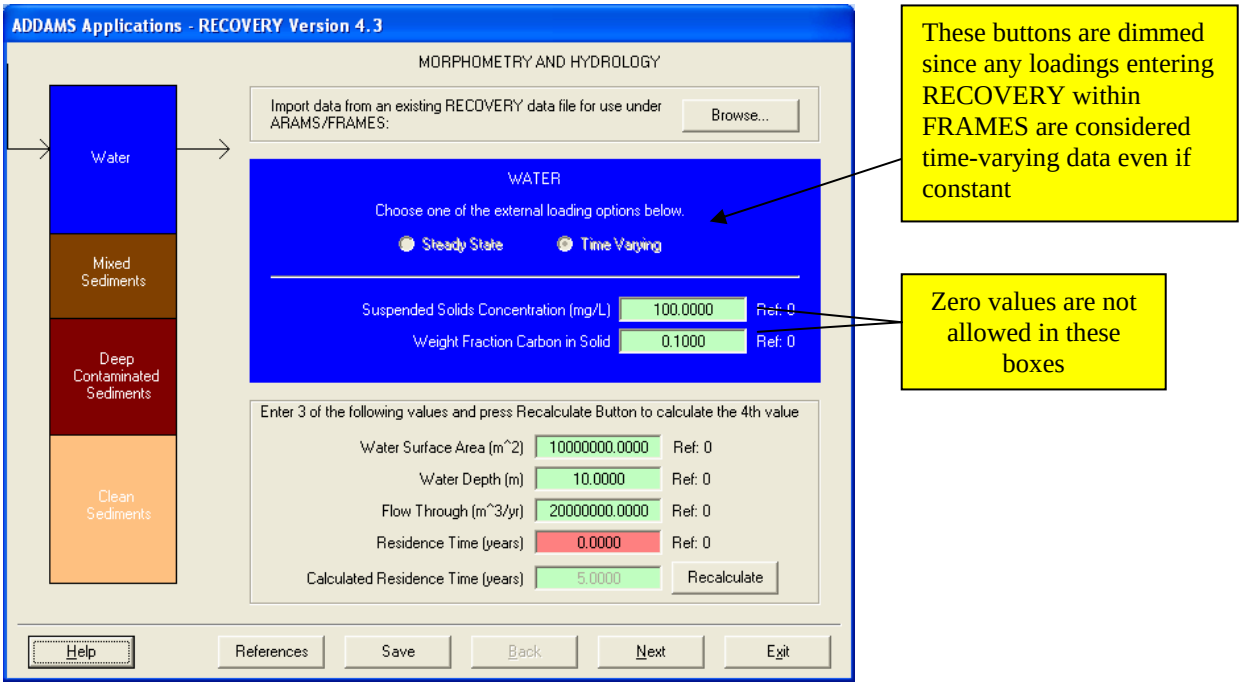

Figure 15. Input screen for RECOVERY morphometry and hydrology

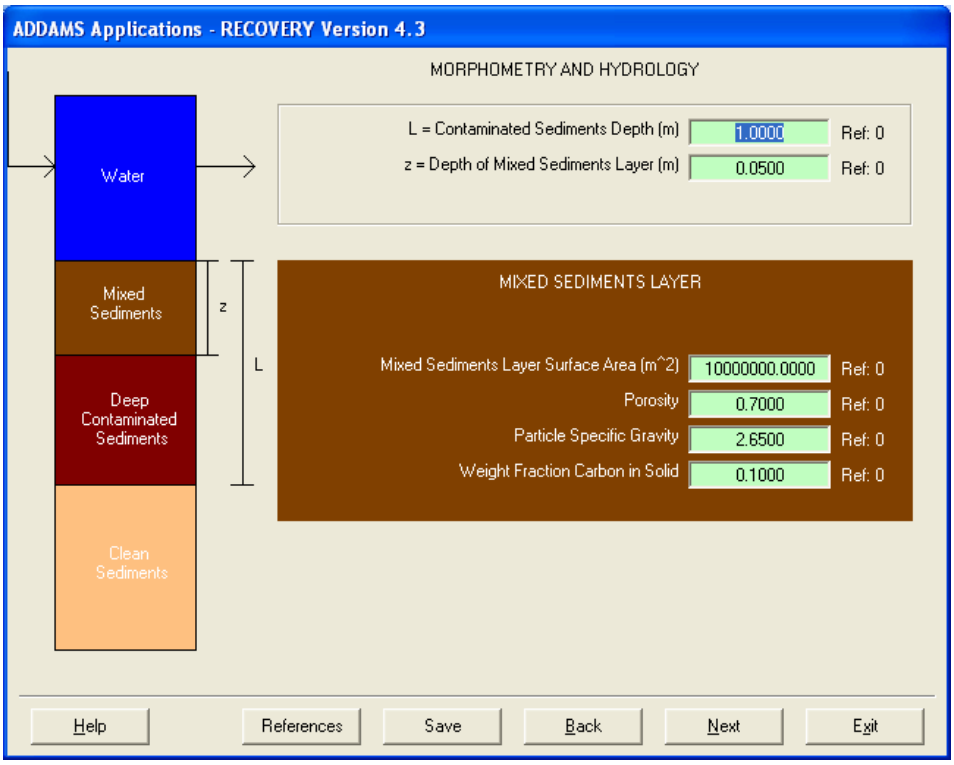

Figure 16. Input screen for RECOVERY mixed sediment layer

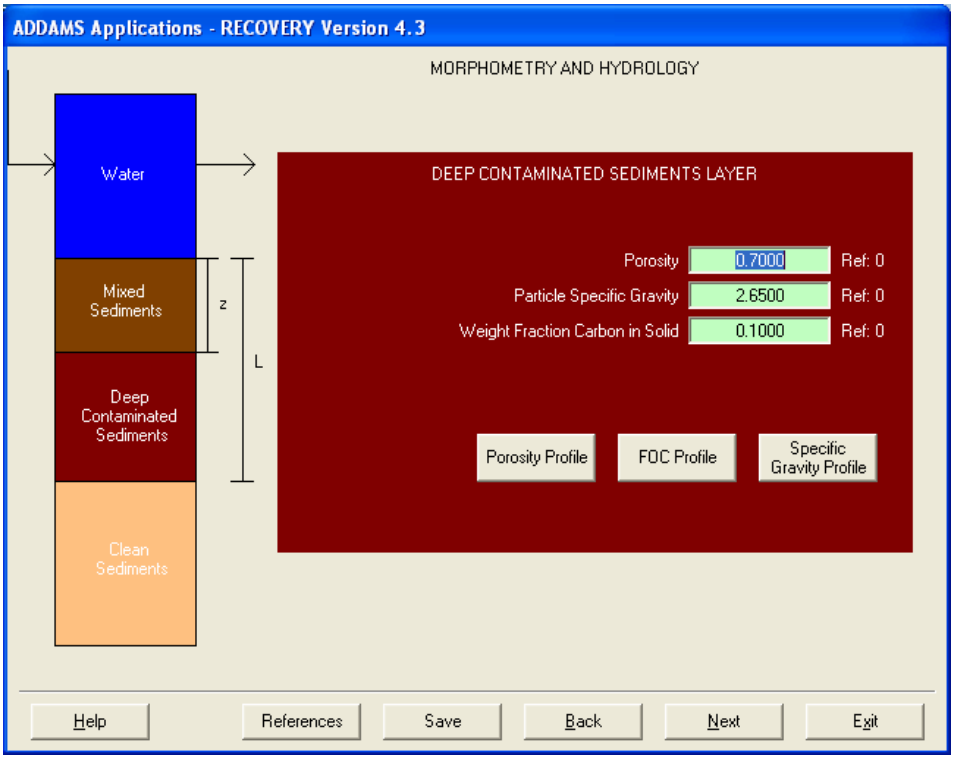

Figure 17. Input screen for RECOVERY deep sediment layers

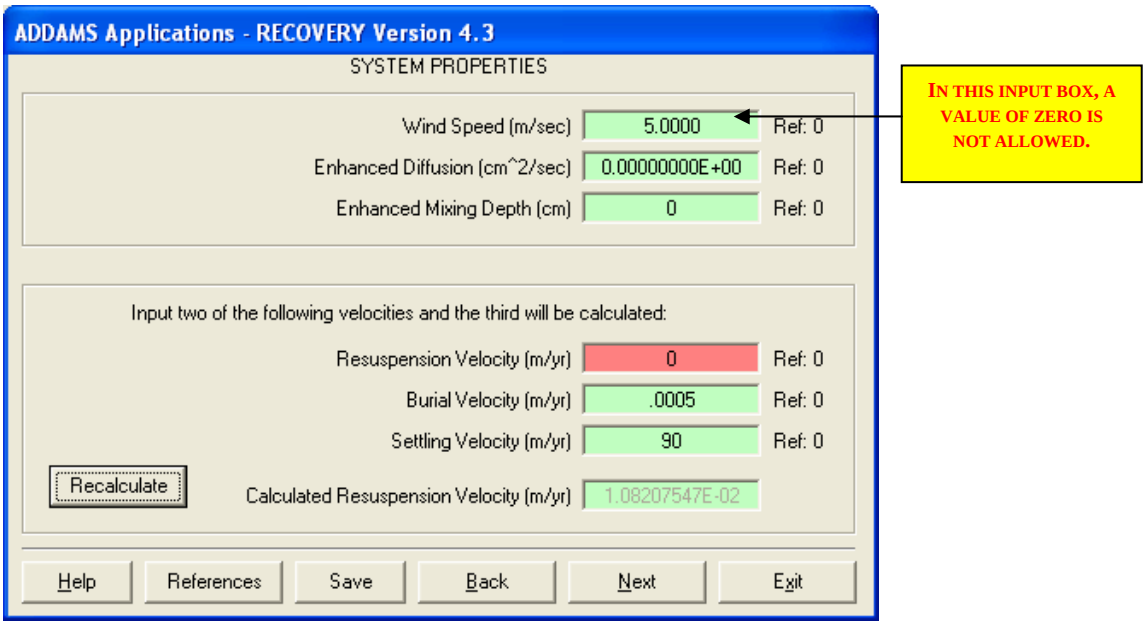

Figure 18. Input screen for RECOVERY system properties

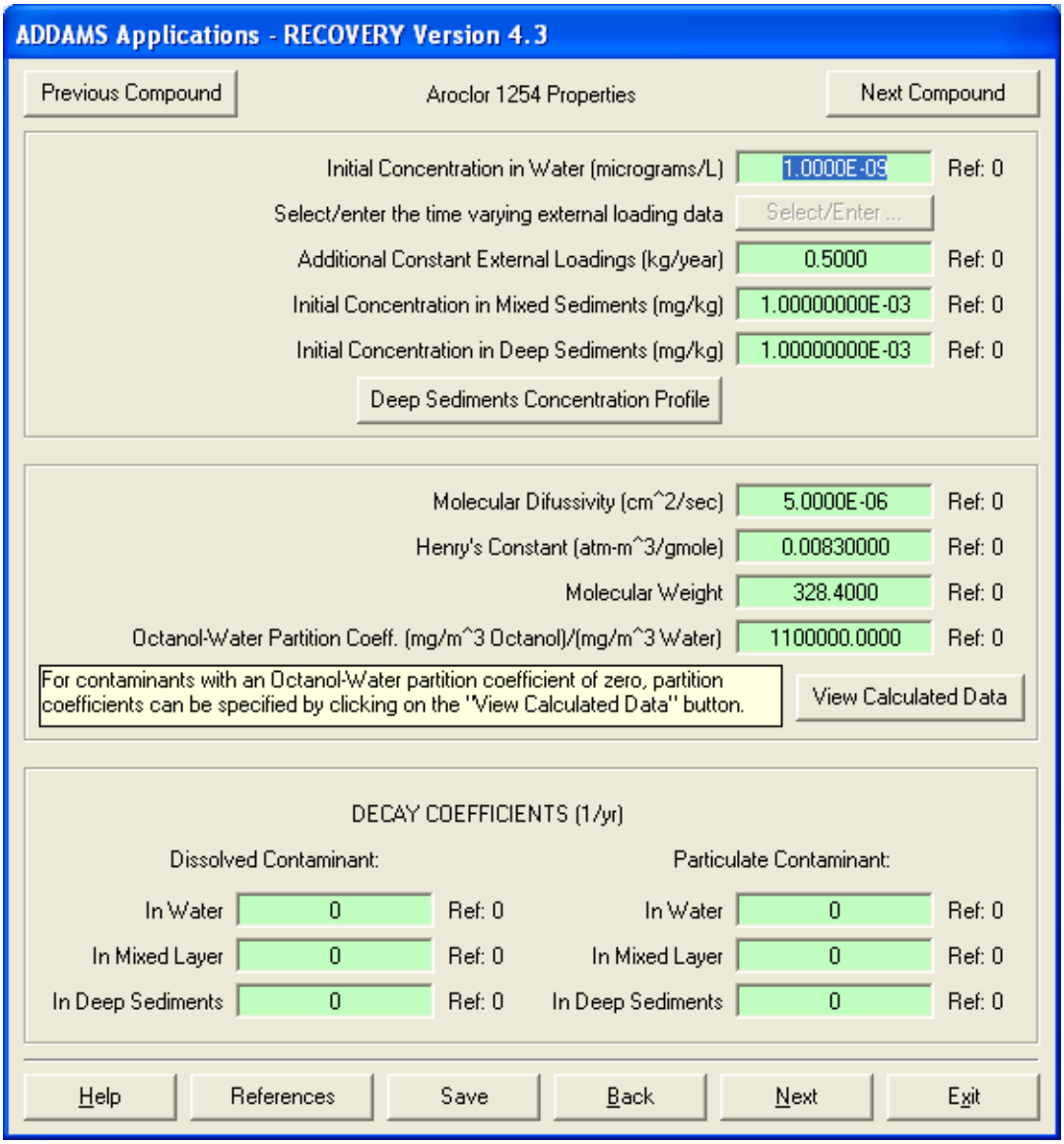

Figure 19. Input screen for RECOVERY Aroclor 1254 properties and decay coefficients

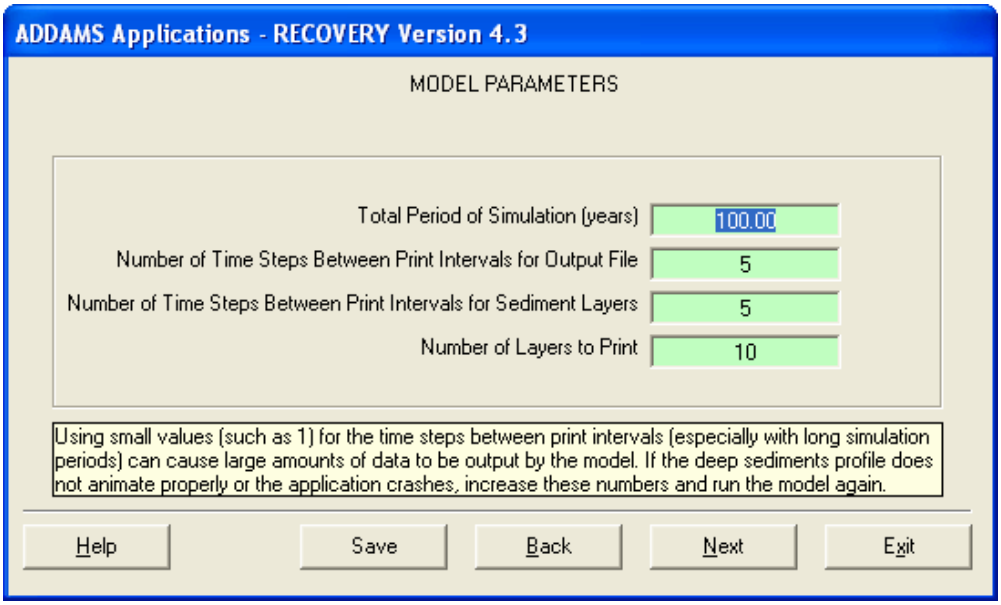

Figure 20. Input screen for RECOVERY model parameters

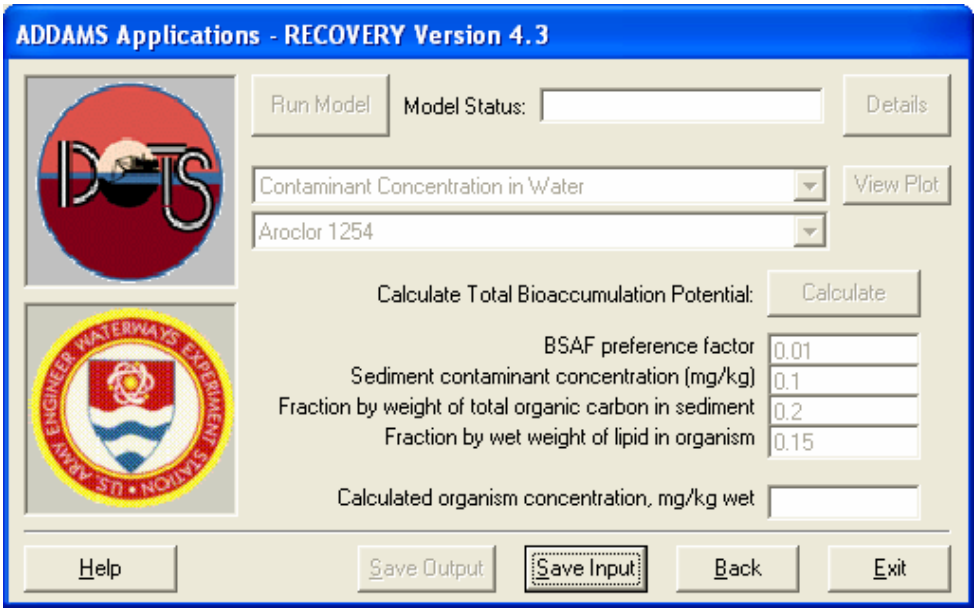

Figure 21. Screen for saving/exiting RECOVERY input

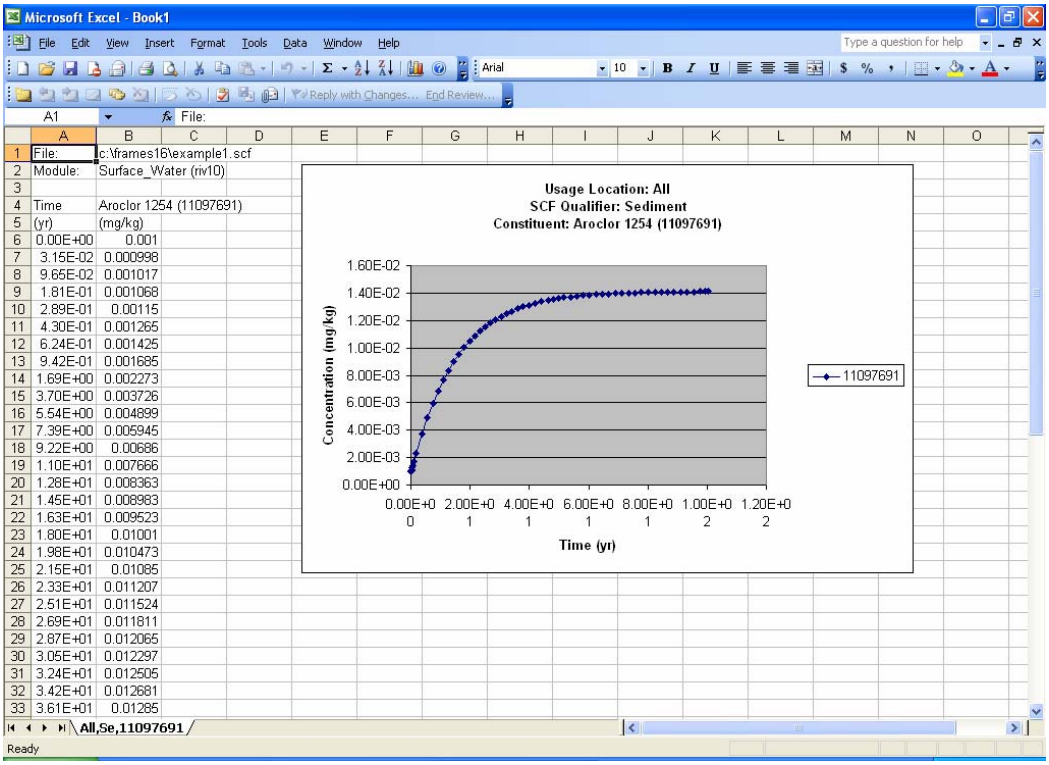

Figure 22. SCF graphical view – sediment concentration

ECO TISSUE CONCENTRATIONS

General Info

A window titled "Object General Information" will appear. In the Label text box, input "TBP Model." In "Select from Applicable Models," choose "Theoretical Bioaccumulation Potential (TBP) DCE," and click "Ok." The status light next to the Eco Tissue Concentrations icon should turn red.

User Input

The main TBP screen will appear (see Figure 23) and is pre-populated with the constituent(s) and organism(s) selected from the Constituent Database and the Aquatic Organism Selector objects, respectively. Lipid and BSAF values are retrieved from the Biota-Sediment Accumulation Factor module. The only additional information required for this module is the Total Organic Carbon (TOC) fraction by weight in the sediment. Upon clicking into the TOC field, another input screen will appear labeled "Reference" at the top. Enter the value for TOC as shown in Figure 24 along with an appropriate reference for this value if so desired. Type into the Short Description field (replacing "No Value") to start a new reference, then add the long description. Make sure the new reference is first "Added," then highlight the new reference in the "References" panel, and click OK to tie this reference to the TOC value. *Note that all references entered during an application for any module can be viewed under the FRAMES File menu.* Upon leaving the references dialog, the TOC value of 0.1 that was entered appears in the TBP input main

screen as shown in Figure 23. Click “File” and choose “Save and Exit.” The Eco Tissue Concentrations icon’s status light will change from red to yellow.

Run Model

The model runs in the background. The status light next to the Eco Tissue Concentrations icon should turn green.

View/Print Module Output

Choose “BBF Graphical View” to view a screen output like Figure 25 (Excel format).

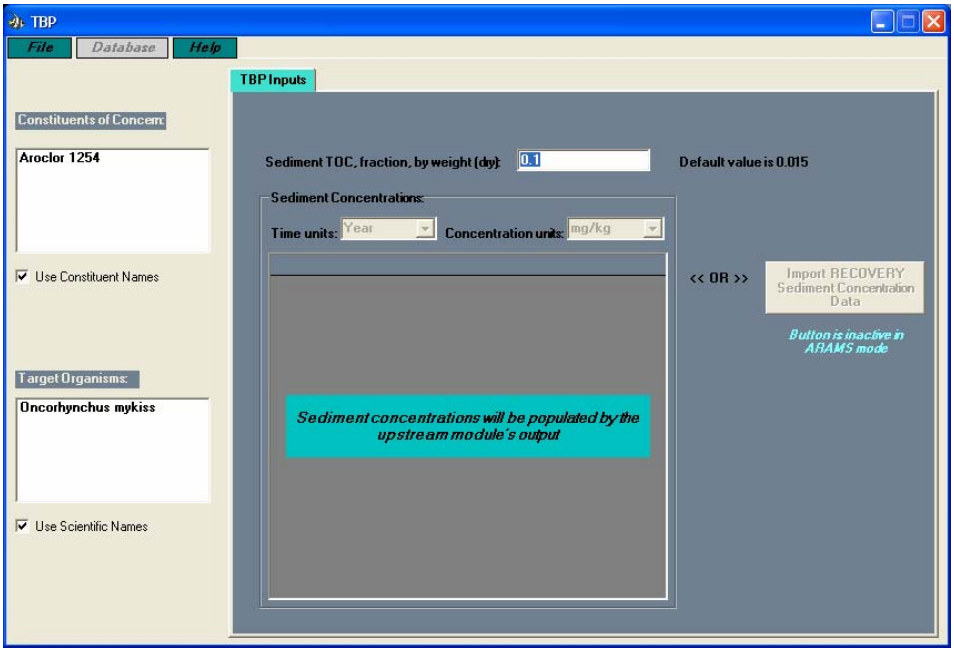

Figure 23. TBP input screen

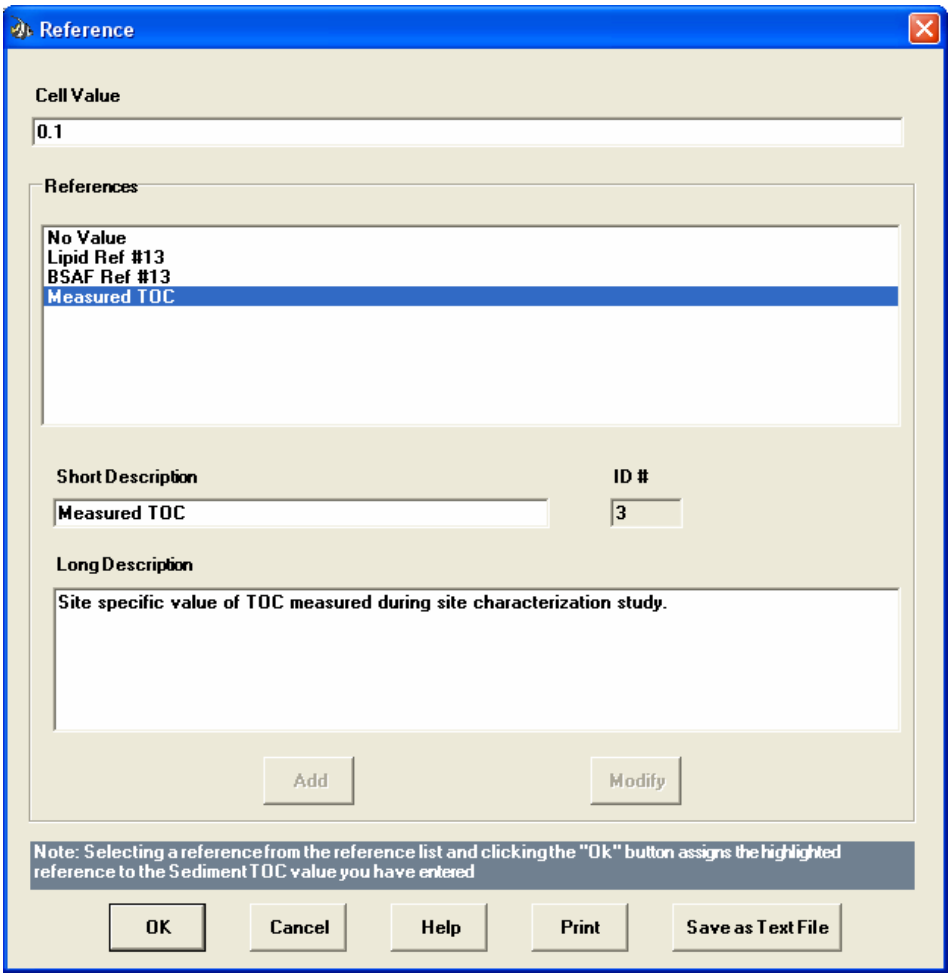

Figure 24. TOC value and references input screen for TBP module

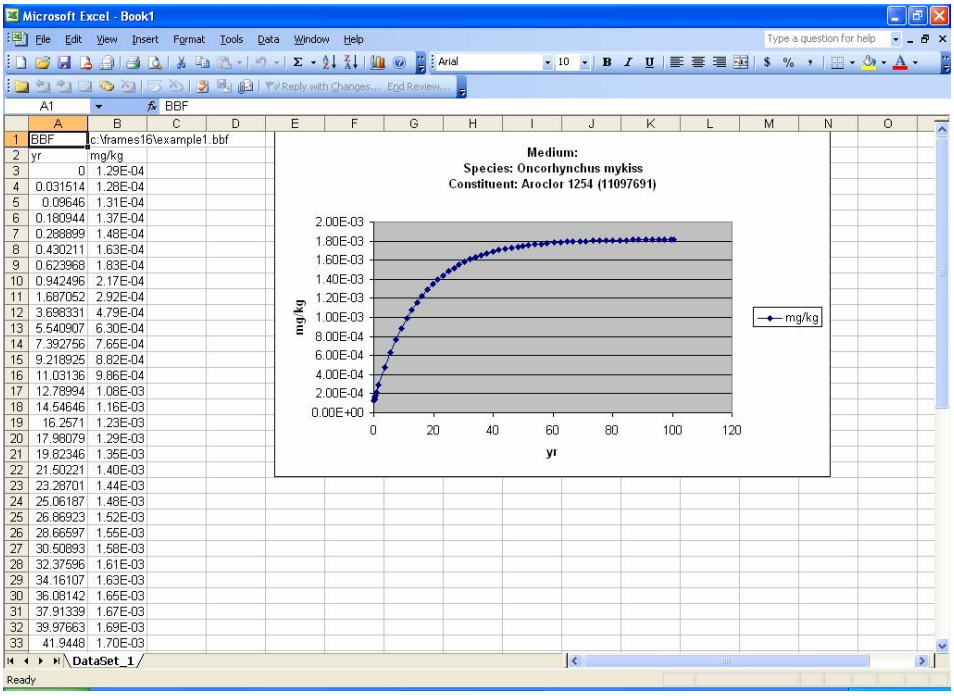

Figure 25. Eco Tissue Concentrations Output (Excel format)

ECO HEALTH EFFECTS

General Info

A window titled "Object General Information" will appear. In the Label text box, input "WEAP Model." In "Select from Applicable Models," choose "Wildlife Ecological Assessment Program" and click "Ok." The status light next to the Eco Effects icon should turn red.

User Input

A window titled "Wildlife Ecological Assessment Program" will appear. In the right panel labeled "Aquatic Body Burden Dose Assessment," click in the check box to the left of "No observable effects dose." There only two boxes that can be checked, "No observable effects dose," and "User defined TRV," where the latter is always available. The former is the only option available because only NOED data were passed from the ERED module. In the data tree at left, click on "Body part of concern" and a list labeled "Body part of concern" will appear at right. From this list make sure "Whole Body" is selected for output (see Figure 26). This is the only option available since only whole body data were passed from the ERED module. Do the same for "Type of effect", and only "Mortality" is available to choose sine this is all that was passed from ERED. If more data had been passed from ERED, the user has the option in WEAP to trim the outputs to consider. Click "File" and choose "Save and Exit" to return to the workspace screen. The Eco Health Effects icon's status light will change from red to yellow.

Run Model

The model runs in the background. The status light next to the Eco Health Effects icon should turn green.

View/Print Module Output

A second menu will appear. Select the "EXF Text View" to view a screen output like Figure 27. Choose "EXF Graphical View" to view a screen output like Figure 28 (Excel format).

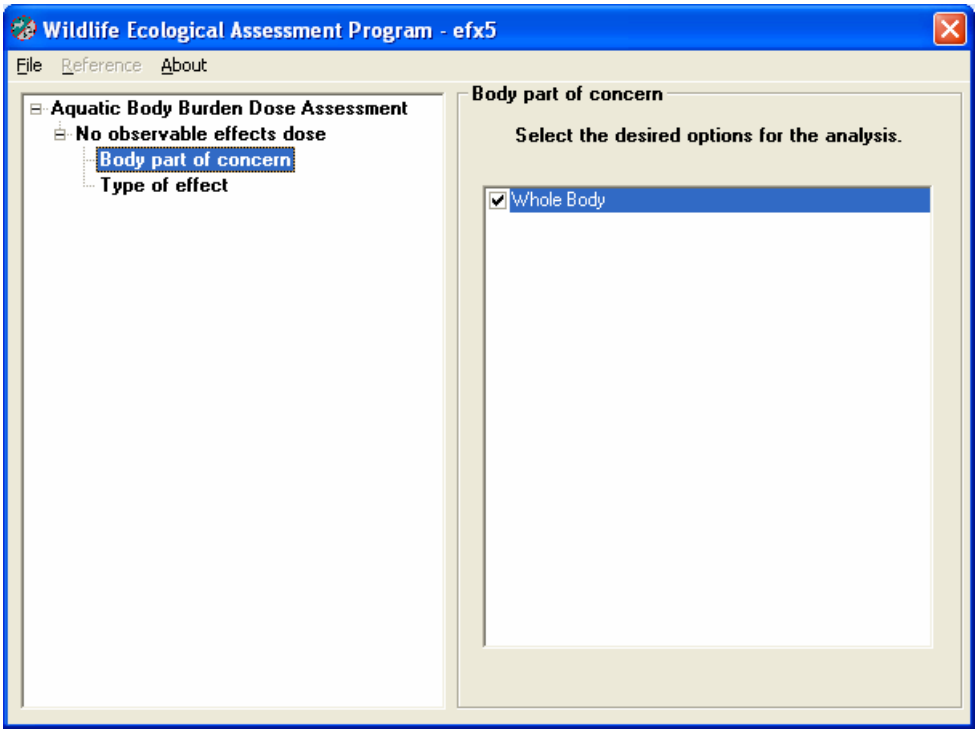

Figure 26. Wildlife Ecological Assessment Program (body part of concern)

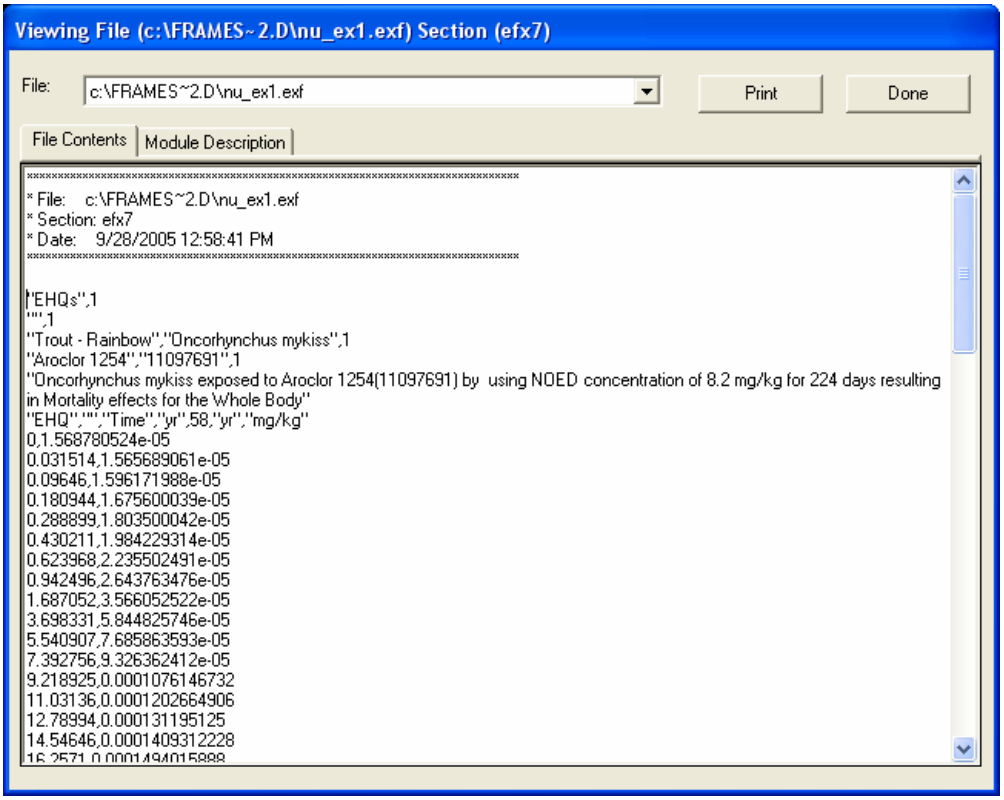

Figure 27. Eco Health Effects output (text view)

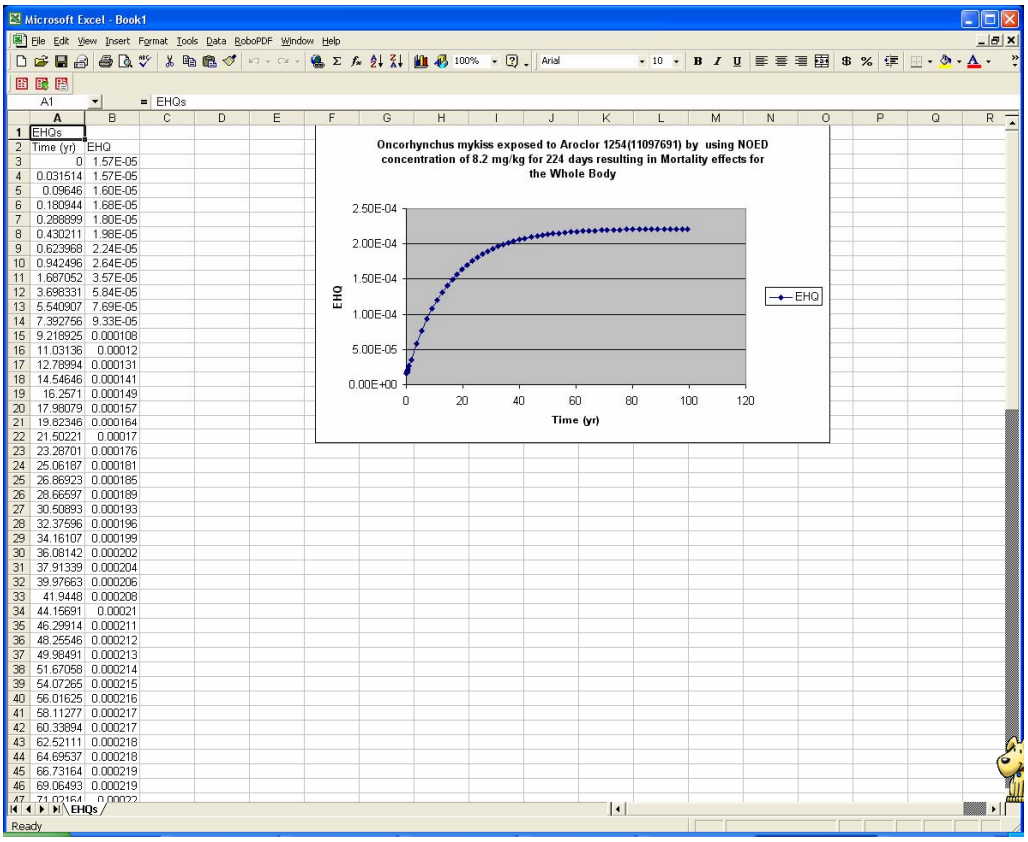

Figure 28. Eco Health Effects Output (Excel format)