This How-To guide provides guidance for the application of the Habitat Suitability Analysis features of EFDC\_Explorer 8.4. This guide will give the user an introduction to the Habitat Suitability Analysis features but is not intended to be comprehensive. As additional modules are added to a model, more parameters become available to be used in the habitat analysis. The demonstration model shown in this guide and the resources to conduct the habitat analysis are available …

1. Goals
	1. Determine the weighted usable habitat area based on defined criteria through time;
	2. Determine the habitat suitability index, for both the entire domain and for each cell, as a function of time;
	3. Analyze the weighted usable area and habitat suitability for the entire domain as a function of discharge using the Instream Flow Incremental Methodology (IFIM);
	4. Analyze the spatial distribution of suitable habitat as a function of time.
2. Model Description

The habitat river demonstration model provides a typical example of a large gravel bed river, with multiple vegetated islands, bars, and side channels. The upstream boundary of the model uses a stepped flow pattern fitting with the IFIM methodology, where flow is gradually increased from low to high flow conditions over a period of three hours. The downstream boundary condition utilizes a rating curve to define the relationship between the water level and flow in the channel. The model simulates the basic 3D hydrodynamics of the river system at various flow and stage combinations.

For this example, two species have been identified for analysis: Muskellunge (*Esox masquinongy*), and Burbot (*Lota lota*). At each life stage, these species seek out specific areas of the river which satisfy a broad set of habitat preferences. To conduct the initial analysis, we focus on water depth and velocity as the primary factors in the habitat suitability for these species.

**Step 1: Run the Model**

Once the model has been loaded into EFDC\_Explorer, Run the model by pressing the *Run EFDC* button on the top bar of the main EE form. This step is required to conduct the habitat analysis in the following steps.

**Step 2: Open the Habitat Suitability Analysis dialog**



From the main form of EE, go to the *Model Analysis* form and open the *Habitat Analysis* tab. Press the *Habitat Suitability Analysis* button to open the *Habitat Suitability Analysis* dialog.



**Step 3: Define Habitat Suitability Curves**

Habitat suitability curves are included in the … for the Muskellunge and Burbot species. Begin by entering in the first fish species and life stage into the *Criteria ID* text box (“Muskellunge Adult”). Next, select *Water Depth* from the drop-down menu under the *Parameters* list. A text box appears next to drop down menu for the model parameter once it has been selected. This text box is used to store the habitat suitability curves for the chosen parameter.



With the text box selected, press enter to open the *XY Data Editing Tool*. In this dialog, XY data can be entered and plotted graphically to assist the user in defining habitat suitability curves for the chosen parameter.



Begin entering XY data from the spreadsheet provided to define the habitat suitability curve for Water Depth for the Muskellunge Adult. Once finished, the curve should appear as shown below.



Hit OK to return to the *Habitat Suitability Criteria* dialog.

**Note that the XY data just entered now appears in the text box next to the drop-down menu. The user has the option to enter XY data in the text box, separating X and Y with a comma, and separating pairs of XY data points with a semi-colon.**

Next, select *Velocity* from the next drop-down menu below *Water Depth*. Once XY data has been entered to define the habitat suitability curve for velocity, hit the *Save* button to save the criteria just defined for the Muskellunge Adult. This will write the habitat suitability curve information for this species to a .hab file under the #habitat folder of the HabitatRiver model folder by default.



Saved habitat suitability files can be reloaded into this dialog using the *Load* button.

**Note that the files saved from this dialog will have the same .hab extension as files generated using the *Critical Limits Time Series* analysis tool, therefore it is important to distinguish between files used for one Habitat Analysis tool or the other. It is suggested that the user append “\_HSC” or “\_CLS” to the end of the file name to make this distinction clearer to the user later on.**

Create .hab files for all of the species listed in the … spreadsheet and save each one of them for use in the following steps of this How-To guide.

**Step 4: Generate Initial Time Series**

Once habitat suitability curves have been generated and saved, the user can begin the analysis. With the desired .hab file loaded into the *Habitat Suitability Criteria* dialog, press the *Generate Initial Time Series* button to extract data from the model output files. The user will be prompted to confirm the number of cells included in the analysis. Select *Yes*.



**Note that the number of cells included in the analysis can be refined using the Sub-Set option in the *Habitat Suitability Criteria* dialog. This dialog can utilize a .p2d or other shapefile to define a region of the model for analysis.**

**Step 5: View the Weighted Usable Area Time Series**

Once model results have been extracted for the desired number of cells, Secondary Processing of Extracted Results options become available to the user in the *Habitat Suitability Criteria* dialog. From the drop-down menu, select *WUA Time Series*, and press View *WUA Time Series* to generate a plot of this data. The data displayed in this plot is automatically extracted to a data file under the #habitat folder in the model directory.



Once you are finished inspecting the time series, press the *Export* button on the top bar to export this time series for use later. Give the time series a distinctive name that you will recognize later. For example, “TS\_MuskellungeAdult\_HSC\_WUA.dat”.

**Step 6: View the WUA vs. Q plot**

Close the *Time Series Data Grapher* to return to the *Habitat Suitability Criteria* dialog. Select *WUA versus Q* from the Type of Processing drop down menu. This will bring up a text box which is used to enter time and discharge data to plot the weighted usable area as a function of discharge. Click the text box and press Enter to open the *XY Data Editing Tool* to enter time and discharge data.



For this guide, the user can copy and paste time and discharge data from the spreadsheet provided or enter time and discharge points as desired. The time and discharge data provided for this exercise was chosen to reflect steady flow conditions in the model reach by choosing times at the end of each step in the discharge curve.



Press *OK* to return to the *Habitat Suitability Criteria* dialog once the Time and Discharge data has been entered, then press the View *WUA versus Q* button to show the data.



Once you are finished inspecting the time series, press the *Export* button on the top bar to export this time series for use later. Give the time series a distinctive name that you will recognize later. For example, “TS\_MuskellungeAdult\_HSC\_WUAvsQ.dat”.

**Step 7: View HSC Time Series**

Close the *Time Series Data Grapher* and return to the *Habitat Suitability Criteria* dialog. From the drop-down menu options for *Secondary Processing of Extracted Results* select *HSC Time Series* and press the *View HSC Time Series* button. The *Time Series Data Grapher* will appear again with a time series of the Habitat Suitability Index for the species of interest.



Once you are finished inspecting the time series, press the *Export* button on the top bar to export this time series for use later. Give the time series a distinctive name that you will recognize later. For example, “TS\_MuskellungeAdult\_HSC\_Index.dat”.

**Step 8: Additional Secondary Processing Options**

From the *Habitat Suitability Criteria* dialog, there are some remaining options to explore under the *Secondary Processing of Extracted Results* drop-down. These are:

1. WUV Time Series: The weighted usable volume time series provides another measure of the usable habitat within the area of interest by taking the Weighted Usable Area and multiplying by the depth of each cell.
2. Volume Time Series: Like the WUV, but without utilizing the weighting criteria.
3. Param Time Series: A time series of the selected parameter for all cells satisfying the habitat suitability criteria.

Explore these remaining options and see how they compare with the same parameter for other species or life stages.

**Step 9: Compare Habitat Suitability for Different Life Stages**

Repeat Steps 3 through 7 for all life stages of the Muskellunge, and the life stages of Burbot. After that task is completed, we can begin to put together the habitat suitability information for analysis.

In the *Habitat Suitability* Criteria dialog, select the type of plot desired from the drop-down menu under *Secondary Processing of Extracted Results* and view the series. From the *Time Series Data Grapher*, press the *Import* button on the top bar. Navigate to the #habitat folder where the other series for that species are saved. Load each of the series into the *Time Series Data Grapher* to overlay the time series on same axes.

You can modify the line styles and axis labels by right clicking on the Legend or Axes.

Below are examples of resulting plots from this step of the How-To guide:





**Step 10: Spatial Analysis of Habitat Suitability**

From the main form of EE, open the ViewPlan to load the 2-D plan view of the model domain and display simulation results. The keyboard shortcut Alt+H can be used to open the habitat analysis tools for the 2-D plan view.



Select the Habitat Suitability Indices option by typing 3 in the text box and pressing OK. The user is then prompted to load a Habitat Suitability Criteria file. Select one of the files in the #habitat folder that was created in Step 3.

Habitat suitability index values between 0 and 1 will then be displayed for every cell in the model domain at the selected model snapshot. To change model snapshots, user the Page Up and Page Down buttons on your keyboard or use the Timing slider on the right side of the ViewPlan Window.



Below are examples showing the comparison between habitat suitability for the Burbot species at who different discharge levels in our model:

![](data:None;base64...)![](data:None;base64...)