HEC-RAS Workshop
Using HEC-EFM Data for Water Surface Profile Calculations

Objective

In this workshop, you will use hydraulic models and GIS tools to investigate spatial aspects of ecosystem changes created by different flow regimes.

This workshop has three parts: 1) using HEC-RAS to simulate water surface profiles for flows (statistical results) generated by HEC-EFM, 2) using HEC-RAS to translate those water surface profiles into inundation maps and depth grids, and 3) using ArcMap to analyze those depth grids from an ecological perspective.

This workshop is designed to introduce the HEC-RAS software tools, show how they can be used for ecosystem analyses, and perform spatial investigations of ecosystem change.

Background

You will be working with a hydraulic model of the Rolling River to analyze statistical results from yesterday's HEC-EFM workshop. This workshop will focus on results for Natural and Gaged flow regimes for the Splittail Spawning and Shoals Spider Lily relationships.

		Natural		Gaged		
Relationship	**Conf.**	**Stage, ft**	**Flow, cfs**	**Chg.**	**Stage, ft**	**Flow, cfs**
Splittail Spawning	n/a	10.5	12,105	Pos	14.4	17,025
Shad and Striped Bass Habitat	n/a	3.2	5,063	Pos	4.2	5,878
Benthic Biodiversity	n/a	24.0	62,935	Neg	20.9	32,050
Shoals Spider Lily	n/a	0.0	1,964	Pos	1.9	4,100
Water Exchange	n/a	4.7	6,263	Pos	6.2	7,620

These results will be input and simulated with HEC-RAS to compute steady-state water surface profiles. Then, HEC-RAS will be used to translate the water surface profile data to inundation maps (depth grids). Finally, you will analyze the depth grids to investigate ecosystem changes.

This workshop is comprised of many tasks. **Work quickly, but thoughtfully, and be sure to read each part carefully.** When you have questions, don't hesitate to ask!

1 Part 1: Entering and Simulating Statistical Results in HEC-RAS

In this part of the workshop, you will simulate HEC-EFM statistical results using HEC-RAS to perform steady-flow simulations.

1.1 Getting Started

The first step is to input the statistical results from HEC-EFM into the river hydraulics model. A calibrated HEC-RAS model called "RollRiverHydraulics.prj" is provided at "C:\..\EFM Workshop\HEC-RAS Model\".

1. Open **HEC-RAS**.
2. Open the HEC-RAS project using the **File | Open Project** menu option. Browse to **RollRiverHydraulics.prj** and click **OK**.
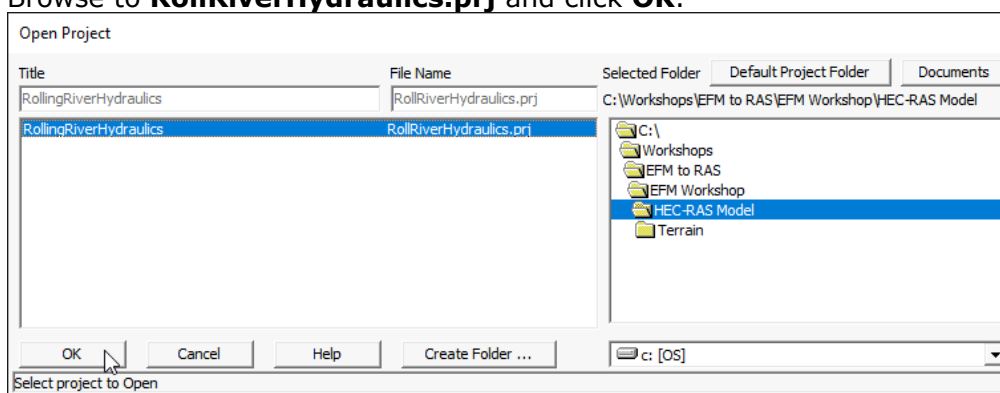
3. Open the **Geometric Data Editor** - . This is the geometry for the Rolling River that your simulation is going to use.
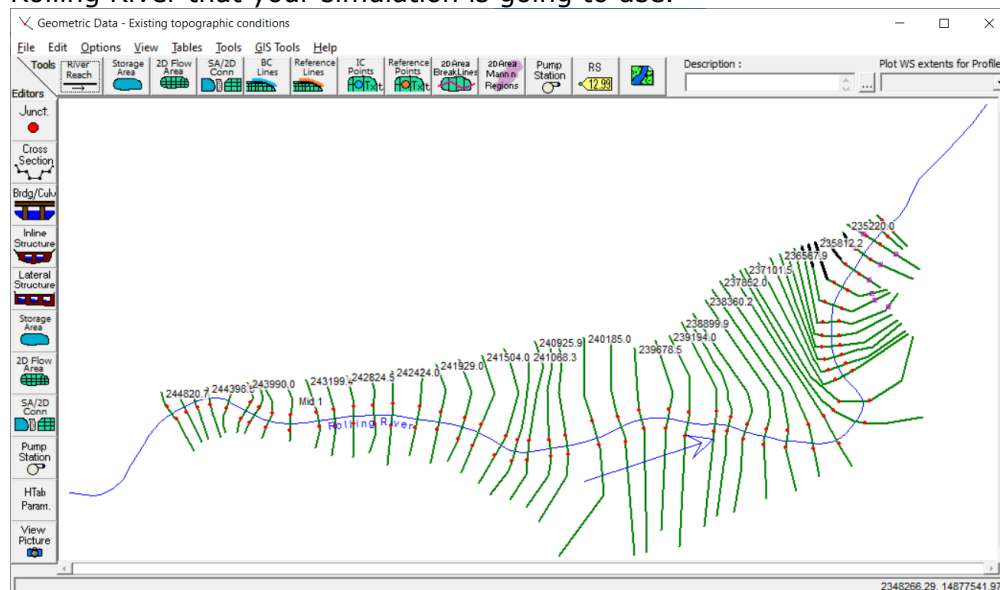
4. Open the **Cross section editor** - [Cross Section icon]. The cross section editor shows the shape, roughness, bank locations, and other data for each cross section along the stream reach. Browse the different cross sections by clicking the up and down arrow buttons on the editor interface.
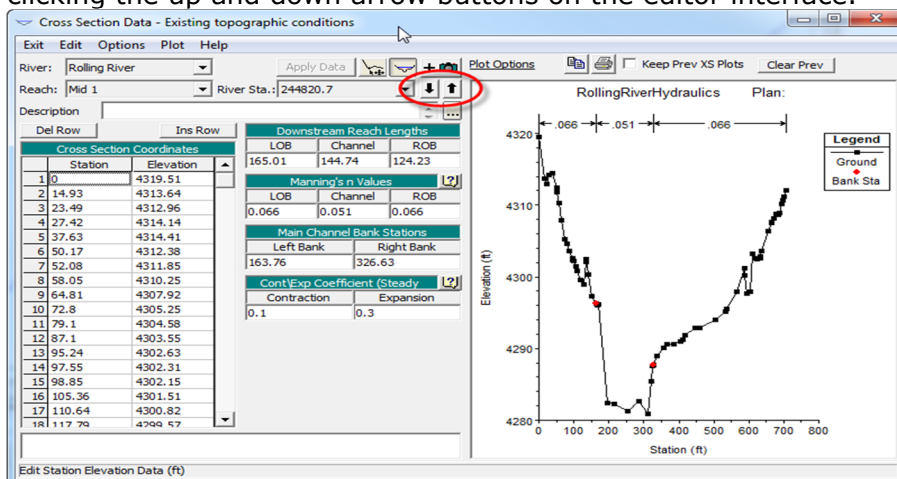
5. Exit the **Cross section editor** and Close the **Geometric Data Editor**. You will not need to edit any geometry in this workshop.

1.2   Enter the Flow Data

Enter the statistical results from the previous HEC-EFM workshop...

6. Open the **Steady Flow Data** editor by pressing the [button] button.
7. Enter **4** for the number of profiles and press the **Enter** key.
8. Select the **Options | Edit Profile Names** menu item and enter "Lily Nat", "Lily Gaged", "Splittail Nat", and "Splittail Gaged" for the profile names.
9. Press **OK** to close the Profile Name window and apply.
10. Enter the flow data based on your HEC-EFM statistical results as shown below.

11. Press the **Reach Boundary Conditions** button - [Reach Boundary Conditions ...].

12. Select the Downstream empty cell for Rolling River Mid1 and press the **Normal Depth** button.

13. Enter a slope of **0.002** and press **OK**.

14. Press **OK** again to close the Boundary Conditions window.

15. Select the **File | Save Flow Data** menu item, enter a name for the flow data (e.g., "Flows") and close the editor.

1.3 Steady Flow Computations

16. Press the button to access the Steady Flow Analysis window.

17. Check to make sure that the geometry file and the steady flow file that you just saved are in the proper dropdown menus.

18. Select the **File | Save Plan** menu item, enter a name for the plan and then for the short identifier (e.g., "EFM" for both).

19. Press the **Compute** button.

20. **Close** the status and Steady Flow Analysis windows after compute ends.

1.3.1 Explore the HEC-RAS results

21. Press the [icon] button to view results by cross section.
    Browse through different cross sections by clicking the up and down arrow buttons on the editor interface.

22. Browse the water surface profiles (ie, HEC-RAS results for different flow regime - relationships pairings) by clicking on the play [icon] button on the editor interface.
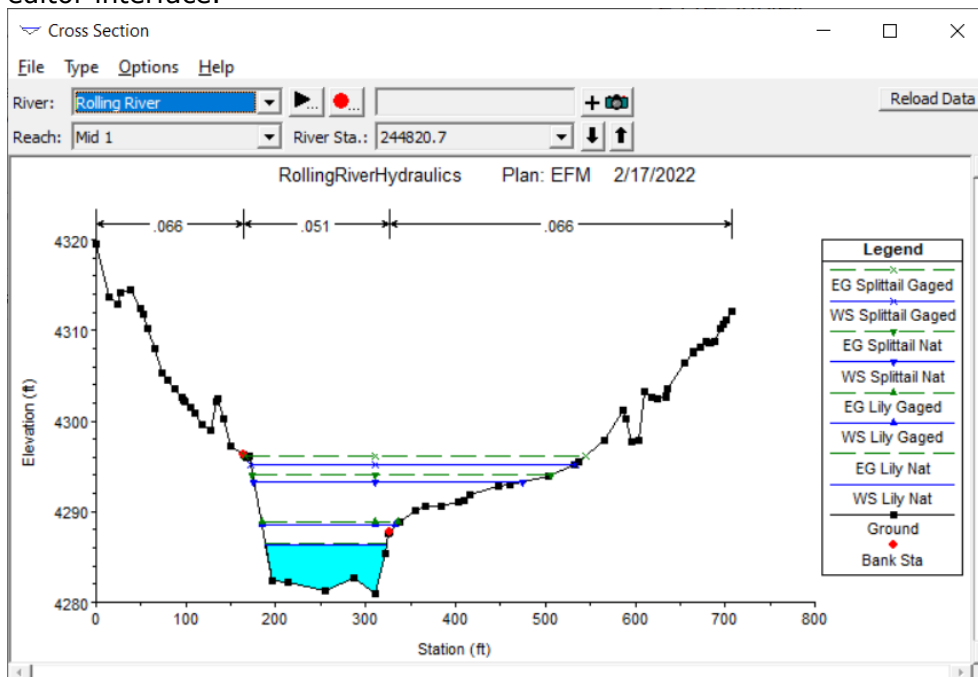
23. **Close** the cross section viewer.

24. Select the **View | X-Y-Z Perspective Plots** menu item to view results in a 3D multiple cross section plot. Change cross section and relationship with the up and down arrow buttons and the play button. Change rotation and Azimuth angle with the scroll bars on the upper right side of interface.
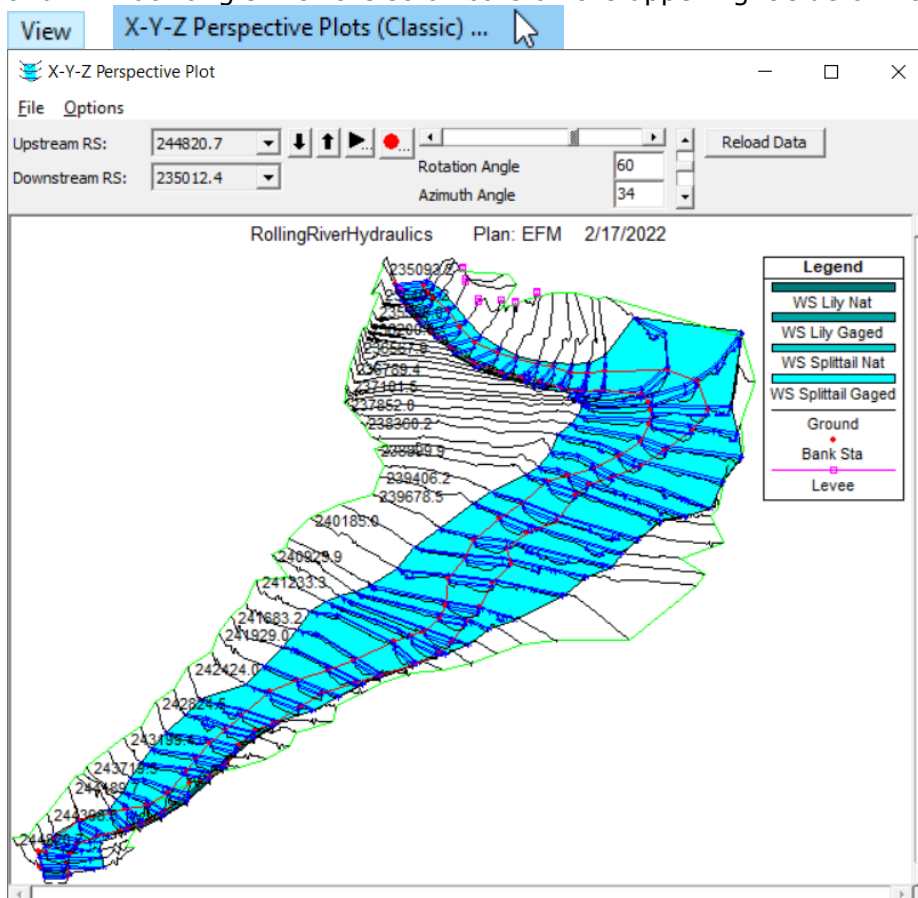
25. **Close** the cross section viewer.

1.4 Review Model Results

Ordinarily, you would not be done at this time. You would need to more carefully review output at each cross section, check the profile plot, etc. When dealing with GIS data, you also need to check your Bounding Polygons! This is extremely important for processing water surface profiles for inundation mapping. In this example, checking them is not too important because the geographic data has already been entered and tested.

2 Part 2: Floodplain Mapping using HEC-RAS Results

In this part of the workshop, you will use HEC-RAS Mapper to translate the HEC-RAS results to inundation mapping and depth grids for use in ArcGIS.

2.5 Getting Started

26. Select the **GIS Tools | RAS Mapper** menu option from the main RAS interface. The RAS Mapper interface is invoked with the RAS Geometry loaded. (Make sure to turn on the Existing geometry layers.)
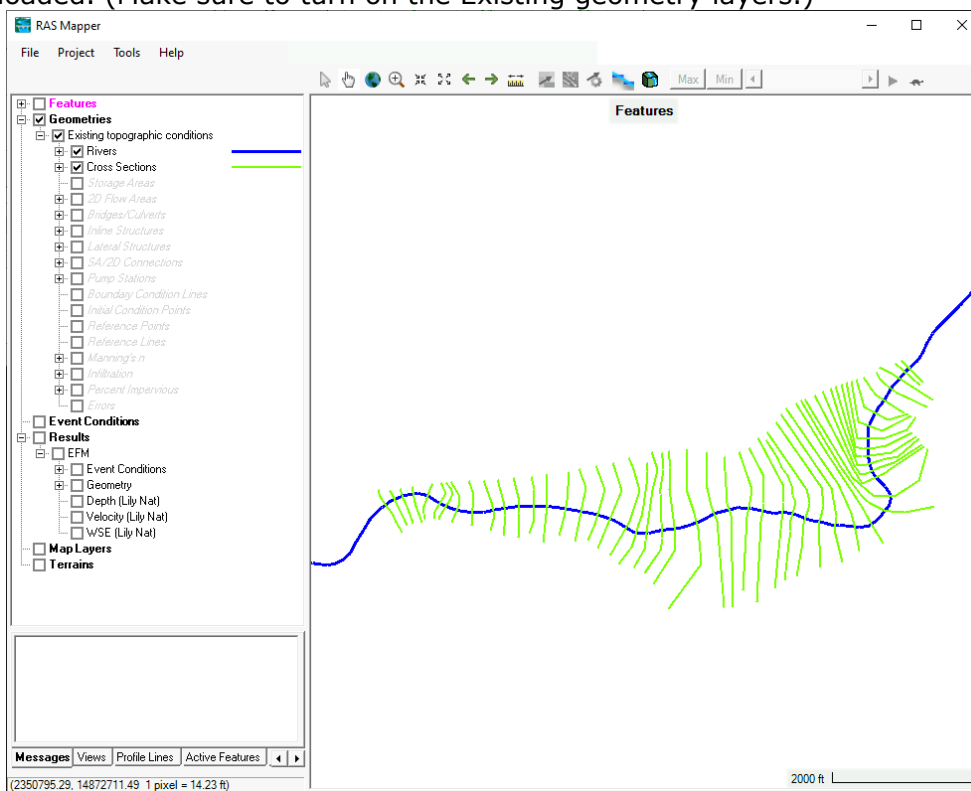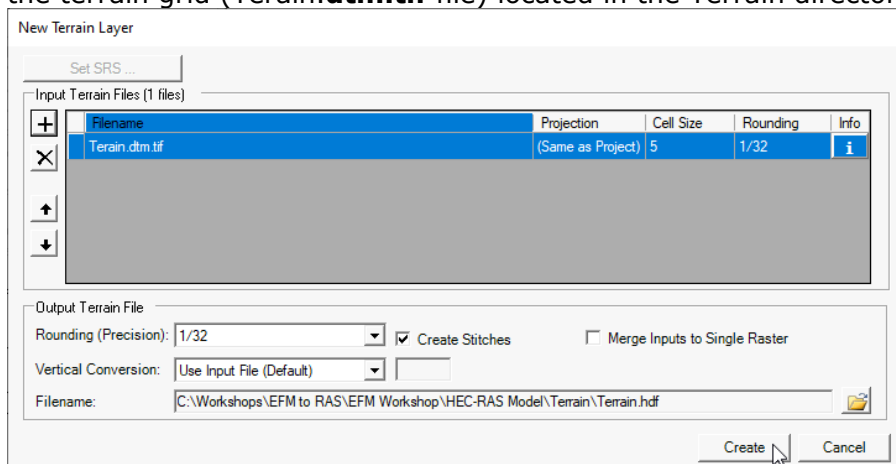

27. Set the projection for the RAS project via the **Project | Set Projection…** menu item. Select "**UTM_11N_ft.prj**" and click Open and then OK.
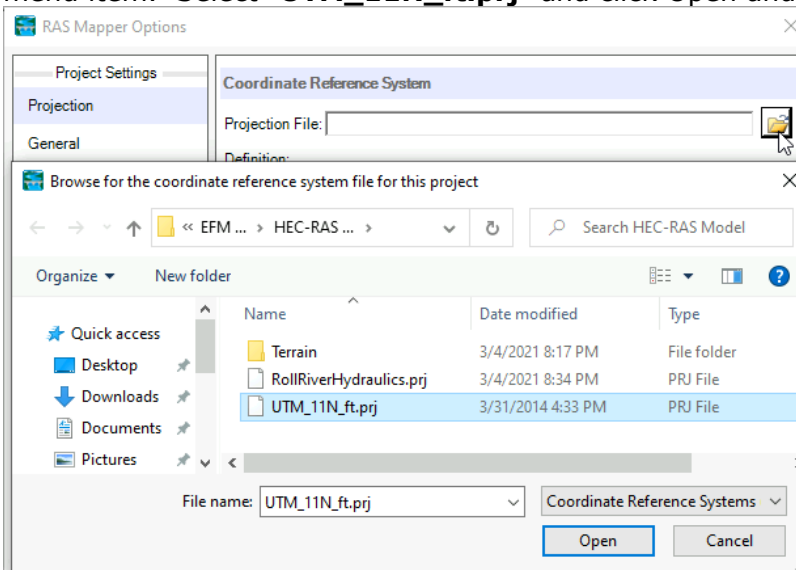

28. **Right-click** on the **Terrains** node. Select **Create a New RAS Terrain.**

29. In the New Terrain Layer dialog, press the **Add Files** button ➕ and select the terrain grid (Terain.**dtm.tif** file) located in the Terrain directory.

30. Click the **Create** button.

31. Terrain data will be processed and added to RAS Mapper. Click Close to dismiss the creation dialog.

32. Select the **Tools | Create Multiple Maps** menu option from the main RAS Mapper interface.
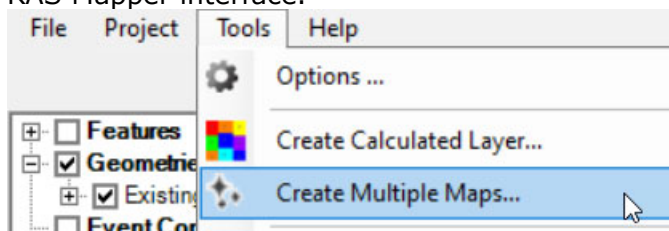
33. Select **All** of the *Profiles* (use the Ctrl key for multiple select)

34. Select **Inundation Boundary** and **Depth** for the *Map Types* (use the Ctrl key for multiple select)

35. Click the **Add Maps to RAS Mapper** option, shown below.
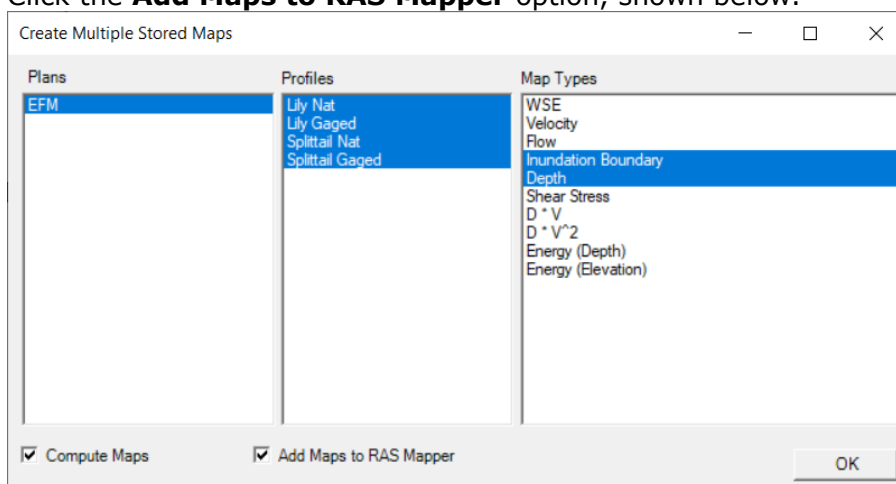
36. Press **OK** to generate the inundation maps.

37. Press **OK** to dismiss the completion dialog.
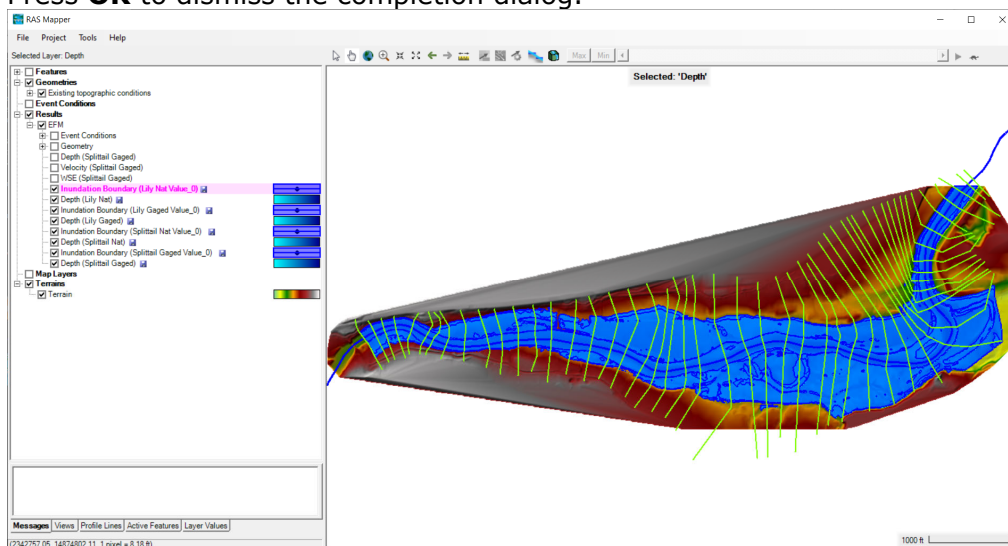
2.6   Examine Results

◇ *How do the depth grids look? Are there any areas where the inundation maps bump against the edge of the tin or bounding polygon (i.e., the max extents of the XS)?*

3   Analysis of Floodplain Maps

In this part of the workshop, you will analyze the inundation maps generated in RAS Mapper. (*Must use **HEC-RAS 6.2** to compute correct area!* Workaround: If you are using a previous version of HEC-RAS, create a new polygon, and digitize the boundary. Or, start editing the polygon and choose the area based on the feature that has the most count/area for the wet polygons.)

3.1   Shoals Spider Lily

This excerpt describes flow conditions needed for protection of the spider lily, which is an endangered plant species in the Savannah Basin: "June and July flows need to be held above 2,700 cfs to limit deer grazing on the spider lily (which are not known to enter the shoals when river edges are wetted)." Let's identify the total area of spider lily protection under both Natural and Gaged flow regimes.

38. Use the flood "Inundation Boundary" polygons to fill in the table below by double clicking on each of those layers and looking up its area.

Lily Habitat Area Table					
	Area (ft^2)		Acres		Which is better?
Habitat Depth	Gaged	Natural	Gaged	Natural	
Total Coverage					

To convert area to acres divide by 43,560 square feet per acre.

◇ *Which flow regime is superior for the Shoals Spider Lily habitat?*

◇ *Does this agree with the conclusion reached during the statistical analysis from yesterday's workshop?*

◇ *Do you have any ideas on how this relationship might be refined/improved? Can you think of other questions that might be asked regarding this analysis?*

3.2   Splittail Spawning

In the previous EFM relationships workshop, we learned Splittail spawn in shallow vegetated floodplain areas. During a follow-up with local scientists, depths less than or equal to 3.0 ft were proposed as ideal though there was a great deal of uncertainty with this. Let's check multiple depth ranges to investigate...

You'll need inundated areas for depths greater than 0 ft, 3 ft, and 7 ft for the natural and gaged flow regimes (so 6 area values). <u>Importantly</u>, to get shallow habitat, you'll need to subtract. For example, the area of depth 0 to 3 ft is equal to the "area greater than 0 ft depth" minus the "area greater than 3 ft depth". *Might be helpful to use a spreadsheet to track numbers.*

Areas for depths greater than 0 ft are easy. Just double click on the Inundation Boundary layers (as done for the spider lily).
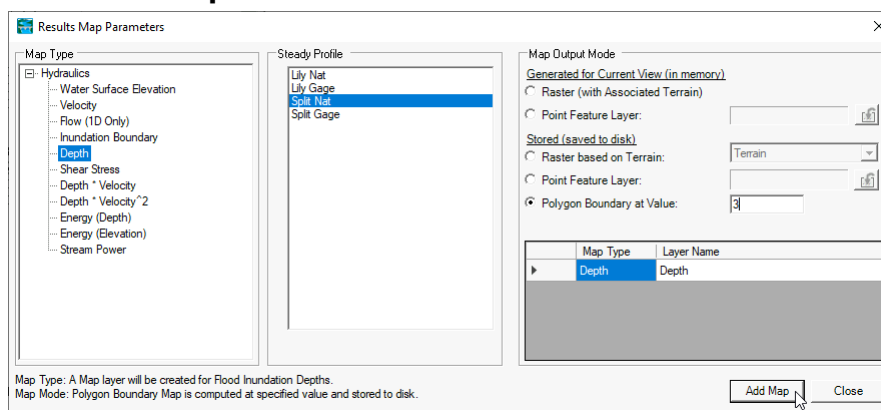
Next, to compute areas for depths greater than 3 ft:

39. Right-click on the Plan (EFM) and choose **Create a New Results Map Layer**
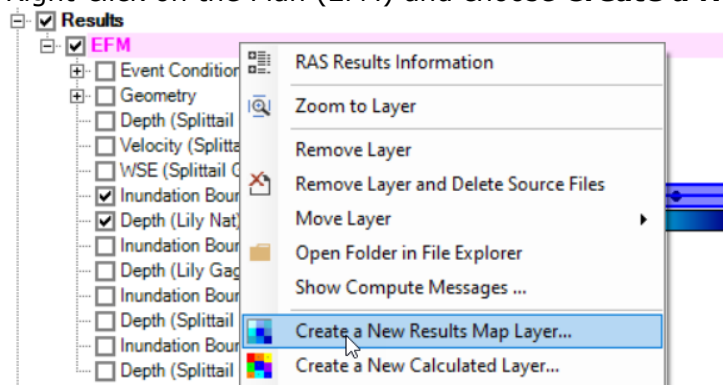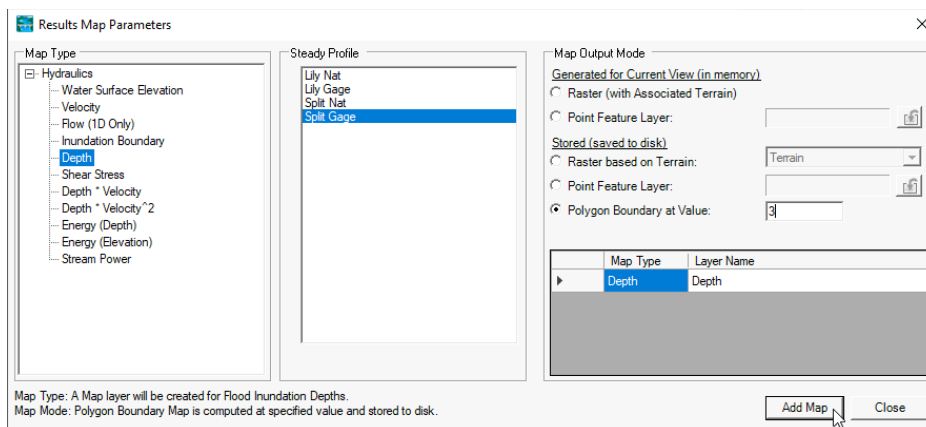

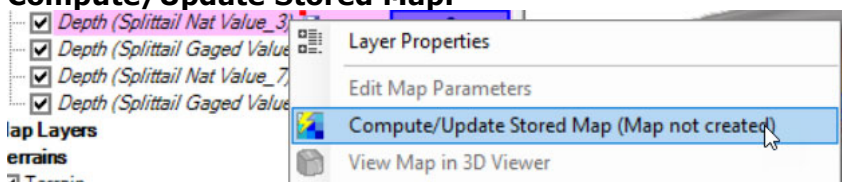40. Choose **Depth**, **Splittail Nat** and **Polygon Boundary at Value: 3**.
41. Press **Add Map**

42. Repeat for **Depth**, **Splittail Gaged**, and **Polygon at Value: 3**.

43. **Repeat** the process for depths greater than **7.0 ft**.

44. Compute the maps (4 maps) by right-clicking on each map and choosing **Compute/Update Stored Map.**

45. Double click on the newly generated Depth layers to obtain areas.

46. Do math and add results to table below and analyze data to answer questions. (*Again, Area_Depth_0-3 = Area_Depth_0 – Area_Depth_7*)

Splittail Habitat Depth Table					
	Area (ft^2)		Acres		Which is better?
Habitat Depth	Gaged	Natural	Gaged	Natural	
Depth 0 to 1ft	250,000	750,000	5.8	17.2	Natural
Depth 0 to 2ft	720,000	1,860,000	16.5	42.8	Natural
Depth 0 to 3ft					
Depth 0 to 4ft	2,730,000	3,480,000	62.7	79.8	Natural
Depth 0 to 5ft	3,480,000	3,740,000	80.0	85.8	Natural
Depth 0 to 6ft	3,940,000	3,940,000	90.4	90.5	Natural
Depth 0 to 7ft					

To convert area to acres, divide by 43,560 square feet per acre.

◇? *Which flow regime is superior for* <u>*Splittail Spawning*</u>*?*

◇? *Does this agree with the conclusion reached during the statistical analysis from yesterday's workshop?*

◇? *What information could you report back to the scientists regarding the uncertainty for the ideal depth range?*