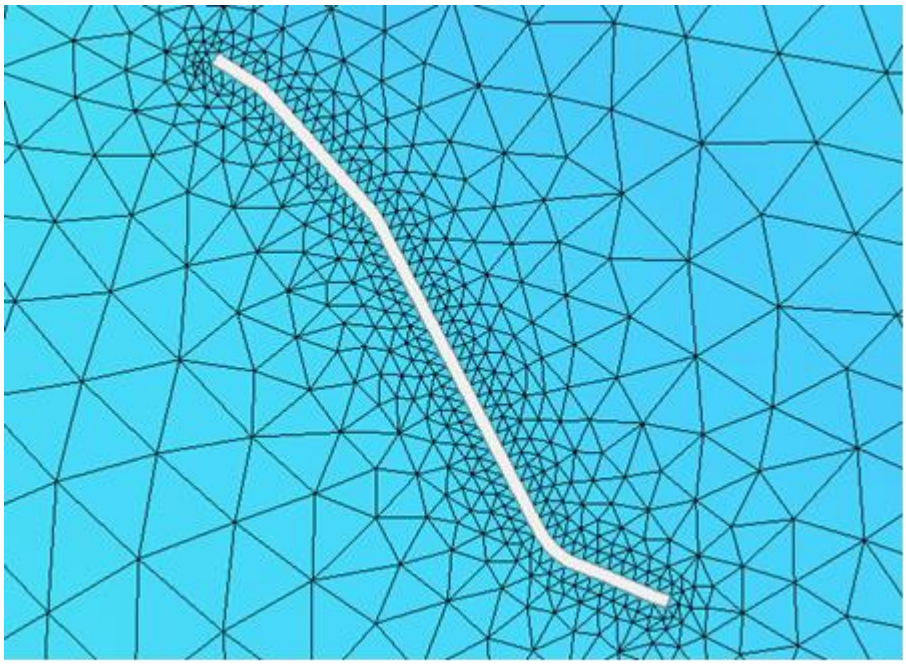
SMS 13.3 Tutorial

EWN Feature to Mesh

Use the EWN Tools to Add a Feature to a 2D Mesh



Objectives

This tutorial discusses how to use the EWN tools to insert a feature into a mesh.

Prerequisite Tutorials

- Overview
- Map Module
- Mesh Generation

Required Components

- SMS Core

Time

- 15–30 minutes

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1 Introduction

The Engineering with Nature (EWN) tools in SMS are designed to make the insertion of natural features into an existing ADCIRC mesh easy as well as numerically stable.

This tutorial illustrates the steps used to add environmental restoration project components into existing ADCIRC simulations. The project site is located in the Chesapeake Bay. This exercise is for demonstration purposes only.

1.1 Getting Started

An initial project will be opened to start this exercise. The project contains an ADCIRC simulation and mesh. To open the starting project, complete the following:

1. Select *File* | **Open...** to bring up the *Open* dialog.
2. Select “All Files (*.*)” from the *Files of type* drop-down.
3. Browse to the *EWN_Feature_to_Mesh\data_files* folder and select “start.sms”.
4. Click **Open** to exit the *Open* dialog and import the project. This project will take approximately 30 seconds to load into SMS.
5. In the Project Explorer, turn off “ Google Hydrid”.

The initial ADICRC project should appear similar to Figure 1.

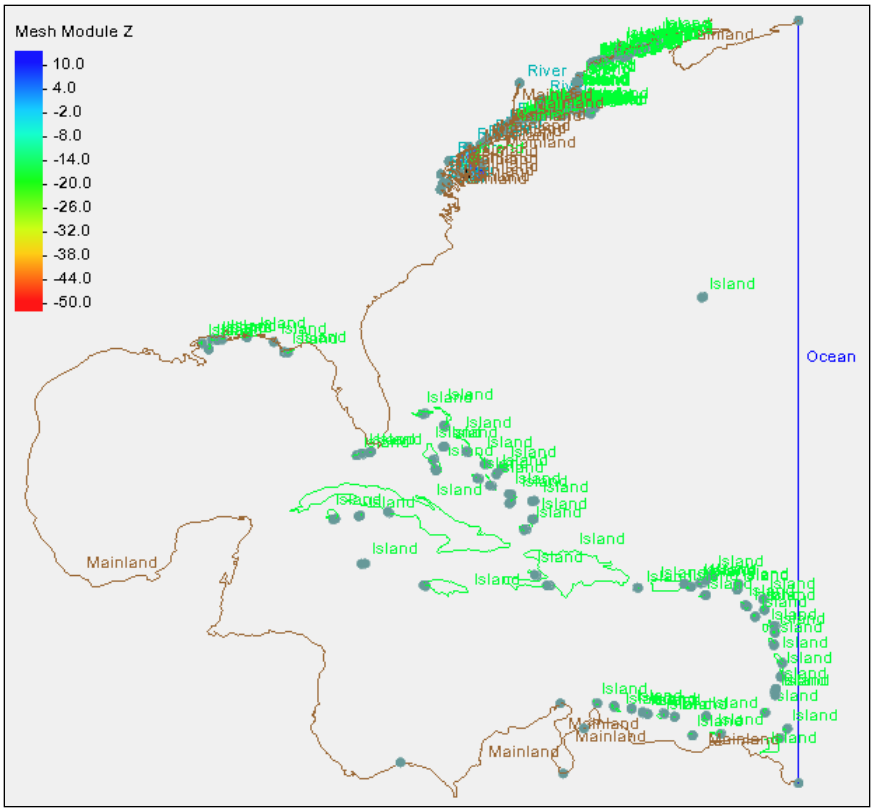

Figure 1 Initial project

1.2 Import a Shapefile

After opening the project, import a shapefile that contains the features which will be added to the mesh. To do this:

1. Select *File* | **Open...** to bring up the *Open* dialog.
2. Select “All Files (*.*)” from the *Files of type* drop-down.
3. Browse to the *EWN1\Version_20201110* folder and select “BreakwaterDesign_v4.shp”.
4. Click **Open** to exit the *Open* dialog and import the shapefile.
5. In the Project Explorer, right-click on “ BreakwaterDesign_v4shp” and select **Zoom to Extents**.
6. Select *File* | **Save As...** to bring up the *Save As* dialog.
7. Browse to the *EW1* directory and enter “Insert Features” for the *File Name*,
8. Click **Save** to save the project.

The polygons in the shapefile should appear similar to Figure 2.

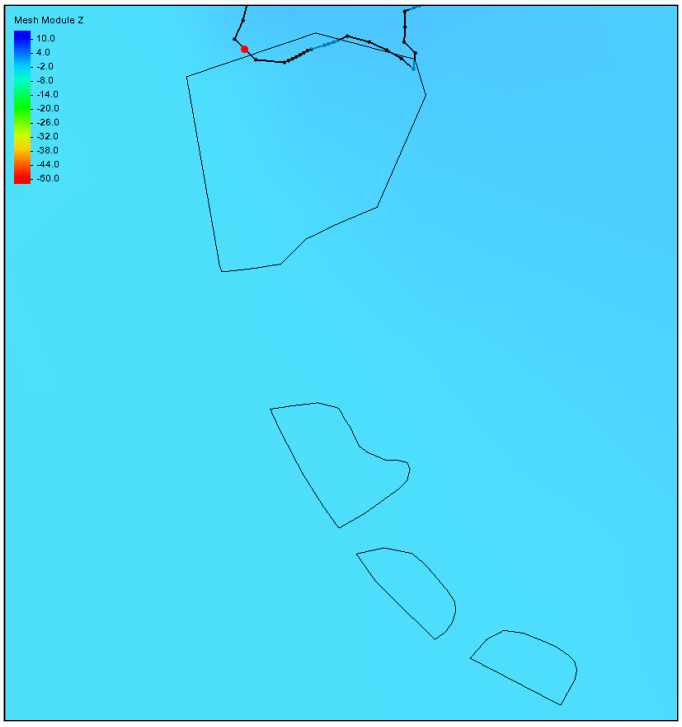

Figure 2 Imported shapefile polygons

2 Create an EWN Coverage

The EWN tools operate on polygons in an EWN coverage. Therefore, the first step of defining the EWN object is to create a coverage assigned as an EWN type. To do this, complete the following:

1. Right-click on "Map Data" and select the **New Coverage…** command to open the *New Coverage* dialog.
2. In the *Models* section, under *Engineering with Nature* select **EWN Features**.
3. For the *Coverage Name*, enter "Barren Island Restoration".
4. Click **OK** to close the *New Coverage* dialog.

A new coverage, "Barren Island Restoration" should appear in the Project Explorer.

3 Converting the Shapefile

With the EWN feature coverage created, the polygons from the shapefile can be transferred to the coverage for use in the project. To do this, complete the following:

1. Right-click on "BreakwaterDesign_v4shp" and select *Convert* **| Shapes → Feature Objects** to open the *GIS to Feature Objects Wizard – Step 1 of 2* dialog.
2. For *Select a coverage for mapping* make certain "Barren Island Restoration" is selected and for *Select shapefiles to map* make certain "BreakwaterDesign_v4.shp" is selected.

3. Click **Next** to go to the *GIS to Feature Objects Wizard – Step 2 of 2* dialog.
4. It is not necessary to map any additional information so click **Finish** to close the *GIS to Feature Objects Wizard – Step 2 of 2* dialog.
5. In the Project Explorer, turn off the "BreakwaterDesign_v4shp".

The polygons will appear on the "Barren Island Restoration" coverage.

4 Using the Sub-Mesh

The ADCIRC mesh in this example includes over 6,181,000 elements. Working with a mesh of this size can be slow. Using a subset of the mesh will speed up the operations significantly. It is advisable to work with a subset whenever significant editing is to be performed on a large mesh such as this one.

A subset mesh has been included in the initial project. This mesh was created by duplicating the original mesh and trimming down the mesh to only include the area of interest. The ENW features will be added the subset mesh which will then be merged with the larger 2D mesh.

1. In the Project Explorer, turn off "Trimmed_mesh".
2. Select "Trimmed_mesh (subset)" to make it active.
3. Right-click on "Trimmed_mesh (subset)" and select **Zoom To Mesh**.

The Graphics Window should appear similar to Figure 3.

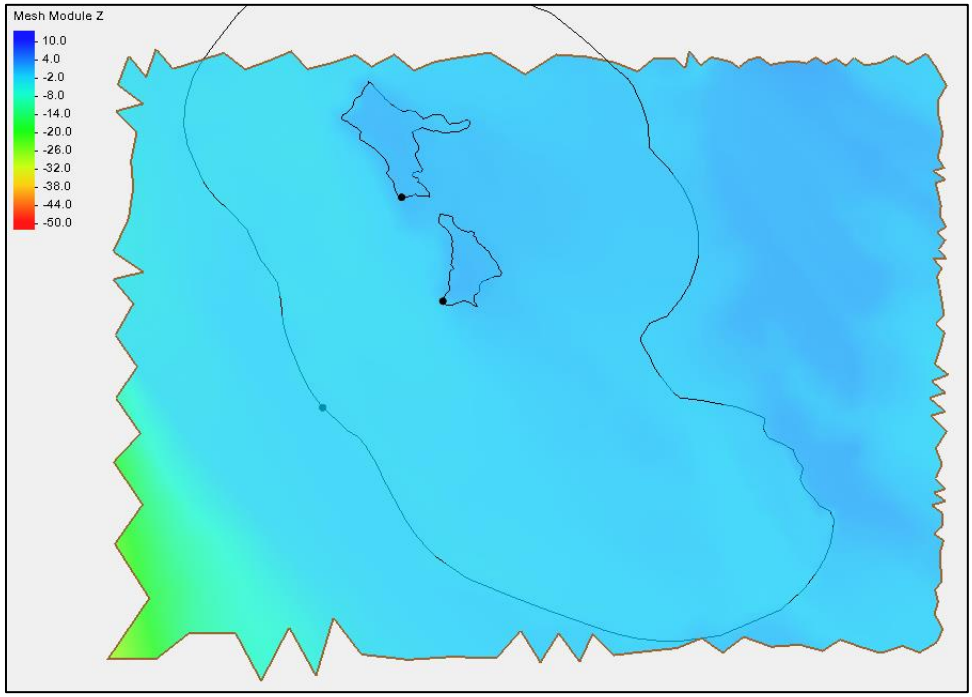

Figure 3 Mesh subset

5 EWN Classification

Now the project is ready to start working with the EWN tools. To begin, it is useful to review the EWN classifications. Do this by doing the following:

1. Select the "Barren Island Restoration" coverage to make active.
2. Right-click on "Barren Island Restoration" and select **EWN Classification Properties** to open the *EWN Classification Properties* dialog.
3. Scroll through the different zone classifications that are defined and select a couple.

When selecting a zone, note that there is an associated default roughness. The use of this will be described in a later exercise

Note: This list is an active area of research and additional zones will be added. The list is loaded into SMS dynamically, rather than compiled into the program, so it can be updated regularly.

4. Click **OK** to close the *EWN Classification Properties* dialog.

6 Editing the Arcs

Now to work with the polygons of the EWN project. Specifically, complete the following to increase the resolution around the polygons to ensure they are adequately represented in the new ADCIRC mesh.

1. Using the **Select Feature Arc** tool, drag a box around all four arcs in the coverage. (Alternately, right-click and *Select All*)
2. Right-click and select **Split Arcs(s)…** to open the *Split Arcs Tool* dialog.
3. Turn off *Split long arcs* and make certain *Split sharp corners* is set to "46".
4. Click **OK** to execute the *Split Arcs Tool* command.
5. Click **OK** at the message dialog stating how the arcs were divided. This operation places feature nodes at "corners" of the polygon to preserve the shape.
6. Using the **Select Feature Point** tool, use the *Shift* key to select the four original nodes. (Figure 4)
7. Right-click and select the **Nodes** ↔ **Vertices** command.

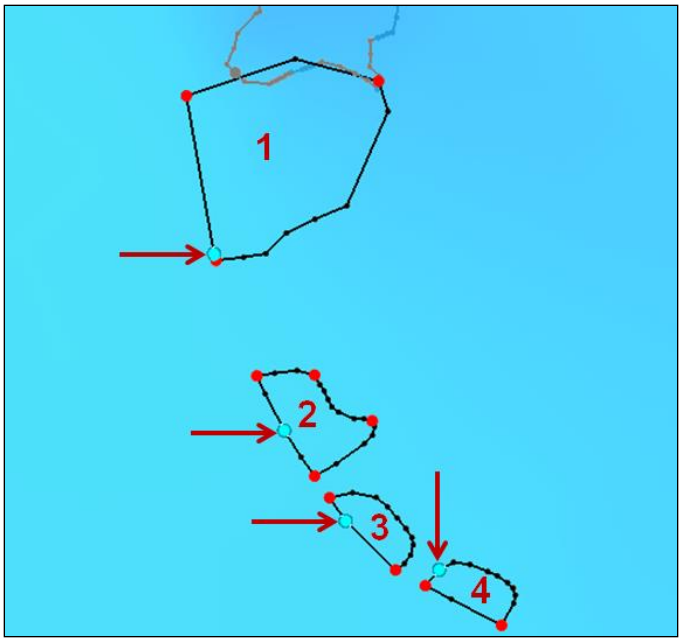

Figure 4 Original points to be converted to vertices

8. Using the **Select Feature Arc** tool, right-click and select the **Select All** command.
9. Right-click and select **Redistribute Vertices…** to open the *Redistribute Vertices* dialog.
10. Make certain the *Length units* option is set to “Degrees”.

Review the *Arc Information* section. Note that the minimum segment length is around “0.0001” and the maximum segment length is around “0.0029”.

11. Under *Arc Redistribution*, set *Specify* to “Specified spacing”.
12. For *Average spacing*, enter “0.0002”. This corresponds to approximately 20 meter spacing.
13. Click **OK** to execute the *Redistribute Vertices* operation.

7 Set EWN Polygon Properties

The EWN properties can now be defined for the four polygons. To do this:

1. Using the **Select Feature Polygon** tool, double-click on the northern polygon (polygon 1 in Figure 4) to open the *EWN Polygon Properties* dialog.
2. For *Name*, enter “Island 1”.
3. For the *Classification*, select “East coast beach/dune”.

This establishes the Manning’s N value as 0.089. This can be specified as a custom value if desired.

4. Set *Elevation* to “Constant” and “0.0”.
5. The *Specify slope* option should be turned off.

The slope is not being used in this case because it creates very small elements around the feature.

6. For *Maximum transition distance*, select “Bounding box factor” and enter “0.5”.
7. In lower section of the dialog, select the *Preview* tab.
8. Click the **Select UGrid/Mesh…** button to open the *Select UGrid/Mesh* dialog.
9. Select the “Trimmed_mesh (subset)” mesh.
10. Click **OK** to close the *Select UGrid/Mesh* dialog.
11. Click **Generate mesh with feature** to see a preview of how the mesh will look.

The magenta lines display the interface between the EWN feature and the existing mesh. Notice that the lines of mesh preview covers the entire visible mesh. More space is needed. To do this, adjust the bounding box factor.

12. Change the “Bounding box factor” to “1.0”.
13. Click **Generate mesh with feature** to see a new preview.

More space is still needed. Continue adjusting the bounding box factor.

14. Change the “Bounding box factor” to “1.5”.
15. Click **Generate mesh with feature** to see a new preview.

The final mesh should appear similar to Figure 5.

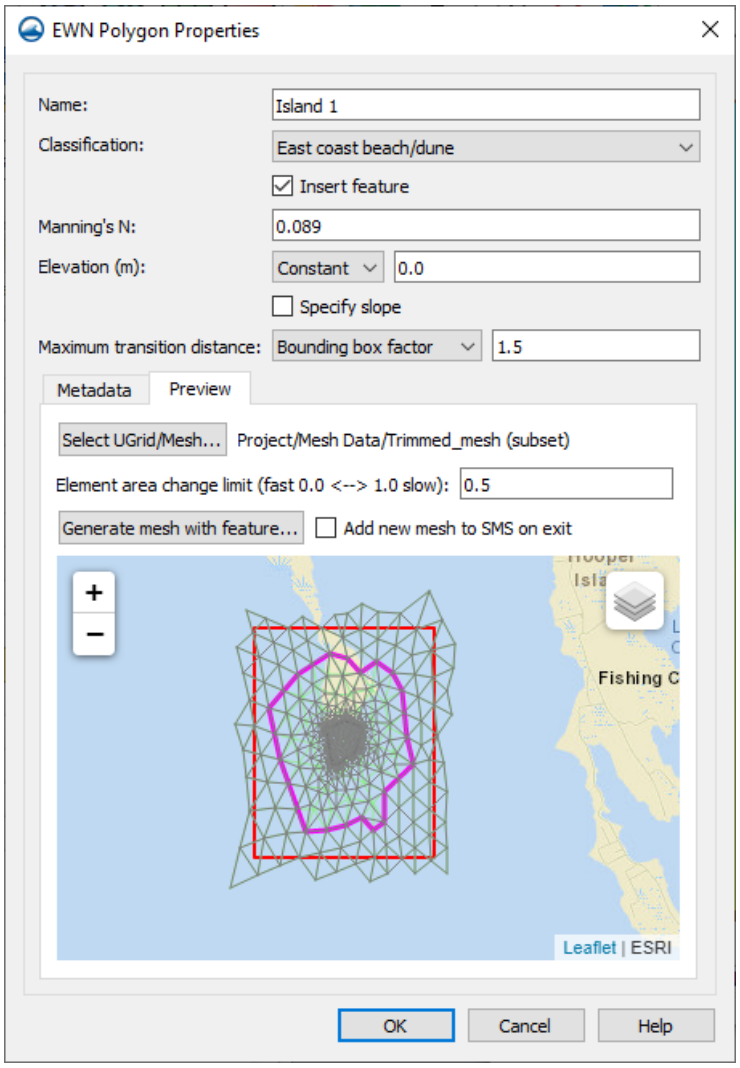

Figure 5 EWN Polygon Properties shoing the mesh preview function

16. Click **OK** to close the *EWN Polygon Properties* dialog.
17. Repeat steps 1–16 for the other polygons. Use the table below for the values to enter in the *EWN Polygon Properties* dialog.

	Polygon 1	**Polygon 2**	**Polygon 3**	**Polygon 4**
Name	Island 1	Island 2	Island 3	Island 4
Classification	East coast beach/dune	East coast beach/dune	East coast beach/dune	East coast beach/dune
Elevation	0.0	0.0	0.0	0.0
Specify slope	Off	Off	Off	Off
Maximum transition distance	1.5	2.5	3.0	3.5

The EWN properties have now been set.

8 Inserting EWN Features

With the EWN properties set, the new features can now be inserted into the mesh.

1. Right-click on the "Barren Island Restoration" and select *Tools* | **Insert EWN Features** to open the *Insert EWN Features* dialog.
2. For the *Target geometry*, click **Select** to open the *Select EWN Geometry* dialog.
3. Select the "Trimmed_mesh (subset)" mesh.
4. Click **OK** to close the *Select EWN Geometry* dialog.
5. Under *EWN Feature coverages*, click the **Select** button to open the *Select EWN Feature Coverages* dialog.
6. Select the "Barren Island Restoration" coverage.
7. Click **OK** to close the *Select EWN Feature Coverages* dialog.

Notice that multiple coverages can be selected. Coverages are inserted into the mesh in the order listed in the dialog. Multiple coverages are often used where there are large features that need to be inserted first before smaller details are added to the interior of that feature.

8. Select **OK** to close the *Insert EWN Features* dialog and bring up the *Insert EWN Features* dialog.
9. When the tool has finished running, click **OK** to close the *EWN Status* dialog.

The EWN features have now been added to a new mesh named "EWN Feature Mesh" and that mesh has been loaded into SMS.

9 Reviewing the Mesh

With the EWN features inserted into the mesh, the mesh can now be reviewed to see how the features were applied.

1. Select *Shift+Z* to go back to the previous view.
2. Click the **Display Options** macro to open the *Display Options* dialog.
3. Select *2D Mesh* from the list on the left.
4. Turn on *Elements*.
5. Click **OK** to close the *Display Options* dialog.
6. Using the **Rotate** tool, rotate the mesh to see how the features were incorporated into the mesh.

Notice how the features have been inserted into the mesh.

10 Inserting the EWN Mesh Into the Original Mesh

The EWN Mesh tool generated a new mesh in the area of the subset that was being edited at the time. This should now be merged into the original mesh. To do this:

1. Turn on and select the "Trimmed_mesh" to make it active.

2. Click the **Toolbox** macro to open the *Toolbox* dialog.
3. Under “Unstructured Grids”, select the *Merge UGrids* tool.
4. Click **Run Tool…** to open the *Merge 2D Grids* tool dialog.
5. For the *Primary grid*, select “Mesh Data/EWN Feature Mesh”.
6. For the *Secondary grid*, select “Mesh Data/Trimmed_mesh”.
7. Set the *Duplicate point tolerance* to “0.0000001”.
8. Set the *Buffer distance option* to “Default”.
9. For the *Merged grid*, enter “Merged”.
10. Select **OK** to close the *Merge 2D Grids* dialog and execute the tool.

A progress dialog will appear tracking the merge operation. When it is complete, a new “ Merged” mesh will appear in the Project Explorer. Review this mesh to see that the new mesh contains the inserted features.

7. Click **Save** to save the project.

11 Conclusion

This concludes the “EWN Feature to Mesh” tutorial. The following key concepts were discussed and demonstrated:

- Creating an EWN Feature coverage
- Defining EWN feature polygons
- Inserting EWN features into a mesh

Continue exploring display themes in SMS or exit the program.