HEC-GeoEFM 2.0
May 2024
Release Notes

GeoEFM is a software tool developed to support spatial analyses commonly used during applications of the Ecosystem Functions Model (HEC-EFM). GeoEFM is programmed as an extension for ArcMap.

Version 2.0 supersedes version 1.0, which was released in June 2011. Version 1.0 must be uninstalled before installation of 2.0.

Use of GeoEFM 2.0 requires a user license for ArcMap 10.1, 10.8.1, or 10.8.2 (advanced level license). Spatial Analyst and 3D Analyst extensions for ArcMap must also be installed and activated for any combination of GeoEFM and ArcMap.

Version 2.0 is available as an install package (.exe). The install package guides the user through the install process and requires computer administrative rights for successful use.

Version 2.0 includes several new features and improved software behaviors, and bug fixes for issues that were not detected prior to release of version 1.0. The User's Manual has also been updated and is currently the most complete and comprehensive source of information about the software. The demonstration project has also been updated to showcase new habitat quality and habitat functionality features. Changes incorporated in the new versions follow:

Testing of version 2.0 involved two phases. First, new features were tested rigorously with the most complex features having a dedicated set of test cases designed to test all aspects of the feature for a range of parameters and inputs. Second, after the new feature passed all of those test cases, a subset of those test cases was incorporated into a series of routine tests designed to exercise all features of GeoEFM, from creation of a new project to application of geoprocessing tools. For example, 7 of the 22 test cases for the new habitat functionality - buffer method were included in routine testing.

The number of beta versions for GeoEFM 2.0 in ArcMap 10.1, 10.8.1, and 10.8.2 was 60, 36, and 18, respectively. There were an estimated 466 bug fixes completed for new features in version 2.0, which are described below.

New Features

- *Habitat quality.* New features were added that allow users to add, copy, rename, and delete paired data sets known as Habitat Suitability Indices (HSIs). HSIs relate a variable such as water depth or velocity to a measure of habitat quality that ranges from 0 (wholly unsuitable) to 1 (perfectly suitable). HSIs are commonly used in ecological modeling, including model applications for habitat mapping (Figure 1).

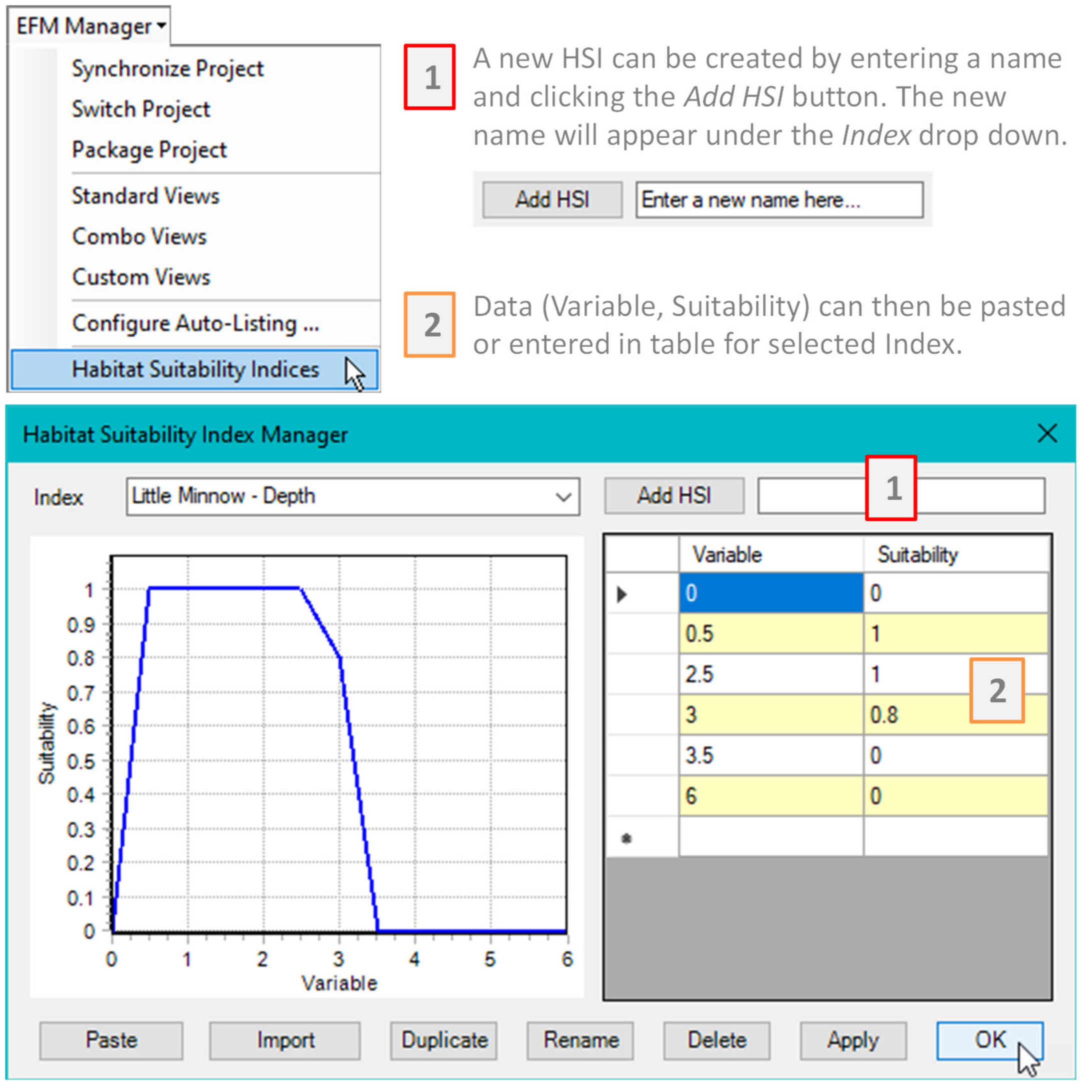


Figure 1. Menu option and interface related to HSIs in GeoEFM.

HSIs are applied via the GeoEFM calculator and batch calculator. HSIs are applied to raster layers. For example, in Figure 2, shows a HSI (Little Minnow – Depth) being applied to a raster of water depths (nat-minnow) to generate a suitability raster (NaMi_Suit_Hab, which is an abbreviated name referring to a raster of suitable habitat for the EFM flow regime “Natural” and the EFM relationship “Little minnow”).

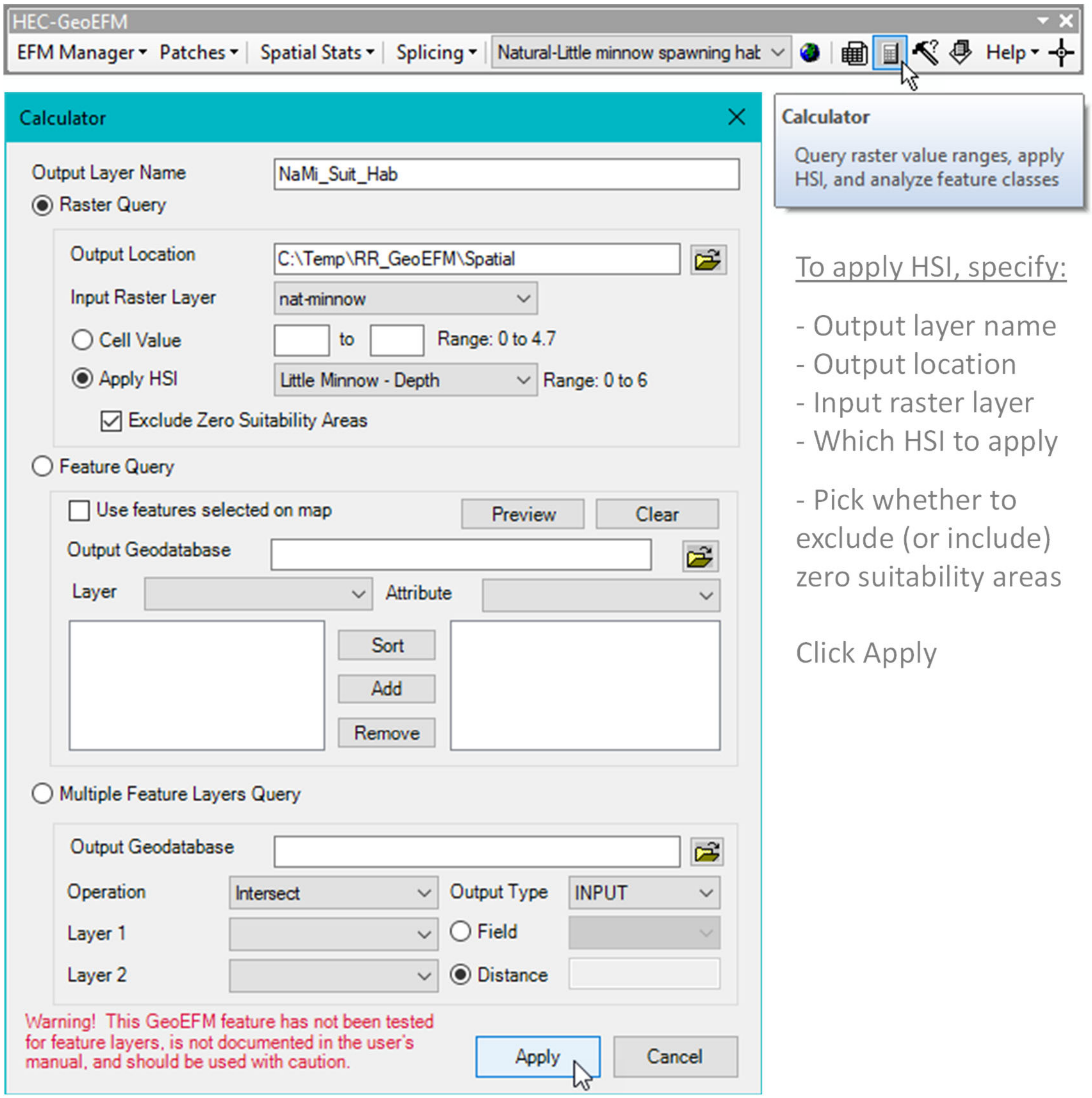


Figure 2. Application of HSI to generate a suitable habitat raster using the GeoEFM calculator.

An option is provided that allows the users to pick whether to exclude (checked) or include (unchecked) zero suitability areas from the output raster (Figure 3).

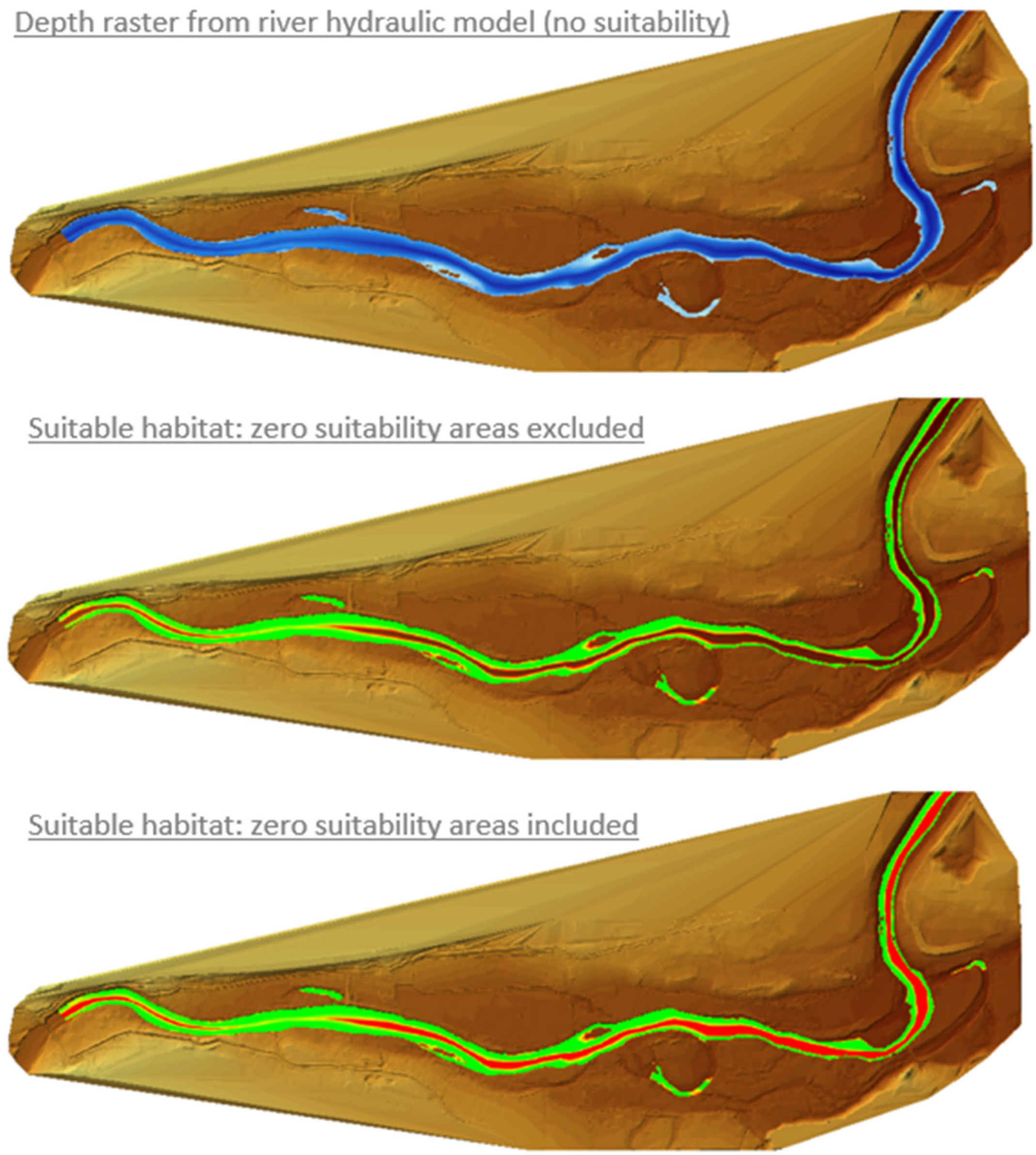


Figure 3. Suitable habitat rasters generated without and with zero suitability areas.

- *Calculators.* GeoEFM has two calculators, one that performs single instance queries of spatial layers (Calculator; Figure 2) and one that performs repeating queries of spatial layers (Batch Calculator). In addition to the HSI features described above calculators can also be used to query raster value ranges (Figure 4). It also has several components related to working with feature classes, though those have not been rigorously tested and should be used with caution.

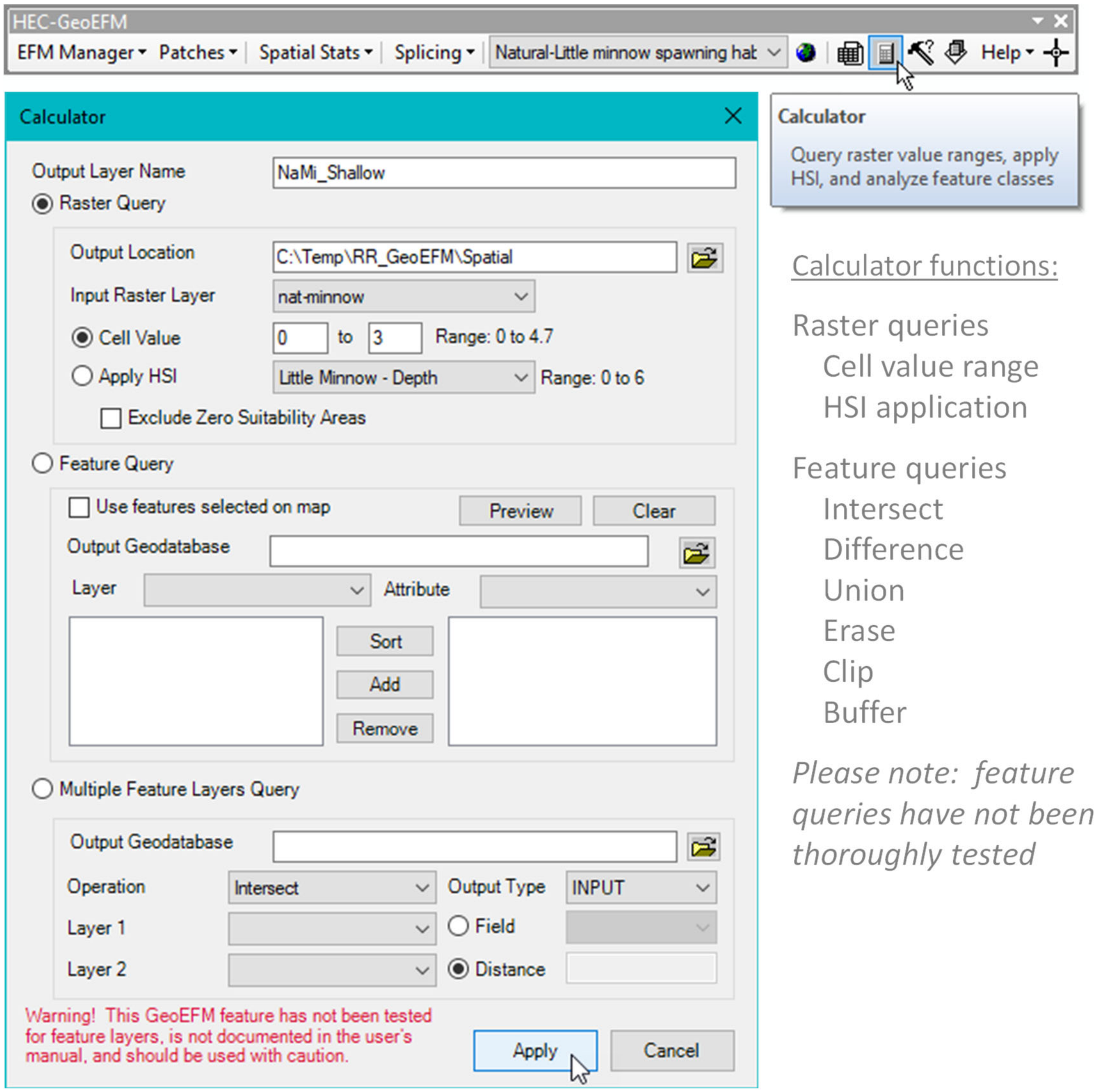


Figure 4. GeoEFM calculator being used to apply a raster cell value range.

Cell value is a simple query that applies a user-defined range to an input raster resulting in an output raster that contains only the cells and corresponding values that are within the range (Figure 5). Ecologically, this is typically used to filter areas that are not relevant to the EFM relationship being considered. In this sense, cell value is similar to the apply HSI option, though cell value does not allow for partial suitability, areas are either in range or dropped from the output layer.

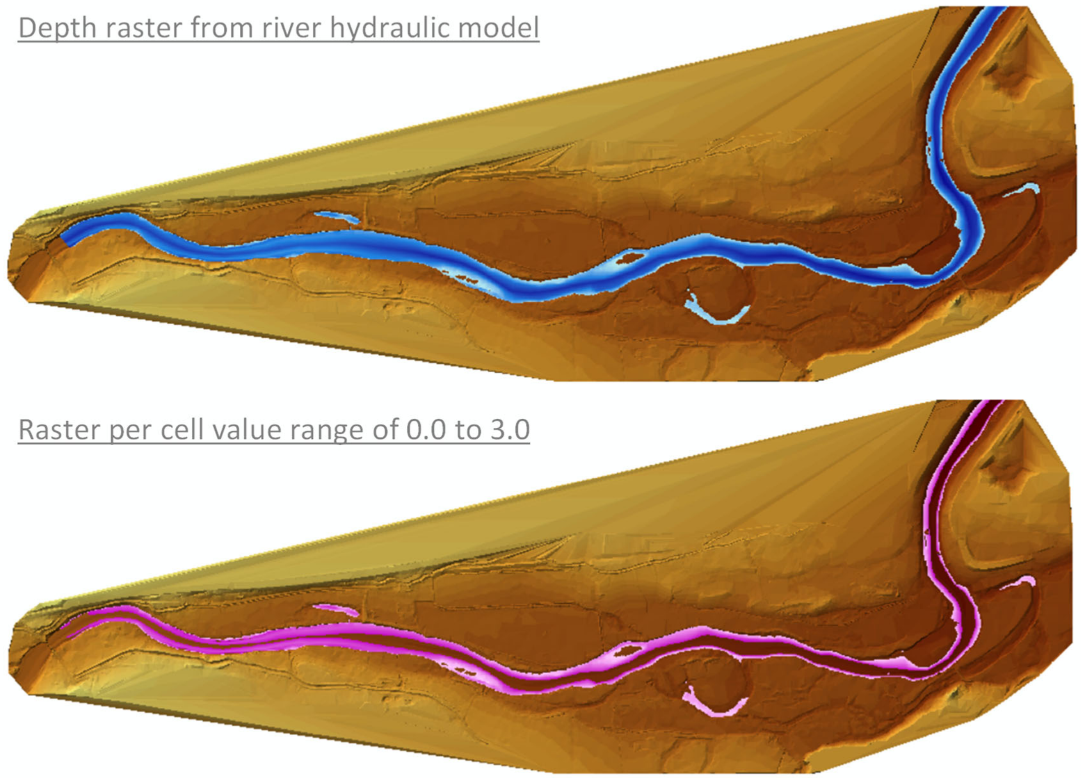


Figure 5. Top image shows a depth raster (blue) from a river hydraulics model. Bottom image show raster of depths from 0.0 to 3.0.

The batch calculator performs a user-defined spatial operation for multiple raster layers. This feature is most commonly used when processing layers for one EFM relationship and many flow regimes. In this case, the same spatial operations, whether cell value or apply HSI, needs to be done for each of the implicated relationship-flow regime pairings (Figure 6).

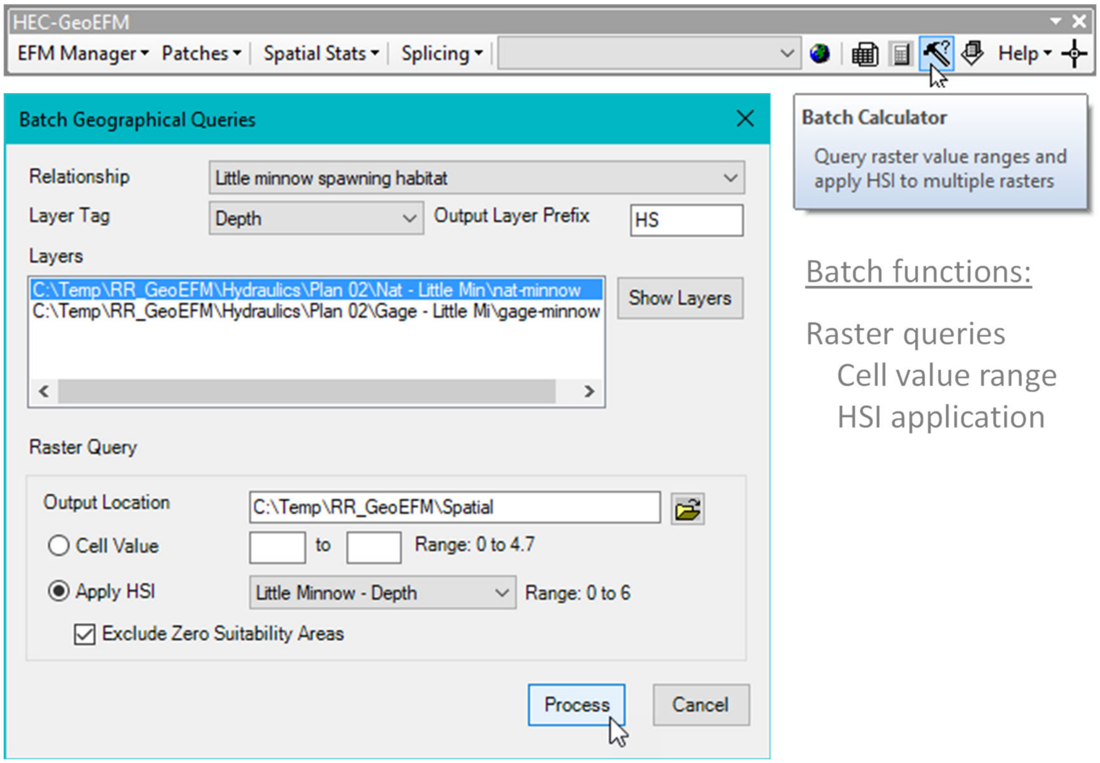
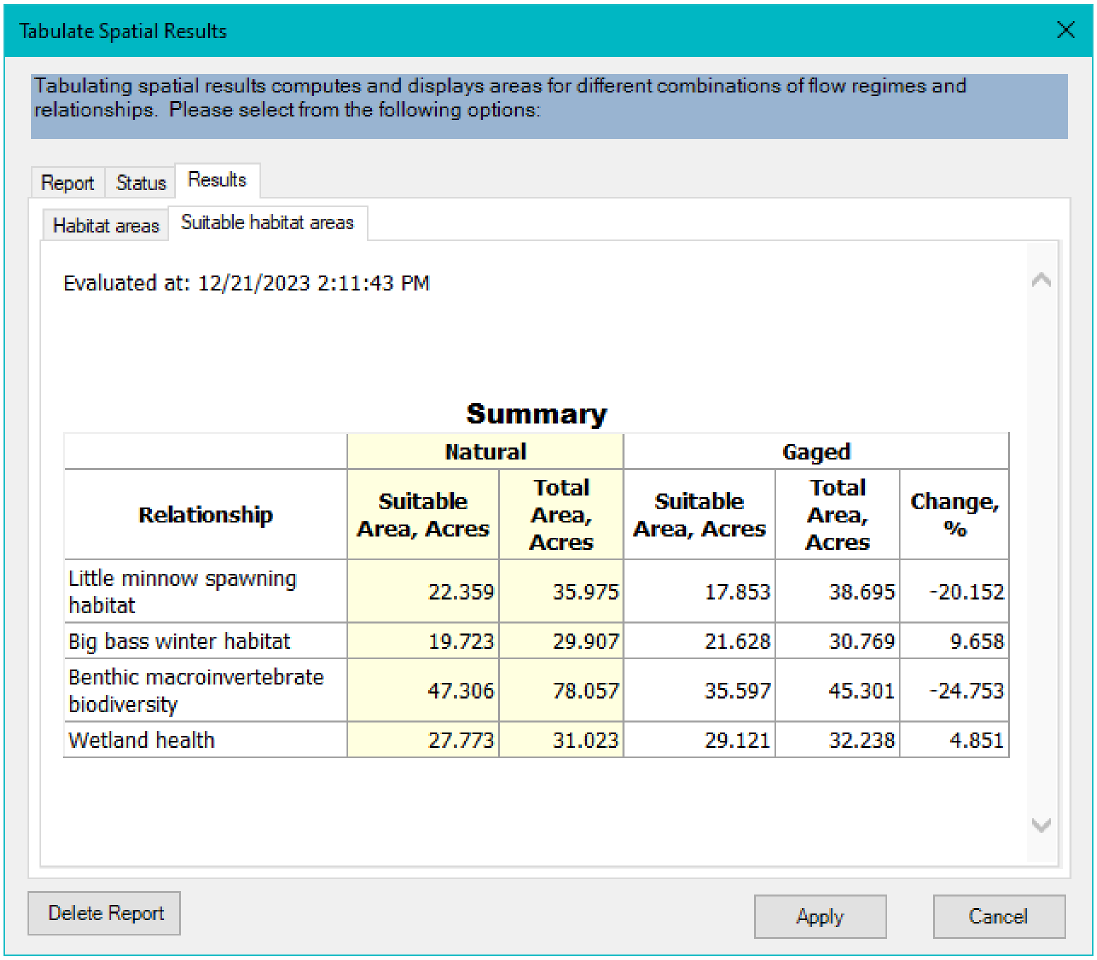


Figure 6. GeoEFM Batch Calculator interface being used to apply a HSI to multiple raster layers.

- *Integration of habitat quality with existing GeoEFM tools*. GeoEFM's tabulate and physical connectivity features were expanded to include habitat quality considerations. For example, the GeoEFM tabulate tool was expanded to include an option to tally suitable habitat in addition to total habitat areas (Figure 7).



Summary

	Natural		Gaged		
Relationship	**Suitable Area, Acres**	**Total Area, Acres**	**Suitable Area, Acres**	**Total Area, Acres**	**Change, %**
Little minnow spawning habitat	22.359	35.975	17.853	38.695	-20.152
Big bass winter habitat	19.723	29.907	21.628	30.769	9.658
Benthic macroinvertebrate biodiversity	47.306	78.057	35.597	45.301	-24.753
Wetland health	27.773	31.023	29.121	32.238	4.851

Figure 7. Suitable and total habitat areas for select pairings of flow regimes and relationships.

- *Habitat functionality.* Ecological concepts like habitat corridors, fragmentation, and functionality can be explored using the GeoEFM patch tool. In version 2.0, two new methods were added to the patch tool, nearest neighbor and buffer. Both methods were adapted from ecological literature related to habitat connectivity. Both methods parse habitat in a raster layer into the unit habitat areas (i.e., patches) that would support individuals or groups of individuals within a population.

  Nearest neighbor is most applicable to gregarious communities that are not strongly territorial. Figure 8 shows nearest neighbor patch results for a raster processed with suitabilities. Larger patches occur in the poorest habitat because more total area is required to meet the user-specified area (suitable) required to make a patch.

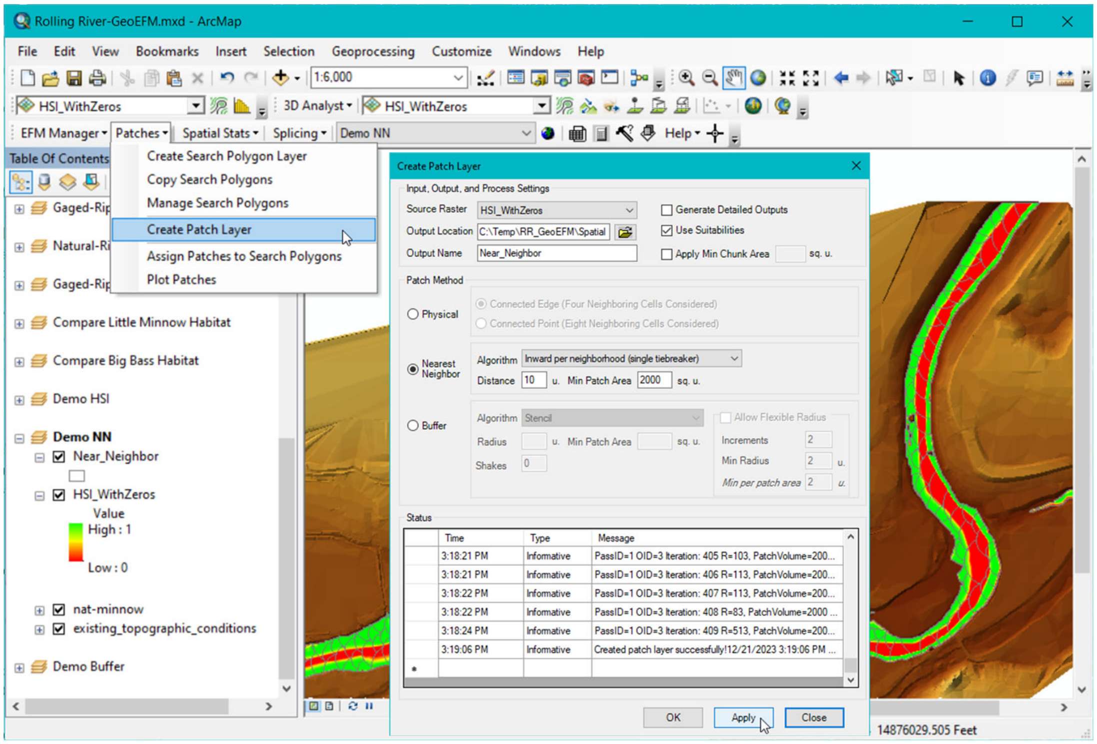


Figure 8. Creating a patch layer using the GeoEFM nearest neighbor method.

Buffer is most applicable to territorial communities that inhabit or utilize or protect an area for one or more of their life stages such as nesting. Figure 9 shows buffer patch results for a raster processed with suitabilities. Patches cut with the larger radius (50 map units) tend to occur in the poorest or sparsest habitat because the larger radius was needed to meet the user-specified area (suitable) required to make a patch.

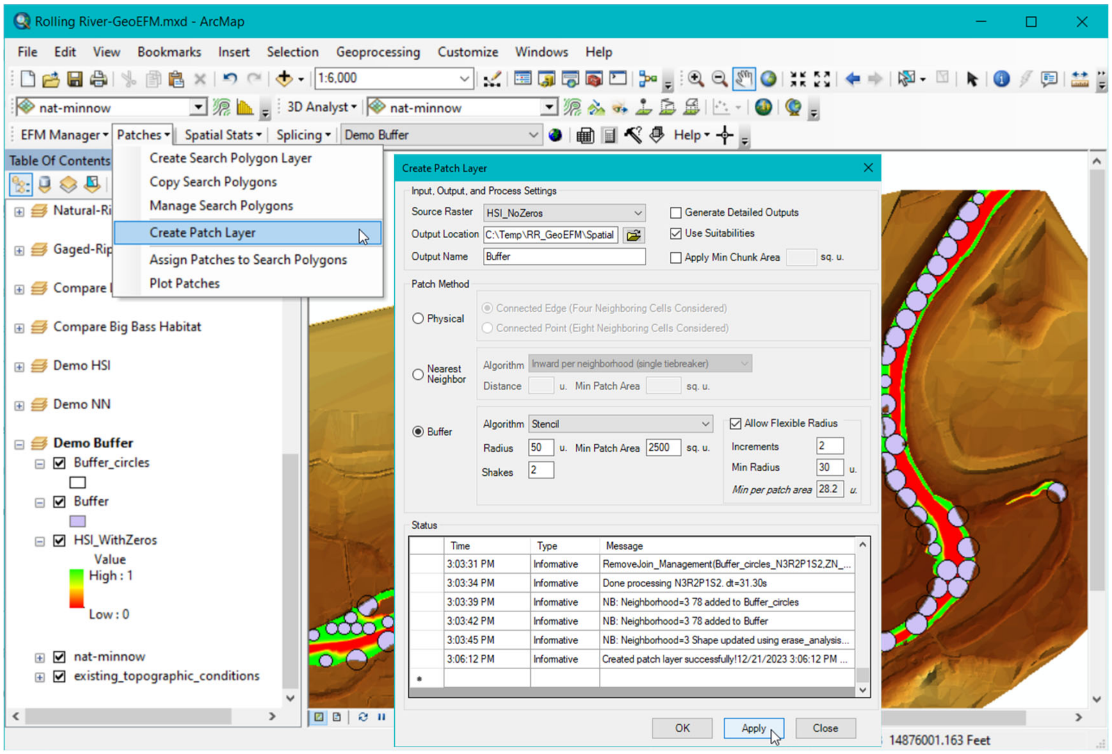


Figure 9. Creating a patch layer using the GeoEFM buffer method.

- *Habitat mosaics*. New features were added to help create habitat mosaics. For example, these features would allow habitat in a tributary stream and its receiving river to be spliced into a single habitat map. In EFM, the stream and river would be assessed separately for the same relationship because each has a different flow regime. Statistical results would be simulated with a hydraulics model to generate maps for the stream reach and for the river reach. Splicing tools in GeoEFM would assist with merging the two layers spatially to create a single map for that habitat type. The basic process for splicing is to make a splicing configuration and then apply it to a set of layers. There are three types of configurations: Polygon, raster, and hydraulic model (Figure 10).

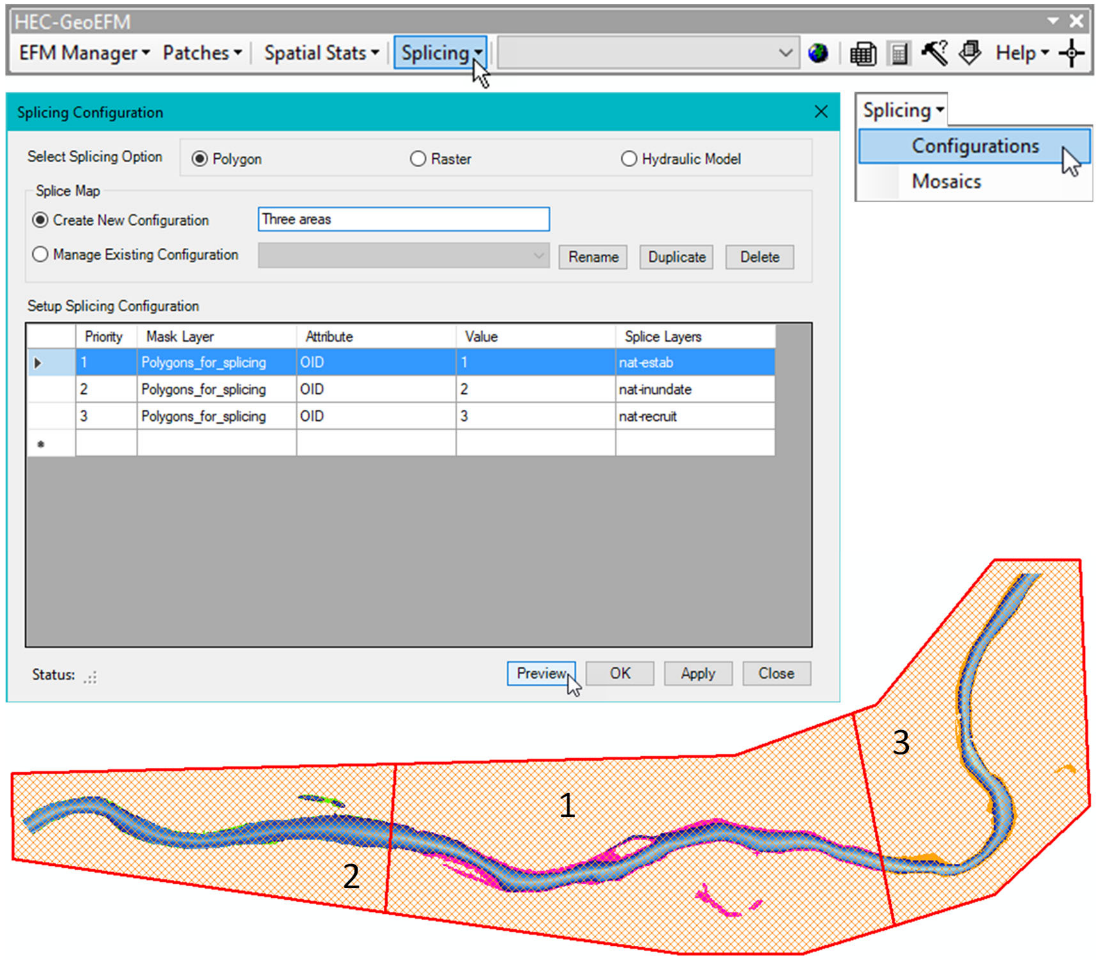


Figure 10. Interface for and preview of a polygon splicing configuration.

Choice of type is controlled by the user via the Select Splicing Option feature. Mosaics made with the polygon option are much like quilts. Polygons are used to define the areas of the quilt and the layers associated with those areas serve as the fabrics that are stitched together to form the mosaic. The raster option uses rasters as both the domain and the areas within that domain to be included in the splice. The hydraulic model option allows mosaics to be assembled based on the layout of 1-dimensional river hydraulics models (Figure 11).

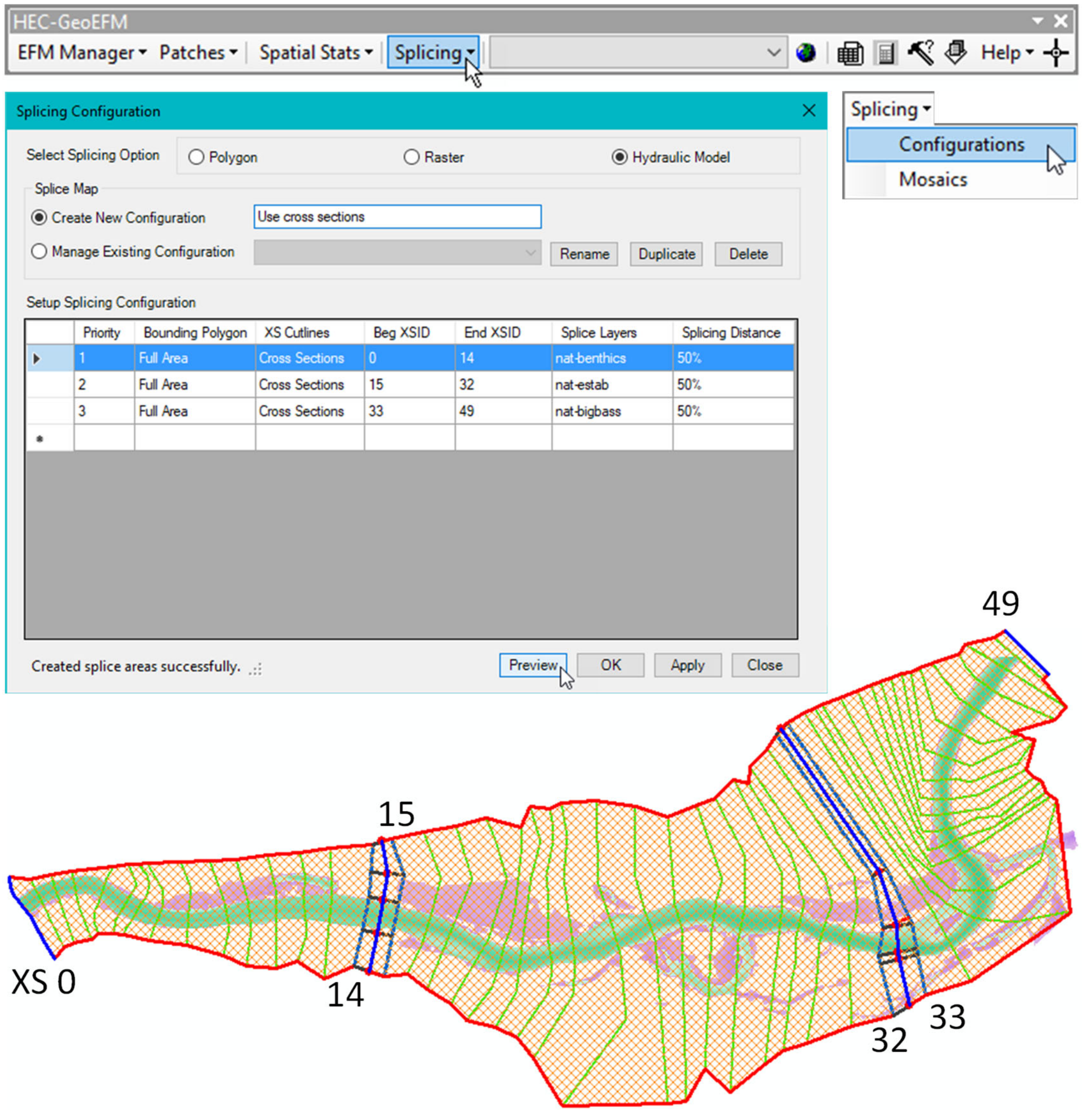


Figure 11. Interface for and preview of a hydraulic model splicing configuration.

The splicing interface executes splices per the use-selected configuration. Options are offered for handling raster cell offsets and overlaps. The mosaic generated is a raster and is displayed in the current view (Figure 12).

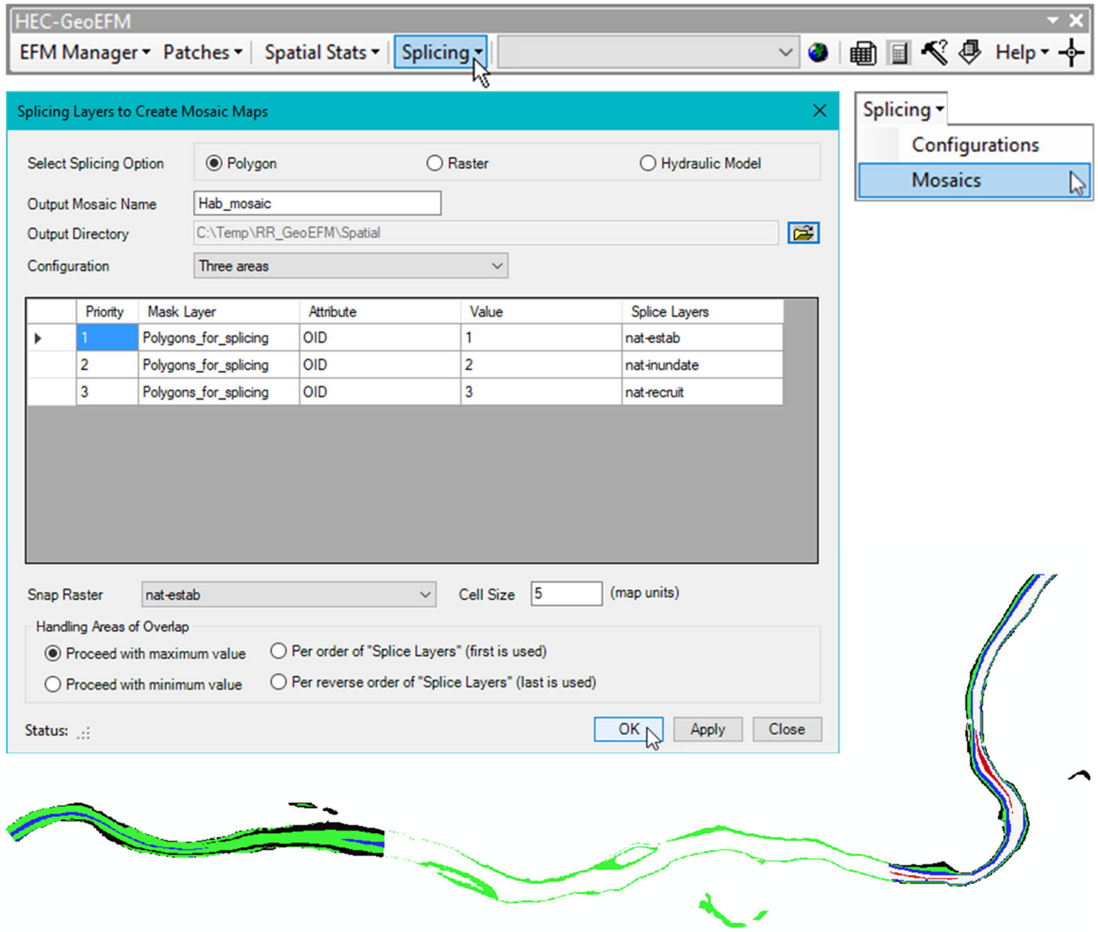


Figure 12. The splicing interface allows users to select and apply combinations of configuration, snap raster, and overlap option to create raster mosaics.

- *Spatial statistics.* New features were added that allow users to display statistical results spatially. This is a different workflow than using a river hydraulics model to generate spatial layers based on EFM results. Instead, statistical results (or derivations based on those results) are associated with locations and then plotted. Information for plotting are stored in three basic data tables: Locations, relationships, and datasets (Figure 13).

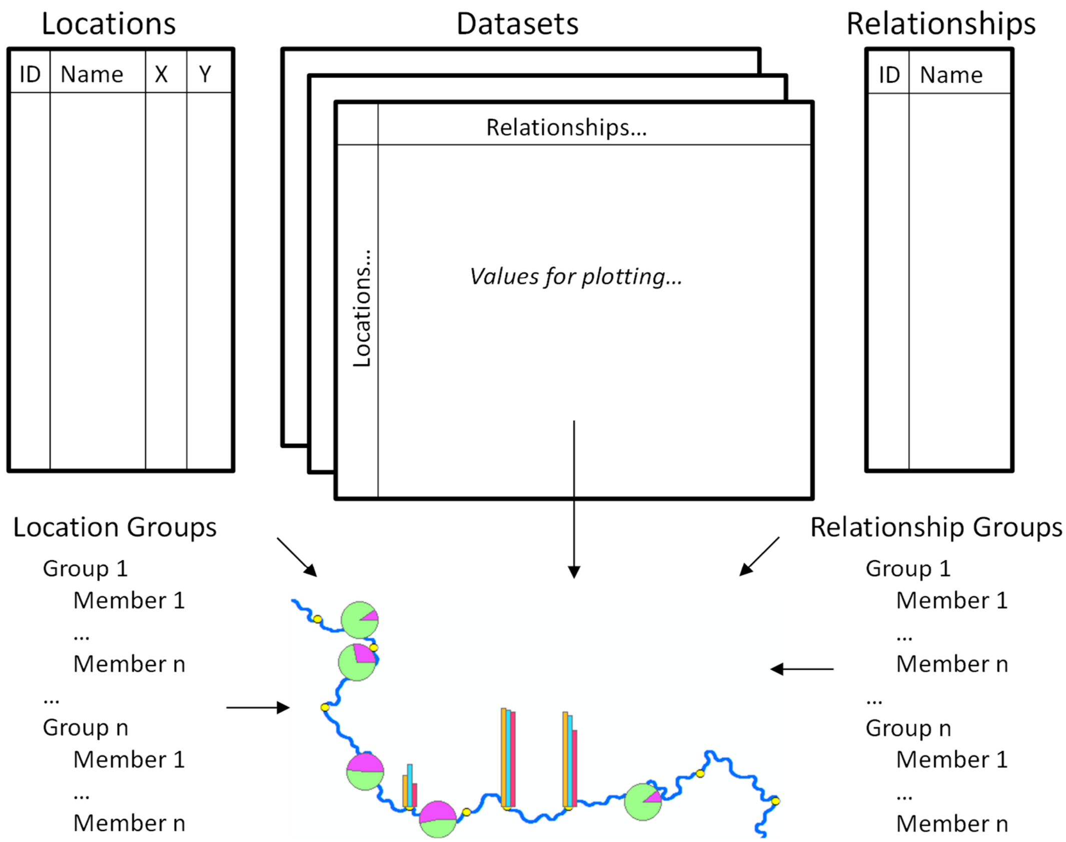


Figure 13. Process and data tables related to GeoEFM mapping of spatial statistics.

After the locations, relationships, and dataset tables are populated, data values may be viewed spatially. Three chart types are available: bar, pie, and stacked. Colors can be adjusted by switching the start and end of ramp colors. When the plot button is clicked, an output layer will be displayed as part of the active data frame (Figure 14). Output layer names do not need to be unique, though duplicate names will replace the existing output layer.

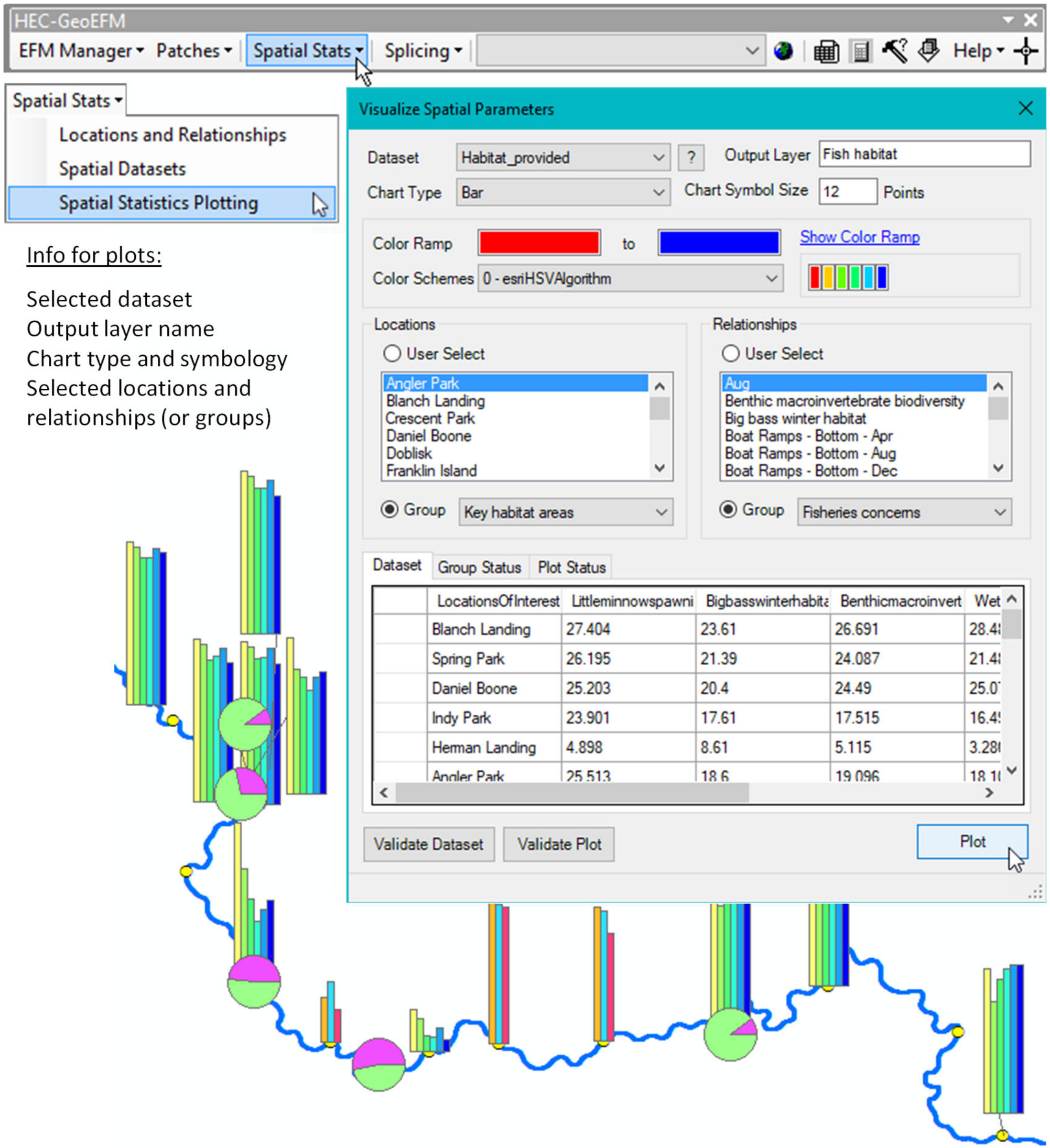


Figure 14. Spatial statistics are plotted via the Visualize Spatial Parameters interface.

Configure Auto-Listing. The configure auto-listing interface allows users to select whether GeoEFM generated layers are automatically associated with their corresponding views when those layers are created (Figure 15). This is a handy time-saving option, especially when working with habitat suitability indices, habitat splicing, and habitat functionality. Each of those GeoEFM features is capable of producing many output layers. The top checkbox option is a master on/off switch. When deselected, auto-listing is off regardless of the other checkbox settings.

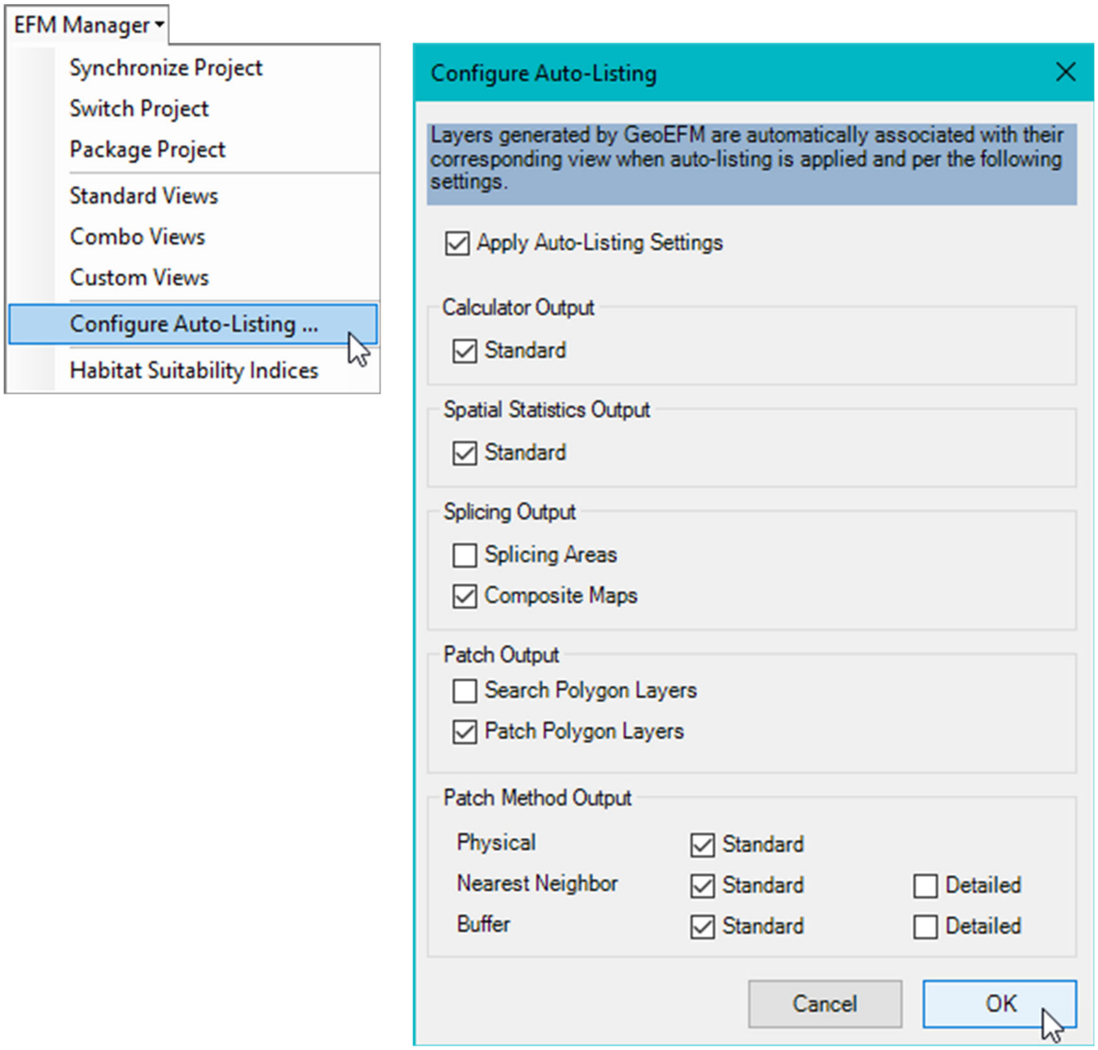


Figure 15. Auto-Listing supports management of layers generated by GeoEFM.

Improved Behaviors

- Habitat area tables were embedded in the tabulate tool to improve user access and interactions with generated tables.
- Precision increased in habitat area table output.
- The consistency of error catching related to user-assigned names for datasets and output rasters was improved by adding additional quality validations.
- Minor enhancements to interface layouts and labels to improve usability.
- Adding layers to standard views was updated to be per order of source view.

Documentation

- The User's Manual was updated to include descriptions of new features (sections added or revised: 5.3, 5.4, 5.5, 5.6, 5.7, and 5.8).

HEC-EFM Status

Information is passed from EFM to GeoEFM for use in GeoEFM applications. No changes were made to EFM in support of GeoEFM 2.0. The latest version of EFM (5.0) and corresponding release notes are available via HEC's website.