4.4 HEC-GeoEFM Workshop Using HEC-EFM and HEC-RAS Data for Ecosystem Analyses

Objective

In this workshop, you will use GeoEFM to investigate spatial aspects of habitat provided by different flow regimes. Specific tasks involve identifying which aspects of the ecosystem are predicted to be most affected (both enhanced and impacted) by a change in flow regime and proposing a location for a boat access/recreation area based on simulated fish habitat.

In this workshop, the student will perform four tasks using GeoEFM: 1) Manage spatial layers, 2) Compute habitat areas using the Tabulate tool, 3) Analyze habitat connectivity using the Patch Analysis tool, and 4) Mapping of Spatial Statistics.

To save time, much of the initial setup of the GeoEFM project has already been done. It is detailed in the next section, which is entitled "Part 1: Background and GeoEFM Project Management". You will not need to actually use the software until Part 2.

This workshop is designed to introduce GeoEFM and show how it can be used for ecosystem analyses through a series of spatial investigations. Feel free to save your work as you go, but do not perform a Save As. This would complicate connections between the GeoEFM project and its associated geodatabases.

Part 1: Background and GeoEFM Project Management

The EFM process involves statistical analyses of flow regimes and ecological relationships, hydraulic modeling, and spatial analyses of layers generated by hydraulics models. This workshop focuses on the third and final step in that process. Results from the statistical analyses are provided in the table below.

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

All of these statistical results (flow values for the Sav Natural and Sav Gaged flow regimes for all relationships) have been simulated with a river hydraulics model to generate depth arids for use in this workshop.

For example, for Shoals Spider Lily in the Sav Natural flow regime there is a depth grid that shows inundated areas and associated depths at a flow rate of 1,964-cfs.



In this part of the workshop, the steps to set up a HEC-GeoEFM project will be demonstrated. Again, these steps have been done for you and are detailed herein only for your information.

Getting Started

To access GeoEFM, open ArcMap and load the GeoEFM toolbar.

- Open ArcMap.
- ☑ Load toolbar by right clicking on the toolbar area of the ArcMap interface and select **HEC-GeoEFM**.



☑ The GeoEFM toolbar will appear and look like this.

EFM Manager Patch Analysis EFM	M Mapping 🕶		📢 🤀 Help 🛛 💂
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HEC-GeoEFM Project Setup

A GeoEFM project is simply an ArcMap document and geodatabase associated with an EFM project, such that ArcMap can access, interpret, and store information from EFM for use in GIS.

Creating a GeoEFM project

To create a GeoEFM project, save the ArcMap document and then synchronize it with an EFM project.

Save the ArcMap document using the **File | Save As** menu option.



☑ Then select **EFM Manager | Synchronize Project** from the GeoEFM toolbar.

ŝ	EFM I	Manager 🕶		
		Synchronize Project		
		Switch Project Package Project	LoadPro	ject
		Standard Views Combo Views	LoadPr	oject
		Custom Views		
		Habitat Suitability Inc	lices	

!

When

☑ The first time the Synchronize Project menu option is selected for a new GeoEFM project, the user will be prompted to load an EFM project. We will be using an EFM project entitled "EFM Relationships Workshop.efm".

Synchronize Project	×
EFM Project	C:\Workshops\GeoEFM\EFM Relationships Work:
	OK Cancel
	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

the EFM project is loaded, the file

and path names of the EFM project are saved as part of the GeoEFM project. With each subsequent **Synchronize Project** command, GeoEFM retrieves the latest saved version of the data from its parent EFM project. Any changes, including adding, renaming, or deleting flow regimes and relationships, must be performed and saved in EFM and then updated in GeoEFM through a **Synchronize Project** command.

## Part 2: Manage Spatial Layers

In this part of the workshop, spatial layers generated from the hydraulic modeling phase of the EFM process and other relevant spatial data will be added to the GeoEFM project. You will start with an existing GeoEFM project and then create Standard Views for the <u>Splittail</u> <u>Spawning relationship</u>; one for the Sav <u>Natural</u> flow regime and one for the Sav <u>Gaged</u> flow regime. The other Standard Views required for this workshop have been already been created.

So, let's get started with the exercise. Open the ArcMap file provided for you. It is entitled "GeoEFM Workshop.mxd" and located at "C:\Workshops\GeoEFM" or at the location specified by the workshop facilitator.

- Open ArcMap.
- Open the GeoEFM ArcMap document using the File | Open menu option.
   Browse to C:\Workshops\GeoEFM\GeoEFM Workshop.mxd and click Open.

Q Open						×
Look in:	🔒 GeoEFM		•	G 🤌	P ።	-   🏠
Recent Places	Depth_Grids	cshop.mxd				
Desktop						
Libraries						
Computer						
Network	File name: Files of type:	GeoEFM Workshop mxd ArcMap Documents (* mxd)			•	Open Cancel

Synchronize the GeoEFM project with the EFM project by selecting **EFM Manager** | Synchronize Project from the GeoEFM toolbar. The EFM project is named "**EFM** Relationships Workshop.efm" and is located at "C:\Workshops\GeoEFM\".

Note that if layers are not displaying and/or if the View Finder on the GeoEFM toolbar is empty, you need to synchronize the project again.

#### 2.1 Add Relevant Data and Statistical Results from EFM

In addition to the data and structure obtained from the EFM project, GeoEFM applications typically begin with layers generated during the hydraulic modeling phase of the EFM process as well as other relevant data such as maps of land use, soils, and vegetation.

The default "Layers" data frame contains cross sections, stream centerline, Existing Topography, and the depth grids for each of the flow regime – relationship pairings in the EFM project. ☑ In GeoEFM, sets of "views" are built per the structure obtained from the EFM project. Each "view" is a data frame. Standard Views are used as workspace for pairings of flow regimes and relationships. Use the Standard Views manager to create standard views for the Splittail Spawning relationship. Eight Standard Views have been created using the following steps.



## 2.2 Create Standard Views

Now, you will create two Standard Views for the Splittail. Let's start with the **gaged** flow regime.

To create a Standard View, use the HEC-GeoEFM toolbar to navigate to the EFM Manager |
 Standard Views menu option.

EFM	l Manager 🕶	
	Synchronize Pro	ject
	Switch Project	
	Package Project	
	Standard Views	
	Combo Views	StandardView
	Custom Views	StandardView
	Habitat Suitabili	y marces

☑ This will activate the **Manage Standard Views** interface which allows you to assign layers from the Source View (in this case "Layers") to the Destination Standard View.

- ☑ Next, select the layers associated with the Sav Gaged-Splittail Spawning view (Cross Sections, Stream Centerline, gage-split, gage-split0-3, and Existing Topography) from the Source View.
- ☑ In the **Destination Standard View** dropdown menu, find the **Sav Gaged-Splittail Spawning** option and select it, then click **Apply**.

inage oraniaal	rd Views					
Source View	Layers				•	Refresh
Layers						
Sel	lect Laye	r Name				*
V	Cros	s Sections				
<b>v</b>	Strea	m Centerline				E
<b>v</b>	gage	split0-3				
	gage-	split				
	gage	benthics				
	gage	lily				
	gage	shadbass				-
4	nane	wetland				•
Destination Sta	andard View	Sav Gaged-	Splittail Spawning			
Destination Sta Layers and Set	andard View tings	Sav Gaged-	Splittail Spawning	Pere	Decult	
Destination Sta Layers and Set Layer	andard View tings	Sav Gaged-	Splittail Spawning	Base	Result	Remove
Destination Sta Layers and Set Layer	andard View tings	Sav Gaged-	Splittail Spawning	Base	Result	Remove
Destination Sta Layers and Set Layer	andard View tings on top	Sav Gaged	Splittail Spawning	Base	Result	Remove

☑ This will create the new Standard View/data frame with the selected layers. This data frame will also become the active data frame (shown in bold).

🕀 🥌 Layers
🖃 🥩 Sav Gaged-Splittail Spawning
😥 🗹 Existing Topography
🕀 🗹 gage-split
🕀 🗹 gage-split0-3
🕀 🗹 Stream Centerline

✓ Splittail require shallow habitat for spawning. Scientists proposed that depths of less than or equal to 3 ft for Splittail spawning would be suitable. The portion of the depth grid that met this depth criterion has been saved as a new layer called "gage-split0-3". As this is the layer that meets all criteria (statistical and spatial) for the relationship and flow regime being considered, identify it as the Result layer by checking the box for gage-split0-3 under the Result column and click Apply.

	Layer	Tags	Base	Result	Remove
	Cross Sections				
	Stream Centerline				
•	gage-split0-3 *			~	
	gage-split				
	Existing Topography				

- Repeat these steps for the natural flow regime of the Splittail. Be sure to select the layers that are relevant to Savannah Natural-Splittail Spawning (Cross Sections, Stream Centerline, <u>nat</u>-split, <u>nat</u>-split0-3, and Existing Topography) and deselect layers associated with the gaged flow regime.
- When you are finished, click the **Close** button.
  - ! There can only be one "Result" layer per Standard View. The Tabulate feature, discussed in the next section, queries Result layers when computing and reporting total habitat areas for different flow regime relationship pairings.

## Part 3: Compute Habitat Areas

In this part of the workshop, total habitat areas for each pairing of flow regime and relationship will be computed and compared.

- ☑ To begin, click the **Tabulate Results** is button on the HEC-GeoEFM toolbar.
- Fill in/select the following information:

Report Location: C:\Workshops\GeoEFM\ Report Name: All_Areas Change from Reference: Percentage Select Units: Acres Reference Flow Regime: Sav Natural Tabulate Flow Regimes: Sav Gaged Relationships: Select All except Water Exchange – Reverse Lookup

port Status					
Report location	C:\Workshop	s\GeoEFM			۵
Report Name	All_Areas			🔲 Use Suitabilitie	es
Select Option		Change from Reference		Select Units	
Total Areas	•	Percentage		Sq Feet	Sq Meters
Change from	m Reference	Difference in area		Acres	Hectares
Both				Sq Miles	Sq Km
Select Row Reg Reference Flow Sav Natural Sav Gaged	ime and Relatior v Regime	iships Tabulate Flow Regimes Sav Gaged	Relati Splittai Shad a Benthi Shoals Water Water	onships I Spawning and Striped Bass Hal c Biodiversity Sigider Lily Exchange Exchange - Reverse	bitat e Lookup

- Press the **OK** button.
- ☑ The Status tab details progress as output is generated and provides warning messages if any problems are encountered.

eport	Status		
	Time	Туре	Message
	11:15:37 AM	Informative	Area of spatial layer is 3037900
	11:15:37 AM	Informative	Area of spatial layer in selected unit type is 69.7381134707191
	11:15:38 AM	Informative	Area for relationship Splittail Spawning is 69.7381134707191
	11:15:38 AM	Informative	Getting spatial layer for view Sav Gaged-Splittail Spawning
	11:15:38 AM	Informative	Spatial layer for view Sav Gaged-Splittail Spawning is located at C:\Worksh
	11:15:38 AM	Informative	Calculating area in Feet (SI) units
	11:15:39 AM	Informative	Area of spatial layer is 1587000
	11:15:39 AM	Informative	Area of spatial layer in selected unit type is 36.4312143513714
	11:15:39 AM	Informative	Reference area for flow regime is 69.7381134707191
	11:15:39 AM	Informative	Area for candiate flow regime Sav Gaged is 36.4312143513714
	11:15:40 AM	Informative	Percent change in area is -47.7599657658251
	11:15:40 AM	Informative	Writing out areas to report
	11:15:40 AM	Informative	Report saved at C:\Workshops\GeoEFM\All_Areas.xml
	11:15:40 AM	Informative	Report created successfully!
*			

 Note that GeoEFM will not compute and report habitat areas unless all required results layers are identified and have defined spatial references. Use the ArcToolbox | Data Management Tools | Projections and Transformations
 | Define Projection feature to assign the appropriate projection.

- All_Areas.xml is generated that shows a summary of the data. Use the summary file to fill in the table below.
- ☑ Tabulate the areas again by going from the Results tab to the Reports tab, but this time use difference in area for the Change from Reference option and fill in the last column of the table.

Habitat Areas for All Relationships								
	Natural	Gaged						
Relationship	Area, Acres	Area, Acres	Change, %	Change, Acres				
Sacramento Splittail								
Shad & Striped Bass								
Benthic Biodiversity								
Shoals Spider Lily								
Water Exchange for Wetland Health								

Based on change in area, which ecological communities or processes gained and lost the most habitat area?

 Based on percent change, which ecological community or process is predicted to be the most enhanced under the gaged flow regime (as compared to the reference flow regime - Sav Natural)? Which is predicted to be the most impacted?

## Part 4: Analyze Habitat Connectivity

Congratulations! You are now a recognized habitat expert for this river system. As such, you have just been asked to identify a location for a proposed community recreation area and boat access site. Community planners have specified that the ideal site would:

- Minimize disturbance to Splittail Spawning, which is a threatened species
- Provide boat access to deeper areas and proximity to open water
- $\circ\,$  For safety purposes, have a gentle slope in the land to water transition zone
- Be located on the North bank of the river to minimize travel time for visitors
- Avoid the North/South reach due to other development plans

Community planners also said that to mitigate for any impacts of the recreation area and to maintain balance between recreation and environmental values, one third of the study area is to be set aside as a conservation zone for Splittail Spawning.

For this task, you will use GeoEFM to analyze connectivity of Splittail Spawning habitat.

☑ Since the Sav Gaged flow regime represents the existing conditions in the river, make sure that the **Sav Gaged-Splittail Spawning** data frame is active. The active data frame is shown in bold font. If it is not the active data frame, go to the GeoEFM toolbar and select it from the View Finder dropdown menu and click the Show View



- ☑ The next step is to define our areas of interest with **Search Polygons**.
- On the HEC-GeoEFM toolbar, navigate to and select the Patches | Create Search Polygon Layer menu option. Name the Search Polygon Layer SearchPoly and click OK.



Create Search Polygon Layer		×
Search Polygon Layer Name	SearchPoly	
	ок	Cancel

Next, select the Patches | Manage Search Polygons menu option. In the Manage Search Polygons window, click the Trace button.





 This will open a Start Editing window that asks which database you would like to edit.
 Select C:\Workshops\GeoEFM\GeoEFM Workshop.mdb (you should see the SearchPoly layer listed in that database) and click OK.

*Note: For the purposes of this workshop, you may disregard any warnings about spatial references not matching the data frame.



☑ The cursor's appearance will change to look like this +. If the cursor does not look like this, click the **Trace** button again. Make a polygon around the area by clicking to create each vertex. Double-click the last vertex to finish the polygon.



☑ Now, split the polygon into three approximately equal areas. To do this, click the **Split** button in the **Manage Search Polygons** window. Create split lines by clicking once at the starting point and then double-clicking at the end point.

Manage Search Polygons	
Search Polygon Layer SearchPoly Edit Search Polygons Create new search polygon Trace Merge search polygons Merge Split search polygon Split	
OK Cancel	

✓ When finished, close the Manage Search Polygons window by clicking the OK button. This will pop up a prompt asking if you want to save your edits, select Yes.

Manage Search Polygons		×
Search Polygon Layer	SearchPoly	•
Edit Search Polygons		
Create new search po	lygon	Trace
Merge search polygor	ıs	Merge
Split search polygon		Split
[	ок	Cancel

Save	×
Do you want to save your edits?	
Yes No	Cancel

- ☑ The next step is to create a **patch raster**, which is simply a raster data set whose data has been split into separate habitat areas or patches. **Patches** are defined as areas that share either a connected edge or a connected point.
  - ☑ To create a patch raster, select the **Patches | Create Patch Layer** menu option.

Patches 🔹 Spatial Stats 🔹 Splicing 👻 Sav Na
Create Search Polygon Layer
Copy Search Polygons
Manage Search Polygons
Create Patch Layer
Assign Patches to Search Polygons
Plot Patches Create Patch Layer

☑ In the Create Patch Raster window, use gage-split0-3 as the Source Raster Layer. Keep the default Area included in patch based on option as Connected Edge. The Output Location should be C:\Workshops\GeoEFM\. The Patch Raster Name should be pr4gage. Then click OK.

Create Patch Laye	r				×
Input, Output, an	d Process Settings				
Source Raster	gage-split0-3	$\sim$	Generate	Detailed Outputs	
Output Location	C:\Workshops\GeoEFM	<b>2</b>	Use Suita	abilities	
Output Name	pr4gage		Apply Mir	n Chunk Area	sq. u.
Patch Method					
Physical	Connected Edge (Four N     Connected Point (Eight )	leighboring Cel Neighboring Cel	ls Considered	) D	
⊖ Nearest Neighbor	Algorithm Inwards_Single_ Distance u. Min P	ThiessenArea atch Area	v sq. u.		
O Buffer	Algorithm Stencil Radius u. Min P Shakes 0	atch Area	sq. u.	Allow Flexible I Increments Min Radius Min per patch area	2       2       0       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1 <t< th=""></t<>
Status Time	Туре	Message			
			ОК	Apply	Cancel

 $\blacksquare$  When the calculations are done, click the **Cancel** button.

Now, we will assign patches to search polygons. Navigate to the **Patch Analysis |** Assign Patches to Search Polygons menu option.



☑ In the Assign Patch ID window, select pr4gage as the Patch Raster Layer, SearchPoly as the Search Polygon Layer, and name the Patch Polygon Layer pp4gagesplit. Keep the default Patches assigned to search polygon based on option as Split at search polygon boundary and assign patch. Click OK.

Assi	gn Pa	tch ID				<b></b> X
Pa	atch R	aster Layer	pr4gage	•		
Se	earch	Polygon Layer	SearchPoly	•		
Pa	atch P	olygon Layer	pp4gagesplit			
F	Patche	es assigned to s	earch polygon base	d on		
	Sp	lit at search po	lygon boundary an	d assign patch		
	⊘ As	sign patch to s	earch polygon whe	re it has most area		
	Status					
	J.	Time	Туре	Message		
,	*					
•	1			III		4
					ОК	Cancel

- ☑ When the calculations are finished, click the **Close** button.
- To see a graphical representation of the patches and their sizes, use the Patch Analysis | Plot Patches menu option.



- ✓ Use the shapefile output (**pp4gagesplit**) and plot patches to answer the following questions.
  - You have analyzed three areas of interest. Which area would you recommend as a conservation zone for Splittail Spawning and why?

Which area would you recommend for the recreation area and boat access and why?

Remember, an ideal site would:

- Minimize disturbance to Splittail Spawning, which is a threatened species
- Provide boat access to deeper areas and proximity to open water
- For safety purposes, have a gentle slope in the land to water transition zone
- $\circ~$  Be located on the North bank of the river to minimize travel time for visitors
- Avoid the North/South reach due to other development plans

As you are writing about your findings, a colleague walking by your work station compliments you on the impressiveness of your GeoEFM project. During the conversation, you learn that a restoration project has just been approved that will implement the Sav Natural flow regime. Follow the process below and use the Patch Analysis tool to analyze the Splittail natural flow regime.

- A new Search Polygon layer could be created, but it is easier to simply copy the existing one. To do this, right click on the SearchPoly layer and choose Copy. Activate the Sav Natural-Splittail Spawning data frame by choosing it from the dropdown menu and click the Show View button. Now, right-click on the Sav Natural-Splittail Spawning data frame and select Paste Layer(s).
- Next, create a Patch Raster using the **nat-split0-3** raster.
- ☑ Then, Assign Patches to Search Polygons.
  - Has the natural flow regime analysis changed your suggestion about locating the conservation zone? Why?
  - What about the recreation area and boat access? Why?

## Part 5: Incorporating Fisheries Monitoring Data

A year later, construction on the recreation area is about to begin and pre-project fish monitoring results have just become available. The fisheries biologist was able to refine criteria for splittail spawning, and questions have been raised about how many shad and bass can overwinter in the study area.

The new splittail information shows that spawning did not occur in less than 0.25 feet of depth, began to taper in depths above 1.5 feet, and was absent in areas deeper than 3 feet.

al)
1

The resulting "Splittail spawning" habitat suitability index (HSI) is:

Additionally, splittail spawners are territorial, defending nest sites as far away as 50 feet. Splittail pairs require 2,000 square feet of habitat for nest creation and local forage.

Let's apply this new information to verify the choice of conservation area and location of recreation center and boat access.

#### 5.1 Create a Habitat Suitability Index (HSI) for Splittail

☑ If it's not active, activate the **Sav Natural-Splittail Spawning** data frame by choosing it from the dropdown menu and click the Show View button

Select the **EFM Manager – Habitat Suitability Indices** menu option.



Habitat Suitability Index Manager  $\times$ Add HSI Splittail Spawning Index  $\sim$ 1 0.9 0.8 0.7 0.7 Suitability 0.5 0.4 0.3 0.2 0.1 0 Ó Variable Duplicate Rename Delete OK Paste Import Apply

☑ Enter name ("Splittail Spawning") for the new HSI and click the **Add HSI** button.

 $\blacksquare$  Enter HSI data and click **Apply**. Close interface by clicking x button or OK.



#### 5.2 Create a suitable habitat map based on the HSI (Splittail)

☑ Open the GeoEFM **Calculator** tool

	📢 🧶 Help 🛛 🔶 💂	
1	مخــــــــــــــــــــــــــــــــــــ	
	Query raster value ranges, apply HSI, and analyze feature classes	

 $\square$  Enter the following information:

# Output Layer Name: s_nat_suit Use the **Raster Query** Output Location: C:\Workshops\GeoEFM Input Raster Layer: nat-split Exclude Zero Suitability Areas

...then click OK

Calculator	×
Output Layer Name Raster Query	s_nat_suit
Output Location	C:\Workshops\GeoEFM
Input Raster Layer	nat-split V
O Cell Value	to Range: 0 to 13.3
Apply HSI	Splittail Spawning V Range: 0 to 20
Exclude Zero	Suitability Areas
O Feature Query	
Use features selec	cted on map Preview Clear
Output Geodatabase	
Layer B_50_3000	_circles
2	Sort Add Remove
O Multiple Feature Layers	s Query
Output Geodatabase	
Operation I	ntersect v Output Type INPUT v
Layer 1	8_50_3000_circles ~ () Field ~
Layer 2	<ul> <li>✓ ● Distance</li> </ul>
Warning! This GeoEFM fea for feature layers, is not do manual, and should be used	ature has not been tested cumented in the user's d with caution.

☑ The resulting suitable habitat map should look like...



### 5.3 Create Patches of Suitable Habitat (nest sites) based on Splittail needs

☑ Select the Patches – Create Patch Layer menu option.



$\checkmark$	Enter the following information:	Source Raster: s_nat_suit
		Output Location: C:\Workshops\GeoEFM
		Output Name: nest_sites
		Use Suitabilities
		Select the Patch Method: Buffer
	then click Apply	Radius =50; Min Patch Area = 2000

s_nat_suit C:\Workshops\GeoEFM nest_sites Connected Edge (Four Connected Point (Eight	Veighboring Cel	Generate	Detailed Outputs bilities Chunk Area sq.	u.
C:\Workshops\GeoEFM nest_sites Connected Edge (Four Connected Point (Eight	Neighboring Cel	Use Suital	bilities Chunk Areasq.	u.
nest_sites Connected Edge (Four Connected Point (Eight	Neighboring Cel	Apply Min	Chunk Area sq.	u.
<ul> <li>Connected Edge (Four</li> <li>Connected Point (Eight</li> </ul>	Neighboring Cel	lle Considered)		
<ul> <li>Connected Edge (Four</li> <li>Connected Point (Eight</li> </ul>	Neighboring Cel	lle Considered)		
	t Neighboring Cel	ells Considered)		
Algorithm Inwards_Single Distance u. Min	_ThiessenArea Patch Area	sq. u.		
Algorithm Stencil Radius 50 u. Min Shakes 0	Patch Area 200	∨ )0 sq. u.	Allow Flexible Radius Increments Min Radius 2 Min per patch area 25.2	s u. 2 <i>u</i> .
Туре	Message			
	Distance u. Min Algorithm Stencil Radius 50 u. Min Shakes 0 Type	Distance u. Min Patch Area Algorithm Stencil Radius 50 u. Min Patch Area 200 Shakes 0 Type Message	Distance u. Min Patch Area sq. u. Algorithm Stencil Radius 50 u. Min Patch Area 2000 sq. u. Shakes 0 Type Message	Distance u. Min Patch Area sq. u. Algorithm Stencil Allow Flexible Radius Radius 50 u. Min Patch Area 2000 sq. u. Shakes 0 Shakes 0 Sha

- ☑ Processing time should take about one minute. GeoEFM is positioning a stencil of circles (radius = 50 feet) over the habitat layer and identifying circles that encompass enough suitable habitat (2,000 square feet) to support spawning.
- ☑ The resulting map of nesting sites should look like...



- $\diamondsuit$  How many nest sites were identified in the study area?
- Does the distribution of nesting sites change your suggestions about locating the conservation zone or the recreation area and boat access? Why?

How many nests are likely to be disturbed and likely lost due to construction?

#### **Overwintering Shad and Bass**

Let's investigate how many shad and bass can overwinter in the study area. Monitoring has shown:

Adults are not territorial during the overwinter period Adult individuals require 15,000 square feet of suitable habitat to overwinter Isolated chunks of habitat with 5,000 square feet of habitat or less are not utilized Pieces of habitat separated by 100 feet should be considered separately Adults prefer depths between 3 to 5 feet Adults avoid areas of depth less than 1 ft and more than 10.

The resulting "Shad and Bass" habitat suitability index (HSI) is:

Variable (depth, ft)	Suitability (0 to 1; 0 is wholly unsuitable and 1 is ideal)
0	0
1	0
3	1
5	1
10	0

#### 5.4 Create a Habitat Suitability Index (HSI) for Shad & Striped Bass

Activate the **Sav Natural-Shad and Striped Bass Habitat** data frame by choosing it from the dropdown and clicking the Show View button.

Select the **EFM Manager – Habitat Suitability Indices** menu option.



☑ Enter name ("Shad and Bass") for the new HSI and click the **Add HSI** button.



 $\square$  Enter HSI data and click **Apply**. Close interface by clicking x button or OK.



#### 5.5 Create a Map of Suitable Habitat based on the HSI (Shad & Striped Bass)

☑ Open the GeoEFM **Calculator** tool



 Enter the following information:
 Output Layer Name: sb_nat_suit Select Raster Query
 Output Location: C:\Workshops\GeoEFM
 Input Raster Layer: nat-shadbass
 ...then click OK
 Include Zero Suitability Areas

lculator	>
Output Layer Name	sb_nat_suit
Raster Query	
Output Location	C:\Workshops\GeoEFM
Input Raster Layer	nat-shadbass $\checkmark$
O Cell Value	to Range: 0 to 8.76
Apply HSI	Shad and Bass V Range: 0 to 10
Exclude Zero	Suitability Areas
Feature Query	
Use features sele	cted on map Preview Clear
Output Geodatabase	
Layer bn_100_10	0000e <-> Attribute Shape_Length <->
952.219908862394 1516.78603382396 1126.00850220784 1673.74581805974 829.295087560727 724.884054886967	<ul> <li>∧ Sort</li> <li>Add</li> <li>∨ Remove</li> </ul>
O Multiple Feature Laye	rs Query
Output Geodatabase	
Operation	Intersect V Output Type INPUT V
Layer 1	bn_100_10000e v 🔿 Field v
Layer 2	<ul> <li>✓ ● Distance</li> </ul>
Varning! This GeoEFM fe or feature layers, is not do nanual, and should be use	ature has not been tested ocumented in the user's or Cancel

 $\blacksquare$  The resulting suitable habitat map should look like...



## 5.6 Create Patches of Suitable Habitat based on overwintering needs

☑ Select the Patches – Create Patch Layer menu option.



$\checkmark$	Enter the following information:	Source Raster: sb_nat_suit
		Output Name: adult_patch
		Uncheck: Generate Detailed Outputs
		Use Suitabilities
		Apply min chunk area = 5000
		Use the Nearest Neighbor Patch Method
	then click Apply	Distance = $100$ ; min patch area = $15000$

	u 1100033 30	.ungo					
Source Raster	sb_nat_suit 🗸 🗸			Generate Detailed Outputs			
Output Location	C:\Worksho	ops∖GeoEFM	<b>2</b>	Use Suitabilities			
Output Name	adult_patch			Apply Min Chunk Area 5000 sq. u.			
Patch Method							
O Physical	<ul> <li>Connected Edge (Four Neighboring Cells Considered)</li> <li>Connected Point (Eight Neighboring Cells Considered)</li> </ul>						
Nearest Neighbor	Algorithm Distance	nwards_Single_ 100 u. Min P	ThiessenArea atch Area 150	∨ 000 sq.u.			
⊖ Buffer	Algorithm Stencil Radius u. Min Patch Area Shakes 0		atch Area	Allow Flexible Radius sq. u. Increments Min Radius Min per patch area 2			
Status							
Time		Туре	Message				
*							

- ☑ Processing time should take about two minutes. GeoEFM is partitioning suitable habitat into patches that contain enough habitat to support an individual adult fish during the overwinter period.
- $\blacksquare$  After a symbology change, the resulting map of nesting sites should look like...



HEC-GeoEFM Workshop

 $\diamondsuit$  How many adults can overwinter in the study area?

 $\diamondsuit$  Does the suitable habitat map make sense based on the hydraulics and HSI?

What parts of the process that you just completed (application of HSI, Nearest Neighbor patch analysis) can exclude pieces of habitat as not viable for adults?