GEO 580 Lab 3 - GIS Analysis Models

Introduction	Introduction to GIS Analysis Models
Part 1	Creating Marine Habitat Parameter Grids
Part 2	Creating Binary and Ranking Suitability Models
Part 3	Using ArcGIS ModelBuilder

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Introduction: What is a GIS Analysis Model ?

This lab will give you more practice in understanding and building a GIS analysis model. A GIS analysis model is a sequence of steps or functions used as part of a GIS analysis (in class we discussed the binary, ranking, rating, and weighted rating analysis models where grids are multiplied, added, averaged and weighted averaged, but there are many, many more approaches possible). These sequences of geoprocessing steps can also be represented in ArcGIS with ModelBuilder, also discussed in class.

GIS analysis models provide:

- A simplified, manageable view of reality
- They capture spatial relationships of objects
- They capture attributes of an object
- Models can help you understand, describe, or predict how things work in the real world
- They can also help us understand our level of knowledge about the real world
- Types: representation & process (suitability, distance, surface, hydrologic and more)

Introduction: What is a GIS Analysis Model?

In this lab you will build analysis models that will represent benthic environments offshore of central California, specifically Carmel Bay (data are courtesy of Deidre Sullivan, OSU doctoral student and director of the Marine Advanced Technology Education Center). Part of this region is currently designated as a marine protected area. High resolution bathymetric data are available from 20 to 200 m of depth and multiple remotely operated vehicle (ROV) transects were also conducted. The analysis models that you build will use a variety of analysis grids that were already created for you with the **Benthic Terrain Modeler (BTM)**. BTM is a collection of ArcGIS-based tools that coastal and marine resource managers can use in concert with bathymetric data in order to examine and classify the benthic environment. BTM was developed by the OSU Davey Jones Locker Seafloor Mapping/Marine GIS Lab in collaboration with the NOAA Coastal Services Center's GIS Integration and Development program. [If you would like your own copy of the BTM tool, download the file **Lab 3_BTM_Tool.zip or go to http://dusk.geo.orst.edu/djl/samoa/tools.html.]**

You will use these grids to build a binary model and a ranking model. Because you are working with bathymetry and ROV observations of benthic fish, these two models can also be viewed as initial steps in building more complex habitat suitability models. You will compare your two models with this in mind. You are probably familiar with the term Essential Fish Habitat (EFH). In this lab you will make a fanciful selection of Essential Nemo Habitat (ENH)! ☺

Introduction: Important Background on BTM and its Grids

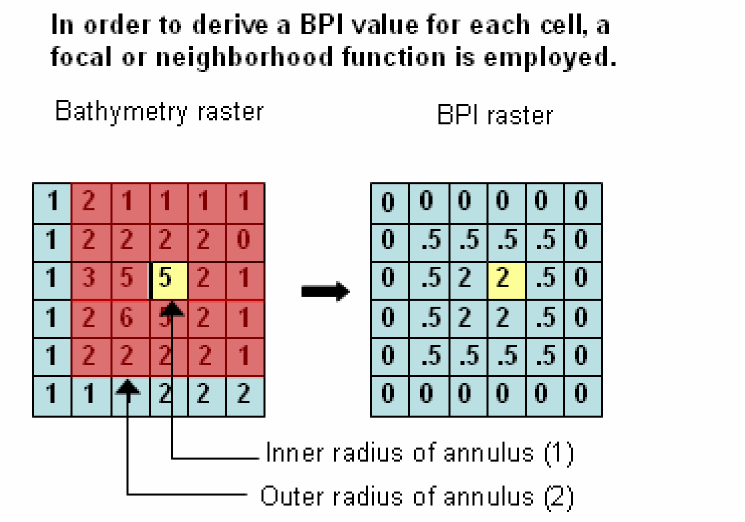
The benthic terrain classification process developed for the BTM was derived from several existing methods used within the landscape ecology and seafloor mapping communities (for more general information on this and to download the tool and tutorial for your own use, see http://dusk.geo.orst.edu/djl/samoa/tools.html, as well as Lundblad et al., 2006 and Rinehart et al., 2004). Using a bathymetry grid as an input, the BTM uses spatial analyst functions in ArcGIS to create three different kinds of output grids: bathymetric position index (BPI) at fine and broad scales, slope, and rugosity. The relationships between these data sets can then be examined and mapped out as a final terrain classification map using an algorithm developed by the user through the creation of a classification dictionary. You will not have to worry about this final classification dictionary and map stage, but in the lab you will be using BPI and rugosity grids as part of the GIS analysis models that you will be constructing. As such, let's take a "crash course" on BPI and rugosity (which also gives you an advance peek at terrain analysis, forthcoming later in the course and in Lab 6).

BPI is a measure of where a referenced location is relative to the locations surrounding it; e.g., a measure of where a point is in the overall landscape or seascape. It is derived from an input bathymetric grid and is a modification of the topographic position index (TPI) algorithm used in landscape ecology studies (e.g., Guisan et al., 1999; Jones et al. 2000; Weiss 2001).

Introduction: Important Background on BTM and its Grids

Many physical and biological processes acting on the landscape/seascape may be highly correlated with topographic/bathymetric position, and in some cases a species' habitat may be partially or wholly defined by the fact it is a hilltop, valley bottom, exposed ridge, flat plain, upper or lower slope, and so forth.

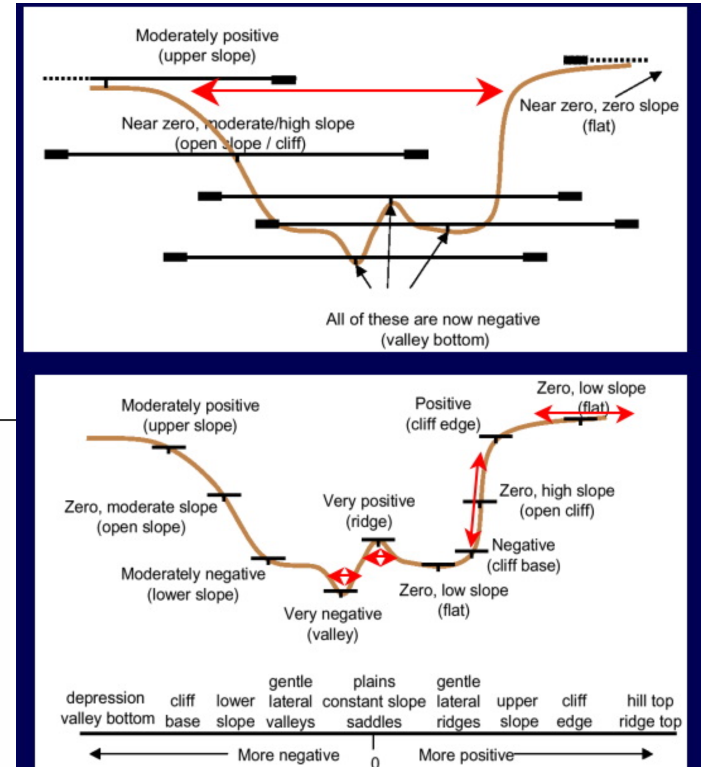
In GIS, the BPI algorithm compares the elevation of a grid cell to the mean elevation of cells in neighborhoods of varying sizes (the neighborhood consisting of an annulus with an inner and outer radius).

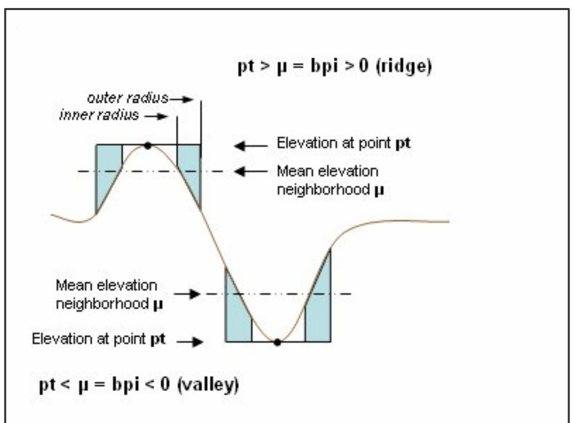


An example of a neighborhood analysis function using an annulus shape

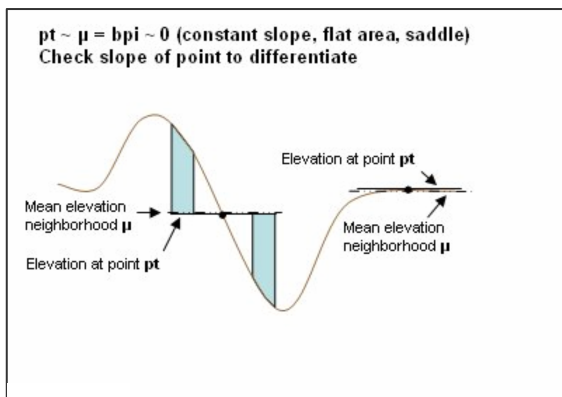
Introduction: Important Background on BTM and its Grids

Positive BPI cell values denote features or regions that are higher than the surrounding area (e.g., ridges). Negative cell values denote features or regions that are lower than the surrounding area (e.g., valleys). BPI values near zero are either flat areas (where the slope is near zero), or areas of constant slope where the slope at the point is significantly greater than zero). The horizontal scale of the neighborhood in which the calculation is made is extremely important.





Positive and negative BPI value derivation for ridges and valleys



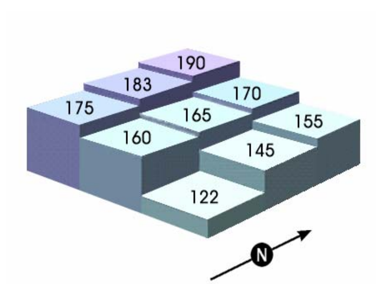
Areas where the BPI value is near or equal to zero. The slope of the terrain at the given point is used to determine the bathymetric position.

Introduction: Rugosity

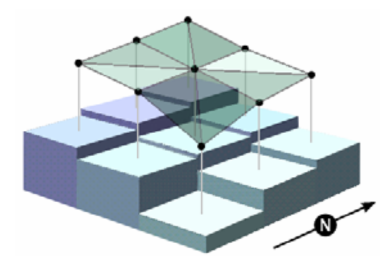
Rugosity is a measure of how rough or bumpy (convoluted or complex) a surface is. This "roughness" may be an effective proxy for species' habitat or biodiversity. One approach to calculating rugosity is to take the ratio of surface area to planar area (Jenness, 2003). For each cell in the grid surrounded by eight neighbors, surface areas are based on areas derived from eight adjacent triangles. Each triangle connects the center point of the central cell with the center points of two adjacent cells. These triangles are located in three-dimensional space, so that the area of the triangle represents the true surface area of the space bounded by the three points. The triangle area is adjusted so that it only represents the portion of the triangle that overlays the central cell. The areas of the eight triangles are then summed to produce the total surface area of that cell. The surface ratio of the cell is calculated by dividing the surface area of the cell by the planimetric area of the cell.

210	190	170	155	140	135
204	183	165	145	125	120
200	175	160	122	110	100
208	187	165	150	126	120

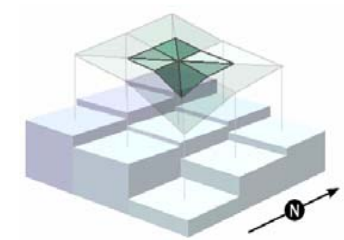
Surface area based on elevations of 8 neighbors



3D view of grid



Center pts of 9 cells connected To make 8 triangles



Portions of 8 triangles overlapping center cell used for surface area

Graphics courtesy of Jeff Jenness, Jenness Enterprises, and Pat Iampietro, California State University, Monterey Bay

Introduction: References

Guisan, A., Weiss, S.B., Weiss, A.D. GLM versus CCA spatial modeling of plant species distribution. *Plant Ecology*, 143: 107-122, 1999.

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Lundblad, E., Wright, D.J., Miller, J., Larkin, E.M., Rinehart, R., Battista, T., Anderson, S.M., Naar, D.F., and Donahue, B.T., A benthic terrain classification scheme for American Samoa, *Marine Geodesy*, 26(2), 89-111, 2006. http://dusk.geo.orst.edu/mgd2006_preprint.pdf

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Modeling Spatial Problems

- Are you asking the right question?
- Do you have the data to answer your question?
- Does the accuracy and resolution of the data meet the demands of your question?
- Do you have a good understanding of the objects in the real world that you are trying to model?

What type of data are available?

- Depth
  - Multibeam
  - X, Y, Z data points
  - Grids
- Side Scan Sonar data (backscatter)
- Observation ROV Video transects

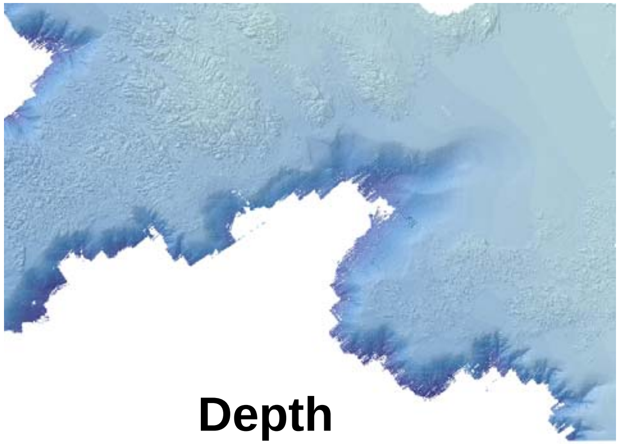
- Multibeam Derived Products
  - Bathymetric Grid (Depth)
  - Slope
  - Aspect
  - Hillshade
  - Rugosity
  - Benthic Position Indices
- Side Scan Sonar data (backscatter)
  - Interpreted images
  - Seafloor Hard/Soft
- ROV Video transects
  - Transects
  - Observations

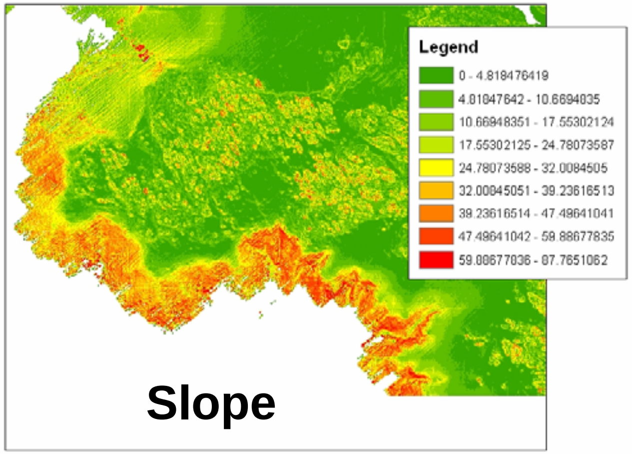
Habitat Parameters Important to Benthic Fish Species

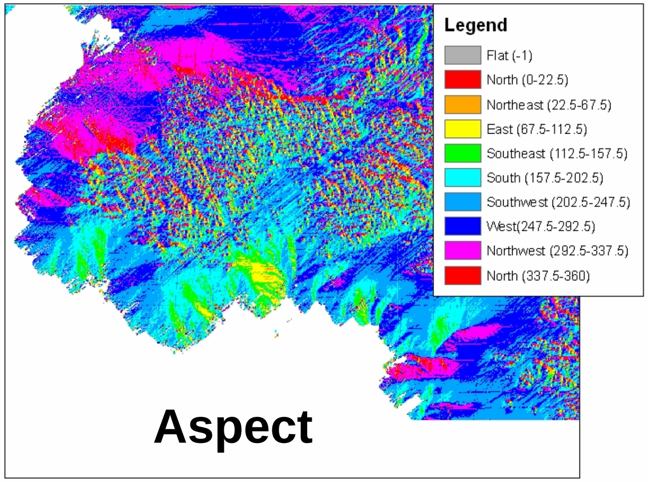
- Water depth
- Sediment depth
- Substrate type
- Sediment type
- Exposure
- Rugosity/BPI
- Slope/Aspect
- Water chemistry
- Water temperature
- Voids/caverns (size & depth)
- Vegetation
- Biotic interactions
- Anthropogenic factors

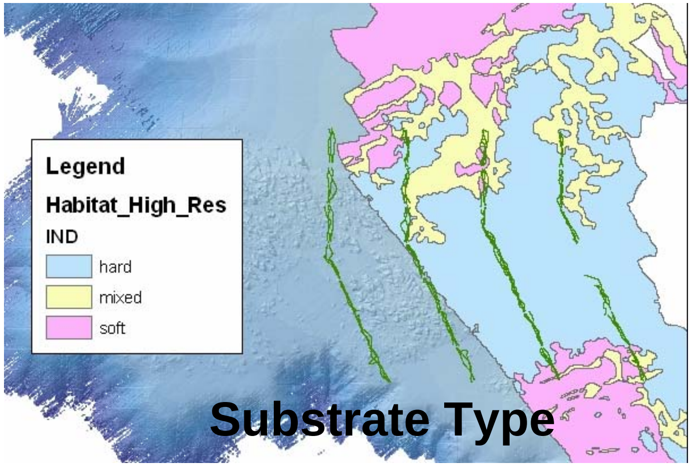
What can we measure directly, interpret, or derive?

Habitat Parameters Important to Benthic Fish Species

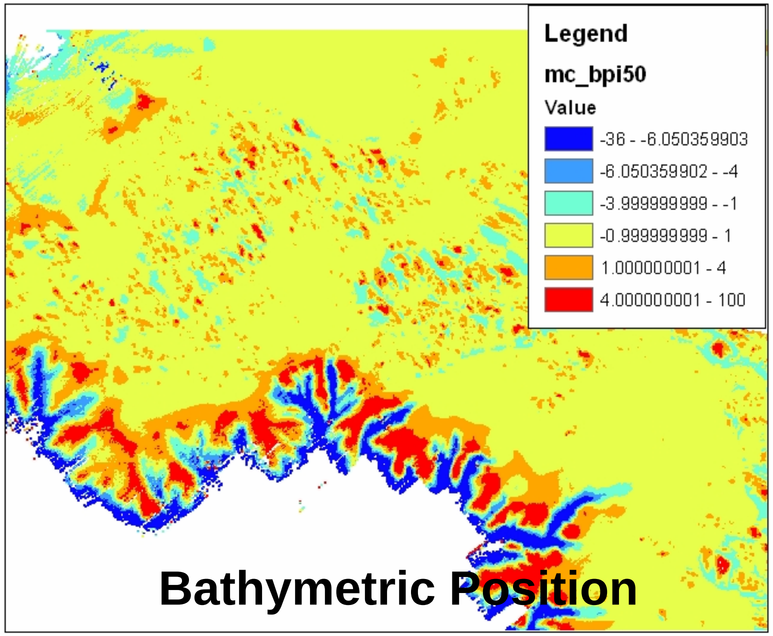


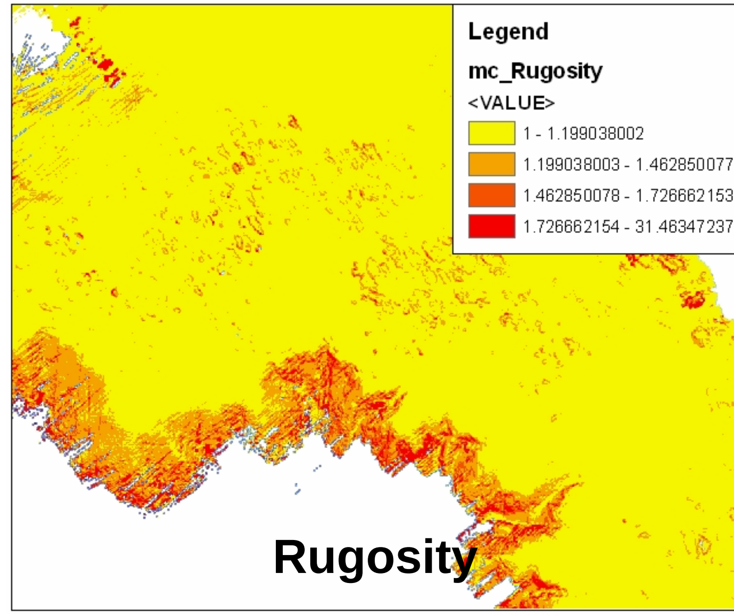






Habitat Parameters Important to Benthic Fish Species





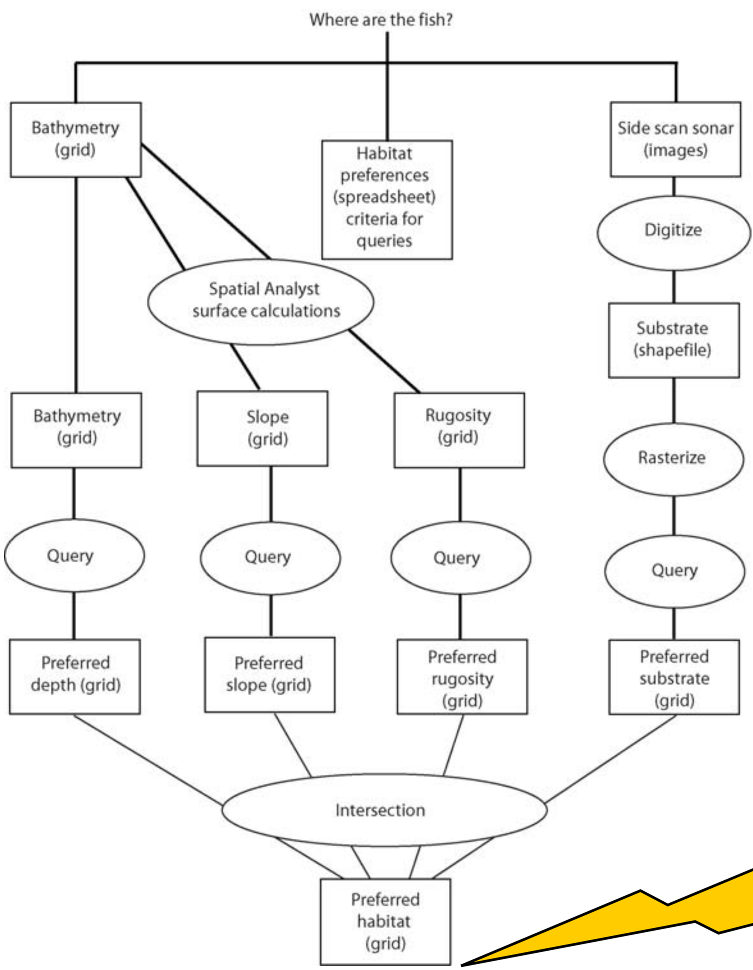
Bathymetric Position Index (BPI)
BPI is a measure of where a referenced location is relative to the locations surrounding it. It is a way of classify landforms such as slope, ridge, valleys, etc.

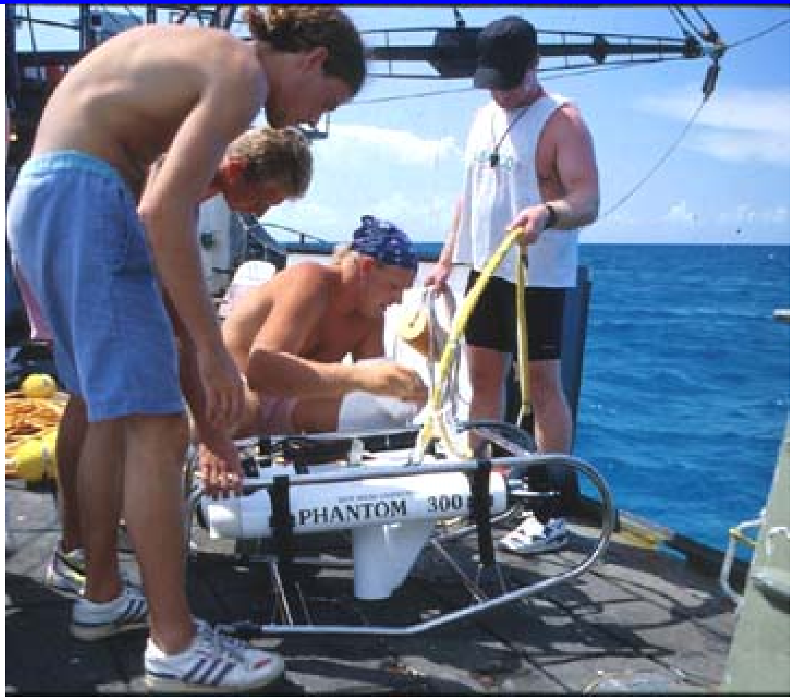
Rugosity is a measure of terrain complexity or the "bumpiness". There are different ways of expressing rugosity. Once method is to use the ratio of three-dimensional surface areas to two-dimensional planar area.

Building a GIS Analysis Model to Help Assess Habitat Suitability

- What do we know about the species' habitat requirements?
- Can we describe these habitat requirements using GIS data?
- Do we have enough information?
- Is it at the right scale?
- Does the model work?

Habitat Parameters Important to Benthic Fish Species





Crew operating a ROV to record biological observations, which could, in fact, validate a GIS analysis model. Photo courtesy of Deidre Sullivan, MATE

Validate the GIS analysis model in the field

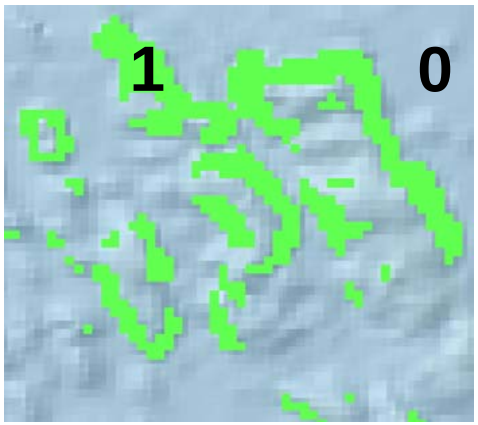
Types of GIS Analysis Models (as discussed in class)

- There are different types of GIS models, including.
  - Binary Model
  - Ranking Model
  - Rating Model
  - Weighted Rating Model

- There are *many* modifications on or additions to the themes above.

Binary Model (Multiplication)

A binary model treats cells as 0s and 1s. Typical a 0 values are areas that do not meet a defined parameter. A value of 1s are areas that do meet a defined parameter.



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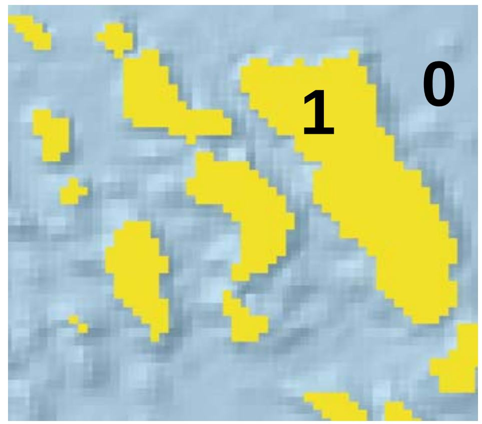

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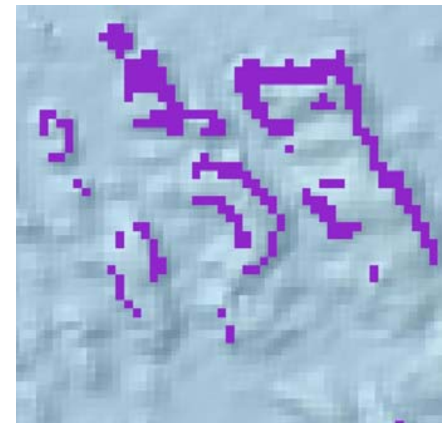
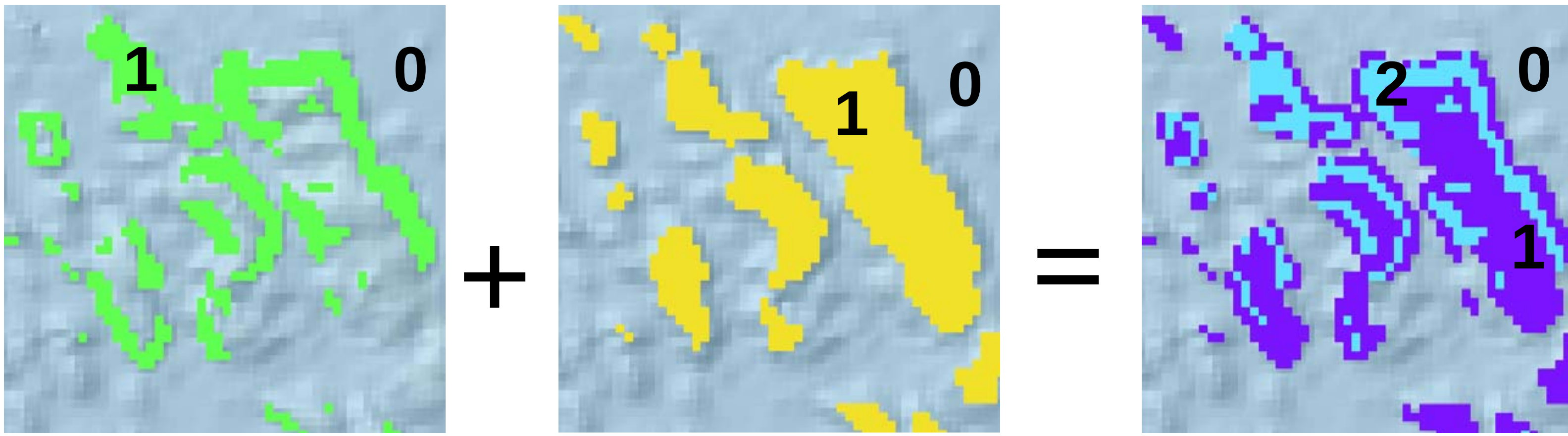


Rugosity greater than 1.2 * BPI greater than 1.5 standard deviation (SD) = Areas that satisfy both criteria

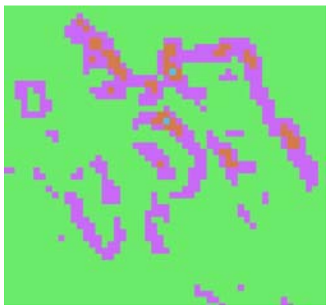
Ranking Model (Addition)



Rugosity is greater than 1.2 SD + BPI greater than 1.5 SD = Ranking based on an ordinal scale of increasing suitability

Rating Model (Addition)

Uses a consistent scale with more than two states to characterize the habitat (simple average).



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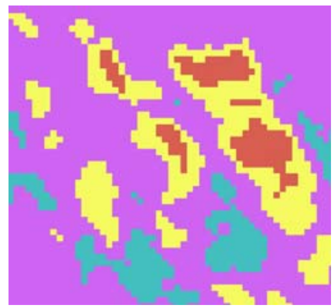

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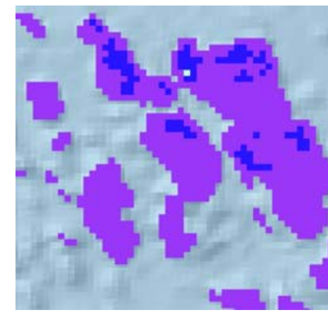


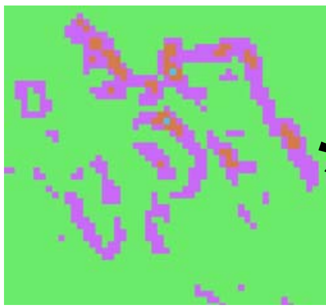
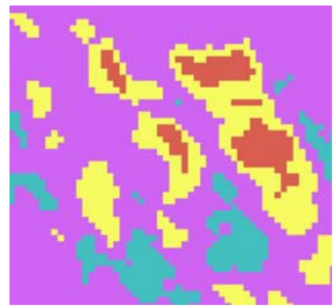
Rugosity is divided into 4 classes by SD then reclassified to have values 1, 2, 3, 4.

BPI is divided into 4 classes by SD then reclassified to have values 1, 2, 3, 4

Relative rating based on the simple average of the factors

Rating Model (Weighted Average)

Uses a consistent scale with more than two states to characterize the habitat. Parameters are weighted based on its amount of influence .

( *5) + 

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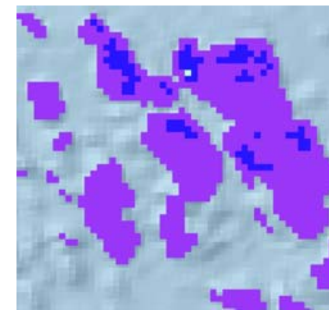
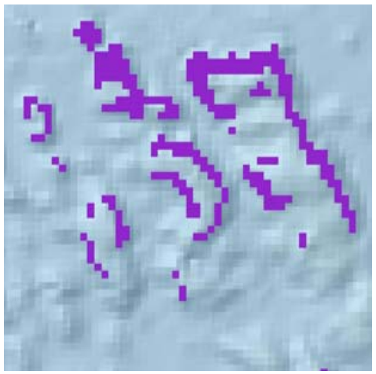
= 

Rugosity is divided into 4 classes by SD then reclassified to have values 1, 2, 3, 4.
It is weighted to be five times more important than BPI

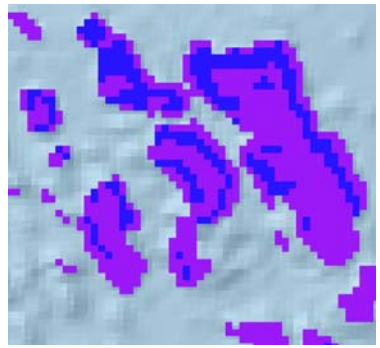
BPI is divided into 4 classes by SD then reclassified to have values 1, 2, 3, 4

Relative rating based on the simple average of the factors

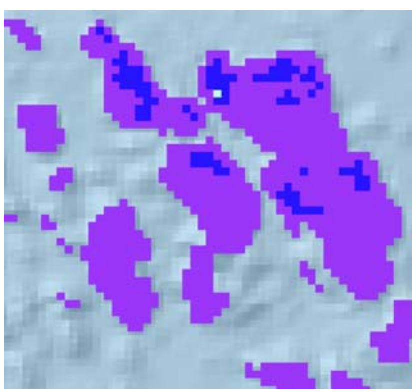
How do they all stack up?



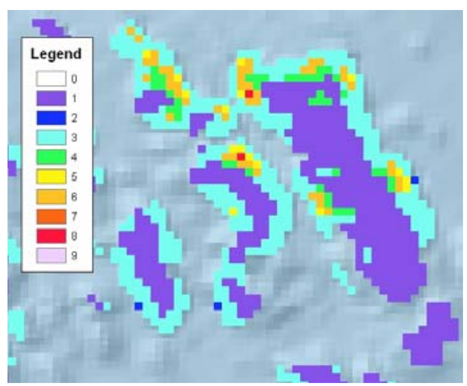
Binary



Ranking



Rating



Weighted Rating

A binary model will depict areas that meet all habitat parameters. There are only two possible states in this model (yes or no).

A ranking model will produce several states that depict potentially good habitat areas that ranked relative to each other.

A simple average rating model uses a consistent scale. Each habitat parameter is given a value based on this scale. The final map depicts habitat suitability based on the average of all habitat parameters.

A weighted rating model expresses relative importance of each parameter to the overall habitat suitability.

GEO 580 Lab 3 - GIS Analysis Models

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Part 1	Creating Marine Habitat Parameter Grids
Part 2	Creating Binary and Ranking Suitability Models
Part 3	Using ArcGIS ModelBuilder

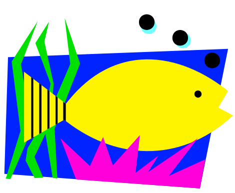
Part 1: Creating Habitat Parameter Grids

In the Introduction, you learned a little about how the Benthic Terrain Modeler creates bathymetric position index (BPI) and rugosity grids. You will now use similar grids in this lab to identify the habitat of *S. nemoi* using a raster based suitability modeling technique.

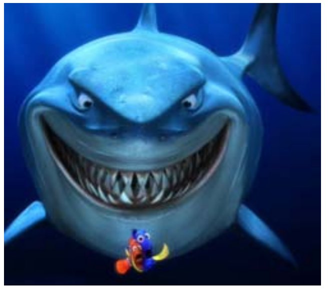
Background

You are a fishery manager for the Department of Fish and Wildlife. Your objective is to designate essential fish habitat for a fictional species of concern, *Sebastes nemoi*. Based on the life history of *S. nemoi,* you need to identify areas with the following habitat parameters.

- Depth between 30 – 50 m
- Pinnacles
- Rocky and complex areas (e.g., nooks and crannies)



Sebastes nemoi



Tools and Data

Spatial Analyst Extension
Raster Calculator
The Raster Calculator uses Map Algebra (the analysis language for Spatial Analysis) to allow you to query raster data and perform mathematical operations. Complex expression similar to SQL can be built and executed in a single command. We will use the Raster Calculator to query cells in a raster grid that meet specific criteria that we define.

Data:
crml_bath – multibeam bathymetric grid from Carmel Bay

crml_hs – Hillshade grid for same area

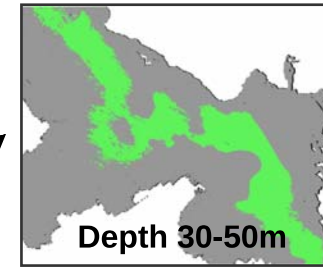
rug – Rugosity grid calculated using the Benthic Terrain Modeler

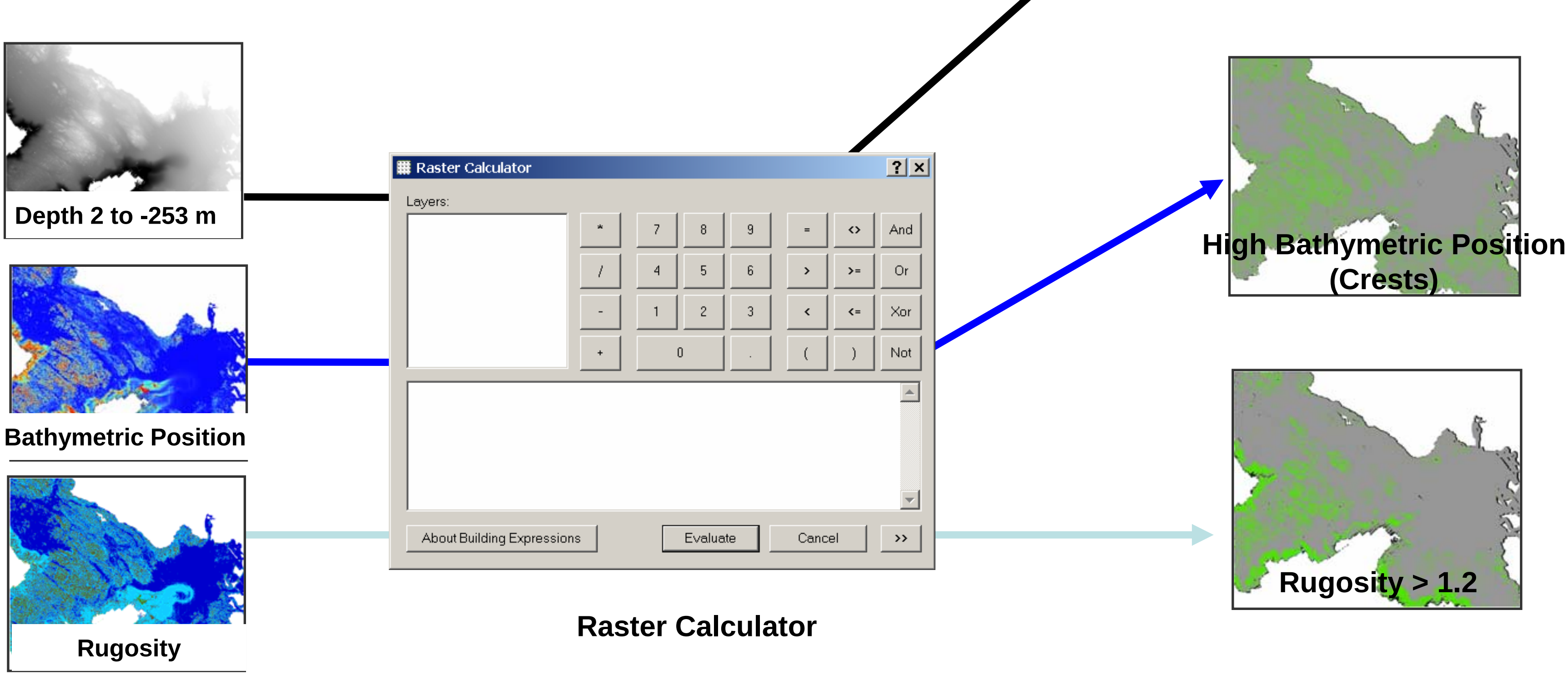
zones - benthic zones calculated using the Benthic Terrain Modeler

Part 1: Creating Habitat Parameter Grids

Summary of Process Steps

1) Create a 30-50 m depth grid using Raster Calculator
2) Create a grid representing high rugosity areas
3) Create a grid representing high bathymetric position areas





Raster Calculator

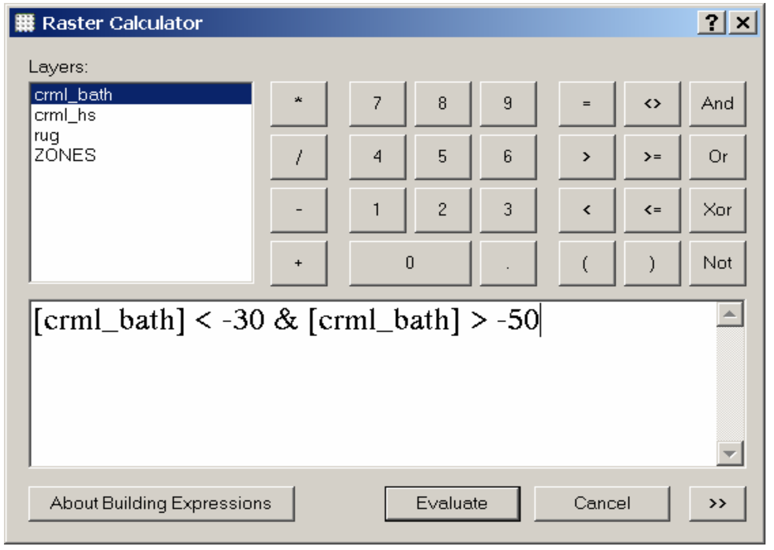
1. Create a 30-50 m depth grid

- ❑ Launch ArcMap and open the **CarmelBay.mxd** map document in the **lab3_data** folder.
- ❑ Click on the **Spatial Analyst** drop down menu and click on the **Raster Calculator…**
- ❑ Double-click on the **crml_bath** layer
- ❑ Click on the **<** button
- ❑ Click the buttons for **-30**
- ❑ Click on the **And** button
- ❑ Click on the **crml_bath** layer
- ❑ Single-click on the **>** button
- ❑ Click buttons for **-50**
- ❑ Click **Evaluate**

Tip

The Raster Calculator allows you to create SQL type “queries” to select cells and create a temporary grid layer. In this step you are querying cells that have a depth value between -30 and -50 meters.

When using the Raster Calculator to build expressions, click on the calculator buttons instead of using the keyboard. This will minimize errors in the expression.

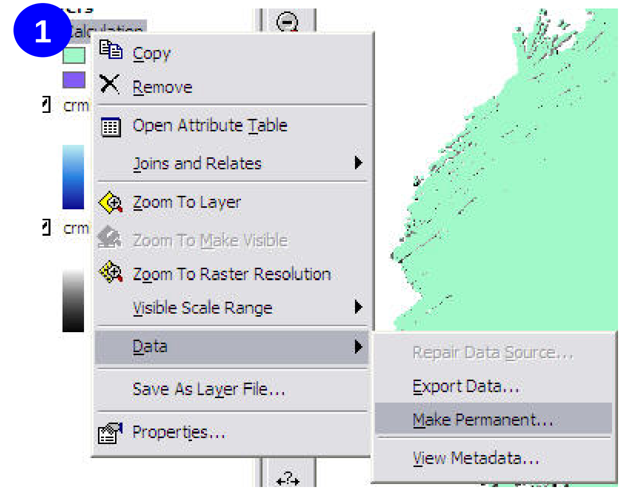


1. Create a 30-50 m depth grid (continue)

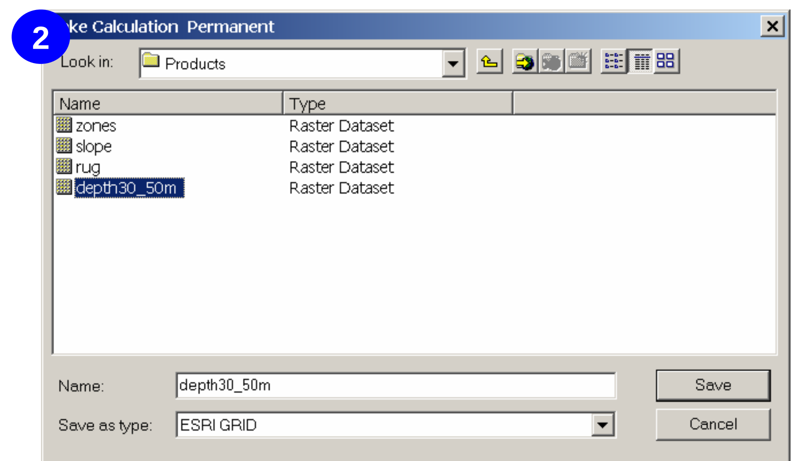
By default, the Raster Calculator will create a temporary grid named Calculation. You can leave it as a temporary layer or commit it to a permanent grid. For this exercise we will make it permanent.

1. Right-click on the Calculation layer, point to **Data**, and click **Make Permanent…**
2. Navigate to the **Products** folder and name the grid **depth30_50m**

- ❑ Remove the Calculation layer and add the depth30-50m grid to your ArcMap project



There are two numeric categories in the depth30_50m layer. Category 1 are cells that are within depths 30-50m. Category 0 are cells that did not meet the depth criteria.



2. Create a grid of high rugosity area

- ❑ Add **rug** to ArcMap
- ❑ Click on the **Spatial Analyst** drop down menu and click on the **Raster Calculator…**
- ❑ Double-click on the **rug** layer
- ❑ Click on the **>** button
- ❑ Click on the buttons for the value 1.2
- ❑ Click **Evaluate**

Make the calculation permanent

- ❑ Right-click on the Calculation layer, point to **Data**, and click **Make Permanent…**
- ❑ Navigate to the **Products** folder and name of the grid **rug_high**
- ❑ Remove the Calculation layer and add the **rug_high** grid to your ArcMap project.

There two numeric categories. Category 1 are cells have meet the 1.2 rugosity values. Category 0 are cells that did not meet the rugosity criteria.

Tip

Rugosity is a measure of bottom complexity. The rugosity grid we created using the Benthic Terrain Modeler calculates rugosity based on planar area to surface area.

3. Create a grid of high topographic relief

- ❑ Add **zones** to ArcMap
- ❑ Click on the **Spatial Analyst** drop down menu and click on the **Raster Calculator…**
- ❑ Double-click on the **zones** layer
- ❑ Click on the **=** button
- ❑ Click on the **1** button
- ❑ Click **Evaluate**

Make the calculation permanent

- ❑ Right-click on the Calculation layer, point to **Data**, and click **Make Permanent…**
- ❑ Navigate to the **Products** folder and name the grid **crests**
- ❑ Remove the Calculation layer and add the **crests** grid to your ArcMap project.
- ❑ There two numeric categories. Category 1 are cells that are categorized as crests. Category 0 are cells that did not meet the BPI criteria.

Tip

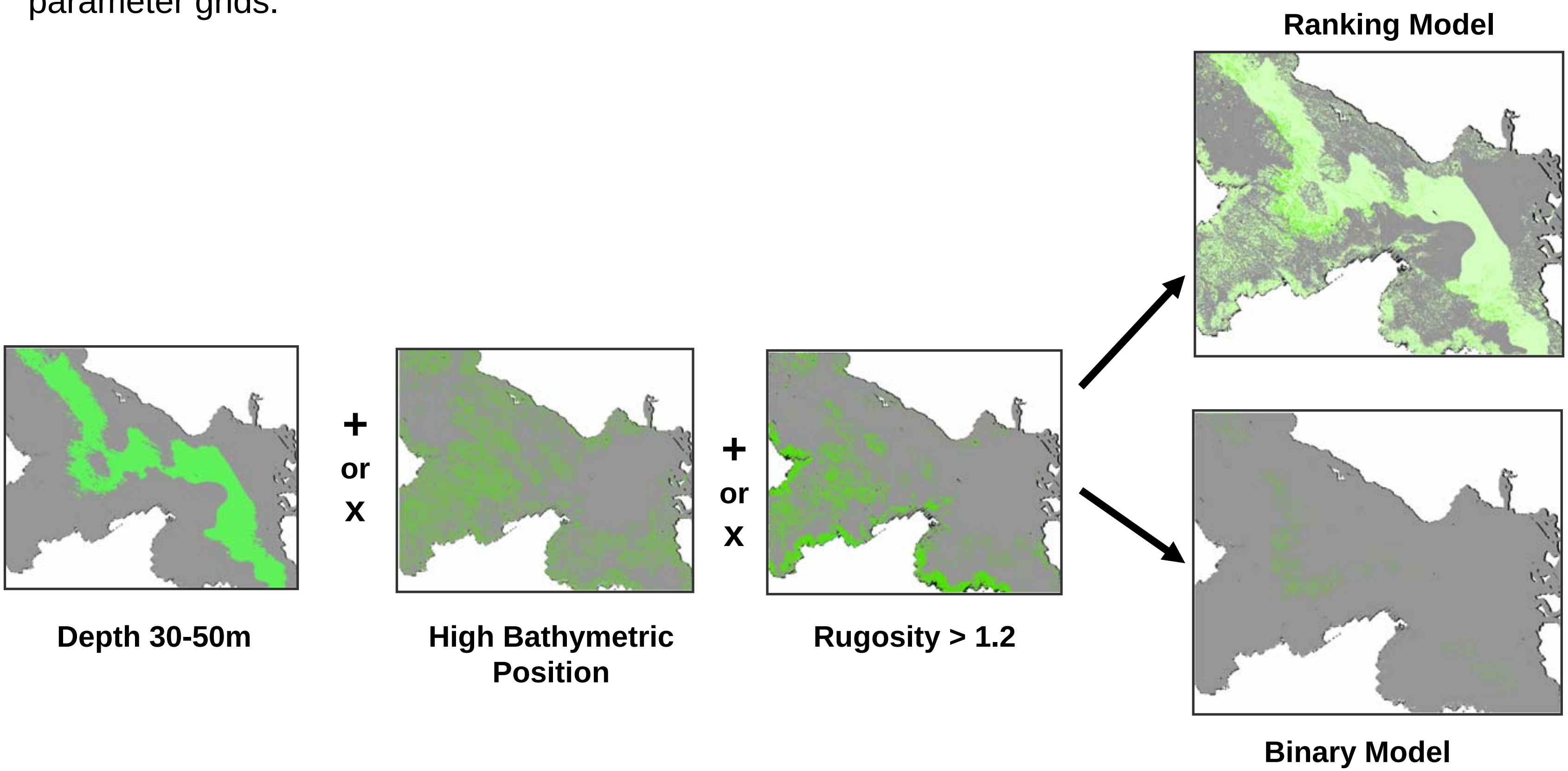
Bathymetric Position Index zones were calculated using the Benthic Terrain Modeler. We will use the Raster Calculator to “query” cells that have been classified as Crests. Remember that the classification zones have a numeric value from 1 – 4 that represent a particular zone. Crests = 1, Depression = 2, Flats = 3, and Slopes = 4.

GEO 580 Lab 3 - GIS Analysis Models

Introduction	Introduction to GIS Analysis Models
Part 1	Creating Marine Habitat Parameter Grids
Part 2	Creating Binary and Ranking Suitability Models
Part 3	Using ArcGIS ModelBuilder

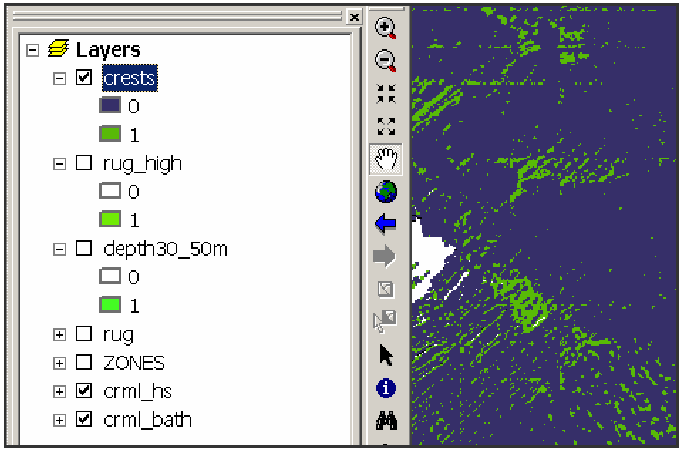
Part 2: Creating a Binary and Ranking Suitability Models

1) Use the Raster Calculator to combine the habitat parameter grids.



Combine the calculated grids to create a binary model.

Before we begin our binary model, let's review and symbolize our calculated grids.

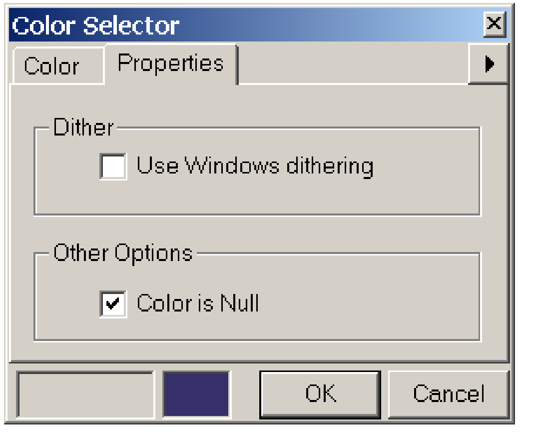


You should have the following grids:

- ❑ **crests** (areas that are relatively high compared to their surroundings)
- ❑ **rug_high** (highly complex or "bumpy" areas)
- ❑ **depth30_50m** (depths between 30 and 50 m)

Make the 0 values transparent so that we can clearly see the terrain features

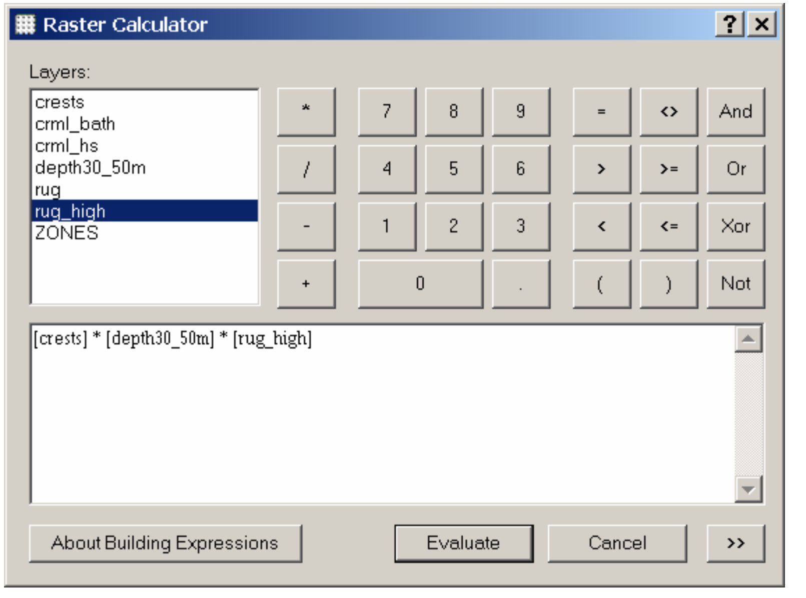
- ❑ In the TOC, click on the color box next to the **0** of the layer to open the Color Selector box
- ❑ Select the Properties Tab and place a check by **Color is Null** and click **OK**
- ❑ Do this for all three calculations



Combine the calculated grids to create a binary model.

Click on the **Spatial Analyst** drop down menu and click on the **Raster Calculator…**

- ❑ Double-click on the **crests** layer
- ❑ Click on the ***** button
- ❑ Double-click on the **depth30_50m** layer
- ❑ Click on the ***** button
- ❑ Double-click on the **rug_high** layer
- ❑ Click on the **Evaluate** button



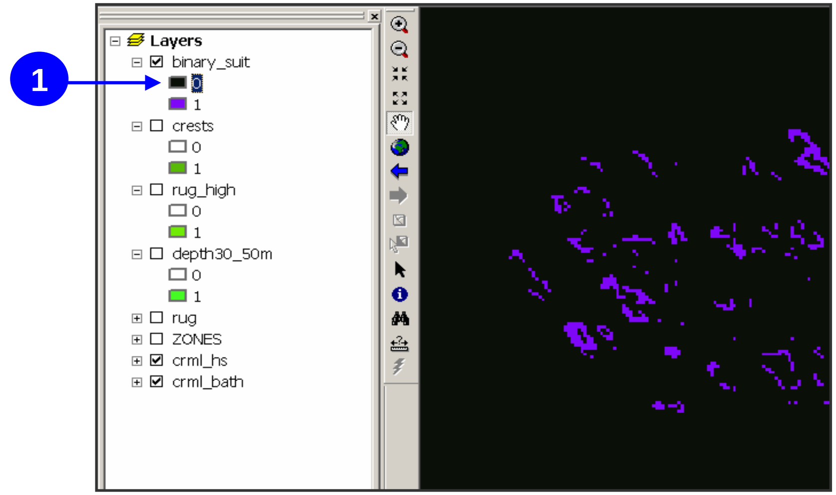
Make the calculation permanent

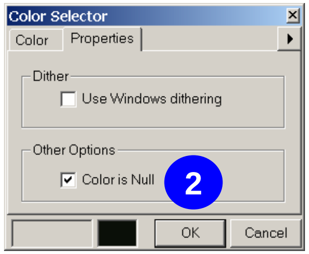
- ❑ Right-click on the Calculation layer, point to **Data**, and click **Make Permanent…**
- ❑ Navigate to the **Products** folder and name of the grid **binary_suit**
- ❑ Remove the Calculation layer and add the **binary_suit** grid to your ArcMap project

Combine the calculated grids to create a binary model (continue)

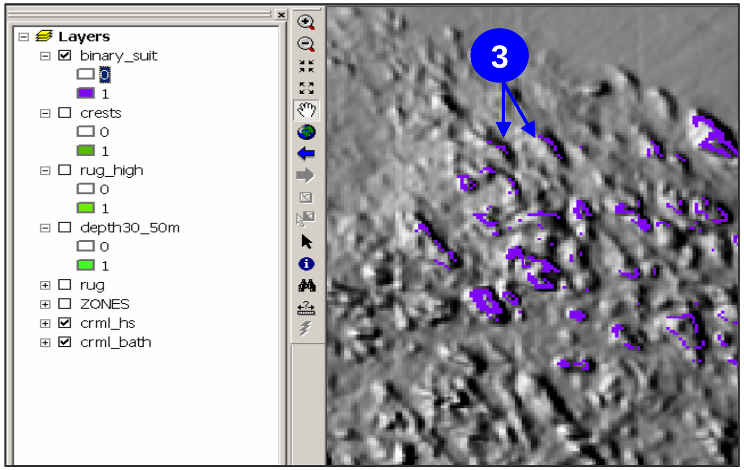
Symbolize the binary_suit grid

1. In the TOC, click on the color box next to the **0** of the layer to open the Color Selector box.
2. Select the Properties Tab and place a check by **Color is Null** and click **OK**





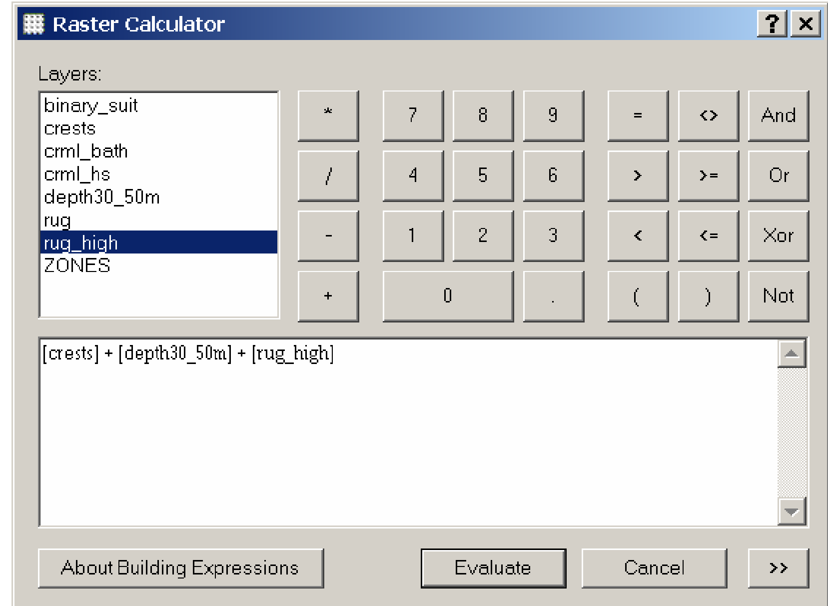
3. The color cells (1) represent areas that met all three habitat parameters, high topographic position, high rugosity and within depths of 30-50 m



Combine the calculated grids to create a ranking model.

Click on the **Spatial Analyst** drop down menu and click on the **Raster Calculator…**

- ❑ Double-click on the **crests** layer
- ❑ Click on the **+** button
- ❑ Double-click on the **depth30_50m** layer
- ❑ Click on the **+** button
- ❑ Double-click on the **rug_high** layer
- ❑ Click on the **Evaluate** button



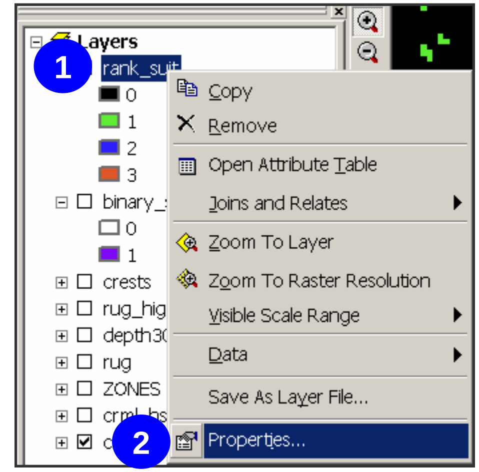
Make the calculation permanent

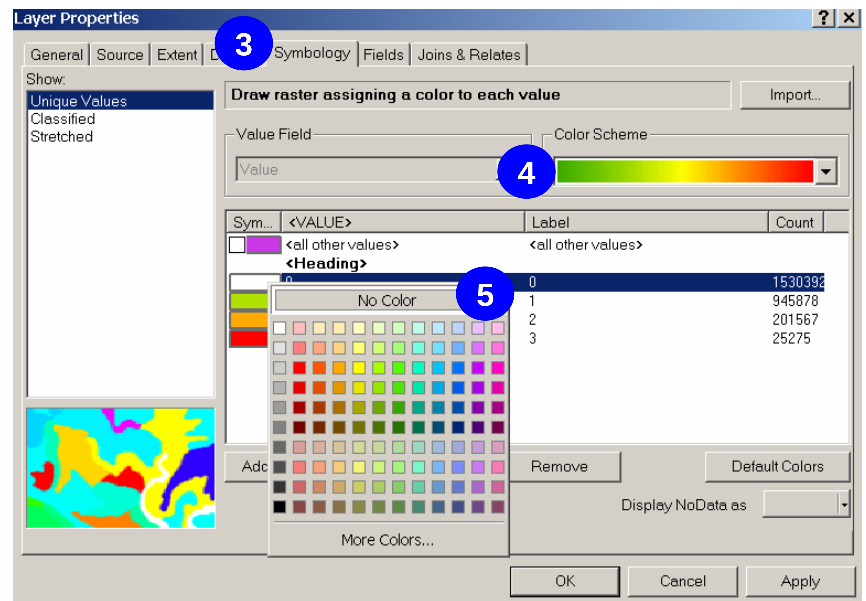
- ❑ Right-click on the Calculation layer, point to **Data**, and click **Make Permanent…**
- ❑ Navigate to the **Products** folder and name of the grid **rank_suit**
- ❑ Remove the Calculation layer and add the **rank_suit** grid to your ArcMap project

Combine the calculated grids to create a ranking model (continue)

Symbolize the rank_suit grid

1. Right-click on the **rank_suit** grid layer in the TOC.
2. Click on **Properties**…
3. Click on the **Symbology** Tab
4. Select the green to red (slope) color ramp
5. Double on the color box next to **0** and select **No Color**



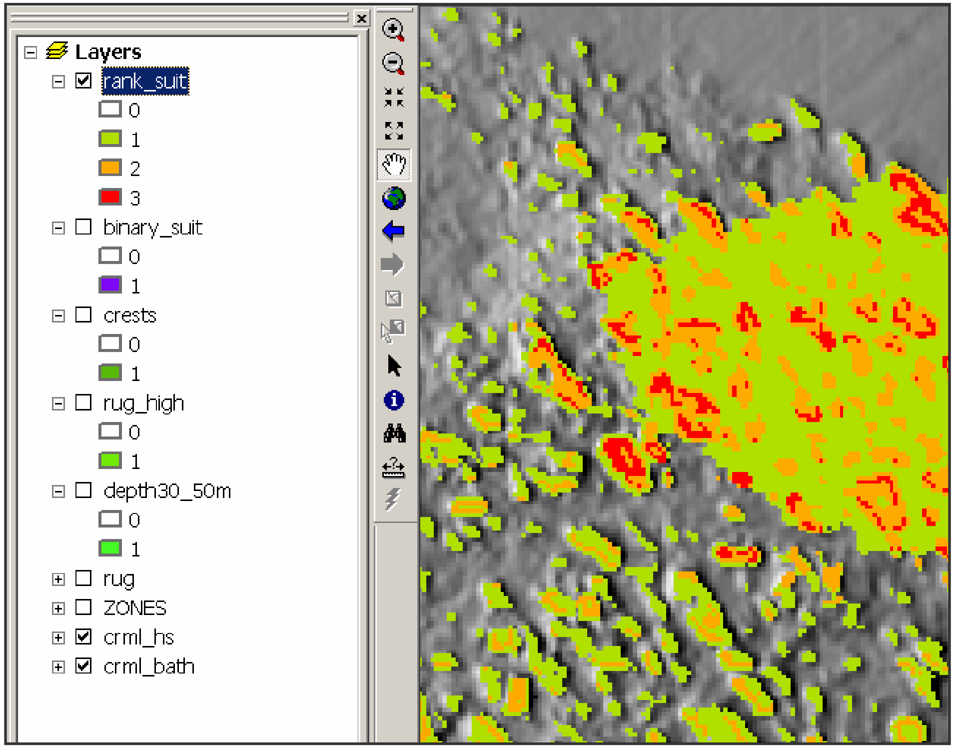


Combine the calculated grids to create a ranking model (continue)

There are 4 classes in rank_suit

- 0 – areas that do not meet any habitat parameter
- 1 – areas that have at least one of the three habitat parameters.
- 2 – areas that meet at least two of parameters
- 3 – areas that meet all three parameters

Examine the rank_suit grid



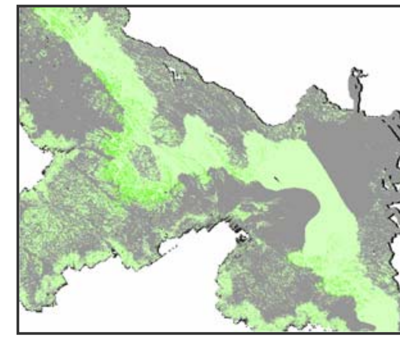
Part 2: Questions

1. **(15 pts.) Compare the *Binary* and *Ranking* layers. How are they similar? How do they differ?**

2. **(15 pts.) Recall that "Nemo's" preferred habitat is:**
   Depths 30 – 50 m
   Pinnacles
   Rocky bottoms
   Nooks and crannies
   Which model does a better of job of showing these areas and why?

3. **(15 pts.) How do you think you would validate (i.e. make sure that the analysis was done correctly) your model? (Hint: Take a look at what layers are in the Table of Contents.)**

Ranking Model



Binary Model

Please type your answers to these questions and turn them in as part of a **Lab 3 writeup**, along with **screen snapshots** (10 pts. each) showing what your final **binary_suit** and **rank_suit** grids look like.

GEO 580 Lab 3 - GIS Analysis Models

Introduction	Introduction to GIS Analysis Models
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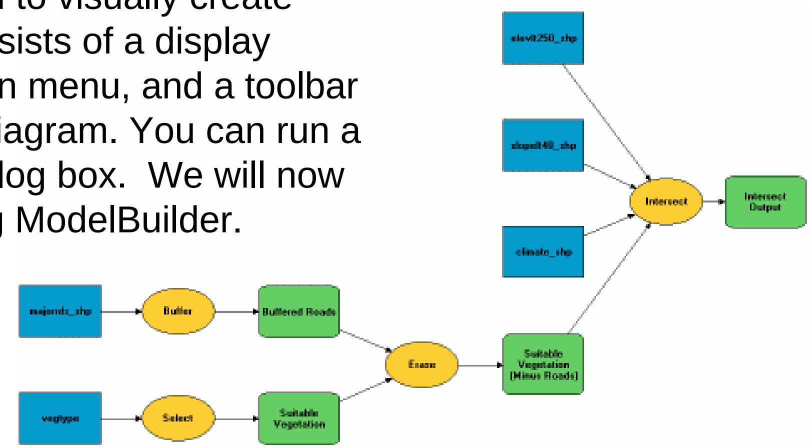
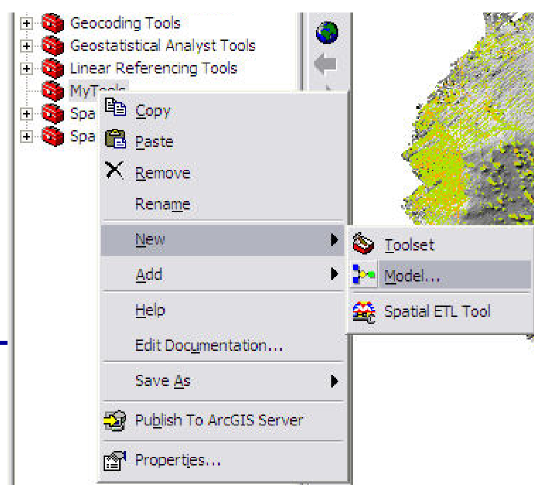
Part 3: Using ArcGIS 9 ModelBuilder

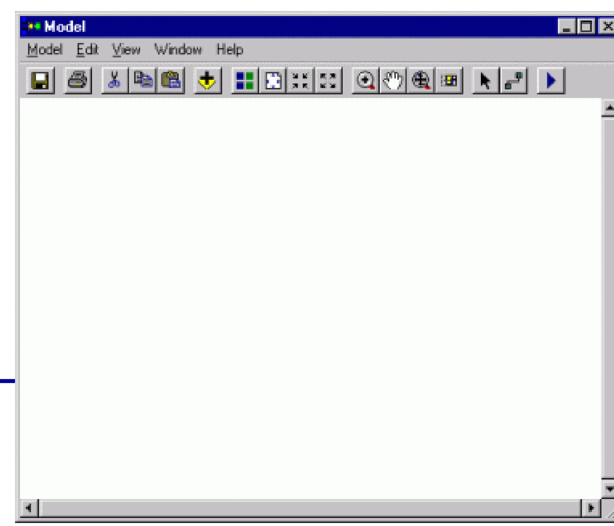
ArcGIS ModelBuilder provides an interface that allows you to visually create analysis models in ArcGIS. The ModelBuilder window consists of a display window in which you build a diagram of your model, a main menu, and a toolbar that you can use to interact with elements in your model diagram. You can run a model from within the ModelBuilder window or from its dialog box. We will now repeat the creation of the binary and ranking models using ModelBuilder.



Images courtesy of ESRI. Used by permission.

(a) To begin, we need to create an empty model. Make sure the ArcToolbox is visible in the center of the display, right-click on the word “ArcToolbox” at the top, and select “New Toolbox”. Name your toolbox “MyTools”. Now right-click on this new toolbox, point to new, and select “Model”. A new model is created in the toolbox, and a default window is opened so you can build your model.





Part 3: Using ArcGIS 9 ModelBuilder

(b) Next, let's add the data we want to use in our model. Click on the add data icon, and add the three layers for the analysis: **depth_30_50m, crests**, and **rug_high**. These will appear as blue ovals (Note: They may be added one on top of the other. You can use the select tool (black arrow) to move them around so all three are visible).

(c) To re-create the Binary model (binary_suit), we'll want to multiply these layers, just like we did using the Spatial Analysis Raster Calculator. The multiply tool is called "times" and is located in the Spatial Analyst Toolbox under "Math". Drag and drop "times" into the model dialog box. We now have our layers, and the tool we want to use on them in our model. Next, we'll make the connection between these elements.

(d) The "times" tool can only be used to multiply two layers at once, so let's start with the **rug_high** and **crests** layers. To make the connection between these layers and the "times" tool, click on the connection icon (two little green boxes connected by a line), which will change the mouse arrow to a magic wand. Then click on each layer individually, and draw a line from that layer to the "times" box. When both raster layers link to the tool, the box will turn orange. You now want to multiply the results of this analysis by one more layer, the **depth_30_50m** layer. Add the "times" tool once again, from the tool box. Use the connection tool to multiply the results of the first multiplication, output raster (green oval), by the **depth_30_50m** layer. Re-name the results of this multiplication, Output Raster (2), to "Binary_ Model_MB" by right clicking on the oval and going to "rename".

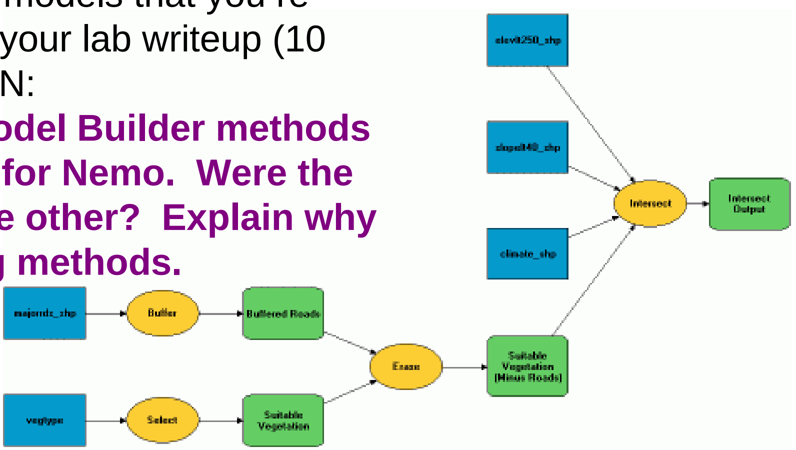
Part 3: Using ArcGIS 9 ModelBuilder

(e) Now run the model, and compare the results to what the raster calculator came up with in Part 2. Click on the “run” icon, the blue arrow on the far right of the dialog box. When the model is finished running, click “Close” on the progress dialog box. To see the results, right-click on the “Binary Model_MB” icon and choose “Add to display”.

Repeat steps (a)-(e), but this time re-create the ranking model using ModelBuilder. The process steps will be the same, but you’ll want to ADD the layers instead of multiplying them. There is a “plus” tool under the Math section of the Spatial AnalystToolbox.

Take a screen-shot of both your Binary and Ranking models that you re-created in ModelBuilder. Include the screen-shots in your lab writeup (10 pts. each) along with the ANSWER to this QUESTION:

4. (15 pts.) Consider the Raster Calculator and Model Builder methods used in this lab to select the best benthic habitat for Nemo. Were the results the same? Was one easier to use than the other? Explain why by comparing and contrasting the model building methods.



Part 3: Using ArcGIS 9 ModelBuilder - Tips for Sharing Models

An additional advantage to using ModelBuilder is that once the steps are visually diagrammed and run, the model as a whole can be saved and shared between multiple users. The completed model can be run again from the ModelBuilder window or exported to a script. Scripts are a good way to share geoprocessing tasks developed in ModelBuilder with other users. However, once exported to a script a model cannot be imported back into the ModelBuilder interface, and any updates to the work flow within the analysis require programming in a scripting language. Therefore, if you think that you'll want to update or change a model, and you don't have a good grasp of scripting languages, it is probably best to keep a copy of your model, even if you export it to a script. For more information on scripting with Python, see **"An overview of writing geoprocessing scripts"** in ArcGIS Desktop help (http://webhelp.esri.com/arcgisdesktop/9.1/index.cfm?id=1925&pid=1924&topicname=An%20overview%20of%20writing%20geoprocessing%20scripts).

You can also store toolboxes along with the data they use in a personal geodatabase. Since models are already stored in toolboxes, they are essentially also stored within the geodatabase. This can be very helpful for sharing data as well as geoprocessing tasks associated related to the data.

If you anticipate not only building models but sharing them, it may be beneficial to build a toolbox(s) within a unique personal geodatabase to store your models. Within your toolbox you can build individual toolsets to group your models. Toolboxes and toolsets can easily be shared between geodatabases and the ArcToolbox window (drag and drop or copy and paste) on individual computers, but not *between* two computers. However, personal geodatabases can be easily shared between multiple computers (just email or copy the mdb file).

Thanks to former OSU Geosciences grad student Chris Zanger for material used in this section, developed while he was on a summer internship at ESRI headquarters.

Part 3: Using ArcGIS 9 ModelBuilder - Tips for Sharing Models

Specific steps:
(i) Build a new geodatabase in ArcCatalog and from within that geodatabase build a new Toolbox (and sublevel toolsets if you want). Right-click in your new toolbox, point to New and click Model. This will open up the ModelBuilder window, when you are done, click save. This will save that model in the toolbox in your new geodatabase. Wherever the geodatabase goes so will the toolbox and models.

(ii) If you already have a model that you didn't build in a geodatabase you can build a new toolbox and drag models into it from your ArcToolbox. YOU CAN ONLY PUT MODELS IN A TOOL BOX!!!

(iii) If you have any further questions about models or geoprocessing click the Contents tab in ArcGIS Desktop Help and navigate to Geoprocessing > Automating your work with models

Lab 3 Summary

In this module you examined the various methods of data collection in the marine environment and examined different types of raster-based GIS analysis models that were used to estimate benthic habitat suitability. We used the Raster Calculator to create habitat parameter grids for depth, topographic position, and rugosity. We then combined these grids to create binary and ranking models. We then re-created the binary and ranking models in ArcGIS 9 ModelBuilder, using it as a tool to visually diagram the geoprocessing steps and data sets involved the analysis. We ended with a discussion and quick primer on how we can share such analysis models with others.

The binary and ranking model approach was actually just a first iteration for estimating habitat suitability. Once a suitability model is created, you can validate your model with existing observations (such as with video footage in the ocean using remotely-operated vehicles), or use the model to predict future observations. You may want to create different habitat parameters for the binary and ranking models.

More References

Related Web Sites

Marine Advanced Technology Education Center (MATE)
http://www.marinetech.org/

Bathymetric Grids were produced by The Seafloor Mapping Lab at California State University, Monterey Bay
http://seafloor.csumb.edu/

Habitat Suitability Modeling for the Biogeographic Assessment of North/Central California, NOAA National Center for Coastal Ocean Science (NCCOS)
http://ccmaserver.nos.noaa.gov/products/biogeography/canms_cd/htm/hsi/hsi.htm

GEO 580, Advanced Applications of GIS in the Geosciences, Oregon State U.
http://dusk.geo.orst.edu/buffgis