# **Calculating Edge to Edge Distances**

These instructions enable you to calculate distances between polygons – from each polygon in one layer to multiple polygons within a specified search radius – using ArcGIS 9.3. An ARCINFO LICENSE IS REQUIRED for the



custom toolbox. For more information refer to: http://webhelp.esri.com/arcgisdesktop/9.3/index.cfm?id=1350&pid=1347&topicname=G enerate\_Near\_Table\_(Analysis)

The analytical scenario for this tool is to calculate the distances between an originating



habitat polygon to available habitat polygons surrounding the origin, but keeping within a certain "buffer." This essentially means that optimal habitat patches within the specified distance are selected first before calculating near parameters to each originating polygon. There are two outputs that may be used for mapping and further analyses between the originating polygon and each available habitat polygon:

- 1. A table that provides the straight-line distances
- 2. A set of lines that provide the shortest/least-cost path distances (this attribute table may be exported)

The tool is meant to be fairly generic for any type of ecological landscape analysis. Please note that the instructions here use a wetland ecology application whereby distances from pond edge are calculated between all optimal habitat patches within 1000 meters.

#### See the APPENDIX for tips/considerations on creating optimal habitat patches and cost/friction layers.

#### ORIGINAL DATA

ponds.shp optimal.shp friction5	originating polygons all available habitat patches (can be created by reclassifying landcover based on your particular criteria and dissolving by the reclass field in to single part polygons) cost raster (or friction surface) grid file where each cell represents the cost of passing through
CREATED DATA	
pond_NEAR.dbf	dBase table resulting from the custom tool calling on the
pond_NEAR_Paths.shp	merged polylines resulting from calculating the shortest paths (least cost paths) between all edge-to-edge combinations for each originating polygons to selected available habitat polygons

#### Set up the ArcMap document with the custom toolbox:

- 1. Start ArcMap with a new empty map document
- Click the SHOW ARCTOOLBOX WINDOW button (if ArcToolbox is currently hidden)



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- 3. Right-click on ArcToolbox and choose ADD TOOLBOX
- 4. Navigate to the directory that contains the **ProximityZones.tbx** file, select it and click OPEN
- 5. Click the "+" beside **ProximityZones** to expand the toolbox and view all the tools it contains



🎠 4 CalcXY

- 6. Click the ADD DATA button and add the following layers:
  - optimal.shp
  - ponds.shp



See APPENDIX for tips on creating optimal.shp.

### *Run the 3 PondHabitatProximityMergeTable tool:*

- 7. In ArcToolbox, double-click on 3\_PondHabitatProximityMergeTable tool to open
- 8. Click SHOW HELP button to view information about the tool
- 9. As you click on each of the parameters, the help sidebar provides information about that parameter

Show Help >>

- 10. Click the TOOL HELP button to open the help file
- 11. Specify the following parameters:
  - Input Ponds: ponds.shp

💰 3\_PondHabitatProximityMergeTable

§ 5\_CostPathByUniqueValuesList

- Unique ID Field: POND ID
- Input Habitat: optimal.shp
- Search Distance: 1000
- Output Workspace: C:\yourworkingdirectory\OUTPUT

Input Ponds	3_PondHabitatProximityMergeTable
C:\WorkSpace\_Research\BrettS\20090625\ponds.shp 🛛 🗃	
Unique ID Field	Generates a table that lists each input feature
POND_ID	(pond) and all of the closest habitat patches
Input Habitat	within a specified distance. The output fields
C:\WorkSpace\_Research\BrettS\20090625\optimal.shp 🛛 🗃	are: IN_FID (habitat patch), NEAR_FID (pond),
Search Distance	degrees) NEAR X and NEAR X RECHIRES
1000	AN ARCINFO LICENSE TO ACCESS THE
Output Workspace	GENERATE NEAR TABLE TOOL!!!
C:\WorkSpace\_Research\BrettS\20090625\OUTPUT	ccn@ualberta.ca
<b>U</b>	
	< III (>)

12. Click OK, wait a short while... then dismiss the status dialog when completed 13. Click ADD DATA and add the **pond NEAR.dbf** table to the map document

- 14. In the SOURCE TAB, right-click on the table name to OPEN TABLE notice the field headings:
  - IN\_FID the optimal habitat patch
  - NEAR\_FID the original pond
  - NEAR\_DIST the distance between features in map units
  - NEAR\_X the X coordinate at habitat edge
  - NEAR\_Y the Y coordinate at habitat edge
  - NEAR\_ANGLE the angle between features (see graphic below)
- 15. CLOSE the attribute table when finished

	Attrik	outes of p	ond_NEAR					
	OID	IN_FID	NEAR_FID	NEAR_DIST	NEAR_X	NEAR_Y	NEAR_ANGLE	^
E		263	0	951.843049	22269.557677	5934260.95073	-87.96036	
	1	264	0	865.682269	22225.021643	5934346.57408	-90.705495	=
	2	265	0	576.712972	22233.347712	5934635.48247	-90.231781	-
	3	270	0	450.999606	21789.66367	5934932.67533	-133.919076	
	4	272	0	9.666687	22234.530085	5935202.58642	-94.763642	
	5	275	0	0	22187.280449	5935383.0884	0	
	6	276	0	586.733727	21531.486484	5935562.37158	162.142591	
	7	277	0	9.070607	22248.162603	5935224.13522	0.535768	
	8	280	0	567.047549	22192.115005	5935951.47149	87.917435	
	9	281	0	397.15767	22636.249715	5935223.52411	-0.075925	
	10	282	0	26.882457	22169.580836	5935411.76473	88.914515	
	11	284	0	882.273098	22682.362589	5936113.74728	55.889512	
	12	286	0	459.905411	22264.812986	5935836.99012	79.881921	
	13	153	1	392.74241	21649.143544	5929114.9711	-93.388986	
	14	160	1	927.155054	22639.187175	5929163.27488	-33.932787	
	15	162	1	388.275244	21463.942534	5929179.42984	-122.4646	<b>~</b>
	Red	cord: 🖬 🖣	1	▶ ▶I Sho	w: All Selecte	ed Records (	0 out of 63 Select	ed) 💌



Note: The table provides only FIDs, which you will want to join back to the original attribute tables later to get at the original information of each polygon.

## Run the 4\_CalcXY tool:

- 16. In ArcToolbox, double-click on 4\_CalcXY tool to open
- 17. Optionally, click the TOOL HELP button to open the help file and learn more about the equations behind the calculations
- 18. Specify the following parameters:
  - Input Table: pond\_NEAR.dbf

Input Table	[a]	Input Table
pona_NEAR		Must be the tabular output from the GENERATE NEAR TABLE tool.
		http://webhelp.esri.com/arcgisdesktop/9.3/index.cfm? id=1350&pid=1347&topicname=Generate_Near_Table (Analysis)

The input MUST be the output from tool #3 or ArcGIS' GENERATE NEAR TABLE. 19. Click OK, wait a short while... then dismiss the status dialog when completed

- 20. In the SOURCE TAB, right-click on the table name to OPEN TABLE notice the two new field headings:
- 21.X the X coordinate at pond edge
- 22. Y the Y coordinate at pond edge

	OID	IN_FID	NEAR_FID	NEAR_DIST	NEAR_X	NEAR_Y	NEAR_ANGLE	х	Y	
F	0	263	To	951.843049	22269.557677	5934260.95073	-87.96036	22235.675086	5935212.19053	
	1	264	0	865.682269	22005 004642	5024246 57498	-90.705495	22235.675433	5935212.19079	
	2/	265	C	576.712972	<sup>21</sup> optima	al habitat 🛛 🛛	-90.231781	22235 677044	5025212 40073	
	Þ	270	0	450.999606	- ' n	atch <sup>3</sup>	-133.919076	2210 D	ond 🕫	
	4	272	0	9.666687	2: P	2	-94.763642	2223	dinates <sup>12</sup>	
	/ 5	275	C	0	2 COOr	dinates 4	0	2218	unates 34	
	6	276	ſ	586 733727	21		162 142591	2208	hg	
tir	nal	rd: 🚺 🖣	1	▶ ▶ She	w: All Selecte	ed Records (	0 out of 63 Select	ed)	Options 🔻	
D	itat		nor	h						
at	ch									
-11	D			י∣ Opt	ionally, ti	he NEAR	X. NEAF	r Y (habi	itat edge	

coordinate pair) and X, Y (pond edge coordinate pair) can be added as an XY event layer, if you wish to visualize these locations prior to the next step. Both these coordinate pairs are necessary for the next step (tool #5).

23. CLOSE the attribute table when finished

#### Run the 5\_CostPathByUniqueValuesList tool:

- 24. In ArcToolbox, double-click on 4\_CalcXY tool to open
- 25. Optionally, click the TOOL HELP button to open the help file and learn more about the equations behind the calculations
- 26. Specify the following parameters:
- 27. Input Table: pond\_NEAR.dbf after running the 4\_CalcXY tool on the table!
- 28. Cost Raster: friction5 see APPENDIX for tips on creating this layer
- 29. Output Workspace: C:\yourworkingdirectory\OUTPUT

nput Table	5_CostPathByUniqueValuesList
orkSpace\_Research\BrettS\20090625\OUTPUT\pond_NEAR.dbf	<ul> <li>Strugger Charles and the second states and states and second states and</li></ul>
lost Raster	Calculates cost paths from an input coster
C:\WorkSpace\_Research\BrettS\20090625\friction5	raster (aka triction surface) and automatically
Output Workspace	sets of X and Y fields: X Y to NEAR X
C:\WorkSpace\_Research\BrettS\20090625\OUTPUT	NEAR_Y. The output is a folder of individual path features that have been generalized. REQUIRES INPUT FROM THE GENERATE NEAR TABLE TOOL. ccn@ualberta.ca

- 30. Click OK, wait a very long while...perhaps set it up to run overnight...
- 31. Click ADD DATA and add the pond\_NEAR\_Paths.shp file to the map document
- 32. In the SOURCE TAB, right-click on the layer name to OPEN ATTRIBUTE TABLE to view the fields – remember the previous note indicating that you can join the NEAR\_FID and IN\_FID back to the ponds.shp and optimal.shp attribute tables FID fields respectively, to get the original polygon information

33. In the table of contents, double-click on the \_Paths.shp file name to access its layer properties



- 34. In the JOINS AND RELATES tab, click the JOIN button and specify the following two joins:
  - Join 1: NEAR\_FID to ponds.shp FID
  - Join 2: IN\_FID to optimal.shp FID

Join Data	? 🗙	Join Data 🤶 🎽
Join lets you append additional data to this layer's attribute table so you for example, symbolize the layer's features using this data.	can,	Join lets you append additional data to this layer's attribute table so you can, for example, symbolize the layer's features using this data.
What do you want to join to this layer?		What do you want to join to this layer?
Join attributes from a table	•	Join attributes from a table
1. Choose the field in this layer that the join will be based on:	•	1. ⊆hoose the field in this layer that the join will be based on:
2. Choose the table to join to this layer, or load the table from disk:		2. Choose the table to join to this layer, or load the table from disk:
♦ ponds	<b>2</b>	🛇 optimal 💌 🖻
Show the attribute tables of layers in this list		Show the attribute tables of layers in this list
3. Choose the field in the table to base the join on:		3. Choose the field in the table to base the join on:
FID	•	FID
- Join Options	_	_ Join Options
Keep all records		
All records in the target table are shown in the resulting table. Unmatched records will contain null values for all fields being appended into the target table from the join table.		All records in the target table are shown in the resulting table. Unmatched records will contain null values for all fields being appended into the target table from the join table.
C Keep only <u>m</u> atching records		C Keep only <u>m</u> atching records
If a record in the target table doesn't have a match in the join table, that record is removed from the resulting target table.		If a record in the target table doesn't have a match in the join table, that record is removed from the resulting target table.
About Joining Data OK Car	ncel	About Joining Data OK Cancel

- 35. Click OK
- 36. If table appears blank, click OPTIONS >>> RELOAD CACHE
- 37. Click OPTIONS >>> EXPORT to a dbf or txt file for external use
  - 38. CLOSE the attribute table when finished

**IMPORTANT NOTE:** The pond\_NEAR.dbf table may have more records in it than the pond\_NEAR\_Paths.shp attribute table. This is because the cost path calculation does not include 0 distance values that the pond\_NEAR.dbf NEAR\_DIST field may contain – you can assume 0 distance values where no polyline paths were created!

### APPENDIX

- A) Suggestions for creating the optimal habitat patches layer
  - a. You must first define what optimal habitat means for your research: Is it for breeding, dispersal, hibernation, predator avoidance, etc.? What landcover classes constitute this? This example defines optimal terrestrial amphibian habitat as forest and/or native grass.
  - b. Next, create a data selection using SELECT BY ATTRIBUTES and the appropriate SQL; e.g. "Class" IN ('Forest', 'Nonforest Native')
  - c. Use the DISSOLVE tool to create a new polygon patch layer named **optimal.shp** (or whatever you wish), do <u>NOT</u> check any Dissolve Fields (this means the shape field is used), and make sure to <u>UNcheck</u> the multipart option!

Create multipart features (optional)

- d. Optionally, add an AREA (double) field and right-click the attribute table heading to CALCULATE GEOMETRY
- B) Suggestions for creating the cost raster/friction surface layer This instruction set does NOT provide details on cost distance analyses. For the full explanations, please see: <u>http://webhelp.esri.com/arcgisdesktop/9.3/index.cfm?TopicName=Understanding</u> <u>cost\_distance\_analysis</u>. However, here are some general instructions on how to create your cost raster (i.e. the friction surface that identifies the cost of traveling through each cell) by assigning cost values to each landcover class:

Select By A	ttributes			? 🗙
<u>L</u> ayer:	landcover	selectable lauer	e in this list	•
<u>M</u> ethod:	Create a new	selection	5 IT (115 list	•
"AREA" "OID_" "Number_1" "Cnt_Number_1" "Name" "Reclass"	- er''			
= <>>>>> < << < _ % () Is SELECT * FFF	Like 1 And 1 Of 1 Not 3 Treed', 'natural	natural grass' oond' esidential' iver' ood' oock' sand' Get Unique ⊻al <u>w</u> HERE: grass')	ues <u>G</u> o To: )	
Clear	Verify	<u>H</u> elp	Loa <u>d</u>	Sa <u>v</u> e
		OK	Apply	<u>C</u> lose

- a. Examine the scientific literature for guidance and use your knowledge of the species to rank your landcover classification according to your purpose. Decide on a scale: this example uses 1 to 100.
- b. Higher cost classes should be given higher values.
- c. Good habitat classes should be assigned no less than a 1 (you may get weird results from cost surfaces that have 0 values).
- d. It is helpful to create a table of unique landcover Class values in one column, and Friction integer values in a second column.
  Complete the table with the friction values based on your scale.
- e. Join to the landcover.shp file using the corresponding Class fields.

Join Data 🔹 🕄 🔀
Join lets you append additional data to this layer's attribute table so you can, for example, symbolize the layer's features using this data.
What do you want to join to this layer?
Join attributes from a table
1. Choose the field in this layer that the join will be based on:
Class
2. Choose the table to join to this layer, or load the table from disk:
🖽 FrictionValues 💽 🖆
Show the attribute tables of layers in this list
3. Choose the field in the table to base the join on:
Class
Join Options
Keep all records
All records in the target table are shown in the resulting table. Unmatched records will contain null values for all fields being appended into the target table from the join table.
C Keep only matching records
If a record in the target table doesn't have a match in the join table, that record is removed from the resulting target table.
About Joining Data OK Cancel

	🖩 Attributes of FrictionValues 📃 🗖 🔀					
	OID	Class	Friction			
E	0	Agricultural	30			
	1	Barren Land	80			
	2	Forest	1			
	3	Impervious	100			
	4	Nonforest Man	60			
	5	Nonforest Native	1			
	6	River	100			
	7	Urban Residential	40			
	8	Wetland	1			
	Record: I I I I I Show: All Selected V					

f. Convert to raster on the joined Friction field using an appropriate CELL SIZE.

Features to Raster	? 🔀
Input features:	landcover_reclass_200906:
Field:	FrictionValues.Friction
Output cell size:	5
Output raster:	ch\BrettS\20090625\friction5
	OK Cancel

g. If a particular landcover class is deemed to be an absolute barrier, then assign those cells with NoData in the input cost raster. Use the RECLASSIFY tool or the CON tool or map algebra function. You may need to flag this class with a value of 999 prior to conversion.