# Calculation of Landscape Development Intensity Index (LDI) Values

1. SCOPE AND APPLICATION

   This procedure details the calculation of the Land Development Intensity (LDI) values using ArcGIS Pro and Microsoft Excel. This SOP assumes a working knowledge of terminology and data manipulation in ArcGIS Pro 2.8 and Microsoft Excel 2016.

2. SUMMARY OF METHOD

   2.1. Biology staff obtains an Excel file with a list of samples with geographic coordinates for which LDI values need to be calculated.

   2.2. ArcGIS Pro is used to correlate a sampling site to the watershed in which it was sampled. The water body (lake, stream, river) associated with a site is selected and a 100-meter buffer is created around it using LDI_Tool_02242016 in ArcGIS Pro.

   2.3. The LDI should only be calculated using the buffer area and should not include the water body itself. The LDI is calculated using ERA_Replacement_Tool in ArcGIS Pro, which uses the most current land use layer. The resulting LDI score is displayed in an Excel file, which is saved to be entered into the Statewide Biological Database (SBIO).

   2.4. If the site was sampled in the past, an older land use layer may be more appropriate, and the LDI should be calculated manually by clipping the buffered area to the appropriate Water Management District (WMD) land use layer. Older land use layers are available X:\GISRAID\GISCloud\LDI_Tool\WMD_LU_by_Year\LDI_Land_Use_by_Year.gdb. The resulting table should be converted to U.S. Acres and exported to Excel. The Excel file is manipulated to calculate the total LDI for the buffered area. The Excel file is saved and the LDI value uploaded into SBIO.

3. SOFTWARE AND FILES

   3.1. ArcGIS Pro (most current version)

   3.2. Excel (most current version)

   3.3. LDI_final.era DEAR\Labs\Lab5\Biology\AppliedBiology\LDI Calculations

   3.4. LDI_lookup.xlsx Calculations\Master LDI_Calc Sheet

   3.5. ArcToolbox LDI Tools X:\GISRAID\GISCloud\LDI_Tool\For_Pro. Open **ArcToolbox** and right click the **ArcToolbox** folder at the top of the window. Select **Add Toolbox** and navigate to the DEAR\GISRAID\GISCloud\LDI_Tool\For_Pro folder. Select the **LDI_Tool_02242016** toolbox (.tbx) to add it to your **ArcToolbox**. Save this toolbox to your **ArcToolbox** by right clicking the **ArcToolbox** folder at the top of the window and selecting **Save Settings** and **To Default**. This adds the LDI_Model_2, LDI_Model_2_No_Area, LDI_Model_No_WB, and the ERA_Replacement_Tool tools to Arc Toolbox.


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## 4. PROCEDURES

4.1. In ArcGIS Pro, in the DEP Custom Tools tab, open the FDEP **Dataminer** 2.0 ( ) tool and locate the layer "Florida NHD" by searching the Water Base Maps and add the layer to the data frame. The **NHD 24** layer will be used in this method. Remove all layers except NHD24K. Within this layer, open the tree (+) and delete all layers except flowline, area, and waterbody.

Also, add the "Current Land Use LDI and LSI" and "Elevation Contours and Depressions" layers.

Note: ArcGIS Pro should be operating as ArcInfo (administrator) to ensure all required all required tools and capabilities are available.

4.1.1. To obtain FDEP Dataminer 2.0 toolbar, select Customize, the Add-in Manager. In the pop-up box, choose Options tab, then select Add Folder. In the "Browse For" Folder window, at the bottom where it says "Folder", manually type in \\floridadep.net\gis\geodata\dep_addins and press "Add folder", then press "Ok". The link should now appear in the Add-in Manager box. To add the toolbar to ArcGIS, in the Add-in Manager pop-up box, click the Customize button and select DEP Toolbar under the Toolbars list. This should now be automatically installed in every ArcGIS map, including new and old projects.

4.2. Each site can be located separately by selecting the **Go to XY** tool and entering the latitude and longitude of the site. Click "mark location" to drop a graphical marker and click "pan to location" to begin working on the LDI for a site.

## 5. EXPORT FEATURES:

5.1. Draw a graphic circle from the sampling point. While the mouse button is depressed and the circle is still being drawn, type "r" before releasing the mouse button to bring up a text field in which to set the radius of the circle. Fill in "10000" to set the radius of the circle to 10,000 m and hit enter. Right-click on the circle and select Properties. Under the Symbol tab, change the Fill Color to "No color". Change the symbol of the flowline to a right arrow. Check against a topography layer to ensure the flowline points in the correct direction.

5.2. Set the zoom level so that all NHDFlowline, NHDArea, and NHDWaterbody features that are **upstream, connected, and within the** graphic circle are in the view extent.

Employ the Select Features by Rectangle ( ) or Select Features by Lasso ( ) tool to select all the upstream features. If the sampling site is located on a single waterbody or area feature, select just that feature. Using the mouse, right-click on the Florida NHD/NHD 24 layer in the Table of Contents (TOC) for each feature type (flowline, waterbody, and area), select Data/Export Data and choose to export "Features". Save to an exports folder to collect exported shapefiles. When multiple feature types are present, they must be exported separately. Save these individual files


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as Station name_flowline, Area, or Waterbody to be able to discern which shapefile goes with what feature. All exported data layers must be saved to the same Exports folder for the ERA_Replacement_Tool to work.

5.3. Change the symbol of the flowline to an arrow to show correct flow direction. Check against a topography layer to ensure the flowline points in the correct direction.

5.3.1. Right click on the newly exported flowline layer and select properties. Select Symbology and navigate to Features -> Single symbol. Under the Symbol option, select the box with the current symbol and scroll down until you find the symbols that are lines with arrows through them.

## 6. EDITING FEATURE LAYERS

6.1. Extraneous waterbodies, areas, and/or flowlines that were selected and exported in 5.3 but are not connected to the system upstream of the sampling point, need to be edited out of each of the layers before a final buffer layer is created. If there are no extraneous features that need to be edited out, proceed to Step 7.

Note: All features that are upstream, connected and within the circle should be included in the final buffered layer. This includes features that are within the circle and flow back outside of the circle, as long as they ultimately return to the inside of the circle.

6.2. Start by selecting the feature (flowline, area, or waterbody) and right-click, then go to "Selection" and select "Make this the only selectable layer". Then select **Editor/Start Editing**. Using the **Edit Tool** arrow, select features that will not be included in the final buffer layer (i.e. not connected and upstream of the sampling point) and press **Delete**. When finished, select **Editor/Stop Editing** and when asked to save edits click **Yes**.

Note: It helps to turn off unnecessary layers to ensure that it is clear what is being selected.

## 7. CREATE THE FINAL BUFFER LAYER

7.1. Use **LDI_Tool_02242016** to create a final buffer layer when a flowline under the sampling point is associated with connected upstream waterbody and/or area features.

7.1.1. Open ArcToolbox (  ), select **LDI_Tool_02242016**.

If there are flowline, waterbody, and area features, select the LDI_Model_2 tool.

If there are flowline and waterbody features, but no area features, select the LDI_Model_2_No_Area tool.

If there are flowline and area features, but no waterbody features, select the LDI_Model_2_No_WB tool.


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7.1.2. Set the **Input Features** as the layers exported in 5.3 and ensure the **Output Feature Class** is set to the designated folder. Click OK to create the final buffer layer.

Note: This model distinguishes between natural waterbodies (erasing them from the final buffer) and reservoirs (leaving them in) in cases where waterbodies are connected upstream.

7.1.3. If there is a segment that extends downstream of the sampling point or beyond the circle's radius and does not flow back in, the buffer needs to be Split to remove those segments. Select **Editor/Start Editing.** In the Editor toolbar, select the Split Polygon Tool (), zoom to the area where the excess buffer is to be Split off, draw a line across the buffer area, perpendicular to the direction of flow. Select the portion to be removed and delete it by pressing the delete or backspace key. When finished, select **Editor/Stop Editing** and when asked to save edits click **Yes**.

Note: Single-click as needed to split the buffer following the contour of the circle. The Splitting line will not stop drawing until you double-click, at which point the Split will be executed.

7.2. If there is a single feature layer:

7.2.1. Create a 100-meter buffer around the layer. Set the **Input Feature** as the exported layer, ensure that the **Output Feature Class** is set to the designated folder; set the **Dissolve Type** to all, and the **Distance** to a **Linear Unit** of 100 meters.

7.2.1.1. For flowlines or non-natural waterbodies, set **Side Type** to Full. For an area or natural waterbody, set the **Side Type** to Outside_Only as natural waterbodies should not be included in LDI values.

Note: Use the Waterbody layer attribute table to determine if a waterbody is natural or not natural (i.e. a reservoir FTYPE 436). Or change the reservoir feature color in the NHD layer to a conspicuous color.

7.3. Click OK to complete buffer. If needed, complete Step 8.1.3 to exclude extraneous information.

8. BUFFER CALCULATION USING ERA_REPLACEMENT_TOOL.

8.1. Run the ERA_Replacement_Tool. Select the final buffer layer for the Feature Input. Select the **Landscape Development Intensity (LDI)** for the LDI Layer. Save the shapefile to the exports file. Output the excel file to a folder for LDI Calculation spreadsheets, named by the Site Nickname and the LDI calculation date. Click OK to Run.

Note: For sampling dates that fall under older land use layers, add these layers through the folder called WMD_LU_by_Year in the folder


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DEAR\GISRAID\GISCLOUD\LDI_TOOL\For_Pro and use the appropriate land use layer for the LDI Layer in the ERA_Replacement_Tool.

8.2. The LDI value will be saved in the excel file. When the ERA_Replacement_Tool is finished, a dialogue box also containing the LDI score will pop-up. Final LDI scores should be rounded to a single decimal place.

8.3. A .jpg copy of the map with the NHD Layer above the final buffer layer, and a callout with the Station Name, Station Nickname, calculation date, and calculator's initials should be exported (File\Export Map) and saved by the Site Nickname and the LDI calculation date in the designated folder for quality control.

9. QUALITY CONTROL AND DOCUMENTATION

9.1. Files are kept for quality control. Required files:

9.1.1. Electronic file with SBIO site info, final LDI, land use layer used, person calculating LDI, date calculated.

9.1.2. Exported .jpg map showing site and buffer used to generate LDI.

9.1.3. The proportional land use calculation file, if used.

9.2. It is recommended that those calculating LDIs participate in an LDI proficiency test. Sites previously calculated by experienced analysts are chosen and re-calculated, using the same station and land use layer as before, and the scores are compared to determine proficiency.

## APPENDIX OF SIGNIFICANT CHANGES

11/23/2010 Document Creation following SOP LB-001.

06/08/2012 Changed ERA tools item to select in 4.6.

06/08/2012 Changed author from Cheryl Swanson to Loretta Wolfe.

05/19/2014 Updated instructions for adding data points from an Excel file.

06/01/2015 Updated to include LDI Stream Buffer Tool method, reservoir inclusion in buffers.

03/01/2016 Updated and appended from old SOP.

07/19/2017 Incorporated a simplified calculation method.

09/26/2018 Changed folder location of old land use years

09/18/2019 Updated ARCMAP version to 10.6. Added folder for old WMD layers in Section 2.4.

08/31/2020 Updated links, added details to 5.2 and 6.2.

01/24/2021 Corrected spellings, edited step procedures and removed step 7.4.


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|---|---|
| 02/16/2022 | Changed the program name and version to ArcGIS Pro 2.8. Corrected version of Dataminer from 5.0 to 2.0. Changed “Cut Polygons “tool name to “Split Polygon”. Changed link for LDI Tools |
| 02/06/2023 | No major changes. |
| 02/07/2024 | Network file paths updated and un-linked (file path, only). |


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