

USER GUIDE

Queensland Environmental Offsets Framework

Landscape Fragmentation and Connectivity (LFC) Tool

Procedural guide gives guidance to assess significant residual impacts for Environmental Offset Regulation 2014 schedule 2 Item 3 Connectivity using the Landscape Fragmentation and Connectivity Tool (LFC)

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Introduction.

1.1 Quick guide to using the LFC tool

The following steps act as a quick guide to running the Landscape Fragmentation and Connectivity (LFC) tool. Section 2 – Using the LFC Tool explains each step in detail.

1. Download the LFC package from the Queensland Spatial Catalogue (QSpatial) ([Queensland Spatial Catalogue : Queensland Government \(information.qld.gov.au\)](https://www.qld.gov.au/information/spatial-catalogue)) and extract its files to a folder of your choosing.
2. Download the most recent 'Vegetation Management Regulated Vegetation Management Map' spatial data from QSpatial. It should be a Queensland wide coverage with a field RVM_CAT.
3. Check the input data, ensuring it is in a single layer polygon, contained in a file type compatible with ArcGIS Pro such as ShapeFile or FileGeodatabase FeatureClass.
4. Open the ArcGIS Pro document LFC_ArcPro_v2_9_5.aprx or ArcPro_v3_1_2.aprx depending on the version you are using
5. Create an output folder named with a meaningful reference (suggest no spaces and starting with a a-z A-Z).
6. Run the LFC tool via the LFC_Toolbox.tbx. The tool will be called <Connectivity Impact Assessment>.
7. Refer to the text file output LOGFILE.txt for information results of the assessment.

Section 3 and 4 explain how to interpret the results derived from the LFC tool.

1.2 Purpose of the tool.

A connectivity area is defined in Schedule 2 (Prescribed environmental matters - matters of state environmental significance) of the Environmental Offsets Regulation 2014, The LFC tool can be used as a guide to determine whether proposed impacts from a prescribed activity on connectivity areas are likely to be significant with respect to the [Queensland Environmental Offset Framework](#).

The tool performs a desktop assessment of proposed impacts on connectivity areas containing remnant vegetation which is classed as Category B on the Vegetation Management Regulated Vegetation Management Map.

Note that assessment officers should consider the context of each individual application and are not limited by the tool when considering the significant residual impact of a development. Furthermore, the guidance does not replace the assessment criteria contained in the assessment legislation. The analysis can also be used more broadly to measure fragmentation and connectivity in the landscape.

1.2.1 Purpose of this document

This document details how to install and run the LFC tool on a computer system running ESRI ArcGIS Pro software (Section 2). It explains the output material and the intended method of interpreting this material with respect to the Queensland Environmental Offset Framework (Section 4). This document also contains a detailed explanation of the background spatial pattern analysis (Sections 5 and 6) and default values of the tool (Section 6).

1.3 System requirements to run the LFC Tool

1.3.1 Software requirements

The LFC tool (Version 2.1) is designed to work with ESRI ArcGIS Pro 2.9.5 and version 3.1.2. It also requires the ESRI Spatial Analyst extension to ArcGIS Pro, as well as Python (version 3.7/3.9) which will come with the ArcGIS Pro installation. The tool may not work correctly if used with software versions other than those described above, however successful testing was also undertaken for ArcGIS Pro version 3.0.3.

1.3.2 Compatibility with various GIS platforms

The LFC tool has been written using version 2.9.5 of ArcGIS Pro to ensure backwards compatibility with later versions of ArcGIS Pro 3.x. The LFC Tool has been tested for ArcGIS Pro 3.0.3 and 3.1.2 and upon trial ran as expected. Note that for version 1.7 of the LFC tool, ArcGIS Desktop (10.x) is no longer supported. This is due to ESRI's decision to transition the software to mature support with no future versions. The legacy version will be retained in the package (unchanged) for users still using ArcGIS Desktop (10.x).

1.3.3 Hardware requirements

The LFC tool is suitable to run on any GIS capable workstation. The running time of the tool can depend on hardware capability. More information on running time is contained in Section 2.5.2.

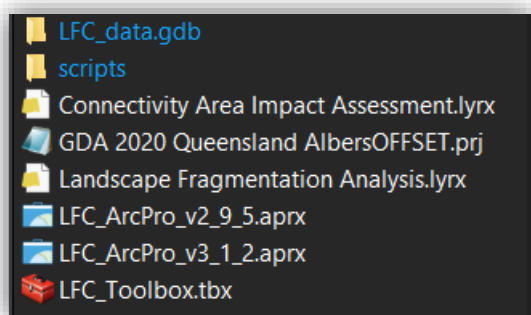
2 Using the LFC Tool

2.1 Step 1: Downloading and extracting the LFC tool

The LFC tool is contained in a zip file package entitled 'Environmental offset landscape connectivity assessment tool', available for download from the [Queensland Government Spatial Catalogue](#) (QSpatial). The LFC tool can be found on this catalogue by searching for a relevant term, for example, "connectivity". Following the download, extract the contents of the package to a folder on either a network drive or your PC. Note the location of this folder for use later in the process.

2.1.1 Contents of the LFC package

The LFC tool package contains the files and folders that make up the tool.



- <LFC_ArcPro_v2_9_5.aprx> An ArcGIS Pro version 2.9.5 file that houses the tools and allows for simplified use of the tools provided. Several Queensland government service layers have also been included to assist interrogation. The file has been set to read only to keep it clean and functioning for the user. Upon closing the user has the option to save the file elsewhere to preserve any modelling runs that have taken place.
- <LFC_ArcPro_v3_1_2.aprx> An ArcGIS Pro version 3.1.2 file that houses the tools and allows for simplified use of the tools provided. Several Queensland government service layers have also been included to assist interrogation. The file has been set to read only to keep it clean and functioning for the user. Upon closing the user has the option to save the file elsewhere to preserve any modelling runs that have taken place.
- <LFC_Toolbox.tbx> A legacy Toolbox that includes two geoprocessing tools:
 - <Connectivity Impact Assessment> is the tool that tests for significance of impact.
 - <Standalone Landscape Fragmentation Analysis> is the tool that applies landscape fragmentation analysis for a feature class that contains vegetation cover information. Note that information for running this tool has not been provided in the overall documentation as it is supplementary to the purpose of the overall LFC Tool.
- LFC_data.gdb is a file geodatabase where working files will be written to, and includes following table:
 - <tbl_Regional_frag_local_threshold> (the local scale threshold table based on the Significant Residual Impact Guideline (as of December 2014)).

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- *<tbl_Regional_frag_local_threshold_test>* a test table for varying the default thresholds. As part of this package threshold values have defaulted to 0.
-
- scripts folder is where the python code is stored that runs the tool it includes:
 - *<LFC_analysis_components.py>* The components of the analysis that are used for the main analysis.
 - *<LFC_run_offset_analysis.py>* The main tool that takes the input parameters and sequences the components.
 - *<LFC_on_FeatureClass.py >* Stand alone script that runs the Landscape Fragmentation Analysis.
 - *<LFC_Tools.py>* A library that includes auxiliary tools such as messaging handling, area calculations.
- *<Connectivity Area Impact Assessment.lyrx>* A layer file (lyrx) that will be copied to a workspace created in the tool and allow for visualisation of impact assessment results.
- *<Landscape Fragmentation Analysis.lyrx>* A layer file (lyrx) that will be copied to a workspace created in the tool and allow for visualisation of landscape fragmentation analysis.
- *<GDA 2020 Queensland AlbersOFFSET.prj>* a default projection file used to ensure the analysis is performed in metres. This is a custom GDA2020 Albers projection designed for Queensland. Using an alternative will require amendments to the underlying code.

2.1.2 Open an ArcGIS Pro project file

Opening the *<LFC_ArcPro_v_2_9_5.aprx>* or *<LFC_ArcPro_v_3_1_2.aprx>* file in the LFC package. This will contain all the required information in relative paths to assist in running the analysis smoothly. This is **highly** recommended to use these files ensure relative path linkages in the overall project rather than importing the tools into a blank ArcGIS Pro document.

2.2 Step 2: Preparing the output folder for your analysis

2.2.1 Overview

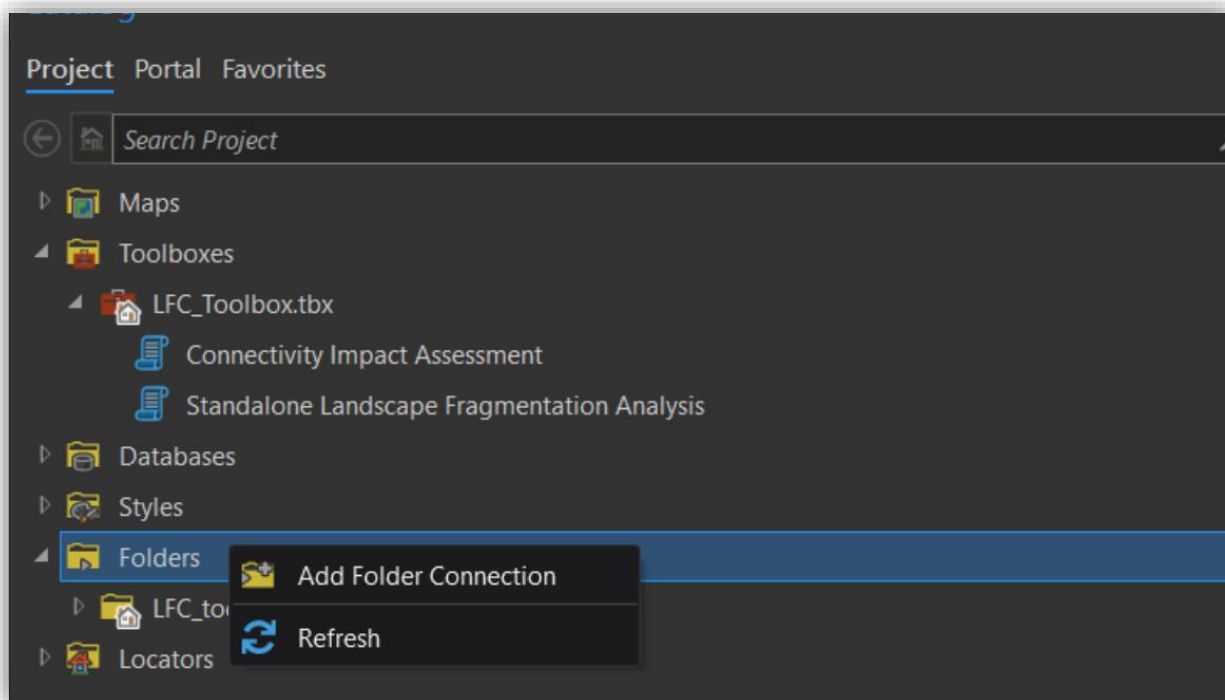
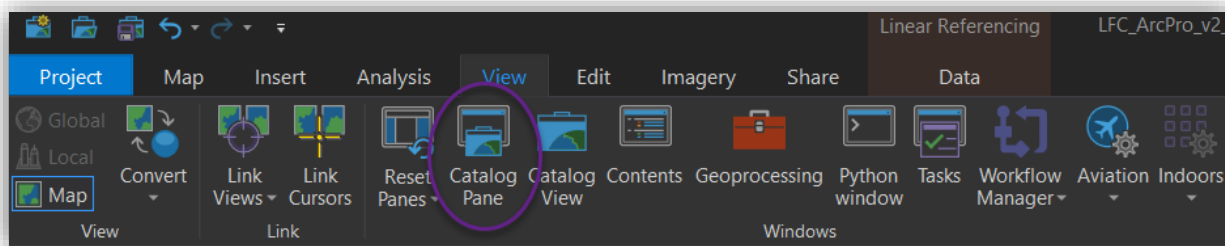
Create three new folder connections:

1. The folder containing the extracted LFC tool files (if opening a blank aprx project rather than the template provided (not recommended);
2. The folder containing the input data; and
3. The root folder where you would like the LFC tool to save each output run.

The folder containing the tool should be set as the Home directory.

2.2.2 How to create folder connections in ArcGIS Pro

Click on “View” in the menu ribbon and click on the Catalog Pane. To connect to a new folder right click on Folders and Add new Folder Connection. Navigate to the folder you wish to connect to and select that folder. Repeat this process for each folder you wish to connect to.



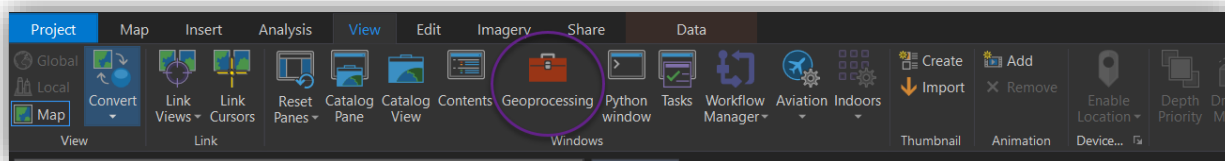
2.3 Step 3: Input data

2.3.1 Impact Site data

The impact site data needs to be contained in a file type compatible with ArcPro GIS. A geodatabase (.gdb) polygon file type (preferred) or shapefile (.shp) is recommended.

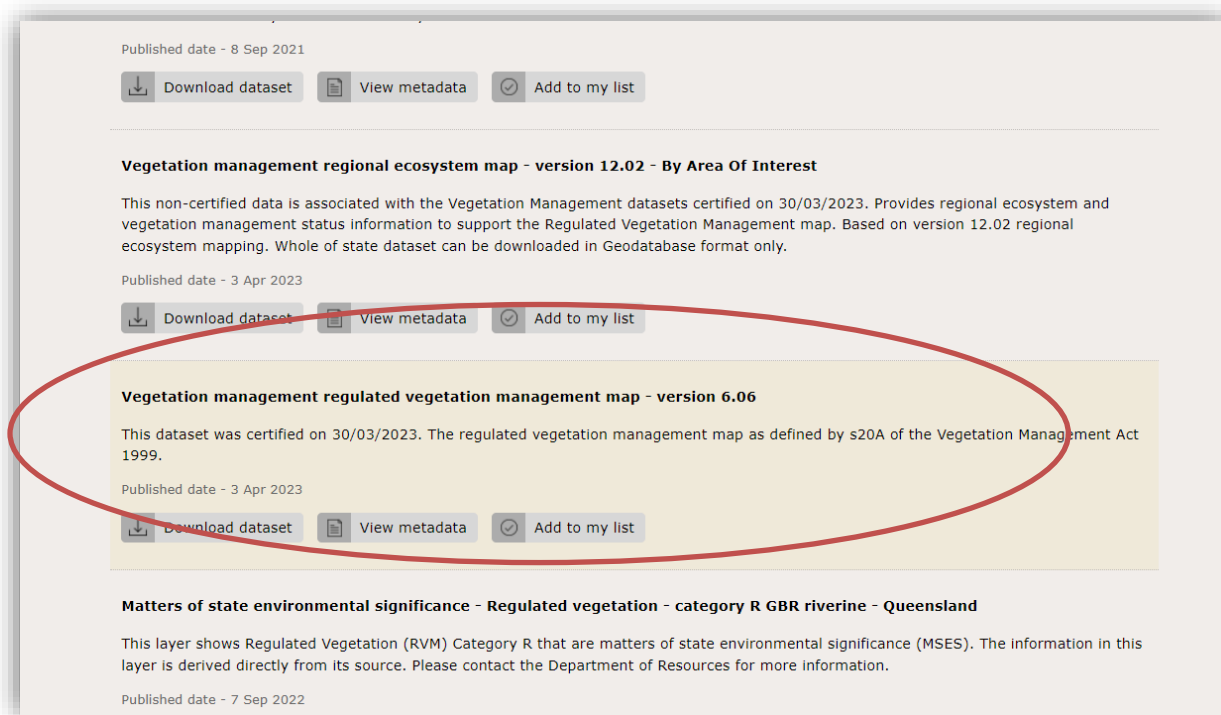
The data should be a single layer with one or more polygon shape(s) representing the impact area. There are several issues that could be present such as multiple separate layers, overlapping data and errors in the makeup of the polygon(s). The “Dissolve/Pairwise Dissolves” geoprocessing tool/s in ArcGIS Pro can be helpful to ensure the data is in a single layer without overlapping polygons. The “Repair Geometry” geoprocessing tool can be used to fix any random errors that could exist in the data. These geoprocessing tools are accessible via the Geoprocessing Pane. Help on using these tools is available in ArcGIS Pro help.

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2.3.2 Regulated vegetation Mapping

As part of the version 1.7 upgrade of the LFC tool, the pre-packaged “Vegetation Management Regulated Vegetation Map” has been discontinued to ensure that users use the latest version. Accordingly, the user will need to download the most recent version of the mapping by following the and unzip the file. Go to [Queensland Government Spatial Catalogue](#) (QSpatial) and search ‘*Vegetation management regulated vegetation map*’. The correct data in the list will go by the same name with a version number associated with it (as per the screen shot below, noting that version number will change from time to time). Follow the appropriate download procedure and unzip the output to the desired location. This will be FileGeodatabase (.gdb) by default.



2.4 Step 4: Loading the Toolbox into ArcPro

To prepare to run the LFC tool, the LFC_Toolbox should be loaded into the ArcGIS Pro project you are working on. If using the ArcGIS Pro template provided in the package this should be loaded by default. A legacy tbx type <LFC_toolbox.tbx> has been provided in the package. Note that attempts to move the toolbox without relative paths of the scripts folder will break the tools connection and require repointing.

Landscape Fragmentation and Connectivity (LFC) Tool

To open the tool:

1. Open the Catalog Pane from the View Ribbon menu
2. Right click on Toolboxes and add LFC_Toolbox.tbx from the LFC tool package.
3. Click the arrow left of the LFC_Toolbox icon to reveal the <Connectivity Impact assessment> tool.
4. Double click Connectivity impact assessment to run the tool. This will start the tool at the “data input form”.

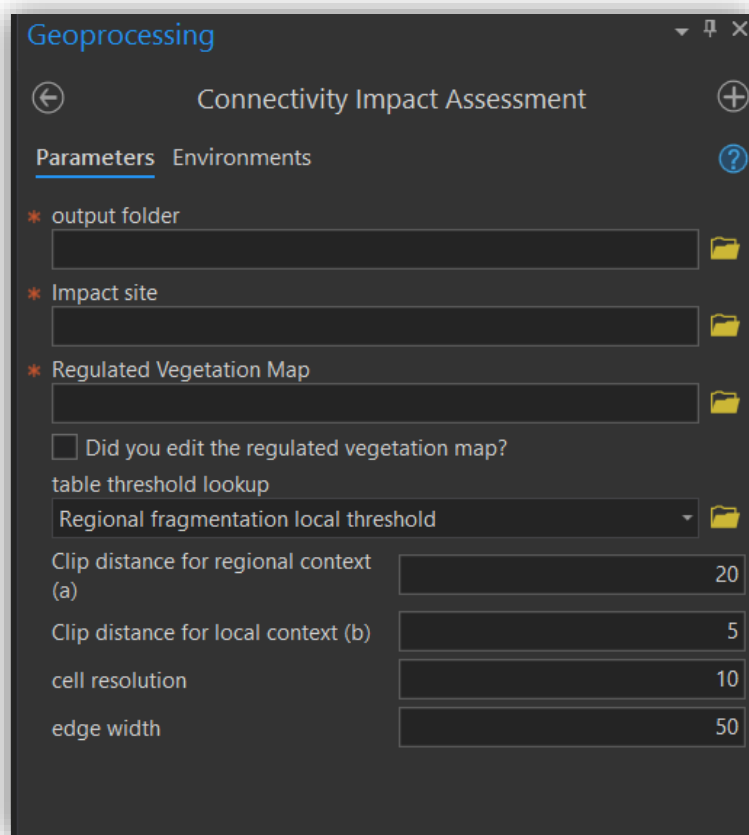
2.5 Step 5: Running the Connectivity Impact Assessment tool

2.5.1 The data input form and required input from the user

For the tool to begin, the user must fill in the three fields marked with a red asterisk (*).

- Output folder: Select the folder you connected in Step 4.2 to store the output files of the tool.
- Regulated Vegetation Map: The regulated vegetation map that will have the field RVM_CAT and contain the following values ['B', 'A', 'C', 'X', 'R', 'Water'].
- Impact site layer: Browse to the folder connection you made in Step 4.2 for the input data and select your input data layer.

All other fields will be pre-filled by default. The purpose of these data fields is explained in Section 6.1.1.



2.5.2 Running time for the tool

The time it will take the tool to complete its analysis depends on the specifications of the computer it is being run on. On most computers it will take around 20 minutes.

If it takes substantially longer to run the tool, or you encounter errors, try increasing the cell resolution. This is one of the pre-filled fields on the data input form. The tool breaks the landscape into cells of a defined size to run its analysis. Increasing the cell size means less processing for the tool, making it less resource-intensive on the system. The trade-off however is that this reduces the detail of the analysis.

2.5.3 Commencing the analysis

Press Run to start the tool. Dialogue for the tool can be viewed at any time by opening the messaging icon. Once the tool has been completed a message should appear in ArcGIS Pro. Warning dialogue will appear if the tool has detected a significant impact on connectivity.

The tool will automatically Add a layer file ‘Connectivity Area Impact Assessment.lyrx’ with the correctly pointed data for the assessment. The output folder name will be added to the layer in the table of content so that the user can differentiate each successive run. The tool will also zoom to the analysis extent. Subsequent runs and a change in folder output will add subsequent layers to the active map.

Landscape Fragmentation and Connectivity (LFC) Tool

Note that the ArcGIS Pro project (aprx) provided is set to read only by default to keep the interface of the tool clean. The user has the option to save the output to an alternative location.

2.5.4 If you encounter problems while running the tool

Most user errors are due to incompatible input data. Refer to Section 2.3 for information on fixing the input data.

For support, email offsets@des.qld.gov.au.

3 Finding out the result

To find out the overall result of the analysis, view LOGFILE.txt which is created by the tool in the output folder you specified earlier. The overall result of the tool will be documented near the end of the log file, as per the red box in the screen shot below. It is recommended that the user studies the detailed results of the analysis in addition to simply viewing the overall result. *Section 4: Interpreting the results* steps the user through this process.

```
RESULT

16:08:29      This analysis has determined a SIGNIFICANT impact on connectivity areas
(A significant reduction in core remnant at the local scale is True OR a change from core to non-core remnant at the site scale is
(Total area of RVM Cat B clearing is 14439.38 hectares)

The significance table has been written to: ..\main_output\lfc_significance_assessment.csv
The local scale summary table has been written to: ..\main_output\lfc_local_scale_summary.csv
The site scale summary table has been written to: ..\main_output\lfc_site_scale_summary.csv
GIS layer files copied into folder \lyr_file within the project folder.
View layers in ArcPro using..D:\LCF_TOOL_update\test_runs\HC_20230605\lyr_file\Connectivity Area Impact Assessment.lyrx

Please scrutinise the output tables and spatial layers to confirm the desktop modelling of connectivity area impact

This analysis used an unedited copy of the Regulated Vegetation layer.

16:08:33      _____COMPLETED LANDSCAPE FRAGMENTATION AND CONNECTIVITY ANALYSIS_____
```

4 Interpreting the results

4.1 Method for assessing the significance of impact

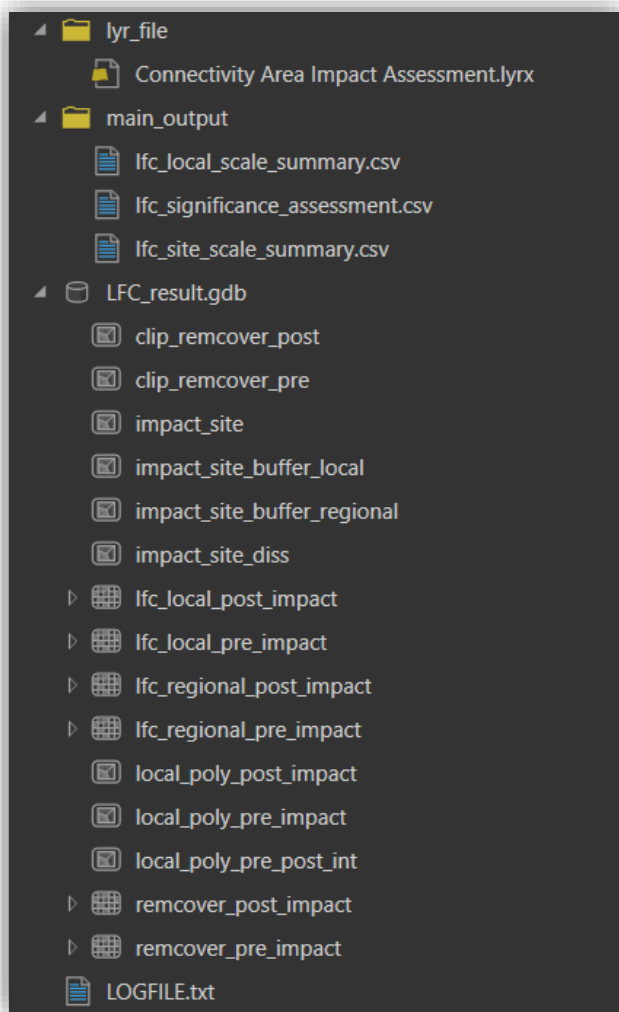
The LFC tool determines the significance of a proposed impact on connectivity areas by assessing:

1. Whether the change in the core **ecosystem** extent at the local scale (post impacts) is greater than a threshold determined by the level of fragmentation at the regional scale; OR
2. If any core area (greater than or equal to one hectare) is lost or reduced to patch fragments (core to non-core).

If the outcome of **either or both** of the tests are true, then the overall impact is significant. Refer to the [Queensland Environmental Offsets Policy](#) and [Significant Impact Guideline](#) for more details.

4.2 Overview of output generated by the tool

Each time the tool is run, a standard set of files and sub-folders and two file geodatabases are created in the **<Output folder>**. **N. B.** Content generated from previous runs in the same folder will be deleted.



4.2.1 File geodatabase with output data from the tool <LFC_result.gdb>.

This will include the main working data that is relevant to the interpretation of the results. Most notably <lfc_regional_post_impact> raster and <lfc_regional_pre_impact> for which the significance is tested.

4.2.2 Folder containing the output layers <lyr_file>

folder holds the group layer files linked to the raster and vector datasets saved in <LFC_result.gdb> ('Connectivity Area Impact Assessment.lyrx'). This should have loaded directly to the active map in your ArcGIS Pro file.

4.2.3 Output connectivity result data <main_output>

The folder containing the three relevant results tables, (lfc_significance_assessment.csv, lfc_local_scale_summary.csv and lfc_site_scale_summary.csv)

4.2.4 Log File <LOGFILE.txt>

Logfile retaining the complete connectivity analysis history (including any script errors)

4.3 Log file

A log file is created each time the LFC analysis tool is run and retains the complete history of all the processing steps and results, including:

- Start date and username;
- Input parameters;
- Metadata title associated with the regulated vegetation management map;
- Folder and file creation;
- Landscape fragmentation analysis steps;
- Regional extent of core remnant;
- Resulting local impact threshold;
- Area of core remnant at the local scale (pre impact);
- Area of core remnant at the local scale (post impact);
- Percent change of core remnant at local scale (post impact);
- Count of core remnant areas (greater or equal to 1 hectare) occurring on the site;
- Count of core remnant areas remaining on the site post impact; and
- Statement describing significance of impact on connectivity areas.

To interpret the log file complete the following steps:

```
Analysing impact on Connectivity Areas
SIGNIFICANCE TEST ONE
The regional total area is 133152.51
The regional extent of core remnant is 43404.93
The regional extent of core remnant is 32.60 percent
This level of regional fragmentation sets a local impact threshold of: 10.0 percent
The table below lists the local impact thresholds for categories of regional core remnant extent:
REGIONAL CORE CATEGORY      LOCAL IMPACT THRESHOLD
< 10                         2.0
10 - 30                      5.0
30 - 50                      10.0
50 - 70                      20.0
70 - 90                      30.0
>90                          50.0
Area of core at the local scale (pre impact): 1172.82
Area of core at the local scale (post impact): 1156.61
Percent change of core at the local scale (post impact): 1.38 percent
SIGNIFICANCE TEST TWO
The number of core remnant areas occurring on the site: 3
The number of core remnant areas remaining on the site post impact: 1
(Only core polygons greater than or equal to 1 hectare are included)
RESULT
16:38:34      This analysis has determined a SIGNIFICANT impact on connectivity areas
(A significant reduction in core remnant at the local scale is False OR a change from core to non-core remnant at
the site scale is True)
(Total area of RVM Cat B clearing is 39.28 hectares)
The significance table has been written to: ..\main_output\lfc_significance_assessment.csv
The local scale summary table has been written to: ..\main_output\lfc_local_scale_summary.csv
The site scale summary table has been written to: ..\main_output\lfc_site_scale_summary.csv
GIS layer files copied into folder \lyr_file within the project folder.
```

4.3.1 Significance test one

To interpret this test, check the “level of regional fragmentation sets a local threshold of” which in our example log file is 10.0%. With this value, check the “regional core category” which is 10-30% to gain the “local impact threshold” which is 5.0%. This means that for this level of fragmentation at the regional level, for a significant impact to occur at the local level it must be more than a change of 5.0%.

Check the “Percentage change of core at the local scale (post impact)” to determine the change. The example log file states that it will change the fragmentation by 1.38%. This is less than the 5.0% local impact threshold. This means that test one is *not significant* for connectivity.

4.3.2 Significance test two

To interpret this test, compare the number of core areas presently on site with the number of core areas that would remain after impacts. In the example file log, there is currently 3 core areas and after impacts there would be 1 remaining. This means that test two is *significant* for connectivity.

4.3.3 Overall

Only one test must be significant for the impact to cause a significant residual impact on *connectivity areas*. In this case, test one was *not significant*, test two was *significant*, and therefore the overall result of the test is *significant*.

The screenshot below contains an excerpt of the logfile showing the concluding sentence generated by the LFC tool. The words in the red boxes are generated based on the results of the tool in test one and test two respectively.

```

RESULT
16:38:34      This analysis has determined a SIGNIFICANT impact on connectivity areas
(A significant reduction in core remnant at the local scale is False OR a change from core to non-core remnant at
the site scale is True
(Total area of RVM Cat B clearing is 39.28 hectares)
    
```

4.3.4 Total area

Where the tool determines the overall result of the test is *significant*, it also calculates the total impact area, which in this example is 39.28 hectares.

4.4 Layer file

Once the analysis run is complete, the results should be loaded into the working ArcGIS Pro document by default, however the user can view the results by opening the layer file in an ArcGIS Pro session (*..\Vyr_file\Connectivity Area Impact Assessment.lyrx*). The layer file group displays the following spatial layers:

- The impact site;
- The area of cleared category B vegetation
- The local and regional buffered areas;
- Regional fragmentation images both pre and post impact; and

[Figure 3](#) at the end of this document provides an example of the layer file.

4.5 Results tables

Once the analysis is complete, the user can view two results tables to confirm the significance of the impact on connectivity areas. These tables are placed in the sub-folder *..\main_output*; select the csv document “*lfc_significance_assessment.csv*” to view a summary of the results:

| H | I | J |
|--------------------------|-------------------|--------------------|
| SIGNIF_LOCAL_CORE_CHANGE | SITE_CORE_NONCORE | SIGNIFICANT_IMPACT |
| FALSE | TRUE | TRUE |

In the above example, the local core change is ‘false’ while the change from core to noncore is ‘true’ which means that overall there is a significant residual impact.

5 Development of the LFC tool

The landscape fragmentation analysis used by this tool is adapted from the Landscape Fragmentation Tool (LFT) developed by Jason Parent in 2009, with support from Centre for Land Use Education and Research (CLEAR) and the Department of Natural Resources and the Environment, at the University of Connecticut (UConn). <https://clear.uconn.edu/mapping/tools/>. The LFT approach is based on the procedure developed by Vogt *et al* (2007), generating an output raster (based on a binary remnant/ non-remnant map) representing the following fragmentation classes:

- 0: the fragmenting class (i.e. non-forest)
- 1: patch
- 2: edge
- 3: perforated
- 4: *core < 100 hectares
- 5: *core \geq 100 ha and < 500 ha
- 6: *core \geq 500 ha
- 7: other (including open water)

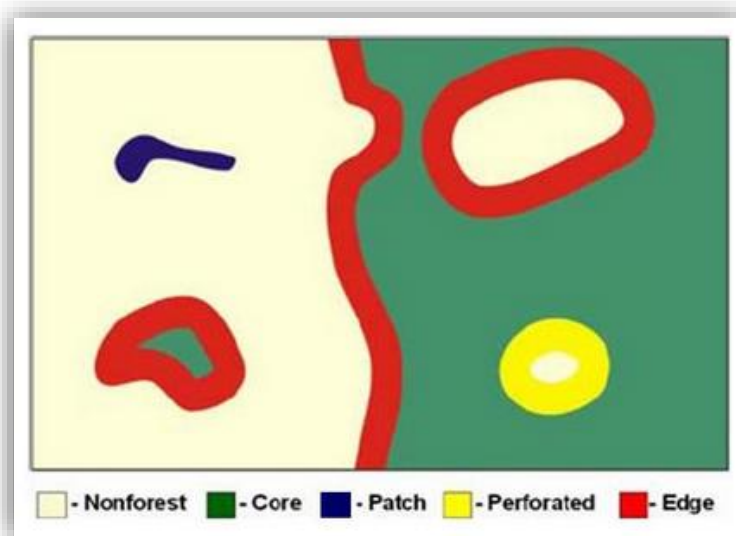


Figure 1: Landscape fragmentation classes (sourced from Vogt *et al* 2007)

*The core thresholds are based on minimum viable forest patch size research.

Defining the edge width is the first step in the fragmentation analysis. There are numerous examples in the scientific literature demonstrating the “edge effect” on wildlife habitat and ecosystems (eg. Saunders *et al* 1991; Hobbs 1993; Laurance 1997; Laurance *et al* 2002 and Franks 2007). In the LFC tool, the edge width is defined as the distance from the boundary between remnant and non-remnant vegetation through to the core remnant ecosystem.

Assuming an edge width of 50 metres (m); core areas are defined as remnant vegetation further than 50m from any non-remnant areas. Peripheral areas consist of remnant within 50m of non-remnant, which form part of a larger tract containing core areas. Peripheral areas are further classified into edge and perforated classes. Perforation edge surrounds small clearings where the radius is less than twice the edge width, within a tract of remnant vegetation. The Periphery zone around any clearings larger than this are classified as outside edge. Patches are small or narrow areas of remnant vegetation that do not include any core (i.e., any remnant more than 50m from non-remnant areas). They are completely influenced by the edge-effect.

6 Definitions

6.1 Notes on each of the tool’s inputs

6.1.1 <Output folder>

An existing folder into which the output datasets will be saved (it is advised that this folder is located on a local rather than a network drive for the sake of speed of execution). The folder name should start with an alphabetical character and avoid the use of spaces.

6.1.2 <Remnant cover layer>

The Queensland Vegetation Management Regulated Vegetation Map is the main input used to assess vegetation configuration for the purpose of this test. This spatial layer is updated by department of Resources monthly, and the current version can always be obtained from the Queensland Spatial Catalogue ([Queensland Spatial Catalogue : Queensland Government \(information.qld.gov.au\)](http://Queensland Spatial Catalogue : Queensland Government (information.qld.gov.au))) – just type ‘Regulated Vegetation Map’ in the search box.

The tool uses the “RVM_CAT” attribute field to create a remnant (Category ‘B’) vs non-remnant (Categories ‘A’, ‘C’, ‘R’, ‘X’) classified map of the landscape, and accounts for the presence of ‘Water’.

6.1.3 <Has this remnant cover layer been edited?>

This box should be ticked if the base data being supplied to the tool as <remnant cover layer> is modified in any way relative to the standard Vegetation Management Regulated Vegetation map supplied in the package (optional).

6.1.4 < regional and local scale thresholds>

The regional scale buffer is used to determine the fragmentation class of the surrounding landscape including the development footprint. This is then used to set the significance of impact test at a local scale for percent of core removed. The table below details the default values used for the assessment that are set out as a guide in the [Significant Residual Impact Guideline](#) (current to December 2014). This table is found in the LFC_data.gdb and will be loaded into the ArcGIS Pro document as a table view as <Regional fragmentation local threshold>.

| % range of core areas within the regional area pre-impact | % core impact threshold at a local scale used to determine significance of impact |
|---|---|
| <10 | 2 |
| 10-30 | 5 |
| 30-50 | 10 |
| 50-70 | 20 |
| 70-90 | 30 |
| >90 | 50 |

Administering Agencies should consider the appropriateness of these guideline thresholds on a case-by-case basis. Factors where the thresholds may be considered for variation include intensity of development, the surrounding condition of the landscape, and the importance of existing corridors. A test table has been included <Regional_fragmentation_local_threshold (test)> that can be used to manually test thresholds and edited according to the user's preference.

6.1.5 <Regional scale buffer distance (km)>

The radius (km) of the regional-scale assessment zone to be constructed around the proposed clearing. The user can use this parameter to select the regional scale buffer that sets the regional fragmentation threshold used to assess significance of impact. The buffer distance used for the regional assessment should consider the level of homogeneity surrounding the impact size. For example, impacts in highly fragmented lowlands should exclude adjacent intact hills so that a reasonable threshold can be determined. The size and shape of the impact is also a relevant consideration (see note in Section 6.1.6). The default radius is 20km.

6.1.6 <Local scale buffer distance (km)>

The radius (km) of the local assessment zone around the proposed clearing. The user can use this parameter to select the local scale buffer used to assess the percent area cleared against the regional fragmentation threshold. The buffer distance used for the local assessment should be considered in the context of the size and shape of the impact. For example, linear infrastructure may require a lower buffer distance to compensate for the larger area that would otherwise be captured compared to impact sites with a lower area to perimeter ratio. It is generally recommended that a ratio of 1:4 between the local scale buffer and the regional equivalent. The default radius is 5km.

6.1.7 <impact site layer>

An impact site feature layer or shapefile. It is advised that you ensure this layer has a spatial reference and there are no spaces or special characters in the name (e.g. ?@&). It is not necessary for this to be in the nominated output folder.

6.1.8 <cell resolution (m)>

The cell size used for spatial analysis. Adjusting this value significantly affects processing times. It is not recommended to use a value less than the default 10m.

6.1.9 <edge width (m)>

The distance from non-remnant landscapes through to the core ecosystem - the edge of remnant ecosystems (default value is 50m).

6.1.10 <Run in memory>

An option to utilise the Environment setting for ArcGIS Pro that stores intermediate outputs in memory rather than in the output file geodatabase. This has been shown to provide significant performance improvement. This is the equivalent in python of declaring `arcpy.env.Workspace='memory'`. The workspace will be cleared of files after each LFC raster assessment is completed. Note that by default the LFC_Toolbox.tbx has turned this variable off as there were issues encountered running in memory within ArcGIS Pro application. For those familiar with python there is a section within `<LFC_run_offset_analysis.py>` that allows for this parameter to be turned on by hardcoding all the input parameters. Running the tool in memory through a python IDE such as Pycharm or Visual Studio has been tested and works successfully and with significant performance improvement. Note that for large scale analysis setting this parameter to **True** may cause the analysis to run out of internal memory.

6.1.11 Note on default values

The default buffer distances, edge width, and threshold values are provided as guidance as per the [Significant Residual Impact Guideline 2014](#) (December 2014). For some scenarios it may be appropriate to alter them. Any changes should be discussed and agreed to by the Administering Agency's assessment officer.

The default projection `<GDA 2020 Queensland AlbersOFFSET.prj>` has also been hardcoded into the analysis and would require knowledge in python to amend.

6.2 lfc_local_scale_summary.csv

This table provides detailed areas and counts, pre and post impact, for landscape fragmentation classes at the local scale. The table can have up to six rows representing each fragmentation class. The following column headings are provided in the table:

6.2.1 <VALUE>

A nominal integer representing the fragmentation class.

6.2.2 <LABEL>

A Text label representing the fragmentation class.

6.2.3 <PRE_GRID_AREA>

The pre impact area in hectares for the fragmentation class.

6.2.4 <PRE_GRID_COUNT>

The pre impact cell count for the fragmentation class.

6.2.5 <PRE_PATCH_COUNT>

The pre impact count of patches within each fragmentation class (only polygons greater than or equal to 1 hectare are counted).

6.2.6 <POST_GRID_AREA>

The post impact area in hectares for the fragmentation class.

6.2.7 <POST_GRID_COUNT>

The post impact cell count for the fragmentation class.

6.2.8 <POST_PATCH_COUNT>

The post impact count of patches within each fragmentation class (only polygons greater than or equal to 1 hectare are counted).

6.2.9 <DIFF_GRID_AREA>

The difference between the pre and post impact area for each fragmentation class.

6.2.10 <DIFF_GRID_COUNT>

The difference between the pre and post impact cell count for each fragmentation class.

6.2.11 <DIFF_PATCH_COUNT>

The difference between pre and post impact patches within each fragmentation class (only polygons greater than or equal to 1 hectare are counted).

6.2.12 <PROP_GRID_AREA>

The proportional change in area for the fragmentation class following impact.

6.2.13 <PROP_GRID_COUNT>

The proportional change in cell count for the fragmentation class following impact.

6.2.14 <PROP_PATCH_COUNT>

The proportional change in patchiness within the fragmentation class following impact.

6.3 lfc_site_scale_summary.csv

This table lists the post impact fragmentation class breakdown for all core remnant areas (greater than or equal to one hectare) that occurred on the impact site prior to the impact. The COREID field is unique to each original core remnant area. Any remaining core values (4;5;6) indicate that the specific core area has been retained post impact. The following column headings are in the table:

6.3.1 <COREID>

The ID relating to a core remnant area (greater than or equal to one hectare) that occurred on the site pre impact.

6.3.2 <VALUE>

A nominal integer representing the fragmentation class breakdown for each core remnant area that occurred on the site pre impact.

6.3.3 <LABEL>

A Text label representing the fragmentation class.

6.3.4 <AREA_HA>

The post impact area in hectares for the fragmentation class.

6.4 significance_assessment.csv

This table provides a summary of the key indicators used to determine the significance of an impact on connectivity areas and only has one row. The following column headings are in the table:

6.4.1 <TOTAL_CORE_REGIONAL>

The total area in hectares of core remnant ecosystem at the regional scale.

6.4.2 <PROP_CORE_REGIONAL>

The proportion of core remnant ecosystem at the regional scale.

6.4.3 <LOCAL_CHANGE_THRESHOLD>

The change threshold used to determine the significance of any change in core ecosystem extent at the local scale.

6.4.4 <TOTAL_CORE_LOCAL>

The total area in hectares of core remnant ecosystem at the local scale.

6.4.5 <PROP_CORE_LOCAL>

The proportion of core remnant ecosystem at the local scale.

6.4.6 <POST_PROP_CORE_LOCAL>

The proportion of core remnant ecosystem at the local scale, post impact.

6.4.7 <PROP_CORE_CHANGE>

The change in the proportion of core remnant ecosystem at the local scale, post impact.

6.4.8 <SIGNIF_LOCAL_CORE_CHANGE>

The decision on the significant impact on core ecosystem at the local scale, post impact.

6.4.9 <SITE_CORE_NONCORE>

The decision on the loss or reduction of core remnant areas at the site scale.

6.4.10 <SIGNIFICANT_IMPACT>

The decision on the significance of the impact on Connectivity Areas.

Figure 2: Examples of fragmentation categories

Landscape Fragmentation and Connectivity (LFC) Tool



Edge: occurs within the "edge effect" zone along the outside edge of a non-patch tract (e.g. the forested area enclosed within the boundary at right).

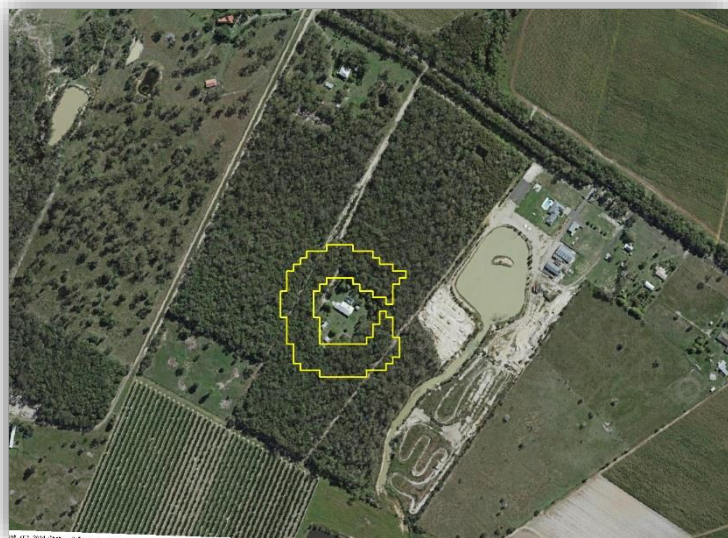


Patch: small fragments that are completely degraded by the "edge effect" (e.g. the skinny riparian area within the boundaries at right).

Landscape Fragmentation and Connectivity (LFC) Tool

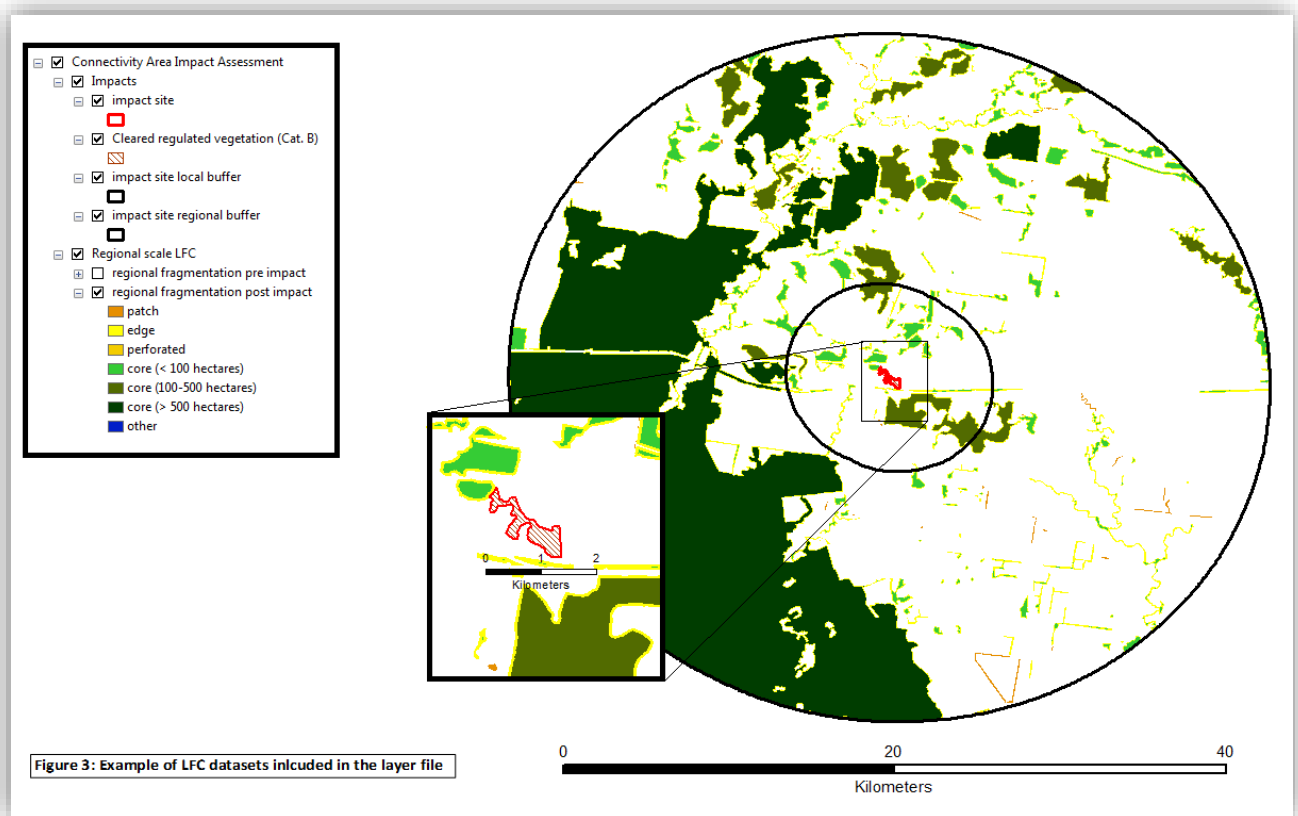


Core (interior): occurs on the inside of the peripheral zone and is considered to be unaffected by the edge effect.



Perforated: occurs within the "edge effect" zone along the edge of a small clearing in a non-patch tract (e.g. the forested area surrounding the cleared house lot and enclosed within the boundary at right).

Landscape Fragmentation and Connectivity (LFC) Tool



7 References

Franks A.J (2007). The ecological consequences of buffel grass *Cenchrus Ciliaris* establishment within remnant vegetation of Queensland. *Pacific Conservation Biology*, Vol. 8, No. 2, 99-107.

Hobbs R.J (1993). Effects of landscape fragmentation on ecosystem processes in the Western Australian wheatbelt. *Biological Conservation* **64**: 193-201.

Laurance W.F (1997). Responses of mammals to rainforest fragmentation in tropical Queensland: a review and synthesis. *Wildlife Research* **24**: 603-612.

Laurance W.F, Lovejoy T.E, Vasconcelos H.L, Bruna E.M, Didham R.K, Stouffer P.C. Gascon C, Bierregaard R.O, Laurance S.G and Sampaio E (2002). Ecosystem decay of Amazonian forest fragments: a 22 year investigation. *Conservation Biology*. Vol. 16, No. 3, 605-618

Saunders D.A, Hobbs R.J, Margules C.R (1991). Biological consequences of ecosystem fragmentation: a review. *Conservation Biology*. Vol. 5, No. 1, 18-32.

Vogt P, Riitters K, Estrenguil C, Kozak J, Wade T and Wickham J (2007). Mapping spatial patterns with morphological image processing. *Landscape Ecology* **22**: 171-177.

8 LFC tool update history notes

8.1 Version 1.6

The update increases the robustness of the script in handling unusual situations of planned clearance in areas completely covered in remnant vegetation, as well as areas that are already cleared apart from the proposed site.

A feature was also introduced which – in the case of a significant result – calculates the impact area in hectares.

8.2 Version 2.01

The LFC tool has been updated to version 2.01 so that it aligns with the user guide version. The tool was upgraded from legacy ArcGIS Desktop to the new ESRI ArcGIS Pro platform. To do this a ArcGIS Pro project was also established that houses the relevant tools and workspaces. Some efficiencies in the analysis were also undertaken to treat working files as temporary and consolidate the outputs into one workspace.

As part of version 2.1, the tool no longer houses a regulated vegetation map FeatureClass due to the data being updated regularly. Requiring manual user download, the most recent version of the layer will always be available for assessments. The version of the regulated vegetation mapping will be reported in the log file.

8.3 Human Rights impact assessment

Proper consideration is required to determine the compatibility of any act, decision or statutory provision with human rights under the *Human Rights Act 2019* (HR Act). An act, decision or statutory provision will be compatible with human rights if it does not limit the human right, or if it limits the human right only to the extent that is reasonable and demonstrably justifiable. This involves a weighing up of a range of factors which are set out in [section 13 of the HR Act](#).

Consider the action or decision you are proposing and ask:

1. Which rights are relevant to the decision or act proposed to be taken?

Nil

2. Will your action or decision limit or restrict any of the rights you've identified? No

Reasons for assessment decision:

There are no implications for human rights under the Human Rights Act 2019.

9 Approval

I approve the recommendation based on the reasons stated in this report. I agree with the assessing officer's assessment of impacts to human rights.

Approved by: Jeanie Heaslop

A/Director, Policy Initiatives
 Department of Environment and Science
Environmental Offsets Act 1994

Enquiries:

Offset Policy Team

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11 December 2023

Version history

| Version | Date | Description of changes |
|---------|-----------------|--|
| 1.00 | 28 October 2014 | Original version approved. |
| 2.00 | 26 April 2018 | The changes made were to reflect the latest version of the LFC tool (version 1.6) as well as amendments that provide users a more comprehensive understanding of how to install and run the LFC tool, how to interpret the outputs of the analysis and the concepts behind the analysis. |
| 2.01 | 5 December 2023 | This will constitute version 2.01 of the tool to align with the version of this document. Changes were made to reflect the upgrade of the LFC tool from ArcGIS Desktop to ArcGIS Pro. of the guidance on the variables associated with the tool were also updated. The new document also conforms to the newer requirements for documentation. |