Alberta Biodiversity
Monitoring Institute

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Effective Mesh Size Layers
Version 1.0 - Metadata

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Contact Information
If you have questions or concerns about this publication, you can contact:
ABMI Information Centre
CW-405 Biological Sciences Centre
University of Alberta
Edmonton, Alberta, Canada, T6G 2E9
Phone: (780) 492-5766
E-mail: abmiinfo@ualberta.ca

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1 Summary

The Alberta Biodiversity Monitoring Institute (ABMI) tracks changes in human footprint (HF) and reports on the status of, and changes in, land use across the province of Alberta. One of the goals of the Institute is to provide credible and understandable information on the amount and location of remaining native vegetation to support natural resources management. This document provides metadata for the Effective Mesh Size layers (Version 1.0) that were derived from the 2012 Wall-to-Wall Human Footprint Layer[1]. The layers are continuously being updated, and new versions of this document will be released periodically.

This document builds upon a previous report prepared for the ABMI by O2 Planning + Design Inc[2].

2 Background on the Alberta Biodiversity Monitoring Institute

The ABMI was initiated in 1997 through a broad partnership of industry, government and academia. The ABMI operates a long-term biodiversity monitoring program and is tasked with tracking the status of, and changes to, biodiversity and habitats throughout Alberta.

3 Base Data Source

The primary source of data when creating the effective mesh size layers was the 2012 Human Footprint Inventory (Version 3.0)[1] - a GIS polygon layer that describes human footprint in Alberta as of December 31, 2012. Polygons in that layer map the location and geographic extent of areas under human use that have either lost their natural cover (e.g., cities, roads, agricultural land, industrial areas), or whose natural cover is periodically or temporarily replaced by resource extraction activities (e.g., forestry, seismic lines).

4 Sub-setting and processing the 2012 Human Footprint Inventory

The 2012 Human Footprint Inventory (referred to as **HF_w2w_2012**) contained information on multiple types of human footprint. This layer was used to create two new layers for further processing (see Section 8):

1. All human footprint types were included as footprint, and
2. All human footprint types except cutlines were included as footprint. Cutlines in the **HF_w2w_2012** layer were derived from the linear Cutline layer in the provincial Base Layer Database where they are defined as: "*A minor roadway/linear clearing (2-10m wide) in which the surface may be exposed soil, rock, and/or low vegetation. Its condition is inferior to that of a truck trail, and usage is light. Cutlines/Trails may include seismic lines, minor pipelines."*. The linear cutlines were buffered with 2 meters post 2005 and 3 meters pre 2005 in the **HF_w2w_2012**.

[1] For details please refer to: Alberta Biodiversity Monitoring Institute. 2015. Human Footprint Inventory for 2012 conditions Version 1.0 - Metadata. Alberta Biodiversity Monitoring Institute, Alberta, Canada. Report available at: abmi.ca.

[2] http://www.o2design.com/

5 Natural vegetation layers

The above two human footprint layers were further processed to create two natural cover layers that were used to create the two effective mesh size layers.

5.1 Wall-to-Wall Natural Cover Layer With All Human Footprint Types Removed

This layer was created with the following steps:

a. First, the 2012 Human Footprint Inventory (**HF_w2w_2012**) was dissolved to create a new layer having a single category of all human footprint (**HF_w2w_2012_dsv).**
b. A wall-to-wall natural layer (**natural_raw**) containing the areas outside of the **HF_w2w_2012_dsv,** was created by applying the **Erase** command to the Alberta Boundary layer and **HF_w2w_2012_dsv**.
c. Polygon 'slivers' with the following characteristics were removed from the **natural_raw** layer to create the **natural_sliver_removed** layer:
   - polygons with area < 200 m^2,
   - polygons with area between 200-1000 m^2 except those "touching" cutlines,
   - polygons "touching" cutblocks and/or mines that were < 2500 m^2, and
   - linearly-shaped polygons <5000 m^2. These 'linearly-shaped polygons' were defined as polygons with an Area/Length ratio of <6.

d. GIS-created stream corridors within the 2012 Human Footprint Inventory layer were removed from the **natural_sliver_removed** layer. These corridors of native vegetation through human footprint originated when the buffered steam line and hydropoly sublayers were overlaid on the HF polygons; the native vegetation dissected the human footprint types such as pipelines, translines, and roads into segments (as shown in Figure 1). By removing these narrow stream corridors, the native vegetation polygons on each side of the linear disturbance were separated into two different polygons. This process was accomplished using the **Erase** command with the original buffered sub-layers of pipelines, cutlines, transmission lines, railway lines, Paved Road, and Soft Road overlaid on the **natural-sliver_removed** layer.

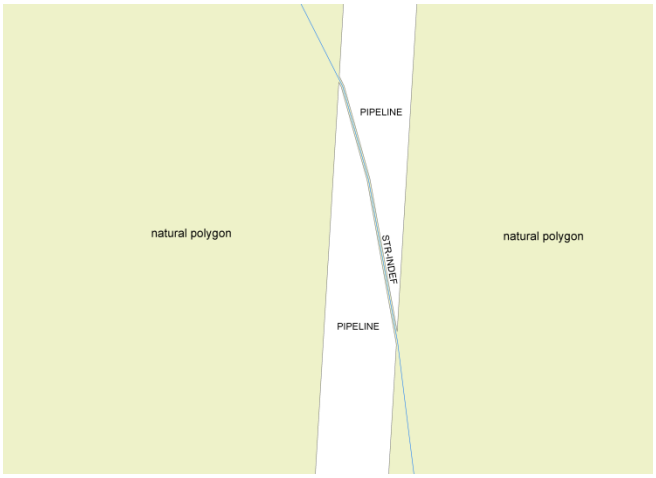

Figure 1: Illustration of the dissection of linear human footprint features (such as a pipeline) by water features such as streams.

e. Artificial corridors between polygons of native vegetation occurred when cutlines had small gaps at their end when adjacent to roads. This resulted in many natural polygons being artificially large because two or more polygons were artificially "joined" along the road margin. To fix this issue, the ends of cutline polygons were "snapped" onto road polygons using following four steps:
    i. First, cutlines that were not connected to the buffered roads, but which were within 10 meters of a buffered road, were selected from the original non-buffered linear cutlines layer.
    ii. Second, the **Densify** command was used to add vertices onto the selected cutlines (most only had start and end points, which would have prevented accurate snapping to the road described next).
    iii. Third, the densified cutlines were extended and snapped into the road with the **Snap** command.
    iv. Fourth, the snapped layer was buffered.
    v. Fifth, the buffered cutline layer was overlaid on results from Step "iv" to remove the artificial corridors using the **Erase** command.

f. The final wall-to-wall natural cover layer was created by dissolving the layer from Step "e" above. This layer was used in the effective mesh size calculation.

5.2 Wall-to-Wall Natural Cover Layer With All Human Footprint Types (Except Cutlines)

a. In the **HF_w2w_2012** layer, all polygons that were not cutlines were selected (FEATURE_TY <> 'CUTLINE-TRAIL') and saved as a new layer named **HF_w2w_2012_noCutlines.**
b. The layer **HF_w2w_2012_noCutlines** was then processed similar to that for Section 5.1 (Following Steps a-d, and f, to create a second natural cover layer). However, because cutlines were excluded from human footprint in that layer Step "5.1.e" was not required.
c. Also note that the sliver removal rules in Step "5.1.c" were replaced as follow:

- polygons with area < 1000 m^2,
- Polygons "touching" cutblocks and/or mines and which were <2500 m^2, and
- Linearly-shaped polygons <5000 m^2. The 'linearly-shaped polygons' were defined as polygons with an Area/Length ratio of <6.

6 Reporting Units (1-km^2 hexagons)

Effective mesh size was calculated within 1-km^2 hexagons that collectively spanned the entire province (a total of 665,211 hexagons). Hexagon size was selected to balance the need for fine-scale detail with computer processing power.

7 Effective Mesh Size calculation

For each hexagon *j*, the effective mesh size (m_{eff}^{CBC}) was calculated following Jaeger (2000) and Moser et al. (2007):

$$m_{eff}^{CBC}(j) = \frac{1}{A_{tj}} \sum_{i=1}^{g} A_{ij} A_{ij}^{cmpl}$$

where *n* is the number of patches intersecting the hexagon *j*, A_{tj} is the total area of hexagon *j*, A_{ij} is the area of patch *i* inside of hexagon *j*, and A_{ij}^{cmpl} is the complete area of patch *i* including the area outside of the boundaries of the hexagon *j*.

The 'cross-boundary' procedure (Moser et al. 2007, Girvetz et al. 2008) used here prevented the hexagon units from artificially fragmenting the landscape by looking outside the bounds of the individual hexagons to assess whether natural cover was connected. Areas with larger mesh sizes contain larger and more connected natural cover, areas with smaller mesh sizes contain less and more fragmented natural cover. Areas with zero mesh size contain no natural cover within that 1 km^2 hexagon.

8 Processing Steps

The following processing steps were followed for each data set described in Section 4:

1. The 1km^2 hexagon layer (Section 6) was overlaid with the Wall-to-Wall Natural Cover Layer (Section 5.1) with all Human Footprint Types Removed using the *Intersect* command. Note, this ensured that the Field *PolygonArea* (the original natural patch area) was in the attribute table of the resultant layer.
2. A field called *AreaInHex_X_AreaCmpl* was created in the attribute table of the resultant layer from Step 1. The value of this field was filled by multiplying *Shape_Area* (the area of the patch inside of the hexagon) and the *PolygonArea* (the complete area of the patch including the area outside of the boundaries of the hexagon). This attribute table was then exported into a Personal Geodatabase (*.mdb).
3. In the Personal Geodatabase, a new table with the sum of the *AreaInHex_X_AreaCmpl* in each Hexagon was derived from the attribute table in Step 2 using MS Access SQL queries.

4. The new table in Step 3 was linked to the attribute table of the 1km^2 hexagon layer based on the Hexagon's ID.
5. A field called *EffMeshSize* was created in the attribute table of the 1km^2 hexagon layer. The value of this field was calculated by dividing sum of the *AreaInHex_X_AreaCmpl* with *Shape_Area* (the Hexagon area).

The same processing steps were also applied to the Wall-to-Wall Natural Cover Layer with all Human Footprint Types Removed (Except Cutlines).

The final layers are illustrated in Figure 2 and Figure 3 below and are available from the ABMI[3].

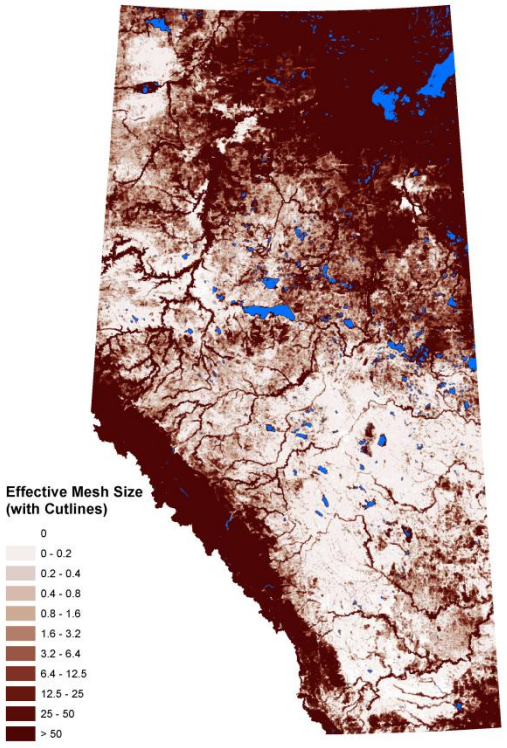

Figure 2: Map of Alberta illustrating the effective mesh size estimates within 1-km^2 hexagons. All human footprint types, including cutlines, were included in these calculations. Hexagons with larger mesh size values (darker brown) contain larger and more connected natural cover, whereas hexagons with smaller mesh size values (lighter brown) contain less and more fragmented natural cover. Areas with mesh size value of zero (white) contain no natural cover within that 1 km^2 hexagon.

[3] Contact ABMI at (780) 492-5766, or email: abmiinfo@ualberta.ca

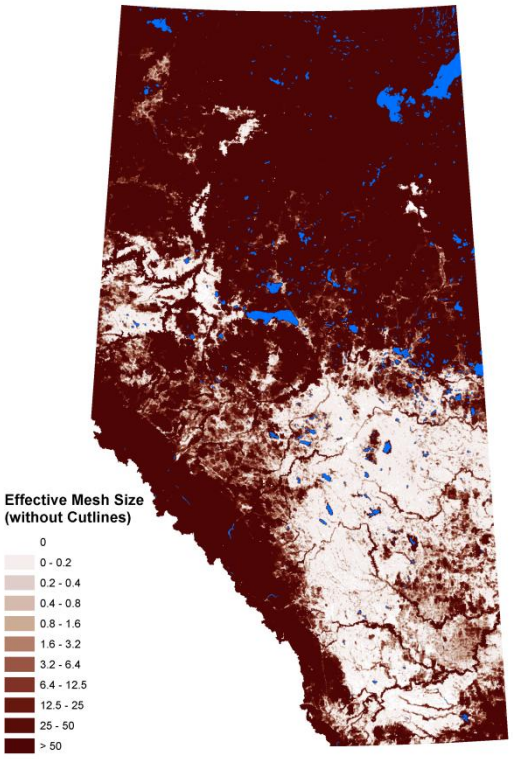

Figure 3: Map of Alberta illustrating the effective mesh size estimates within 1-km^2 hexagons. All human footprint types, with the exception of cutlines, were included in these calculations. Hexagons with larger mesh size values (darker brown) contain larger and more connected natural cover, whereas hexagons with smaller mesh size values (lighter brown) contain less and more fragmented natural cover. Areas with mesh size value of zero (white) contain no natural cover within that 1 km^2 hexagon.

9 References

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Jaeger, J.A.G. (2000): Landscape division, splitting index, and effective mesh size: New measures of landscape fragmentation. Landscape Ecology 15(2): 115–130.

Moser, B., Jaeger, J.A.G., Tappeiner, U., Tasser, E., Eiselt, B., 2007. Modification of the effective mesh size for measuring landscape fragmentation to solve the boundary problem. Landscape Ecology 22: 447–459.