Human Footprint Intensity mapping:

A tool for tracking human footprint change in the Calgary Region

Greg Chernoff and
Guy Greenaway

Document prepared for the
Calgary Regional Partnership

February 2017

Calgary
Regional
Partnership

Innovative research. Engaged communities. Healthy landscapes.

Human Footprint Intensity Mapping:
A tool for tracking human footprint change in the Calgary Region

Prepared by Greg Chernoff and Guy Greenaway
February 2017

Miistakis Institute
Rm U271, Mount Royal University
4825 Mount Royal Gate SW
Calgary, Alberta T3E 6K6

Phone: (403) 440-8444
Email: institute@rockies.ca
Web: www.rockies.ca

Contents

Ecological Data Update

The *Human Footprint Comparison* project was the primary effort under the *Ecological Data Update.* The intent was to create a spatially-explicit representation of the land use and natural features in the Calgary Region around a set of pre-determined themes.

The Human Footprint Comparison focused on the goal of showing the changes in human use and development on the landscape between the first Calgary Metropolitan Plan (2009) and the second (2014). The intent was not to assess the "good" or the "bad" of that change, but simply give the CRP and its members a data-based picture of how and where development occurred between the two plans which could then be compared to the goals that had been set out in the plans.

That information would then be used to inform both the *Ecological Conservation and Protection Plan* (the CRP EcoPlan) as well as any other applicable strategy under the Calgary Metropolitan Plan. It would also create a systematic methodological foundation for future iterations of the Calgary Metropolitan Plan.

Human Footprint Intensity Modeling

The *Human Footprint Intensity* model created a spatially-explicit representation of the human 'footprint' on the landscape across the Calgary Region[1] at three different time stamps: 2007, 2010, and 2012. The 'intensity' of various land uses was determined by the Ecological Conservation and Protection Initiative's *Advisory Group* (drawn from the CRP members).

Footprint data for the Calgary Region was clipped from the Alberta Biodiversity Monitoring Institute's (ABMI's) Alberta-wide human footprint datasets for 2007, 2010, and 2012. The ABMI datasets were chosen as 1) they are robust datasets showing a wide range of human development and footprint, and 2) the ABMI has committed to updating these datasets on a regular basis, allowing the CRP GIS personnel to re-run the model at future dates.

---

[1] Because the source data for the Human Footprint Comparison covers the entire Calgary Region. no distinction was made between 'member' or non-member' landbases.

Data Processing

Considerable thought was given at the outset as to how the resultant data would – and should – look like. Two critical decisions were made.

First, the 'pixels'[2] for the derived maps were chosen to be hexagonal. Pixels are most often square, but this raises challenges in a landscape where the ownership is also surveyed as squares (townships, quarters, quarter-sections, etc.). In these cases, pixels that are intended to represent a mathematically calculated generalization of that rough land area, are assumed to be directly correlated with the landowner's or land manager's actions or philosophy. Instead they are the result of many policy, management, and individual choices.

Hexagonal polygons can give map users a visual clue that this information is not directly correlated with those parcels, landowners or specific management regime.

Second, the size of those pixels was chosen to be calculated at three different scales: 10 ha, 100 ha, and 1000 ha. The intent of the CRP EcoPlan is to be usable at both the individual municipality scale, as well as the regional scale. Therefore the data and the maps will be capable of informing planning assessments and decisions at both of those scales (and in between).
(see *Sample Results* for examples of how this appears in practice)

All data sets were forwarded to the CRP and are now in the hands of the GIS staff.

Scoring by Users

The ABMI human footprint datasets only represent where and what type of human development was created on the landscape. Of course, all land uses do not affect ecological processes an services in equally. However, making that distinction is heavily context-specific (a given type of human development may be relatively benign in one context and of great concern in another).

To address this issue, the *Ecological Data Update* project developed a rating/scaling system that could be modified in every instance, ensuring the 'standardized' dataset was made relevant for each use in the Calgary Region. All human footprints

---

[2] 'Pixels' are the smallest unit of information on the map, representing a certain data type.

To pilot this system, a facilitated process (Delphi-like) was developed and used with the Advisory Group members. In a workshop setting, they were guided through an exercise of scaling the different types of footprint based on the 'intensity' of land use each represented. Sample modeling was run based on the workshop results (see Figure 1: Human Footprint Intensity Scores from Advisory Group Workshop). A more detailed version is available in Appendix 1: *Detailed Human Footprint Intensity Scores from Advisory Group Workshop*.

Figure 1: Human Footprint Intensity Scores from Advisory Group Workshop

ABMI HF LAND USE TYPE	CRP Human Footprint Type	HFI SCORE (0-10)
Borrow-Pits/Dugouts/Sumps	Constructed Depressions	4
Canals	Irrigation Canals	9
Cultivation (Crop/Pasture/Bare Ground	Agricultural Land	2
Cut Blocks	Forestry Cut Blocks	4
High Density Livestock Operation	Feedlots	10
Industrial Site Rural	Industrial Sites	10
Mine Site	Open Mines	10
Municipal (Water and Sewage)	Municipal Water Treatment	9
Other Disturbed Vegetation	Open Vegetated Sites	4
Pipeline	Pipelines	3
Rail – Hard Surface	Railway	9
Rail – Vegetated Verge	Railway Verge	7
Reservoirs	Reservoirs	5
Road – Hard Surface	Roads	9
Road – Vegetated Verge	Road Verges	7
Road/Trail (Vegetated)	Unimproved Roads & Trails	4
Rural (Residential/Industrial)	Country Residential/Acreages	7
Seismic line	Seismic Lines	3
Transmission Line	High Voltage Transmission Lines	7
Urban	Urban Settlements	8
Well Site	Wellpads	9
Wind Generation Facility	Wind Turbines	9

Once completed, the scores allowed the model to be run, and for CRP and its members to assess the change in human activity which may have an impact on ecological infrastructure and services at the three different spatial resolutions (1000 hectare, 100 ha, and 10 ha).

Sample Results

To illustrate what the *Human Footprint Intensity* (HFI) model runs could show, three examples are given below. The first (*Cochrane Area*) shows how a human footprint map (dataset) can be transformed into an HFI map using the area around the Town of Cochrane as an example. The result is a series of 10 ha pixel maps for 2007, 2010, and 2012.

The second (*Cochrane-Calgary Corridor*) uses the area between the town of Cochrane and the city of Calgary, creating 100 ha pixel maps for 2007, 2010 and 2012. The final example covers the entire region (*Calgary Region*), using the same three years, but at a 1000 ha pixel resolution.

Cochrane Area

Figure 2: Cochrane Area Human Footprint (2007)
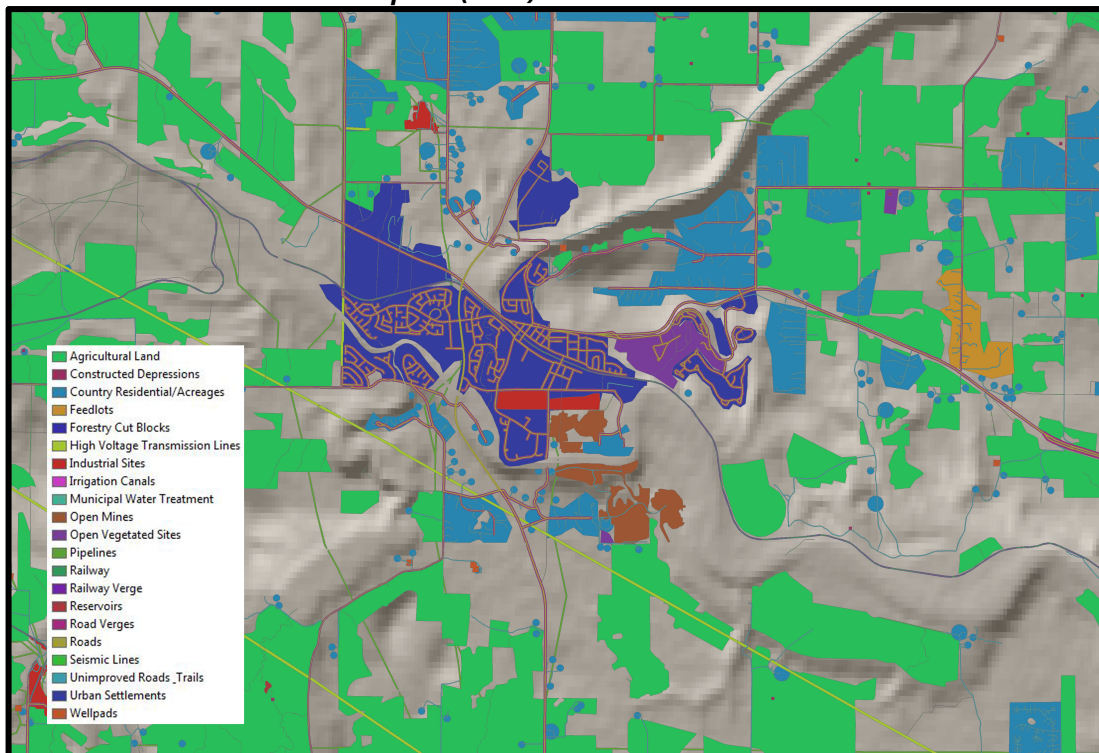
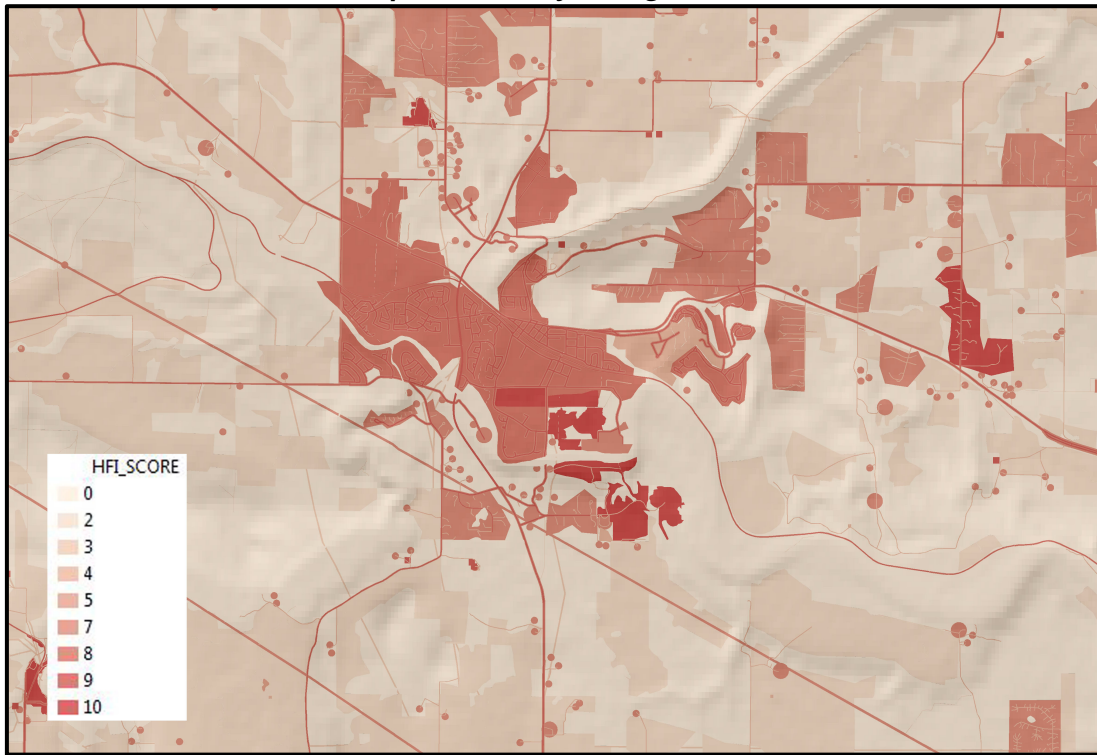*Figure 3: Cochrane Area Human Footprint Intensity Rating (2007)*

Figure 4: Cochrane Area Human Footprint Intensity and 10 ha Hexagonal Grid (2007)
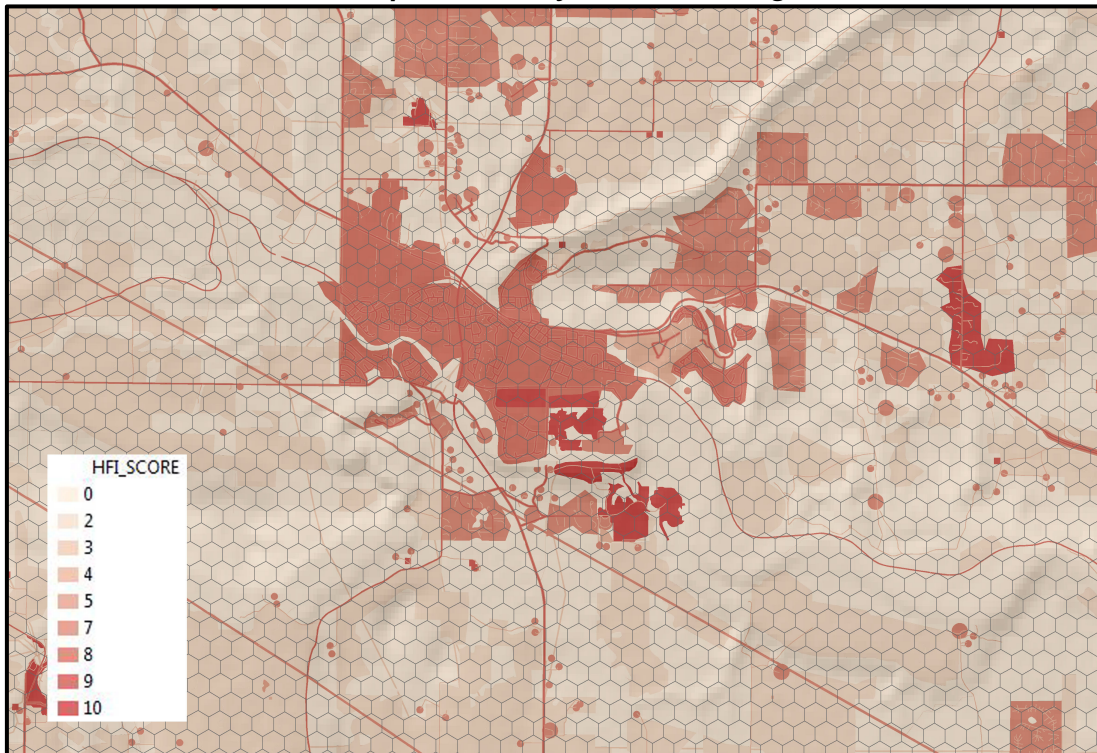
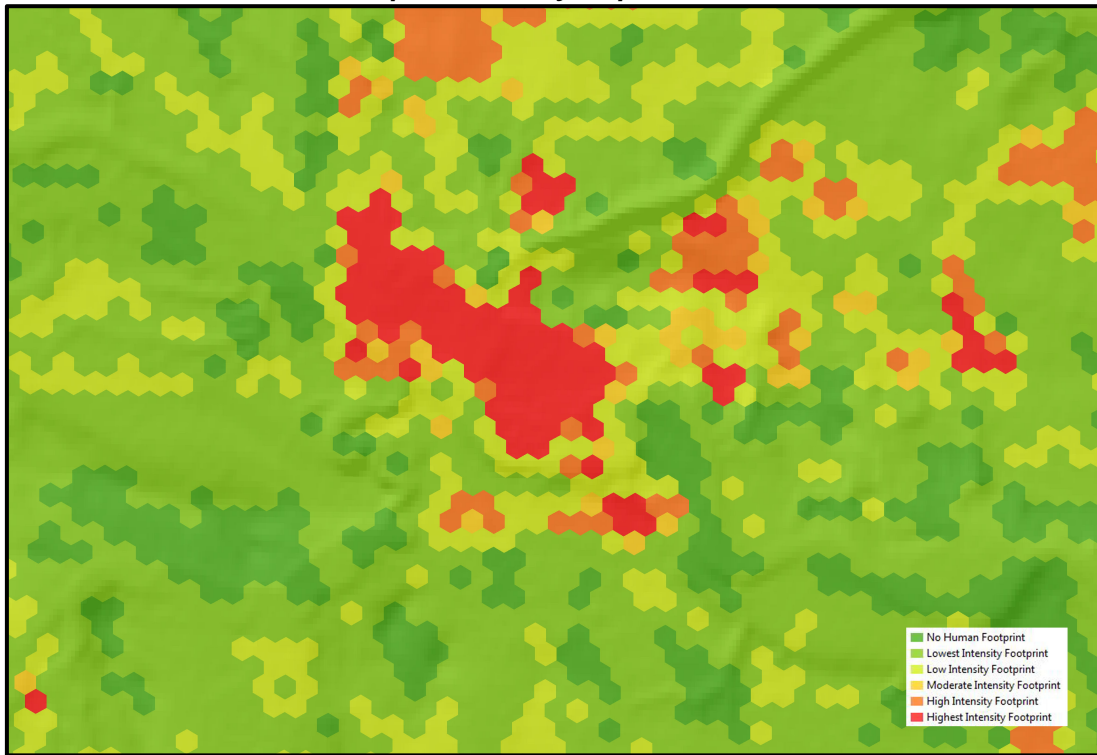*Figure 5: Cochrane Area Human Footprint Intensity Map, 10 ha (2007)*

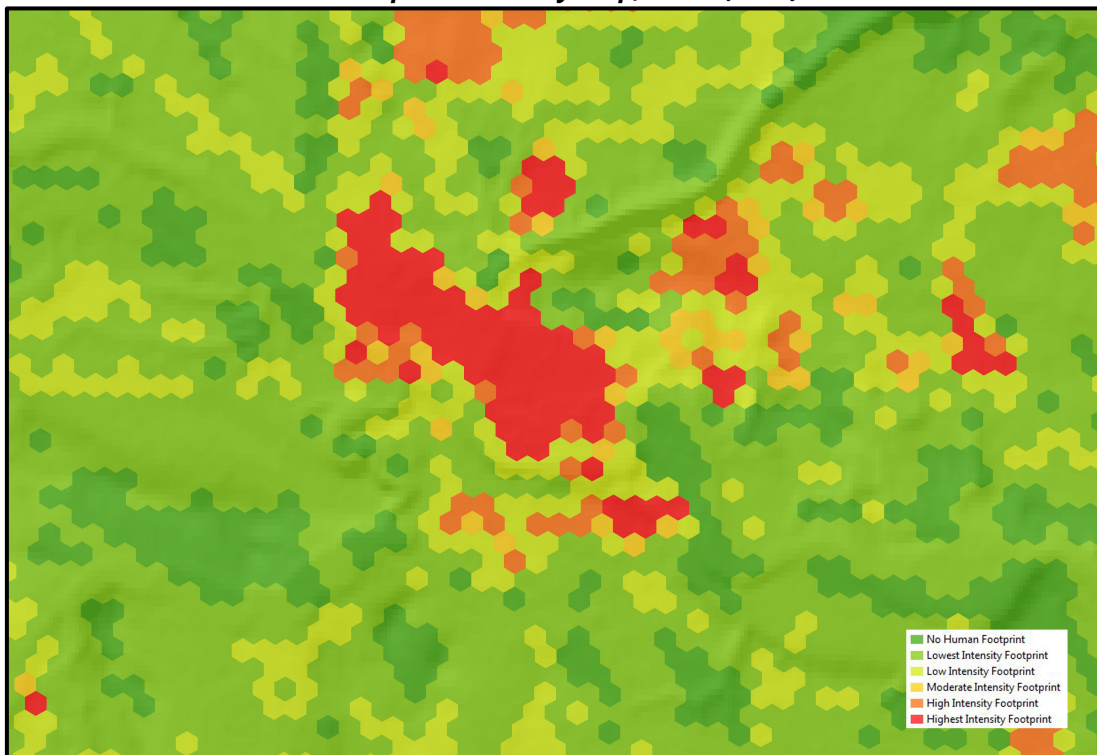*Figure 6: Cochrane Area Human Footprint Intensity Map, 10 ha (2010)*
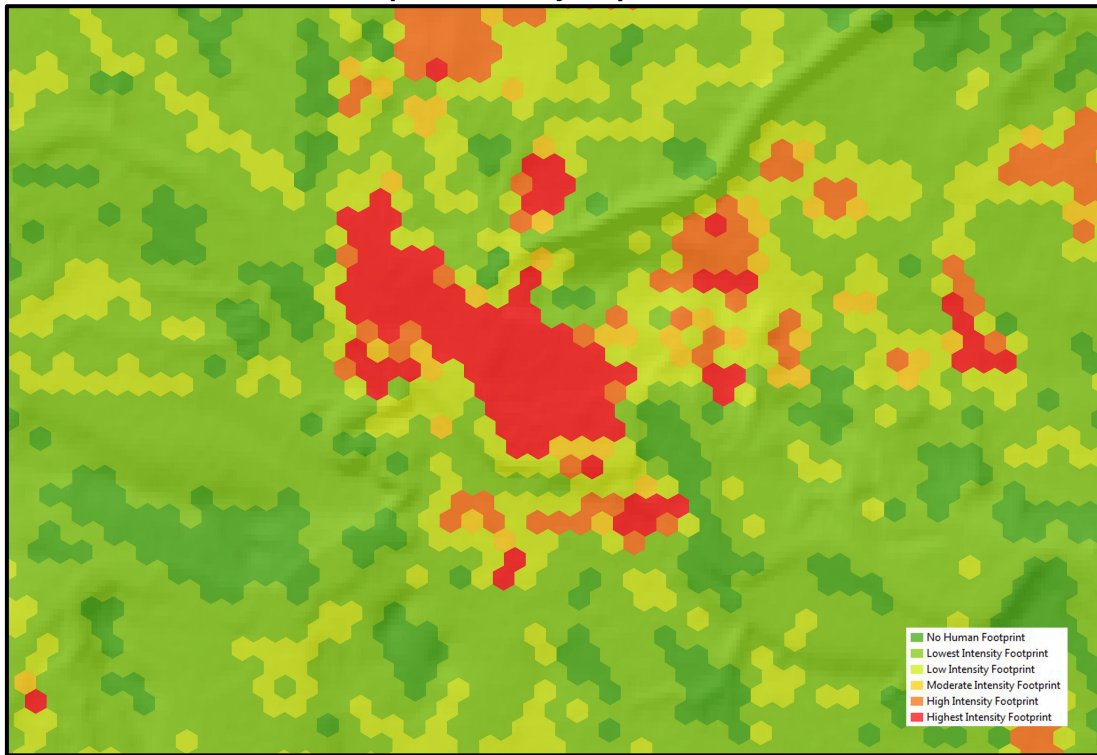
Figure 7: Cochrane Area Human Footprint Intensity Map, 10 ha (2012)

Cochrane-Calgary Corridor

Figure 8: Cochrane-Calgary Corridor Area Human Footprint Intensity Map, 100 ha (2007)
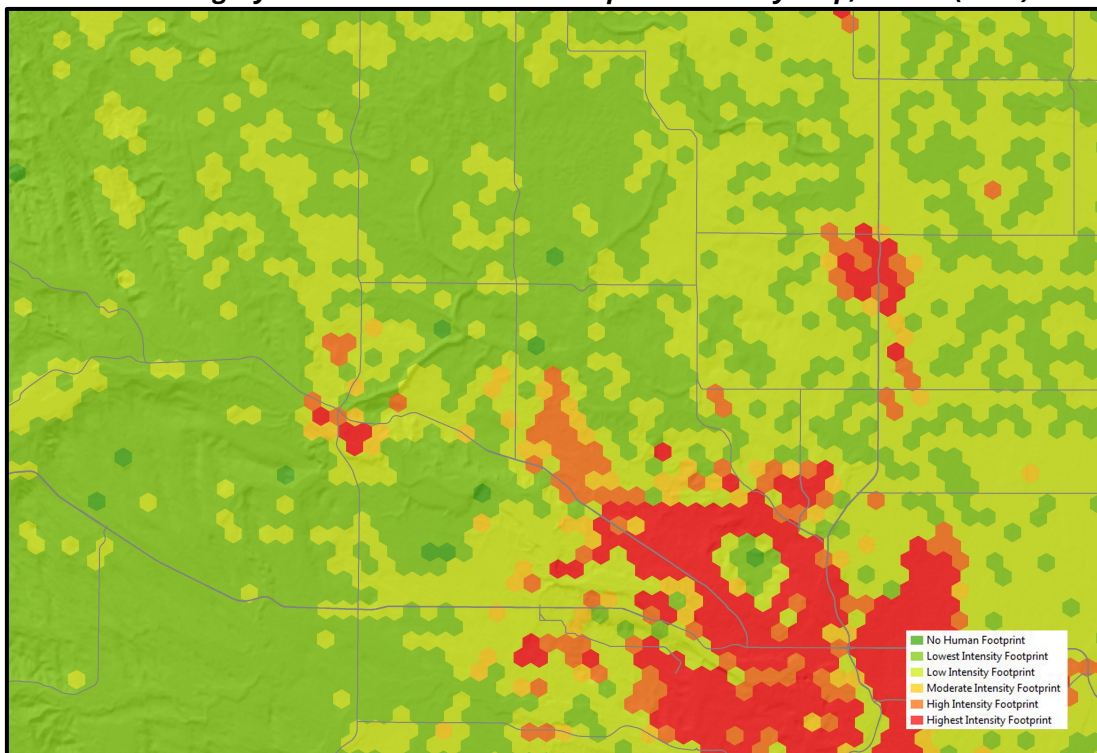
Figure 9: Cochrane-Calgary Corridor Area Human Footprint Intensity Map, 100 ha (2010)
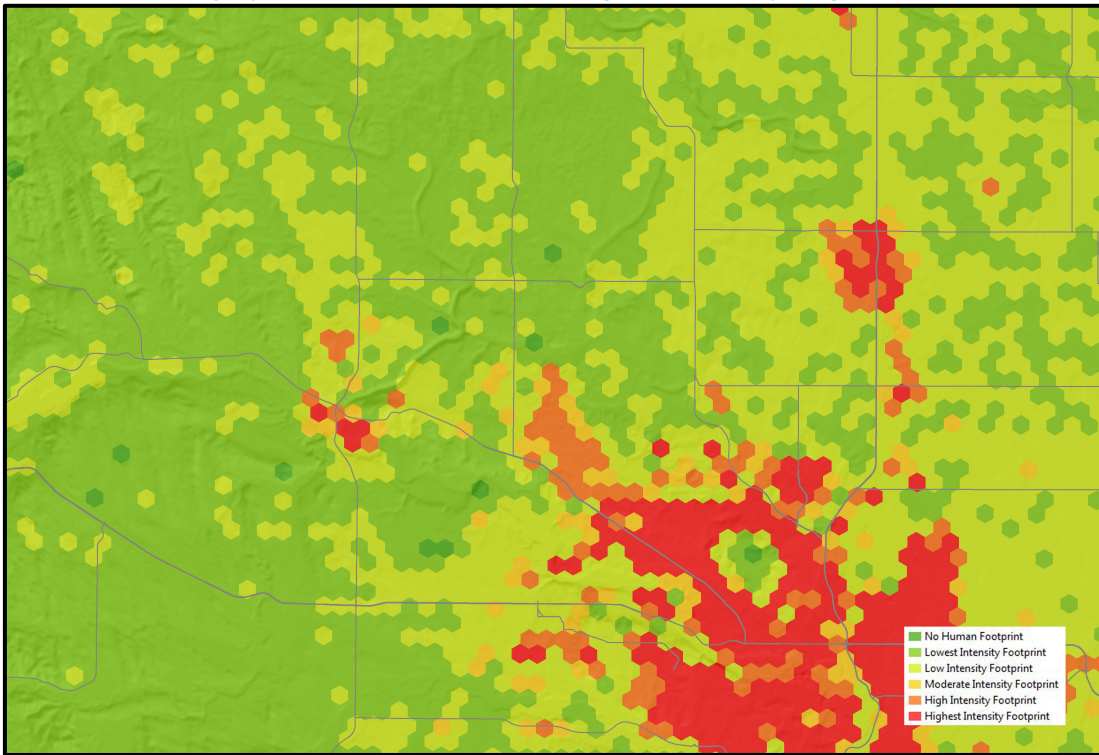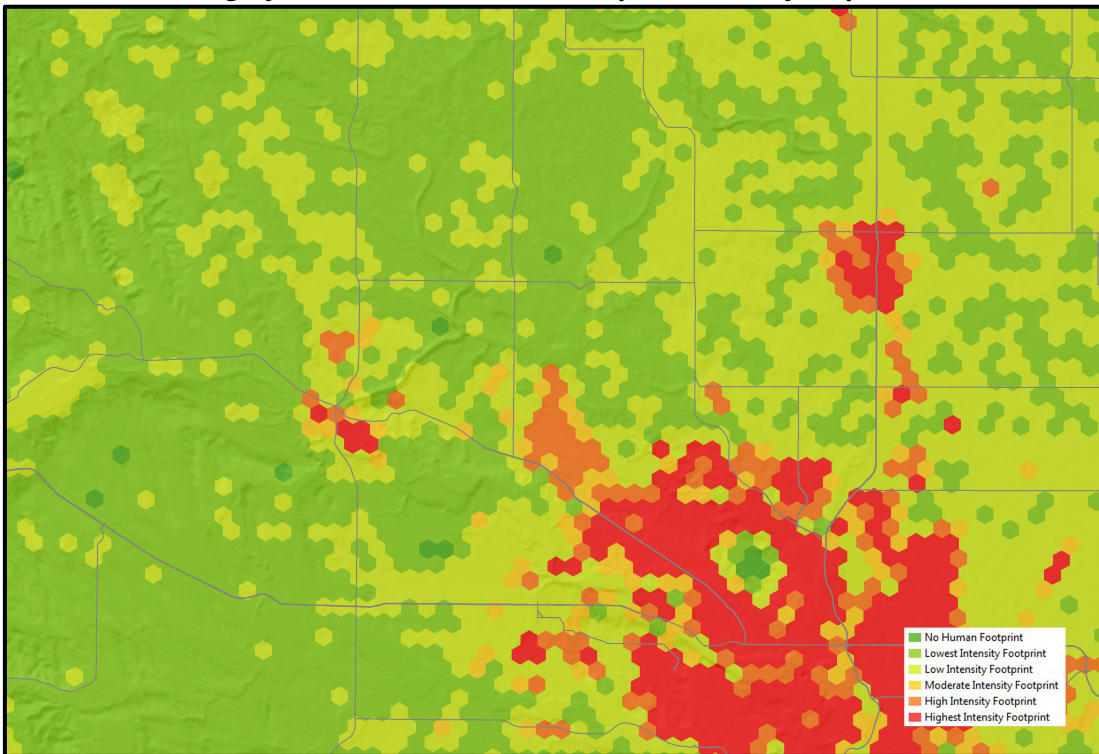

Figure 10: Cochrane-Calgary Corridor Area Human Footprint Intensity Map, 100 ha (2012)

Calgary Region

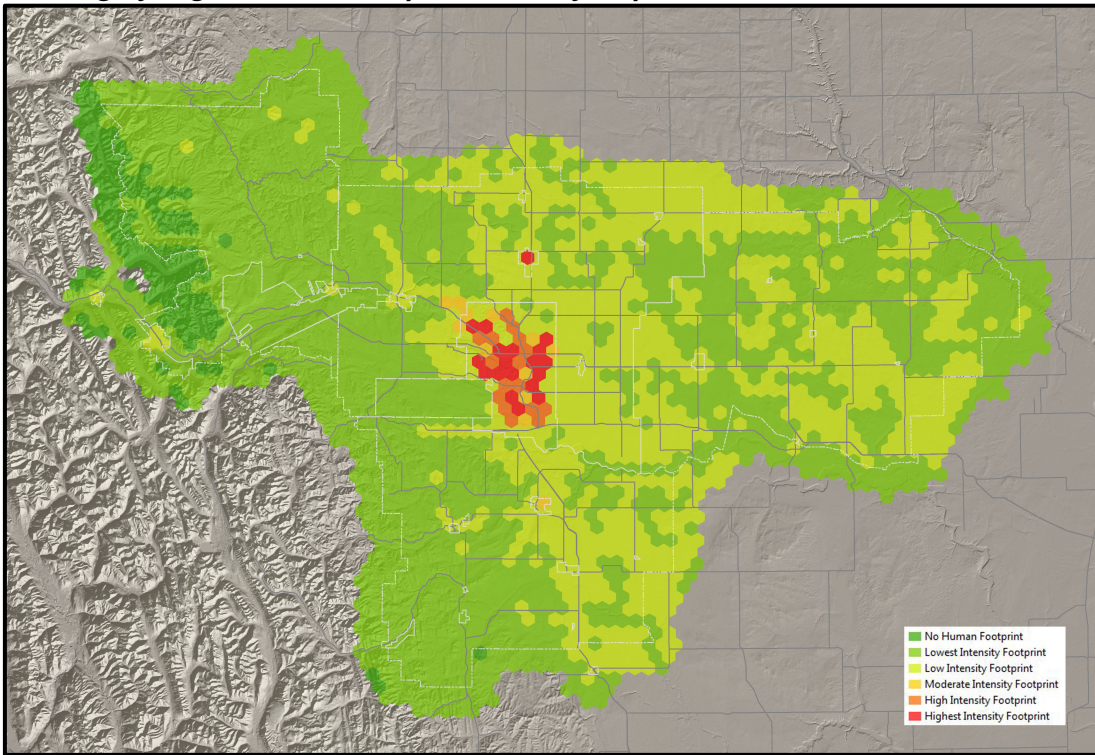*Figure 11: Calgary Region Human Footprint Intensity Map, 1000 ha (2007)*

Figure 12: Calgary Region Human Footprint Intensity Map, 1000 ha (2010)

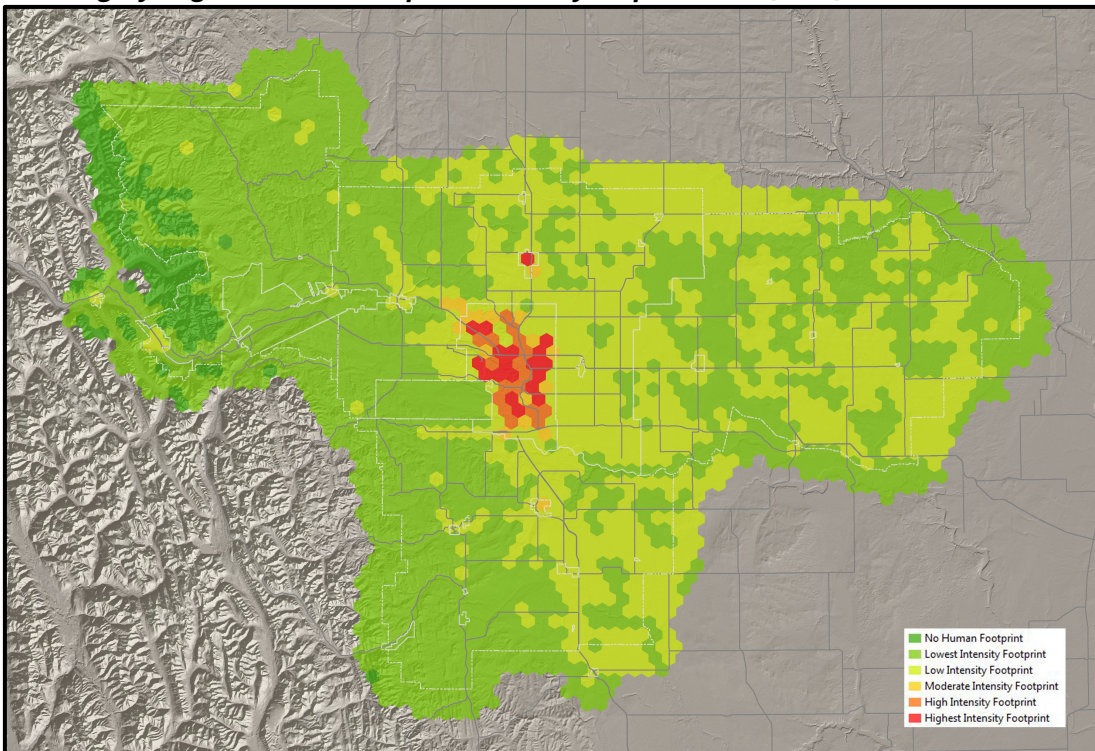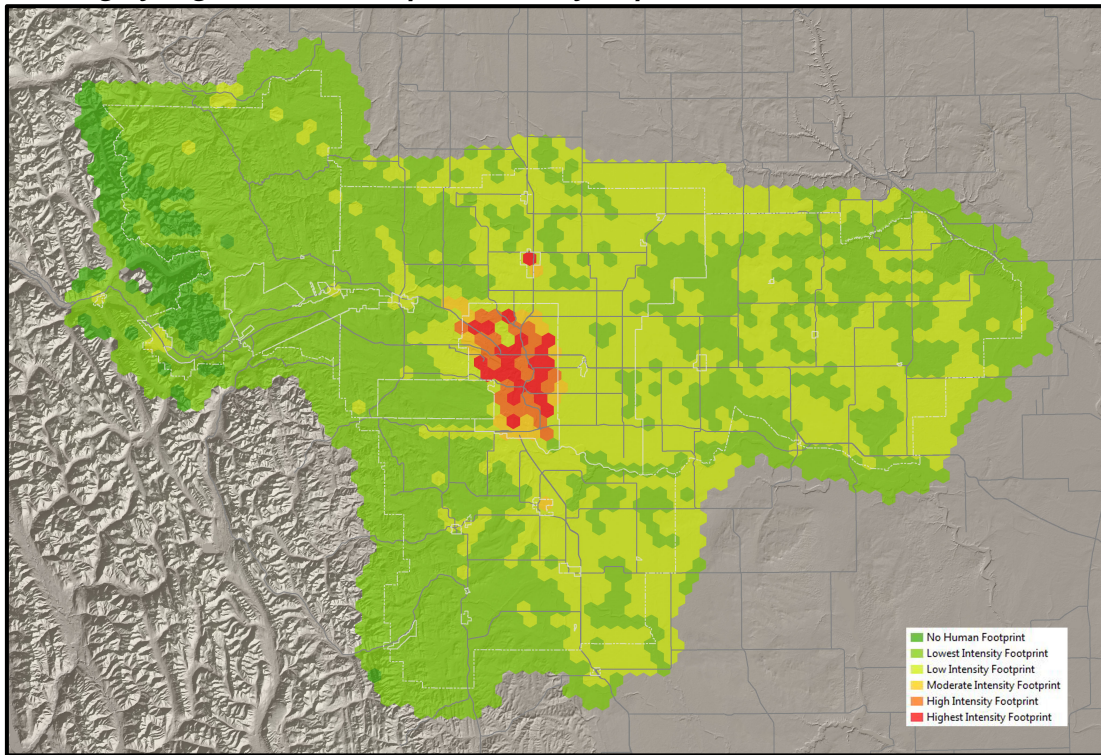*Figure 13: Calgary Region Human Footprint Intensity Map, 1000 ha (2012)*

Legend:
- No Human Footprint
- Lowest Intensity Footprint
- Low Intensity Footprint
- Moderate Intensity Footprint
- High Intensity Footprint
- Highest Intensity Footprint

Appendix 1: Detailed Human Footprint Intensity Scores from Advisory Group Workshop

GENERAL		DETAILED		
ABMI HF LAND USE TYPE	**CRP Human Footprint Type**	**ABMI HF LAND USE TYPE**	**CRP Human Footprint Type**	**HFI SCORE (0-10)**
Borrow-Pits/Dugouts/Sumps	Constructed Depressions	Borrow-Pits/Dugouts/Sumps	Constructed Depressions	4
Canals	Irrigation Canals	Canals	Irrigation Canals	9
Cultivation (Crop/Pasture/Bare Ground)	Agricultural Land	Cultivation (Crop/Pasture/Bare Ground)	Agricultural Land	2
Cut Blocks	Forestry Cut Blocks	Cut Blocks	Forestry Cut Blocks	4
High Density Livestock Operation	Feedlots	High Density Livestock Operation	Feedlots	10
Industrial Site Rural	Industrial Sites	IND-HIGH	Heavy Industry	10
		IND-LOW	Light/Medium Industry	8
		LANDFILL	Landfill Sites	10
Mine Site	Open Mines	Mine Site	Open Mines	10
Municipal (Water and Sewage)	Municipal Water Treatment	Municipal (Water and Sewage)	Municipal Water Treatment	9
Other Disturbed Vegetation	Open Vegetated Sites	Other Disturbed Vegetation	Open Vegetated Sites	4
Pipeline	Pipelines	Pipeline	Pipelines	3
Rail – Hard Surface	Railway	Rail – Hard Surface	Railway	9
Rail – Vegetated Verge	Railway Verge	Rail – Vegetated Verge	Railway Verge	7
Reservoirs	Reservoirs	Reservoirs	Reservoirs	5
Road – Hard Surface	Roads	ROAD-GRAVEL-1L	One-lane Gravel Road	5
		ROAD-GRAVEL-2L	Two-lane Gravel Road	6
		ROAD-PAVED-UNDIV-1L	One-lane Paved Road	6
		ROAD-PAVED-UNDIV-2L	Two-Lane Paved Road	7
		ROAD-PAVED-UNDIV-4L	Four-Lane Paved Road	9
		ROAD-PAVED-DIV	Major Thoroughfare Roads	10
		INTERCHANGE-RAMP	Roads - Ramps and Interchanges	10
Road – Vegetated Verge	Road Verges	SOFT_ROAD-GRAVEL-1L	Verge - One-lane Gravel Road	4
		SOFT_ROAD-GRAVEL-2L	Verge - Two-lane Gravel Road	5
		SOFT_ROAD-PAVED-UNDIV-1L	Verge - One-lane Paved Road	5
		SOFT_ROAD-PAVED-UNDIV-2L	Verge - Two-lane Paved Road	6
		SOFT_ROAD-PAVED-UNDIV-4L	Verge - Four-lane Paved Road	8
		SOFT_ROAD-PAVED-DIV	Verge - Major Thoroughfare Road	8
		SOFT_INTERCHANGE-RAMP	Verge - Ramps and Interchanges	8
Road/Trail (Vegetated)	Unimproved Roads & Trails	Road/Trail (Vegetated)	Unimproved Roads & Trails	4
Rural (Residential/Industrial)	Country Residential/Acreages	Rural (Residential/Industrial)	Country Residential/Acreages	7
Seismic line	Seismic Lines	Seismic line	Seismic Lines	3
Transmission Line	High Voltage Transmission Lines	Transmission Line	High Voltage Transmission Lines	7
Urban	Urban Settlements	Urban	Urban Settlements	8
Well Site	Wellpads	Well Site	Wellpads	9
Wind Generation Facility	Wind Turbines	Wind Generation Facility	Wind Turbines	9