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# Measuring Up: A Preliminary Assessment of Potential CRP EcoPlan Sub- Theme Measures

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A Preliminary Assessment of  
Potential CRP EcoPlan Sub-  
Theme Measures**

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# INTRODUCTION

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A vital linkage between the goals of the CRP EcoPlan (and Calgary Metropolitan Plan) and the ability for CRP members to individually and collectively act on them, is the development of a set of practical measures for each of the Ecological Conservation and Protection 'Themes.'

The CRP EcoPlan has refined the ecological conservation and protection Themes and led to this preliminary consideration as to how we might meaningfully measure and map some key components of the regional and local landscapes of the Calgary Region.

For each EcoPlan sub-theme, this report considers the following questions:

- What are the most meaningful things to measure regarding this sub-theme?
- What data and other resources already exist that would allow for measurement of these things? Where can we find, and how can we acquire this data?
- What critical data needs exist? What analysis is required in order to fill critical gaps? How can we fill these gaps and meet these needs?
- Is there any key information missing, which precludes meaningfully addressing any of the above questions? How do we gather the required information?

This report is intended to provide the CRP and other stakeholders with some solid guidance as to the opportunities and challenges in the practical measurement of the CRP EcoPlan Themes.

# REPORT STRUCTURE

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This report is organized around the CRP EcoPlan Themes, and Sub-themes. For each theme, there is an assessment of:

- *Measures That Matter* – a consideration of the practical measures that could be used for this theme

- *Available Data and Resources* – a preliminary assessment of the availability of datasets and information that could support this theme’s measurement
- *Data and Analysis Needs* – a consideration of the collection issues and possible pitfalls, and suggestions for the best approach to gathering the needed measurement information
- *Missing Information* – a brief analysis of the gap between what data and information is needed to capably measure the theme, and where we are today

# LANDSCAPE HEALTH THEMES

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## CONNECTIVITY ZONES

### Measures That Matter

Successfully conserving and protecting connectivity within the Calgary Region will be less about delineating and designating as protected “movement corridors”, and more about understanding the characteristics, dynamics, and sensitivity to land use change of the entire landscape viewed through a lens of connectivity. That is, the most meaningful measure of connectivity will provide an improved understanding of the entire regional network(s), rather than simply drawing lines around areas that are deemed important zones or corridors.

Assessment of connectivity is necessarily multi-scalar. Measures need to be relevant at the scale of a municipality or even an area structure plan, but the regional perspective is critical as changes at a site-specific level have the potential to cause major changes across the whole landscape.

We need to consider connectivity not just for terrestrial ecology, but also for aquatic and hydrological components of the landscape.

### Available Data and Resources

In 2012, A collaborative research effort spearheaded by Drs. Michael Quinn and Mary-Ellen Tyler undertook a regional-scale connectivity analysis. The details of this analysis are described in a report that was submitted to the CRP, and a peer-reviewed publication (Quinn et al, 2014).

Outputs of this analysis – connectivity networks and associated landscape metrics – have been shared with CRP staff, with the permission of the primary investigators. These data are also available to CRP members for internal use.

Quinn et al modeled connectivity based on ground conditions within the region in 2010, so the available data provides a valuable baseline understanding of one assessment of connectivity at a single point in time. This will help CRP members and stakeholders begin to understand their regional landscape from a connectivity perspective.

## Data and Analysis Needs

Any past efforts to understand connectivity at a regional or local scale have involved one-time analyses that produced static outputs and delineations of connectivity corridors or zones on the landscape. These have provided snapshots with some informative value, but lack the replicability, transparency of method, and applicability to the consideration of real land use planning problems that the CRP EcoPlan will require.

What is needed is less a discrete product, and more a standardized process for assessing connectivity in a way that makes sense to local and regional decision-makers and will assist them in planning growth management and other land use strategies. It should also be intuitive and replicable, even by GIS professionals with little or no background in landscape ecology.

A standardized process for modeling and mapping connectivity throughout the Calgary region is one of the foremost priorities for next steps in the Ecological Data Update component of the evolving CRP EcoPlan. Miistakis has developed a detailed proposal for undertaking this work; it is included as Appendix B.

## Missing Information

The main pieces missing from our current understanding of the importance of connectivity in the context of the EcoPlan, and how to best model, measure, and map it across the landscape, deal with questions around the theoretical underpinnings of modeling connectivity. For example:

- What types of connectivity are we interested in?
- How do we accurately represent the hindrances to connectivity?
- How do we present the results of connectivity in a meaningful way?

The proposed standardized process will involve consultation with the CRP and stakeholders, and facilitated discussion that will seek to generate the answers to these questions, from the people that will be using information about connectivity to make better land use decisions.

## ESCARPMENTS AND RIDGES

### Measures That Matter

Escarpments and ridges are important components of the regional landscape around Calgary. We can measure them by mapping their distribution on the landscape. If protection of these landforms is an objective of the CRP EcoPlan, we can track the amount of land use change that happens within these areas.

### Available Data and Resources

Escarpments and ridges were mapped on behalf of the CRP, as part of a previous ecological infrastructure mapping project. CRP may already have this data, or be able to secure access to it.

Digital Elevation data will be an essential input to the mapping of escarpments and ridges, and also will be useful to the creation of other landscape metrics. There are a few options for free digital elevation model (DEM) raster data that covers the Calgary Region. Three of these data sets have been assembled for the Calgary Region and shared with the CRP – different data sets are suitable for different respective purposes.

### Data and Analysis Needs

If the data is available to CRP, and if the previous delineation of escarpments and ridges still serves the needs of the CRP, then there is no need to re-map these features throughout the region. However, if changes are required or the data is unavailable, it will be necessary to precisely define these features and then map them.

### Missing Information

We have the data inputs we need in order to build a data layer representing escarpments and ridges. We lack some precise information regarding how these features are defined by CRP and stakeholders. We also need to better understand what constitute ecologically impactful change within these landscape features, and how to measure changes that may lead to undesirable impacts. We have a general sense of how this could work technically, but will rely on CRP and stakeholders to provide meaningful guidance on what precisely we should measure, and how.

## LARGE PATCHES OF NATURAL VEGETATION

### Measures That Matter

This sub-theme and the required data to measure and map it are, at least at a conceptual level, self-explanatory. Large patches of undisturbed natural vegetation obviously promote plant biodiversity, but they also serve as refugia for many wildlife species, often play significant roles in improving water quality and quantity, and provide a variety of other ecosystem services.

Knowing where large patches of undisturbed vegetation are within the region will help to measure and track these associated ecosystem services and set goals for conservation on private and public lands.

### Available Data and Resources

The Alberta Biodiversity Monitoring Institute (ABMI) Land Cover data set serves as a suitable starting point for measuring and mapping native vegetation cover. This free data set has been assembled and clipped to the Calgary Region, and provided to CRP staff for sharing with members and other stakeholders.

Miistakis has also undertaken a quick analysis of the ABMI data to extract native vegetation land cover classes, dissolve boundaries between adjacent polygons (e.g. native prairie adjoining shrubland), and calculate areas for these dissolved polygons. Arbitrarily assuming that “large patches” are any contiguous areas of natural vegetation greater than or equal to 160 acres (the size of a quarter section), a binary field was added to the attribute table that distinguishes “large” from “not large” patches. This data set, created from the ABMI data, has been shared with the CRP and serves as potentially useful data, or at least as an example of how we can use available data to measure this sub-theme on the regional landscape.

### Data and Analysis Needs

The ABMI Land Cover data differentiates between types of forest at the level of coniferous/deciduous/mixedwood, but does not specifically map the extent to which a given patch of forested landscape is “native”. Deviation from native state is largely a function of forest resource extraction; lands that have been previously forested may be new, barren cut blocks, newly planted blocks, or single-species plantations ready for the next round of harvest.

It might be useful, therefore, to supplement the ABMI land use layer with some stand age data from the Province, or from holders of Forest management Agreements within the region. However, these data have historically been very challenging to access, and they may not be available to the CRP for this work.

### **Missing Information**

The biggest missing piece regarding native vegetation is an answer to the question: “How big does a natural vegetation patch have to be for it to be considered ‘large?’” This discussion can happen among CRP Staff and its members, and incorporated into future versions of the data Miistakis has already provided to the CRP.

# WATERSHED HEALTH THEMES

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## WETLANDS

### Measures That Matter

Wetlands are a component of the regional ecological landscape that is essential to many conservation priorities for the CRP and its members. They play a vital role in the natural hydrological processes that promote water quality and availability. They are essential habitat for aquatic, avian, and terrestrial species. Healthy wetlands support important regional land uses like agriculture. Within the region and beyond, wetlands are a perennial conservation priority.

Knowing the precise and accurate location of wetlands is important, but it is likely not enough. To understand the role of wetlands to broader ecological conservation objectives and to track the changes to these sensitive and naturally dynamic features, we need to understand something more of the quality of wetlands. It will also be important to gain a sense of how wetlands have changed – both naturally and anthropogenically – over time.

### Available Data and Resources

Currently, the best publicly available wetlands data that covers almost the entire Calgary region is the Government of Alberta's Merged Wetland Inventory (AMWI). This product has cobbled together the best available wetland data from a variety of sources to create a single inventory for the province. The AMWI is not perfect, nor even sufficient to meet the probable needs of CRP EcoPlan. Aside from the variable quality of the data that went into creating the AMWI, it also combines data from different times, and is not likely to be repeated – precluding the chance of any longitudinality for the data. But it's the best data currently available, and it at least provides a general reference for where wetlands are in the region. Wetlands are mapped to general classes, (e.g. open water, marsh, bog, etc.). Miistakis has clipped the AMWI to the Calgary region and shared this data with CRP staff.

In c.2005, Rocky View County partnered with Ducks Unlimited to create a Drained Wetland Inventory for the county. The project mapped wetlands from air photos acquired in the 1960s and compared them to wetlands mapped in the early-mid 2000s, creating a two-stage change map. This serves as an interesting example that the CRP could consider following, and a potentially useful data set for portions of

the region. Rocky View County has allowed Miistakis access to this data, for work on the CRP EcoPlan. It will be shared with CRP staff.

Miistakis will also share a compound topographic index (CTI) with CRP. CTI is a steady-state moisture index, calculated by manipulating a digital elevation model (we used the methodology described here: <http://gis4geomorphology.com/topographic-index-model/>). The Miistakis CTI only covers a portion of the Calgary region, but it can be used for exploratory purposes, and a region-wide CTI could easily be calculated from one of the DEMs provided to CRP. CTI cannot predict the location or quality of wetlands on a landscape, but it does show locations with the capacity to collect and retain water, which might be useful in consideration of wetland restoration, constructed wetlands, or offset planning.

## **Data and Analysis Needs**

Understanding the importance, location and quality of wetlands within the Calgary region is a critical component of the CRP EcoPlan's Ecological Data Update. Not only is this essential information for the EcoPlan; it will be of significance to regional growth management plans, and to local and regional adherence to the anticipated Provincial Wetlands Policy.

The Government of Alberta has shown some commitment and dedicated substantial resources to accurately mapping wetlands across the province, recognizing that this data is a critical underpinning to administering, monitoring, and enforcing a wetland policy. However, all efforts to map wetlands province wide have fallen short of expectations, and led to the default AMWI being created as a provisional resource.

The wetlands mapping process undertaken by Rocky View County demonstrates the utility of such a data set, but filling the need in this way may be prohibitively costly, or difficult to coordinate across the region.

A standardized process for mapping wetlands throughout the Calgary region is one of the foremost priorities for next steps in the Ecological Data Update component of the evolving CRP EcoPlan. Miistakis has developed a detailed proposal for undertaking this work; it is included as Appendix C.

## Missing Information

The critical pieces missing from our understanding of how to meaningfully map and measure wetlands, and the spatial data that will be required, are contingent on meeting with CRP EcoPlan stakeholders to further refine the wetlands sub-theme and determine conservation objectives and related information/data needs. A directed discussion of these issues is a key component of the proposed Standardized Wetlands Mapping Process work.

## RIPARIAN AREAS

### Measures That Matter

Knowledge of riparian areas is an important need in support of growth management, land use, and conservation planning within the Calgary region. Many climate models predict a warmer, drier future for our region, and these interstitial ribbons of verdant vegetation and critical habitat are likely to grow in importance for conserving and connecting both terrestrial and hydrological landscapes.

To support the EcoPlan, municipal land use and conservation plans, and other local and regional initiatives, it is important to have an accurate measure, not just of the location of riparian areas, but also of their quality and condition.

### Available Data and Resources

No suitable data currently exists that maps riparian areas within the Calgary region. The Province's Grasslands Vegetation Inventory has a riparian "view", but the structure of the data base (in some cases containing many overlapping polygons, each describing the ecosite differently) and the subjectivity with which riparian features were mapped make this data impractical for use.

The typical approach to mapping riparian areas involves a crude spatial estimation process, wherein buffered polygons are created at a specific width around water features. This approach, though easy to follow and relatively cheap to produce, ignores any differences in local land form, leading to a gross overestimation of riparian areas in confined areas (e.g. canyons, or kettle lakes) and a likely underestimation in more open areas (e.g. prairie streams, coulees, or shallow depressions).

## Data and Analysis Needs

As suggested above, we currently lack an accurate sense of where riparian areas are. And without reliable locational data for riparian areas, it isn't yet feasible to consider questions around riparian health. However, there are some options to explore to fill these gaps, with a good chance of producing favourable results.

One option for mapping riparian areas is to do so using satellite image interpretation. Miistakis has mapped riparian areas using this method in the past, with some success. The imagery used as inputs are freely available, and cover a wide range of dates. This would allow a prescribed classification method to be applied to a broad temporal range of images, and provide for a longitudinal assessment of changing riparian conditions; and also replication of this method into the future. However, satellite image interpretation is a specialized sub-discipline of GIS, requiring some expertise to perform. The process may also require special software, representing an added cost.

A simpler and more accessible approach, that may yield acceptable results, is to map riparian areas by modifying the buffer approach described above to account for terrain. This could be achieved by first buffering water features, then altering these buffered polygons to reflect the terrain surrounding them. This approach would require only a DEM, data showing location of hydrological features, and standard GIS software applications.

Once riparian areas are mapped, some assessment of the quality of these areas will be necessary before deciding what target conditions are, and what strategies are required to set and achieve these targets.

The Alberta Riparian Habitat Management Society (a.k.a. Cows and Fish) has developed a standardized, proven methodology for assessing riparian health, including user guides and associated tools. Their approach is well-documented. Although it is designed to be used on individual properties by local land owners, there may be a way to adapt this methodology to inform the design of a spatial modeling approach to region-wide riparian health assessment. This will never replace the need for site-specific assessments, but shows promise for its potential to provide a regional or sub-regional perspective on riparian health.

## Missing Information

Ongoing discussion with CRP stakeholders will be essential to make sure that we are creating meaningful measures and data sets to support the EcoPlan.

## WATER QUALITY

### Measures That Matter

The CRP EcoPlan will focus on reducing surface and ground water pollution. This will require an accurate, region-wide way in which to measure to extent to which pollution is occurring, and sources of this pollution.

### Available Data and Resources

The Government of Alberta monitors water quality along all major watercourses in the province, and publishes this data to a web site in near-real-time. The data is available through this link:

<http://www.environment.alberta.ca/apps/basins/default.aspx>

Most of the Calgary Region is within the Bow River Basin. This basin has 15 monitoring stations, 2 of which are likely east of the regional boundary.

It would be inefficient to extract data from this web site and convert it to a useful spatial data layer, but contacting the stewards of this data directly may help identify other opportunities for using this data.

The other potentially useful resource is a reporting and monitoring tool created for the Bow River Basin Council (BRBC) called the Web-Based State of the Watershed (WSOW) Tool. <http://brbc-wsow.ca/brbc/index.php>

WSOW is designed to map water quality and quantity indicators across the watershed at a sub-basin scale. It compiles data from various sources, live-linking data when possible and relying on BRBC or support staff to update other indicators.

The BRBC WSOW may be useful to the CRP as-is, to monitor water quality conditions throughout the Bow Basin portions of the region. The context information provided in WSOW, related to indicators, thresholds, and interpreting data, may also be instructive to CRP stakeholders when discussing what to measure, setting targets, and planning strategies for achieving water quality conservation objectives.

For groundwater quality, the only potentially useful resource identified through this research is the Government of Alberta SSRP Groundwater Vulnerability data set: <https://geodiscover.alberta.ca/geoportal/catalog/search/resource/details.page?uuid=%7B835844A6-7576-48C1-A674-E602B2A54BE1%7D>

This data has not been acquired or explored, but the metadata document describes it as a “high level overview of the sensitivity of shallow groundwater quality to potential impacts by surface activities.” As such, it may serve as at least a good starting point for measuring the potential impacts of land use on groundwater quality.

## Data and Analysis Needs

The existing array of hydrological monitoring stations within the Calgary Region is quite sparse. There are no stations on smaller streams, and (probably) only fewer than 20 stations over the entire region. The extent to which this is a concern is not presently known; the movement of water – at least in terms of its direction of flow – is predictable and unchanging for the foreseeable future; therefore, water quality at a downstream point is known to be the result of whatever has happened upstream. Some elements of this sub-theme may not require region-wide mapping.

If the CRP desires a denser sampling than current monitoring allows, this might be an excellent opportunity for a citizen science project. Water is a conservation issue that many Albertans care deeply about, and many key indicators of water quality are relatively easy for laypersons to measure. A citizen science project may serve the dual purpose of both filling critical data gaps for the region, and engaging residents of the region in hands-on water stewardship activities. There are even existing water quality citizen science initiatives that could be drawn upon for guidance (e.g. RiverWatch/CreekWatch – <http://www.riverwatch.ab.ca/science/creekwatch#>).

Although the Groundwater Vulnerability data set shows initial promise as a starting point for measuring and understanding threats to groundwater quality, there are numerous significant gaps related to groundwater (e.g. How much groundwater is beneath the region? Where is it? What is its “natural” quality? How do different surface and sub-surface human uses impact groundwater quality?). These represent serious challenges to the aims of the CRP EcoPlan, and other regional planning initiatives.

## Missing Information

Ongoing discussion with CRP stakeholders will be essential to make sure that we are creating meaningful measures and data sets to support the EcoPlan. Specifically, it is essential to determine what desired conditions of water quality are, and the range of deviation from these conditions that are tolerable in the short and longer terms.

Water is a critical resource, and most municipalities have protocols for monitoring water quality. The monitoring protocols followed by individual municipalities, the extent to which municipal data might be harmonized, and the way that this data might be used to create meaningful measures, targets, and strategies, are all avenues of enquiry that remain unexplored.

The BRBC is a key stakeholder in EcoPlan themes related to water. Keeping abreast of their efforts to monitor and protect water quality within the region will ensure alignment of purpose and objectives, and make best use of the work the BRBC is doing.

## WATER QUANTITY

### Measures That Matter

Regarding water quantity, three main things are important to measure:

1. Water supply or availability: How much water is in the region? How much of that water is available for human use? Are the limitations on this availability imposed by ecological constraints, or legislative (licensing) constraints, or infrastructure (servicing) constraints, or all three? Are there seasonal variations in water supply?
2. Water demand or consumption: How much water is the region using individually or collectively? What amount of water use is associated with different human activities (household consumption, industry, etc.)?
3. Water balance: Does the supply of water within the regional system meet the demand? How much of a surplus remains in the system for downstream use? Conversely, how much demand is there in excess of supply?

Each of these three components must be measured both in present time, and in the future, responding to predictable and foreseeable changes like population growth and also to less certain changes to global, regional, and local climate regimes.

## **Available Data and Resources**

Certainly, the amount of water available for use based on legal constraints is known. Water has been a contentious issue within the Calgary region since before the inception of the CRP, and allocated water licenses are known quantities. Research and arithmetic should be all that's required to tally water license amounts across jurisdictions within the region. However, water licenses are not tied to physical availability of water, and many Alberta watersheds are allocated beyond their hydrological capacity.

The province monitors flow rates in all major rivers and streams through an array of monitoring stations (see water quality, above) – there are more gauges monitoring flow rates than water quality. These flow rates could be used to infer region-wide availability via surface water sources.

Most, but not all households of the Calgary region are metered for water use. Although general figures are available, water use is not metered for many industrial activities. Farm water metering in Alberta is voluntary, and agriculture is the most water-intensive human activity in the region.

The Water Footprint Assessment approach is one option for a rigorous, widely-used, well-documented method of calculating water use within the region. The process calculates the amount of water required for all land uses within a study area. More information can be found at [www.waterfootprint.org](http://www.waterfootprint.org), or by reviewing The Water Footprint Assessment Manual ([Hoekstra et al, 2011](#)).

A range of possibilities exist for measuring water balance: from empirical measures of water consumption versus availability; to more qualitative assessments like tracking water shortages or water use restrictions in a systematic way.

## **Data and Analysis Needs**

Very little is known about the quantity and distribution of available groundwater in Alberta. This is a critical gap, and a hindrance to accurate measurement of regional water quantity.

On the consumption side, the biggest gap is that not all water consumption is recorded. Metering of all use of water would greatly improve the ability to measure regional water quantity.

## **Missing Information**

Ongoing discussion with CRP stakeholders will be essential to make sure that we are creating meaningful measures and data sets to support the EcoPlan.

## **SOURCE WATER**

### **Measures That Matter**

In order to set targets and strategies for source water protection, the CRP EcoPlan will require a clear understanding of the dynamics of the entire regional hydrological system. Some elements of this system are better understood through spatial data, and some not.

Aside from understanding the location, role, interconnectedness, and relative importance of different components of source water, it will also be important to understand the threats to security of these source water resources, and the potential impact of different kinds of threats.

Lastly, some understanding of elements of the regional ecology or built environment that serve to protect source waters would be a useful consideration in planning for source water protection.

### **Available Data and Resources**

As previously mentioned, there is a province-wide dearth of knowledge of the complex dynamics of hydrological systems. This translates to very little available data describing source water and connected hydrological dynamics, either spatial or non-spatial. In the SSRP source water was only very coarsely mapped, using crude landscape metrics and resulting in most of the foothills and subalpine natural subregions being identified as significant.

Springs, seeps, and other elements of this landscape are not systematically mapped in Alberta. Perhaps there is an opportunity for citizen science to play a role here, but it may be difficult to garner enough participation to generate a comprehensive

data set, owing partly to landowners' potential sensitivity to sharing information about their private property.

Unfortunately, the only accurate means of measuring the health of source waters, given the lack of sufficient information, might be to monitor water at the point of consumption, and track when lapses occur in quality or quantity of available water. From there it may be possible to infer back to land uses as potential sources of the problem, but this logic is speculative and difficult to defend, and regardless only provides a chance to react to unfavourable circumstances.

There may be value in considering the Groundwater Vulnerability data set mentioned above (see Water Quality) for potential use in this sub-theme.

With so little to build on in this theme, it may be more profitable to dedicate effort to conservation sub-themes that will incidentally help conserve source water resources. The wetlands, riparian, water quantity, and water quality sub themes are all closely related; flood zones and native vegetation more peripherally.

It seems likely that the most fruitful initiatives in this sub-theme will not be built on the foundation of spatial data sets.

## **Data and Analysis Needs**

As mentioned, precise spatial knowledge of the dynamics of hydrological systems, especially groundwater and these essential source water resources, is woefully lacking in Alberta. This represents a serious gap in our understanding of the natural environment, and a major hindrance to conservation and responsible land use planning at all scales.

## **Missing Information**

Ongoing discussion with CRP stakeholders will be essential to make sure that we are creating meaningful measures and data sets to support the EcoPlan. Other initiatives to identify and protect critical headwater and source water resources are ongoing; perhaps these can inform the work of the CRP, and the EcoPlan can benefit from the anticipated success of these efforts.

# NATURAL SPACES THEME

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## NATURAL OPEN SPACE

### Measures That Matter

Aside from mapping the location of natural open spaces within the region, the CRP may wish to measure the density or distribution of such features across the landscape.

### Available Data and Resources

To an extent, natural open space will be mapped and measured using the data assembled other sub-themes, notably native vegetation. However, the definition of a “large” tract of natural vegetation is quite likely different in an urban setting than the region-wide context, so some other data will be important to consider:

- Within urban areas, it is possible to use ABMI data sets to map natural (undeveloped) sites with native vegetation.
- The City of Calgary has a “Natural Area Parks” designation. These areas could be included, as could similarly designated open spaces in other jurisdictions.
- Provincial parks and [protected areas](http://www.albertaparks.ca/media/2941843/parks_and_protected_areas_alberta.zip) are mapped in a publicly available data set:  
[http://www.albertaparks.ca/media/2941843/parks\\_and\\_protected\\_areas\\_alberta.zip](http://www.albertaparks.ca/media/2941843/parks_and_protected_areas_alberta.zip)

### Data and Analysis Needs

All data required to map natural open spaces throughout the region is readily available, or relatively easy to produce.

Potentially useful analysis might include calculating the density (e.g. in area per square kilometre) of these spaces, or a raster surface showing the distance to nearest natural open space.

### Missing Information

The only significant missing piece is a clearer sense of what is meant by natural open space, and what is the desired/measurable outcome of conserving these

spaces. Ongoing discussion with CRP stakeholders will be essential to make sure that we are creating meaningful measures and data sets to support the EcoPlan.

## **URBAN FOREST**

### **Measures That Matter**

By design this sub-theme is confined to urban areas. Meaningful measures might include an enumeration and/or mapping of urban trees or forests, or a calculation of the value of ecological services that these features provide.

### **Available Data and Resources**

Many CRP municipalities maintain a record of trees that are planted on municipal property, for purposes of asset reporting, public works maintenance, etc. These could provide a valuable basis for mapping and measuring urban forests.

### **Data and Analysis Needs**

It will likely be more difficult to gain a sense of trees and forests planted on private properties. This gap can be filled through analysis of satellite or orthoimagery, or simply noted as a limitation of the measurement of urban forests.

### **Missing Information**

Ongoing discussion with CRP stakeholders will be essential to make sure that we are creating meaningful measures and data sets to support the EcoPlan.

## **PERMEABLE SURFACES**

### **Measures That Matter**

It is likely that the most useful measure for this theme, if a region-wide spatially explicit measure is possible, is some form of permeability index, assigning a value to each land use or land cover type that reflects its ability to absorb water.

### **Available Data and Resources**

At the regional scale, the ABMI Human Footprint and Land Cover inventories would be suitable inputs for the creation of a permeability index.

Finer scale data may be available for some municipalities, but likely not all.

Soils and surface geology data could help to refine the permeability scores assigned to land cover types. These are available for most of the Calgary region (excluding the “Green Zone” of the province) via the AGRASID data product:

[http://www1.agric.gov.ab.ca/\\$department/deptdocs.nsf/all/sag5173?opendocument](http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/sag5173?opendocument)

## **Data and Analysis Needs**

If a finer scale assessment of permeability is essential, it would likely need to be created through classification of land use and land cover to a level relevant to assessing permeability.

Processing of input data would be required to create meaningful land use / land cover types, determine appropriate relative or absolute permeability values, and calculate the permeability index.

## **Missing Information**

Consultation with CRP EcoPlan stakeholders, identified experts, or an appointed advisory group, would be required in order to evaluate the relative permeability of all land use and land cover types.

Ongoing discussion with CRP stakeholders will be essential to make sure that we are creating meaningful measures and data sets to support the EcoPlan.

## **NATURAL FLOOD ZONES**

### **Measures That Matter**

To preserve the ecological function of Natural Flood Zones, we need to know where they are located. We may also wish to understand the extent to which these zones have been developed, the resultant impact on ecological function, and the required measures, targets, and strategies to preserve viable flood zones within the region.

### **Available Data and Resources**

Following the major floods of 2013, the Government of Alberta undertook to map all Flood Hazard Areas within the province. The data set identifies both floodways

and flood fringes – respectively, the Red and Pink Zones commonly recognized by most residents of southern Alberta. This data set is publicly available through the GeoDiscover Portal, and is described here: <http://esrd.alberta.ca/water/programs-and-services/flood-hazard-identification-program/flood-hazard-mapping.aspx>

Although they have been mapped for purposes of hazard assessment, these data may serve as a useful starting point for identifying flood zones for ecological conservation purposes.

As a component of revising their Land Use Bylaw – a process which is nearing completion – the MD of Foothills has mapped flood zones within their municipality. If the mapped flood zones have not been extracted directly from the provincial hazard mapping data described above, and if the MD is willing to share their methods for mapping flood zones, then this mapping may serve as a methodological model for other municipalities in the region to follow. The flood zone layer was shared with Miistakis (under a data sharing agreement), and passed on to CRP staff as part of the Land Use Zoning data.

## **Data and Analysis Needs**

It seems likely that the CRP can get what it needs for delineating flood zones from existing and publicly available data.

To assess the extent to which development has encroached on flood zones, human footprint intensity (HFI) data – or even the ABMI Human Footprint Inventory data that was used to calculate HFI – could be summarized within the mapped flood zones. This could be the starting point for discussions around permitted or restricted uses of these areas, or as the basis for a deeper and more rigorous analysis of the effect different land use types have on decreasing desired ecological function within the flood zone.

## **Missing Information**

Ongoing discussion with CRP stakeholders will be essential to make sure that we are creating meaningful measures and data sets to support the EcoPlan.

# FOOD PRODUCTION THEME

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## AGRICULTURAL LAND BASE

### Measures That Matter

The CRP is currently developing a regional strategy called Food Secure, with the objective of working toward a stated CMP goal of “continued access to safe, affordable, and sustainably produced food for the region's population.” The Food Secure process has identified 6 goals, some of which can translate easily into mappable measures and targets under the Food Production Theme of the EcoPlan.

Critical to measuring food production capacity is an understanding of the agricultural land base; the regional landscape's capacity to produce food for its residents, and threats to this capacity.

### Available Data and Resources

Understanding what crops are grown where can inform discussions of food production capacity, and what might be possible for the regional crop-growing and food-production future.

Agriculture and Agri-food Canada has produced an Annual Crop Inventory every year since 2009. This Inventory maps farm crops by type throughout the agricultural regions of Canada using a satellite image classification method that is validated through comparison to crop insurance data ([AAFC 2015](#)). The inventory covers all food-production regions of the Calgary region, and is available for free download through the Government of Canada's [Open Data Portal](#):

<http://open.canada.ca/data/en/dataset/ba2645d5-4458-414d-b196-6303ac06c1c9>

One of the biggest threats to agricultural capacity in the Calgary region is conversion of cropland to other uses, most notably residential development.

The human footprint intensity data layers created by Miistakis during the first phase of this research project, along with the soon-to-be-completed regional generalized land use zoning mapping, can help us understand development trends and pressures within the region.

In addition, Miistakis developed a rural residential density layer in 2012, mapping residential structures per quarter section back over 100 years. The data is current to 2010, and covers all regional municipalities except Wheatland County. This data set shows spatial patterns of rural residential expansion and can help the CRP and its members better understand threats to agricultural capacity. It has been shared with the CRP, and is available publicly at [www.rockies.ca](http://www.rockies.ca).

## **Data and Analysis Needs**

There are some useful data sets to help understand food production capacity in the regional context. The biggest gaps, however, exist at finer scales; it might be useful to acquire or create data layers describing the location and capacity of market gardens, community garden plots in urban and rural locations, and local direct-to-market producers, community-supported agriculture (CSA) businesses, etc.

## **Missing Information**

The Food Secure Strategy is still in early stages of development, with implementation expected in 2017. As Food Secure progresses, it will be important to keep abreast of new developments that might guide measures, targets and strategies in this theme.

# AIRSHED HEALTH THEME

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## AIR QUALITY

### Measures That Matter

To assess status and set targets for this sub-theme, reliable, accurate and timely measures should be acquired on all of the air quality indicators monitored by the Calgary Regional Airshed Zone (CRAZ). Present measures should be compared both to provincially mandated air quality standards, and to some ideal or optimal standard promoting healthy living and a healthy environment.

### Available Data and Resources

CRAZ maintains three active monitoring stations, dispersed throughout the City of Calgary. It would be difficult to create a region-wide measure of air quality using only three proximate stations.

However, CRAZ also maintains a network of approximately 40 passive monitoring stations, dispersed throughout the CRAZ region (which includes the entire Calgary region). These stations only record NO<sub>2</sub>, Ozone, and SO<sub>2</sub>, but they might serve as basis for a general regional depiction of air quality.

CRAZ has worked to create management plans that may be of use in setting desired targets and thresholds.

### Data and Analysis Needs

Further exploration is required to determine if any other useful resources exist. Municipalities may monitor air quality, and there may be a need to establish a regional monitoring standard to complement the CRAZ monitoring protocol.

### Missing Information

Ongoing discussion with CRP stakeholders will be essential to make sure that we are creating meaningful measures and data sets to support the EcoPlan.

## **GREENHOUSE GAS MITIGATION**

### **Measures That Matter**

It might be useful for the CRP to develop a process for periodically measuring GHG emissions throughout the region, and tracking these against desired targets and established thresholds.

### **Available Data and Resources**

A non-spatial approach may be the best way to measure GHG emissions in the Calgary region.

There are numerous resources to help individuals or municipalities calculate GHG emissions for individuals, corporations, or municipalities (e.g. <http://www.ghgprotocol.org/calculation-tools>). Such tools could help the CRP to conduct an emissions audit for the region, and potentially develop a standardized auditing protocol for the CRP and its members. This would allow CRP to track emissions on an ongoing basis, and help with the setting of targets and thresholds.

### **Data and Analysis Needs**

In order to devise an emissions monitoring protocol and subsequent strategies that work, some expertise in this field is likely required to ensure that a consensus-based, attainable approach to managing GHG emissions is reached.

### **Missing Information**

Ongoing discussion with CRP stakeholders will be essential to make sure that we are creating meaningful measures and data sets to support the EcoPlan.

## REFERENCES

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