Using ALCES Online for Cumulative Effects Assessment of Central Barren-Ground Caribou Herds – Training Guide

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ALCES

Sustainable Landscapes Sustainable Futures

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1 Introduction

ALCES Online is a web application for cumulative effects assessment that consists of the following tools:

- Maps for viewing data;
- Data Library for importing and managing data layers;
- Advanced Calculator for building indicator relationships;
- Charts for preparing indicator dashboards;
- Mapper for landscape simulations; and
- PopDyn for population dynamic simulations.

This training session will introduce participants how to use the Maps, Data Library, and Dashboards to view and import data. Participants are also introduced to how to prepare new layers by defining expressions using Advanced Calculator.

Additional details on ALCES Online are available in the ALCES Online User Guide. The user guide is available within ALCES Online by clicking the **?** icon in the top left corner and also as a google document.

2 Using the Maps Tool: An introduction to viewing data

1. **Sign In.** Open ALCES Online by going to www.online.alces.ca and using the login (cimpbgc) and password (caribou259).

2. **Maps Tool.** Part 1 focuses on the Maps tool. Click the globe icon to access the Maps tool.

ALCES Online is made up of a number of tools (User Guide Section 2). The tools can be accessed from the home screen by clicking the icons in the top left corner of the screen.

ALCES Online contains a large volume of time sequenced and area based cell data and regions. The Maps Tool allows the user to create customized maps of these data. The Maps Tool has three panels: the Mapping Options panel on the left, the Map Panel in the middle, and the Graph panel on the left. This exercise introduces the user to the Maps tool, with an emphasis on the Mapping Options panel that is used to define a map.

A variety of basemaps are available. Basemaps are selected by clicking the Layers icon in the top left corner of the Map Panel.

The +/- buttons below the layers icon can be used to change the zoom.

3. **Data and Analysis.** From the Mapping Options panel, click the Data & Analysis button and then click Select Indicator.

The data layers that are available can be reviewed by clicking the list icon to the right of the Add Indicator… box. The indicators are organized into categories (folders). Clicking a folder will display the layers that are available within the category. Placing your mouse over top of an indicator will display an “i” symbol that can be clicked to access metadata.

Table 1 provides an overview of the data layers that are available within the Maps tool.

- A dataset important to how ALCES Online calculates indicators and simulates landscape change is called the Unity data set. The Unity data set is a collection of natural and anthropogenic cover types that account for the entire landscape.
- ALCES Online represents space using cells, and each cell is covered by one or more of the cover types in the unity layer such that coverage by the types sums to 100%. The layer is prepared by intersecting land cover and footprint inventories to generate a non-overlapping representation of landscape composition.
- Landscape composition is modified during simulations by converting unity types in such a way that maintains total coverage at 100%. Unity types are also used as covariates in indicator equations (e.g., caribou RSFs).
- When preparing indicator equations and landscape simulations, it is important to understand which land cover and footprint types make up the unity layer so that your analysis respects the assumption of 100% coverage.
- The unity dataset is located in the folder CBGC Unity and consists of a number of natural and anthropogenic cover types.

Table 1: Indicator categories (folders) available in the Maps tool.

Indicator Category	Description
BNE RSF, BNW RSF, CBA RSF, TP RSF	These folders contain seasonal RSFs (e.g., BNE RSF - Calving) and 0-1 habitat indices (e.g., BNE expRSF linear stretch - Calving) for each herd, as well as related datasets used in the preparation of the RSFs and habitat indices. The RSFs and habitat indicates were prepared using each herd's MCP-based annual range as the study area.
Barrenground Caribou Seasonal Popdyn Output	Simulated total population by season for each herd in response to the high development and climate change scenario. The study area for the simulations were each herd's MCP-based annual range.
Basic Geography	DEM variables
CBGC Unity	Landcover and footprint types[1]
Climate	Historical and project future (RCPs 4.5 and 8.5) monthly climate variables (average/min/max temperature, precipitation, precipitation as snow, evaporation, shortwave radiation)
Coordinates	Latitude and longitude
Distance to footprints	Distance (m) to each footprint type.
Ecoregion Shift Climate	Ecoregion shift and refugia variables that were applied when simulating land cover shift in response to climate change.
For use in Mapper	Variables used in landscape simulations. These variables are not meaningful as outputs.
Forest Disturbance Metrics	Forest age and fire variables. *CBGC Forest Age* is the variable to select to view forest age outcomes from simulations. It is also the variable applied in the RSF equations.
Landscape Summary	Landscape summary variables calculated by adding landcover and/or footprint types together.

[1] Two versions exist for a subset of cover types that were adjusted to remove footprint that occurs exclusively on waterbodies. These types include: Road Winter No Waterbody; Other Footprint – Road No Waterbody; Cutline adjusted; Mining and exploration adjusted; and Waterbodies adjusted.

Moving winter 10km footprints	Footprint area within 10 km of each 1-km cell. Used when preparing caribou RSFs.
Popdyn Inputs	Variables prepared for use in Popdyn. Most of the variables relate to modifying mortality and fecundity rates in response to climate change. Also includes initial population variables that are applied at the start of Popdyn simulations.
Seasonal Caribou Climate	Climate summaries calculated for each herd and season based on the timing of seasonal ranges. These seasonal climate summaries are used as covariates in the caribou RSFs.
Snow depth indicators - BGC	Annual and seasonal snow depth projections under RCP 8.5. Fall seasonal snow depth is used to adjust fecundity in popdyn simulations that incorporate climate change.
Wildlife Population Dynamics - Barrenground Caribou	Output variables for the Popdyn simulations. These variables are currently empty (i.e., no data).

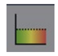
2.1 Mapping Tool Data Viewing Exercise

This exercise provides an introduction to the options that are available when preparing a map of a data layer, using *Sub-polar or polar shrubland-lichen-moss* as an example. Mapping options are described in greater detail in section 3.1 of the user guide.

a. **View metadata**. Open the *CBGC Unity* folder, hover the cursor over *Sub-polar or polar shrubland-lichen-moss* and click the i that appears to view the metadata.
b. **Create a map**. Click *Sub-polar or polar shrubland-lichen-moss*. Click the green GO button on the left panel to produce a map
c. **Change the study area**. Click Select Study Area in the top of the left panel. Click the check mark to the right of "Central Barren Ground Caribou Study Area". Click the View List icon that appears. Open the folder *BNE MCPs Females* and click *BNE_MCP_all_seasons_females_only_2005_19*. Then click the green GO button to produce a map. Other study areas that are available are summarized in table 2.
d. **Change the resolution**. Increase the resolution to 10000 m and click GO again.
e. **Create a timeseries map**. Create a dynamic map showing the response of *Sub-polar or polar shrubland-lichen-moss* to the scenario "CBGC High Development Scenario". To do this, click the wrench icon located beneath the indicator name in Choose Existing, and select the scenario. Then adjust the time bar under Map Type so that it goes from 2010 to 2060 (click and drag to the right). Click GO. View the dynamic map by clicking play or dragging the time bar located on the map panel.
f. **Change from heat map to grid**. Change the display mode by clicking the Select Map Style button and selecting Grid Cell
g. **Change the breakpoints**. Change the breakpoints by clicking the wrench icon beneath Breakpoints and Color Scheme options. The default breakpoint option is Equal Quantiles (i.e., set breakpoints to divide cells area equally across non-zero categories). Click the smaller wrench icon to enter user-defined breakpoints of 35, 30, 25, 20, 15, 10, 5 (starting from the top). Click GO.
h. **Change the colour scheme**. Change the colour scheme by clicking the palette to the left of the breakpoints. Select the 2nd option from the left. Click GO to implement the colour scheme.
i. Add region layers. Region layers are polygons that can be added to maps as overlays. The region layers that are available are the same set of polygons that are available as study areas (Table 2). To add an overlay, click Layers and then Regions in the left panel. Sub-regions occurring within each region category can be explored by clicking the folder icon. To view a region category or sub-region as an overlay, click the box to the left. As an example, click the box to the left of Seasonal UDs Bluenose East to view them as overlays. If they do not appear, click the layer icon in the top left corner of the map window and slide Region Opacity to the right; you may need to scroll down to view Region Opacity. To view individual seasonal UD, click the folder and use the check boxes. To identify the name of one of the Seasonal UD overlays, click the arrow (Select a layer) icon in the Map Tools bar and click one of the Seasonal UDs in the map.

The following exercise provides an opportunity to explore data layers and continue to practice using the Maps tool

1. **Topography example - Elevation**
    a. Click "Select Study Area" and set the study area to *5_herd_MCPs* which is located in the *Multi Herd MCPs Females* region folder
    b. Click "Select Indicator" and open the Basic Geography folder
    c. Select *Mean Elevation*
    d. Set the resolution 1000 m

   e. Set the time bar to start at 2010 and end at 2010.
   f. Click “Select Map Style”. Select the Equal Quantiles breakpoint option by clicking the equal quantiles icon 
   g. Click GO

2. **Linear footprint example - Road Minor**
   a. Open the *CBGC Unity* folder
   b. Select *Road Minor*
   c. Click GO
3. **Polygonal footprint example - Settlement**
   a. Open the *CBGC Unity* folder
   b. Select *Settlement*
   c. Click GO
4. **Forest disturbance example - Forest Age**
   a. Open the *Forest Disturbance Metrics* folder
   b. Select *CBGC Forest Age*
   c. Click the wrench icon and set the scenario to *CBGC High Development Scenario*
   d. Set the time bar to start at 2020 and end at 2060
   e. Click Select Map Style and then click the wrench icon below and to the right of “Quantification”. Enter the following Custom Breakpoints: 100, 80, 60, 40, 20, 10, 0.
5. **Climate example - June Temperature**
   a. Open the *Climate* folder
   b. Select *June Average Temperature*
   c. Click the wrench icon and set the scenario to *CanESM2 RCP 8.5*.
   d. Set the time bar to start at 1990 and end at 2030.
   e. Click “Select Map Style”. Select the Equal Quantiles breakpoint option by clicking the equal quantiles icon 
   f. Click GO
6. **Snow depth example - Fall snow depth**
   a. Open the *Snow depth indicators - BGC* folder
   b. Select *BGC fall snow depth*
   c. Set the time bar to start at 2010 and end at 2060
   d. Click GO
7. **Ecoregion example**
   a. Open the *Ecoregion Shift Climate* folder
   b. Select *Ecoregion level*
   c. Set the time bar to start at 2010 and end at 2050
   d. Click GO
8. **RSF example**
   a. Change the study area to *BluenoseEast_Summer_MCP_females_only_2005_19* from the *BNE MCPs Females* folder.
   b. Open the *BNE RSF* indicator folder

c. Select *BNE expRSF linear stretch - Summer*
d. Click the wrench icon and set the scenario to *CBGC High Development Scenario*
e. Set the time bar to start at 2010 and end at 2060
f. Click GO

Table 2: Region categories (folders) available in the Maps tool.
Categories that contain regions that are being used as study areas for simulations in the project are underlined.

Region Categories	**Description**
BNE MCPs Females, Bathurst MCPs Females, BNW MCPs Females, Capebathurst Mcps Females, Tukpen MCPs Females	Seasonal ranges for caribou herds as calculated from minimum convex polygons using female caribou locations from 2005 to 2019
Barrenground Caribou Annual Range	GNWT annual caribou range boundaries
Bathurst Assessment Areas Aug25 2015	Assessment areas referred to in the Bathurst Range Plan
CBGC User-defined Regions	User-defined polygons created in ALCES Online for use in analyses.
Central Barren Ground Caribou Study Area	The full extent of the region for which ALCES Online has been initialized with data for the project. Includes all of NWT and western Nunavut.
Core Seasonal Range Bluenose East, Core Seasonal Range Bluenose West, Core Seasonal Range Cape Bathurst, Core Seasonal Range Tukpen	GNWT core seasonal range boundaries.
Five Seasonal Range Bluenose East, Five Seasonal Range Bluenose West, Fiver Seasonal Range Cape Bathurst, Four Seasonal Range Tuk Peninsula	Aggregations of GNWT core seasonal range boundaries to match seasons that are being used in this project.
Homogeneous Fire Regime Zones	Regions delineated based on similarity of fire behaviour. The zones are applied when simulating fire in the landscape simulations.
Multi Herd MCPs Females	The combined annual range across herds, as defined by MCPs using female caribou locations from 2005 to 2019. The combined range across the 5 herds (5_herd_MCPs) is the study area for landscape simulations.
Seasonal UDs Bathurst, Seasonal UDs Bluenose East, Seasonal UDs Bluenose West, Seasonal UDs Cape Bathurst, Seasonal UDs Tuk Peninsula	Kernel density based range boundaries calculated from female caribou locations from 2005 to 2019.

3 Using the Data Library

Data Library is a tool within ALCES Online for importing and managing data layers.

3.1 Importing Data using Data Library Exercise

There are two primary types of data that can be imported in AO: Regions and Indicators.

Regions are <u>polygonal features</u> used for filtering and making selections of other data. They may be thought of as *spatial zones* or *study areas*. In addition to being stored as vector polygons, regions are also converted to 100m raster for subsequent use in AO indicator queries and simulations.

We will import Bathurst Assessment Areas to demonstrate how to import region data into ALCES Online.

1. To upload data in ALCES Online, go to the Data Library tool by clicking the cloud icon in the top left corner. Click the globe symbol on the left-hand side panel and then click the blue button Import Region Zip.
2. Navigate to the zipped Bathurst Assessment Areas data set and click open. A blue notification box will appear in the top right corner of the screen indicating that the file is being processed, and then a green notification box will appear indicating that the file has uploaded successfully.
3. Click on the Pending folder that has appeared under My Regions. To rename the region as it will appear in AO, click on the pencil icon, type a new name (for this training include your name or initials at the end to differentiate your region from regions uploaded by other participants), and click Accept.
4. Next, click the file name and two panels will appear below. The left-hand panel is a preview of the region and the right-hand panel has fields that need to be completed to finish importing the region. Under Super Region, click the field box and select Central Barren-Ground Caribou. Under Region Name, click the column header containing the region names. Click the green Save button.
5. When you click save, a green text box will appear in the top right-hand corner indicating that the region has been submitted to the processing que. Once the data import job appears in the job table under Imports, it is OK to navigate away. The status will appear as Complete when the region has finished processing. Once imported, the file will appear in the Elk Valley folder under My Regions and from here you can edit the region name or delete the region if desired. Jobs marked complete can be used for data analysis immediately but tile rendering can take time to complete, so large files may not be immediately viewable in Maps.
6. To view the imported region, go to the Map tool and then under Layers select Regions. Navigate to your region, click on it to reveal the region names, and click the white boxes to make them viewable.
7. The imported regions will be available as study areas. Use the region to prepare a map of total footprint within assessment area 1. This can be done using the indicator “CBGC Total Footprint”.

3.2 Indicators

Indicators are rasterized data (values) that are the basis of all AO analyses (e.g., advanced calculator, mapper, popdyn). The source data can be raster or vector (points, lines, polygons), which are converted to 100m raster and then preprocessed (at the time of import) into multiple nesting resolutions.

1. Indicators are accessed through 'Select Indicator – Choose Existing' under the Data & Analysis tab on the map window.

To import indicator data, follow the steps described in section 5.2 of the user guide.

4 Using the Charts Tool

Charts is a tool in ALCES Online for preparing indicator dashboards. A dashboard is a page with multiple dynamic maps and graphs to summarize simulation outcomes for multiple scenarios and/or indicators. The Charts tool is described in greater detail in section 6 of the User Guide.

4.1 Creating Dashboards with the Charts Tool Exercise

To prepare a dashboard that summarizes landscape dynamics produced by a climate change scenario, go to the Charts tool by clicking the charts icon in the top left corner.

1. Set the study area as the *Fall* region from the Season UDs Bathurst folder.
2. Click Data & Analysis in the left panel, and then Select Indicator. Set the indicator to *CBGC Total Shrub* from the Landscape Summary folder. Set the scenario to RCP 8.5 induced land cover shift by clicking the wrench and using the dropdown box. Keep the resolution at 25000 m and the Chart Type at Decades. Set the timeline to go from 2020 to 2060. Click GO. A chart will appear.
3. Change the indicator to *CBGC Total Grassland* from the same folder, and keep the other settings the same. Click GO. The second indicator will be added to the chart.
4. Now add a dynamic map to the dashboard. Click the plus icon in the bottom left corner of the dashboard window. Change the indicator to CBGC Total Shrub and click GO. Once the chart appears, click the chart icon in the top right of the chart. In the dropdown box that appears, select the Map option.
5. To add a dynamic map of grassland to the dashboard, click the plus icon again and then follow the same steps as used for shrub other than changing the indicator name to CBGC Total Grassland.
6. Experiment with moving panels around by clicking and dragging the top of a panel.
7. Experiment with resizing panels by clicking and dragging the bottom right hand corner of a panel. After resizing a map panel, click the chart icon in the top right corner of the map panel and click the Map option again.
8. Rename your dashboard by clicking 'Chart Dashboard' near the top of the dashboard.
9. Save your dashboard by clicking the disc icon in the bottom left of the dashboard. Saved dashboards can be retrieved by clicking the folder icon in the bottom left of the dashboard.

5 Using Advanced Calculator

Advanced Calculator (User Guide Section 4) is used to define expressions that create new indicators by combining existing indicators and applying spatial, mathematical, and logical functions. Expressions are the logic (i.e., equations) that define how one or more existing ALCES Online indicators should be applied to calculate a new variable (e.g., wildlife habitat). An indicator is a spatial data layer that represents the spatial and temporal distribution of a variable. Publishing applies the logic of an expression to an ALCES Online spatial data set so that the new indicator can be viewed in the Maps tool. An expression can be applied to multiple time periods (e.g., current and future decades), simulations, and study areas (e.g., a caribou range) to create numerous data layers for use in ALCES Online.

1. **Sign In.** Open Advanced Calculator by going to advanced.alces.ca and using the login (cimpbgc) and password (caribou259). The first page that you visit when opening Advanced Calculator is the Expressions page. The Expressions page lists expressions that are available to you. Expressions are organized into three lists: My Expressions, Team Expressions, and Popular Expressions. We will only be using My Expressions in the training session.
2. **Build an expression.** In this exercise you will prepare an expression to calculate total forest by using the sum function to add together forest types. The interface takes the user through 4 steps when preparing an expression: overview, expression, units, and publish.
    a. **Create the expression**. Click + Create New Expression at the top of the page.
    b. **Enter the expression overview information**. In the Overview page, enter the indicator information including:
        i. **Name** – use the name Total Forest followed by your initials or name to allow you to differentiate from the same indicator created by others
        ii. **Description** – e.g. The total area across forest types
        iii. **Access Permission** – keep it at User (i.e., no sharing with other accounts)
        iv. **Expression category** – select the Training category
        v. **Super Region** – select Central Barren Ground Caribou
        vi. **Expression Image** – select an image (optional)
    c. **Prepare the expression**. Click the Expression tab. Total forest is calculated by summing together forest types using the sum() function.
        i. Begin typing the word sum in the expression box and then click the red word "sum" that appears on the right part of the screen. That will bring up the syntax for the sum() function in the expression box (to the left) and inputs for the sum() function (to the right).
        ii. Use the toggle to turn off the Single Input option, because you need to sum multiple inputs (i.e., data layers).
        iii. Set the units to absolute, so that the output will be stored as m2.
        iv. There is no need to select a scenario, because that will be done when the expression is published.
        v. You need to sum together footprint indicators that are located in the CBGC Unity folder, so type that name as the "Indicator Category". Now click the boxes

for forest types (Mixed forest, Sub-polar taiga needleleaf forest, Temperate or sub-polar broadleaf deciduous forest, Temperate or sub-polar needleleaf forest)

vi. Click to APPLY data from the sum interface. This will insert the inputs from the right part of the screen into the expression syntax in the expression box.

vii. Other commonly used functions are listed below in table 3.

d. **Set the units**. Click the Units tab and set the units as Area-based and metres squared.

e. **Publish the expression**. Click the Publish tab to create an indicator that can be viewed with the Maps tool. Publishing an indicator requires that you specify the region (5_herd_MCPs), resolution (1000 m), scenario (RCP 8.5 induced land cover shift), temporal options (Decadal time increment with Start Time=2010 and End Time=2060), Team (Central Barren-Ground Caribou), the name and description (defaults to what was entered in the Overview page), and the indicator category (CBGC Training). Click GO to publish the indicator.

f. **View output.** Once your indicator is done publishing you can view it in ALCES Online. In another window open online.alces.ca. Navigate to the Maps tool by clicking the Globe icon in the top left. Open the Select Study Area panel and set the Study Area to 5_herd_MCPs. Open the Data & Analysis panel and select your indicator, set the scenario, set the resolution, set the time bar, and click GO. The change in the indicator during the simulation is very minor (declining from 159,022 km2 to 158,884 km2).

Table 3: Functions that are commonly used to build expressions in Advanced Calculator.

Function (and arguments)	**Description**
indicator(name, units)	Accesses the indicator layer identified by the <u>name</u> argument. The <u>units</u> are set as absolute (default) or density.
expression(category, name)	Accesses the saved expression identified by the <u>name</u> argument.
sum()	Aggregate a dataset to a single value using a Sum, or perform a Sum element-wise (along multiple data at the grid-cell level)
cell_size(units)	The area of a raster cell in <u>units</u> of km2, m2, ha, square miles, or acres.

buffer(input, distance, fill, replace_fill)	Expand areas identified by the input layer by the specified distance. Cells within the buffer receive a value equal to the fill argument. Cells outside of the buffer receive a value equal to the replace_fill argument.
regional_modifier(input, regions, multiplier, non-region multiplier)	Multiplies a cell's input value by a multiplier that differs depending on the region that the cell is located in. The non-region multiplier is applied to cells that are not located in the regions.
region_stats(input, regions)	Calculates a summary statistic method (mean, min, max, sum, standard deviation, or variance) for the input value across cells located within each region.
moving_window(input, radius, method)	Applies a statistical method (mean, min, max, sum, standard deviation, or variance) to the input value across a neighbourhood of cells within a specified radius that are not masked by NoData.
if(conditional statement, value if true, value if false)	If the conditional statement is true for a cell, the value if true is returned. If the conditional statement is false, the value if false is returned.input
patches(input, method)	Applies a statistical method (mean, min, max, sum, standard deviation, or variance) to the input value across groups of contiguous cells with an input value.
univariate_modifier(input, min, max, use_trend, trend_type, reverse)	Transforms an input value using an x-y graph where the x-axis is the original input value and the y-axis is the transformed value. The range for the x-axis is the range of the input value across cells. The range of the y-axis is defined using the ymin and ymax arguments, with default values of 0 and 1. If use_trend is true the relationship between the input and transformed value is defined by a user-defined trend of trend_type linear or log. If use_trend is false the relationship is defined by a user-defined line.
proximity(input)	Calculates the minimum distance (m) from a cell to any cell with an input value.

min(x, y, z, …,n)	Aggregate a dataset to a single value using a Minimum, or perform a Minimum element-wise (along multiple data at the grid-cell level)
max(x, y, z, …,n)	Aggregate a dataset to a single value using a Maximum, or perform a Maximum element-wise (along multiple data at the grid-cell level)
least_cost(input)	Generate a least cost surface or least cost paths by minimizing the cumulative input value.
random()	Returns a random number between 0 and 1.
log(x), log2(x), log10(x)	Returns the natural logarithm, base2 logarithm, or base10 logarithm of x.
trunc(x), floor(x), ceil(x)	Converts x to an integer by truncating, rounding down, or rounding up.
cos(x), cosh(x), acos(x), acosh(x), sin(x), sinh(x), asin(x), asinh(x), tan(x), tanh(x), atan(x), atan2(x), atanh(x)	Returns the cosine, etc. of x
abs(x)	Returns the absolute of x