



# Prioritizing Zones for Caribou Habitat Restoration in the Canada's Oil Sands Innovation Alliance (COSIA) Area Version 4.0



# Prioritizing Zones for Caribou Habitat Restoration in the Canada's Oil Sands Innovation Alliance (COSIA) Area. Version 4.0 - Oil Sands Project Boundary Update.

Final Report - December 2021

Prepared for Canada's Oil Sands Innovation Alliance (COSIA)  
COSIA Land Environmental Priority Area  
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## Background & Objectives

Canada's Oil Sands Innovation Alliance (COSIA) has worked with the Alberta Biodiversity Monitoring Institute (ABMI) to prioritize townships for the restoration of linear features within five caribou ranges in northeast Alberta: Cold Lake, East Side of the Athabasca River, Red Earth, Richardson, and West Side of the Athabasca River. In Versions 1.0 (Alberta Biodiversity Monitoring Institute, 2016) and 2.0 (Alberta Biodiversity Monitoring Institute, 2017), each township's priority was based on the potential increase of undisturbed caribou habitat that could be achieved through linear feature restoration, accounting for both the restoration cost and the potential for future resource development. Version 3.0 (Alberta Biodiversity Monitoring Institute, 2020) built upon this work, to incorporate caribou habitat value, update information on current and future industrial disturbance, including both energy and forestry, and add decision-support guidance at multiple spatial scales. The reader is directed to these previous versions for a better understanding of how this work has evolved.

The overarching goal of this iterative project has been to provide a tool to help guide where to prioritize restoration to benefit caribou in a cost-effective manner while maintaining resource development on a shared landscape. To maximize the relevance of the Version 3.0 project outcomes, the technical work was guided by a multi-stakeholder advisory committee comprised of COSIA member companies, other energy sector companies, forestry sector, Government of Alberta, and the research community. The committee highlighted the need to understand where development is most likely to occur to reduce inefficient use of restoration funds and effort by guiding restoration away from areas likely to be developed, thus avoiding re-disturbance of lines following restoration.

Version 3.0 used the most up to date public information, circa 2016, on current and planned project boundaries from the Oil Sands Information Portal (OSIP). OSIP boundaries were understood to provide for a transparent depiction of where oil sands operations were occurring or would soon be occurring on the landscape, to support delineation of areas that are not candidates for near-term restoration. Due to the age of the OSIP boundaries and the low frequency in which they are updated, the boundaries contain spatial and temporal discrepancies that must be considered when interpreting or applying the results of this work.

To address these discrepancies in this current version (4.0), we used the most current and regularly updated spatial files associated with approved oil sands projects which are available on the Alberta Energy Regulator website

(<https://extmapviewer.aer.ca/AERSchemeApprovalArea/Index.html>). Every approved oil sands project is issued a scheme approval under the Oil Sands Conservation Act (OSCA). Associated with this scheme approval is an approved scheme area. We combined these approved scheme areas with the project areas of proposed oil sands schemes that are currently in the regulatory application review process. Only active and applied oil sands projects and their associated boundaries, were incorporated in the prioritization process to identify priority townships for restoration. These final boundaries, i.e., approved scheme areas and proposed oil sands

projects in the regulatory application review process, are hereby referred to as “Project Boundaries.”

## Methods

Step 1: Download most recent approvals shapefiles from AER

The most recent shapefile of each Oil Sands Conservation Act (OSCA) approved scheme boundary available as of October 1, 2021 was downloaded from AER’s scheme approval viewer site (<https://extmapviewer.aer.ca/AERSchemeApprovalArea/Index.html>).

Step 2: Extract Active In Situ projects

From the file “In Situ Oil Sands Scheme Approval\_NAD83\_10TM\_AEPForest.shp” all projects with a scheme status of Active (AC) were extracted into a new shapefile. All scheme subtypes were included (Commercial, Commercial-CSS, Commercial-SAGD, Enhanced Recovery, Experimental, and Primary).

Step 3: Merge In Situ projects with Oil Sands Mines.

The *in situ* projects collected in Step 2 were merged with the projects in the file “Mineable Oil Sands Scheme Approval\_NAD83\_10TM\_AEPForest.shp”. The Mineable Oil Sands data has fewer attributes than the In Situ data. The Geological Field and Scheme Status attributes were entered manually (GEO\_FIELD=Athabasca Oil Sands and SCH\_STATUS=AC).

Step 4: Additional information attribute completed and QAQC

Additional fields were added to the dataset to indicate Caribou Range (CaribouRg), Oil Sands Project Number (OSP\_NO), and Application Number (ApplicatnN). The Caribou Range attribute was populated with information regarding which Caribou Range(s) each project overlapped. Where available, the Oil Sands Project Number (OSP\_NO) were included to facilitate cross-referencing datasets with AEP’s Oil Sands Project Boundaries. Note that projects without names were not assigned numbers as has been the process in the past. Some corrections to the production field attribute were made.

Step 5: Review dataset with industry operators

The project spreadsheet and map were shared with operators and COSIA for review. Operators were requested to review their project specific information for correctness and completeness. Additional projects that were not included in the shapefile at the end of Step 4, but were in the regulatory application process were flagged for inclusion and attributes and spatial extent provided.

Step 6: Merge final project boundaries into one shapefile

The Project Boundaries were updated with additional shapefiles for projects in the application stage (projects without approvals are not included in the AER data). The Application number field (ApplicatnN) was completed with information from operators.

## Step 7: Quality assurance and quality control

Projects were reviewed spatially and tabular data was reviewed for completeness and accuracy.

### Prioritization Process

In Version 4.0, we replicated the final process in which townships were ranked into priority zones from Version 3.0 (Alberta Biodiversity Monitoring Institute, 2020). Each township was ranked based on dividing the gain in undisturbed (GIU) habitat (i.e. the “bang”) by the density of seismic lines in each township (the cost, or “buck”). This “Bang for Buck” (B4B) value was then downgraded by the economic value of that township, and upgraded based on the relative use of that township by caribou. We used updated project boundaries from Steps 1 through 7 in place of OSIP boundaries. We also updated the Human Footprint Inventory (HFI) to 2018 (Alberta Biodiversity Monitoring Institute, 2018), and used wildfire boundaries as of 2018 to match the vintage of the HFI layer. The weightings from the Resource Valuation Layer (RVL) and Caribou index data were identical to COSIA 3.0 (Alberta Biodiversity Monitoring Institute, 2020).

We calculated the GIU by subtracting the estimated area disturbed following the restoration of conventional seismic lines from the current area disturbed, and dividing by the area of the township. Area disturbed was calculated as the area covered by HFI buffered by 500 m and non-buffered wildfire <40 years old. As per previous iterations, features classified as low-impact seismic lines were not included as anthropogenic disturbance, and areas overlapped by project boundaries (buffered by 500m) were considered fully disturbed. We then calculated each township’s B4B as the GIU divided by its density of seismic lines. Seismic lines inside project boundaries (buffered by 500m) were considered as non-candidates for restoration in the near-term. The B4B for each township was then multiplied by the inverse of the township’s normalized RVL, such that the RVL-adjusted B4B is reduced in areas with higher RVL. The RVL-adjusted B4B was then multiplied by the caribou-use index for each township, such that townships with higher caribou use increased in score. Alternative caribou weightings were explored in Version 3.0, but here we present only the final weighting criteria. Below is an example calculation:

Step	Description	Example Calculation
A	Current disturbance (%)	82
B	Simulated disturbance following restoration (%)	36
C	Gain in undisturbed (GIU)	$82 - 36 = 46$
D	Cost (conventional seismic density)	1.2
E	Bang for buck (B4B)	$46 / 1.2 = 38.3$
F	1- (Normalized RVL (RVL/max RVL))	0.33
G	Caribou index	0.61
H	Final ranking value	$38.3 \times 0.33 \times 0.61 = 7.72$

We used the final ranking values to group townships in each caribou range into 5 zones for each caribou range, with an approximately equal number of townships in each zone, per range. The

number of township units in a zone will differ by range depending on the total size of a range (i.e., the number of townships in each zone is equal within a range, but ranges differ in their number of townships). Zones with higher final ranking values (i.e., higher caribou- and RVL-adjusted B4B) were assigned to Zone 1, and descending values down to Zone 5. The proportional representation of the various priority zones across all caribou ranges is consistent with the range priority zonation approach described in Version 2.0 and 3.0. Zones were created per range, rather than across ranges, to ensure that higher priority zones are included within each caribou range. This is consistent with the range-level process identified by the Federal recovery strategy (Environment Canada, 2012), which states that all boreal ranges are to be recovered where feasible.

We then calculated the percent area disturbed within each range by anthropogenic disturbance only (buffered by 500m and including all areas within Project Boundaries as disturbed) with and without fires <40 years old (non-buffered) as restoration progressed from Zone 1 through Zone 5. Recognizing that the HFI layer is collected at a finer-resolution than the data used to create the federal target of 35% disturbance, we calibrated the HFI data to the data used by the federal recovery strategy following the same steps as Version 2.0. See Appendix B for the empirical relationships used to calibrate HFI to ECCC.

## Results

Updated Project Boundaries are visualized in Figures 1 through 6.

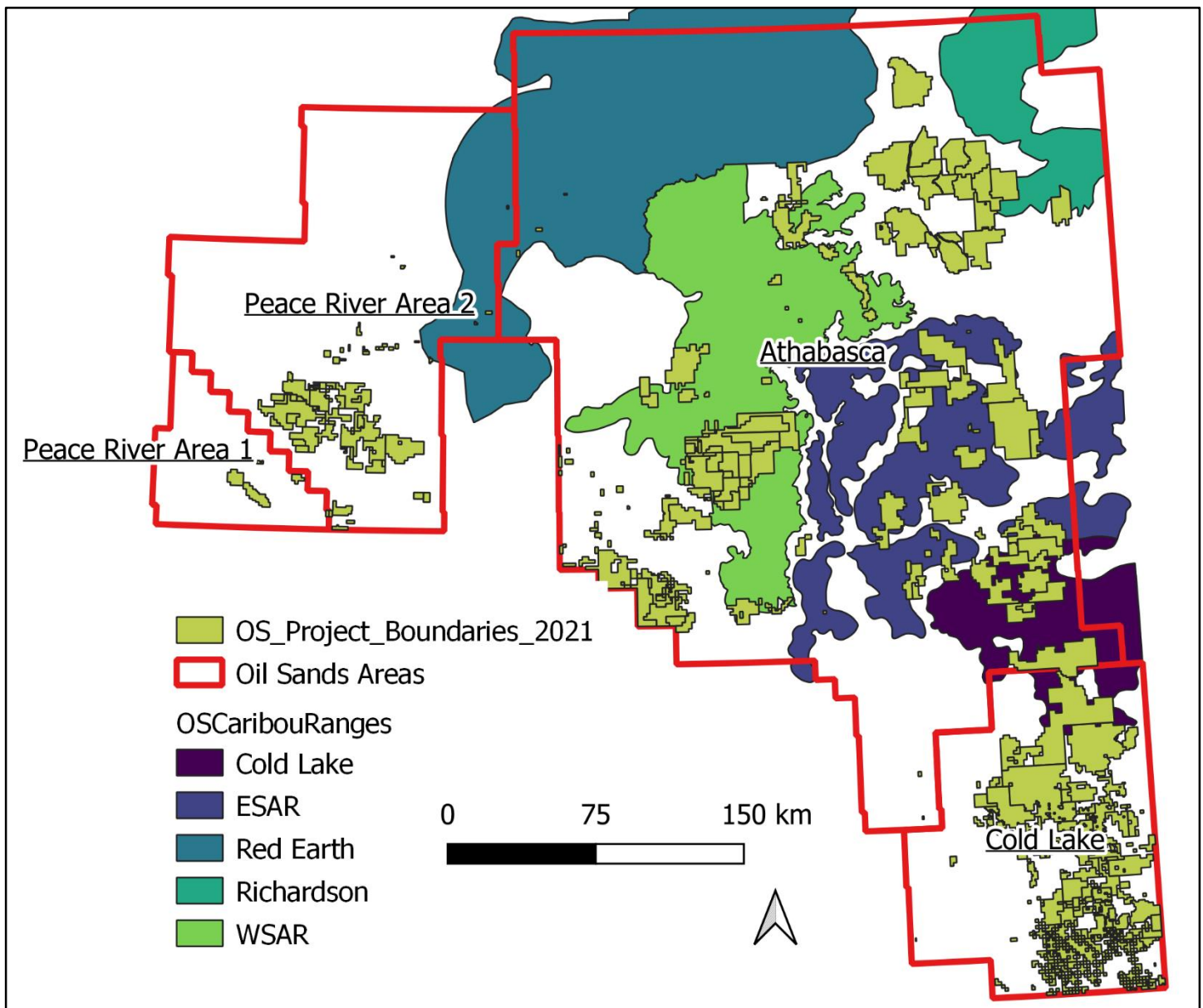


Figure 1: Updated Project Boundaries created by combining approved scheme areas and proposed oil sands projects in the regulatory application review process (Steps 1 through 7). Caribou ranges and Oil Sands Areas are shown for context.

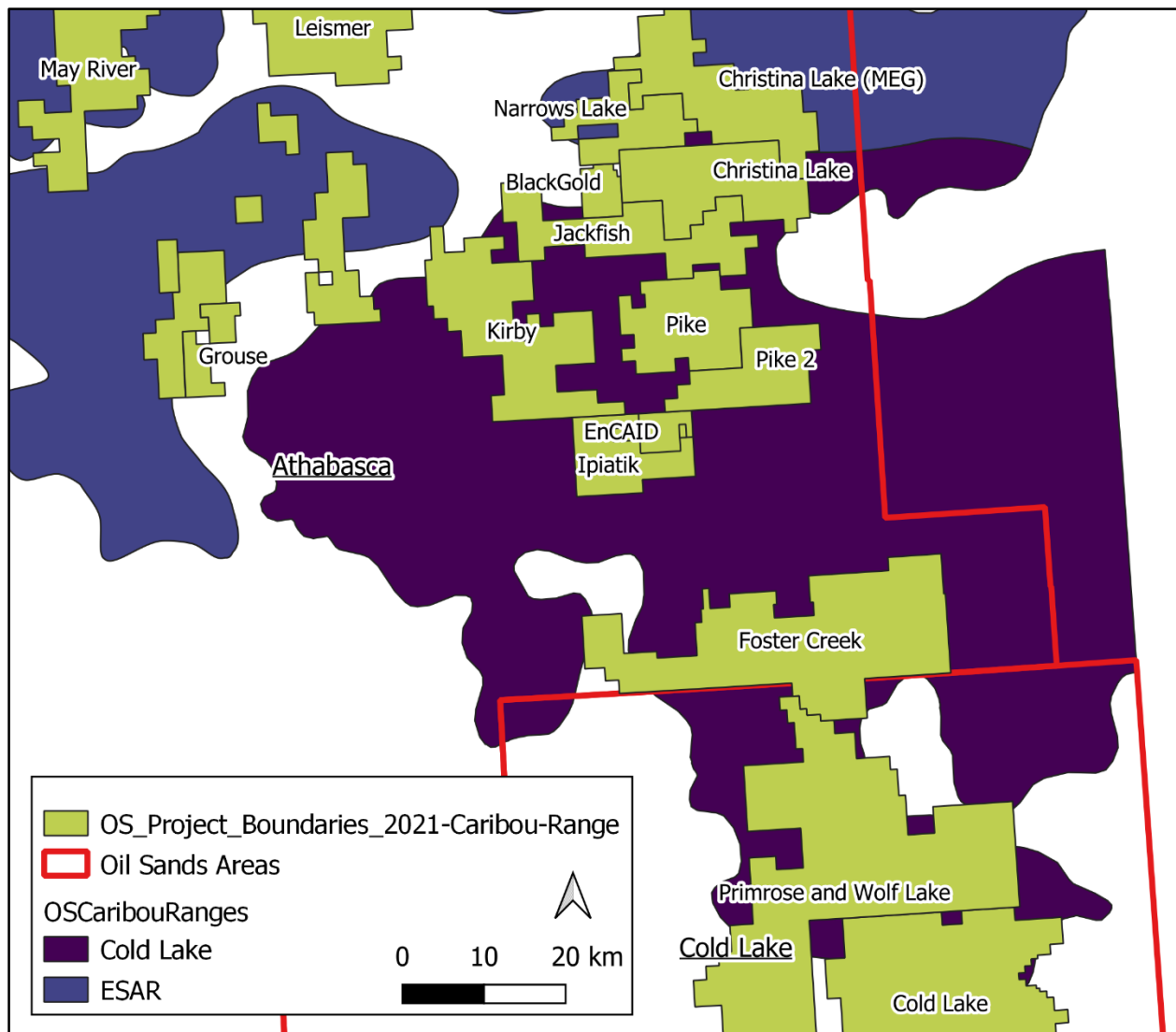


Figure 2: Updated Project Boundaries within and surrounding the Cold Lake caribou range. Caribou ranges and Oil Sands Areas are shown for context.



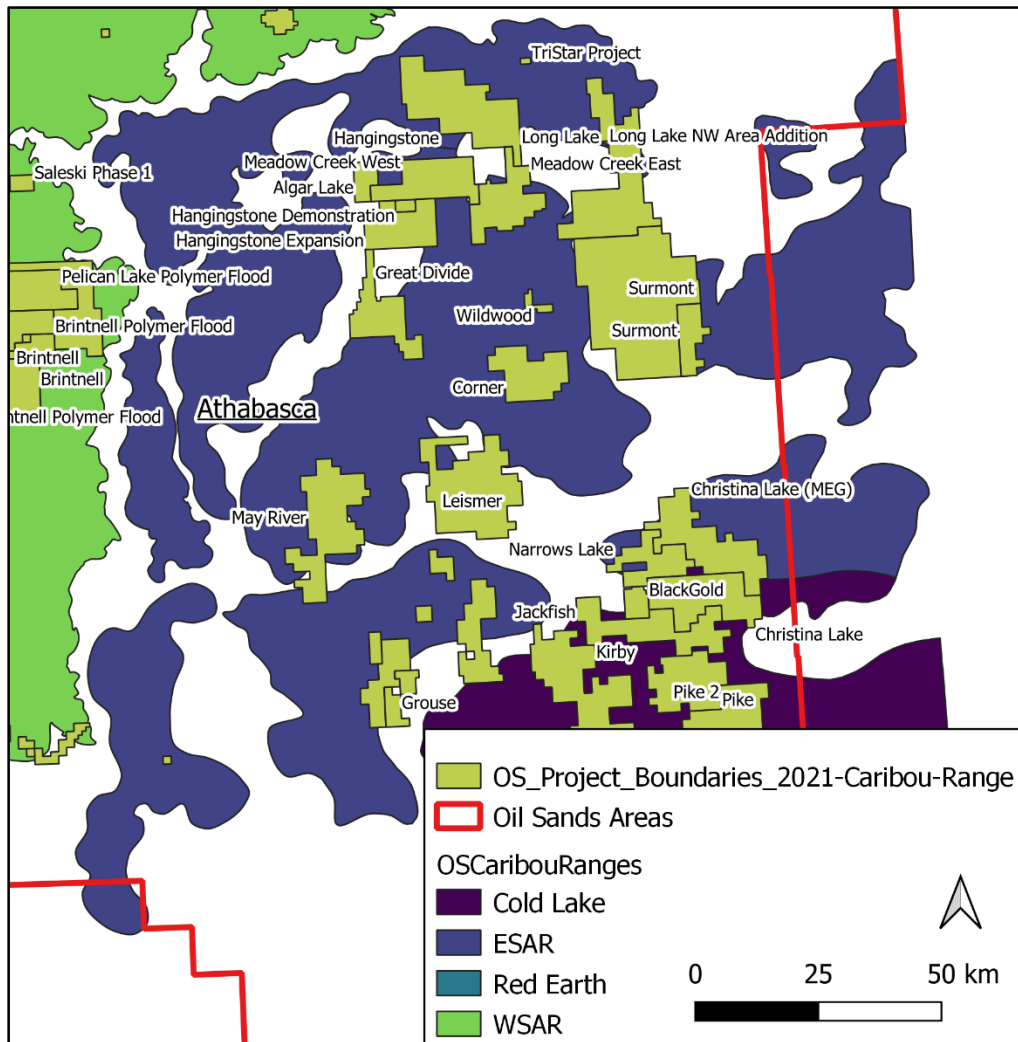


Figure 3: Updated Project Boundaries within and surrounding the East Side of the Athabasca River caribou range. Caribou ranges and Oil Sands Areas are shown for context.

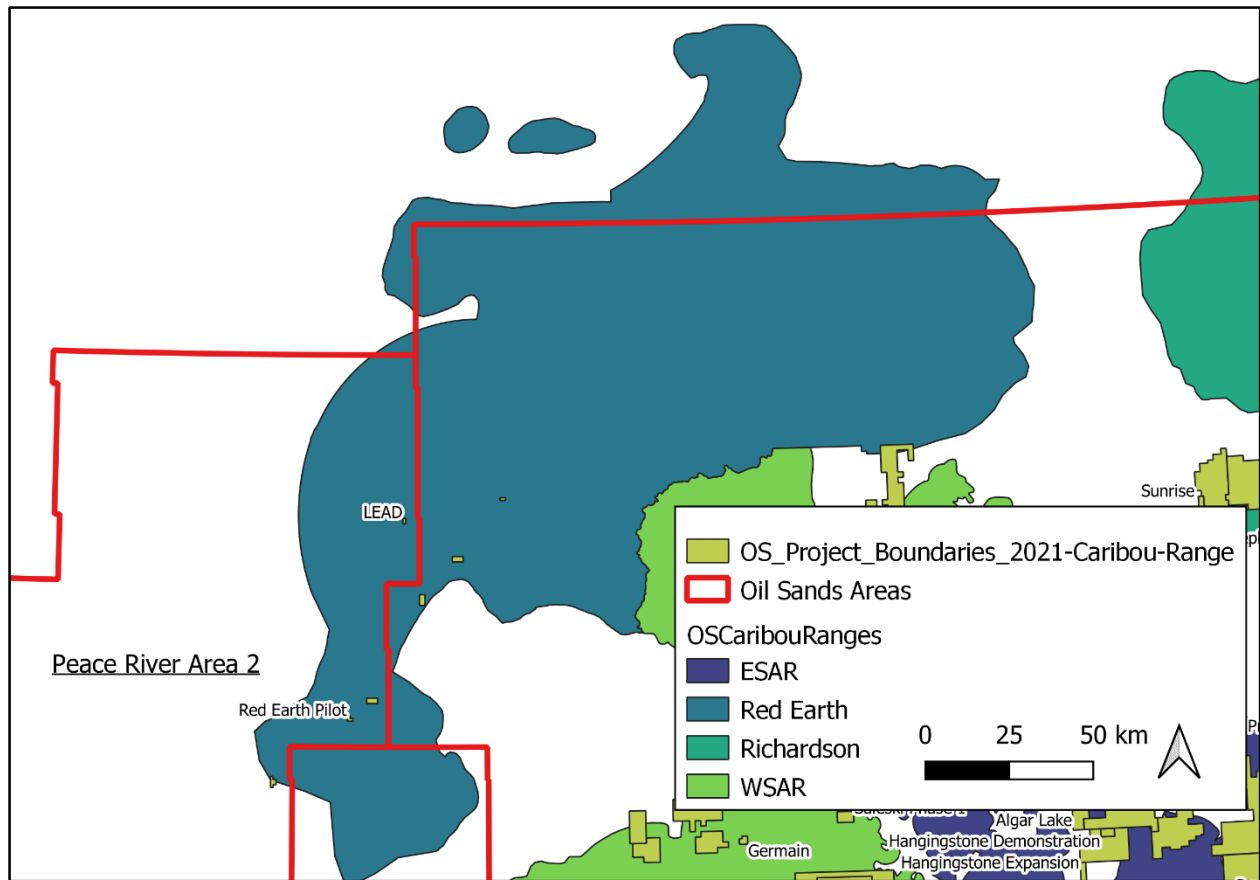


Figure 4: Updated Project Boundaries within and surrounding the Red Earth caribou range. Caribou ranges and Oil Sands Areas are shown for context.

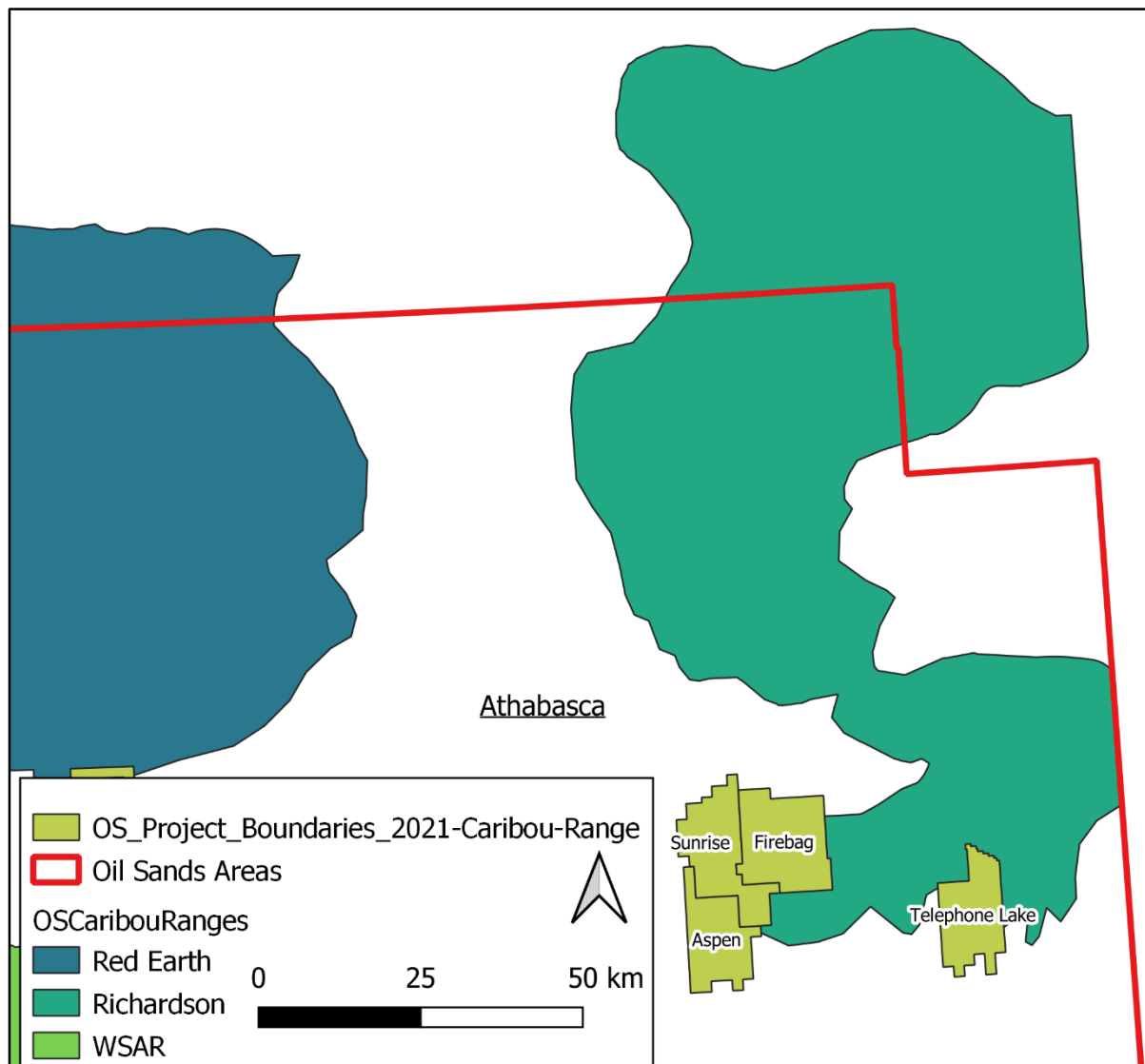


Figure 5: Updated Project Boundaries within and surrounding the Richardson caribou range. Caribou ranges and Oil Sands Areas are shown for context.

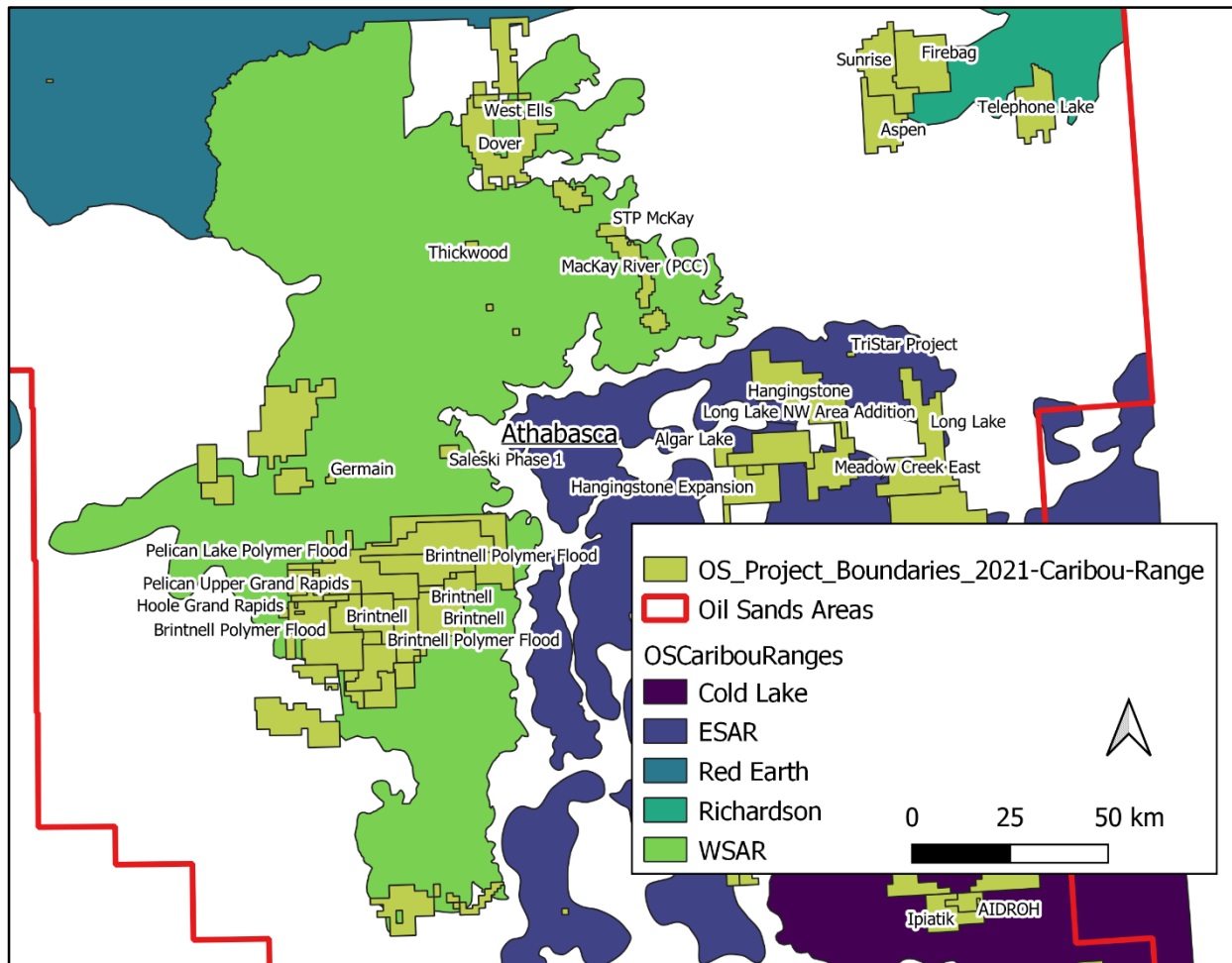


Figure 6: Updated Project Boundaries within and surrounding the West Side of the Athabasca River caribou range. Caribou ranges and Oil Sands Areas are shown for context.

#### Prioritization process

Version 4.0 priority zones are shown in Figure 7. Notable differences in Zones between versions 3.0 and 4.0 can be seen in the West Side Athabasca River caribou range as a result of the differences in the OSIP (circa 2016) and Project Boundaries (circa 2021). Likewise, notable differences arose in the Richardson range as a result of updated HFI and wildfire data. Other minor differences in Zones resulted from updated HFI data.

When excluding fire, the federal target of 35% disturbed is achieved by restoring conventional seismic lines in Zone 1 for Richardson, Zones 1-5 for Red Earth (Table 1; Figure 9). When ABMI's HFI data are calibrated to ECCC's data, whereby the 35% disturbance target was created, the federal target of 35% disturbed is achieved by restoring conventional seismic lines in Zone 1 for Richardson, Zones 1-2 for Red Earth (Table 1; Figure 9). If restoration is not conducted within Project Boundaries, none of the remaining caribou ranges meet the federal target of 35% disturbance, even when ABMI's high-resolution data are calibrated to ECCC's data.

When including fire, the federal target of 35% disturbed is not achieved by restoring conventional seismic lines if Project Boundaries remain perpetually disturbed. These results are comparable to the results from Version 3.0, with the exception that Red Earth met the 35% disturbance target at Zones 1-3 in Version 3.0. The difference in Red Earth is a result of the updated feature classification and mapping in the HFI 2018 data from the 2017 version used in Version 3.0.

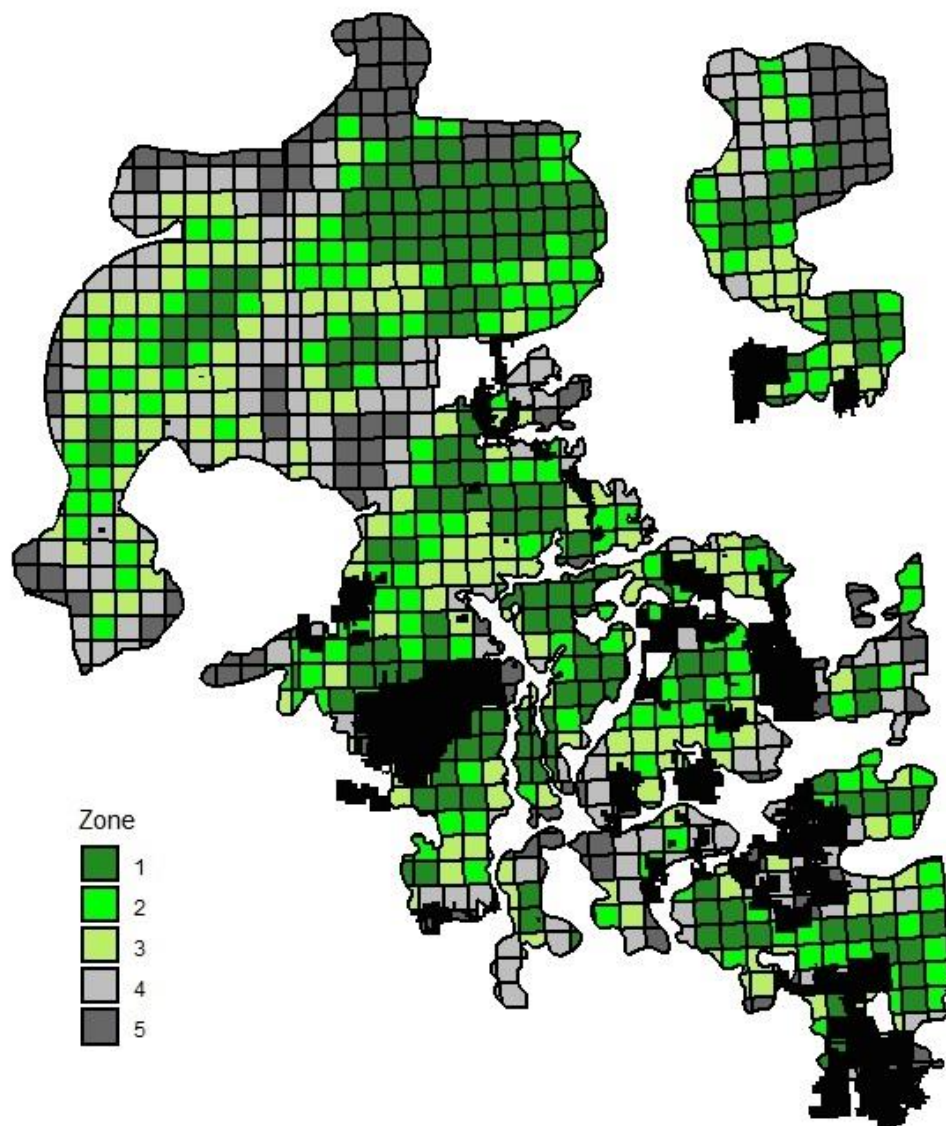


Figure 7: Version 4.0 restoration priority zones incorporating “Bang for Buck”, potential future resource value (RVL), caribou use index, and updated Project Boundaries. Townships are ranked into priority zones for restoration, with Zone 1 (dark green) being highest priority and Zone 5 (dark grey) the lowest. Any area within Project Boundaries (black), are considered non-candidate areas for restoration.

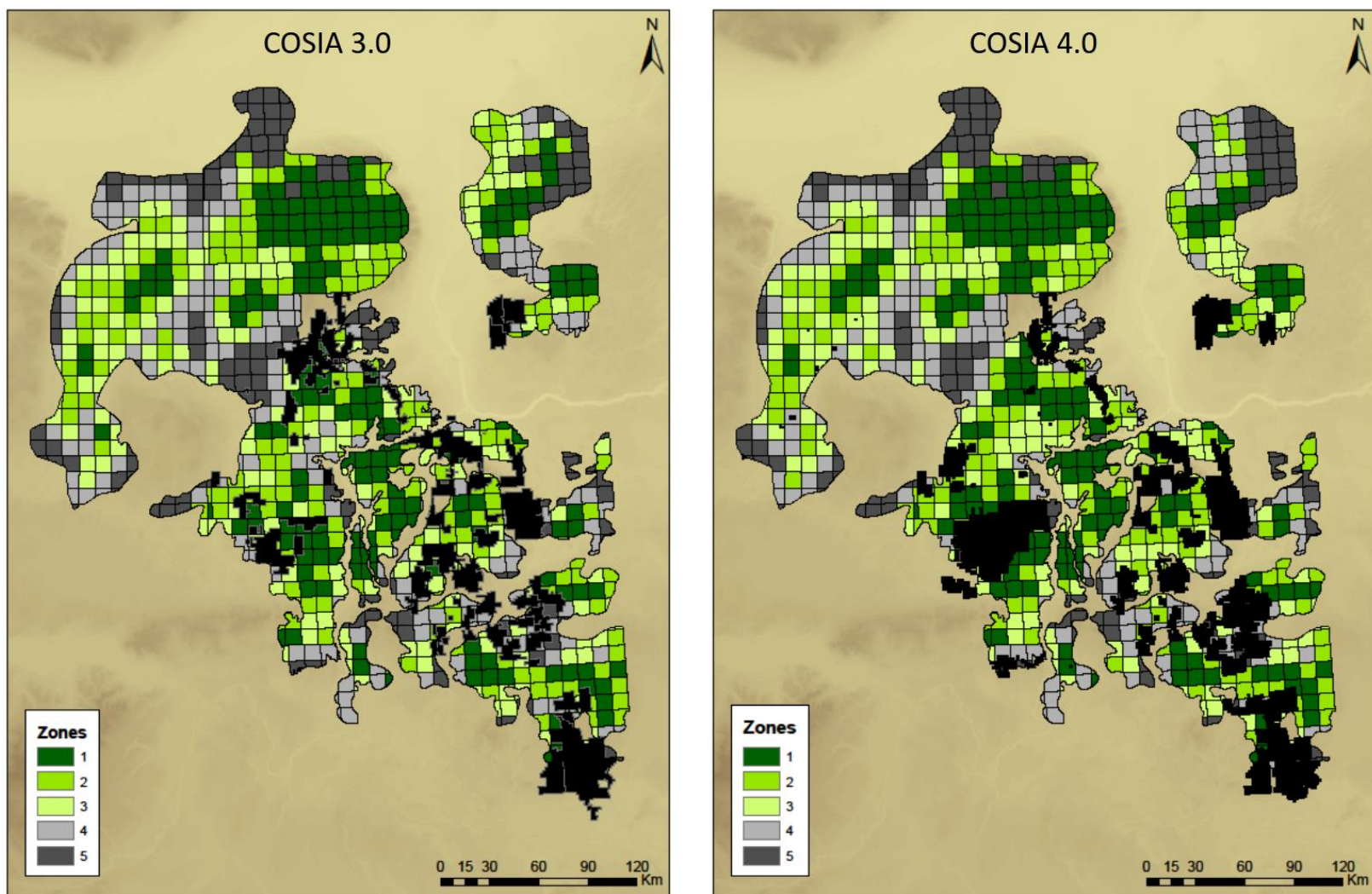


Figure 8: Comparison of priority Zones from COSIA 3.0 and 4.0. Townships are ranked into priority zones for restoration, with Zone 1 (dark green) being highest priority and Zone 5 (dark grey) the lowest. On the left, COSIA 3.0, any areas within OSIP boundaries (black; operating, approved, applied for, and announced projects) are considered non-candidate for restoration. On the right, any area within Project Boundaries (black), are considered non-candidate areas for restoration.



Table 1: The percent (%) area disturbed as restoration progresses from Zone 1 through 5 following the restoration of conventional seismic lines. Percent area disturbed is calculated as anthropogenic only (buffered by 500m) and as anthropogenic (buffered by 500m) plus fires less than 40 years old. Areas within Project Boundaries (buffered by 500m) are considered disturbed. Low-impact seismic are removed from all calculations.

Range	Current % Area Disturbed	% Area Disturbed (Buffered Anthropogenic Only)				
		Zone 1 Restored	Zones 1-2 Restored	Zones 1-3 Restored	Zones 1-4 Restored	Zones 1-5 Restored
Cold Lake	87	79	71	66	64	63
East Side Athabasca River	88	80	74	70	66	65
Red Earth	69	59	51	43	37	34
Richardson	36	33	30	28	28	28
West Side Athabasca River	85	78	71	65	60	58

Range	Current % Area Disturbed	% Area Disturbed (Buffered Anthropogenic + Non-Buffered Fire <40 years old)				
		Zone 1 Restored	Zones 1-2 Restored	Zones 1-3 Restored	Zones 1-4 Restored	Zones 1-5 Restored
Cold Lake	93	87	83	81	80	80
East Side Athabasca River	90	84	81	78	75	74
Red Earth	82	79	74	69	65	63
Richardson	91	89	88	87	87	87
West Side Athabasca River	87	80	74	68	64	62



## Literature Cited

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- Alberta Biodiversity Monitoring Institute, 2020. Prioritizing Zones for Caribou Habitat Restoration in the Canada's Oil Sands Innovation Alliance (COSIA) Area. Version 3.0. Edmonton, AB.
- Environment Canada, 2012. Recovery Strategy for Woodland Caribou (*Rangifer tarandus caribou*), Boreal population, in Canada. Ottawa.

## Appendix A: Metadata to facilitate interpreting data layers

Table A1: Metadata for spatial data fields

Field	Attribute	Description
SCHEME_NO	Scheme Number	A unique identifier that uniquely identifies a scheme. Note that a scheme does not have a meaningful identifier on its own but is described by its type and one or more administrative boundaries such as a pool name. The scheme number is distinct from the approval and application numbers.
SCHEME_TYP	Scheme Type	The type of scheme. This is a higher level grouping of "Application Type". Options are In Situ or Oil Sands Mining
GEO_FIELD	Geological Field	The designated name of the field or area.
GEO_POOL	Geological Pool	The designated name of the oil sands geological pool.
PRE_APP_NA	Previous Approval Name	An updated approval to a scheme results in it being cancelled and replaced with a new scheme (perhaps identical) under a new approval number. This attribute provides a link to previous, related schemes subsequently replaced by this scheme as a result of a new approval number being issued.
SECT_NAME	Sector Name	Designated name of the oil sands sector.
SCH_STATUS	Scheme Status	The status of the scheme. Active (AC) - Approved Projects that are in operation, actively producing. Application (AP) - Projects that have filed applications and are being reviewed by the AER.
APP HOLDER	Approval Holder	Project name including company name and site specific reference.
SCHE_NAME	Scheme Name	The name of the individual scheme project. (Project Name)
SCH_SUB_TY	Scheme Sub Type	The further qualification of the scheme type. Examples for In Situ are: Commercial, Commercial-CSS, Commercial-SAGD, Experimental, Enhanced Recovery, and Primary. Not applicable for Oil Sands Mines.
SCH_DESCRI	Scheme Description	The full description of a particular reference value.
APP_NO	Approval Number	The Order/Approval/Permit number assigned to the application upon approval of the specific component of the application that would result in a licence, approval or permit. This acts as a reference to the licence or permit issued as a result of this application. Not applicable for projects in the regulatory application process.
TERM_DATE	Term Date	The date when the scheme ceased to have the AER's approval to continue operations. This value cannot be future dated. Scheme_Expiry_Date is used to define scheduled scheme terminations.
PROD_POOL	Production Pool	The designated producing pool or deposit name
PROD_FIELD	Production Field	The designated producing field or area name
CaribouRg	Caribou Range	The Caribou Range(s) that overlap with each Oil Sands Project
OSP_NO	Oil Sands Project Number	The Oil Sands Project number assigned to each project.
ApplicatnN	Application Number	The Application Number for each Oil Sands Project as registered with AER. Only complete for projects in the regulatory approval process.

## Appendix B: Calibrating disturbance layers to federal recovery strategy target

The Federal recovery strategy identifies 65% undisturbed habitat (i.e., 35 % disturbance) in a caribou range as the disturbance management threshold, which provides a measurable probability (60%) for a local population to be self-sustaining (Environment Canada, 2012). The 35% disturbance target is derived using a 30 m resolution LANDSAT imagery (hereby termed “ECCC data”). In contrast, the Alberta Biodiversity Monitoring Institute’s Human Footprint Inventory (hereby termed “HFI”; ABMI 2018) uses 2.5 m resolution imagery, and thus identifies smaller features, and is also more recently updated. In order to use the higher resolution, more recent HFI data to prioritize areas for restoration, while being able to meaningfully evaluate progress towards the Federal 35 % disturbance target, we calibrated the HFI data to the coarser ECCC data.

We evaluated the relationship between the ECCC percent disturbance and the HFI percent disturbance for each range using simple linear models. We created two models for each range; one model including wildfire in both datasets, and one excluding fire. The mathematical equations describing the disturbance relationship for each range (Table 1) were then used to estimate the equivalent percent disturbance associated with ECCC’s data throughout the main text of this paper. Disturbance values calculated using HFI consistently estimated higher current disturbance values than those used by ECCC. These findings have implications for tracking progress towards the nationally-developed disturbance targets.

Table B1: Empirical relationships between percent area disturbed using Environment Canada and Climate Change data (2012) and the Alberta Biodiversity Monitoring Institute’s Human Footprint Inventory (2018) for each caribou range. Percent area disturbed was calculated for anthropogenic features (buffered by 500m) only, and for anthropogenic features (buffered by 500m) including wildlife (un-buffered). Model coefficients and 95 % confidence intervals are reported for simple linear regressions predicting ECCC disturbance as a function of ABMI disturbance, with townships within each range used as the sampling unit. Low-impact seismic lines are omitted from ABMI’s HFI data.

Range	Term	Anthropogenic only			Anthropogenic + Fire		
		Estimate	LCI	UCI	Estimate	LCI	UCI
Cold Lake	Intercept	-35.282	-45.478	-25.086	2.001	-15.279	19.280
	Slope	1.236	1.120	1.351	0.893	0.706	1.079
East Side Athabasca River	Intercept	-14.650	-21.213	-8.086	-11.902	-20.883	-2.922
	Slope	1.034	0.960	1.107	1.021	0.923	1.119
Red Earth	Intercept	-6.981	-11.535	-2.427	3.595	-4.801	11.990
	Slope	0.754	0.694	0.814	0.721	0.624	0.819
Richardson	Intercept	-5.250	-10.169	-0.330	-44.350	-64.299	-24.402
	Slope	0.768	0.676	0.861	1.384	1.169	1.599
West Side Athabasca River	Intercept	-12.486	-20.411	-4.561	-10.539	-21.800	0.722
	Slope	0.927	0.835	1.018	0.895	0.767	1.024