Appendix 13-E

MacHydro Effects Assessment - Future Conditions Scenario Modelling

NWP COAL CROWN MOUNTAIN

Effects Assessment - Future Conditions Scenario Modelling

1. INTRODUCTION

The NWP Coal Crown Mountain Effects Assessment used ALCES Online to evaluate Valued Component (VC) response to three scenarios focused on future disturbance within the context of cumulative effects. The assessment focused on the Crown Mountain RSA area over a 50-year temporal scale (Figure 1). Scenarios were run at 100 m spatial resolution and simulated at an annual time scale with outputs that correspond to current condition (year 2021), Crown Mountain maximum buildout (year 2038), and Crown Mountain post-closure (year 2055).

Future disturbance was simulated under the following scenarios: 1) The direct effects of NWP Coal's proposed development at maximum build-out and post closure, 2) Crown Mountain maximum build-out with cumulative effects, and 3) Crown Mountain maximum build-out with cumulative effects, and natural disturbance. This document outlines how the scenarios were developed and describes the assumptions that were used in the assessment.

The scenario analysis was completed using ALCES Online (https://online.alces.ca/), a computer simulation model designed for comprehensive assessment of the cumulative effects of multiple land uses and natural disturbances to ecosystems. ALCES Online simulates landscape dynamics by exposing a cell-based representation of the current condition landscape to user-defined trajectories that differ with respect to the rate and spatial pattern of future development and natural disturbance. The simulation engine incorporates numerous drivers such as forestry, mining, settlements, gas exploration, agriculture, transportation networks, fire, insect outbreaks, climate change, and reclamation. Indicator relationships are applied to track the consequences of simulated changes in landscape composition and forest age to values such as wildlife. Indicator outcomes are mapped at the resolution of individual cells or sub-regional scales such as watersheds. The tool is web-based to enable collaboration, utilize the processing capacity of powerful servers, and facilitate dissemination of results (Carlson, 2020).

ALCES Online has been applied to inform cumulative effects assessment and land-use planning in multiple jurisdictions (British Columbia, Alberta, Northwest Territories, Yukon, Saskatchewan, Manitoba, Ontario, Australia, Paraguay, India) and planning contexts. Examples include regional land-use planning (e.g., Carlson et al. 2014), conservation planning (e.g., Carlson et al. 2019), forest management (e.g., Leston et al. 2020), community-based land-use planning by First Nations, and urban planning (e.g., Carlson et al. 2015). The tool was applied to inform the Elk Valley Cumulative Effects Assessment (Elk Valley Cumulative Effects Working Group 2018) through the simulation of forestry, mining, settlements, fire, and climate change over the next five decades in the Elk Valley. The implications of the scenarios were assessed by mapping the future impacts to five valued components at the scale of the EV-CEMF study area (Figure 1): old growth/mature forests, riparian habitat, aquatic hazard, grizzly bear, and bighorn sheep. Although the simulations were developed at the scale of the Crown Mountain RSA, VC response was only evaluated within the EV-CEMF study area, as the EV-CEMF VC models are spatially linked to that region. The NWP Coal's Effects Assessment builds upon knowledge from the EV-CEMF process to evaluate impacts within the context of multiple drivers that are shaping the region.

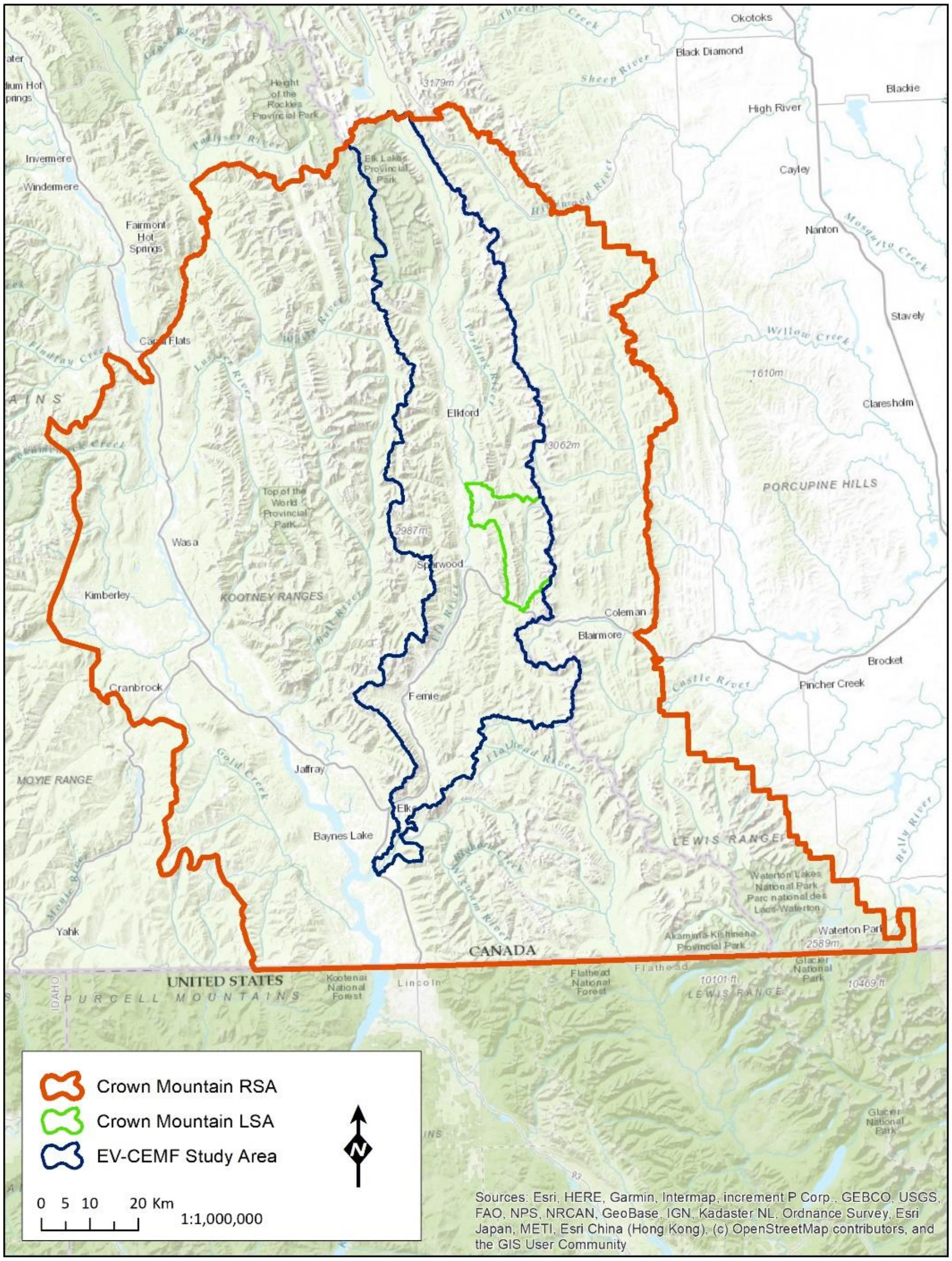

FIGURE 1. NWP COAL'S CROWN MOUNTAIN EFFECTS ASSESSMENT STUDY AREAS

2. Methods

ALCES Online's spatial simulation engine was used to simulate natural processes and landscape change over time. Simulations forecasted values to project future landscape change for the three scenarios described. Scenarios are built by defining a series of actions, each of which causes one or more transitions to landscape composition, forest age, and/or forest origin. Landscape composition, age and origin are established as part of the current condition modeling. See Appendix A for data sources used to establish current condition of the study area. Each action represents a process that alters the study area. Examples include settlement expansion, forest harvest, road construction, fire, and mine reclamation. The tool simulates the cumulative effect of a set of actions. (ALCES Online User Guide 2017). The Elk Valley CEMF valued components (VCs) were assessed under each scenario by mapping the future impacts to old growth/mature forests, aquatic habitat, grizzly bear, and bighorn sheep.

2.1 Scenarios

2.1.1 Scenario 1 - Project Case

Data provided by NWP Coal showing the proposed Crown Mountain development and sequence of development over the life of the mine will be used as inputs for the scenario (Table 1).

TABLE 1. DATA USED FOR SCENARIO 1 DEVELOPMENT

Description	Dataset	Format
Proposed NWP Coal Crown Mountain Footprint	YR15_Final_Design_Pit_Area_CLOSE	Shapefile
Crown Mountain Reclamation Footprint	YR15_Final_Reclaimed_Area_CLOSE	Shapefile

Assumptions for the Project Case Scenario include:

a. The area (m^2) converted to mine footprint (mine area allocation) is based on NWP Coal's proposed development sequence. The proposed mine footprint layer (see Table 1) was used to allocate equal mine growth of 199,145 m^2 annually over 15 years, filling out the mine footprint shown in Figure 2.
b. Mine reclamation was simulated using the spatial reclamation data. A shapefile was provided by NWP Coal that delineated the reclamation footprint. Refer to Figure 3, below for the area allocated to Reclamation. Table 2 outlines the landcover types that were assigned to reclamation areas. The entire reclamation footprint (4,884,655 m^2) was converted in year 40 of the simulation (2055).

TABLE 2. LANDCOVER TYPES WITHIN IDENTIFIED RECLAMATION POLYGONS AND ASSOCIATED ALLOCATED AREAS IN m^2.

Landcover Type	Allocated area (m2)
Coniferous Dense	4,374,870
Exposed Land	47,758
Shrub Tall	60,036
Grassland	6,160
Herb	395,831

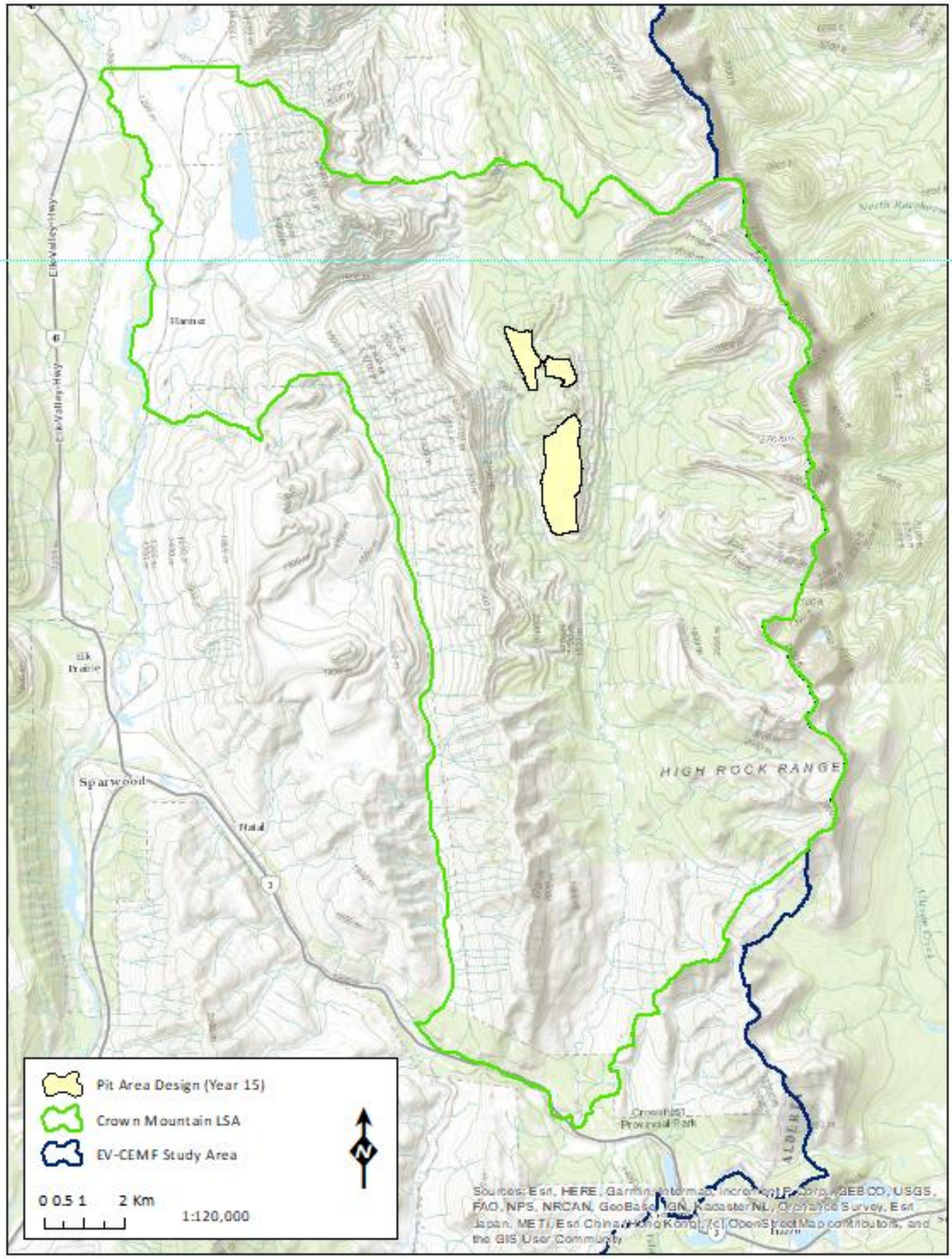

FIGURE 2. PROPOSED NWP COAL'S CROWN MOUNTAIN FOOTPRINT AT MAXIMUM BUILDOUT

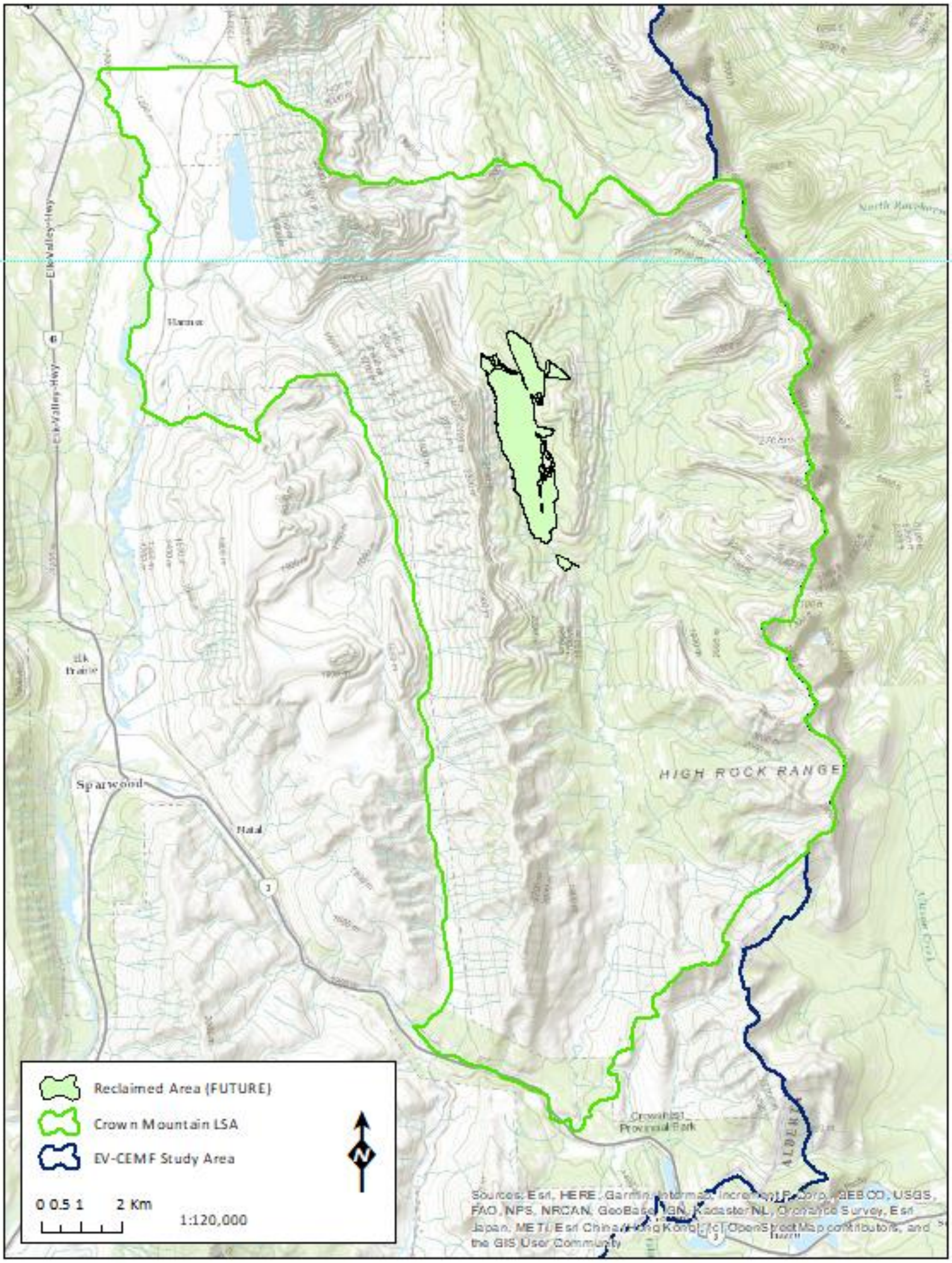

FIGURE 3. NWP COAL'S CROWN MOUNTAIN RECLAIMED AREA (FUTURE)

The VC response to the scenario was assessed at year 2021 (current), year 2038 (maximum project extent), and year 2055 (post-closure).

2.1.2 Scenario 2 – Project Case with Cumulative Effects Scenario

The scenario and allocations described in the Project Case Scenario (Section 2.1.1) were carried forward to form the core of the cumulative effects scenario. Additional disturbance footprints were added to this scenario to represent the cumulative foreseeable development within the study area (Table 3).

TABLE 3. DATA USED FOR SCENARIO 2 DEVELOPMENT

Description	Dataset	Format
Proposed Mine Footprints	Future_MineProjects	Shapefile
Proposed Mine Footprints	CumulativeEffects_Energy_PGN	Shapefile
Mine Reclamation Footprints	CumulativeEffects_MajorMineReclamation_PGN	Shapefile
Cutblocks	CumulativeEffects_Cutblocks_PGN	Shapefile
Proposed NWP Coal Crown Mountain Footprint	YR15_Final_Design_Pit_Area_CLOSE	Shapefile
Crown Mountain Reclamation Footprint	YR15_Final_Reclaimed_Area_CLOSE	Shapefile

The following sections describe the methods and assumptions used to simulate these disturbances. All additional disturbance was simulated to occur on the landscape within the 50-year simulation timeframe.

a. Mine Footprints

Mine area allocation for proposed developments (Figure 4) were scheduled to occur on the landscape following the timeline and allocations in Table 4.

TABLE 4. SPATIAL ALLOCATIONS FOR MINE DEVELOPMENT IN SCENARIO 2

Mine	Total footprint area (m^2)	Annual allocation (m^2) from 2021-2038
Fording River Extension Project	53,278,300	3,134,0178
Grassy Mountain Coal Project	36,991,000	2,175,941
Bingay Main Project	11,416,900	671,582
Elan Hard Coking Coal Project	151,060,000	8,885,882
Fording River Operations	1,216,090	71,535
Michel Coal Project - Head	4,603,300	270,782
Michel Coal Project - Loop Ridge	9,662,100	568,359
Tent Mountain Mine	17,114,178	684,567

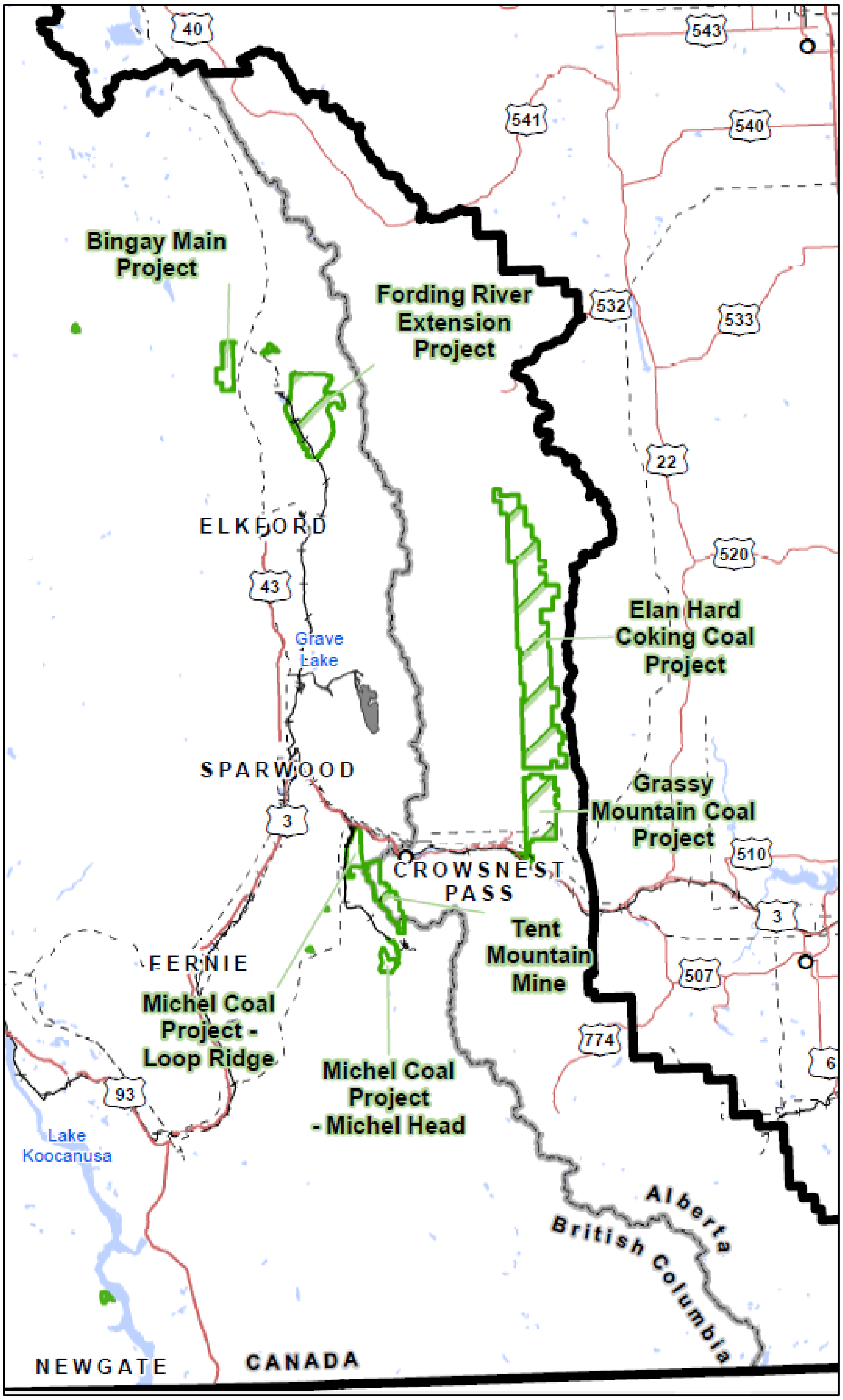

FIGURE 4. FUTURE MINE DEVELOPMENTS (EXCERPT FROM NWP COAL CANADA LTD., FIGURE 1. CROWN MOUNTAIN COKING COAL PROJECT (DRAFT), 2021-04-14).

b. Forest Harvest

Future forest harvest data were not available for a majority of the study area with the exception of data provided by the Client in the CumulativeEffects_Cutblocks_PGN shapefile. The future cutblocks from this shapefile were incorporated into the simulation by directing harvest to blocks identified by a harvest date of 2020 onwards (to 2050 – the latest harvest date in the dataset). In total, 5,053 hectares of forest harvest activities are planned to occur in the study area (Figure 5).

To account for additional forest harvest activities in the remainder of the study area, forest harvest was simulated using the following assumptions:

- Simulated cutblocks were confined to the timber harvest land base (THLB) within the Invermere and Cranbrook Timber Supply Areas (TSAs), and the Spray Lakes Forest Management Unit (FMU) in Alberta (forested areas only).
- Spatial arrangement of cutblocks were randomly distributed within those areas described above.
- Cutblock size distribution was based on the historic size of cutblocks in the Elk Valley.

TABLE 5. CUTBLOCK SIZE CLASSES

Cutblock Size Class (m^2)	Proportion of Cutblocks
100,000	0.5
500,000	0.5

- In B.C., the total area of simulated cutblocks was based on the Elk Valley Cumulative Effects Management Framework (EV CEMF 2018) Reference Scenario. The cutblock area from the EV-CEMF was scaled up and multiplied by a proportion to account for the larger Crown Mountain RSA.

TABLE 6. CUTBLOCK ANNUAL ALLOCATION

	Area (m^2)	Proportion of Study Area	Annual Allocation (m^2)
Cranbrook THLB in RSA	3,171,028,049	0.64	7,668,622
Invermere THLB in RSA	1,797,618,387	0.36	2,193,451
TOTAL	4,968,646,436	1.0	9,862,073

- Information was drawn from the Spray Lakes Sawmills Detailed Forest Management Plan 2001 to 2026 to simulate cutblocks in Alberta. The total annual forest harvest (m^2) from the Timber Supply Analysis (Run 4) was multiplied by the proportion of the Forest Management Unit within the Crown Mountain RSA.

TABLE 7. CUTBLOCK ALLOCATION IN THE ALBERTA PORTION OF THE RSA

Total area of Spray Lakes FMU (m^2)	2,847,606,208
FMU area in Crown Mountain RSA (m^2)	430,872,437
Proportion of FMU in Crown Mountain RSA	0.15
Annual area harvested under “Run 4” scenario (m^2)	374,876
Study area annual harvest (m^2)	56,723
Size classes (m^2)	10,000 (50%) 25,000 (50%)

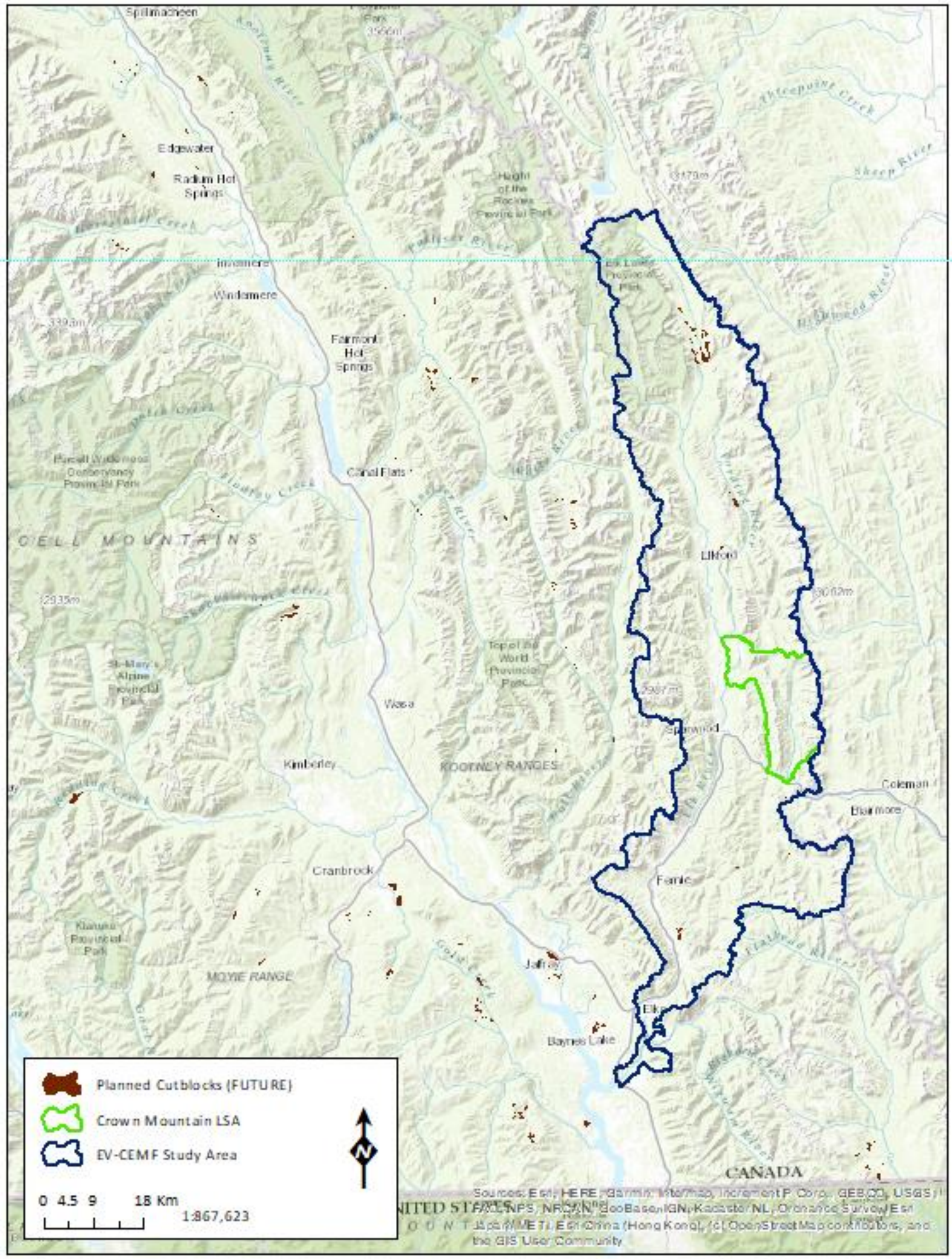

FIGURE 5. PLANNED FOREST HARVEST (2020-2050)

c. Roads

Road development on the landscape was simulated to access future forest cutblocks by applying a least-cost path between the existing road network and simulated cutblocks. The road development simulations were set up so that road pathways follow the lowest elevation routes, and avoid water features.

d. Built-Up Areas and Recreation

The expansion of the towns (Fernie, Sparwood, Elkford) and ski hills within the study area follows the assumptions used in the EV-CEMF Reference Scenario for Urban expansion, and EV-CEMF Maximum Scenario for ski hill growth. A mask was used to direct future growth to those areas identified for urban expansion and recreation growth by Official Community Plans for each community.

e. Mine Reclamation

Mine reclamation was simulated using spatial reclamation data. A shapefile was provided by NWP Coal that delineated the reclamation footprint of the Crown Mountain mine, as well as expected reclamation at other mines in the region. Refer to Figure 6, below for the area allocated to Reclamation. Table 8 outlines the landcover types that were assigned to reclamation at Crown Mountain and other mines in the region. All reclamation (161,260,144 m^2 at other mine sites and 4,884,655 m^2 at Crown Mountain) was converted in year 40 of the simulation (2055).

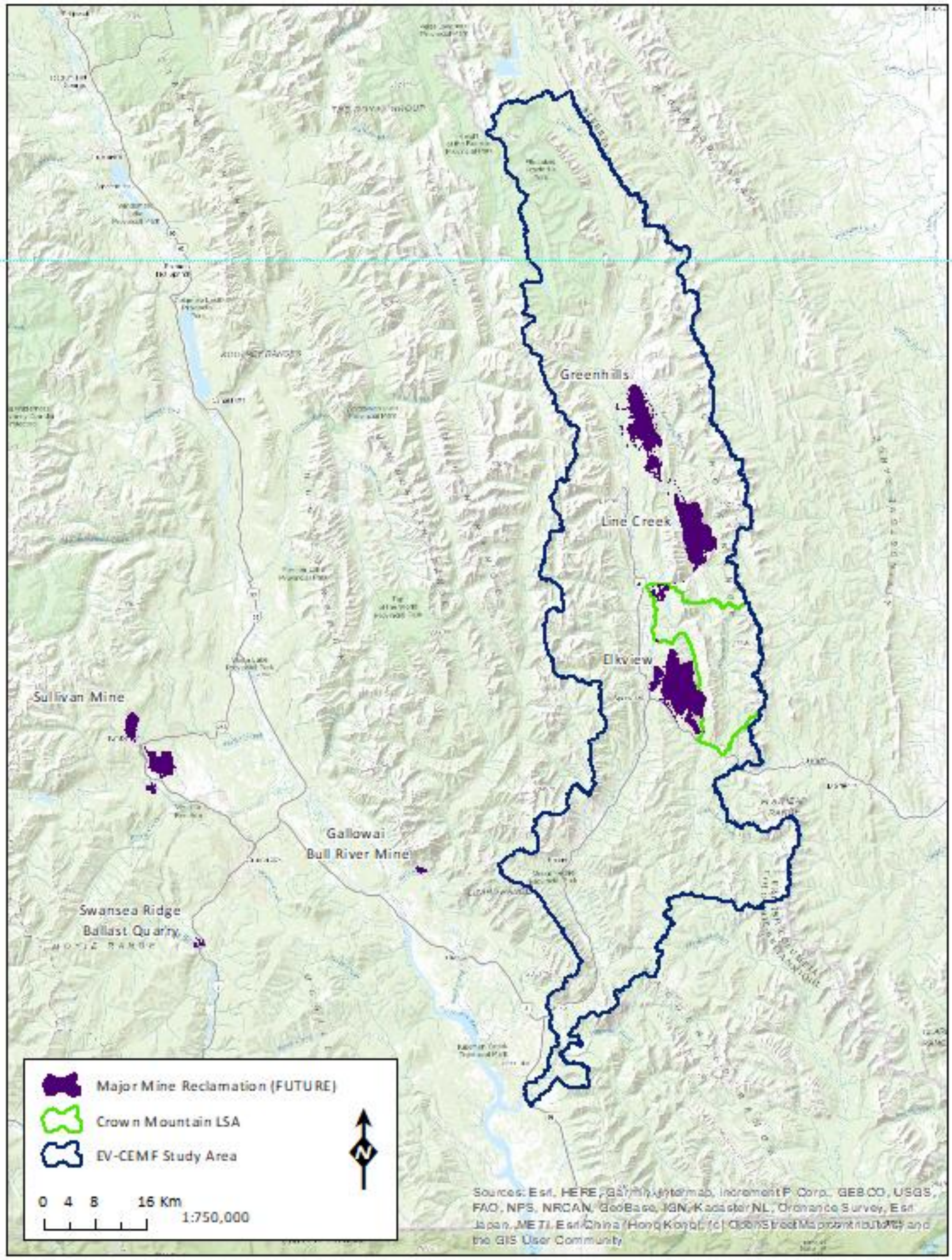

FIGURE 6. FUTURE MINE RECLAMATION

TABLE 8. SCHEDULE OF RECLAMATION ACTIVITIES FOR EACH MINE AND ASSOCIATED AREA (m²)

		Mine Site					
		Sullivan Mine	Greenhills Operations	Line Creek Operations	Elkview Operations	Gallowai Bull River	Crown Mountain
Landcover Type	Exposed Land	4,543,938	9,666,929	10,776,045	35,159,350	557,435	47,758
	Water	207,865	189,171	55,812	206,874	-	
	Shrub	858,037	680,480	2,014,625	387,877	95,260	60,036
	Herb	1,108,875	3,365,953	1,121,545	1,582,248	314,657	395,831
	Grassland	547,944	1,419,701	547,388	3,250,044	1,136	6,160
	Cropland	-	25,946	612,562	71,704	-	
	Forest	10,790,415	24,766,776	28,318,469	14,209,889	76,211	4,374,870
	Rock	3,291,522	-	302,524	-	118,291	
	Wetland	16,646	-	-	-	-	

2.1.3 Scenario 3 – Project Case with Cumulative Effects and Natural Disturbance Scenario

This scenario builds off Scenario 2 described in Section 2.1.2, by adding fire and insect outbreak natural disturbances.

TABLE 9. DATA USED FOR SCENARIO 3 DEVELOPMENT

Description	Dataset	Format
Proposed Mine Footprints	Future_MineProjects	Shapefile
Mine Reclamation Footprints	CumulativeEffects_MajorMineReclamation_PGN	Shapefile
Cutblocks	CumulativeEffects_Cutblocks_PGN	Shapefile
Proposed NWP Coal Crown Mountain Footprint	YR15_Final_Design_Pit_Area_CLOSE	Shapefile
Crown Mountain Reclamation Footprint	YR15_Final_Reclaimed_Area_CLOSE	Shapefile
Fire	No dataset used; random allocation distributed	NA
Insect Outbreak	Forest Health Factor (FHF)	Shapefile
Insect Outbreak	Insect Hazard Class Ratings	Shapefile

All aspects of Scenario 2 remain unchanged, with the following additions:

a. Fire

Fire was simulated using the assumptions from a scenario analysis that was recently completed in the North Thompson region of BC (Carlson, 2020, pers. comm.). Spatial variation in relative burn probability is influenced by vegetation zones, forest type, and age. Relative burn probability is calculated by multiplying normalized BEC burn rates (Table 10) by fire selection ratios by forest cover and age class (Table 11). Fire selection ratios are available for forest types (deciduous and coniferous); shrubland is assumed to have the same relative burn probability as young deciduous forest, the forest category exhibiting the lowest fire selection ratio (Wilson, 2015; Bernier, 2016).

The general equation for simulated fire is as follows[1]:

*((Coniferous Dense + Coniferous Open + Coniferous Sparse) *IF (Forest age>89, THEN 2.9, ELSE IF(Forest Age > 29, THEN 2, ELSE 0.8)))*((Shrub Low + Shrub Tall + Broadleaf Dense + Broadleaf Open)*IF(Forest Age >89, THEN 0.63, ELSE IF (Forest Age >29, THEN 0.4, ELSE 0.15)))*Regional Modifier (BEC Zones with Relative probabilities as outlined in Table 10)*

TABLE 10. RELATIVE BURN PROBABILITIES OF BEC ZONES (FROM WILSON, 2015)

BEC category	BEC Zones	Relative burn probability
Alpine Tundra (AT)	IMA, CMA, BAFA	0
Bunchgrass (BG)	BG	0
High Elevation Spruce (NHE Spruce)	SWB, BWBS, ESSF	1.06
Mixed low elevation spruce (CMLE Spruce)	SBPS, SBS, MS	1.31
Douglas fir (IDF)	IDF, CWF	0.74
Interior cedar and hemlock (ICH)	ICH	1.15

TABLE 11. RELATIVE BURN PROBABILITIES FOR FOREST TYPE AND FOREST AGE CATEGORIES (FROM BERNIER, 2016)

	Young (<30 years)	Mature (30-89 years)	Old (>89 years)
Conifer	0.8	2	2.9
Deciduous	0.15	0.4	0.63

Area allocated to fire was based on the EV CEMF Reference Scenario (EV CEMF 2018) with a multiplier applied to account for the larger Crown Mountain RSA. Table 12 shows the simulated total area burned for each decade.

[1] Model equations used in ALCES don't conform to standard mathematical equation structure.

TABLE 12. SIMULATED AREA (m^2) AFFECTED BY FIRE

Decade	Annual Burned Area (m^2)
2020	62,935,526
2030	7,081,782
2040	3,571,720
2050	22,554,518
2060	171,161

b. Insect Outbreaks

Insect outbreak assumptions are based primarily on two data sets: The Forest Health Factor (FHF) which is comprised of polygons created from aerial observations of current forest infestations conducted by FLNRORD (filename: AOS_2020_Polygons.shp; 2020), and; the Beetle Susceptibility data which provides hazard classes of forests for each insect (filename: pest_infestation_poly.gdb; BC Catalogue 2019):

FHF data were filtered to include only IBS (spruce beetle), IBD (Douglas fir beetle), and IBM (Mountain pine beetle) polygons within the Kootenay Boundary Region in order to determine size classes of insect outbreak.

For the BC portion of the RSA, the Beetle Susceptibility dataset was used to spatially constrain simulated insect outbreaks to those areas identified at risk for beetle infestations. For Alberta, eligible areas for insect infestation were constrained to coniferous land cover. The proportion of each hazard class assigned to the insect outbreak were calculated by multiplying the infestation rating by the susceptible area taken from the FHF aerial surveys (2019) for each beetle species, and are outlined in Table 10 - Table 15. Annual infestation allocations for BC were applied to Alberta for mountain pine and spruce beetles using a multiplier related to the area of the Alberta portion within the study area.

- Percent of coniferous forest impacted by insect outbreaks for each Hazard Class (Susceptibility Rating):
    - High (H) – 100%
    - Moderate (M) – 66%
    - Low (L)– 33%
    - Very Low (V) – 5%

The areas were divided by ten years to determine the annual infestation area; these numbers are based on the assumption that there is a ten-year insect infestation cycle (pers. comm. Marnie Dulthie-Holt, 2019).

TABLE 13. ANNUAL AREA (M^2) OF DOUGLAS FIR BEETLE (IBD) INFESTATIONS FOR EACH HAZARD CLASS

Hazard (Bark Beetle Susceptibility Rating)	Infestation Rate	Susceptible Area (m^2)	Infestation Area (m^2)	Annual Area (m^2)
H	1	122,039,600	122,039,600	12,203,960
M	0.66	193,299,800	127,577,868	12,757,787
L	0.33	2,012,053,000	663,977,490	66,397,749
V	0.05	1,487,678,000	74,383,900	7,438,390

TABLE 14. ANNUAL AREA (M^2) OF SPRUCE BARK BEETLE (IBS) INFESTATIONS FOR EACH HAZARD CLASS

Hazard (Bark Beetle Susceptibility Rating)	Infestation Rate	Susceptible Area (m^2)	Infestation Area (m^2)	Annual Area (m^2)
H	1	59,425,020	59,425,020	5,942,502
M	0.66	300,284,930	198,188,050	19,818,805
L	0.33	3,983,573,430	1,314,579,230	131,457,923
V	0.05	748,238,200	37,411,910	3,741,191

TABLE 15. ANNUAL AREA (M^2) OF MOUNTAIN PINE BEETLE (IBM) INFESTATIONS FOR EACH HAZARD CLASS

Hazard (Bark Beetle Susceptibility Rating)	Infestation Rate	Susceptible Area (m2)	Infestation Area (m2)	Annual Area (m2)
H	1	820,555,318	820,555,318	82,055,532
M	0.66	921,131,076	607,946,510	60,794,651
L	0.33	3,254,398,871	1,073,951,630	107,395,163
V	0.05	2,655,922,949	132,796,150	13,279,615

- Categories of observed infestations from the Beetle Susceptibility data relate to the FHF hazard class ratings; i.e. Patch sizes from the FHF with "S" infestation (severe) apply to the High Hazard areas defined by the Bark Beetle Susceptibility Rating dataset. In order to compare between the two datasets, the “VL” (very low) and “T” (trace) infestation classes of the FHF data were combined into one category of “VL”.
- The 2019 FHF survey data were used to allocate size class and total area (m^2) of bark beetle impacts for the simulations. Size classes were assigned for each insect Hazard Class (Table 9).

TABLE 16. SIZE CLASS ALLOCATIONS FOR INSECT OUTBREAKS

Insect	Severity	Size Class Rounded (m^2)	Proportion
IBD	L	480,000	1
IBD	M	160,000	1
IBD	S	120,000	1
IBD	V	200,000	1
IBM	L	140,000	1
IBM	M	270,000	1
IBM	S	170,000	1
IBM	V	230,000	0.5
IBM	V	380,000	0.5
IBS	L	500,000	1
IBS	M	1,140,000	1
IBS	S	550,000	1
IBS	V	550,000	1

3. REFERENCES

Carlson, M., D. Browne, and C. Callaghan. 2019. Application of land-use simulation to protected area selection for efficient avoidance of biodiversity loss in Canada's western boreal region. Land Use Policy 82:821-831.

Carlson, M., J. Quinn, and B. Stelfox. 2015. Exploring Cumulative Effects of Regional Urban Growth Strategies: A Planning Scenario Case Study from the Calgary Region of Western Canada. International Society of City and Regional Planners (ISOCARP) Review 11.

Carlson, M. and B. Stelfox. 2014. Alberta oil sands development and risk management of Canadian boreal ecosystems. In: J.E. Gates, D.L. Trauger and B. Czech (Eds.) Peak Oil, Economic Growth, and Wildlife Conservation. Springer, New York, New York.

Elk Valley Cumulative Effects Management Framework Working Group (EV CEMF). 2018. *Elk Valley Cumulative Effects Assessment and Management Report.*

Leston L, Bayne E, Dzus E, Sólymos P, Moore T, Andison D, Cheyne D and Carlson M. 2020. Quantifying Long-Term Bird Population Responses to Simulated Harvest Plans and Cumulative Effects of Disturbance. Front. Ecol. Evol. 8:252. doi: 10.3389/fevo.2020.00252

Appendix A – Baseline Data Sources

Listed Data Source Acronyms

- ABMI HFI: Alberta Biodiversity Monitoring Institute Human Footprint Inventory
  - Author: ABMI
  - Year (Version): 2017 (version 1)
  - Last Modified: 2019-05-13
  - Date downloaded: February 2019
  - Source link: https://www.abmi.ca/home/data-analytics/da-top/da-product-overview/Human-Footprint-Products/HF-inventory.html
- CEMF: Cumulative Effects Management Framework
  - Author: Forests, Lands, Natural Resource Operations and Rural Development
  - Year (Version): December 2018
  - Last Modified: -
  - Date downloaded: December 2018
  - Source link: n/a
- EOSD Landcover: Earth Observation for Sustainable Development of Forests Landcover dataset
  - Author: Earth Observation for Sustainable Development of Forests
  - Year (Version): 2000
  - Last Modified: -
  - Date downloaded: January 2019
  - Source link: https://open.canada.ca/data/en/dataset/97126362-5a85-4fe0-9dc2-915464cfdbb7
- VRI: Vegetation Resource Inventory
  - Author: Ministry of Forests, Lands, Natural Resource Operations and Rural Development
  - Year (Version): 2011-03-09
  - Last Modified: 2019-06-11
  - Date downloaded: January 2019
  - Source link: https://catalogue.data.gov.bc.ca/dataset/vri-forest-vegetation-composite-polygons-and-rank-1-layer
- NASA forest age dataset: National Aeronautics and Space Administration forest age dataset
  - Author: Pan, Y., J. M. Chen, R. Birdsey, K. McCullough, L. He, and F. Deng.
  - Year (Version): 2012 (data from 2004)
  - Last Modified: June 13, 2012
  - Date downloaded: January 2019
  - Source link: https://daac.ornl.gov/cgi-bin/dsviewer.pl?ds_id=1096
- AVI: Alberta Vegetation Inventory
  - Author: Forest Management Branch, Forestry Division, Alberta Agriculture and Forestry. Government of Alberta
  - Year (Version): 2017-09-18
  - Last Modified: 2017-10-11
  - Date downloaded: January 2019
  - Source link: https://geodiscover.alberta.ca/geoportal/catalog/search/resource/fullMetadata.page?uuid=%7B3DBCFA02-E97A-4059-9414-1ED8E0700E80%7D
- SIBEC: Site Index Estimates by BEC Site Series

- Author: Ministry of Forests, Lands, Natural Resource Operations and Rural Development
  - Year (Version): 2014-12-03
  - Last Modified: 2017-12-05
  - Date downloaded: January 2019
  - Source link: https://catalogue.data.gov.bc.ca/dataset/site-productivity-site-index-by-tree-species
- BC Consolidated Cutblocks:
  - Author: Ministry of Forests, Lands, Natural Resource Operations and Rural Development
  - Year (Version): 2016-07-21
  - Last Modified: 2019-06-03
  - Date downloaded: January 2019
  - Source link: https://catalogue.data.gov.bc.ca/dataset/harvested-areas-of-bc-consolidated-cutblocks-
- BC Fire Perimeters - Historical:
  - Author: Ministry of Forests, Lands, Natural Resource Operations and Rural Development
  - Year (Version): 2011-03-09
  - Last Modified: 2019-05-04
  - Date downloaded: January 2019
  - Source link: https://catalogue.data.gov.bc.ca/dataset/fire-perimeters-historical
- BC Fire Perimeters - Current:
  - Author: Ministry of Forests, Lands, Natural Resource Operations and Rural Development
  - Year (Version): 2011-03-09
  - Last Modified: 2019-05-17
  - Date downloaded: January 2019
  - Source link: https://catalogue.data.gov.bc.ca/dataset/fire-perimeters-current
- Alberta Wildfire Perimeters – Historical
  - Author: Alberta Agriculture and Forestry
  - Year (Version): n/a
  - Last Modified: 2019-03-05
  - Date downloaded: January 2019
  - Source link: https://wildfire.alberta.ca/resources/historical-data/spatial-wildfire-data.aspx
- AltaLIS Lakes: AltaLIS Base Waterbody Polygon
  - Author: Alberta Environment and Parks, Government of Alberta
  - Year (Version): 2004-10-25
  - Last Modified: n/a
  - Date downloaded: March 2019
  - Source link: https://maps.alberta.ca/genesis/rest/services/Base_Water_Feature/Latest/MapServer
- AltaLIS Streams: AltaLIS Base Stream and Flow Representation
  - Author: Alberta Environment and Parks, Government of Alberta
  - Year (Version): 2000-09-05
  - Last Modified: n/a
  - Date downloaded: March 2019
  - Source link: https://maps.alberta.ca/genesis/rest/services/Base_Water_Feature/Latest/MapServer
- FWA Lakes: Freshwater Atlas lake features

- Author: Ministry of Forests, Lands, Natural Resource Operations and Rural Development
    - Year (Version): 2011-03-09
    - Last Modified: 2019-05-02
    - Date downloaded: March 2019
    - Source link: https://catalogue.data.gov.bc.ca/dataset/freshwater-atlas-lakes
- FWA Streams: Freshwater Atlas river features
    - Author: Ministry of Forests, Lands, Natural Resource Operations and Rural Development
    - Year (Version): 2011-03-09
    - Last Modified: 2019-05-07
    - Date downloaded: March 2019
    - Source link: https://catalogue.data.gov.bc.ca/dataset/freshwater-atlas-rivers
- PSCIS: Provincial Stream Crossing Information System
    - Author: Ministry of Environment and Climate Change Strategy
    - Year (Version): 2013-04-15
    - Last Modified: 2019-05-04
    - Date downloaded: March 2019
    - Source link: https://catalogue.data.gov.bc.ca/dataset/pscis-assessments
- Road Point Events dataset
    - Author: Alberta Environment and Parks, Government of Alberta
    - Year (Version): n/a
    - Last Modified: 2019-06-28
    - Date downloaded: March 2019
    - Source link: https://geodiscover.alberta.ca/geoportal/catalog/search/resource/fullMetadata.page?uuid=%7B659BD290-C829-4397-A7E2-47774A6310C6%7D
- Reconnaissance Karst Potential Mapping
    - Author: Ministry of Forests, Lands, Natural Resource Operations and Rural Development
    - Year (Version): 2011-03-09
    - Last Modified: 2019-05-04
    - Date downloaded: March 2019
    - Source link: https://catalogue.data.gov.bc.ca/dataset/reconnaissance-karst-potential-mapping
- Significant Landforms of Alberta
    - Author: Alberta Parks, Government of Alberta
    - Year (Version): 2014
    - Last Modified: n/a
    - Date downloaded: March 2019
    - Source link: https://www.albertaparks.ca/albertaparksca/management-land-use/significant-landforms-of-alberta/

Explanation of Data Processing

- Footprint types and updated water features were then cross walked between AB and BC data sources to ensure consistency between categories across provincial boundaries:
- Hierarchies were then defined for each final indicator class to determine the coverage in the case of overlapping polygons. The lowest hierarchy number was assigned the highest priority:

Indicator Name	Hierarchy
Highway	1
Paved Road	2
Gravel Road	3
Railway	4
Transmission Line	5
Mine	6
Built-Up	7
Recreation	8
Pipeline	9
Well Site	10
Seismic Lines	11
Trail	12
Canal, Dugout, Lagoon, Quarry Pit	13
Reservoir	14
Lake	15
Major River	16
Stream Permanent	17
Stream Recurring	18
Coniferous Dense	19
Coniferous Open	20
Coniferous Sparse	21
Deciduous Dense	22
Deciduous Open	23
Deciduous Sparse	24
Mixedwood Dense	25
Mixedwood Open	26
Mixedwood Sparse	27
Shrub Low	28
Shrub Tall	29
Wetland - Treed	30
Wetland - Shrub	31
Wetland - Herb	32
Herb	33
Grassland	34
Exposed Land	35
Rock/Rubble	36
Snow/Ice	37
Cropland	38
Pasture	39
Agriculture - undifferentiated	40
Water - Undifferentiated	41

Developed	42
Unknown	43

DATA UPLOAD TO ALCES ONLINE

Once the landcover and footprint data was crosswalked and hierarchies were determined polygon datasets were uploaded to the ALCES Online software, and rasterized at a 25m resolution. Data concerning indicator coverage within a pixel was retained by means of proportional coverage; this means that at the level of the pixel, data is aspatial in nature.

Indicators representing non-landcover/footprint types were also uploaded to AO through rasterization at 100 m. These include forest age, forest origin, elevation, slope, aspect, spring snow, soil types, PEM site series, PEM BEC zones, ecosite phase codes, surficial geology types, solar radiation, and solar duration.