Elk Valley Cumulative Effects Management Framework – Upper Elk Case Study

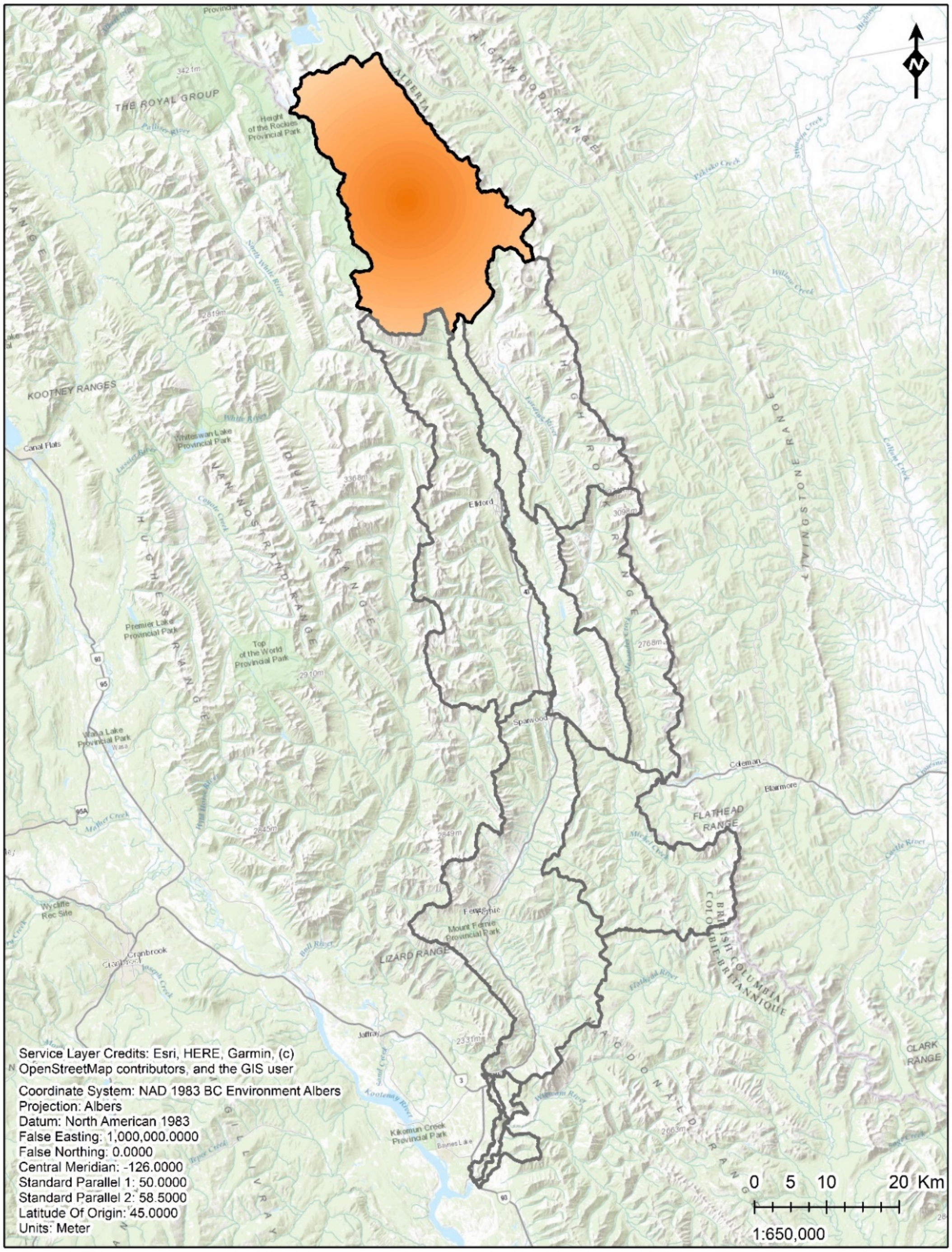
1. Introduction

The British Columbia interim Cumulative Effects Framework (CEF) Policy states that a*vailable CEF assessments should be considered by government and decision-makers when reviewing applications for the use of land and natural resources that could potential affect CEF values* (2016; section 13.1.1.1). The Elk Valley Cumulative Effects Management Framework (EV CEMF) Assessment and Management Report (CEAM) has been provided guidance from the Environmental Assessment Office (EAO), suggesting that the EAO will use the EV CEMF as an additional tool in decision making. In addition to the EAO, the Ministry of Energy, Mines and Petroleum Resources (EMPR) has been providing guidance to proponents to include the EV CEMF Valued Component (VC) analysis in various types of applications. The EV CEMF and the provincial Cumulative Effects Framework (CEF) have been assessing how best to apply CE tools and analysis. This has been done using case studies with EV CEMF Working Group members, including on development projects by NWP Coal and Canfor Forest Products Ltd. (Canfor) to-date.

The Upper Elk Valley case study was initiated due to increasing forest health issues related to insect outbreak and concerns about the potential cumulative impacts of harvest for the purpose of beetle sanitation on valued components. This document outlines how the case study was conducted in collaboration with Canfor, Ktunaxa Nation Council and FLNRORD and describes key findings relevant to the EV CEMF and guidance on CE assessment and forestry.

2. Methods

The upper Elk Valley case study used ALCES Online to evaluate VC response to eight scenarios focused on forestry development within the context of natural disturbances from wildfire and pests. The case study focused on a Landscape Unit (LU) C22 (64,386 ha, Figure 1), and over a 10-year temporal scale from 2020-2029. Each scenario had variation in disturbance related to either harvest and associated road development, wildfire and/or insect outbreak (spruce bark beetle, mountain pine beetle and Douglas fir beetle), and mitigation (road rehabilitation).



Date: 2020-02-26

Figure 1. Landscape Unit C22 in the Upper Elk Valley (shown in orange).

Scenario 1 - Proposed Harvest

Data provided by Canfor Forest Products Ltd. (Canfor) identified the proposed cutblocks, timeline, and road development over the next 10-year period and were model inputs for the proposed development scenarios. The area encompassed by proposed cutblocks during this time period is approximately 14.2 km^2, shown in Figure 2. Figure 3 shows all current and proposed 10 year harvest roads in LU C22.

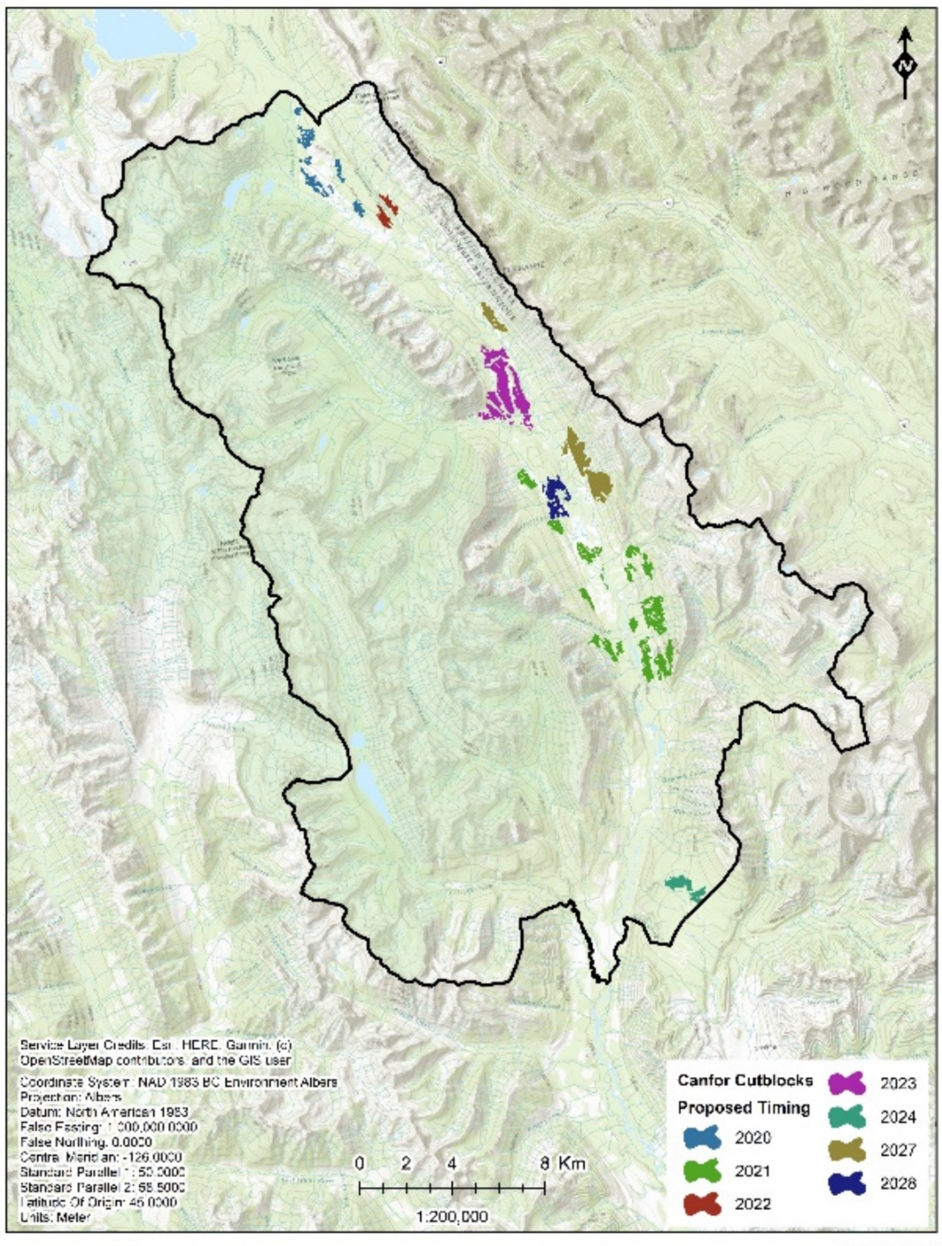
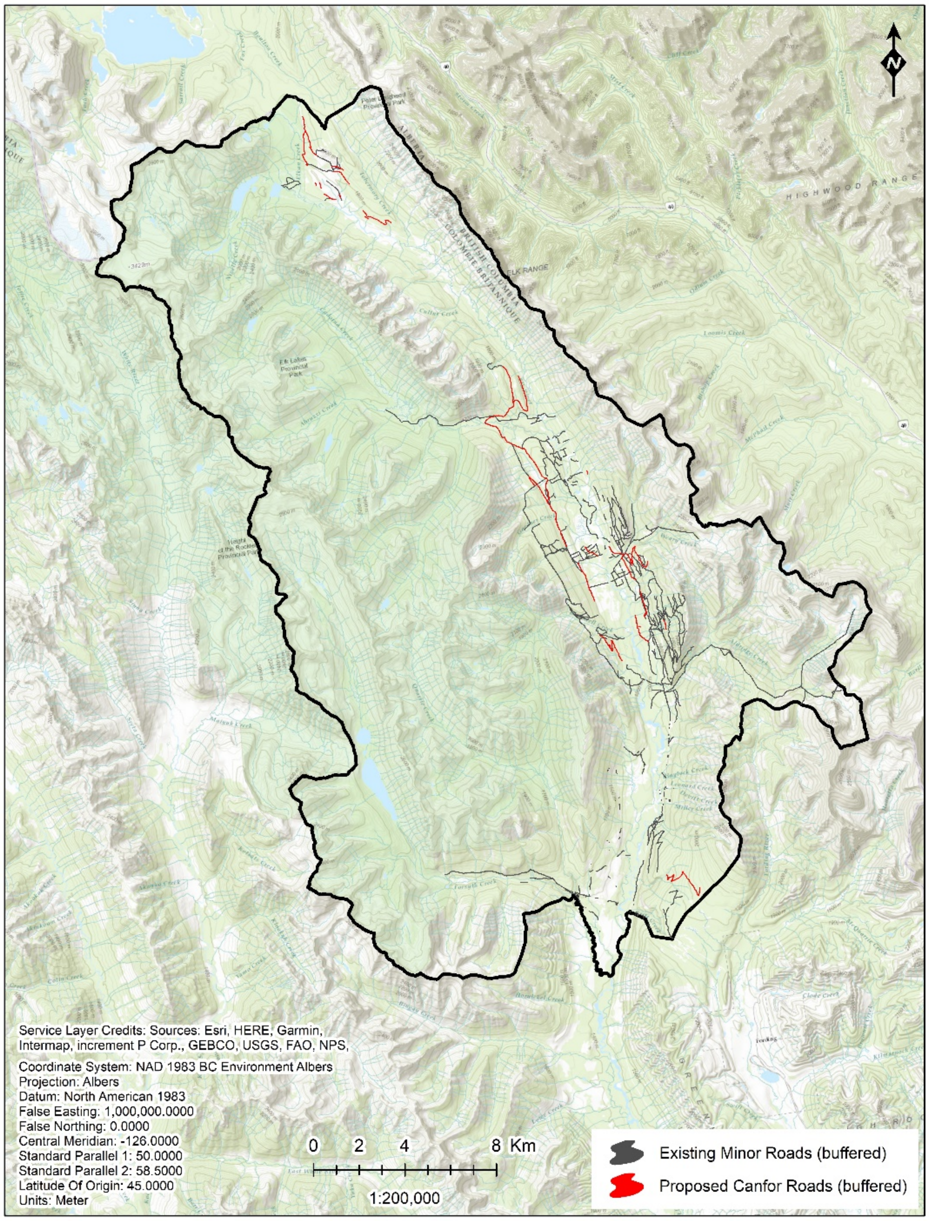


Figure 2. Potential Canfor Cutblocks in LU C22 from 2020-2029.



Date: 2020-02-26

Figure 3. Existing minor roads and Canfor proposed roads (376.6 km) (2020 – 2029) in LU C22.

Assumptions for the Proposed Harvest Scenario included:

a. Annual harvest allocation was based on the proposed harvest timeline and associated cutblock areas (Table 3). The 10-year proposed harvest layer was used to focus the harvest allocation only in proposed cutblocks.

Table 1. Annual harvest area allocation for Scenario 1

Period	Area (m2)
2020	1,400,353
2021	4,899,353
2022	528,245
2023	2,948,637
2024	762,032
2025	0
2026	0
2027	2,561,645
2028	1,036,287
2029	0

b. Road development was simulated using the same methods as described above for annual harvest allocation. The Canfor 10-year road development layer was incorporated into the scenario as a raster mask to focus road development only along proposed routes. Annual road area allocation can be found in Table 2.

Table 2. Annual road area allocation for Scenario 1

Period	Area (m^2)	Length (km)
2020	118509	6.97
2021	304765	17.93
2022	23689	1.39
2023	187957	11.06
2024	56386	3.32
2025	0	0
2026	0	0
2027	2544	0.15
2028	0	0
2029	0	0

SCENARIO 2 - BARK BEETLE (SPRUCE, MOUNTAIN PINE, DOUGLAS-FIR)

To develop assumptions for the simulation of bark beetle impacts in LU C22, the Bark Beetle Susceptibility Rating dataset and Forest Health Factor (FHF) observations were referenced for the insect pests Mountain pine beetle (IBM), Spruce bark beetle (IBS), and Douglas-fire beetle (IBD). Size classes used in the simulations were estimated based on FHF aerial overview observations.

Figures 4, 5, and 6, show the hazard class associated with each of the insect pests.

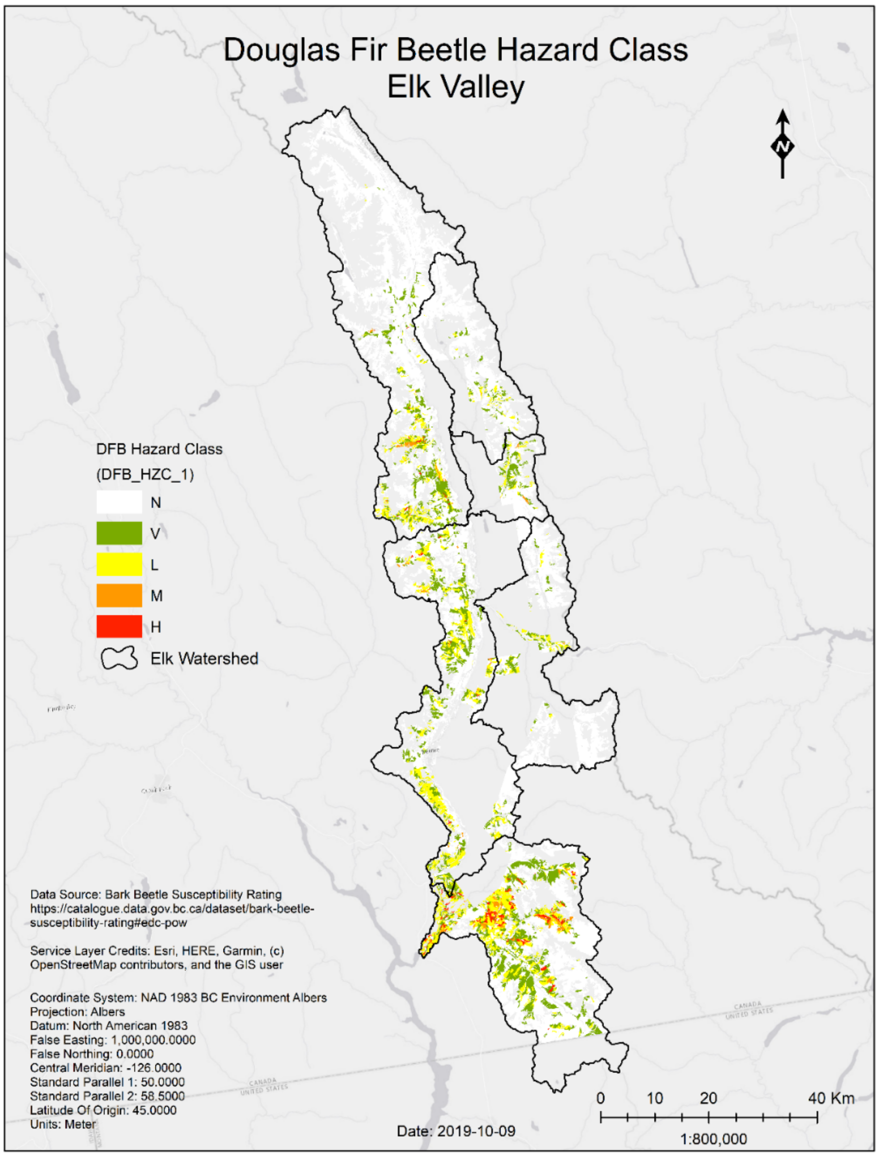


Figure 4. Douglas-fir beetle hazard classes in the Elk Valley.

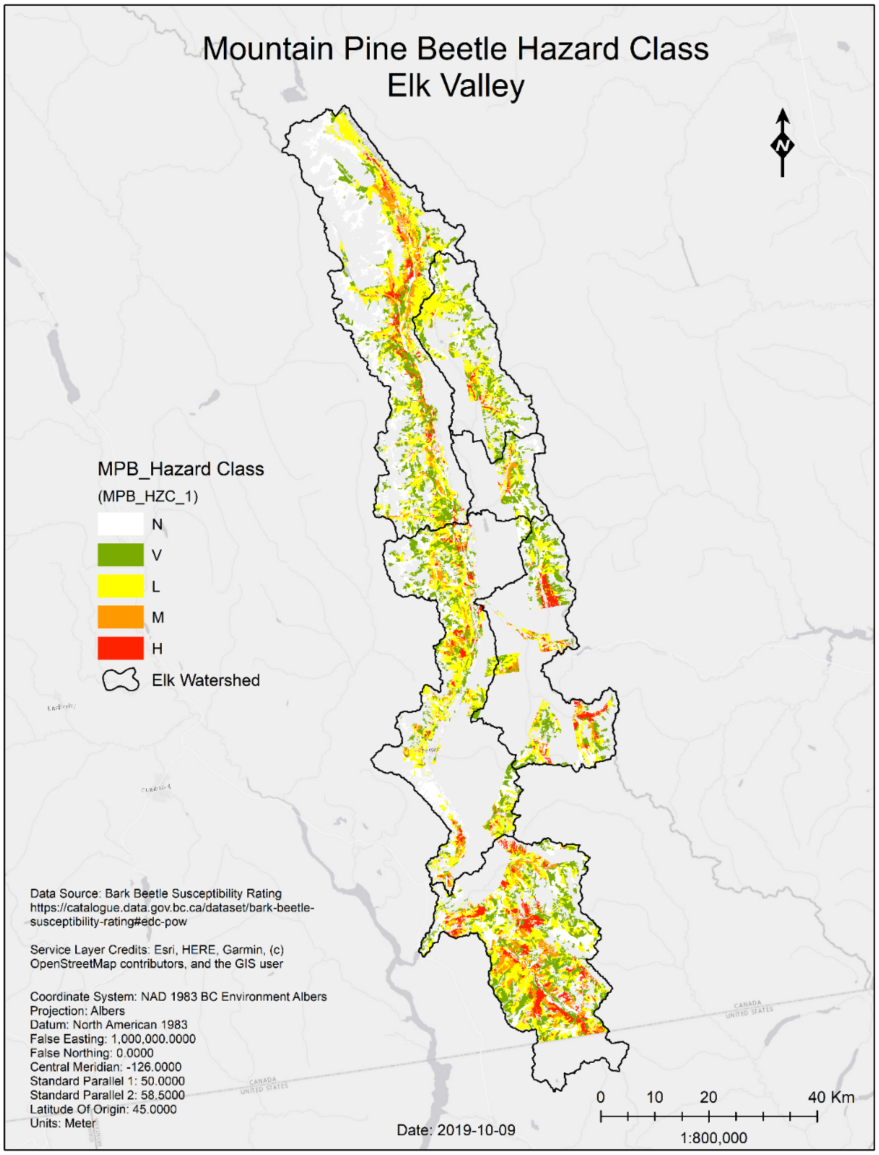


Figure 5. Mountain pine beetle hazard classes in the Elk Valley.

Assumptions for the Bark Beetle Scenario included:

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

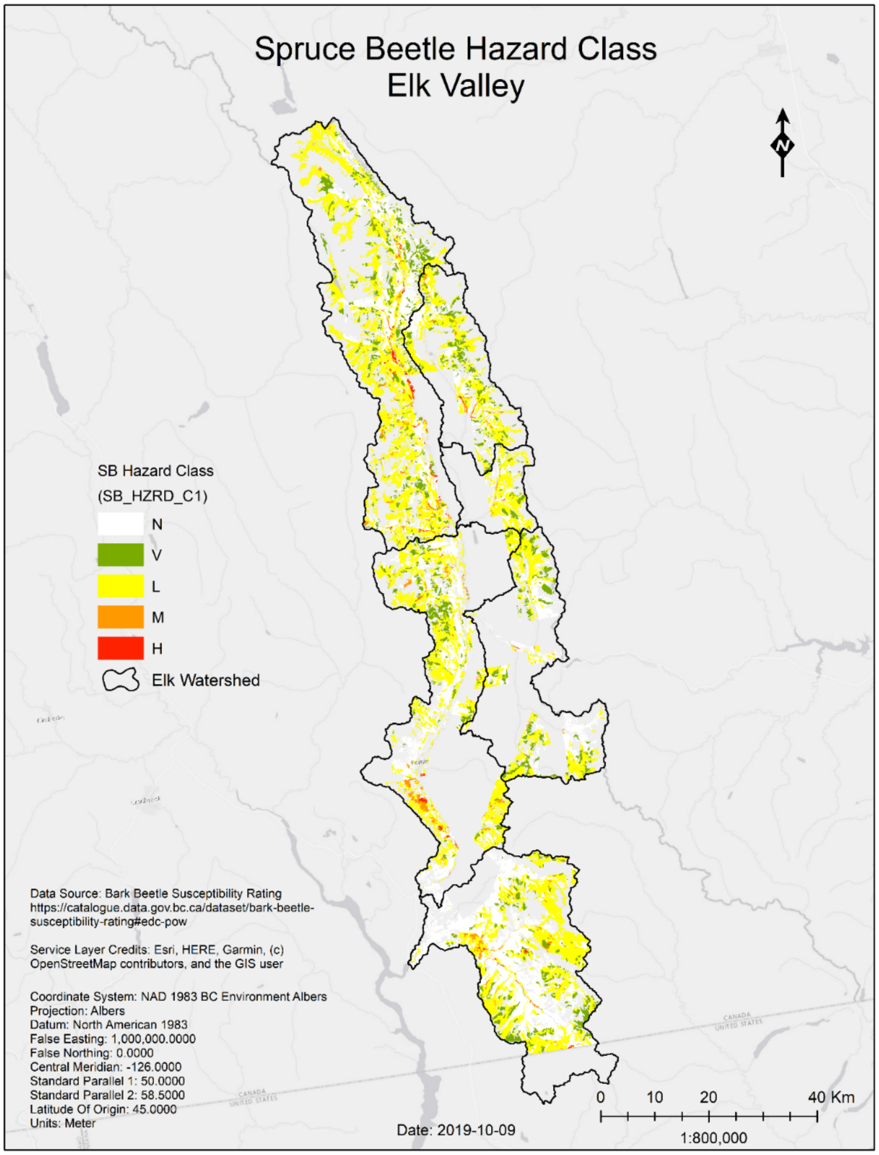


Figure 6. Spruce beetle hazard classes in the Elk Valley.

b. Table 3 summarizes the proportion of outbreak assigned to each Hazard Class for the three insect pests included in the scenario.

Table 3. Insect pest hazard rating proportions

	Hazard Rating			
Insect Pest	H	M	L	V
IBS	0.0403	0.0886	0.8381	0.0328
IBM	0.2341	0.2289	0.4817	0.0553
IBD	0.0880	0.0981	0.6860	0.1278

c. The 2019 FHF aerial overview survey data were used to allocate size class and total area (m²) of bark beetle impacts for the simulations. Size classes were based on the range of recorded infestation areas from the aerial overview surveys, summarized in Table 4.

Table 3. Size class allocations for insect pest outbreaks

IBS							
H		M		L		V	
Size Class (m²)	Proportion	Size Class (m²)	Proportion	Size Class (m²)	Proportion	Size Class (m²)	Proportion
240000	0.615	182000	0.897	197000	0.875	950000	0.5
1220000	0.308	620000	0.069	870000	0.125	1400000	0.5
7800000	0.080	4420000	0.035	-	-	-	-
240000	1.000	240000	1.000	240000	1.000	240000	1.000
260000	0.666	260000	0.666	260000	0.666	260000	0.666
340000	0.333	340000	0.333	340000	0.333	340000	0.333

d. A 10-year cycle was assumed for insect pests. IBS outbreaks historically last between 7 to 8 years, with this infestation starting in 2013. However, outbreaks can last longer, if host triggers persist including defoliation by 2-year cycle budworm, drought, flooding, and blowdown, all of which are present in this study unit.

e. The Spruce beetle cycle is currently in year 6, whereas the Mountain pine beetle and Douglas-fir beetle are in year 1.

f. The annual schedule of bark beetle impacted area is summarized in Table 5.

Table 4. Annual allocation (m²) impacted by bark beetle

Period	IBD Area (m²)	IBS Area (m²)	IBM Area (m²)
2020	5874846	154184647	30510653
2021	5874846	25697441	30510653
2022	5874846	25697441	30510653
2023	5874846	25697441	30510653
2024	5874846	25697441	30510653
2025	5874846	0	30510653
2026	5874846	0	30510653
2027	5874846	0	30510653
2028	5874846	0	30510653
2029	5874846	0	30510653

PEST – YEAR 2029 (CUMULATIVE)

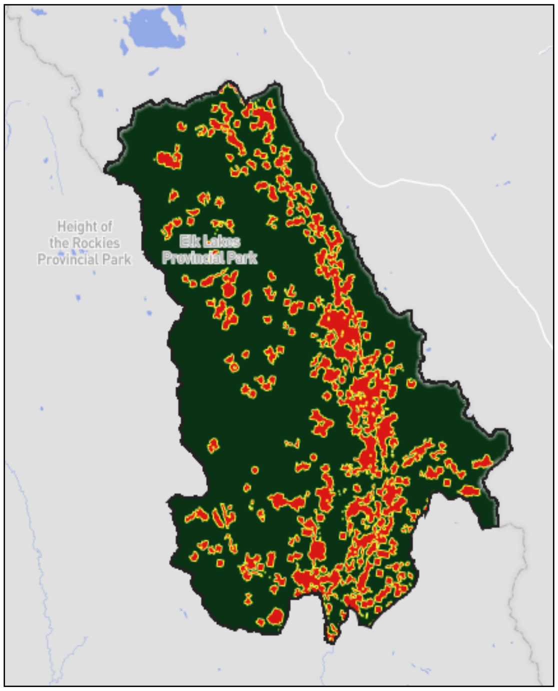


Figure 7. Pest disturbance, year 2029 for Scenario 2, 3, 4 and 7, total Area = 112.30 km^2.

SCENARIO 3 - BARK BEETLE AND FIRE

Fire was added to Scenario 2 to simulate the effect of both bark beetle and fire on the indicators over time (Figure 8). Land cover changes were evaluated independently in order to determine the effects of individual disturbances. One limitation of this approach is that beetle-killed stands would be more susceptible to fire. The modelling assumptions applied here did not preferentially burn beetle-killed stands.

Fire simulations applied the same assumptions as the original EV CEMF Reference Scenario. Annual burn rate was calculated by dividing the annual burned area by the current area of forest, grassland, and brushland in the Elk Valley. The low average fire rate (0.077%) is consistent with Boulanger et al. (2014) for the Southern Cordillera fire regime zone. Boulanger et al. (2014) project average burn rates of 0.074% to 0.085% out to 2040 under future climate change scenarios driven by representative concentration pathway 4.5 and 8.5 scenarios, respectively. The Elk Valley historical fire rate is intermediate between these future rates; therefore, we applied only one future rate (0.085%). These scenarios assume fire suppression remains and there is no change in fire size relative to historical sizes.

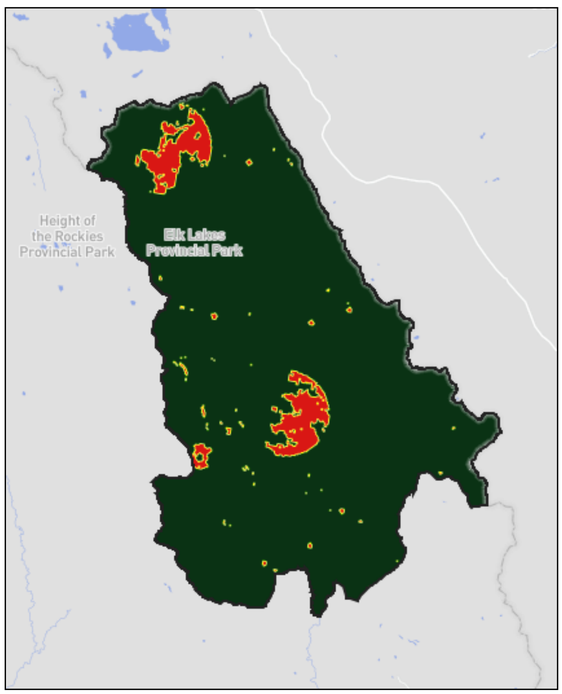


Figure 8. Fire disturbance, year 2029 for Scenarios 3, 4, 7, and 8, total area = 22.56 km^2.

SCENARIO 4 - BARK BEETLE, FIRE, AND PROPOSED HARVEST

To simulate the effects of bark beetle, fire and proposed harvest on the indicators, Scenarios 3 and 1 were combined.

SCENARIO 5 - MAXIMUM HARVEST (MAD LOGGER)

A spatial data layer was provided by Canfor including all potential future cutblocks regardless of the likelihood these would ever be harvested. This layer was used as a model input for the Maximum Harvest Scenario. The area encompassed by the cutblocks is approximately 48.8 km^2, shown in Figure 9. Figure 9 also shows all the major and minor roads in LU C22, including the proposed CFP roads associated with the maximum forest harvest activities. Figure 10 shows all existing major and minor roads in LU C22.

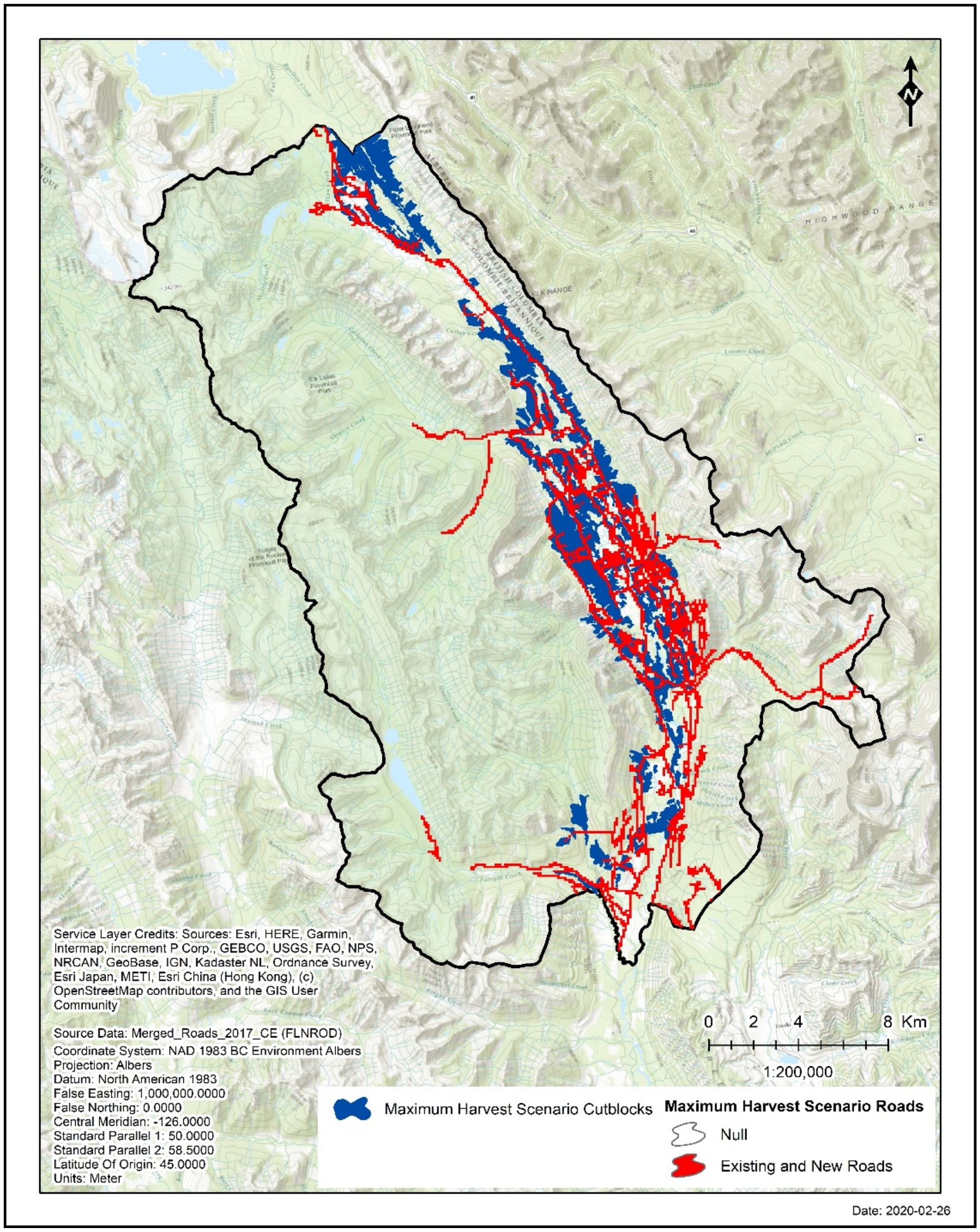


Figure 9. Harvest area, existing and proposed roads for the Maximum Harvest Scenario (393.1 km).

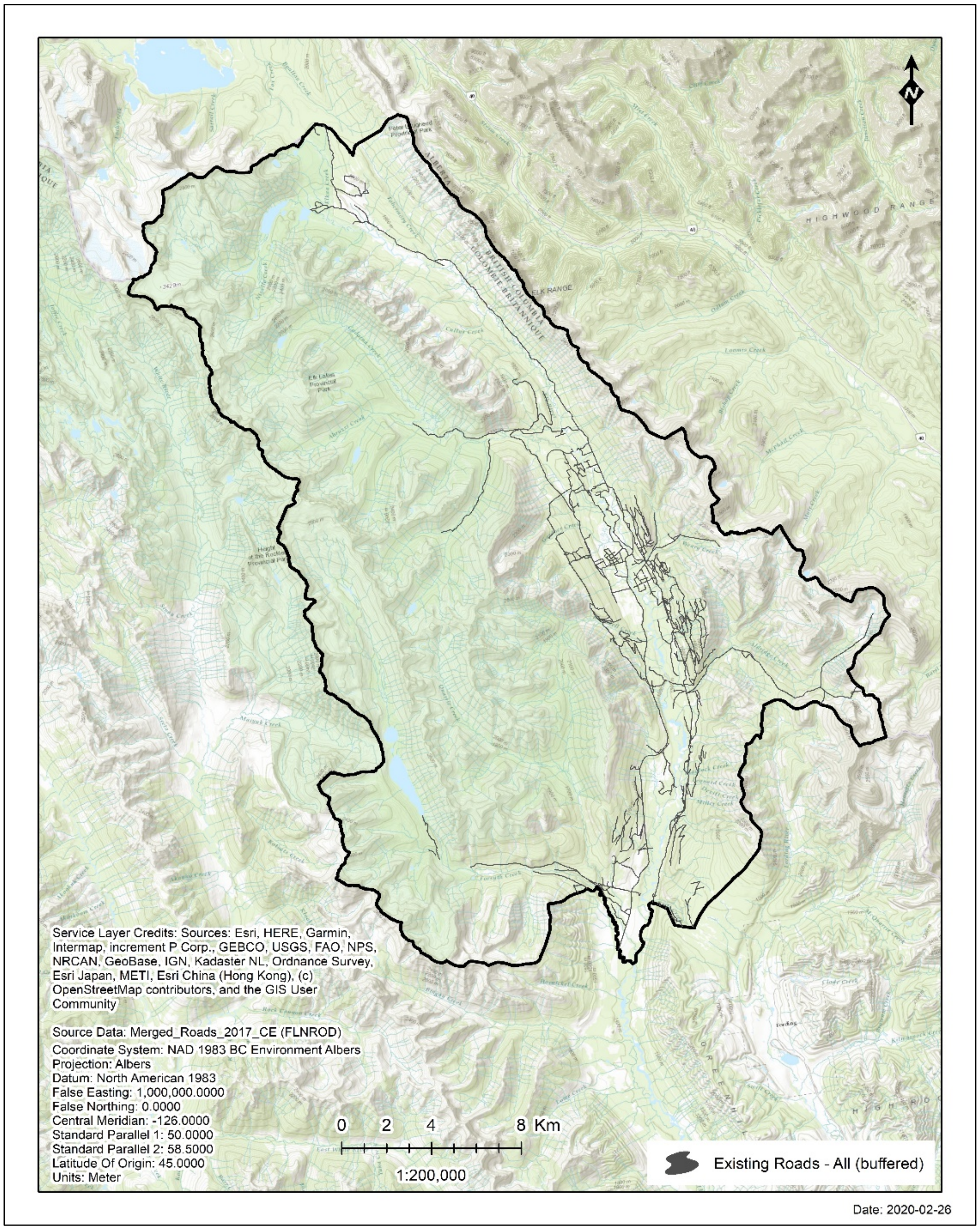


Figure 10. All existing roads in LU C22 (340.6 km).

Assumptions for the Maximum Harvest Scenario included:

1. Cutblocks were randomly assigned a harvest sequence.
2. The annual harvest area allocation was determined by taking the sum of the gross harvest area and dividing the value over 10 years.

3. Following the randomly assigned harvest sequence, harvest year was assigned to each cutblock, so that each harvest year was as close as possible to the annual harvest allocation calculated (Table 6).
4. The maximum harvest layer was used as a raster mask to focus the harvest allocation only within defined cutblocks.

Table 5. Annual harvest area allocation for Scenario 5

Period	Area (m^2)
2020	5179774
2021	4689636
2022	5022201
2023	4658532
2024	4815982
2025	4701658
2026	4874233
2027	4453077
2028	5430364
2029	4933978

5. Road development was simulated using a linear allocation method to grow road paths between existing major and minor roads and new cutblock areas. Only closest paths were connected, and preference was given to lower elevation areas.

Scenario 6 - Proposed Harvest and Road Reclamation

All newly developed roads (12.7 km) were removed from the simulation after harvest activities were completed. This scenario differs from Scenario 1 in that road reclamation occurs, whereby all newly created roads were converted to reclaimed roads.

Scenario 7 - Bark Beetle, Fire, Proposed Harvest and Road Reclamation

In Scenario 7, the road reclamation action was applied to Scenario 4 (Bark Beetle, Fire and Proposed harvest).

Scenario 8 - Bark Beetle (80% Reduction in Beetles), Fire, Proposed Harvest, and Road Reclamation

Scenario 8 was developed to simulate an 80% reduction in bark beetle impact (Figure 9) while fire, proposed harvest and road reclamation remained consistent with Scenario 7. An 80% reduction in beetles simulates suppression management activities to control bark beetle populations. Suppression is the most aggressive management strategy which aims to keep an area at a low level of infestation, evidently driving the population down.

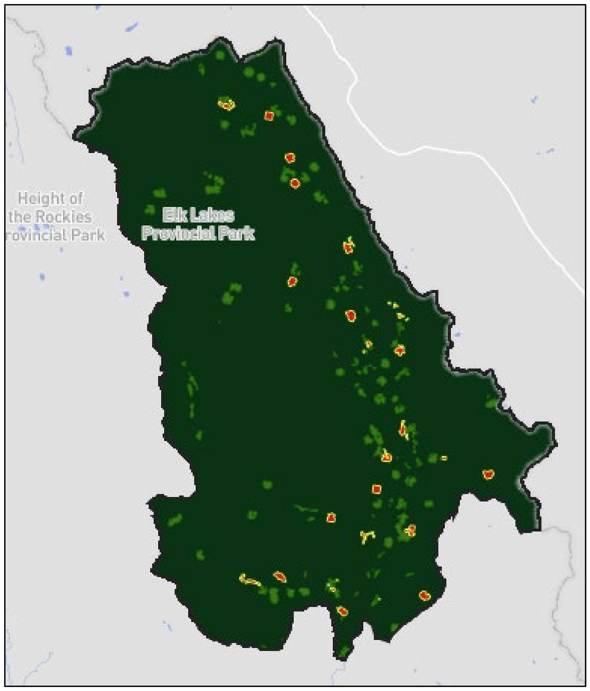


Figure 9. Pest disturbance, year 2029 for Scenario 8, Total Area = 22.46 km^2

3. Results

3.1 Indicator Response

Current Condition

Old Forest Z-Score: Lower values indicate higher deviations from the amount expected under the Range of Natural Variation (RoNV). Z-scores currently range from -3 (high hazard) to +1 (very low hazard), depending on the location in the Elk Valley (Figure 10). The MS BGC zone is currently in high hazard, with the ESSF in moderate hazard in this LU.

Grizzly Bear: Three measures of Grizzly bear habitat were assessed: habitat availability, which reflects habitat value (0 to 1) without taking into consideration the impact of roads and built-up areas; Secure Habitat, which is a function of habitat that is available to Grizzly bear without influence of road development (determined as a 500 m buffer around roads); and Hazard, which includes the road effect, built up areas and habitat availability.

There is currently substantial grizzly habitat available throughout the study area, with higher elevations having the most habitat (Figure 11). The secure habitat score is 74%, indicating there are relatively few dendritic road networks and a high amount of secure habitat in this LU. Overall hazard to Grizzly bear is relatively high across the study area, with lower elevation areas occupied by the current road network showing the greatest hazard (Figure 12).

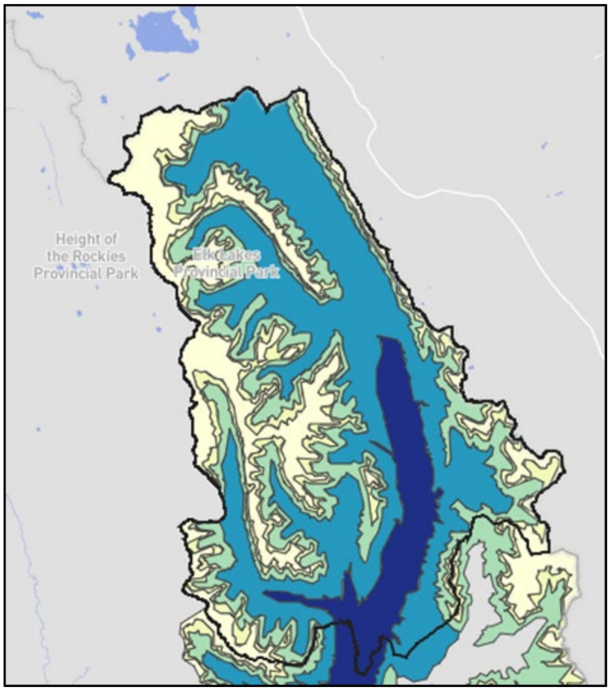


Figure 10. Old Forest Z-Score, Current Condition, Mean =-1.4

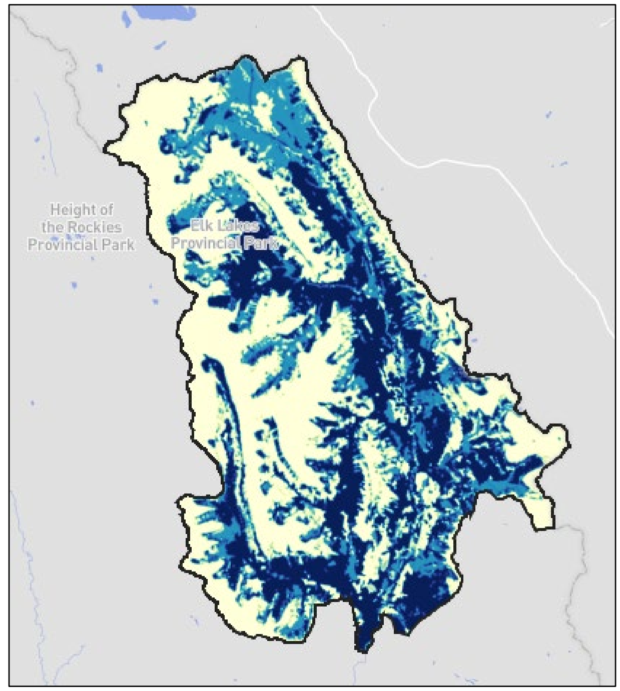


Figure 11. Grizzly Habitat Availability (white indicates high availability), Current Condition, Mean = 0.31

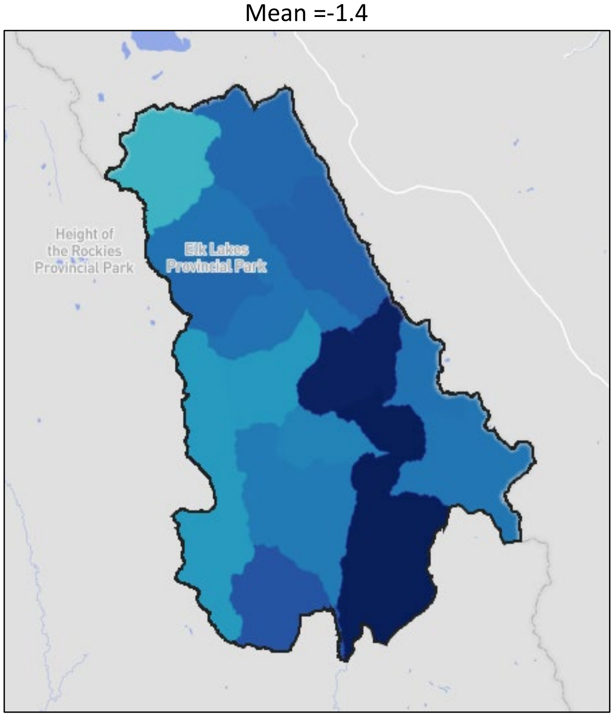


Figure 12. Grizzly Hazard, Current Condition, Mean= 0.73

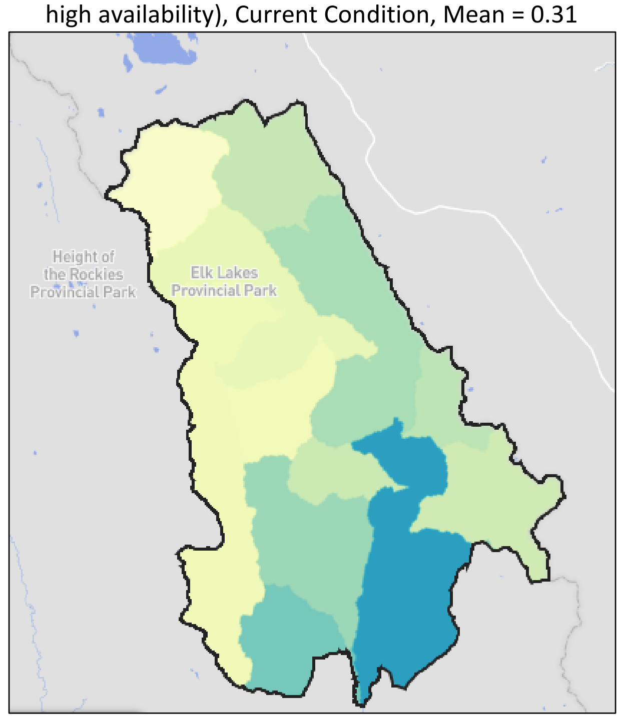


Figure 13.Equivalent Clearcut Area, Current Condition, Mean = 14.04%

Aquatic Ecosystem: The Equivalent Clearcut Area (ECA) and combined aquatic ecosystem hazard were the focus for this case study. ECA is relatively low across the study area, with higher values occurring in Assessment Watersheds (AWs) where harvest has already occurred (Figure 13). This is also reflected in the combined aquatic hazard value, where overall the hazard is relatively low but higher in AWs with existing development (Figure 14).

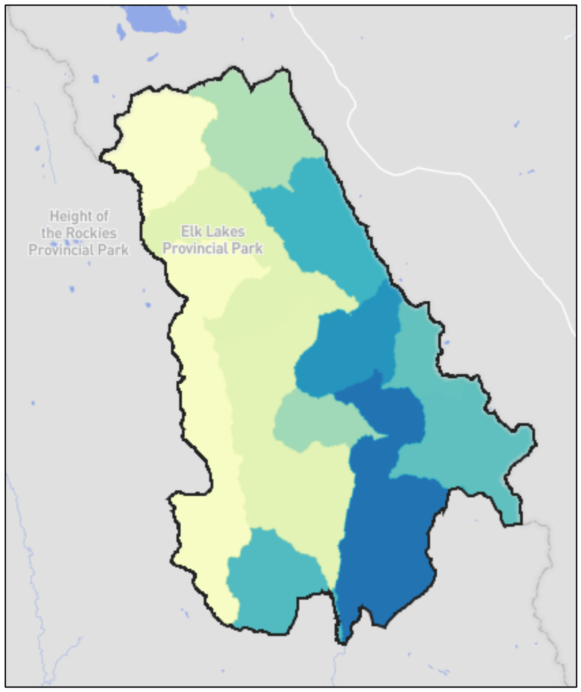
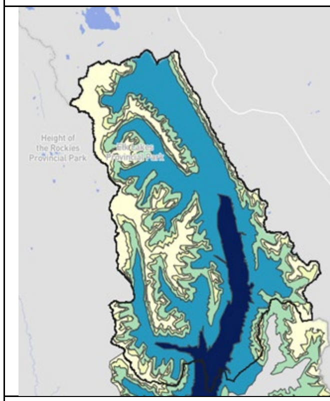
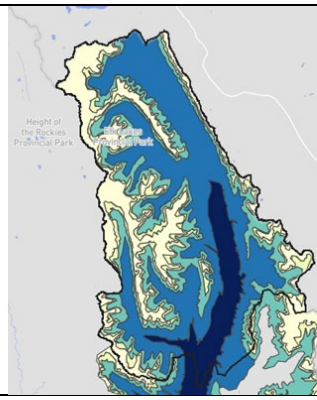
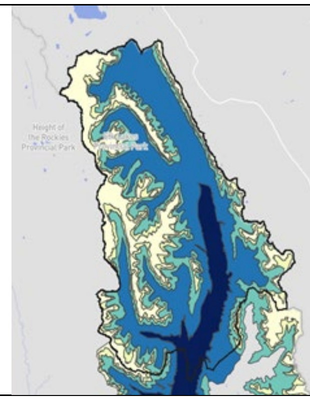
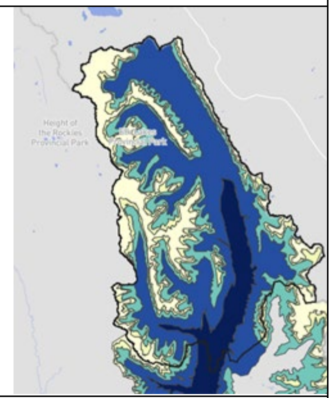
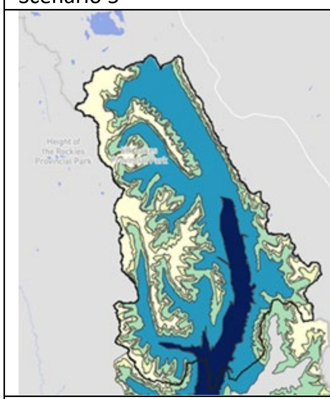
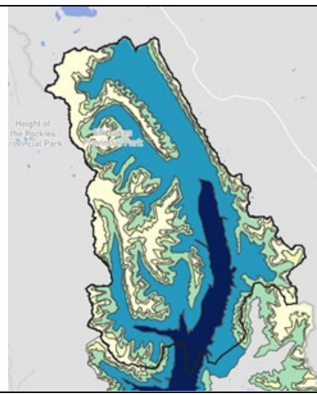
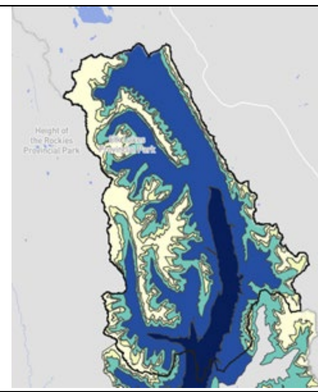
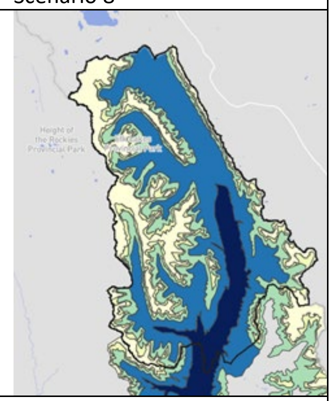


Figure 14. Combined Aquatic Hazard, Current Condition, Mean = 0.34.

Potential Future Conditions based on Scenarios

Old Forest Z-Score: Overall, the cumulative effects of both land use and natural disturbance resulted in the most substantive change in old forest z-score under the 10-year simulation, although only slightly lower than the natural disturbance scenario on its own. Assessing harvest in absence of natural disturbance resulted in no change in future condition relative to old forest z-score, except for slightly lower values in the MS BGC subzone (Figure 15 and Figure 16). These results suggest that not accounting for natural disturbance is likely to result in an incomplete assessment of potential old forest conditions into the future. Importantly, the results persist over time, with the MS and the ESSdk2 BGC zones remaining in high hazard (low z-score) well into the future (2059; Figure 16).

Scenario 1	Scenario 2	Scenario 3	Scenario 4
			
Mean -1.4	Mean -1.6	Mean -1.7	Mean -1.7
Scenario 5	Scenario 6	Scenario 7	Scenario 8
			
Mean -1.4	Mean -1.4	Mean -1.7	Mean -1.5

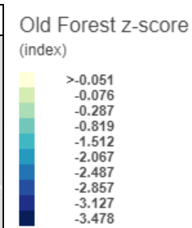


Figure 15. Old Forest Z-Score Year 2029. Scenario 1 - Proposed harvest, Scenario 2 - Beetle, scenario 3 Beetle and Fire, Scenario 4 - Beetle, fire, proposed harvest, Scenario 5 - Maximum harvest, Scenario 6 - Proposed harvest and road reclamation, Scenario 7 - Beetle, fire, proposed harvest and road reclamation, Scenario 8 - Beetle reduction (80%).

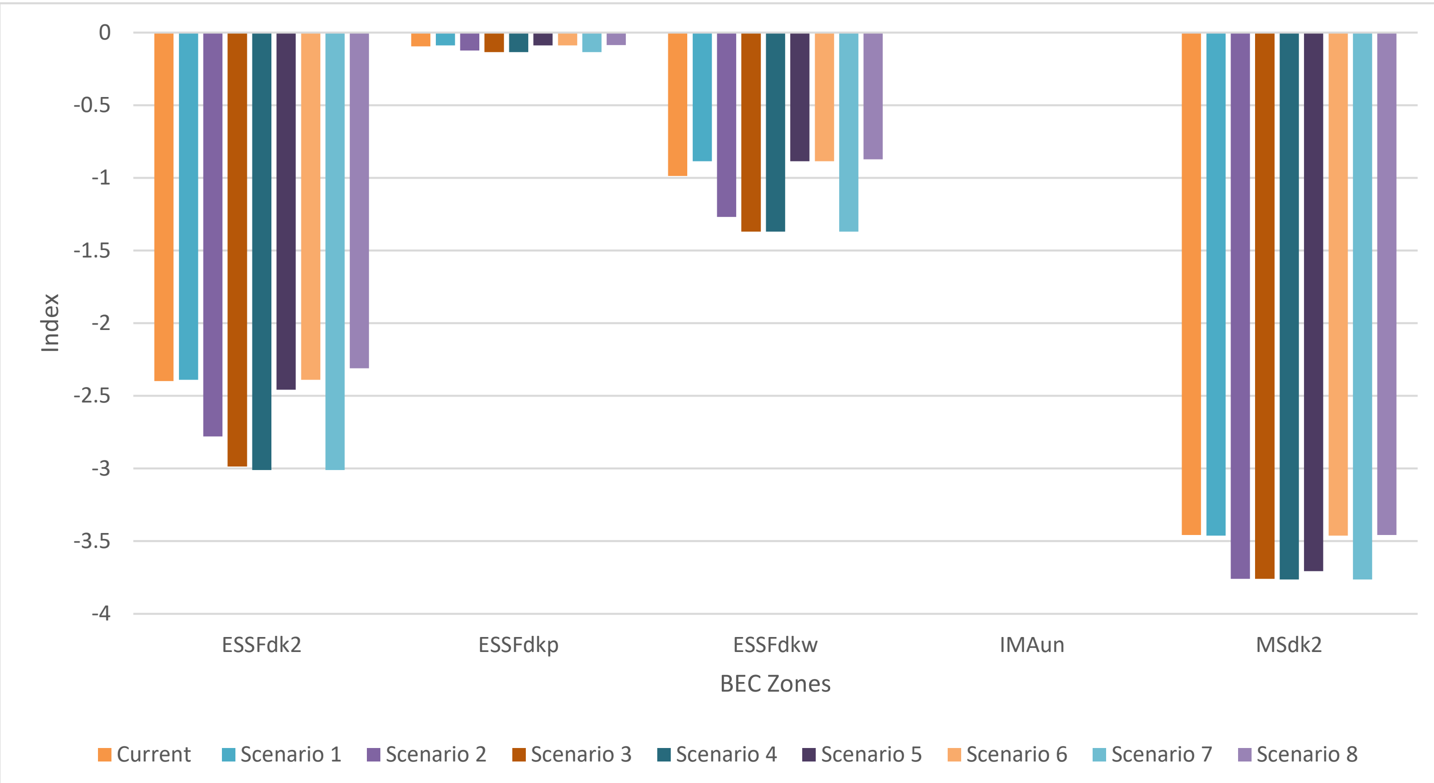


Figure 16. Old Forest Z-Score by BGC Zone for Forest Harvest Scenarios 1 - 8 (Year 2059): Scenario 1- Proposed harvest, Scenario 2 - Beetle, Scenario 3 - Beetle and Fire, Scenario 4 - Beetle, fire, proposed harvest, Scenario 5 Maximum harvest, Scenario 6 - Proposed harvest and road reclamation, Scenario 7 - Beetle, fire, proposed harvest and road reclamation, Scenario 8 - Beetle reduction (80%).

Aquatic Hazard: Similar to the old forest z-score, aquatic indicators were most responsive to the cumulative effects of land use and natural disturbance, with both harvest and natural disturbance driving ECA increases (Figure 17). Although Scenario 5 (Maximum harvest) did result in higher ECA relative to current condition, the results do demonstrate that harvest alone is not likely to shift ECA across the study area into substantially higher hazard ratings and the effect of harvest alone is constrained spatially (Figure 17). Similar effects are simulated to occur when assessing aquatic hazard (Figure 18 and Figure 19). Overall, these results suggest higher disturbance in the watershed could lead to changes in hydrologic regimes. Again, accounting for natural disturbance and land use is important when assessing these types of indicators.

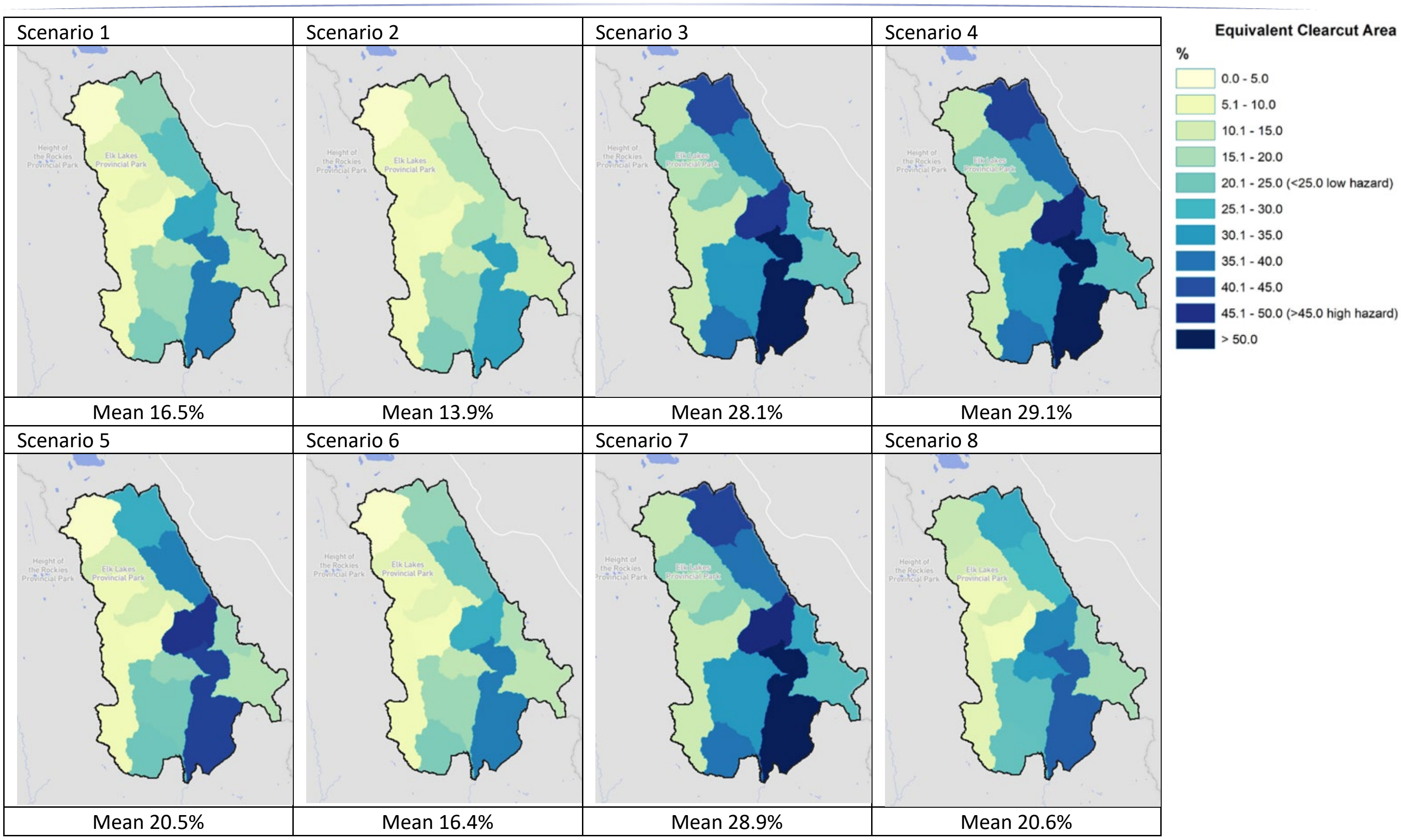


Figure 17. Equivalent Clearcut Area, 2029. Scenario 1 - Proposed harvest, Scenario 2 - Beetle, Scenario 3 - Beetle and Fire, Scenario 4 - Beetle, fire, proposed harvest, Scenario 5 - Maximum harvest, Scenario 6 - Proposed harvest and road reclamation, Scenario 7 - Beetle, fire, proposed harvest and road reclamation, Scenario 8 - Beetle reduction (80%).

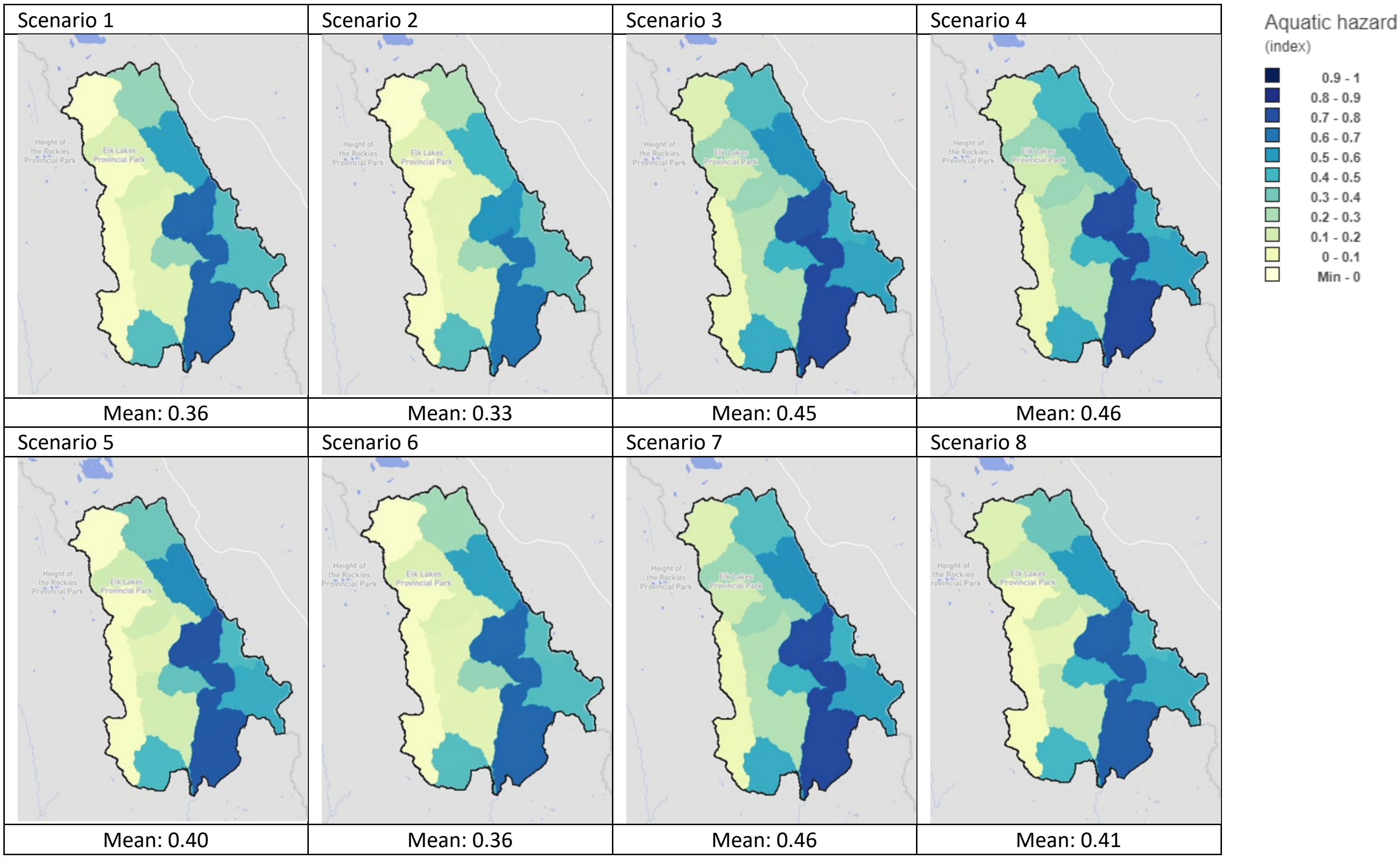


Figure 8. Aquatic Hazard, 2029. Scenario 1 - Proposed harvest, Scenario 2 - Beetle, Scenario 3 - Beetle and fire, Scenario 4 - Beetle, fire, proposed harvest, Scenario 5 - Maximum harvest, Scenario 6 - Proposed harvest and road reclamation, Scenario 7 - Beetle, fire, proposed harvest and road reclamation, Scenario 8 - Beetle reduction (80%).

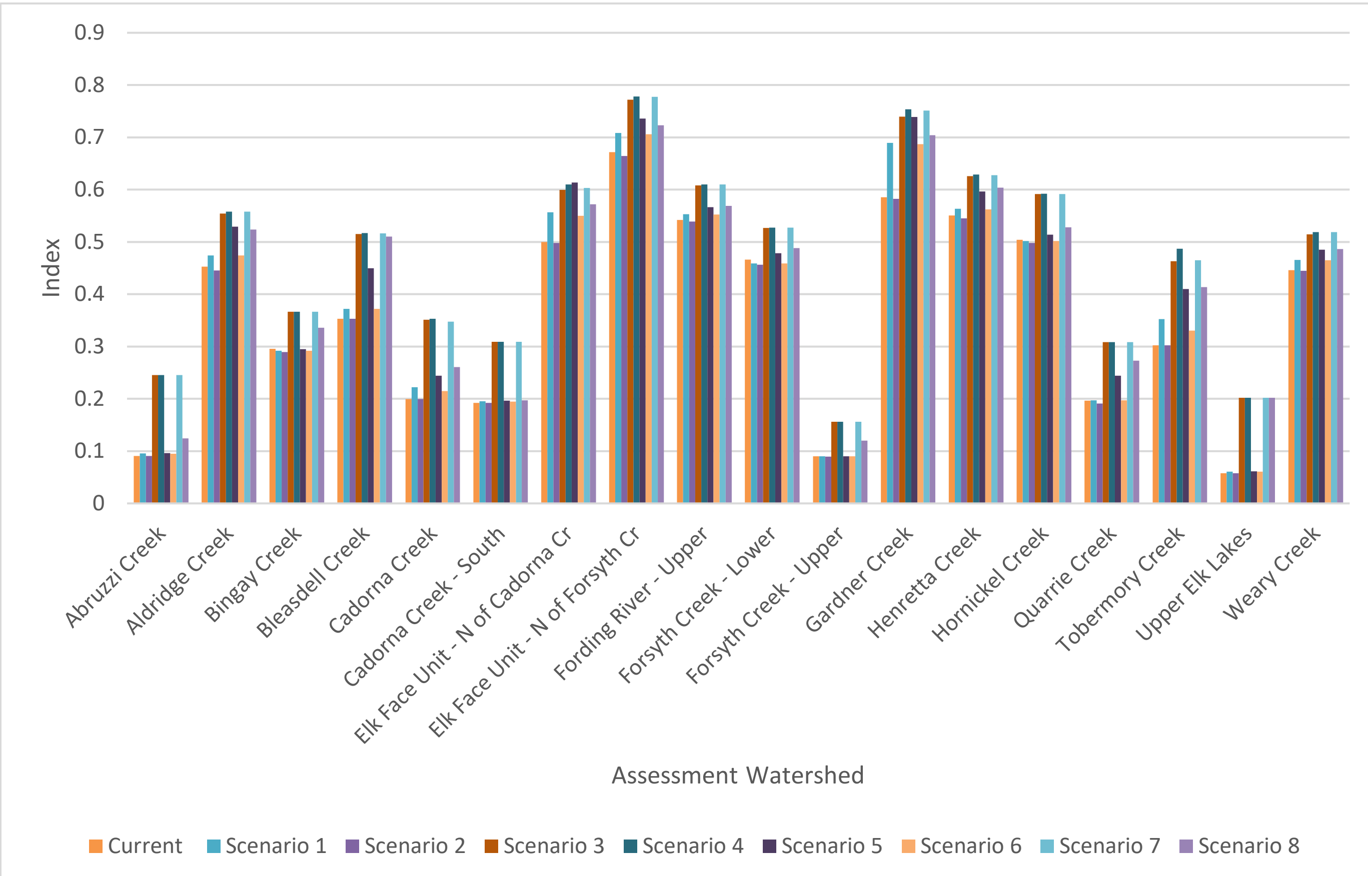
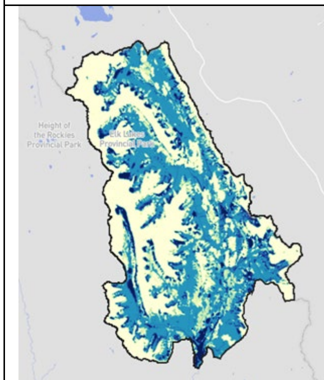
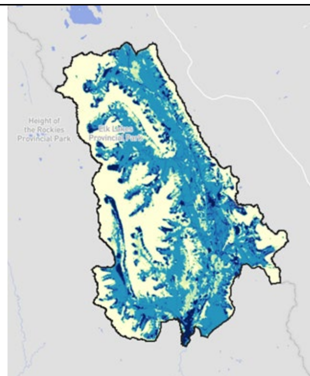
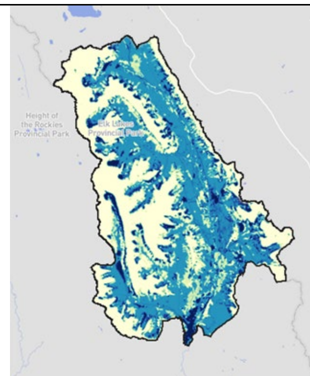
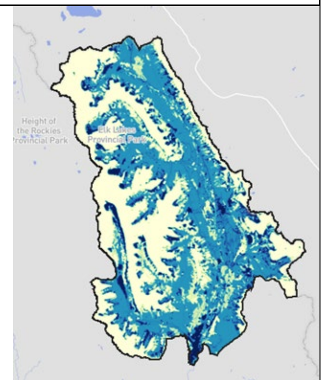
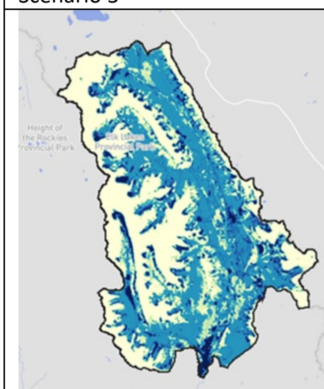
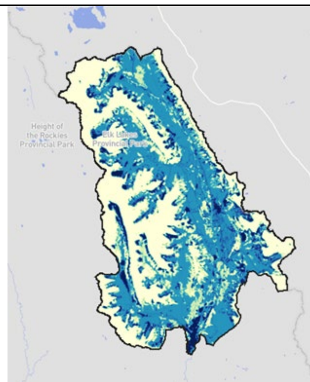
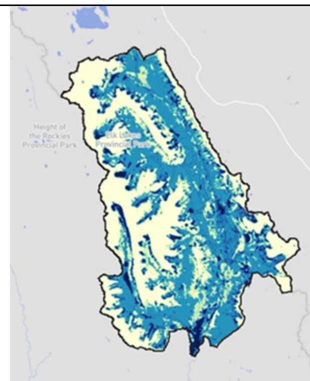
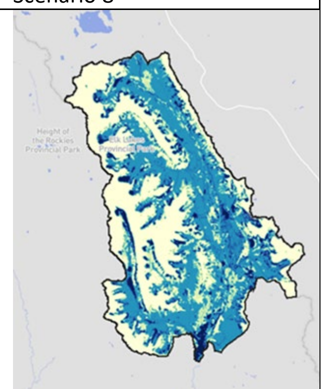


Figure 9.Aquatic Hazard by Assessment Watershed for Forest Harvest Scenarios 1 – 8: Scenario 1 - Proposed harvest, Scenario 2 - Beetle, Scenario 3 - Beetle and Fire, Scenario 4 - Beetle, fire, proposed harvest, Scenario 5 - Maximum harvest, Scenario 6 - Proposed harvest and road reclamation, Scenario 7 - Beetle, fire, proposed harvest and road reclamation, Scenario 8 - Beetle reduction (80%).

Grizzly Bear: Grizzly bear habitat availability is simulated to increase under the future scenarios (Figure 19). This is because there is more available habitat in young forest. This increase in available habitat also leads to a decrease in hazard during the simulation period, even with more road development (Figure 20).

Scenario 1	Scenario 2	Scenario 3	Scenario 4
			
Mean: 0.35	Mean: 0.34	Mean: 0.34	Mean: 0.34
Scenario 5	Scenario 6	Scenario 7	Scenario 8
			
Mean: 0.34	Mean: 0.34	Mean: 0.34	Mean: 0.34

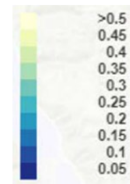
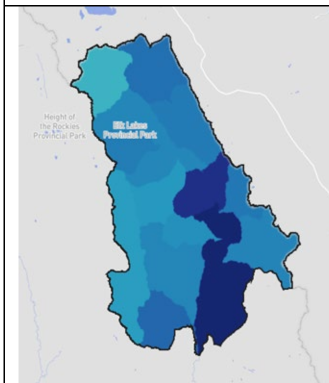
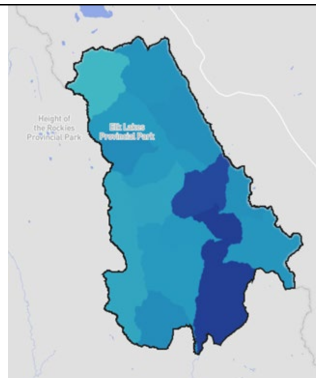
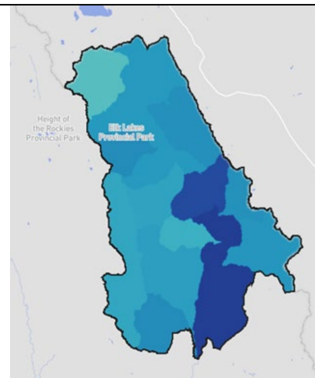
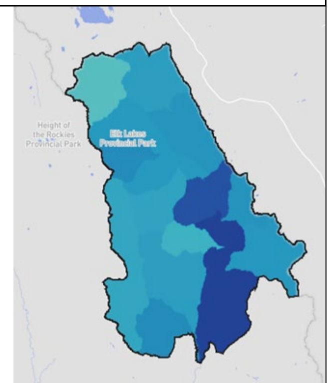
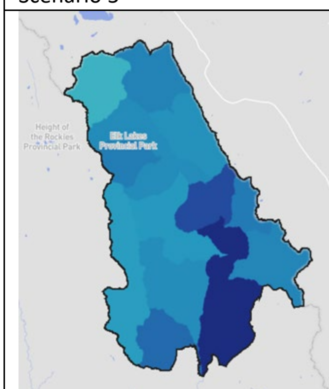
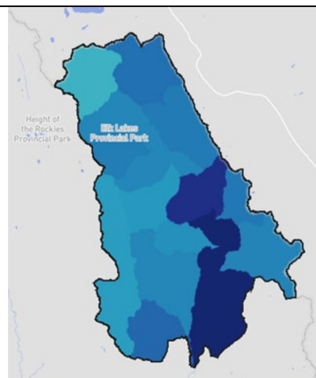
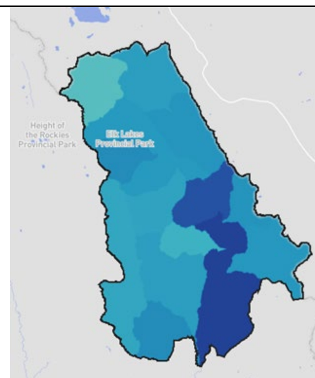
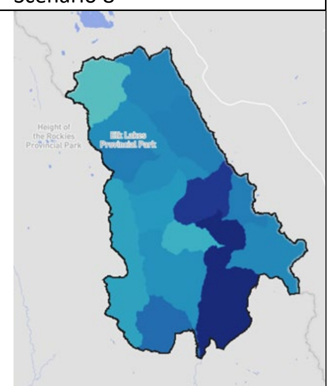


Figure 10. Grizzly Habitat Availability, 2029. Scenario 1 - Proposed harvest, Scenario 2 - Beetle, Scenario 3 - Beetle and Fire, Scenario 4 - Beetle, fire, proposed harvest, Scenario 5 - Maximum harvest, Scenario 6 - Proposed harvest and road reclamation, Scenario 7 - Beetle, fire, proposed harvest and road reclamation, Scenario 8 - Beetle reduction (80%).

Scenario 1	Scenario 2	Scenario 3	Scenario 4
			
Mean: 0.69	Mean: 0.63	Mean: 0.62	Mean: 0.62
Scenario 5	Scenario 6	Scenario 7	Scenario 8
			
Mean: 0.66	Mean: 0.69	Mean: 0.62	Mean: 0.67

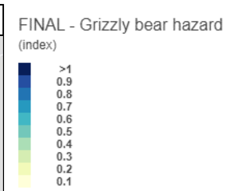


Figure 11.Grizzly Bear Hazard, 2029. Scenario 1 - Proposed harvest, Scenario 2 - Beetle, Scenario 3 - Beetle and Fire, Scenario 4 - Beetle, fire, proposed harvest, Scenario 5 - Maximum harvest, Scenario 6 - Proposed harvest and road reclamation, Scenario 7 - Beetle, fire, proposed harvest and road reclamation, Scenario 8 - Beetle reduction (80%).

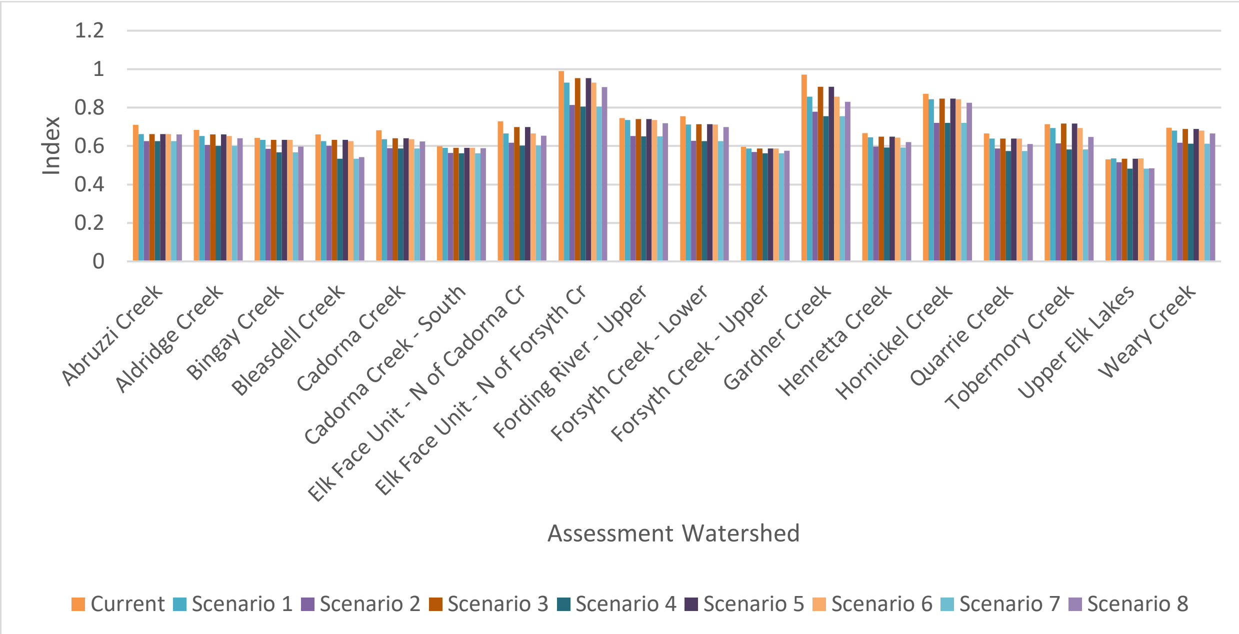


Figure 12.Grizzly Bear Hazard by Assessment Watershed, 2029. Scenario 1 - Proposed harvest, Scenario 2 - Beetle, Scenario 3 - Beetle and Fire, Scenario 4 - Beetle, fire, proposed harvest, Scenario 5 - Maximum harvest, Scenario 6 - Proposed harvest and road reclamation, Scenario 7 - Beetle, fire, proposed harvest and road reclamation, Scenario 8 - Beetle reduction (80%).

This study has demonstrated that hazards to watersheds in the upper Elk Valley are likely to increase as a function of harvest and natural disturbance, where the largest effects are potentially noticed in aquatic ecosystems. Although hazard for some VCs may increase, changes in forest demography towards younger seral stages could result in improved habitat for Grizzly Bear. Cumulatively, changes in hazard should be considered when assessing impacts to VCs and evaluating potential monitoring or mitigation strategies. If successful, mitigating beetle outbreak as demonstrated in Scenario 8, would likely result in a reduction in hazard in the upper Elk Valley.

4. Case Study Learnings

This assessment used data and methods that have been established through the EV CEMF process and it was found that these data and methods were appropriate to support this type of analysis. Some additional data compilation was required for the proposed harvest assumptions by Canfor and improved beetle disturbance assumptions developed using the Forest Health Factor and expertise of the Regional Entomologist. In particular, the readily available datasets made the process of conducting this analysis efficient and effective. This demonstrates there is high value in compiling data and tools to support these types of assessments through the CE process.

Outcomes from this case study has highlighted some key points, previously identified in the EV CEMF Assessment and Management (CEAM) Report. An important consideration is the scale of project and the scale of the questions being asked of the assessment. The case study conducted is ultimately guiding decisions and management at the operational scale; however, applied VC assessment methods best guide decisions and management at the tactical and strategic scales (Figure 22). The assessment methods developed through the EV CEMF are well-suited to guide larger-scale management decisions at the regional and sub-regional level. Ultimately, these types of assessments should be used to guide management targets for VCs of interest and establish landscape-level objectives. These targets and objectives can subsequently be used at operational scales to guide planning processes, mitigation, and monitoring objectives.

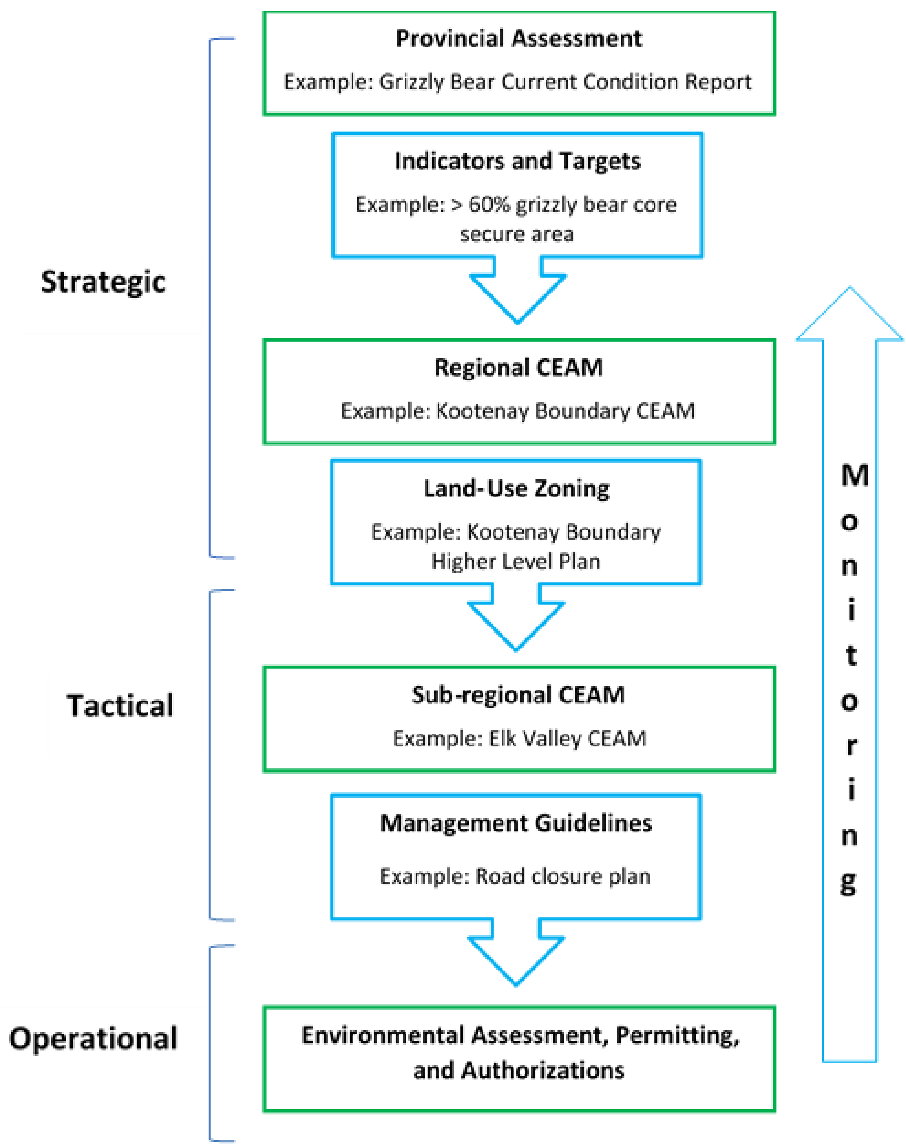


Figure 13. Vertically integrated cumulative effects assessment, adopted from the EV CEAM Report 2018.

Despite the large scale of the assessment, VC indicators were responsive to the scenarios and did provide important learnings. The most responsive indicators were related to forest demography, with old forest z-score and aquatic indicators demonstrating the greatest response. The benchmarks were useful in determining how hazard shifted. However, there is no causal link made between VC indicator response and VC response. Further work could be conducted to make these linkages clearer, which would help land managers make more informed decisions. In addition, a key finding from this analysis was that short-term forecasts (e.g. 10 years) may underestimate the effects on VC indicators and that natural disturbance must be considered. This case study provided very useful information in terms of how development in combination with natural disturbance may affect VC indicator performance.

Another key learning from this case study is that scenario analysis can be used to guide planning decisions, even at the operational scale (e.g. individual cutblock or road development), particularly when considering natural disturbance. The absence of accounting for natural disturbance would have led to an inappropriate evaluation of potential VC indicator response.

This analysis did not evaluate mitigation potential, other than through road rehabilitation. The EV CEMF Working Group has been engaged in substantial efforts around road rehabilitation. However, there is currently no strategic framework or legislative tool within the Forest and Range Practices Act (FRPA) to support these types of activities.

5. Conclusions

In general, this case study proved highly valuable in terms of providing scenario analysis to evaluate the cumulative effects of land use and natural disturbance within the upper Elk Valley. The process was efficient, with eight scenarios developed and three VCs assessed – showcasing the importance of having models and data readily available. The case study did identify some key learnings and limitations as well:

1. The EV CEMF scales of assessment (AWs and BEC Zones) are coarse for operational-level decision support.
2. Operational scale assessment should be focused on evaluating site-specific effects and mitigation, driven by tactical-scale objectives/plans.
3. Scenario analysis is useful for planning at all scales and should include multiple overlapping factors, including natural disturbance and land use.
4. Scenario analysis should be conducted at longer temporal scales to properly incorporate long-term landscape change and to guide management.
5. Legislative tools to implement meaningful mitigation related to forest development are lacking.

6. References

Boulanger, Y., S. Gauthier, and P.J. Burton. 2014. A refinement of models projecting future Canadian fire regimes using homogeneous fire regime zones. Canadian Journal of Forest Research 44:1-12.

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

MacKillop, D.J, A.J. Ehman, K.E. Iverson, and E.B. McKenzie. 2018. A field guide to site classification and identification for southeast British Columbia: the East Kootenay. Prov. B.C., Victoria, B.C., Land Manag. Handb. 71.