

# Assessing Cumulative Impacts to Wide-Ranging Species Across the Peace Break Region of Northeastern British Columbia

A Summary Report Prepared by **Clayton Apps**, Ph.D., R.P.Bio.  
Commissioned by **Yellowstone to Yukon Conservation Initiative**  
(For the full report see [www.y2y.net/publications](http://www.y2y.net/publications))

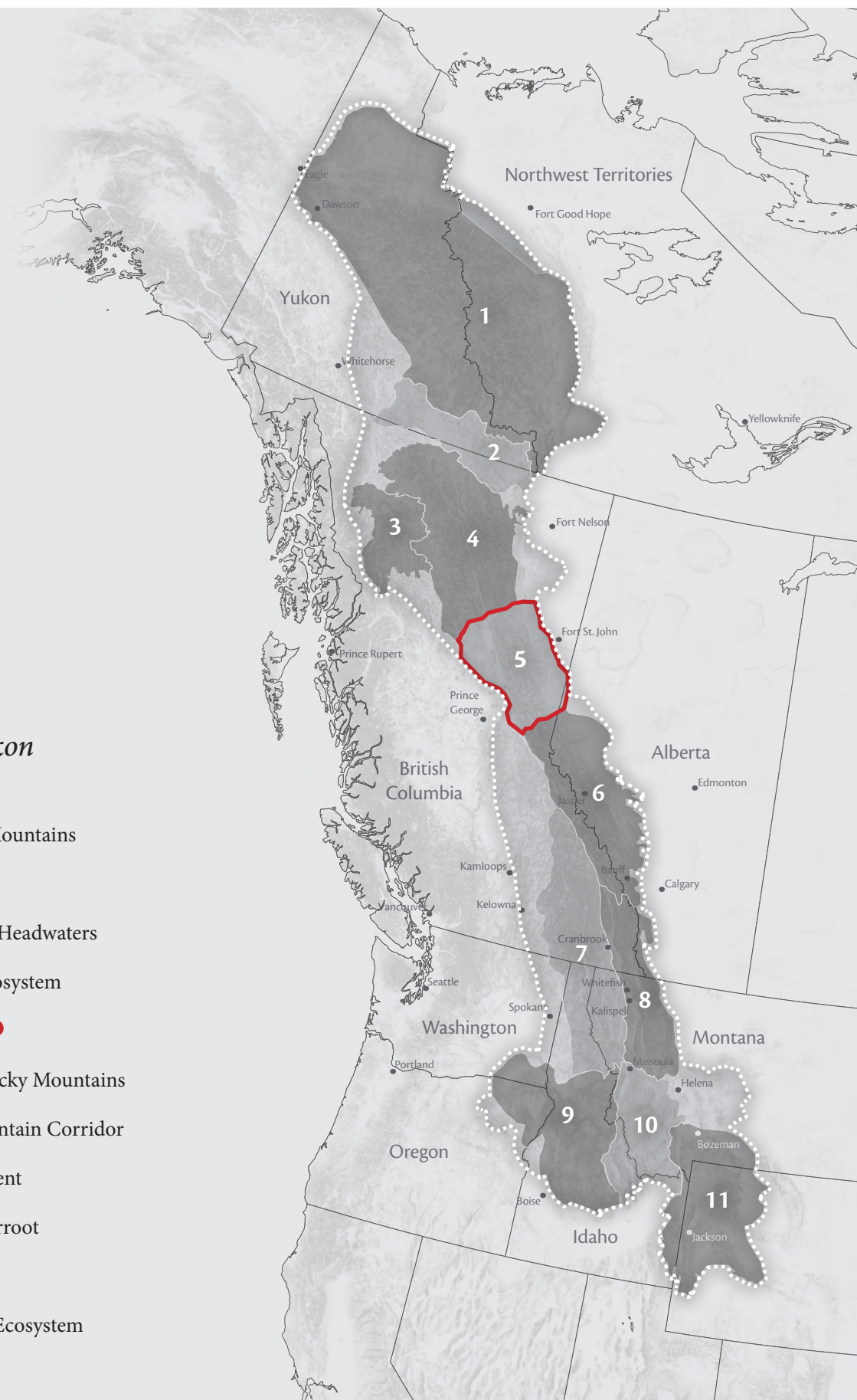


Yellowstone to Yukon  
Conservation Initiative



## *Yellowstone to Yukon Priority Areas*

1. Greater Mackenzie Mountains
2. Upper Liard River
3. Stikine-Nass-Skeena Headwaters
4. Muskwa-Kechika Ecosystem
5. **Peace River Break** ●
6. Central Canadian Rocky Mountains
7. Cabinet-Purcell Mountain Corridor
8. Crown of the Continent
9. Salmon-Selway-Bitterroot
10. High Divide
11. Greater Yellowstone Ecosystem



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## Introduction

In a world dominated by human activity, the Rocky Mountain cordillera of North America, from Yellowstone to Yukon (Y2Y), is composed largely of wild lands that are relatively intact to various degrees. One key linkage in the Y2Y region is the Peace River watershed of northeastern British Columbia, with the river providing a natural east-west break in the Rocky Mountain ranges. Known as the Peace Break, this area is ecologically diverse with a long history of First Nations use and, later, European settlement (see *Figure 1*). In contrast to most other Rocky Mountain regions, the Peace Break has little protected area representation and a substantial existing human development footprint. This, combined with natural constraints, results in a critical “pinch-point” in the continuity of ecologically intact and functioning landscapes along the north-south extent of the Canadian Rocky Mountains in the Y2Y region. The

tenuous continuity and unique ecological values of the Peace Break are potentially threatened by the “cumulative” impact of rapid industrial expansion including several major proposed developments.

### *Purpose of the Assessment*

Population connectivity for several wide-ranging terrestrial species and some aquatic species is likely to be highly constrained in the Peace Break region, with the potential for fracture. This impact could be exacerbated by additional cumulative effects resulting from current resource development trends and multiple proposed major projects, including the proposed Site C hydroelectric dam and impoundment on the Peace River.

My report describes an extensive, broad-scale assessment of cumulative human impacts and their influence on landscape potential to support

**Figure 1 (opposite): Map of the Y2Y region with priority areas, with the Peace Break Region highlighted in red.**

*(cover/back photo: Larry Peterson)*

wide-ranging terrestrial species across the Peace Break. Terrestrial species addressed are associated with a range of ecological conditions that are broadly represented within the larger region. There are two parallel and related aspects to this assessment:

1. Understanding current and potential-future changes to the ability of specific landscapes to support defined focal species, and
2. Understanding spatial patterns of population connectivity that are important in the long-term stability and resilience of these species and the ecological communities they represent.

## Background

Central to the Peace Break region of northeastern BC is the Peace River valley which “breaks” through the Rocky Mountains and funnels warm, moist Pacific air east of the Rockies. Owing

to this and other physiographic and climatic influences, the Peace Break is ecologically diverse, with inherent variation in the potential for species occurrence and distribution.

For my analysis, I defined a “regional” assessment area of 74,325 km<sup>2</sup>. Within this I embedded a “local” assessment area of 13,416 km<sup>2</sup> defined by a 25 km buffer surrounding the original course of the Peace River (*see Figure 2*).

Both local and regional areas have a long history of human use. After thousands of years of First Nations use, European influence began with the fur trade followed by agriculture and permanent settlement in the early 1900s. Highways, logging, oil and gas, and hydroelectric development continued through the latter part of the century. Today, many types of human activities emanate from several major population centres and other smaller communities. Within the Peace River Regional District, the resident human population

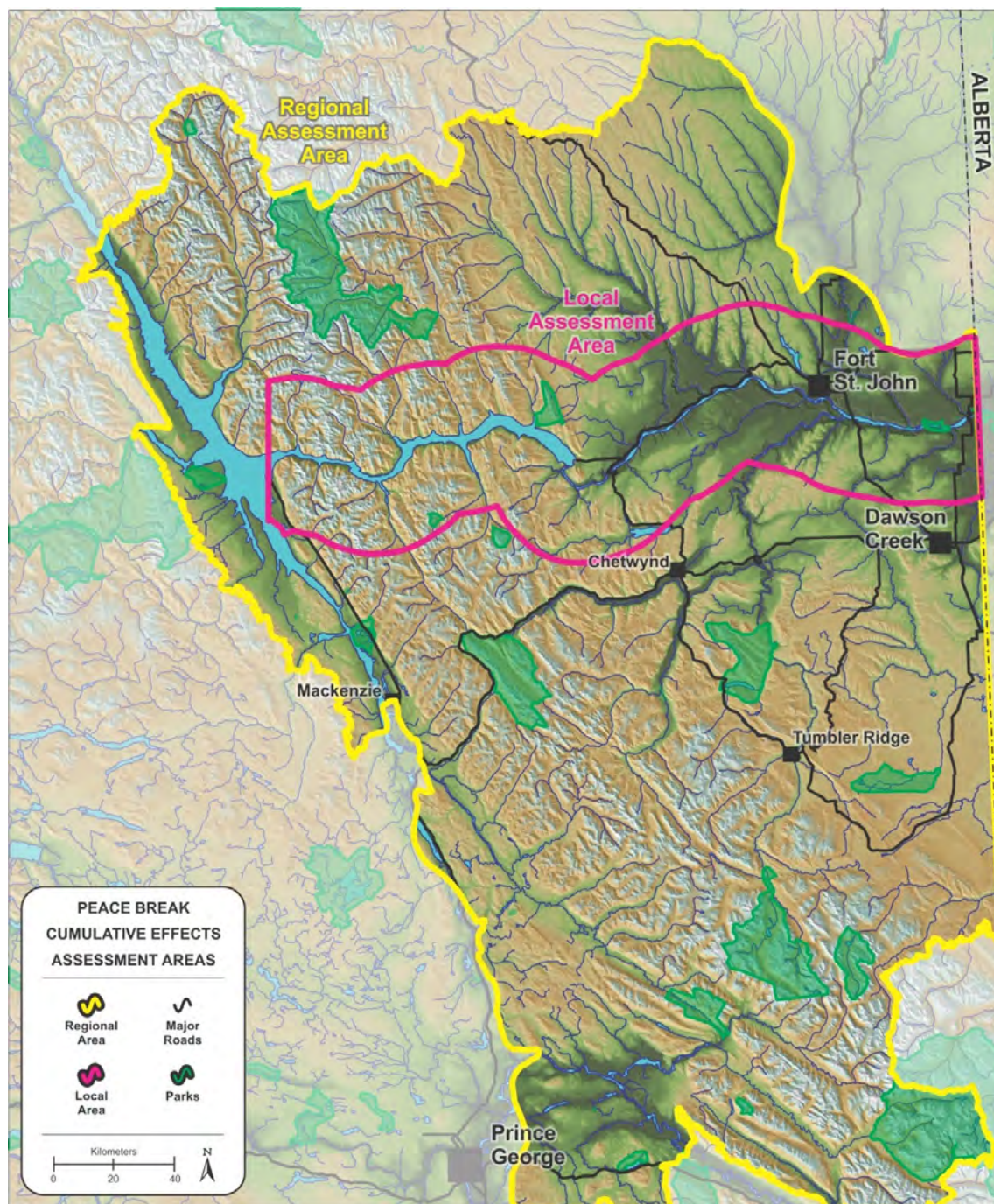
### *The Concept of Cumulative Effects*

The notion that human environmental and social impacts accrue cumulatively over space and time stems from the recognition that environmental degradation is largely due to the “tyranny of small decisions”<sup>1</sup>. In Canada, cumulative effects assessment (CEA) was defined in the 1980s as “impacts on the natural and social environment which occur so frequently in time or so closely in space that they cannot be assimilated, or they combine with effects of other activities in a synergistic manner”<sup>2</sup>.

Fundamental to the concept of cumulative effects is that the end degradation is greater than would be expected if impacts were considered individually. For example, species extirpation (local or extensive) and other population impacts are virtually never tied to single developments and are always mediated by underlying habitat conditions and dynamics, whether natural or human-influenced. Essential to managing cumulative effects is the establishment of common goals and specific thresholds for acceptable impacts, coordinated among government agencies and jurisdictions<sup>3</sup>.



Figure 2: The regional and local assessment areas defined for evaluating the cumulative impact of human activity on select wide-ranging focal species.



grew 6.7% between 2007 and 2011, from 60,220 to 64,280<sup>4</sup>. To the year 2036, with current demographic trends, this growth rate is expected to decline somewhat, but still increase a further 23.5% to 79,384<sup>5</sup>.

In the mid-twentieth century, four major hydroelectric dams on the Peace River were proposed. Two were built while the other two

were rejected in the early 1980s. However, one dam that was initially rejected has been resurrected for proposed development. This “Site C” dam would impound the Peace River and its tributaries about 7 km southwest of Fort St. John, flooding 5,550 ha of land.

The Site C development proposal is in the final stages of a joint federal/provincial environmental



assessment process. Given the broad range of existing human activities and associated impacts within the Peace Break region, cumulative effects have been raised as an issue in the evaluation of the Site C development. That is, this major project should be considered within the context of a plethora of existing impacts that have and will continue to accrue over space and time.

For wide-ranging species, regional evaluation of cumulative effects is especially important since population viability and stability are greatly affected by spatial patterns of distribution and the broad-scale movement of individuals and their genes. A regional assessment should be comprehensive with respect to human use, since the habitat requirements of wildlife species can be affected by many types of resource development or other activity. The spatial pattern of impacts is the key to cumulative effects assessment, since most species are affected by habitat connectivity and fragmentation at different scales.

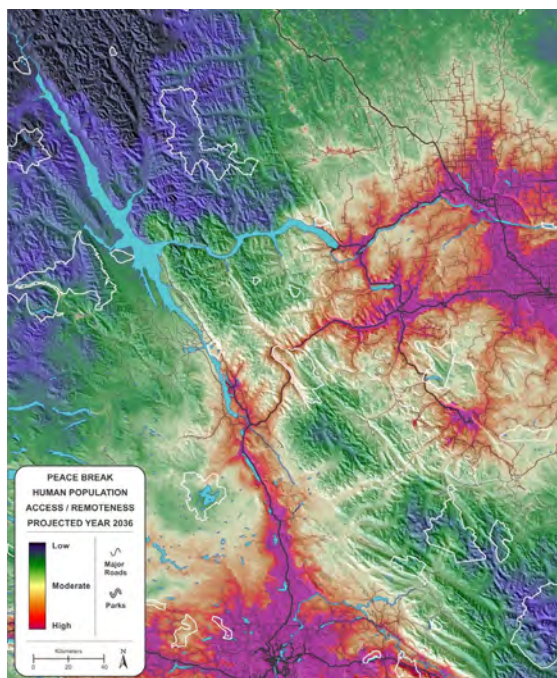
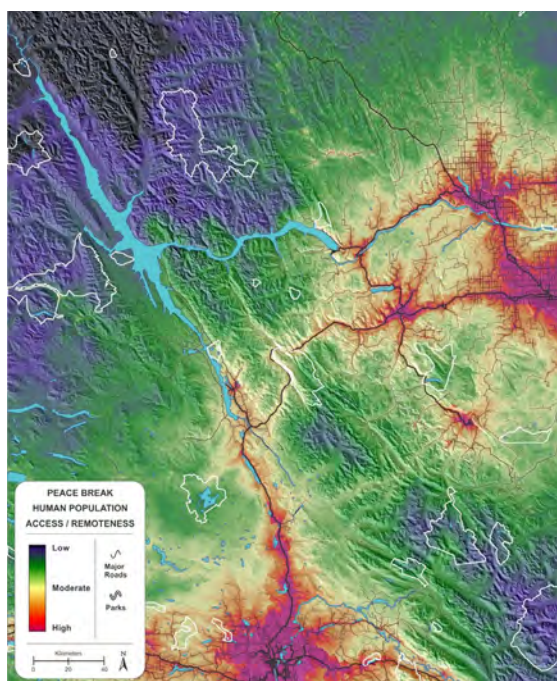
## Focal Species Profiles

Aside from conservation issues that may be unique to individual species, wide-ranging species are appropriate surrogates for the conservation of biodiversity and associated natural processes at broad, regional scales. In modeling for the assessment and mitigation of cumulative effects, I selected a suite of species representing the array of regional ecosystem conditions while also being sensitive in different ways to human impacts. These focal species are: grizzly bear, lynx, fisher, wolf, wolverine and woodland caribou. Since the proposed Site C development would affect the aquatic ecosystem, I also considered bull trout and Arctic grayling

though only through qualitative means. For each species, I profiled ecological requirements, local knowledge, impacts and threats as well as current status and conservation.

## Evaluating Landscape Effectiveness

For each terrestrial focal species, I evaluated the potential influence of present and future



*Figure 3: Index of human population access/remoteness across the Peace Break assessment area, current (top) and projected to year 2036 (bottom).*

cumulative human impacts on the underlying potential for landscape-scale habitat effectiveness and connectivity at the population level. Spatial modeling was based on the best available data and current understanding relevant to predicting species occurrence and distribution across the Peace Break assessment areas. This involved assembling GIS coverage from data sources of climate and physiography, land cover and vegetation, and human use. From this spatial database, I derived predictive factors for modeling species requirements and cumulative human impacts. Modeling approaches varied among species, with modeling scales for each species based on known or expected female core home range size.

In addition to current habitat conditions and resulting landscape potential, human accessibility to the landscape is perhaps the most relevant

predictor of population fragmentation among wildlife species. To account for cumulative human influence on each species, I therefore applied a modeling approach that considers human travel time to a given site on the landscape as influenced by biophysical conditions and human features (such as roads or trails) that facilitate access and travel speed. The model accounts for accessibility from any resident human population and the size of those centres. Output is interpreted in terms of the ease of landscape accessibility by, and remoteness from, people. The derived index of accessibility was projected into the future (e.g., to year 2036) given expected demographic trends (*see Figure 3*). Considering the nature of human impacts on each focal species, I approximated the shape of the relationship between human population access and the potential that each species may persist and move within or among occupied

### *Importance of Regional Context*

Cumulative Effects Assessment (CEA) is most relevant to comprehensive multi-scale evaluation within the context of larger population areas, current and projected human impacts, and changing environmental conditions. This regional approach is especially important for wide-ranging species given the challenge in balancing their needs against other multiple resource values. It is unrealistic to expect that meaningful assessment of impacts to grizzly bears, for example, could be achieved in highly localized project-specific assessment. Without the regional context, it is difficult to consider the relevance of localized impacts at the most important, population level. Further, CEA should ideally be carried out against regional-level thresholds of acceptable impact. Since no such standards exist in British Columbia as pertaining to any wide-ranging species, the “significance” of any cumulative impact is impossible to determine regardless of how large or small a relative change appears to be. The utility of CEA is thus in comparing among scenarios or in demonstrating the mitigation necessary to theoretically balance or offset predicted impacts.

landscapes. As translated to mathematical functions, I applied these curves to the human accessibility model to approximate the relative reduction in landscape potential for each species, termed realized landscape effectiveness.

I compared model outputs among three scenarios:

1. “Undisturbed” conditions with current land cover attributes (i.e., vegetation cover and water surfaces) but no human influence;
2. “Current impact” considering all present human infrastructure, population and development (*see Figure 4*); and
3. “Future year 2036” involving projected regional population growth given existing.

## Results

Results reflect the differing nature of cumulative impacts and the potential for landscape occupancy and connectivity among species, with significant changes apparent among scenarios.

Absolute reductions in regional landscape effectiveness among species range from 7% to 47% at present to a projected loss of between 11% and 55% in 25 years. Within the local assessment area, the reduction in landscape effectiveness among species ranges from 13% to 55% at present to a projected loss of between 19% and 62% in 25 years (*see Figure 5*). Impacts are compounded by increased fragmentation that is apparent for most species at either or both analysis scales. Both the absolute loss and the fragmentation of landscape effectiveness can also be qualitatively assessed through the mapped pattern of modeled species

demographic trends and completion of the proposed Site C hydroelectric development.

The latter scenario is likely to be a conservative estimate of future impacts because it cannot account for all potential future human use and development, including access infrastructure, which are impossible to predict. I compared impacts among these three scenarios, measuring average landscape effectiveness for each species (i.e., accounting for human influence) across defined assessment areas. I also quantified landscape connectivity for each species by calculating the area/perimeter ratio of landscapes that are within four thresholds of landscape effectiveness. I interpreted impacts based on the change in both average landscape effectiveness and associated fragmentation among scenarios.

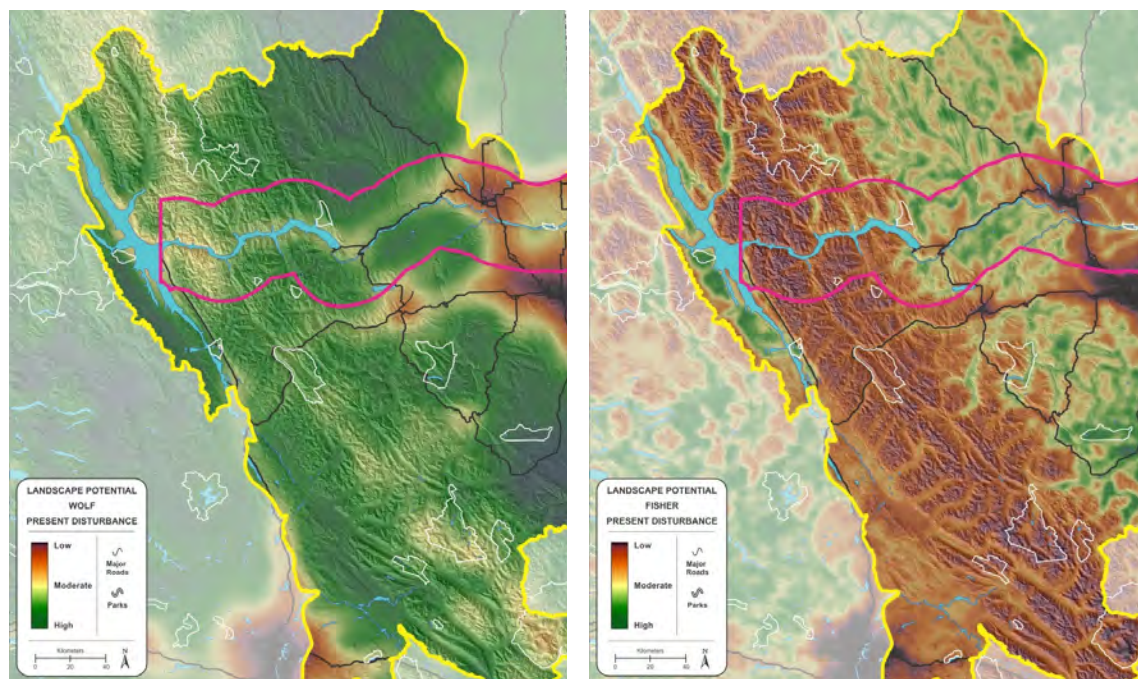
occurrence and distribution among potential, realized and future-projected scenarios.

### *Wolf*

Current impacts are greater for species whose natural distribution is more strongly linked to lower elevations and/or subdued terrain conditions. This is especially true for wolves, which range extensively, tend to conflict with particular human values and activities such as agriculture and hunting, and are afforded little protection outside of certain parks. Despite these impacts, wolves have persisted due to their higher resilience than many other wide-ranging carnivores. At both analysis scales, total landscape effectiveness for wolves has been markedly reduced (i.e., 12% loss) and this



**Figure 4: Landscape Potential  
Present Disturbance  
Wolf (left), Fisher (right)**



is likely to continue into the future (i.e., 22% loss). Impacts to wolves are exacerbated by the pattern of fragmentation, whereby current and future scenarios are associated with substantial fracturing of the highest quality landscapes, with increased interspersions of marginal habitat conditions.

### *Fisher*

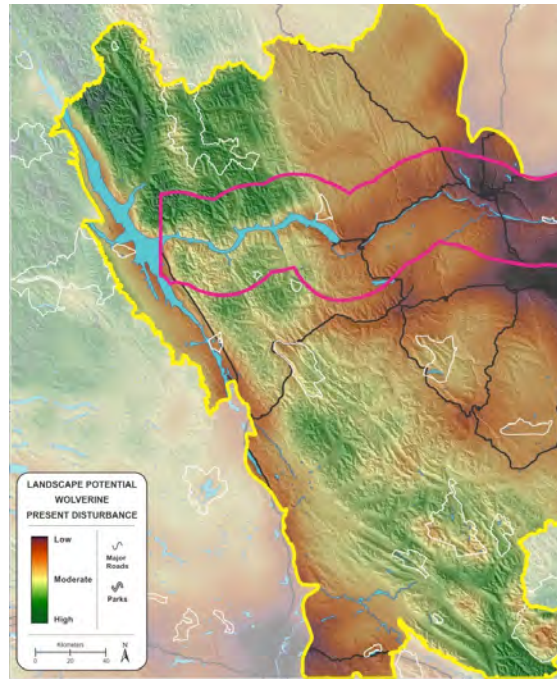
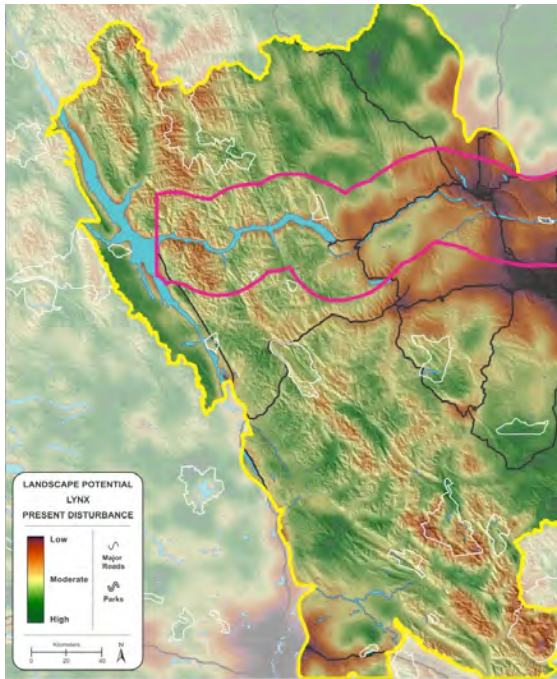
Within the assessment area, the potential distribution of fisher habitat also is associated with landscapes of relatively high overall human influence. While fishers generally do not conflict with people, they are potentially vulnerable to trapping mortality and are thus impacted to some degree by human accessibility. Fisher habitat distribution and connectivity also tends to occur at a finer scale than other wider-ranging species and particularly in association with riparian areas with specific attributes of forest composition and structure.

Fishers are vulnerable to habitat loss and fragmentation, especially due to complete

alienation such as through forest clearing and agriculture in addition to flooding for hydroelectric impoundment. Analysis results suggest that impacts to fishers are more significant at the local (13% currently) than the regional scale (8% currently), likely as a result of the close association of fisher habitat with landscapes of current and proposed modification, including hydroelectric impoundments within the Peace River valley. While population connectivity is undoubtedly important in conservation planning for fishers, the more acute conservation issue appears to be the absolute loss and alienation of quality habitat.

### *Lynx*

Like fisher, human impacts on lynx are also primarily by way of increased mortality risk through legal and illegal harvest. The majority of lynx harvest in the assessment area is through trapping. However, human accessibility potentially impacts lynx more than many other furbearers since lynx are classified as a big game



**Figure 4: Landscape Potential  
Present Disturbance  
Lynx (left), Wolverine (right)**

species and are subject to hound hunting as well<sup>6</sup>. Lynx can also range very widely, easily covering multiple trap line areas. They are naturally vulnerable to periodic die-offs and population fluctuations, and population persistence is greatly dependent on successful dispersal. Lynx are relatively specialized with respect to prey and habitat conditions, and the best habitat often occurs in association with extensive areas of relatively subdued terrain having specific climatic and forest attributes. Within ecologically diverse regions such as the Peace Break, such landscapes tend to be naturally disjunct in distribution. For lynx, population fragmentation is further exacerbated by human accessibility both within core habitat areas and within the connective landscapes through which lynx move and which they occupy on at least an ephemeral basis.

Within the Peace Break region, the loss of landscape effectiveness for lynx is notable at both the regional (10% currently) and local scale (16%). Fragmentation is also an issue, but more so at the local scale where both moderate and

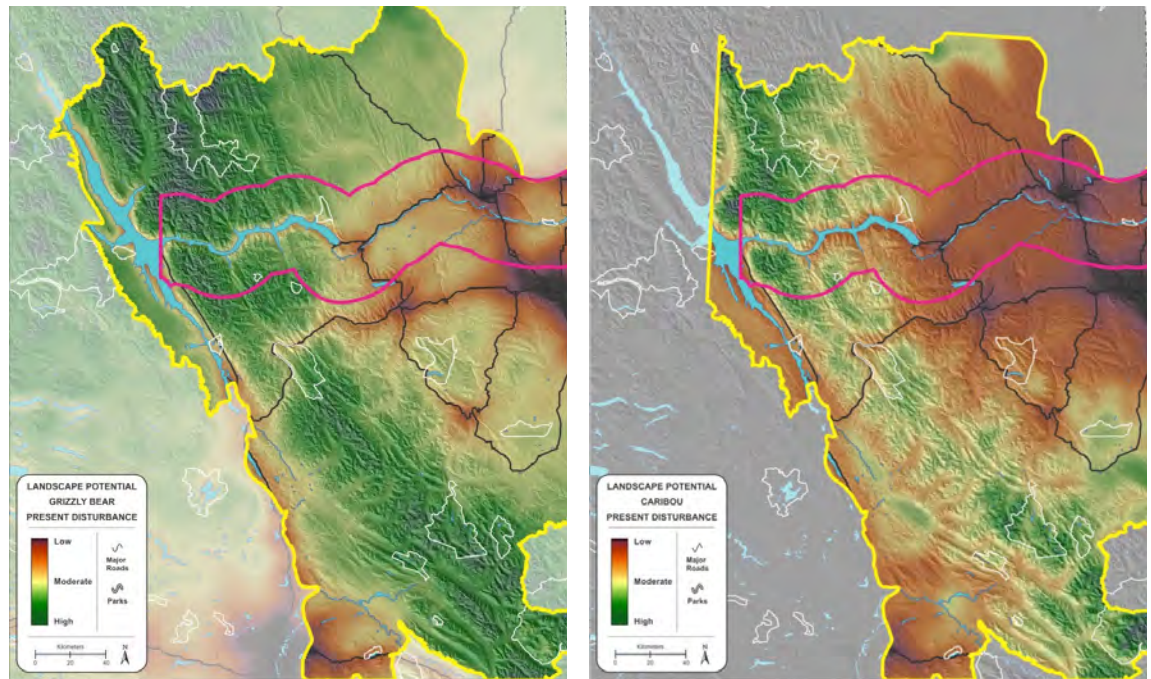
marginal habitats are being transformed to and interspersed with highly suboptimal conditions.

## Wolverine

Wolverines do not rely on a narrow range of habitat conditions as do lynx and fisher. Moreover, wolverine population distribution tends to be associated with rugged and relatively high elevation landscapes, especially where the snowpack consistently persists well into May. Hence, patterns of cumulative human influence do not impact wolverine to the degree observed for several of the other focal species. However, wolverine occur at very low densities and exhibit massive home ranges. Relatively minor levels of human accessibility can put regional populations at risk without de facto protection from harvest. This is reflected in results that indicate a great loss in both regional (46% currently) and local (54% currently) landscape effectiveness for wolverines. With respect to fragmentation, the projected trend is reduced continuity of highest



**Figure 4: Landscape Potential  
Present Disturbance**  
*Grizzly Bear (left),  
Caribou (right)*



quality landscapes and increased interspersions of moderate and marginal conditions.

### *Grizzly Bear*

The relationship between grizzly bear landscape occupancy/distribution and cumulative human impacts can be characterized in terms of both mortality risk and behavioural displacement from otherwise suitable habitat. Mortality risk is the more important impact and results from both intentional killing of bears as well as killing resulting from conflict situations. Such situations are particularly prevalent among ungulate hunters carrying firearms, but management removals within landscapes that have moderate levels of human use are also common.

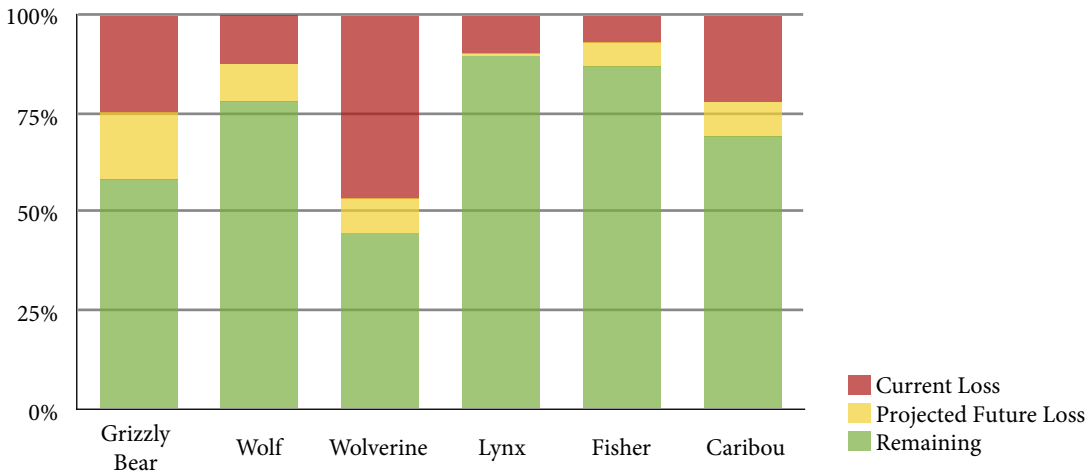
While underlying densities may vary, grizzly bears are potentially widespread in distribution and rarely can persist in close association with people. Among the suite of focal species, grizzly bears are subject to significant impact resulting from cumulative effects of increasing landscape accessibility. At present, landscape effectiveness

is reduced by 25% and 36% at regional and local scales respectively, and is likely to fall by a total reduction of at least 42% and 44% in the future. Population fragmentation is also a major concern, with landscapes of both high and moderate quality being fractured and interspersed with marginal to highly suboptimal conditions.

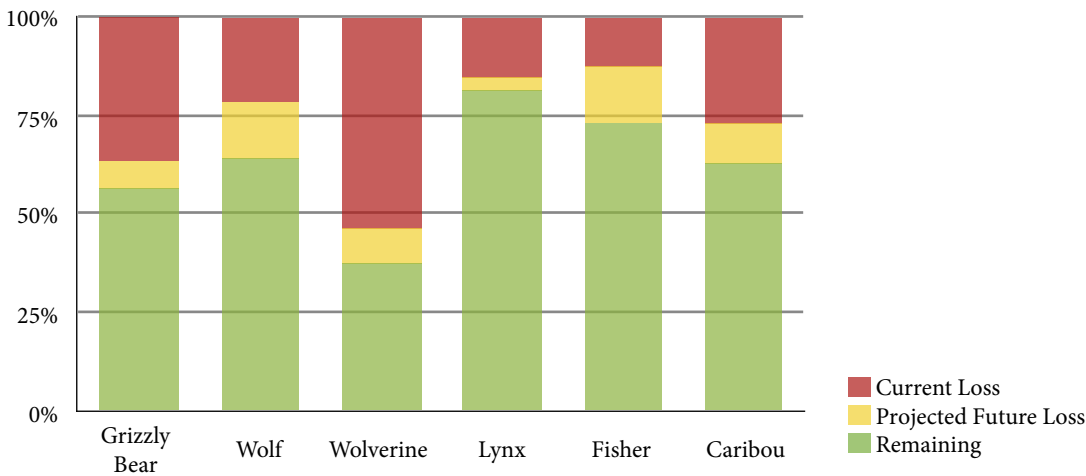
### *Caribou*

For woodland caribou, cumulative human accessibility as modeled for this assessment may function directly to limit caribou population distribution and connectivity through human-caused mortality and displacement effects. But increasing accessibility is also indicative of landscape change resulting in dominant forest conditions incompatible with caribou habitat requirements and likely contributing to increased predation risk. Current reductions of 22% and 27% landscape effectiveness at regional and local scales respectively are projected to be reduced further to at least 31% and 37% in the future. These numbers are likely conservative since the

## Landscape Effectiveness - Regional Change



## Landscape Effectiveness - Local Change



*Figure 5: Estimated proportional reduction in regional (top) and local (bottom) landscape effectiveness (relative to maximum potential) among wide-ranging focal species given current and projected year 2036 scenarios.*

analysis can only account for human influence from access and not habitat change directly.

At the regional scale, the highest quality landscapes are being fractured and interspersed with marginal conditions, and this trend is projected to continue. These analysis results support the current observation that much of the Peace Break assessment area currently supports relatively small and disjunct caribou herds. Moreover, without proactive conservation measures, fragmentation among the larger regional population is likely to be exacerbated

given the future trend of human activity and development.

## Hydro-Electric Impoundments

Among the wide-ranging focal species considered in this assessment, fishers have the greatest potential to suffer major loss of occupied landscapes entirely due to flooding for hydro-electric impoundment. The loss of biologically-productive and seasonally-important riparian and floodplain habitats is also undoubtedly significant for other focal species. But it is the effect of landscape flooding on the movements



### *The Issue of Connectivity*

Ecological connectivity is a fundamental principle in the conservation of wildlife, ecosystems and biodiversity<sup>7</sup>. In a general sense, all animal and plant populations are shaped by, and persist because of, spatial connections. Habitat connections are needed for mobile animals to move through and survive within resident home ranges. At broader scales, landscape linkages allow individuals to move among core habitat areas, providing stability to regional populations and allowing range peripheries to be occupied through periodic or continual augmentation. The resulting genetic flow across large connected populations also contributes to localized adaptability to a changing environment and helps to ensure that only genes beneficial to individual fitness are expressed.

The threat to ecological connectivity is greatly influenced by the spatial pattern of human development. For example, highways often concentrate settlement and development in a manner that can pose a significant threat to ecological connectivity by influencing both animal movements and mortality risk<sup>8</sup>. The nature of these or other localized impacts depends on the current potential to support a connected population across the larger region given existing biophysical and human conditions. Hence, maintaining and enhancing connectivity across regional landscapes requires consideration of specific movement options as well as landscape management for habitat effectiveness and security.

of individuals and hence the connectivity of the larger population that is of particular concern.

For all focal species considered, major reservoirs will obviously reduce landscape permeability dramatically. Such large water bodies can be expected to contribute to measureable breaks in demographic and possibly genetic connectivity. However, these features are unlikely to constitute absolute barriers. All of the wide-ranging focal species considered in this assessment have known potential to move across water bodies (swim or traverse ice) similar to the existing and proposed impoundments of the Peace River (see full report for details).

Understanding the potential for each species to move across major water bodies is relevant to recommendations on mitigating existing and any future reservoirs. In particular, the potential for individuals to traverse such impoundments likely depends on the proximity and effectiveness of core habitat areas. Mitigation strategies should consider the potential for enhancements to habitat productivity and security in landscapes that have high inherent potential for given species and are adjacent to existing or proposed impoundments.

# Conclusions & Recommendations

## *Cumulative Effects*

My intent in this assessment has been to evaluate cumulative human influence on landscape effectiveness and connectivity for a suite of wide-ranging species. For each species, my report describes the magnitude of development impacts and compares past, present and potential future scenarios. Current and projected impacts for each species are a function of (1) inherent habitat requirements, (2) different sensitivities to human activities, and (3) resulting potential for population distribution and connectivity.

Although the nature of impacts varies among species, I judge from assessment results that net cumulative impacts at both the regional and local scales are highly significant for all species. While it is not possible to know the specific threshold of population persistence for a given species at either assessment scale, that point is undoubtedly exceeded in many landscapes and resulting population fragmentation is an obvious threat. Given the current trend, this fragmentation is likely to increase, further reducing regional population stability and viability for the species considered, regardless of whether Site C is constructed.

## *Planning and Management for Conservation*

There does, however, appear to exist for each species at least some secure and effective habitat areas that are likely to sustain productive individuals and connected population cores. The protection and enhancement or recovery of such known or potential core areas and connections

is central to conservation planning for these species. This end is most likely to be achieved through the flexible application of available conservation mechanisms, such as new protected areas and special management regimes, that may involve partnerships among government, non-government, industry and private organizations and individuals.

While the distribution of private land is extensive in the Peace Break region, the majority of lands with reasonable value to the wide-ranging focal species considered in the report is under public ownership and therefore available for protective management. Here, the conservation of healthy and naturally distributed wildlife populations is an important mandate of British Columbia environment and natural resource ministries. Thus, halting and potentially reversing the recent trend of cumulative human impacts on focal species within the Peace Break region is a reasonable goal. But, effective long-term conservation is a less likely outcome if Site C is to proceed.

Regardless of the decision on Site C, offsetting and moving toward the reversal of existing and potential-future cumulative human impacts within the Peace Break region will require focused mitigation and conservation planning at local to regional scales. The species considered in the assessment are effective indicators for conservation of complete terrestrial communities and related ecological processes, especially at broad scales.

The modeling and analytical outputs provided in the report can assist in the planning process,



particularly in defining landscapes where specific mitigations and/or conservation zoning are likely to be most effective. Planning efforts should focus on the protection and enhancement of landscape conditions that facilitate core population areas appropriately buffered from negative human impacts. These core areas will most effectively anchor a resilient regional population where connecting linkage zones are also protected, enhanced and/or restored. Central to such efforts will be the management and reduction of human access in such core areas (especially motorized). But habitat management that is appropriate to the local ecosystems and their regime of natural disturbance is also important. Planning for such enhancements with species-specific or biodiversity objectives should be carried out in concert with human-use management to avoid the promotion of attractive population “sinks” with high levels of mortality risk.

### *Landscape Fractures and Linkages*

In managing and conserving broad-scale population connectivity for wide-ranging species, conservation strategies to address major fracture zones are of great importance. Such fractures are often associated with highways and the linear pattern of human development along them especially where associated with private land. This highway-fracture association is apparent within the Peace Break region. But it is also important to note that the course of the Peace River and its hydroelectric impoundments, including the Peace Reach of the Williston Reservoir, also represent a present or emerging population fracture for most of the species considered in the report. Here, connectivity

may be best conserved and/or enhanced through increased protection of adjacent landscapes from further human access and impacts. Many human impacts, including impoundments, do not necessarily constitute absolute barriers to movement. Such movements, however infrequent, will be much more likely if adjacent landscapes are attractive, secure and productive for a given species. Moreover, any opportunities that exist to secure and potentially enhance movement opportunities through non-flooded landscapes spanning the Peace Valley should be of high conservation priority. This should include a potential linkage zone through lands between the W.A.C. Bennett Dam and the Dinosaur Reservoir, southeast to northeast of the Peace Arm of the Williston Reservoir. It should be noted that much work toward the promotion of an ecological connectivity network for the Peace Lowlands Ecoregion is completed and available<sup>9</sup>.

### *The Need for Reliable Information and Knowledge*

There is an obvious paucity of information derived from local research or inventory for most of the species considered in the report. Such local understanding and/or survey or monitoring data would greatly contribute to the modeling of species occurrence, distribution and connectivity and in evaluating current impacts and trends. For example, despite the availability of highly effective survey methods, there is virtually no information on grizzly bear abundance and distribution within the Peace Break relative to many other regions of the province. In the absence of such information to reliably inform modeling and population viability analyses, I recommend that the precautionary principle

be applied in the consideration of the Site C project and other developments that are likely to exacerbate the adverse cumulative impacts that presently pervade the region.

### *Cumulative Effects and Proponent Responsibility*

Maintaining viable and naturally distributed populations of native wildlife is consistent with public policy in British Columbia<sup>10</sup>. It follows that acceptable landscape-specific thresholds of cumulative effects (quantifiably estimated) be established on behalf of the public. Against these standards, it is appropriate that development proponents individually or collectively shoulder the responsibility for demonstrating that the cumulative impact to long-term persistence and viability of the wide-ranging focal species is not excessive or can be effectively mitigated.

### *Continental Significance - the Y2Y Context*

The Y2Y region includes the Rocky Mountains and associated ranges of western North America stretching from the greater Yellowstone ecosystem to the Yukon's Peel River watershed. These mountain ranges are globally significant in their large component of wild lands and the relatively continuous and connected populations of most native large mammals that are supported. However, without proactive conservation planning, a regional fracture of ecologically connected landscapes may eventually emerge due to current and projected levels of cumulative human impacts across the Peace Break region. The consequences of this scenario are of potential significance at a continental scale.

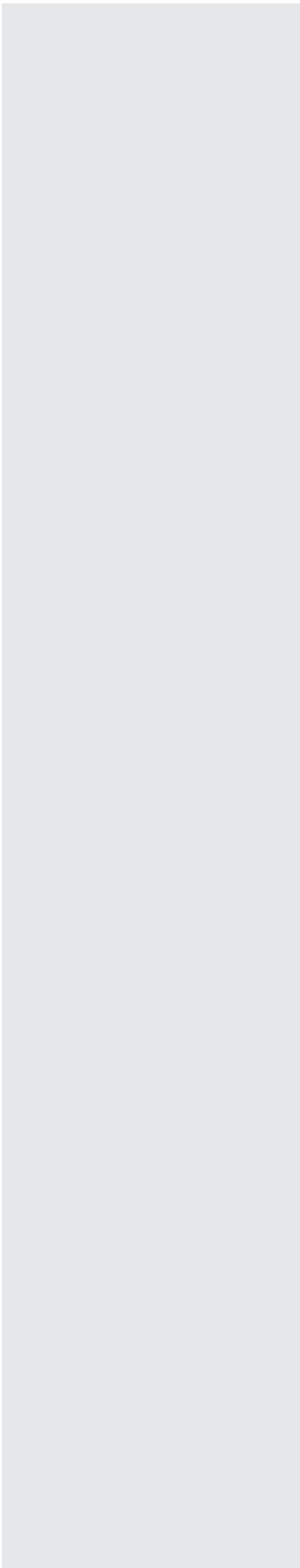


*The Peace River valley, running east-west through the heart of the region, supports abundant and diverse wildlife populations. (photo: Larry Peterson)*

# Primary Points of Conclusion and Recommendations

- For wide-ranging species, evaluation and mitigation of cumulative human impacts is most relevant at broad scales of regional population distribution and should consider the potential for landscape occupancy, productivity and population connectivity.
  - I judge the net cumulative impacts at both the regional and local assessment scales to be significant for all wide-ranging terrestrial species considered.
  - A threshold of population persistence has undoubtedly been exceeded in many landscapes and resulting population fragmentation is a threat.
  - The direct and indirect impacts of Site C hydro-electric development and impoundment will further erode the potential for local and regional landscapes to support the wide-ranging species considered herein.
  - Bull trout and Arctic grayling fish are also under pressure from a number of inter-related impacts within the Peace Break region. The Site C development will clearly impact these species in different ways but the net impact and the nature and extent of planned mitigation is unclear (see full report for background description of impacts on fish species).
  - Projected human population and development trends suggest that the stability and viability of focal species populations may be further compromised in the future without proactive conservation planning.
- As a result, already vulnerable populations may be driven even closer to local extirpation.
- There may be opportunities for increased protection of some landscapes, contributing to the enhancement and/or recovery of secure and effective habitat areas for multiple species. These should focus on population cores and important linkage zones.
  - Management and reduction of motorized human access is central to effective conservation planning. But habitat management appropriate to local ecosystems and associated regimes of natural disturbance is also important. Habitat enhancement should be planned in concert with human-use management to avoid the potential for localized conflict with people and/or increased mortality among focal species.
  - Special attention should be given to measures that can enhance habitat effectiveness and security adjacent to potential population fractures through which some movement by a given species is possible and desirable. The landscape directly east of the W.A.C. Bennett Dam that is not subject to flooding should be of high conservation priority as a multi-species linkage zone.
  - Given current development trends and associated cumulative effects, the Peace Break Region may eventually constitute an ecological fracture within the Y2Y region that is significant at a continental scale.





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