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ARCKP

Alberta Regional Caribou Knowledge Partnership

PROJECT REPORT

Exploring the Implementation of Aggregated Harvest in Woodland Caribou Ranges

Exploring the Implementation of Aggregated Harvest in Woodland Caribou Ranges

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Executive Summary

Aggregating forest harvesting is an important strategy to reduce the impacts of forestry on caribou. In this study, we ran timber supply modelling scenarios in Patchworks™ to investigate the feasibility and impacts of implementing aggregated harvest scenarios in three of Alberta's regional caribou planning sub-regions. The three regions show varying response to the harvest patterns, caribou habitat metrics, and associated socio-economic values. Clear tradeoffs between harvest patch size, harvest volume, and caribou habitat metrics can be observed within the modelled scenarios. Increasing harvest patch size results in a reduction in harvest volume but increases the proportion of undisturbed caribou habitat within the ranges. The greatest impact of implementing large harvest patches is a reduction of the area disturbed by the harvest buffer. In the context of the federal target for 65% undisturbed habitat, harvest reductions from baseline levels will be required in all the assessed regions, with the degree of reduction required varying between the regions.

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1. Introduction

Designing and implementing aggregated harvest sequences has been identified as a key strategy to reduce the impact of forest harvesting on woodland caribou[1]. This approach aggregates forest harvesting into large patches and aims to emulate natural disturbance patterns, reduce access requirements, and help to maintain and create larger patches of intact undisturbed caribou habitat. However, there is a lack of understanding of how the scale of aggregation influences caribou habitat, and what tradeoffs exists between harvest aggregation and other values.

In this project, we implement a trade-off scenario analysis using a custom-built modeling environment to quantify how aggregated harvest will affect caribou habitat metrics, other species and values, and socio-economic considerations. This approach has the benefit of a flexible model that allows for the testing of innovative approaches, but importantly, does this in a way that is directly comparable to existing Forest Management Plans. This allows comparisons for non-timber assessments and socio-economic assessments that are part of these plans, providing a greater understating of aggregated harvest impacts.

We have identified unexplored aspects of the aggregated harvest approach that we believe warrant further investigation and analysis. These primarily involve the scale at which the aggregation approach is implemented. As part of the range planning process, a number of forestry companies have developed aggregated harvest sequences, but these are designed at very different scales. Some are landscape-level (e.g., single units of 50,000+ ha) while others are far more localized (e.g., single units of 2,000 ha). This has far reaching implications for caribou habitat and for other species. Theoretically, larger units should be beneficial for caribou because they concentrate disturbance more effectively, leaving larger areas of undisturbed habitat. However, impacts to other species, and operational or societal concerns may limit feasibility. In this study we examine the effect of scale and regional constraints on the application of aggregated approaches through scenario analysis. This important element of the aggregated harvest

[1] Government of Alberta (2017). Draft Provincial Woodland Caribou Range Plan. Downloaded from: http://aep.alberta.ca/fish-wildlife/wildlife-management/caribou-range-planning/documents/DRAFT-CaribouRangePlanAndAppendices-Dec2017.pdf

approach has been little explored, and we identify it to be an important avenue for innovation, in terms of finding balanced and effective ways to apply this approach.

2. Objectives

The primary objective for this project is to assist in answering the following questions for different regions of Alberta:

- How can aggregated harvest approaches be tailored to work most effectively for caribou and provide for a working landscape?
- What are the trade-offs between aggregated harvesting and other values, both ecological and socio-economic?

We also aim to provide additional knowledge on the nuances of the aggregated harvest approach, in terms of the relatively unexplored question of how the scale of implementation affects outcomes, and the complexities of the buffering and spatial layout. Key steps to achieve this were to:

- Test a range of different aggregated harvest scenarios against business as usual (BAU) approaches (existing Spatial Harvest Sequences) that compare different harvest levels, spatial layouts, and re-entry rules. For each scenario tested, provide an assessment of the impact on caribou habitat and on a wide range of other species and values and on socio-economic metrics.
- Compare assessments of harvest scenarios between different regions of the province in order to better understand how regional differences influence the costs and benefits of alternative harvest approaches.
- Test how the scale of aggregation affects outcomes. To the best of our knowledge, the effect of scale on the effectiveness of aggregated harvest approaches has not been explicitly examined.

3. Approach and Methodology

This project utilizes an integrated and spatially explicit modeling environment based on the Patchworks™ forest management planning software to evaluate the impacts of novel harvesting approaches in comparison to business-as-usual (BAU) approaches. While this software is typically used within the limited confines of a Forest Management Plan, the "sandbox" nature of the platform allows the custom-building of a modeling environment that allows for the efficient analysis of forest harvest metrics, caribou habitat metrics, and other species indicators within a single platform. The benefits of this include the ability to rapidly conduct sensitivity analysis that show the relative impacts of changes in harvest pattern on a wide variety of metrics, meaning a comprehensive assessment can be made. In addition, the spatially explicit nature of the modeling environment allows for examination of how local landscape effects influence results with different harvest approaches (e.g., achieving benefits to caribou habitat with an aggregated harvest approach is more challenging in environments with a large proportion of non-productive landbase).

As described above, we think that there is an unexplored aspect of the aggregated harvest approach in terms of the different harvest patch sizes. At the largest patch sizes, where a single aggregated harvest unit might provide the necessary volume for many years of mill operation, it may be possible to have the largest reductions in disturbance footprint. Such an approach would only be possible in larger caribou ranges with large patches of contiguous active landbase. At the smallest harvest patch sizes, aggregated sequences are highly clustered around homogenous stands, and harvesting more stands at their optimal age, but perhaps having limited benefits to caribou disturbance metrics. The approach applied in this project examines the different patch sizes and their impacts on harvest volumes, caribou disturbance and other values such as habitat and watershed management. We also examine how harvest patterns relate to the very differently sized caribou ranges (e.g., A La Peche winter range at ~165,000 ha vs Chinchaga at ~1,765,000 ha).

3.1 Study Area

In this project, we explore aggregated harvesting in three of the caribou planning regions in Alberta: Berland, Chinchaga, and Wandering River. These planning regions include areas within and outside of caribou ranges and have been delineated to meet objectives for caribou habitat, other species values and socio-economic outcomes. The Berland region contains two caribou ranges, the Little Smoky and the A La Peche ranges. The A La Peche range is further subdivided into the A La Peche summer and winter ranges, and the summer range falls entirely within protected areas (Willmore Wilderness Park and Jasper National Park). The Chinchaga and Wandering River regions each overlap with one caribou range, the Chinchaga and the East Side Athabasca River ranges respectively.

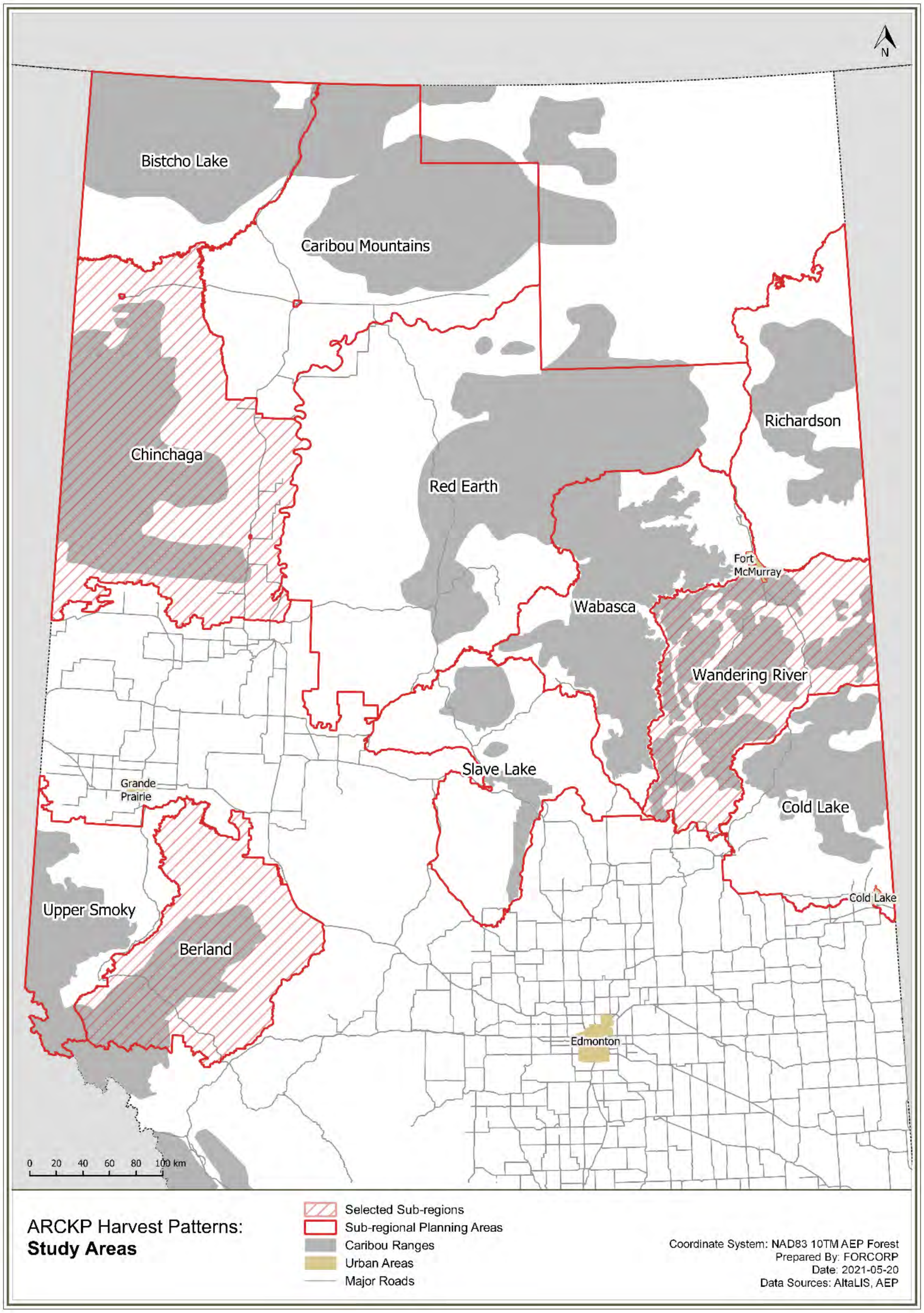

Figure 1. Study area

3.2 Methodology

Scenarios in Patchworks were developed and compared to each other and to BAU harvest scenarios, using existing Spatial Harvest Sequences (SHS). The following analyses were included:

- **Comparison of regional differences using three caribou planning regions:** These included one each in the Northeast, Northwest and West-Central regions of the province. We modeled the ranges within the larger regional planning areas of Chinchaga, Berland and Wandering River.
- **Harvest aggregation size and scale:** For each range, we examined harvest block aggregation sizes, from individual harvest blocks up to very large patches (e.g., > 10,000 ha).
- **Harvest timing:** For each combination of range, aggregation sizes and harvest level, we examined a range of timing options, including:
  - Consistent even flow entry into the range; or,
  - Constraining entry timing into the range. We allowed harvest within the range for a limited number of decades (e.g., 3 or 4 decades) and excluded entry for the remaining decades. The decades chosen for entry were variable between sub-regions and were not required to be consecutive.
- **Road building/maintenance:** Road building and maintenance levels were adjusted within the model to determine the effect on timber harvesting and caribou habitat.

Each scenario has assessments for caribou habitat, socio-economic, and other value metrics. Comparison reports are provided to clearly quantify the differences between scenarios.

3.2.1 Patchworks Modelling Assumptions

Some types of existing disturbances on the landscape are progressively reclaimed throughout the 100-year planning horizon. This uses the same assumptions as the current provincial modelling framework for caribou habitat. No new non-forestry disturbances are allowed. The reclamation timing in the model is shown in Table 1. Cutblocks are considered to be reclaimed immediately after the harvest date.

Harvest rules are typical harvesting, with strata going back to the same strata after harvest. Minimum harvest ages are 60 years for pure deciduous stands, 80 years for mixedwood and most pure conifer stands, and 110 years for pure black spruce stands. Yields are based on provincial yield curves developed by the GOA.

Table 1. Reclamation timing of existing disturbances on the landscape[2,3].

Feature Type	Description	Time to Reclamation (Years)	Source
BORROW	Borrowpits, dugouts and sumps	5	ABMI HF 2018
HF-OTHER	Unknown clearings, surrounding vegetation	20	ABMI HF 2018
INDUSTRIAL SITE	Oil and gas facilities (not mines), industrial camps, tank farms	60	ABMI HF 2018
MINE SITE	Coal, peat, other mines	60	ABMI HF 2018
PERMANENT	Railroads, runways, transmission lines, residences, urban, cropland, paved roads	999	ABMI HF 2018
PIPELINE-ACTIVE	Operating or permitted pipelines	40	ABMI HF 2018 / AER Data
PIPELINE-INACTIVE	Abandoned or discontinued pipelines	20	ABMI HF 2018 / AER Data
ROAD-TEMP-1L	Unclassified, unimproved, unpaved and gravel 1 lane roads	20	ABMI HF 2018
ROAD-TEMP-2L	Unpaved and gravel 2 lane roads	40	ABMI HF 2018
ROAD-TRAIL	ATV and truck trails	20	ABMI HF 2018
ROAD-WINTER	Winter access roads	20	ABMI HF 2018
SEISMIC LINE	Seismic lines and trails, excluding low-impact seismic lines	40	ABMI HF 2018
WELL-ABANDONED	Abandoned well pads	10	ST37 2021
WELL-ACTIVE	Issued, amended, re-entered well pads	20	ST37 2021
WELL-RECLAIMED	Rec-certified, rec-exempt well pads	0	ST37 2021
WELL-SUSPENDED	Suspended well pads	20	ST37 2021

[2] Alberta Biodiversity Monitoring Institute (ABMI) (2018). Wall-to-Wall Human Footprint Inventory. Downloaded from: https://abmi.ca/home/data-analytics/da-top/da-product-overview/Human-Footprint-Products/HF-inventory.html

[3] Alberta Energy Regulator (2021). ST37: List of Wells in Alberta Monthly Updates. Downloaded from: https://www.aer.ca/providing-information/data-and-reports/statistical-reports/st37

3.2.2 Caribou Habitat Assessments

Impacts on caribou habitat were assessed based on research provided in the Federal range planning strategy and from Alberta Environment & Parks (AEP), and follow the assumptions used in provincial caribou modelling by AEP:

- **Undisturbed Habitat**: Undisturbed caribou habitat is considered to be habitat that is not within disturbance features or their buffers. After a disturbance feature has been reclaimed and restored (as defined in Table 1), it is not considered undisturbed caribou habitat again until 40 years have passed. As cutblocks are considered to be reclaimed immediately after harvest, they remain as disturbances in the model for forty years after their harvest year. Current disturbances are assumed to be reclaimed over time and some features have a known age, which is used to adjust the time to reclamation. See Table 1 for details. The federal target is to have all caribou ranges at >= 65% undisturbed habitat.
    - **Disturbance and Buffering**: All anthropogenic features are buffered by 500m and the area within these buffers is considered to be disturbed caribou habitat. This follows the methodology used in the Federal range planning guidance[4]. Assessments were made on harvest blocks and their buffers only, and on total disturbance including access roads and other industrial disturbances. Seismic and wildfire disturbances were not included, as much of the chosen caribou ranges are currently disturbed by seismic lines and their buffers and including these would make it more difficult to interpret the impact of harvest patterns and aggregation on caribou habitat. Aggregated harvest approaches are expected to lessen the disturbance metric due to the impact of grouped harvest reducing the effect of buffering.
- **Biophysical Habitat**: This uses research provided by AEP. AEP defines[5] biophysical habitat as the stand types and ages that have the attributes required by caribou to carry out life processes necessary for survival and recovery. Biophysical habitat varies by region and season, with habitat preferences often changing during calving, rutting, and winter periods. For southern mountain caribou, biophysical habitat includes open pine-leading stands (i.e., lodgepole pine, black spruce) greater than 80 years of age and treed muskeg areas with abundant lichens. For boreal caribou, coniferous forests (i.e., jack pine, black spruce, and tamarack) greater than 60 years of age and treed peatlands, muskegs, and bogs are the key areas required to sustain populations into the future.
    - This metric is affected by the amount of harvest in certain stand types rather than the layout of harvest but is still important to understand the overall dynamics. For example, if an aggregated harvest approach required a greater overall harvest area because of the reduced volumes from stands harvested outside of their ideal age range, this may result in a poorer result for biophysical habitat despite an improved disturbance metric.
    - Our reporting on biophysical habitat from the model is reported in three categories based on the initial strata in the model and the ages of that strata, 1) current biophysical area,

[4] Environment Canada (2011). Scientific Assessment to Inform the Identification of Critical Habitat for Woodland Caribou (*Rangifer tarandus caribou*), Boreal Population, in Canada. Downloaded from: https://www.registrelep-sararegistry.gc.ca/virtual_sara/files/ri_boreal_caribou_science_0811_eng.pdf

[5] Alberta Environment and Parks (2018). Methods for Refining Federal Classification of Woodland Caribou Biophysical Critical Habitat for Alberta.

2) area that could be biophysical but is currently too young, and 3) area that does not qualify as biophysical habitat based on strata. For category three, in reality this could change with succession or reclamation strategies, but for the purposes of this model it does not change over time.

3.2.3 Socio-economic Assessments

To clearly identify how adopting aggregated harvest approaches potentially impacts forestry companies, socio-economic impacts were assessed using common forestry metrics that are directly applicable to forestry professionals.

- **Harvest Volumes**: Includes impacts to overall AAC and to even-flow harvest volume. Aggregated harvest approaches may make achieving even-flow more complex due to homogenous age profiles.
- **Harvest Age**: Assesses the impact of harvesting stands outside of the ideal harvest age and the potential losses to productivity that may result.
- **Access Requirements**: Includes the amount of access road that will be required and the time period that access will need to be maintained. Aggregated harvest units are expected to require less access roads at any one time, but that access will need to be maintained for a longer period. Patchworks has an integrated road module that optimizes road networks based on build, haul, and maintenance costs. This framework was used to compare access requirements.

3.2.4 Other Species and Value Assessments

Aggregated harvest approaches may positively or negatively affect many different values in comparison to BAU approaches. The following metrics, which are commonly assessed in forest management plans, were also assessed:

- **Forest Songbirds**: Selected species were modelled using existing models developed by AEP for the FMP process. These have been integrated into the Patchworks modeling environment for ease of use, allowing rapid comparisons between scenarios. The following species were chosen for modelling:
    - Bay-Breasted Warbler (*Setophaga castanea*)[6]: A forest-dependent species that is mostly found in old white spruce coniferous forest stands, but also found in mixedwood and deciduous forests in Alberta. Considered a sensitive species by AEP.
    - Black Throated Green Warbler (*Setophaga virens*)[7]: A mature/old forest specialist with a preference for interior forest habitat. It is strongly associated with large white spruce trees, which it uses as foraging sites to glean insects from the outer part of the branches.
    - Brown Creeper (*Certhia american*a)[8]: An old forest and forest interior specialist. In mature forests, it selects the largest available trees and snags to meet nesting and foraging requirements, but it will live in deciduous or even marshy forests if there is nesting habitat

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[6] Alberta Biodiversity Monitoring Institute and Boreal Avian Modelling Project. 2020. Bay-breasted Warbler (*Setophaga castanea*). ABMI Website: abmi.ca/home/data-analytics/biobrowser-home/species-profile?tsn=99001404.

[7] Alberta Biodiversity Monitoring Institute and Boreal Avian Modelling Project. 2020. Black-throated Green Warbler (*Setophaga virens*). ABMI Website: abmi.ca/home/data-analytics/biobrowser-home/species-profile?tsn=99001402.

[8] Alberta Biodiversity Monitoring Institute and Boreal Avian Modelling Project. 2020. Brown Creeper (*Certhia americana*). ABMI Website: abmi.ca/home/data-analytics/biobrowser-home/species-profile?tsn=99002654.

available. The Brown Creeper nests under the peeling bark of dead and dying trees, or wherever it can find a sheltered overhang. Considered a sensitive species by AEP.

  - Canada Warbler (*Cardellina canadensis*)[9]: Most commonly associated with old deciduous and mixedwood forests, particularly riparian areas with steep slopes adjacent to streams and small rivers. They will however use a wide variety of forest types and stand ages provided there is a well-developed shrub layer. Considered a threatened species under Alberta's Wildlife Act.
  - Ovenbird (*Seiurus aurocapilla*)[10]: Prefers large, contiguous mature/old stands of deciduous or mixedwood forests. Large areas of contiguous forested habitat are preferred for breeding. Considered a secure species under Alberta's Wildlife Act.
  - Varied Thrush (*Ixoreus naevius*)[11]: Associated with mature coniferous forests and prefers large, continuous stands over small, wooded patches. It typically nests in understory vegetation in mature forests. Considered a secure species under Alberta's Wildlife Act.

- **American Marten (*Martes americana*)[12]:** Population trends are assessed using existing AEP methodology. Marten are associated with mature/old coniferous and mixedwood forests. Marten depend on contiguous areas of mature/old forest at the landscape scale, as well as habitat structure typically more abundant in older forests at the stand scale to meet foraging and cover requirements, such as large trees and snags, coarse-woody debris, and understory vegetation
- **Watersheds:** Aggregated harvest approaches have a high risk of causing large impacts on specific watersheds in comparison to BAU due to the concentrated nature of the harvest pattern. Quantifying these impacts is an important element of the assessment. We used Equivalent Clearcut Area (ECA) modeling, directly integrated into the modeling environment, to assess these impacts.
- **Traplines:** Aggregated harvest may affect traplines in a similar way to watersheds with aggregated harvest approaches potentially having major local impacts on some traplines when harvest is focused in that area. We have provided assessments of how traplines might be impacted.

3.2.5 Neptune

Neptune is a tool used to examine how the size, shape, and distribution of disturbance events impacts the total amount and connectivity of disturbed area on the landscape. Neptune is a stand-alone Python tool that automates the conversion of any disturbance event into a common spatial language and compares

[9] Alberta Biodiversity Monitoring Institute and Boreal Avian Modelling Project. 2020. Canada Warbler (*Cardellina canadensis*). ABMI Website: abmi.ca/home/data-analytics/biobrowser-home/species-profile?tsn=99001416.

[10] Alberta Biodiversity Monitoring Institute and Boreal Avian Modelling Project. 2020. Ovenbird (*Seiurus aurocapilla*). ABMI Website: abmi.ca/home/data-analytics/biobrowser-home/species-profile?tsn=726205.

[11] Alberta Biodiversity Monitoring Institute and Boreal Avian Modelling Project. 2020. Varied Thrush (*Ixoreus naevius*). ABMI Website: abmi.ca/home/data-analytics/biobrowser-home/species-profile?tsn=179773.

[12] Alberta Biodiversity Monitoring Institute. 2020. Marten (*Martes americana*). ABMI Website: abmi.ca/home/data-analytics/biobrowser-home/species-profile?tsn=180559.

pattern metrics to the natural range of variation for 10 metrics including event size and shape, number of disturbed patches, disturbed patch shape, island sizes, and the area of disturbances, islands, and matrix remnants.

Disturbance events are created from spatial files using the following steps:

1. Isolating disturbed patches by dissolving any islands into the patch;
2. Buffering the disturbed patch boundaries out by 200 m;
3. Filling in any internal holes to smooth the boundary and joining most of the disturbed patches;
4. Buffering the disturbed patch in by 200 m; and
5. Adding the islands back in.

The result is a polygon called a disturbance event which is composed of the original disturbance area, matrix remnants (connective patches generated through buffering), and the original island remnants left by the disturbance. Islands within the disturbance that are not forested (e.g., waterbodies) are classified as “Other”. Neptune is then used to calculate and compare various disturbance metrics and compare the pattern of disturbance to those created by natural disturbance (i.e., wildfires). An example of the process to generate disturbance events is shown in Figure 2.

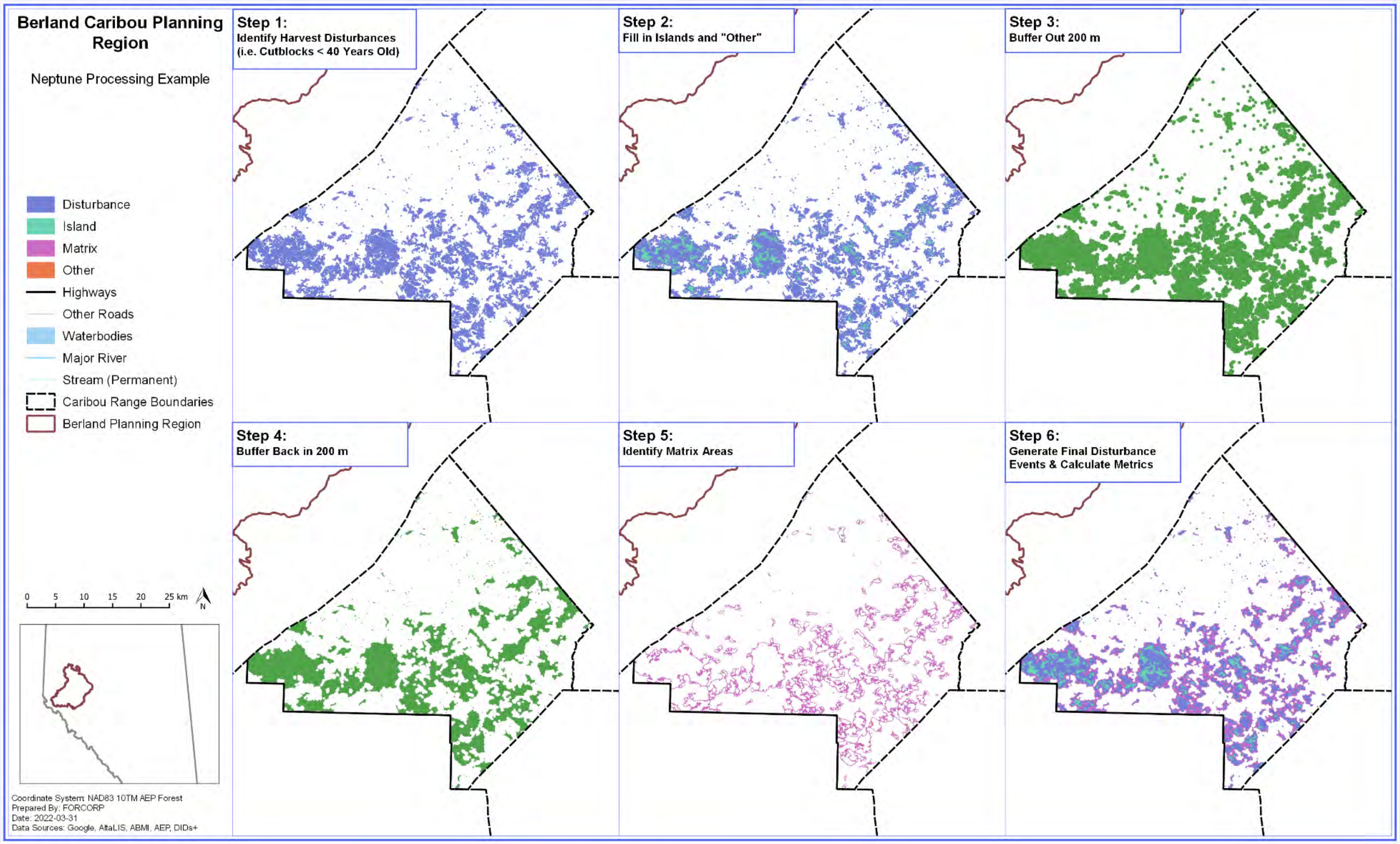


Figure 2. Neptune processing example for a scenario (BERR_M) for harvest disturbances at year 50 within the A La Peche Winter range.

4. Analysis

4.1 Sub-Region Summary

Table 2 summarises the areas selected for the planning sub-regions, including the area of active and passive landbase within or outside the caribou range(s). Figure 3 through Figure 5 show maps of each sub-region. The area and distribution of active landbase has a significant impact on the ability to aggregate harvest and achieve caribou habitat objectives. Where patches of active landbase are more scattered across the landscape, such as in the East Side Athabasca River caribou range in the Wandering River sub-region (Figure 5), it limits the patch sizes that can be achieved by aggregating harvest. Where active landbase is more concentrated, such as in the A La Peche Winter and Little Smoky ranges in the Berland sub-region (Figure 3), aggregating harvest is simpler to achieve and much larger patch sizes can be created. However, the higher percentage of active landbase in the Berland sub-region means that the harvest level will likely need to be reduced by a greater amount from the theoretical maximum to achieve caribou habitat goals, compared to Wandering River where there is much less active landbase within the caribou range.

The A La Peche Summer range has almost no active landbase (Table 2), as it is entirely within the existing protected areas (Figure 3), and the small area of active landbase in this range is due to partially overlapping polygons caused by the hexagonal landbase format. For this reason, caribou habitat metrics are not reported for this seasonal range as its metrics are not influenced by timber harvesting.

Table 2. Area summary of each sub-region.

Subregion	Caribou Range	Landbase Status					
		Active		Passive		Total	
		Area (ha)	% of range	Area (ha)	% of range	Area (ha)	% of Subregion
Berland	A La Peche (Summer)	104	0	221,351	100	221,455	11
	A La Peche (Winter)	99,574	60	66,903	40	166,477	8
	Little Smoky	151,104	49	157,319	51	308,423	15
	Subtotal	*250,782*	*36*	*445,573*	*64*	*696,355*	*35*
	Outside Caribou Range	670,595	51	644,318	49	1,314,912	65
Subtotal		*921,377*	*46*	*1,089,890*	*54*	*2,011,267*	*100*
Chinchaga	Chinchaga	597,121	34	1,167,170	66	1,764,291	46
	Outside Caribou Range	881,184	42	1,214,608	58	2,095,793	54
Subtotal		*1,478,305*	*38*	*2,381,779*	*62*	*3,860,084*	*100*
Wandering River	East Side Athabasca	212,486	18	985,370	82	1,197,856	53
	Outside Caribou Range	407,752	38	663,941	62	1,071,693	47
Subtotal		*620,239*	*27*	*1,649,311*	*73*	*2,269,549*	*100*

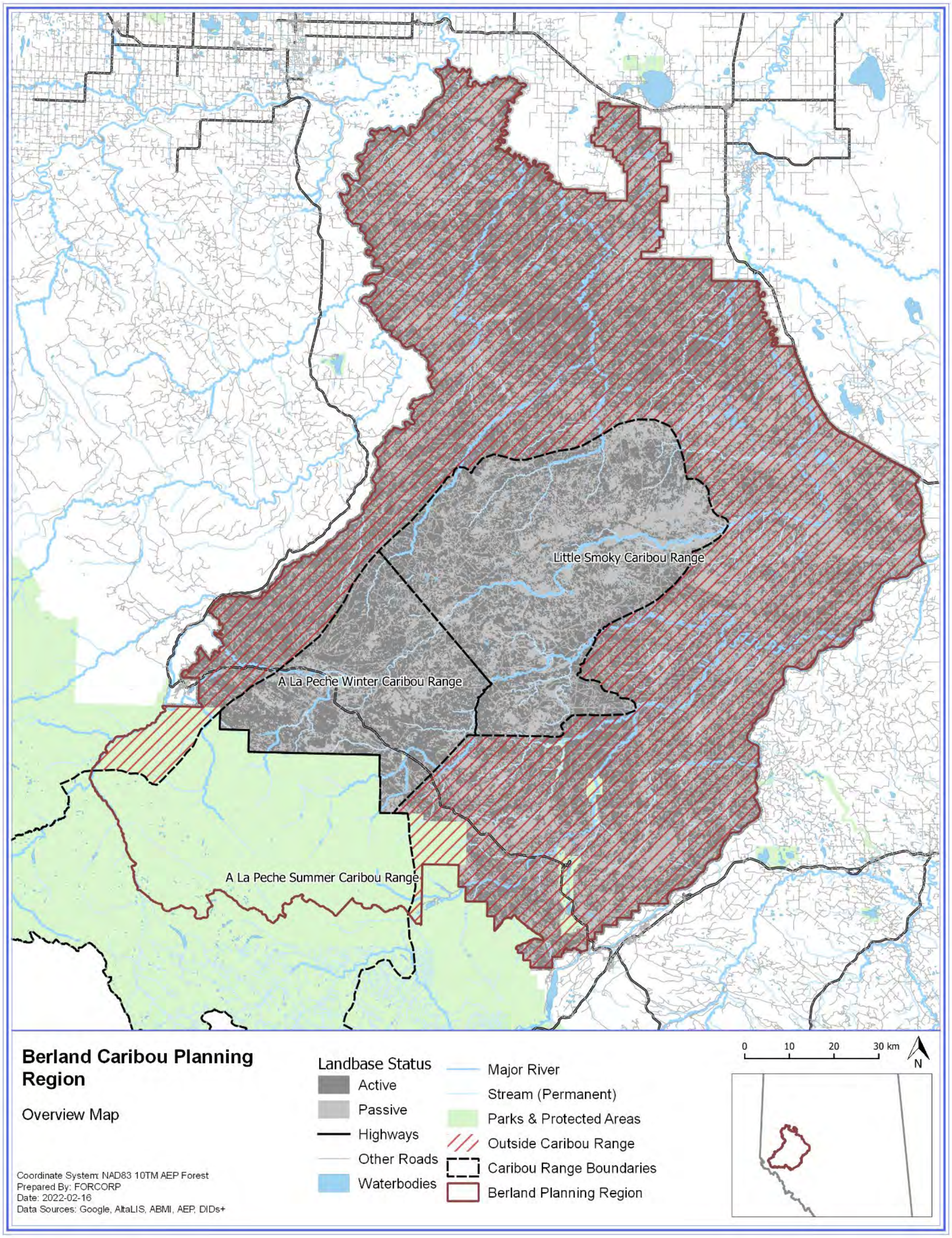


Figure 3. Berland caribou planning sub-region.

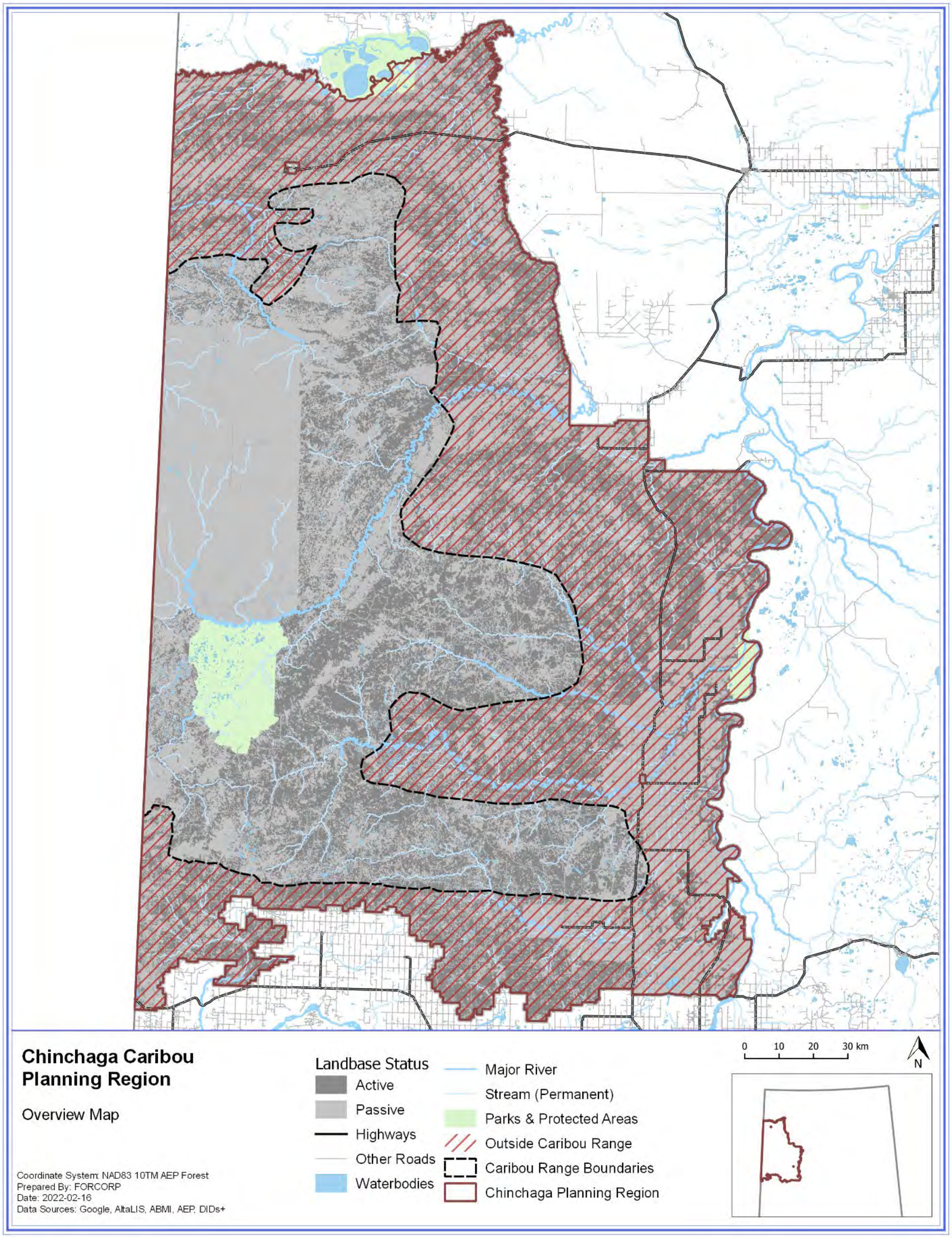


Figure 4. Chinchaga caribou planning sub-region.

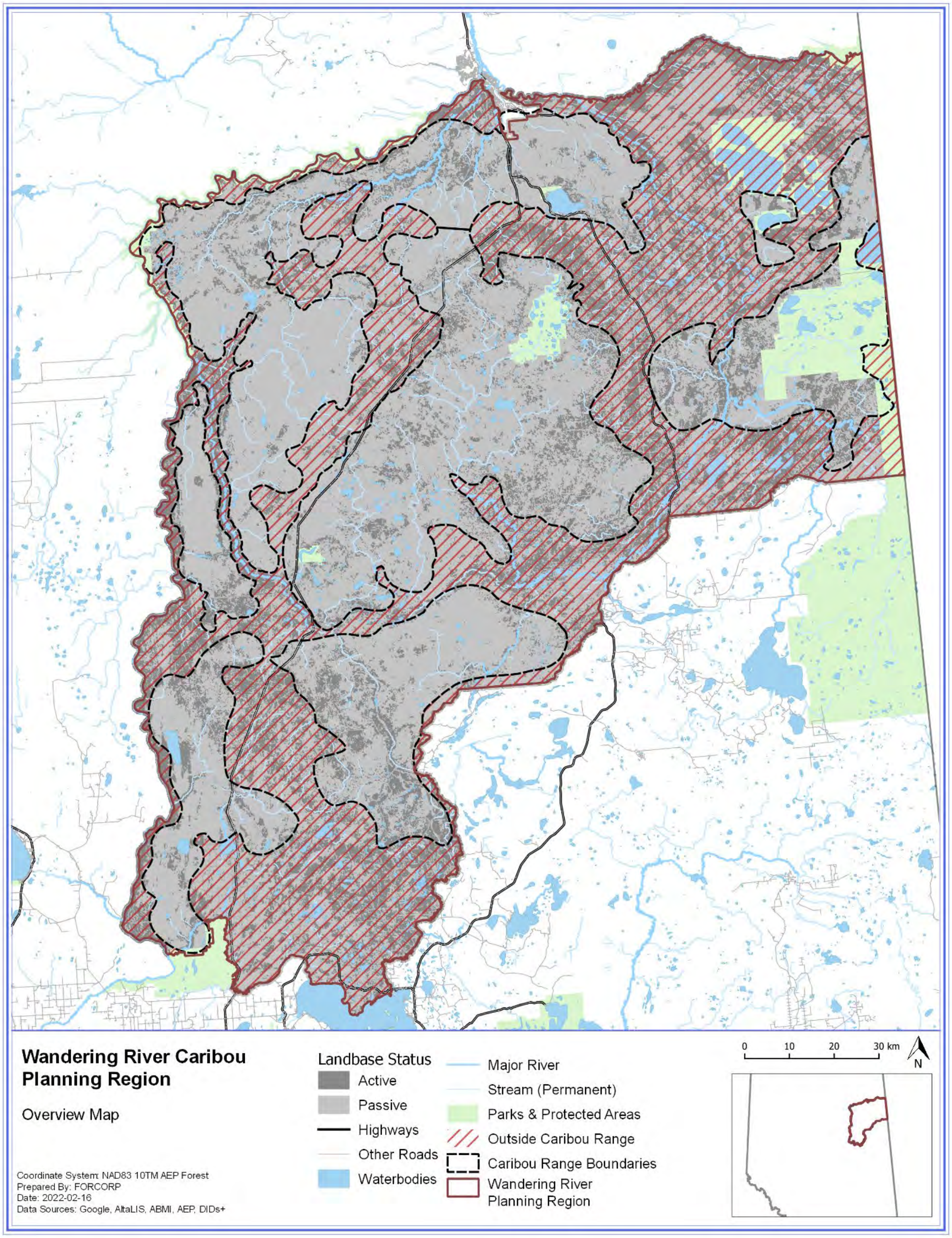


Figure 5. Wandering River caribou planning sub-region.

Table 3 compares the area of contiguous active landbase in different patch size classes for each sub-region and caribou range. These are also displayed in Figure 6 through Figure 9. The patch shape index is the perimeter of the patch, divided by the perimeter of a circle of the same area, and is a relative measure of the perimeter of each patch. Patches with a higher shape index (i.e., more perimeter), will have a greater buffered area when harvested for calculating disturbance metrics.

The Berland and Chinchaga sub-regions have a much greater percentage of the landbase area in large patches, compared to the Wandering River sub-region. This makes it simpler to aggregate harvest in these sub-regions, and to achieve larger patch sizes.

Table 3. Active landbase patch size summary of each sub-region.

Subregion	Caribou Range	Patch Size Class	# of Patches	Area (ha)	% Area	Average Patch Shape Index
Berland	A La Peche Winter	0 - 20	542	3,163	3	1.20
		20 - 50	100	3,093	3	1.77
		50 - 100	46	3,138	3	2.09
		100 - 250	42	9,216	9	2.86
		500 - 1000	18	13,705	14	4.56
		1000 - 2000	9	12,644	13	5.57
		2000+	5	55,199	55	12.92
	Little Smoky	0 - 20	1,750	10,034	7	1.19
		20 - 50	241	7,601	5	1.77
		50 - 100	114	8,108	5	2.11
		100 - 250	174	38,661	25	2.98
		500 - 1000	32	21,857	14	4.50
		1000 - 2000	13	18,214	12	6.70
		2000+	15	47,755	31	8.74
Chinchaga	Chinchaga	0 - 20	7,710	44,104	7	1.20
		20 - 50	1,049	32,784	5	1.84
		50 - 100	347	24,399	4	2.31
		100 - 250	374	79,697	13	3.19
		500 - 1000	59	38,703	6	4.74
		1000 - 2000	38	55,665	9	6.75
		2000+	34	326,079	54	12.51
Wandering River	East Side Athabasca	0 - 20	6,494	37,172	17	1.20
		20 - 50	772	24,470	11	1.82
		50 - 100	299	21,439	10	2.28
		100 - 250	306	60,151	28	3.00
		500 - 1000	35	23,501	11	4.80
		1000 - 2000	22	30,162	14	6.29
		2000+	5	17,643	8	10.32

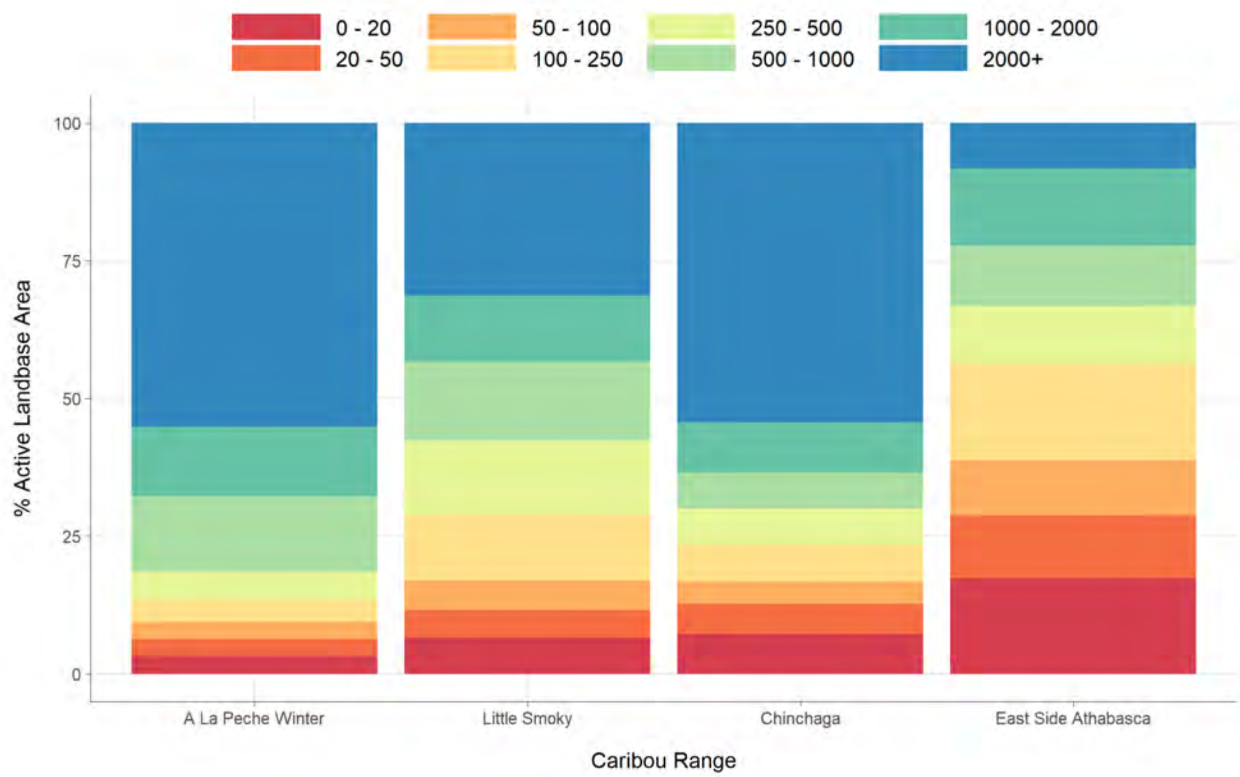


Figure 6. Percentage of the active landbase within each patch size class for each caribou range.

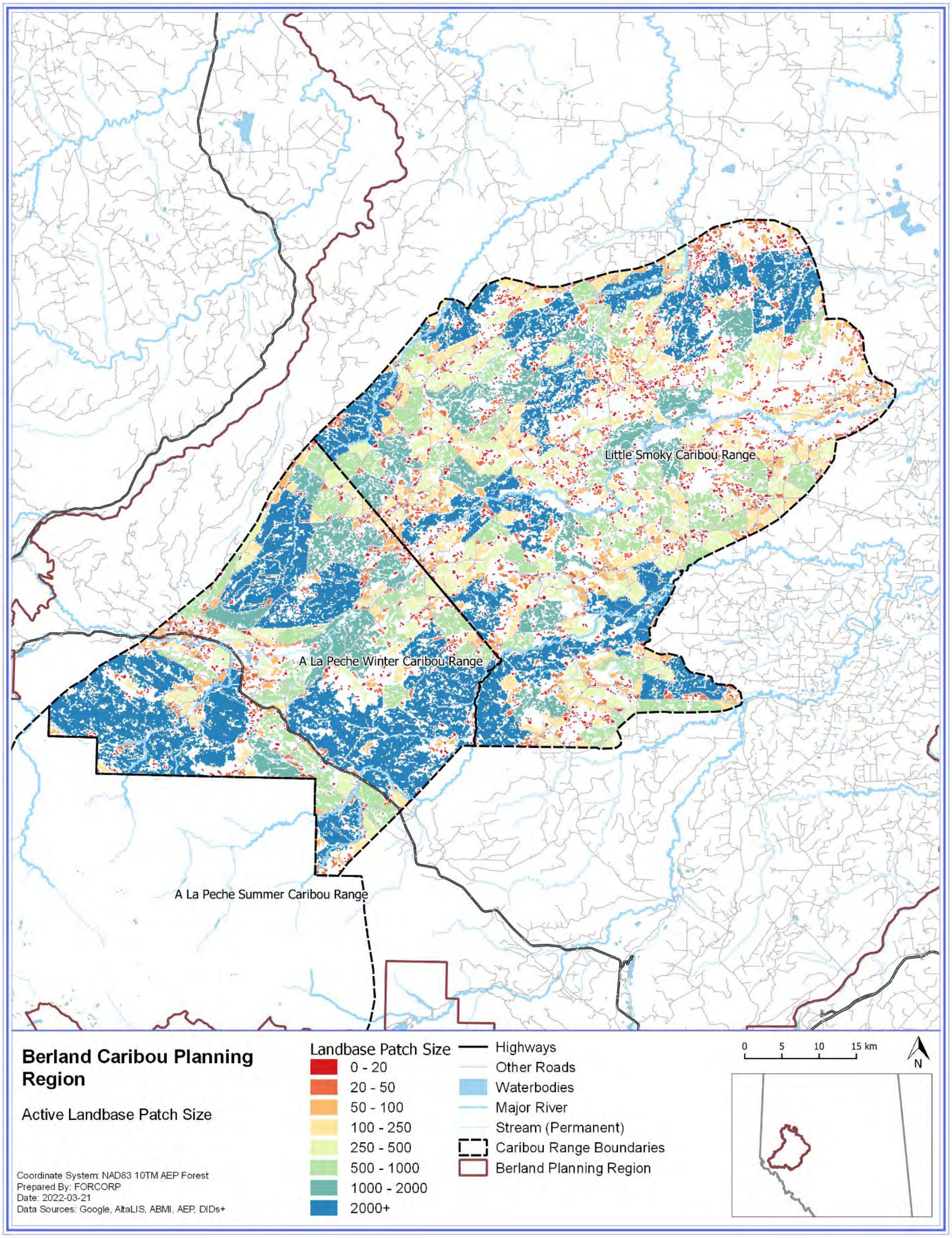


Figure 7. Active landbase patch size in the Berland caribou planning sub-region.

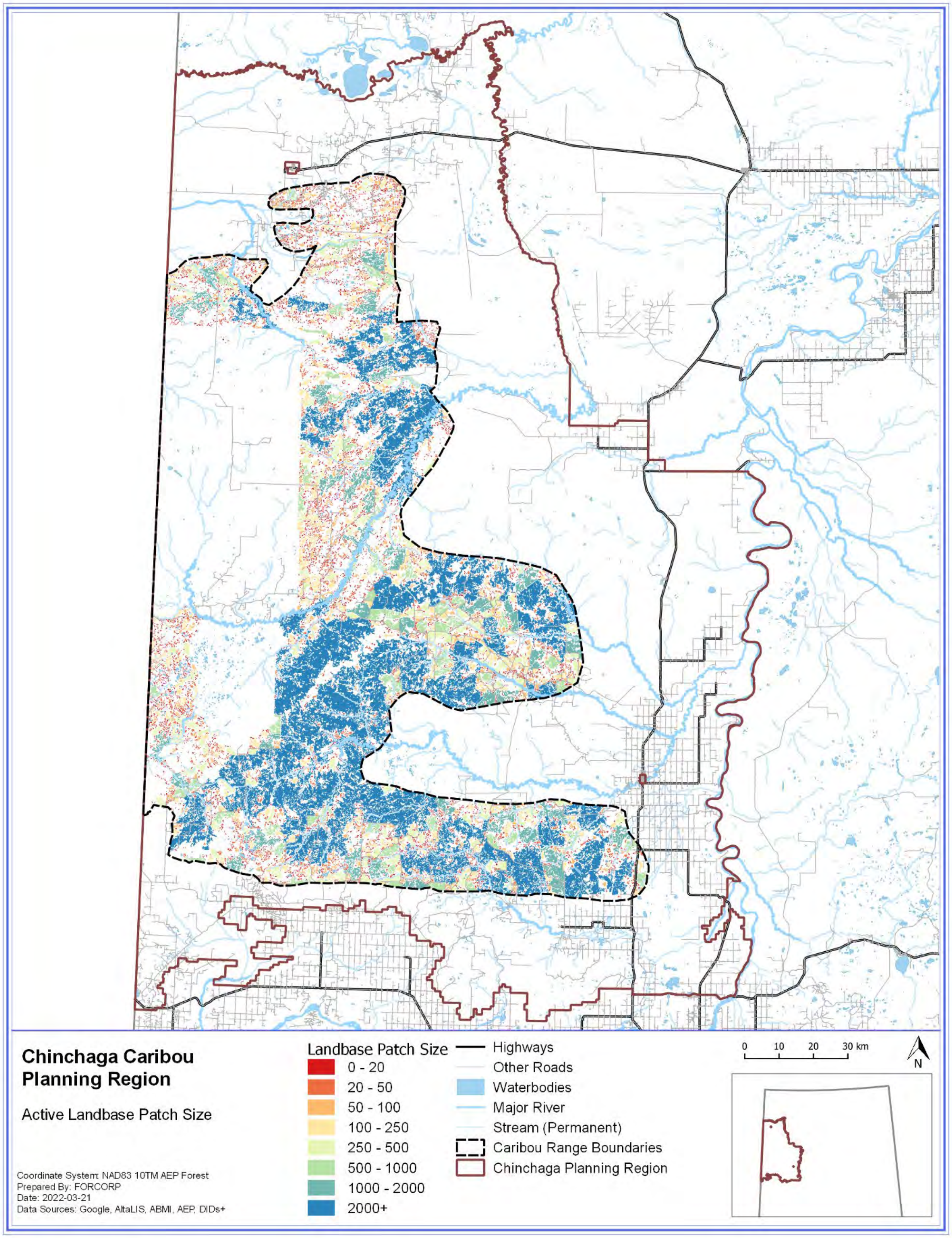


Figure 8. Active landbase patch size in the Chinchaga caribou planning sub-region.

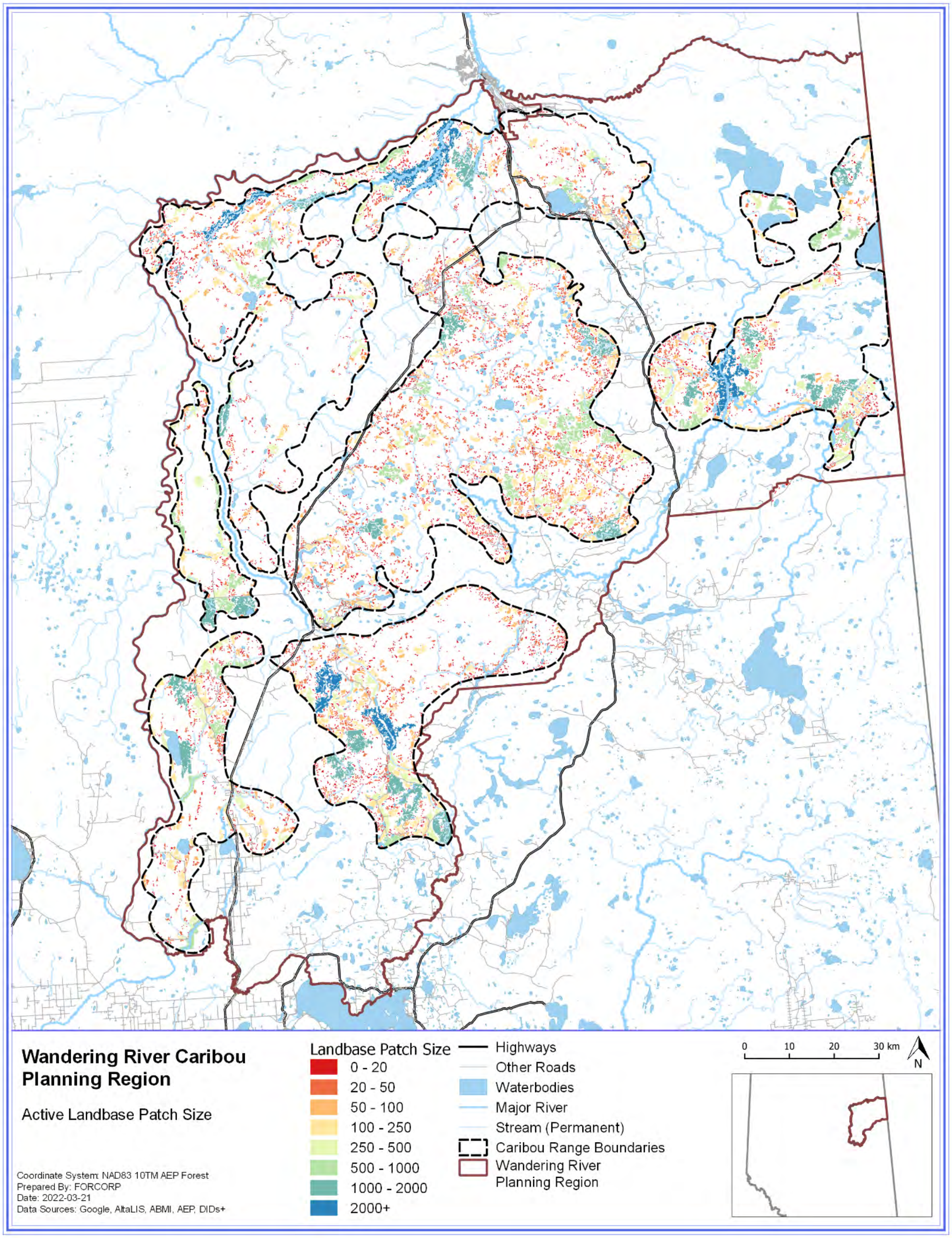


Figure 9. Active landbase patch size in the Wandering River caribou planning sub-region.

4.2 Scenarios

A total of eight scenarios were developed for each sub-region. These examined the impact of aggregation, timing, and access constraints on metrics like timber harvest levels, the amount of undisturbed and biophysical habitat available, and the size, shape, connectivity, and distribution of disturbance events in the planning sub-regions. When needed, additional scenarios were completed to determine what would be required to achieve the federal disturbance target of >65% undisturbed habitat in each caribou range. Table 4 summarizes the scenarios used in each sub-region and provides a brief description of the targets and/or constraints applied. Each scenario had a 100-year planning horizon.

Each sub-region began with a baseline scenario (BASE). These were developed by looking at the patch size distribution (i.e., % of harvest area in various patch size classes) of the previous forty years of harvesting within each sub-region. We then developed a scenario with targets to achieve a similar patch size distribution as the historical harvesting, and to determine the maximum AAC while maintaining this distribution. The baseline scenario represents the BAU approach, where there is no separate control of harvest patches within or outside the caribou range. This is not intended to represent current AACs or harvest patterns for the sub-regions. It is not practical to compare to the current harvest levels because multiple tenures overlap with the sub-regions, and the sub-region boundaries do not match the boundaries of the FMUs they are within, which is the scale at which current AAC levels are calculated. Our process also used provincial yield curves, whereas AAC levels in each FMA/FMU are determined by more localized yield curves. Furthermore, the baseline scenario is not subject to the same rigor and review as a forest management plan and is likely overestimating the harvest volume that could be approved in a forest management plan.

Four scenarios were then evaluated in each sub-region across a gradient of small to very large harvest patch sizes within the caribou range (S, M, L, and VL), to determine the effects of aggregated harvesting.

Scenario ROAD in each sub-region had the road building and maintenance constrained compared to the other scenarios to determine the effects of reducing access on harvest levels in caribou ranges.

Scenarios EVEN and DECADE in each sub-region compared the impact of having even-flow harvest from the caribou range through time versus aggregating harvest from the caribou range into only a few decades. The decades used to aggregate harvesting for scenario DECADE were determined subjectively by identifying three or four decades in other scenarios that had relatively more harvest within the caribou range. All harvest within the caribou range was then pushed into those selected decades, and no harvesting was permitted in other decades.

An additional scenario was completed for the Berland sub-region (BERR_FORCE65) and the Chinchaga sub-region (CHINR_FORCE65) to determine what patch distribution and harvest levels would be required to achieve > 65% undisturbed habitat in each caribou range by year 100, as none of the other scenarios achieved the federal disturbance target.

All scenarios had even-flow harvesting for the entire sub-region, except for scenarios BERR_DECADE, CHINR_DECADE, where the temporal aggregation of harvesting within the caribou range caused there to be slightly variable harvest levels. All scenarios also had a constraint applied to maintain Black Throated Green Warbler habitat suitability levels to >= 70% of the initial level throughout the 100-year planning horizon. This was added as all scenarios in the Berland sub-region went below the 70% risk threshold if the model was not constrained, and some scenarios in Chinchaga and Wandering River also approached or went below the 70% threshold if left unconstrained.

Table 4. Scenario summary by sub-region.

Sub-Region	Scenario Name	Description
Berland	BERR_BASE	Baseline scenario, patch size ranges determined by historical harvesting in subregion. No separate control of patches in vs. out of caribou range.
	BERR_S	Target small patches in caribou range.
	BERR_M	Target small to moderate patches in caribou range.
	BERR_L	Target moderate to large patches in caribou range.
	BERR_VL	Target very large patches in caribou range.
	BERR_ROAD	Target large to very large patches in caribou range, use constraints to reduce road building and maintenance to attempt to aggregate harvest.
	BERR_EVEN	Target large to very large patches in caribou range, even flow harvest from the caribou range through time.
	BERR_DECADE	Target large to very large patches in caribou range. Aggregate harvesting in the caribou range into a few decades.
	BERR_FORCE65	Target very large patches in caribou range. Achieve > 65% undisturbed in all caribou ranges by year 100.
Chinchaga	CHINR_BASE	Baseline scenario, patch size ranges determined by historical harvesting in subregion. No separate control of patches in vs. out of caribou range.
	CHINR_S	Target small patches in caribou range.
	CHINR_M	Target small to moderate patches in caribou range.
	CHINR_L	Target moderate to large patches in caribou range.
	CHINR_VL	Target very large patches in caribou range.
	CHINR_ROAD	Target large to very large patches in caribou range, use constraints to reduce road building and maintenance to attempt to aggregate harvest.
	CHINR_EVEN	Target large to very large patches in caribou range, even flow harvest from the caribou range through time.
	CHINR_DECADE	Target large to very large patches in caribou range. Aggregate harvesting in the caribou range into a few decades.
	CHINR_FORCE65	Target very large patches in caribou range. Achieve > 65% undisturbed in all caribou ranges by year 100.
Wandering River	WRR_BASE	Baseline scenario, patch size ranges determined by historical harvesting in subregion. No separate control of patches in vs. out of caribou range.
	WRR_S	Target small patches in caribou range.
	WRR_M	Target small to moderate patches in caribou range.
	WRR_L	Target moderate to large patches in caribou range.
	WRR_VL	Target very large patches in caribou range.
	WRR_ROAD	Target large to very large patches in caribou range, use constraints to reduce road building and maintenance to attempt to aggregate harvest.
	WRR_EVEN	Target large to very large patches in caribou range, even flow harvest from the caribou range through time.
	WRR_DECADE	Target large to very large patches in caribou range. Aggregate harvesting in the caribou range into a few decades.

4.3 Harvest Levels

Scenarios were completed for the Berland, Chinchaga, and Wandering River Sub-Regional Planning Areas with targets for a range of patch sizes and constraints on harvest timing and access requirements. Each scenario was broken down by the total volume of conifer and deciduous harvest. They were then further broken down by the total volumes of conifer and deciduous both inside and outside of each caribou range within the sub-region. Spatial harvest sequence maps for all scenarios within each sub-region can be found in Appendix I.

The following conclusions can be drawn from the modeling results:

- BAU harvest levels will not achieve caribou habitat objectives in any sub-region.
- Regardless of aggregation targets or constraints, the harvest volume in m^3/ha begins to decline steadily at year 50-60 in all sub-regions. This is accompanied with a reduction in average harvest age and is likely due to the model moving into second rotation, resulting in harvest of younger stands with less growing stock.
- Harvest aggregation typically causes harvest levels to decrease from baseline levels, with increasing patch size corresponding to decreasing volume. This is likely caused by increased area harvested at less-than-optimal ages, which reduces the volumes available in the stand at harvest, and also by reducing the area of landbase available for harvest, by preventing harvesting in smaller patches of active landbase.
- Whether reduced harvest levels within ranges can be compensated for in part by increased harvest levels outside the range is dependent on the conditions of the planning area; however, the volume loss cannot be fully compensated for in any of the scenarios or sub-regions.
- The impacts of timing and access restrictions differ by sub-region and are more variable than aggregation results.

Overall, there is a negative relationship between patch size and timber volume, though volume outputs show a nominal increase when small patches are targeted. Reduced harvest within caribou ranges can only be minimally compensated for by increasing harvest outside of ranges and this varies by sub-region. The impacts of timing and access constraints also vary by sub-region, though the scenario introducing road building and maintenance constraints typically resulted in the lowest volume.

4.3.1 Berland Sub-Regional Planning Area

Harvest Volume Overview

Table 5 shows the volume of coniferous and deciduous timber harvested annually for each scenario in the Berland sub-region, and Figure 10 visualizes the conifer and deciduous harvest levels within and outside the caribou range. Introducing patch size targets and harvesting constraints had a more significant impact on total coniferous volume than total deciduous volume for the area, as most of the deciduous volume comes from outside the caribou ranges.

Compared to the baseline scenario (BERR_BASE), scenario BERR_S (small patches in the caribou range) achieves a similar harvest level, after which volume decreases steadily as the target patch size increases in subsequent scenarios. This is mainly due to reduced harvest volume from within the caribou range

The scenario directing the model to achieve >65% undisturbed habitat (BERR_FORCE65) results in the lowest overall conifer volume at 1,115,852 m^3 per year (81% of baseline level). With the exception of a slight decrease in harvested conifer outside of the caribou range in the scenario targeting small-moderate patches (BERR_M), conifer harvesting outside of caribou ranges remains fairly consistent in the first eight scenarios.

The baseline scenario resulted in the highest deciduous volume output at 829,830 m^3 per year, and the scenarios targeting small and small-moderate patches had similar volumes. The total harvested deciduous volume remains fairly consistent across each scenario with the largest reduction seen in the scenario introducing access constraints (BERR_ROAD), which dropped deciduous harvest levels to 730,061 m^3 per year (88% of baseline level).

In order to meet federal disturbance targets (met only by scenario BERR_FORCE65, see Section 4.4.1) total conifer harvest would have to decrease to 81% of the baseline level, and conifer harvest within the caribou ranges would need to decrease to 37% of the baseline level. This is somewhat compensated for in the model by increasing the harvest level outside the caribou range. Total deciduous harvest would have to decrease to 96% of the baseline level, dropping to 38% of baseline within the ranges.

Table 5. Harvest levels by scenario in the Berland Sub-Regional Planning Area (m^3/year and percentage of baseline level).

	Conifer						Deciduous					
	Outside Range		Inside Range		Total		Outside Range		Inside Range		Total	
Scenario	m^3/year	% of baseline	m^3/year	% of baseline	m^3/year	% of baseline	m^3/year	% of baseline	m^3/year	% of baseline	m^3/year	% of baseline
BERR_BASE	857,437	100	512,571	100	1,370,009	100	757,058	100	72,772	100	829,830	100
BERR_S	861,193	100	508,836	99	1,370,029	100	756,446	100	71,971	99	828,417	100
BERR_M	764,698	89	435,906	85	1,200,604	88	764,479	101	64,365	88	828,844	100
BERR_L	809,057	94	343,110	67	1,152,167	84	754,606	100	49,626	68	804,232	97
BERR_VL	843,916	98	291,885	57	1,135,800	83	763,715	101	41,236	57	804,952	97
BERR_ROAD	799,263	93	295,056	58	1,094,320	80	688,518	91	41,544	57	730,061	88
BERR_EVEN	806,596	94	273,387	53	1,079,983	79	761,417	101	40,489	56	801,906	97
BERR_DECADE	829,535	97	331,776	65	1,161,311	85	740,363	98	47,056	65	787,419	95
BERR_FORCE65	925,062	108	190,790	37	1,115,852	81	770,989	102	27,759	38	798,748	96

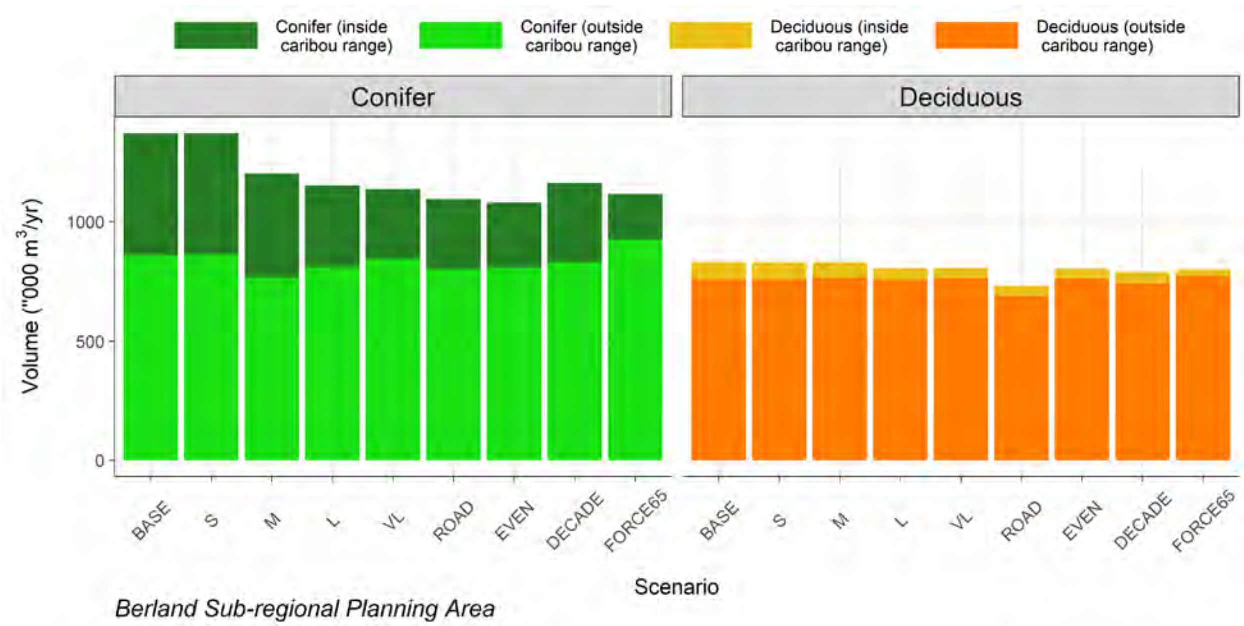


Figure 10. Harvest volume by scenario in the Berland Sub-Regional Planning Area (100 year average).

Harvest Levels and Age

Volume levels in m^3/ha peak at year 50 for most scenarios and at year 60 for scenarios BERR_L and BERR_DECADE. This indicates that targeting moderate-large patches and aggregating harvest timing may slightly delay volume declines (Figure 11). The decline over the last 40-50 years is accompanied by a decline in average harvest age (Figure 12). The baseline scenario (BERR_BASE) and scenarios targeting smaller patch sizes (BERR_S) typically harvest higher volume stands, with the scenario constraining access (BERR_ROAD) and forcing the model to reach disturbance targets (BERR_FORCE65) also performing well until year 50. Scenario results are different for deciduous outputs, with the most heavily constrained scenario (BERR_FORCE65) harvesting higher volume stands until year 50, at which point the volume in BERR_L increases and the volume in BERR_FORCE65 decreases. Conifer volumes show a sharper decline over the planning horizon than deciduous volumes. By year 80, conifer volumes are similar for all scenarios while deciduous volumes remain slightly more variable.

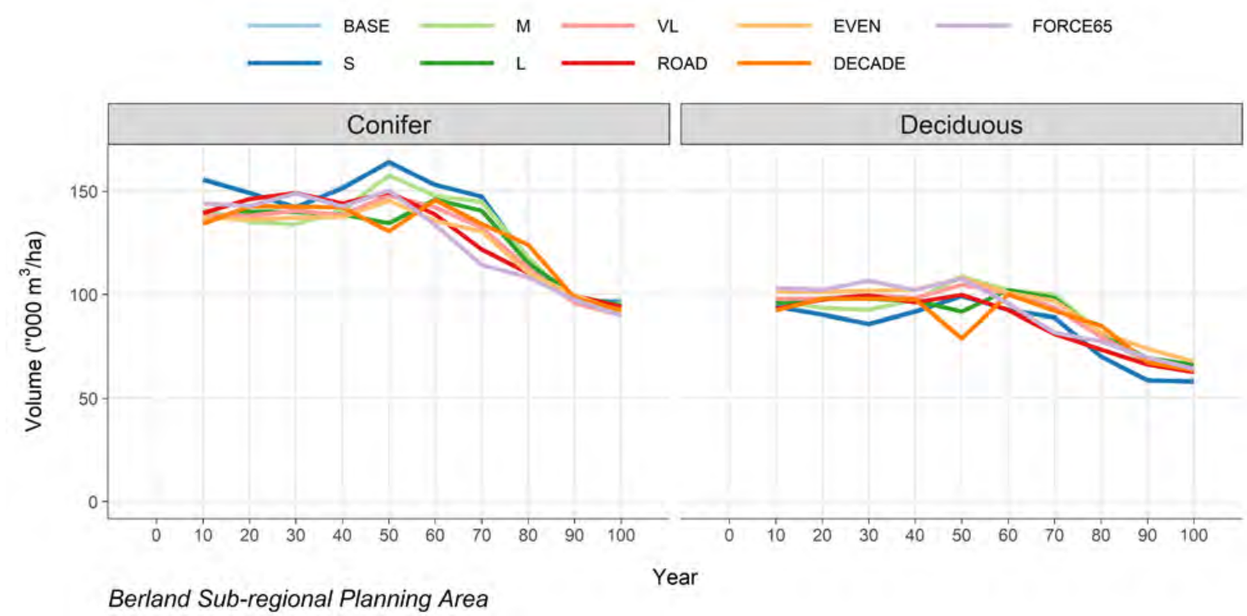


Figure 11. Harvest volume (m³/ha) by decade in the Berland Sub-Regional Planning Area (0-100 years).

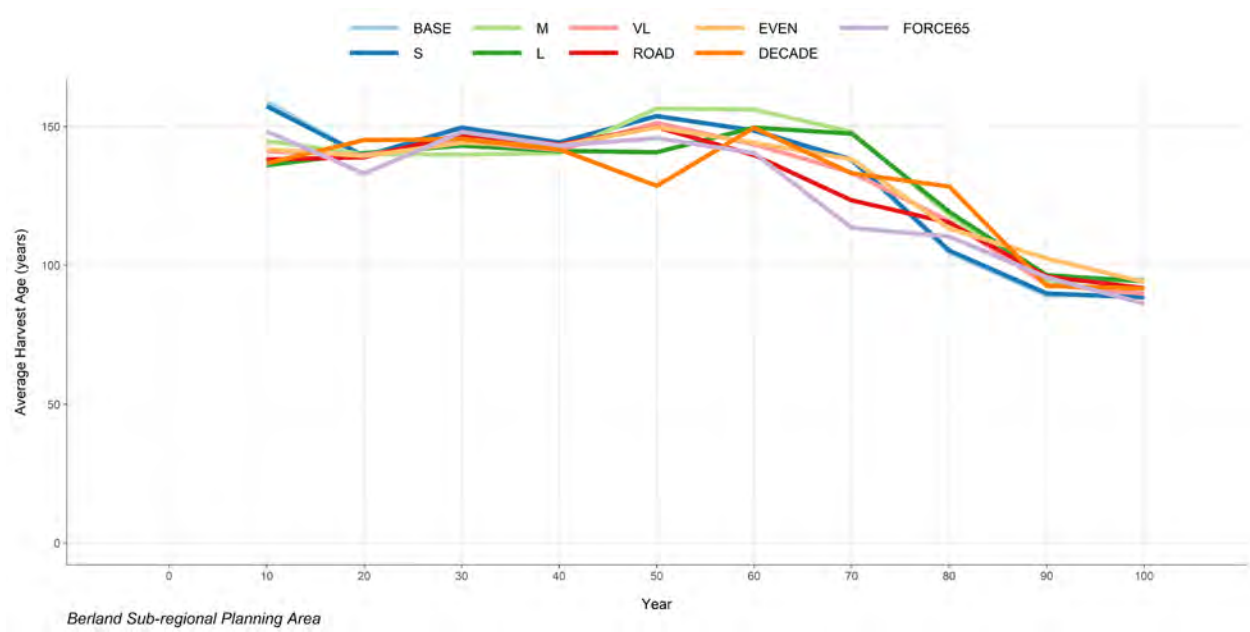


Figure 12. Average harvest age by decade in the Berland Sub-Regional Planning Area (0-100 years).

Harvest Patch Size Distribution

Figure 13 displays the harvest patch size distribution by scenario in both the greater Berland sub-region and within the Little Smoky and A La Peche winter caribou ranges. The total harvested area decreases in both the sub-region and within caribou ranges moving from BAU toward very large patch targets. The BAU (BERR_BASE) and small patch scenarios (BERR_S) result in the largest harvested areas. The scenario directing the model to achieve >65% undisturbed habitat (BERR_FORCE65) results in the smallest area being harvested within the caribou ranges while the scenario introducing access constraints (BERR_ROAD) results in the smallest area being harvested in the overall sub-region.

The baseline scenario results in close to 50% of the harvest area within caribou ranges being composed of patches 0-20 ha in size. Patch size distribution is heavily skewed towards smaller patch sizes. In contrast, the area harvested within the entire sub-region has a fairly even distribution of different sized patches, with patches sized 100-250 ha making up the greatest proportion of area harvested and patches >2,000 ha making up the lowest proportion.

As scenarios move towards higher levels of aggregation and additional constraints are introduced, a significant proportion of harvested area within the caribou ranges is composed of patches greater than 2,000 ha in size. BERR_FORCE65 results in the greatest percentage of area within the caribou ranges being harvested in patches >2,000 ha, and there are no patches less than 250 ha in size. In scenarios BERR_VL through BERR_DECADE, over 50% of the area composed of patches at least 1,000 ha in size. Scenario BERR_FORCE65, which achieves > 65% undisturbed in the caribou range (see Section 4.4.1), had over 60% of its harvested area in patches >2,000 ha in size.

Aggregating harvest within the caribou range does not have a substantial effect on the patch size distribution in the entire Berland sub-region, as the portion outside the range is much larger than the caribou ranges. The area harvested in patches >2,000 ha increases as patch sizes in the caribou range increase, but other patch size classes remain relatively consistent between the scenarios. The proportion of both very small (0-20 ha) and very large (>2,000) patches increases slightly in all scenarios compared to business as usual.

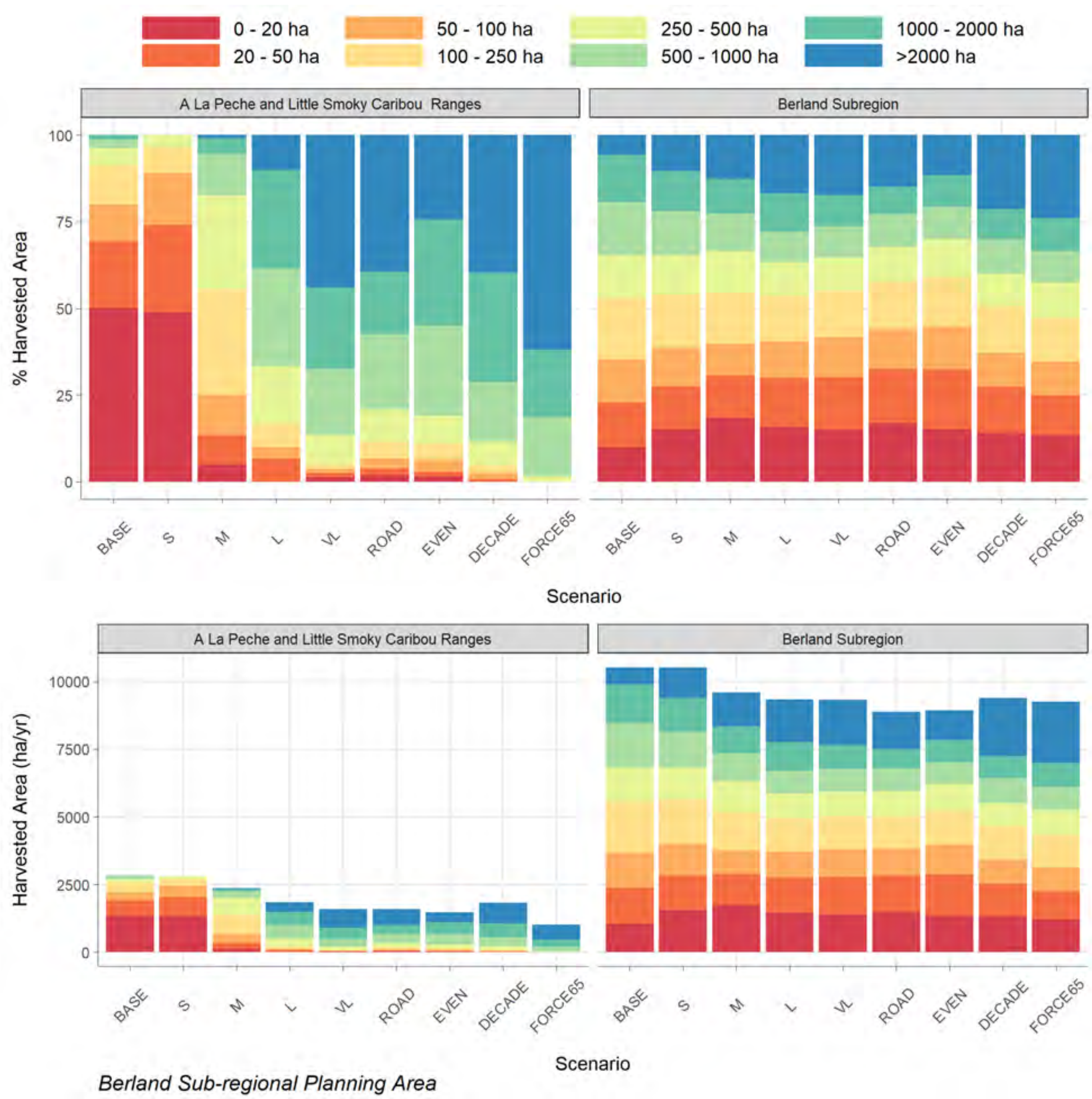


Figure 13. Harvest patch size distribution (ha/yr and %) by scenario in the Berland sub-region and Little Smoky and A La Peche winter caribou ranges.

4.3.2 Chinchaga Sub-Regional Planning Area

Harvest Volume Overview

Table 6 shows the volume of conifer and deciduous timber harvested annually in each scenario in the Chinchaga sub-region, and Figure 14 visualizes the conifer and deciduous harvest levels within and outside the caribou range. Introducing patch size targets and harvesting constraints had a more significant impact on total coniferous volume than total deciduous volume for the area, though the effect on deciduous volume is greater than observed in the Berland sub-region.

From the baseline scenario (CHINR_BASE), harvested volumes decrease as the target patch size increases. The baseline scenario results in the highest conifer volume output at 1,543,000 m^3 per year. While the conifer volume harvested outside the caribou range remains relatively consistent in all scenarios except for CHINR_ROAD, the conifer volume harvested within caribou ranges declines compared to previous scenarios when moderate to very large patch sizes are targeted (CHINR_L and CHINR_VL) and when access constraints are introduced (CHINR_ROAD). The scenario targeting large to very large patches and aggregating harvest in the caribou range into a few decades (CHINR_DECADE) results in the lowest overall conifer volume at 1,205,329 m^3 per year (78% of baseline) and access constraints also result in less volume than scenarios targeting patches of all sizes.

Deciduous volumes follow the same trend, with volume declining as patches move towards higher aggregation. The baseline scenario achieves the highest deciduous volume at 2,270,000 m^3 per year. The scenario with stricter access constraints (CHINR_ROAD) results in the lowest deciduous volume output at 1,982,989 m^3 year (84% of baseline).

In order to meet and maintain federal disturbance targets up to and including year 100 (met only by scenario CHINR_FORCE65, see Section 4.4.2), total conifer harvest would have to decrease to 78% of the baseline level, with a harvest level of 51% of the baseline level within the caribou range. Total deciduous harvest would have to decrease to 88% of the baseline level, dropping to 52% of baseline within the range.

Table 6. Harvest levels by scenario in the Chinchaga Sub-Regional Planning Area (m^3/year and percentage of baseline level).

	Conifer						Deciduous					
	Outside Range		Inside Range		Total		Outside Range		Inside Range		Total	
Scenario	m^3/year	% of baseline	m^3/year	% of baseline	m^3/year	% of baseline	m^3/year	% of baseline	m^3/year	% of baseline	m^3/year	% of baseline
CHINR_BASE	823,138	100	719,862	100	1,543,000	100	1,569,541	100	700,459	100	2,270,000	100
CHINR_S	823,564	100	719,409	100	1,542,974	100	1,569,952	100	700,012	100	2,269,964	100
CHINR_M	822,632	100	713,269	99	1,535,901	100	1,567,550	100	692,379	99	2,259,930	100
CHINR_L	838,038	102	555,169	77	1,393,207	90	1,618,984	103	526,977	75	2,145,961	95
CHINR_VL	807,786	98	468,668	65	1,276,455	83	1,587,683	101	434,995	62	2,022,678	89
CHINR_ROAD	732,965	89	465,325	65	1,198,290	78	1,441,128	92	458,976	66	1,900,104	84
CHINR_EVEN	836,837	102	459,441	64	1,296,278	84	1,627,723	104	432,687	62	2,060,410	91
CHINR_DECADE	806,108	98	365,773	51	1,171,881	76	1,521,909	97	476,725	68	1,998,633	88
CHINR_FORCE65	830,263	101	375,066	52	1,205,329	78	1,621,185	103	361,804	52	1,982,989	87

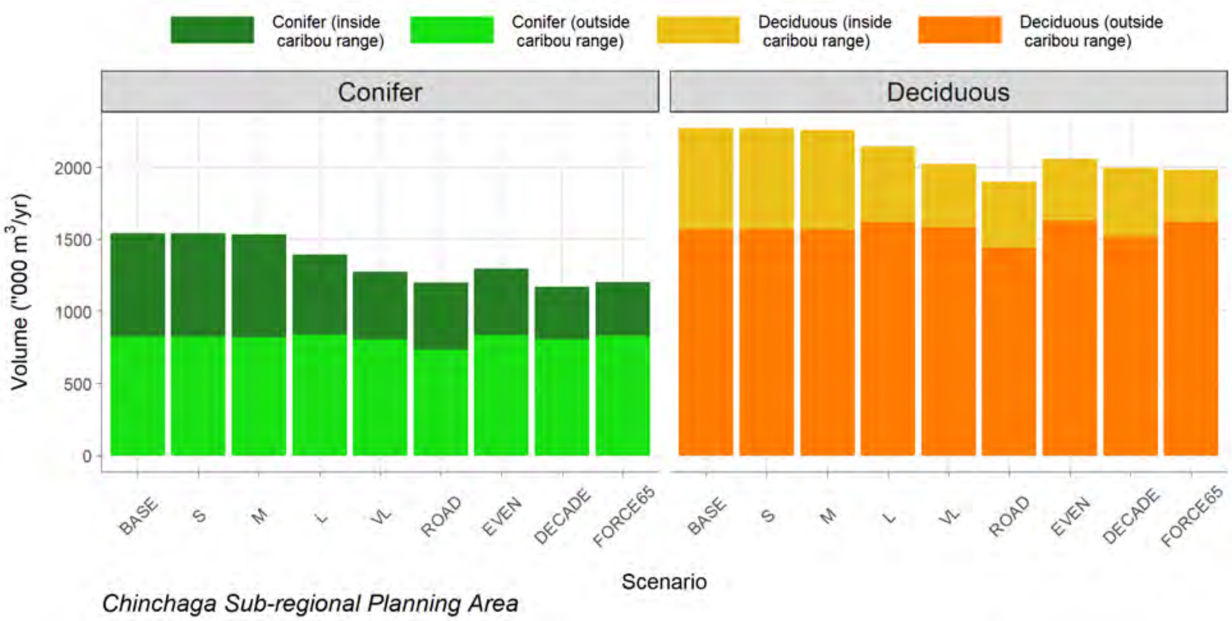


Figure 14. Harvest volume by scenario in the Chinchaga Sub-Regional Planning Area (100 year average).

Harvest Levels and Age

Harvest volume in m^3/ha peaks at year 50 for both conifer and deciduous in all scenarios before declining steadily (Figure 15), which is accompanied by a decline in average harvest age (Figure 16). The baseline scenario and scenarios targeting smaller patch sizes harvests higher volume stands than other scenarios output over the planning horizon, while the scenario aggregating harvest timing (CHINR_DECADE) harvests the lowest volume stands of any scenario. Conversely, by year 20 aggregating harvest timing (results in the model harvesting higher volume deciduous stands until year 70. Deciduous volumes show greater variability and a sharper decline over the planning horizon than coniferous volumes, with BAU and minimal aggregation consistently performing poorly over time.

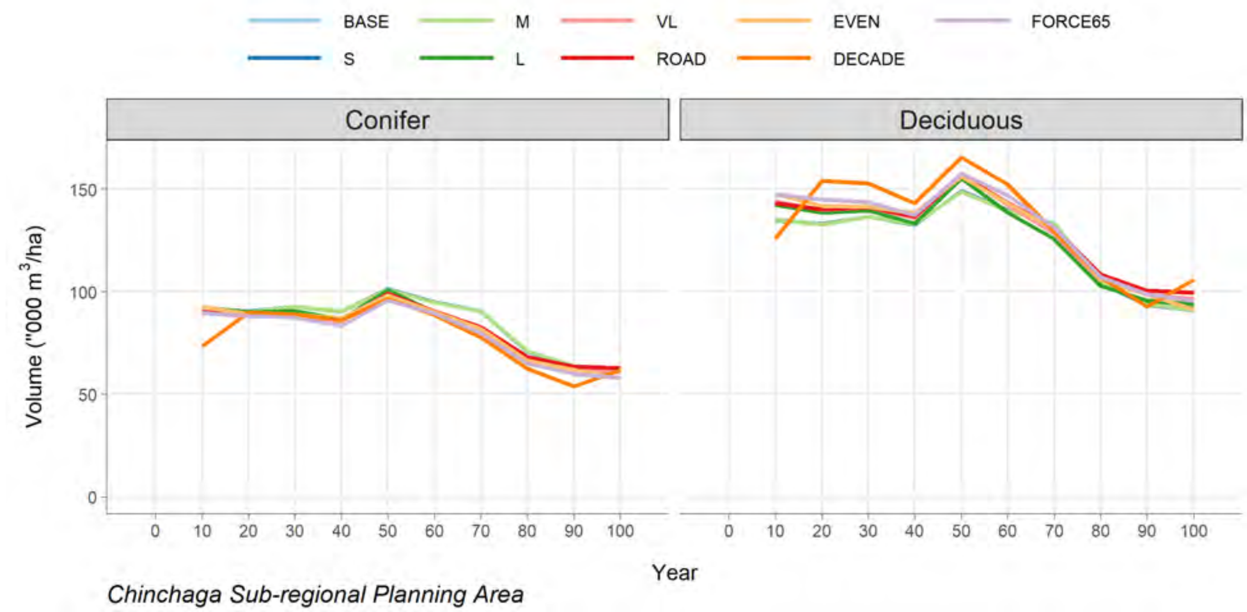


Figure 15. Harvest volume (m³/ha) by decade in the Chinchaga Sub-Regional Planning Area (0-100 years).

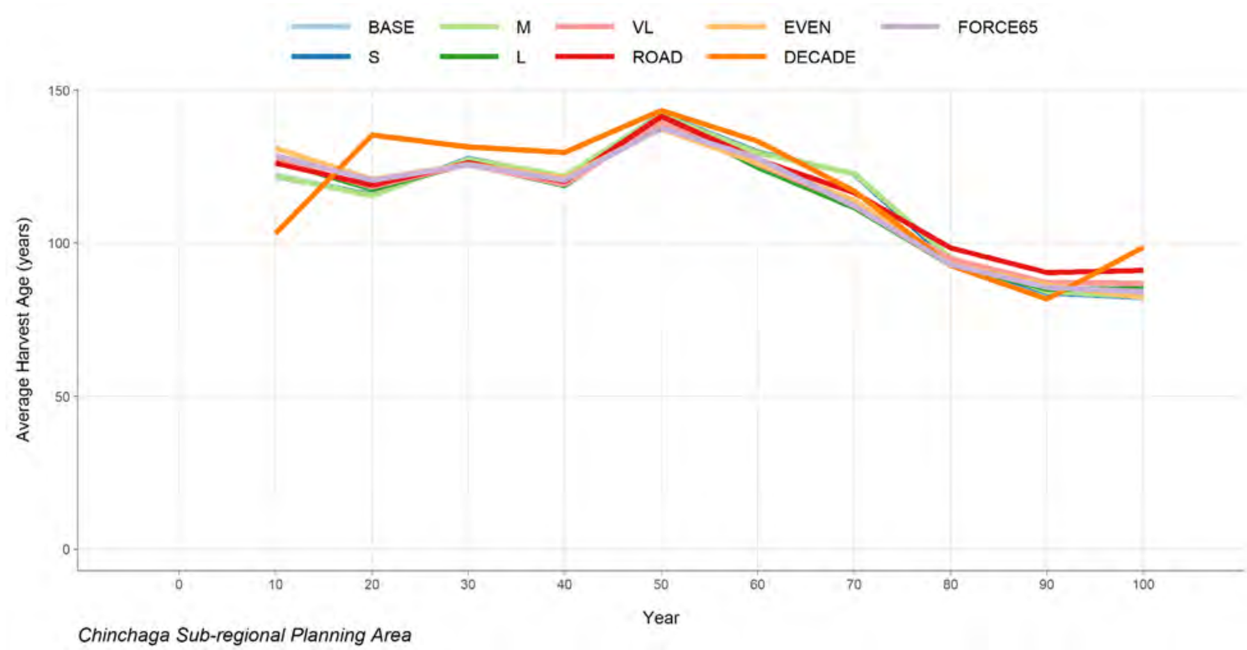


Figure 16. Average harvest age in the Chinchaga Sub-Regional Planning Area (0-100 years).

Harvest Patch Size Distribution

Figure 17 displays the harvest patch size distribution by scenario in both the greater Chinchaga sub-region and within the Chinchaga caribou range. The total harvested area decreases in both the sub-region and within the caribou range moving from BAU toward very large patch targets. The BAU (CHINR_BASE), small patch (CHINR_S), and small-moderate patch scenarios (CHINR_M) result in the largest harvested areas. The scenario directing the model to achieve >65% undisturbed habitat (CHINR_FORCE65) results in the smallest area being harvested within the Chinchaga caribou range while the scenario introducing access constraints (CHINR_ROAD) results in the smallest area being harvested in the overall sub-region. The scenario targeting even-flow harvest (CHINR_EVEN) results in a greater harvested area than aggregation alone both within the range and sub-region.

The baseline scenario results in approximately 20% of the harvest area within caribou range being composed of patches 0-20 ha in size. Patch size distribution is fairly balanced until patches reach 250-500 ha in size, when the proportion begins to decrease. In contrast, the area harvested within the Chinchaga sub-region has a more even distribution of patch size with patches sized 100-250 ha making up the largest portion in the BAU scenario.

As scenarios move towards higher levels of aggregation and additional constraints are introduced, a significant proportion of harvested area both within the caribou range and the sub-region is composed of patches greater than 2,000 ha in size. CHINR_EVEN results in the greatest area within the caribou range being harvested in patches >2,000 ha, at around 35%. For scenarios CHINR_L through CHINR_FORCE65, approximately 50-80% of the area within the caribou range is composed of patches at least 1,000 ha in size. Scenario CHINR_FORCE65 has no patches less than 250 ha in size within the caribou range.

Aggregating harvest within the caribou range does not have a substantial effect on the patch size distribution in the entire Chinchaga sub-region. The area harvested in patches >2,000 ha increases as patch sizes in the caribou range increase, but other patch size classes remain relatively consistent between the scenarios.

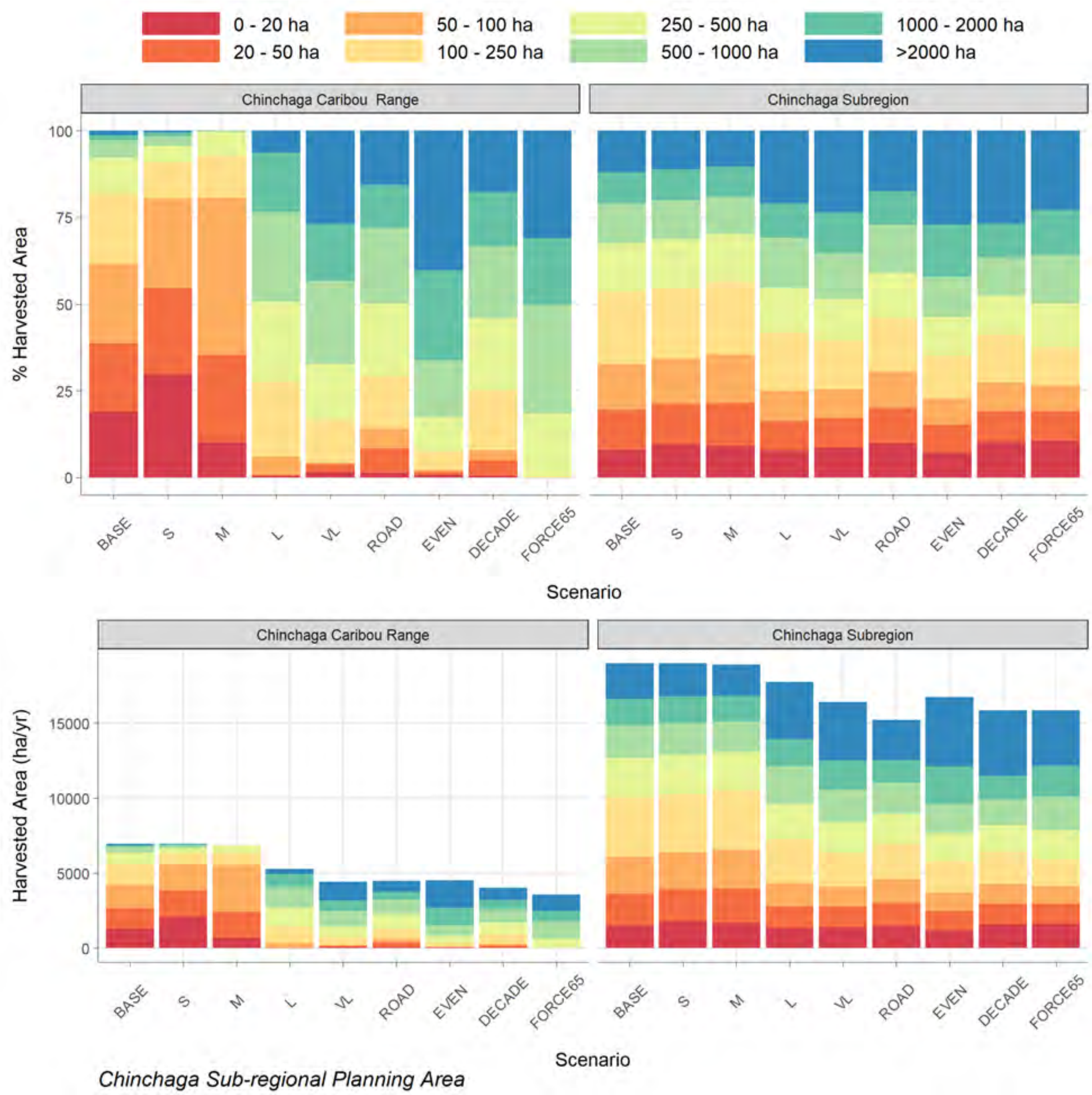


Figure 17. Harvest patch size distribution (ha/yr and %) by scenario in the Chinchaga sub-region and Chinchaga caribou range.

4.3.3 Wandering River Sub-Regional Planning Area

Harvest Volume Overview

Table 7 shows the volume of conifer and deciduous harvested annually for each scenario for the Wandering River sub-region, and Figure 18 visualizes the conifer and deciduous harvest levels within and outside the caribou range. Introducing patch size targets and harvesting constraints had a similar impact on total coniferous and deciduous volume for the area.

From the baseline scenario (WRR_BASE), there is a similar harvest level when targeting small patches in scenario WRR_S before volumes decrease steadily as the target patch size increases. The scenario aggregating harvest into very large patches (WRR_VL) results in the lowest overall conifer volume at 424,959 m^3 per year (81% of baseline). Decreases in harvest from the caribou range are slightly compensated for by increases from outside the caribou range in all scenarios expect for WRR_ROAD.

The total volume of harvested deciduous decreases as the target patch size increases in the caribou range. The baseline scenario results in the highest deciduous volume output at 749,936 m^3 per year. The introduction of access constraints in scenario WRR_ROAD results in the lowest deciduous volume output at 629,999 m^3 per year (84% of baseline). The baseline scenario resulted in the highest deciduous volume output, though the scenario targeting small patches was comparable.

In order to meet federal disturbance targets within 80 years (met by scenarios WRR_VL, WRR_ROAD, and WRR_DECADE, see Section 4.4.3), total conifer harvest would have to decrease to 81-86% of the baseline level with only 28-45% of baseline harvest occurring inside the caribou ranges. Total deciduous harvest would have to decrease to 84-87% of the baseline level, dropping to 33-54% of baseline within the range. Scenarios WRR_L and WRR_EVEN also meet > 65% undisturbed by year 90, with a total conifer harvest level of 84-85% of baseline with only 35-38% of baseline harvest occurring inside the caribou range, and a total deciduous harvest level of 86-87% of the baseline level, dropping to 35-39% of baseline within the range. Scenario BERR_M also comes very close to reaching > 65% undisturbed in year 100 (64.25%, Table 10), with 95% of the baseline conifer harvest level (67% of baseline within the range) and 93% of the baseline deciduous harvest level (63% of baseline within the range). Thus, it is likely that 65% undisturbed can be accomplished with higher harvest levels than those shown in scenarios WRR_L through WRR_DECADE.

Table 7. Harvest levels by scenario in the Wandering River Sub-Regional Planning Area.

	Conifer						Deciduous					
	Outside Range		Inside Range		Total		Outside Range		Inside Range		Total	
Scenario	m^3/year	% of baseline	m^3/year	% of baseline	m^3/year	% of baseline	m^3/year	% of baseline	m^3/year	% of baseline	m^3/year	% of baseline
WRR_BASE	337,668	100	187,329	100	524,997	100	540,609	100	209,327	100	749,936	100
WRR_S	339,751	101	185,258	99	525,009	100	541,628	100	208,131	99	749,760	100
WRR_M	373,748	111	125,535	67	499,283	95	568,610	105	131,023	63	699,633	93
WRR_L	375,025	111	66,183	35	441,208	84	573,812	106	80,734	39	654,546	87
WRR_VL	373,043	110	51,915	28	424,959	81	574,356	106	68,504	33	642,860	86
WRR_ROAD	335,115	99	99,885	53	435,000	83	516,607	96	113,393	54	629,999	84
WRR_EVEN	375,387	111	71,884	38	447,271	85	572,821	106	74,041	35	646,862	86
WRR_DECADE	366,423	109	83,516	45	449,939	86	549,856	102	100,234	48	650,091	87

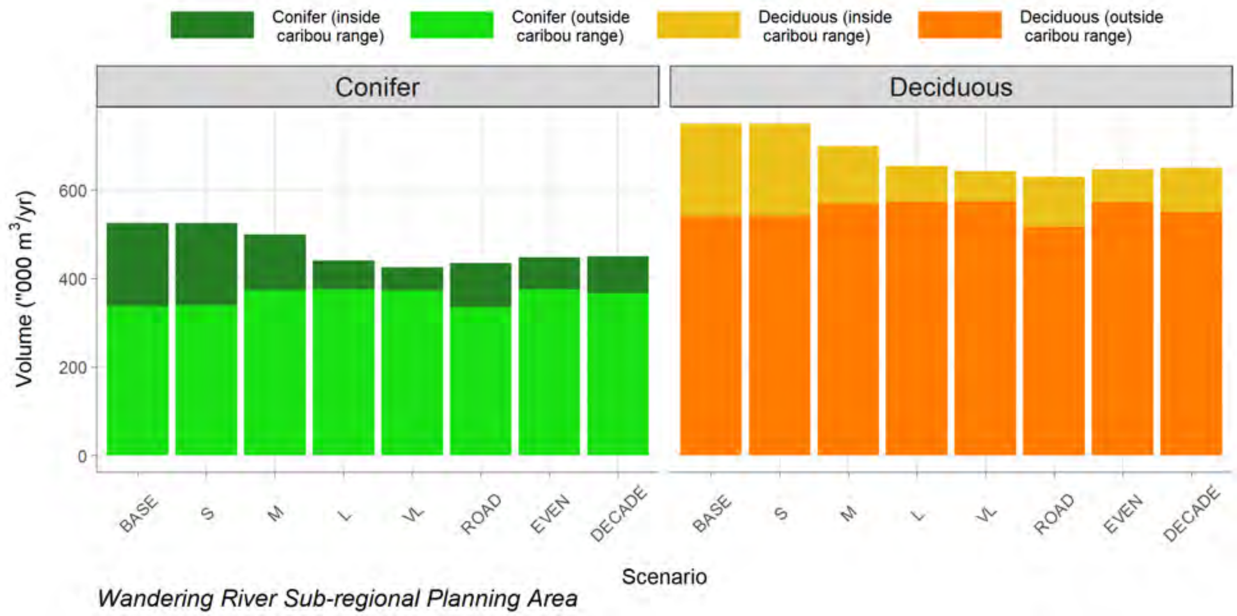


Figure 18. Harvest volume by scenario in the Wandering River Sub-Regional Planning Area (100 year average).

Harvest Levels and Age

Harvest volume in m^3/ha peaks at year 50 for both conifer and deciduous in all scenarios before declining steadily (Figure 19), which is accompanied with a decline in average harvest age (Figure 20). Scenario results are considerably less variable than in the other two sub-regions. Most scenarios perform similarly in terms of conifer volume outputs, with slightly more variable results for deciduous volumes. Overall, deciduous volumes show a slightly sharper decline over the planning horizon than coniferous volumes.

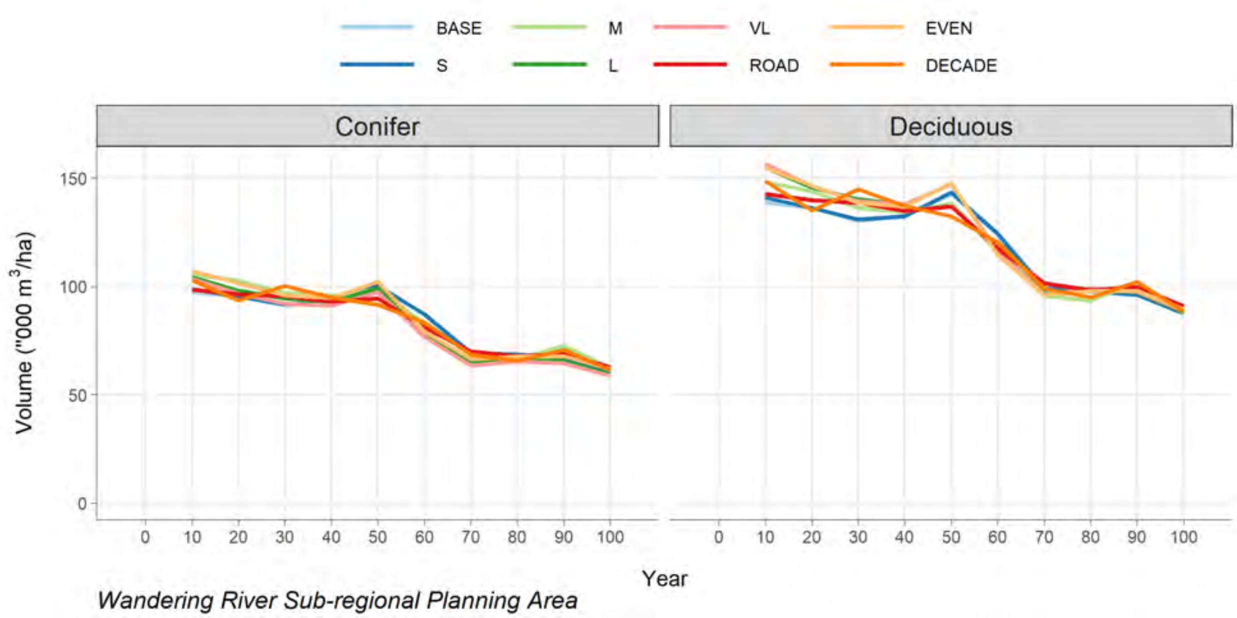


Figure 19. Harvest volume (m³/yr) by year in the Wandering River Sub-Regional Planning Area (0-100 years).

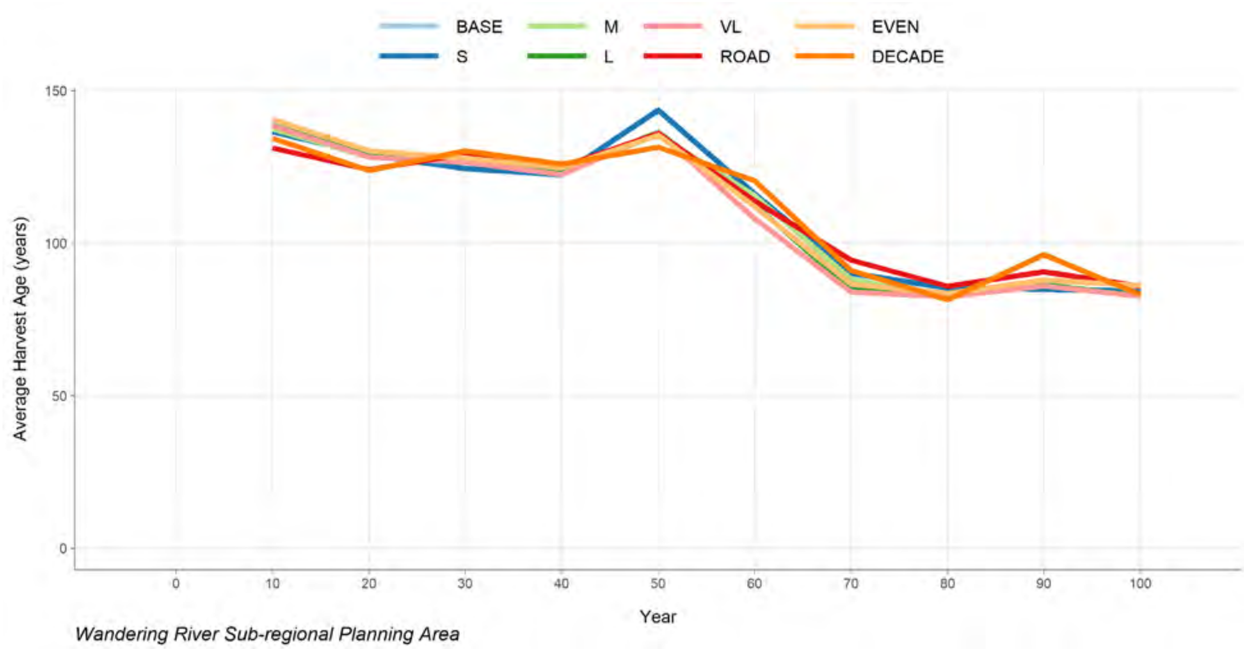


Figure 20. Average harvest age in the Wandering River Sub-Regional Planning Area (0-100 years).

Harvest Patch Size Distribution

Figure 21 displays the harvest patch size distribution by scenario in both the greater Wandering River sub-region and within the East Side Athabasca River caribou range. The total harvested area decreases in both the sub-region and within the caribou range moving from BAU toward very large patch targets. The BAU (WRR_BASE) and small patch scenarios (WRR_S) result in the largest harvested areas. The scenario targeting very large patches (WRR_VL) results in the smallest area being harvested within the East Side Athabasca River caribou range while the scenario with stricter access constraints (WRR_ROAD) results in the smallest area being harvested in the overall sub-region.

The baseline scenario and WRR_S have around 50% of the harvested area within the caribou range within patches 0-20 ha in size. Patch size distribution in the caribou range is heavily skewed towards smaller patches, with no patches >500 ha in size in these scenarios. In contrast, the area harvested within the Wandering River sub-region has a more even distribution of patch size though the majority of patches are still under 250 ha in size.

As scenarios move towards the higher levels of aggregation and additional constraints are introduced, a slightly higher proportion of harvested area in the sub-region is composed of patches greater than 1,000 ha in size (with the exception of WRR_EVEN). Only scenarios WRR_VL and WRR_DECADE have patches >2,000 ha being harvested within the caribou range, with WRR_VL having the greatest area being harvested in patches >1,000 ha.

There is less of an effect on patch size in the Wandering River sub-region, where the area harvested in patches >500 ha increases moderately as harvest within the caribou range is aggregated. Patches >2,000 ha increase slightly for most scenarios and the distribution of other patch sizes remain relatively consistent, with smaller patches constituting the majority of harvested areas.

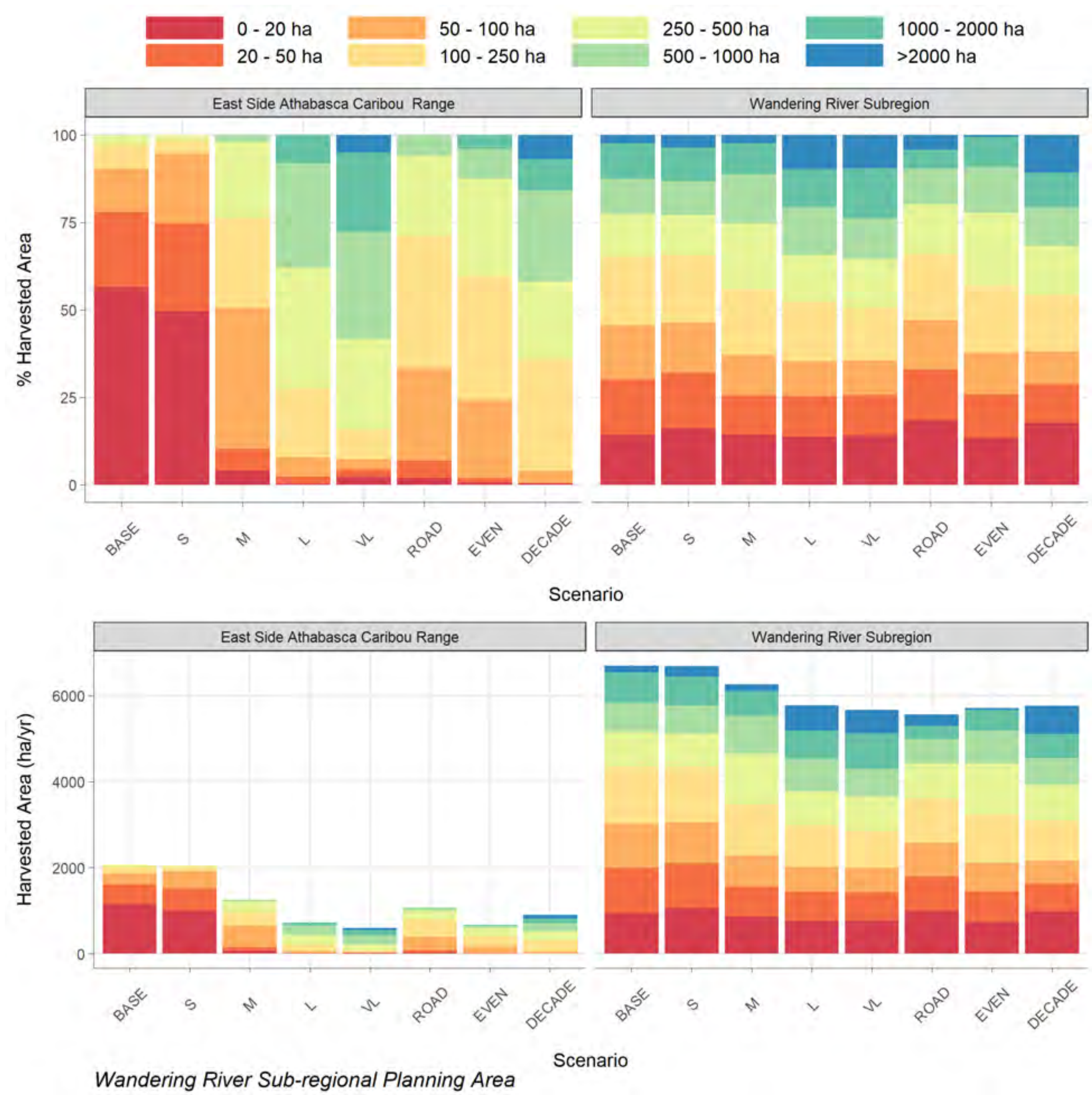


Figure 21. Harvest patch size distribution (ha/yr and %) by scenario in the Wandering River sub-region and East Side Athabasca caribou range.

4.4 Undisturbed Habitat

Anthropogenic disturbances within caribou ranges are buffered by 500 m to assess disturbance levels, as described in the boreal caribou range planning strategy. Disturbances and their associated buffers can be considered permanent or temporary. Permanent disturbances include highways, transmission lines, railways, and municipal infrastructure. Temporary disturbances are those that are expected to be reclaimed or revegetated in the future, with different types of disturbances impacting the landscape for varying amounts of time. Temporary disturbances and buffers may include resource roads (including temporary forestry roads), well pads, mines, industrial facilities, and pipelines, though roads are the most important temporary disturbance in the model for these sub-regions. Some existing roads and other temporary disturbances (e.g., pipelines, wellsites) are progressively reclaimed throughout the 100 years as described in Section 3.2.1. Harvest blocks can also be categorized as temporary disturbances, though they are considered separately in the model.

For this model, undisturbed habitat does not include seismic lines or wildfires. Seismic lines cover a significant portion of the current ranges and including them muddles the effects of harvest patch size changes. Stochastic natural disturbance events (i.e., wildfires and pest invasions) are difficult to predict and model. The model also keeps the percentage of permanently disturbed area even over the 100-year planning horizon and does not consider any additional infrastructure that may be built in the future. Reducing the amount of temporary and forestry buffers provides additional flexibility to accommodate future permanent disturbances. Undisturbed habitat maps for all scenarios within each sub-region can be found in Appendix II.

The following conclusions can be drawn from the modeling results:

- Disturbance due to forest harvesting increases in the near term for most scenarios in the Chinchaga and Wandering River sub-regions. This is due to historical natural disturbances (e.g., wildfires in the Chinchaga planning sub-region), and a history of avoiding harvesting within the caribou range as caribou range plans were being developed, resulting in age class distributions that force timber harvest into the older forest within the caribou ranges.
- It will be challenging to meet disturbance targets by year 100 in the Berland Sub-Regional Planning Area, which is currently highly disturbed.
- The federal disturbance target will not be met within 80 years for any of the modeled sub-regions under the modeled scenarios, at which point many of the existing industrial disturbances on the landscape are considered to be reclaimed.
- As harvest patch size increases, the percentage of undisturbed habitat increases due to a corresponding decrease in the total buffered area. Aggregating harvest results in significantly less forestry buffer area contributing to disturbance levels in caribou range(s).

Examples of the differences in harvest patterns and disturbance patterns achieved by small versus large patches (scenarios BERR_S and BERR_VL) in the Berland sub-region are shown in Figure 22 and Figure 23.

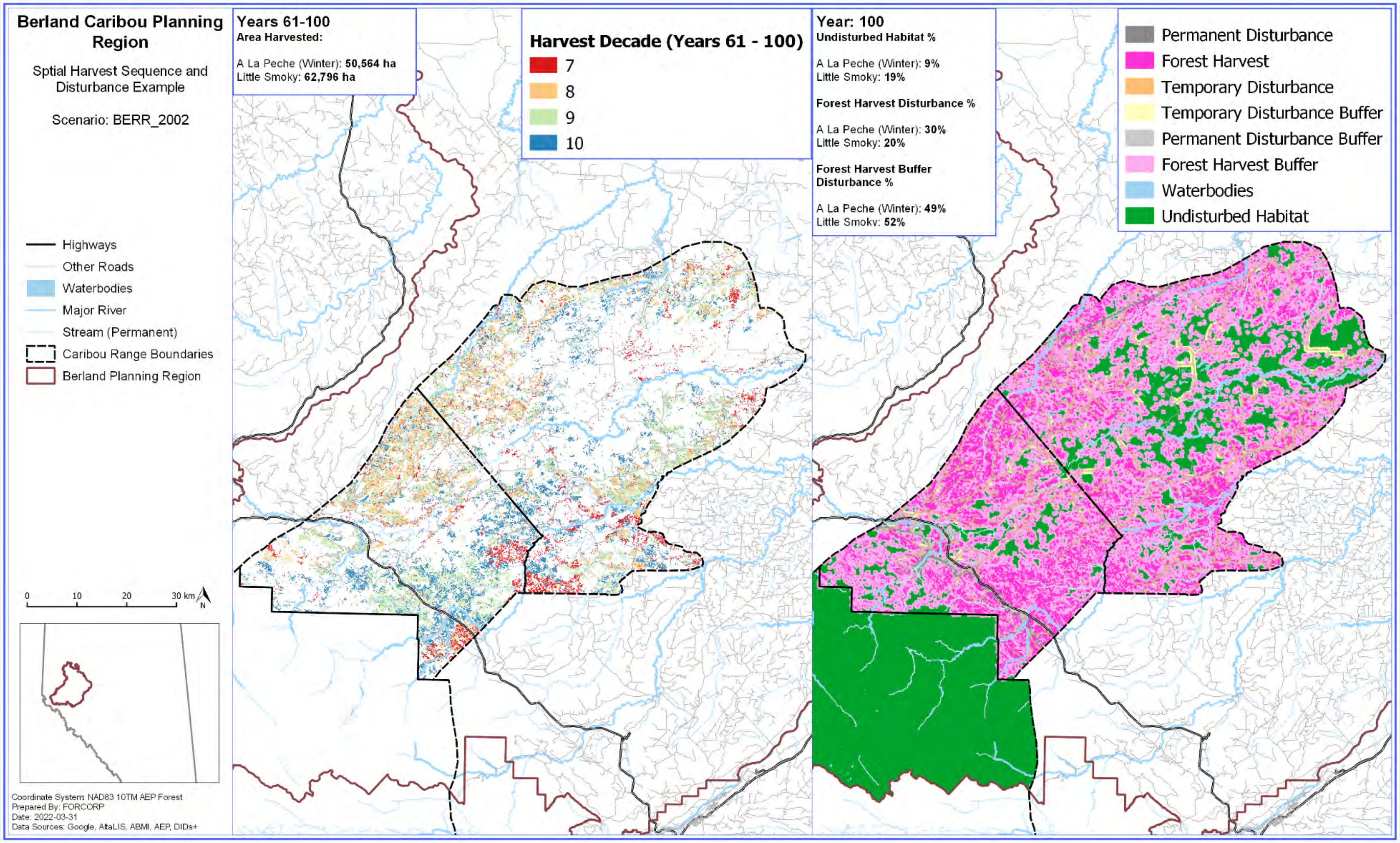


Figure 22. Spatial harvest sequence for the last four decades of BERR_S, and the resulting disturbance patterns at year 100.

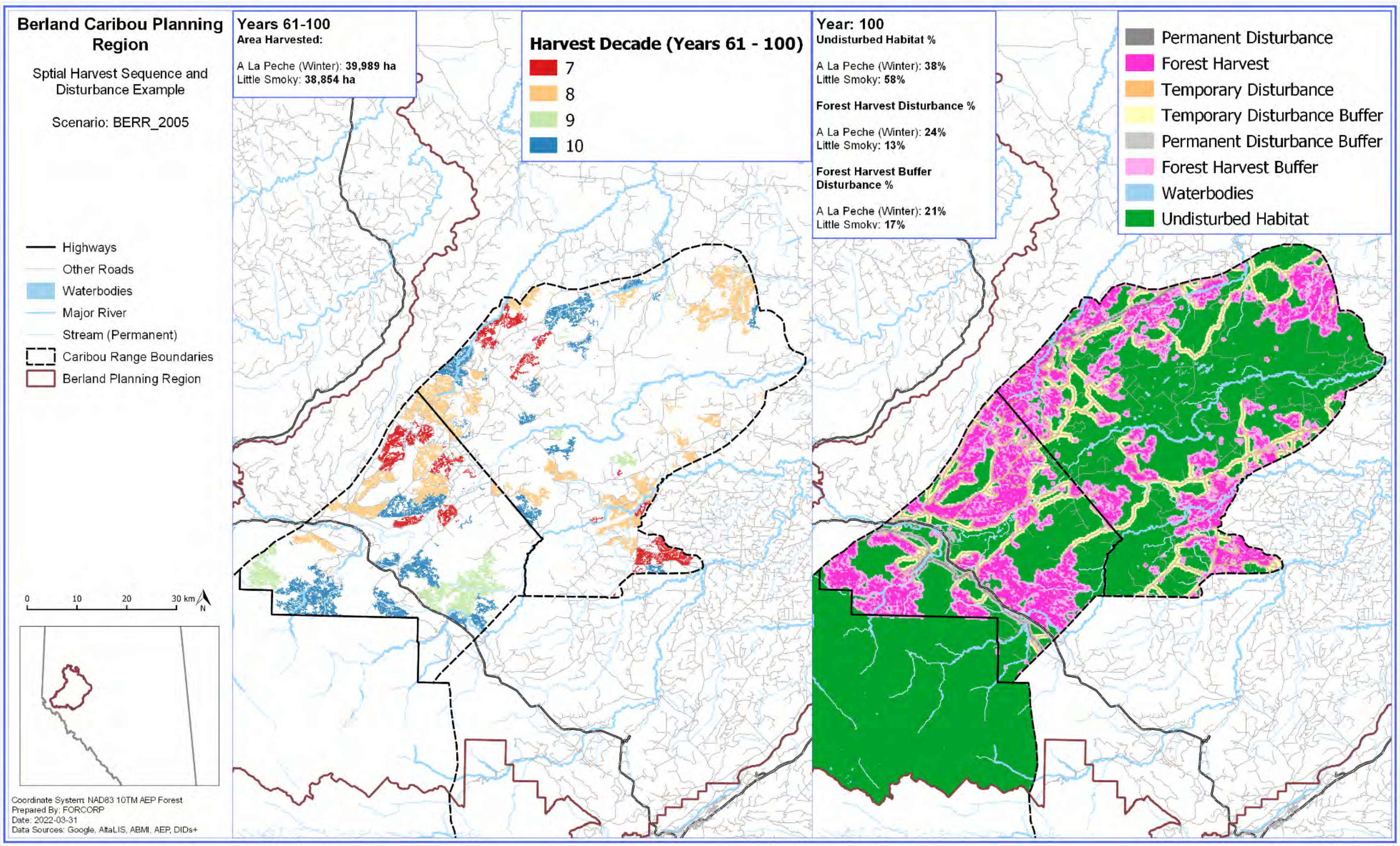


Figure 23. Spatial harvest sequence for the last four decades of BERR_VL, and the resulting disturbance patterns at year 100.

4.4.1 Berland Sub-Regional Planning Area

Habitat Disturbance Overview

In the Berland sub-region, none of the initial eight scenarios in this project achieve and maintain > 65% undisturbed by year 100, in either the Little Smoky or A La Peche Winter caribou ranges. Results are not presented for the A La Peche summer range, as it falls entirely within existing protected areas and is not influenced by forest harvesting. Table 8 summarizes the percentage of undisturbed habitat in the Berland sub-region by scenario over the 100-year planning horizon. The disturbance target was achieved for both ranges in one scenario:

- **BERR_FORCE65**: Target very large patches in caribou range and achieve >65% undisturbed habitat in all ranges by year 100.
  - A La Peche winter range achieved 66.69% undisturbed habitat by year 90.
  - Little Smoky achieved 67.78% undisturbed habitat by year 100.

BERR_DECADE, which targeted large to very large patches and aggregated harvesting in the caribou range into a few decades, reached 79% undisturbed in year 90 in the A La Peche Winter range. However, harvesting in the last decade dropped it back down to 42% undisturbed, which is still a higher level of undisturbed habitat than any of scenarios BERR_BASE through BERR_EVEN.

Table 8. Percentage of undisturbed habitat by scenario in the Berland Sub-Regional Planning Area.

		Year										
Sub-Region	Scenario Name	0	10	20	30	40	50	60	70	80	90	100
A La Peche Winter	BERR_BASE	46.94	23.1	13.63	10.39	4.61	7.75	11	16.62	23.15	10.87	10.42
	BERR_S	46.94	20.81	11.69	8.11	2.63	5.44	7.62	14	20.87	9.11	8.8
	BERR_M	46.94	30.96	18.2	17.37	16.32	21.62	32.26	29.39	29.6	23.89	19.17
	BERR_L	46.94	31.41	30.87	31.48	31.91	25.65	29.94	26.23	29.84	42.72	35.98
	BERR_VL	46.94	31.72	29.68	29.5	28.94	36.69	41.01	40.69	46.2	45.49	37.85
	BERR_ROAD	46.94	30.88	28.35	27.84	27.15	36.54	41.95	41.32	46.27	45.75	38.75
	BERR_EVEN	46.94	36.89	30.92	26.81	25.03	28.13	36.1	38.34	45.76	43.31	40.45
	BERR_DECADE	46.94	25.6	26.89	29.4	33.3	32.74	38.15	38.18	41.38	**79.33**	41.69
	BERR_FORCE65	46.94	44.63	42.12	42.7	42.64	44.53	54.78	55.52	62.58	**66.69**	**66.19**
Little Smoky	BERR_BASE	28.17	19.01	13.01	8.18	5.48	5.56	6.74	10.78	20.95	20.49	19.96
	BERR_S	28.17	18	11.76	6.72	3.86	4.83	6.2	10.35	20.08	18.42	18.81
	BERR_M	28.15	23.73	14.78	15.39	18.15	22.27	36.67	28.08	26.2	23.02	22.36
	BERR_L	28.16	24.04	25.47	27.11	31.81	31.69	41.08	37.71	37.56	54.41	54.01
	BERR_VL	28.16	24.12	25.48	27.3	32.49	34.27	45.62	44.08	44.68	58.17	57.96
	BERR_ROAD	28.18	23.46	24.62	26.27	31.08	33.14	45.17	43.28	43.59	56.73	55.72
	BERR_EVEN	28.16	25.56	24.94	23.74	26.76	28.18	41.24	43.27	55.4	61.09	63.95
	BERR_DECADE	28.17	22.6	24.54	27.25	32.98	32.73	45.28	45.38	37.67	53.45	55.8
	BERR_FORCE65	28.17	24.64	26.71	29.46	35.6	36.39	50.21	50.36	50.69	64.87	**67.78**

Figure 24 illustrates the positive relationship between harvest patch size and the proportion of undisturbed habitat. At year 50, the largest increase occurs as patch size targets move from small (BERR_S) to small-moderate (BERR_M). At year 100, the greatest jump occurs as patch size targets move from small-moderate to large (BERR_L), particularly notable in the Little Smoky range. The scenario with stricter access constraints (BERR_ROAD) performs similarly over time to the scenario targeting very large patch sizes (BERR_VL), indicating that constraining road building and maintenance does not have a significant impact when targeting large and very large harvest patches. While timing constraints (BERR_DECADE) improved undisturbed habitat nominally in the A La Peche Winter range, the even-flow harvest scenario targeting large-very large patches (BERR_EVEN) resulted in a greater percentage of undisturbed habitat at year 100 than any other of the initial scenarios.

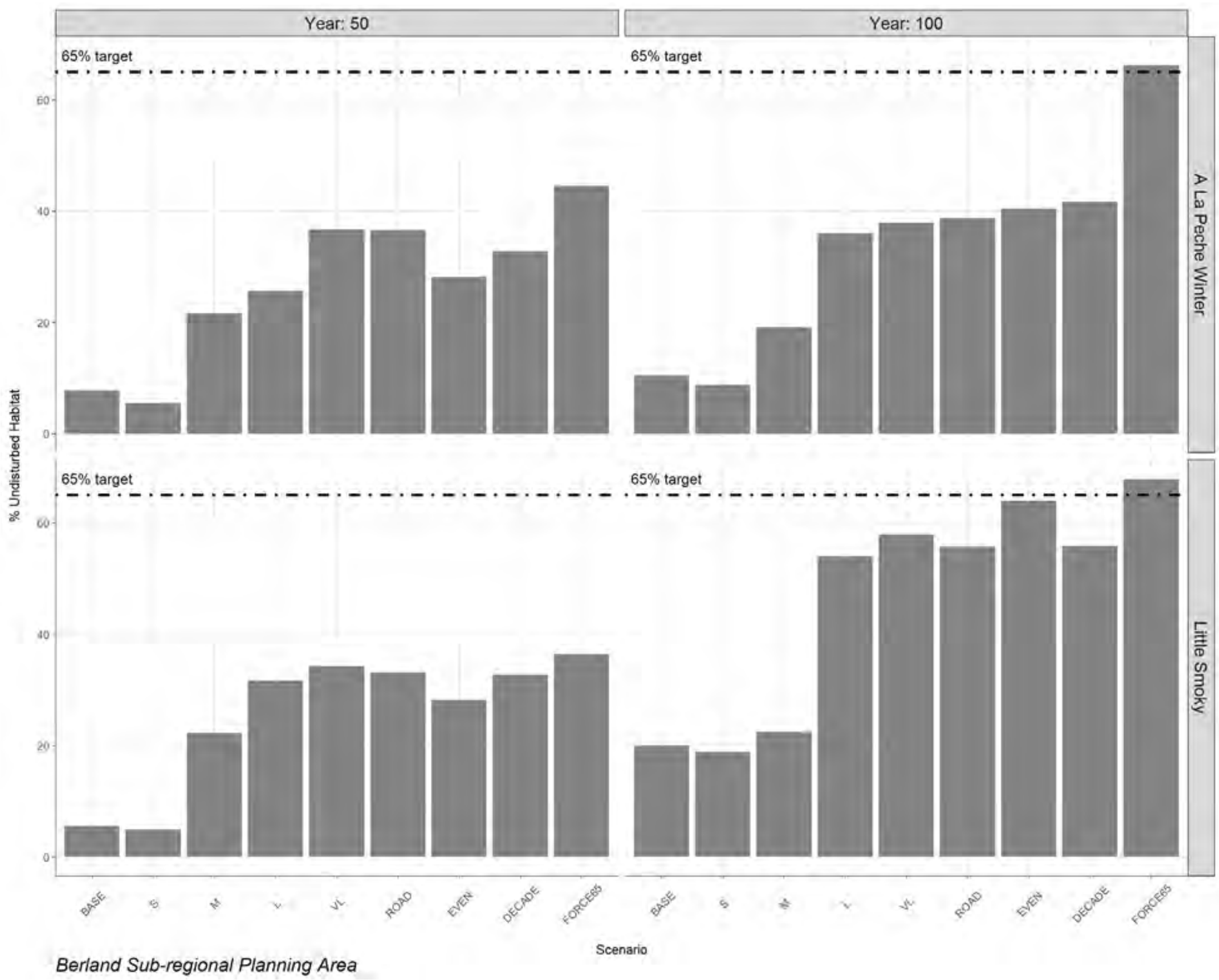


Figure 24. Percentage of undisturbed habitat by scenario in the Berland Sub-Regional Planning Area (Year 50 and Year 100).

Disturbance Types

Figure 25 illustrates the proportion of undisturbed and disturbed area within the sub-region with initial levels at year 0 displayed for comparison purposes. At present, the Berland sub-region is highly disturbed with over ~55% of the A La Peche Winter range and ~70% of the Little Smoky range categorized as disturbed (excluding seismic and wildfires). Forestry and forestry buffers comprise a significant portion of disturbed area (~30%).

The baseline and small patch scenarios result in a very low percentage of undisturbed area at year 50 (<10%) and year 100 (<20%). At year 50, the scenario targeting very large patches (BERR_VL) and constraining access (BERR_ROAD) results in the largest percentage of undisturbed habitat when considering the original eight scenarios only. By year 100, the scenario with the time constraint (BERR_DECADE) results in the greatest proportion of undisturbed habitat in the A La Peche winter range while the even-flow scenario (BERR_EVEN) provides the best outcome in Little Smoky (excluding BERR_FORCE65).

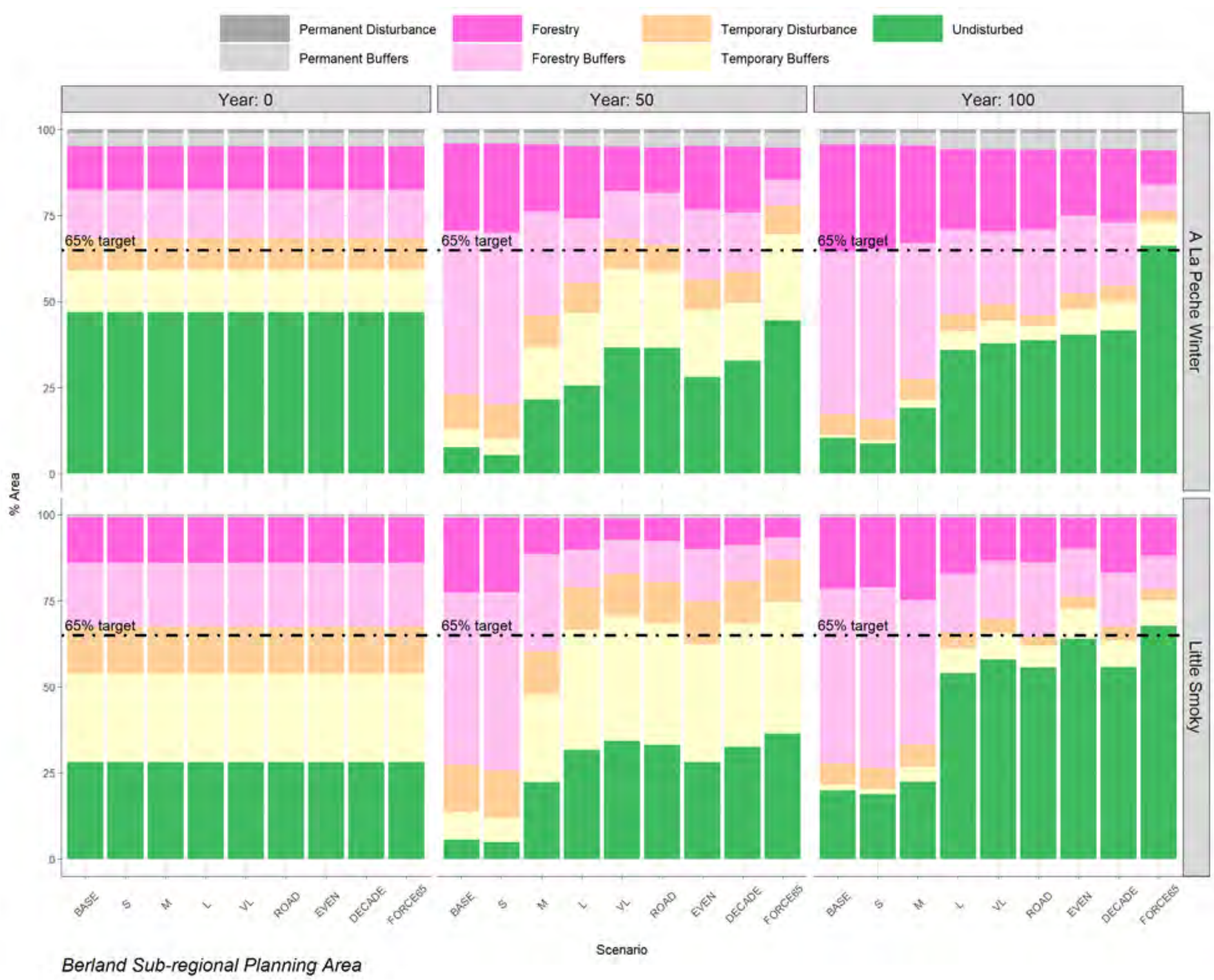


Figure 25. Area (%) of disturbance type by scenario in the Berland Sub-Regional Planning Area (Year 0, 50, 100).

Forestry and Forestry Buffers

Figure 26 illustrates harvest disturbance with initial levels at year 0 displayed for comparison purposes. At present, approximately 30% of the Berland sub-region is disturbed by forest harvesting and forestry buffers. The proportion of buffers is currently slightly larger than the proportion of harvest area.

A relatively steady and moderate decrease in forest harvesting moving away from the BAU scenario towards increased aggregation results in a disproportionate decrease in the area of forestry buffers. The effect is especially pronounced in the Little Smoky range. The effect of aggregation on reducing the buffered area is further visualized in Figure 27, which demonstrates that scenarios with larger patches have a lower ratio of buffered area to harvested area. This outcome demonstrates the importance of aggregation for reducing temporary disturbances on the working landscape, especially in areas with a high level of historical and contemporary timber harvest.

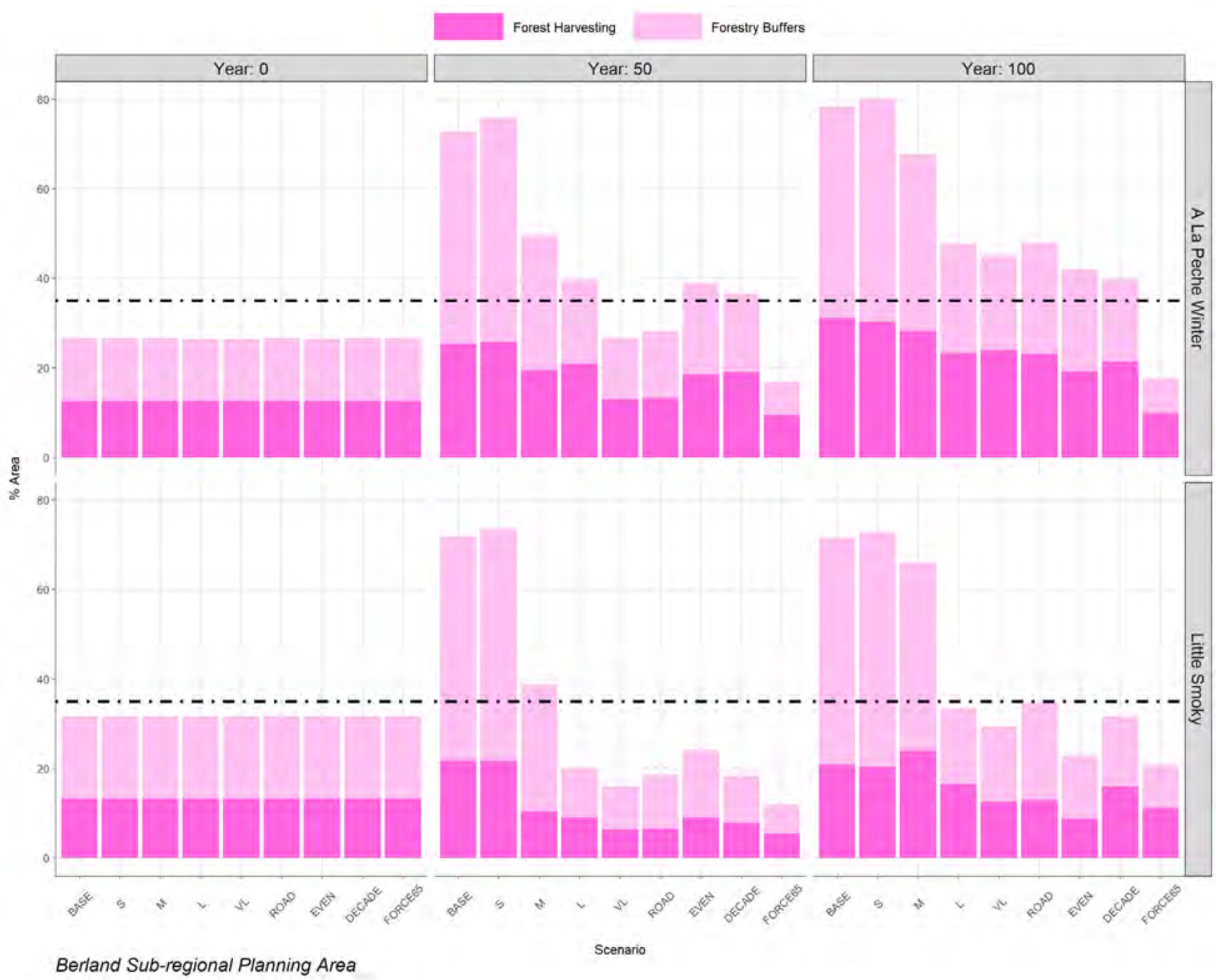


Figure 26. Area (%) of forest harvesting and forestry buffers by scenario in the Berland Sub-Regional Planning Area (Year 0, 50, and 100).

Figure 27. Ratio between the area disturbed by forest harvest buffers and the area disturbed by forest harvesting in the Berland Sub-Regional Planning Area.

Relationship to Harvest Volume

The trend lines in Figure 28 demonstrate the negative relationship between the percentage of undisturbed habitat and timber volume at year 100. As the percentage of undisturbed habitat increases, the volume decreases. The slopes of the regression lines (displayed in the text at the bottom) indicate the level of volume decrease for increasing the % undisturbed habitat by 1%. For example, the slope for the A La Peche Winter range indicates that on average the harvested conifer volume decreases by 5,037 m^3/yr for each 1% increase in the undisturbed caribou habitat, a reduction of 0.37% compared to the baseline harvest level. The BAU and low aggregation scenarios have the highest volume while more aggregated and constrained scenarios have the lowest. The scenario constraining access (BERR_ROAD) has the lowest volume, excluding coniferous volume in the A La Peche Winter range, which was lowest when even-flow harvest is applied. The negative trend is more prominent in conifer stands than deciduous stands.

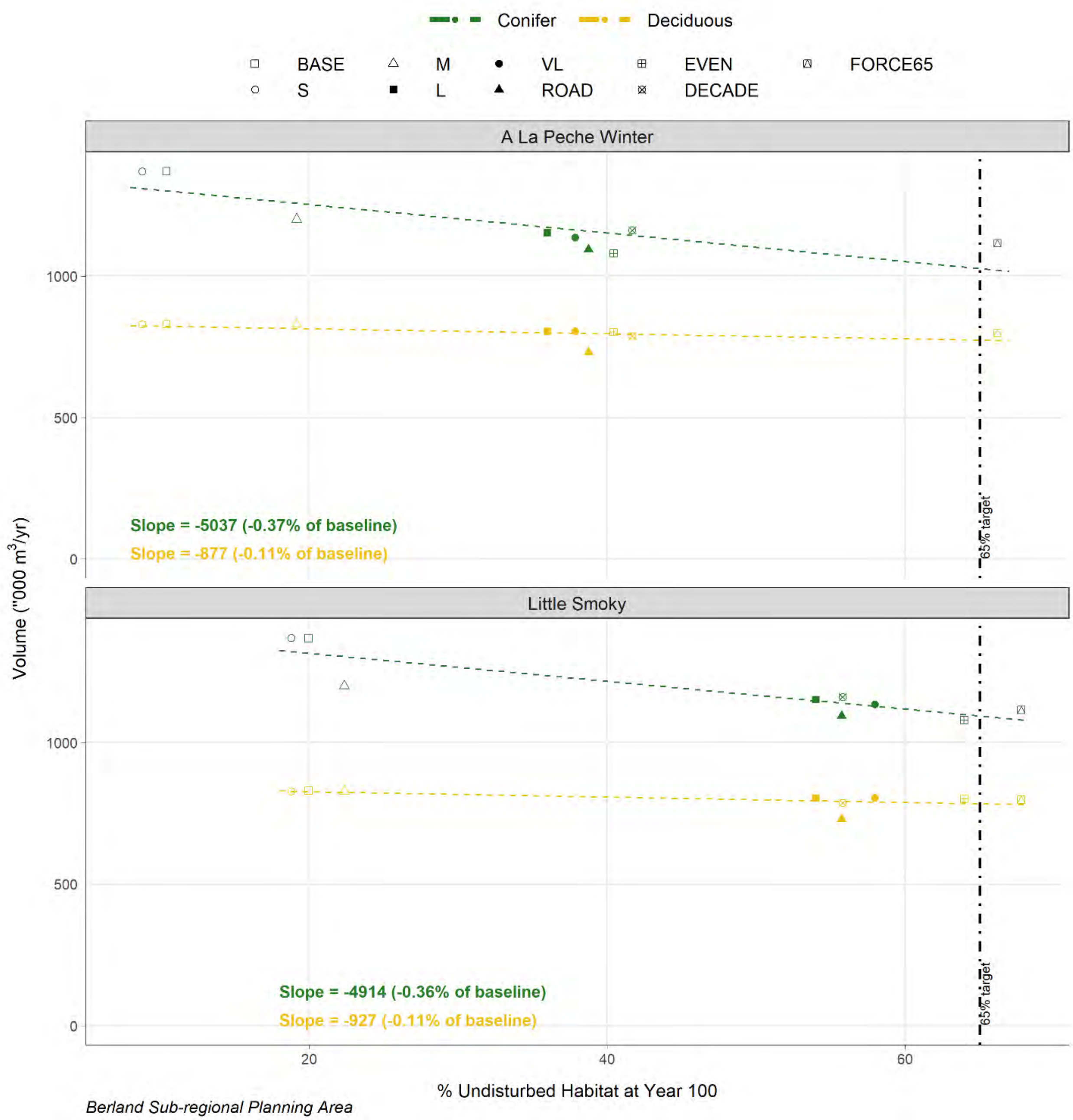


Figure 28. Comparison of volume to undisturbed habitat (%) at Year 100 in the Berland Sub-Regional Planning Area.

4.4.2 Chinchaga Sub-Regional Planning Area

Habitat Disturbance Overview

Table 9 summarizes the percentage of undisturbed habitat in the Chinchaga sub-region by scenario over the 100-year planning horizon. The disturbance target was achieved and maintained in one scenario:

- CHINR_FORCE65: Target large to very large patches in caribou range. Reduce harvesting to achieve >65% undisturbed by year 100 in all caribou ranges.
    - Achieved 67.59% undisturbed habitat by year 90.

CHINR_DECADE, which targeted large to very large patches and aggregated harvesting in the caribou range into a few decades, also achieved the disturbance target in year 90. However, the percentage of undisturbed habitat dropped back to 54% at year 100 due to harvesting in the final decade.

Table 9. Percentage of undisturbed habitat by scenario in the Chinchaga Sub-Regional Planning Area.

Sub-Region	Scenario Name	Year 0	10	20	30	40	50	60	70	80	90	100
Chinchaga	CHINR_BASE	60.47	47.63	42.02	37.93	36.28	34.81	34.08	32.95	38.02	39.91	41.02
	CHINR_S	60.48	44.88	40.42	36.78	36	34.43	33.73	32.54	37.68	39.65	40.89
	CHINR_M	60.5	48.04	41.91	38	36.35	34.76	34.05	32.97	37.91	39.9	40.95
	CHINR_L	60.53	55.34	51.18	48.11	46.15	44.74	46.61	45.28	51.02	52.63	52.67
	CHINR_VL	60.52	55.77	52.09	49.47	48.44	47.06	49.66	48.77	54.05	55.2	54.6
	CHINR_ROAD	59.21	55.95	53.14	51.09	50.55	49.67	52.77	51.37	57.94	60.06	59.13
	CHINR_EVEN	60.51	56.61	52.39	49.9	48.79	48.13	51.62	51.66	57.42	58.36	57.76
	CHINR_DECADE	60.97	60.64	55.3	56.71	46.99	47.32	53.52	41.1	62.95	**65.22**	53.57
	CHINR_FORCE65	59.33	56.7	55.71	54.65	55.79	55.16	58.9	57.7	64.7	**67.59**	**67.95**

Figure 29 illustrates the relationship between harvest patch size and the proportion of undisturbed habitat. Scenarios CHINR_BASE, CHINR_S, and CHINR_M result in a similar level of undisturbed habitat at both year 50 and year 100. At year 50 and 100, undisturbed habitat levels begin to increase as patch size targets move from small-moderate (CHINR_M) to moderate-large (CHINR_L). Of the first eight scenarios, the scenario with stricter access constraints (CHINR_ROAD) had the highest level of undisturbed habitat at year 50 and 100, with scenario CHINR_EVEN having comparable results.

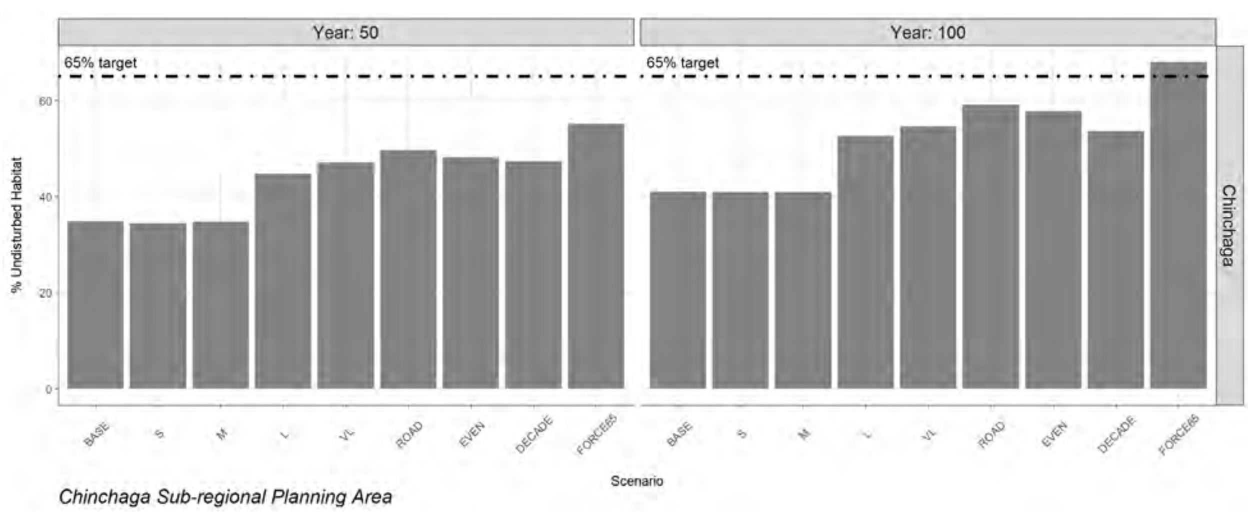


Figure 29. Percentage of undisturbed habitat by scenario in the Chinchaga Sub-Regional Planning Area (Year 50 and Year 100).

Disturbance Types

Figure 30 illustrates the proportion of undisturbed and disturbed area within the sub-region with initial levels at year 0 displayed for comparison purposes. At present, the Chinchaga sub-region is moderately disturbed with approximately 40% of the landscape categorized as disturbed. Temporary disturbances and temporary buffers comprise the majority of disturbed area (~30%).

The baseline, small, and small-moderate patch scenarios result in an equal and relatively low percentage of undisturbed area at year 50 (<35%) and year 100 (<40%). At year 50 and 100, CHINR_FORCE65 results in the largest proportion of undisturbed habitat. The total area of temporary disturbances and their buffers remains similar in all scenarios at year 50, though the proportion categorized as buffer increases. By year 100, temporary disturbances/buffers make up less of the disturbed area, with CHINR_ROAD and CHINR_FORCE65 providing the best outcomes.

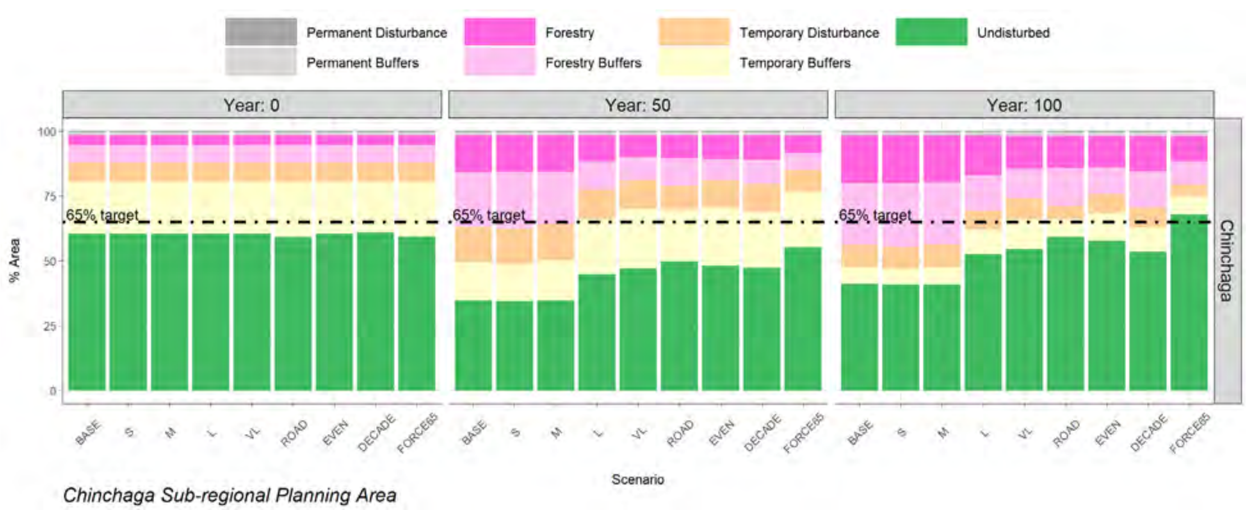


Figure 30. Area (%) of disturbance type by scenario in the Chinchaga Sub-Regional Planning Area (Year 0, 50 and 100).

Forestry and Forestry Buffers

Figure 31 illustrates harvest disturbance with initial levels at year 0 displayed for comparison purposes. At present, approximately 15% of the Chinchaga sub-region is disturbed by forest harvesting and forestry buffers. The current proportion of buffers is approximately double the proportion of harvest area. The overall disturbance due to forest harvesting and harvesting buffers increases in all scenarios compared to year 0, as there is little existing harvest footprint within this range. This is partially due to several large historical wildfires covering the range, such as the Chinchaga wildfire in 1950, and a few other wildfires in the 1980s. Moving from the patch sizes in scenario CHINR_M to CHINR_L results in a 3-5% decrease in the area directly disturbed by forest harvesting, but a ~10% decrease in the area within forest harvesting buffers. The effect of aggregation on reducing the buffered area is further visualized in Figure 32, which demonstrates that scenarios with larger patches have a lower ratio of buffered area to harvested area. This outcome demonstrates the importance of aggregation for reducing disturbance levels on the working landscape.

Figure 31. Area (%) of forest harvesting and forestry buffers by scenario in the Chinchaga Sub-Regional Planning Area (Year 0, 50, and 100).

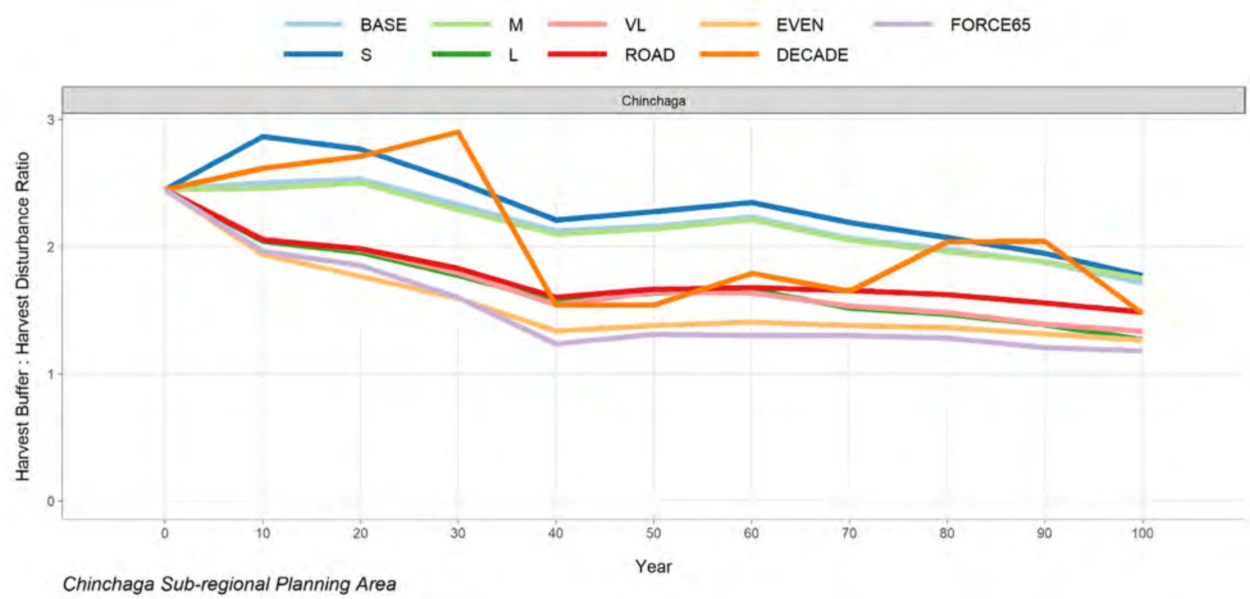


Figure 32. Ratio between the area disturbed by forest harvest buffers and the area disturbed by forest harvesting in the Chinchaga Sub-Regional Planning Area.

Relationship to Harvest Volume

The trend lines in Figure 33 demonstrates the negative relationship between the percentage of undisturbed habitat and timber volume at year 100. Scenarios CHINR_BASE, CHINR_S, and CHINR_M have similar harvest and % undisturbed habitat levels, and subsequent scenarios demonstrate a volume decrease as the percentage of undisturbed habitat increases. The slopes of the regression lines (displayed in the text at the bottom of the figure) indicate the level of volume decrease for increasing the percent of undisturbed habitat by 1%. For example, the slope for conifer volume indicates that on average the harvested conifer volume decreases by 14,645 m^3/yr for each 1% increase in undisturbed caribou habitat, a reduction of 0.37% compared to the baseline harvest level.

The BAU and low aggregation scenarios have the highest volume while more aggregated and constrained scenarios have the lowest. The scenario constraining harvest timing (CHINR_DECADE) results in the lowest conifer volume while the scenario constraining access (CHINR_ROAD) results in the lowest deciduous volume. The negative trend is similar in coniferous and deciduous stands.

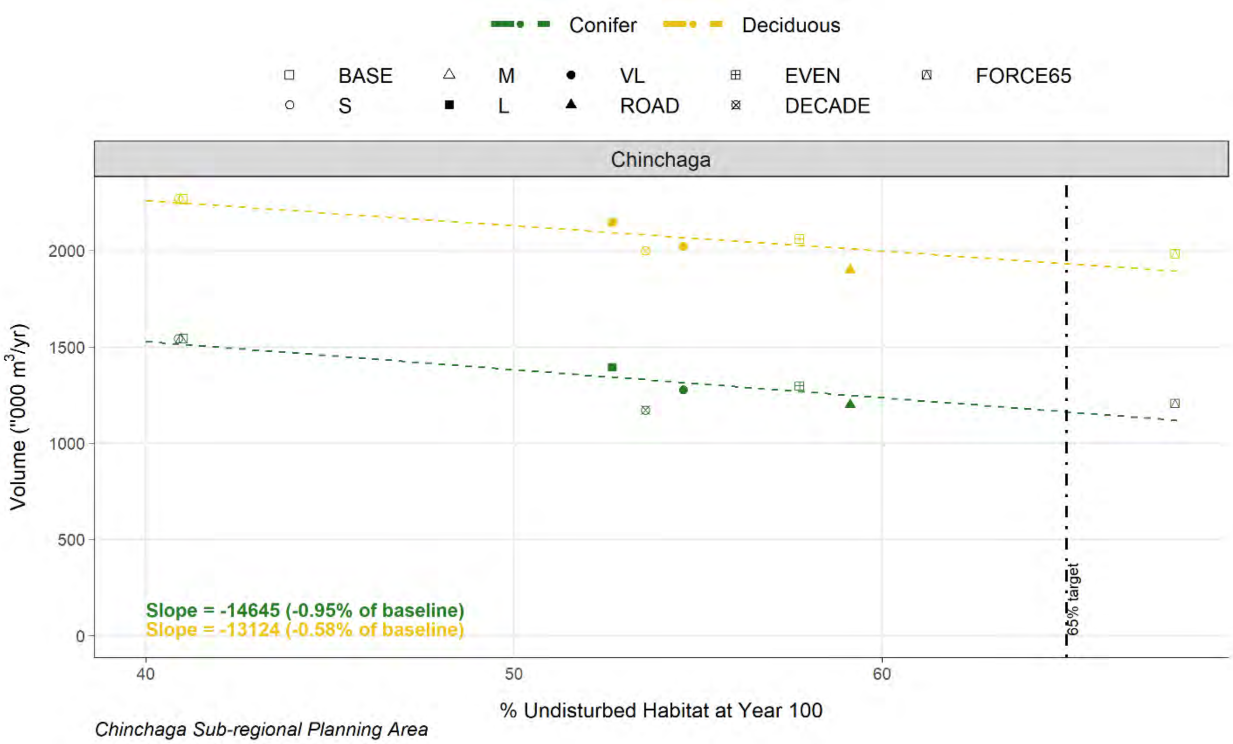


Figure 33. Comparison of volume to undisturbed habitat (%) at Year 100 in the Chinchaga Sub-Regional Planning Unit.

4.4.3 Wandering River Sub-Regional Planning Area

Habitat Disturbance Overview

Table 10 summarizes the percentage of undisturbed habitat in the Wandering River sub-region by scenario over the 100-year planning horizon. The differences at year 0 are due to some slight differences in active roads in the model between the scenarios (see Section 4.6.3). Several of the scenarios managed to achieve the federal disturbance target due to the spatial distribution of active landbase and the small percentage of active landbase falling within the East Side Athabasca River caribou range. The target was achieved and maintained in five scenarios:

- **WRR_L**: Target very large patches in caribou range.
    - 65.72% achieved by year 90.
- **WRR_VL**: Target very large patches in caribou range.
    - 66.92% achieved by year 80.
- **WRR_ROAD**: Target large to very large patches in caribou range and use constraints to reduce road building and maintenance to attempt to aggregate harvest.
    - 65.85% achieved by year 80.
- **WRR_EVEN**: Target large to very large patches in caribou range and even-flow harvest from the caribou range over time.
    - 66.19% achieved by year 90.
- **WRR_DECADE**: Target large to very large patches in caribou range and aggregate harvesting in the caribou range into a few decades.
    - 69.29% achieved by year 80.

Table 10. Percentage of undisturbed habitat by scenario in the Wandering River Sub-Regional Planning Area.

		Year										
Sub-Region	Scenario Name	0	10	20	30	40	50	60	70	80	90	100
East Side Athabasca	WRR_BASE	59.72	47.49	44.21	41.38	41.56	42.4	42.32	40.77	44.35	46.97	48.36
	WRR_S	59.72	47.9	44.36	41.75	41.76	42.49	42.4	40.81	44.41	47.02	48.42
	WRR_M	56.45	48.72	47.92	47.41	48.68	49.47	50.21	52.22	57.84	60.51	64.25
	WRR_L	56.08	50.85	49.37	50.24	52.86	52.83	57.2	58.12	63.56	**65.72**	**67.89**
	WRR_VL	57.97	53	52.28	52.91	56.54	55.39	59.49	61.01	**66.92**	**69.21**	**70.82**
	WRR_ROAD	61.31	58.55	58.65	58.52	60.47	58.41	59.09	60.09	**65.85**	**69.08**	**73.2**
	WRR_EVEN	56.54	50.77	49.99	50.5	51.56	52.23	55.49	56.7	63.84	**66.19**	**67.82**
	WRR_DECADE	61.31	58.77	54.55	55.93	58.46	54.03	63.05	63.13	**69.29**	**71.19**	**72.76**

Results indicate that the percentage of undisturbed habitat increases as target patch size increases (Figure 34). The largest jump occurs as patch size targets move from small (WRR_S) to small-moderate (WRR_M), followed by a gradual increase as harvest patterns move towards greater aggregation. The scenario introducing the additional access constraint has the highest percentage of undisturbed habitat at both year 50 and year 100. The timing constraint (WRR_DECADE) has less of an effect at year 50 but by year 100 it results in a greater percentage of undisturbed habitat than patch size considerations alone, though still less than WRR_ROAD. The even-flow scenario (WRR_EVEN) does not perform as well as the scenarios targeting large to very large patches.

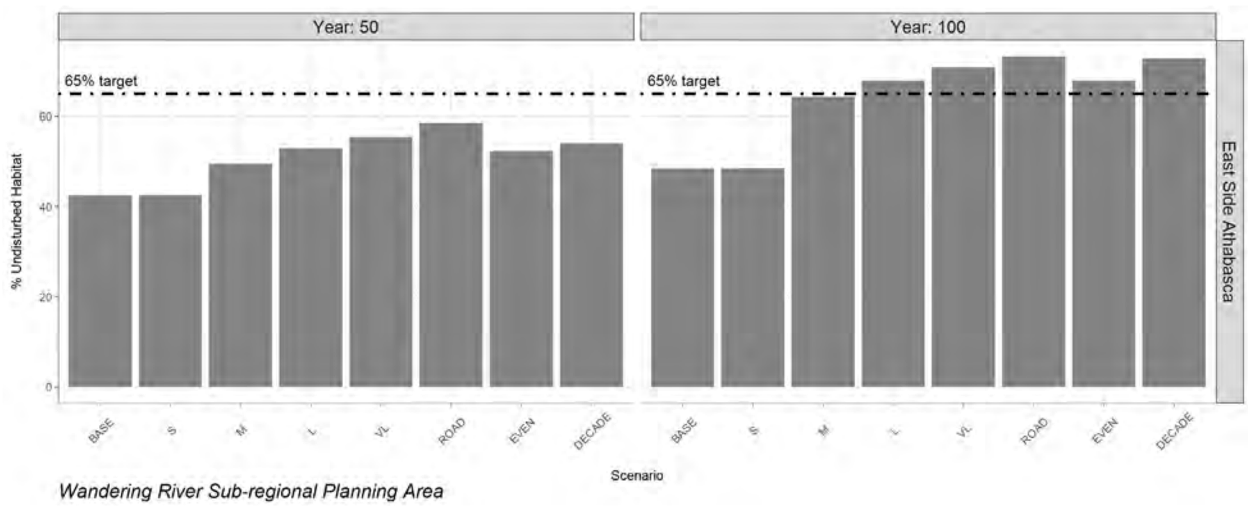


Figure 34. Percentage of undisturbed habitat by scenario in the Wandering River Sub-Regional Planning Area (Year 50 and Year 100).

Disturbance Types

Figure 35 illustrates the proportion of undisturbed and disturbed area within the sub-region with initial levels at year 0 displayed for comparison purposes. At present, the Wandering River sub-region is moderately disturbed with approximately 40% of the landscape categorized as disturbed. Temporary disturbances and temporary buffers comprise the majority of disturbed area.

Area categorized as temporary disturbance or temporary buffer increases slightly in proportion as patch size targets move to small-moderate and then remains steady over time. Temporary disturbances and buffers have the greatest area in the even-flow scenario (WRR_EVEN) and the least area in the scenario with stricter access constraints (WRR_ROAD), both at the 50 and 100 year mark. The area disturbed by temporary disturbances (i.e., roads) and their buffers is greater than the area disturbed by forest harvesting and forest harvest buffers, except for scenarios WRR_BASE and WRR_S. By reducing the road footprint, scenario WRR_ROAD achieved a higher proportion of undisturbed habitat than scenarios WRR_L through WRR_DECADE, despite having more area disturbed by harvesting and harvest buffers (Figure 36) due to the reduction in temporary disturbance/buffers. This indicates that controlling access and road building is an important strategy to decrease the disturbance footprint within this caribou range.

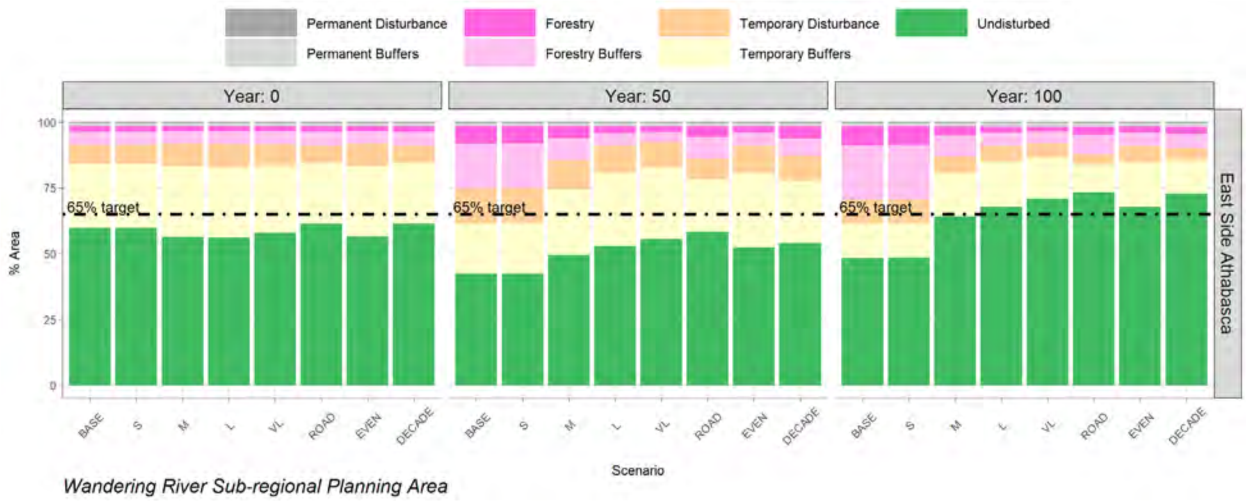


Figure 35. Area (%) of disturbance type by scenario in the Wandering River Sub-Regional Planning Area (Year 0, 50, and 100).

Forestry and Forestry Buffers

Figure 36 illustrates harvest disturbance with initial levels at year 0 displayed for comparison purposes. At present, <10% of the Wandering River sub-region is disturbed by forest harvesting and forestry buffers. The current proportion of buffers is approximately double the proportion of harvest area.

Aggregating harvest significantly decreasing the area of forestry buffers. Again, the change is most prominent between small and small-moderate patch size targets, indicating that even moderate amounts of aggregation can have a considerable effect on the amount of buffered area contributing to disturbance levels on the working landscape. The effect of aggregation on reducing the buffered area is further visualized in Figure 37, which demonstrates that scenarios with larger patches have a lower ratio of buffered area to harvested area. Harvest aggregation has the greatest effect on reducing forestry buffers, especially when combined with constraints on timing and access.

Figure 36. Area (%) of forest harvesting and forestry buffers by scenario in the Wandering River Sub-Regional Planning Area (Year 0, 50, and 100).

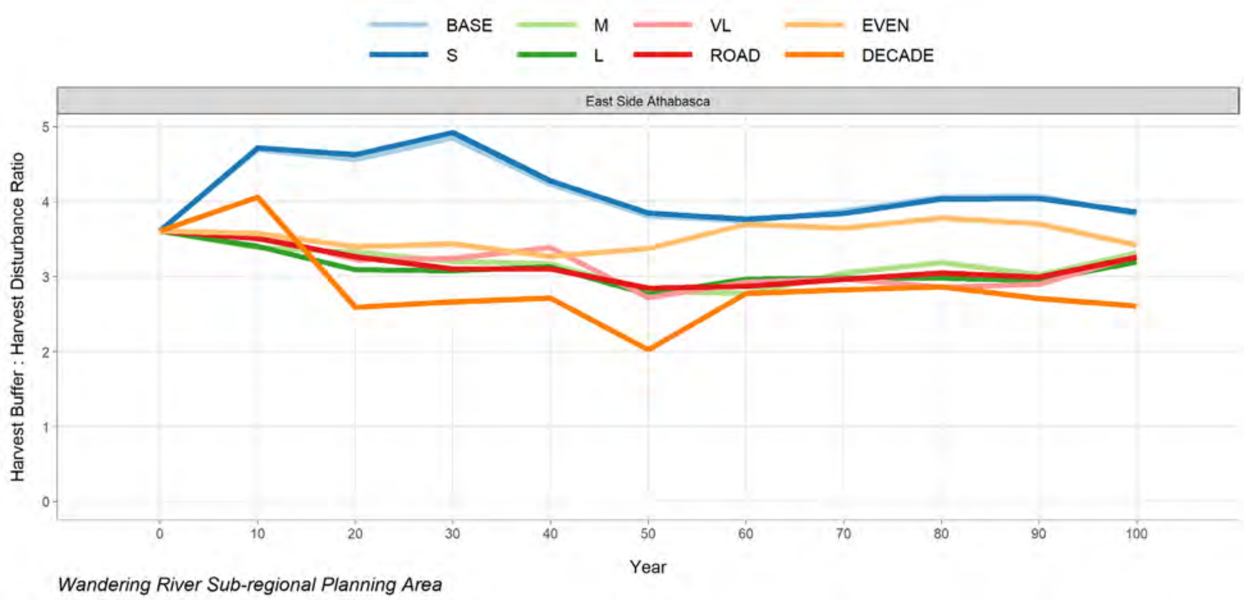


Figure 37. Ratio between the area disturbed by forest harvest buffers and the area disturbed by forest harvesting in the Wandering River Sub-Regional Planning Area.

Relationship to Harvest Volume

The trend lines in Figure 38 demonstrate the negative relationship between the percentage of undisturbed habitat and timber volume at year 100. As the percentage of undisturbed habitat increases, the volume decreases. The slopes of the regression lines (displayed in the text at the bottom of the figure) indicate the level of volume decrease for increasing the percent of undisturbed habitat by 1%. For example, the slope of -4,654 for deciduous volume indicates that on average the harvested deciduous volume decreases by 4,654 m^3/yr for each 1% increase in undisturbed caribou habitat, a reduction of 0.71% compared to the baseline harvest level.

The BAU and small patch size scenarios have the highest volume while more aggregated and constrained scenarios have the lowest. The scenario targeting very large patches (WRR_VL) had the lowest coniferous volume while the scenario constraining access (WRR_ROAD) has the lowest deciduous volume. The negative trend is slightly more prominent in deciduous stands than coniferous stands.

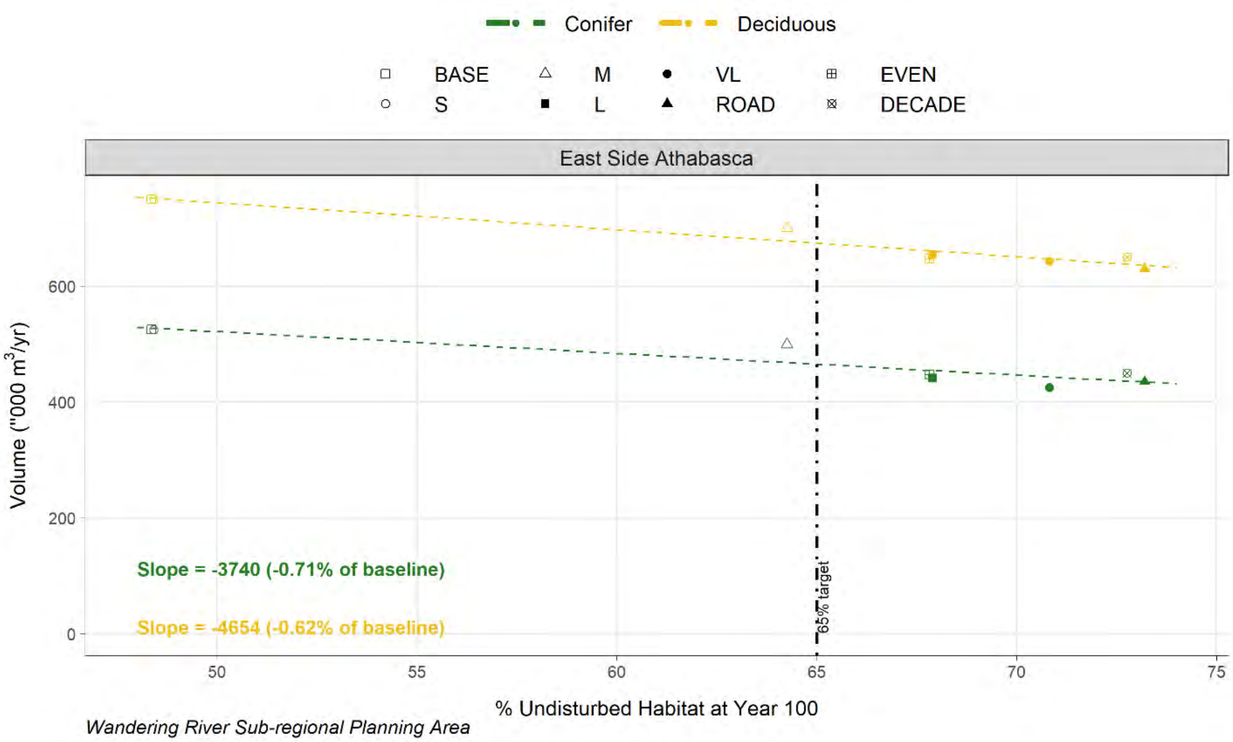


Figure 38. Comparison of volume to undisturbed habitat (%) at Year 100 in the Wandering River Sub-Regional Planning Unit.

Aggregating harvest into moderate-large sized patches is an effective method to achieve the 65% target in the Wandering River sub-region over the 100-year planning horizon, with five of the eight scenarios meeting the threshold by year 90. A greater percentage of undisturbed area can also be achieved by introducing road building and maintenance constraints. Applying similar access constraints as WRR_ROAD to scenario WRR_M would have likely resulted in it meeting > 65% undisturbed as well, with only a negligible decrease in volume from the baseline.

4.5 Biophysical Habitat

The spatial pattern of harvest does not affect biophysical habitat as much as the total area harvested. However, harvesting can fragment the landscape and alter the connectivity of caribou habitat. Additionally, aggregated harvest may negatively impact biophysical habitat if the approach requires a greater overall harvest area because of the reduced volumes from stands harvested outside of their ideal age range.

The amount of potential biophysical habitat available on the landscape varies by planning area and is split into “Current Biophysical” or “Not-current Biophysical” based on the stand age for the period reported. Some area is classified as “Not-eligible Biophysical” based on the assigned stratification, where non-vegetated or specific stand types are not eligible at any age. The A La Peche Winter range has the smallest proportion of habitat categorized as being Not-eligible Biophysical (~5%) while ~30% of the Chinchaga range is characterized as such. Ranges with a greater area of Not-eligible Biophysical experience less variation in biophysical habitat due to harvesting. Biophysical habitat maps for all scenarios within each sub-region can be found in Appendix III.

The following conclusion can be drawn from the modeling results:

- Harvest aggregation increases the proportion of biophysical habitat.

4.5.1 Berland Sub-Regional Planning Area

Biophysical Habitat Overview

Table 11 summarizes the percentage of total biophysical habitat available by scenario over the 100-year planning horizon. Figure 39 illustrates the proportion of Current Biophysical, Not-current Biophysical, and Not-eligible Biophysical habitat within the Berland sub-region with initial levels at year 0 displayed for comparison purposes. 5% of the landscape within the A La Peche Winter range is categorized as Not-eligible Biophysical while 17% of the landscape within the Little Smoky range is categorized as Not-eligible Biophysical. At year 0, ~73% of the landscape in the A La Peche Winter caribou range is categorized as Current Biophysical habitat. In the Little Smoky range, ~65% of the landscape is categorized as Current Biophysical habitat.

Table 11. Total biophysical habitat by scenario in the Berland Sub-Regional Planning Area (0-100 years).

		Year										
Sub-Region	Scenario Name	0	10	20	30	40	50	60	70	80	90	100
A La Peche Winter	BERR_BASE	72.78	62.19	55.34	51.19	42.35	43.34	39.46	38.24	37.19	37.1	34.99
	BERR_S	72.78	62.61	55.76	51.29	41.97	43.37	39.35	38.93	37.52	37.3	35.35
	BERR_M	72.76	66.04	55.11	53.81	51.49	53.45	46.7	43.82	43.18	45.12	44.69
	BERR_L	72.79	65.55	65.38	65.6	64.48	51.54	52.03	48.57	48.17	51.17	45.33
	BERR_VL	72.77	63.06	61.72	60.54	58.4	57.19	55.41	54.54	53.91	58.17	51.63
	BERR_ROAD	72.93	62.87	61.37	60.29	58.05	56.88	55.59	55.2	56.28	60.63	54.47
	BERR_EVEN	72.75	67.85	63.84	60.79	57.43	56.46	53.96	52.17	53.52	53.49	52.84
	BERR_DECADE	72.79	57.56	58.35	59.91	61.43	45.55	47.99	50.8	56.61	72	49.93
	BERR_FORCE65	72.81	71.12	69.46	68.84	67.49	68.85	68.98	69.35	73.28	72.82	72.42
Little Smoky	BERR_BASE	65.19	63.86	59.96	53.99	49.04	49.31	50.42	48.76	48.87	49.45	52.16
	BERR_S	65.19	63.82	59.95	54.11	48.51	49.21	50.35	49.42	49.16	49.66	52.84
	BERR_M	65.2	63.8	57.65	57.11	57.79	60.09	62.36	58.39	58.06	56.02	52.15
	BERR_L	65.2	62.22	61.94	61.86	63.31	59.33	65.64	66.31	59.1	59.25	57.27
	BERR_VL	65.19	62.71	62.43	62.39	64.14	62.41	68.8	70.24	64.72	64.87	63.11
	BERR_ROAD	65.36	62.84	62.57	62.48	64.22	62.34	68.75	70.52	65.27	65.41	63.68
	BERR_EVEN	65.19	63.84	62.3	60.85	61.26	61.34	67.14	67.66	67.35	67.84	68.25
	BERR_DECADE	65.18	61.19	61.32	61.83	64.22	59.64	66.99	72.03	60.73	58.23	58.26
	BERR_FORCE65	65.22	62.59	62.72	63.22	65.64	62.93	70.34	73.98	66.66	64.62	64.65

Compared to the baseline scenario, biophysical habitat increases as harvest patch size increases in both ranges. In general, harvesting larger patches increases total biophysical area by decreasing the total area harvested. The BAU and small patch scenarios resulted in the smallest proportion of biophysical habitat, with only ~35% of the A La Peche Winter range and ~52% of the Little Smoky range being categorized as biophysical habitat at year 100. At year 100, BERR_FORCE65 provides the best outcome for biophysical habitat in the A La Peche Winter range (72.42%) while the scenario targeting large and very large patches with even-flow harvest within the caribou range (BERR_EVEN) provides the best outcome for the Little Smoky range (68.25%).

At year 100, all scenarios resulted in a decreased level of biophysical habitat as compared to year 0 in the A La Peche Winter range, though BERR_FORCE65 results in a very comparable level. The other scenarios resulted in a drop of 19-38%. Scenario BERR_EVEN is the only scenario that results in increased biophysical habitat at year 100 in the Little Smoky range with the other scenarios resulting in a drop of up to 13%.

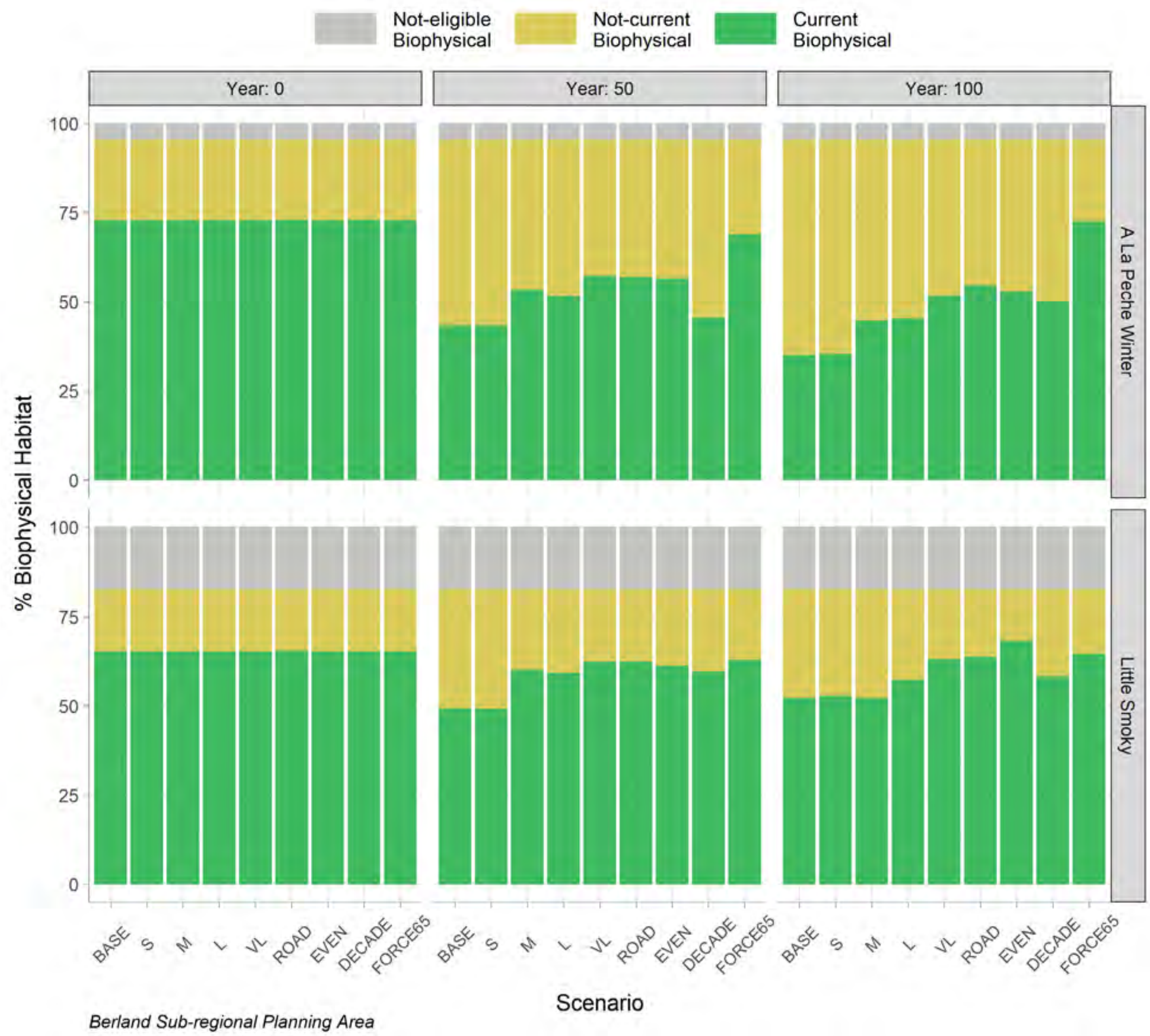


Figure 39. Distribution of biophysical habitat and not-eligible biophysical area by scenario in the Berland Sub-Regional Planning Area (Year 0, 50, and 100).

4.5.2 Chinchaga Sub-Regional Planning Area

Biophysical Habitat Overview

Table 12 summarizes the percentage of biophysical habitat available by scenario over the 100-year planning horizon. Figure 40 illustrates the proportion of Current Biophysical, Not-current Biophysical, and Not-eligible Biophysical habitat within the Chinchaga sub-region with initial levels at year 0 displayed for comparison purposes. Approximately 31% of the area is categorized as Not-eligible Biophysical. At year 0, ~53% of the landscape in the Chinchaga sub-region is categorized as Current Biophysical habitat.

Table 12. Total biophysical habitat by scenario in the Chinchaga Sub-Regional Planning Area (0-100 years).

		Year										
Sub-Region	Scenario Name	0	10	20	30	40	50	60	70	80	90	100
Chinchaga	CHINR_BASE	52.79	51.24	49.63	53.53	51.89	51.17	51.3	50.13	49.62	50.19	51.1
	CHINR_S	52.79	50.8	49.3	53.17	51.76	51.01	51.15	50.03	49.57	50.15	51.06
	CHINR_M	52.8	51.35	49.6	53.65	51.98	51.23	51.38	50.21	49.66	50.2	51.11
	CHINR_L	52.8	52.69	51.67	56.74	55.57	55.31	56.43	54.7	53.85	53.91	54.31
	CHINR_VL	52.8	52.88	51.94	57.26	56.4	56.36	57.77	56.06	55.23	55.12	55.35
	CHINR_ROAD	52.73	52.97	52.18	57.65	57.07	57.22	58.99	57.8	57.27	57.38	57.62
	CHINR_EVEN	52.8	52.81	51.72	57.07	56.28	56.06	57.48	56.5	55.94	55.63	55.73
	CHINR_DECADE	52.93	53.98	52.42	59.18	56.14	57.36	60.54	56.8	58.38	58.45	59.36
	CHINR_FORCE65	52.74	53.11	52.68	58.44	58.28	58.57	60.68	59.68	59.2	59.2	59.46

Compared to the baseline scenario, biophysical habitat typically increases as harvest patch size increases, though the scenarios targeting small (CHINR_S) and small-moderate patches (CHINR_M) perform similarly to the BAU scenario. The BAU, small, and small-moderate patch scenarios resulted in the smallest proportion of biophysical habitat, with ~51% of the range being categorized as biophysical habitat at year 100. CHINR_FORCE65 results in the highest level of biophysical habitat at both year 50 (58.57%) and year 100 (59.46%). Outcomes are less variable than in the Berland sub-region, with scenarios CHINR_L through CHINR_FORCE65 all resulting in a 1-6% increase in biophysical habitat at year 100 as compared to year 0.

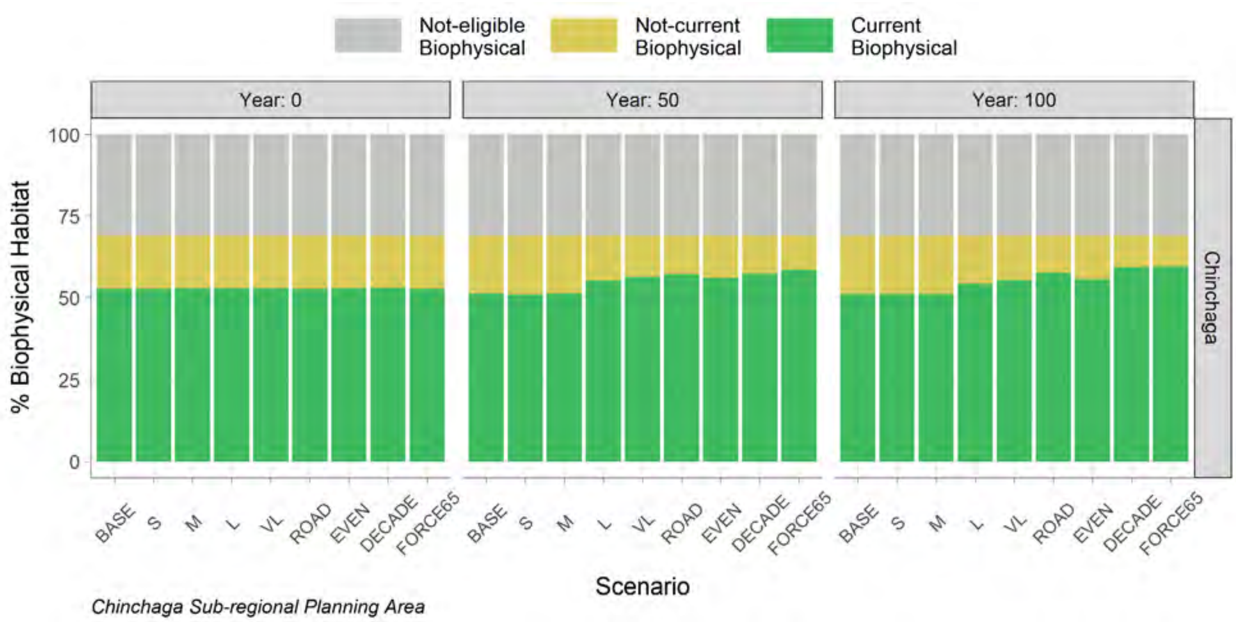


Figure 40. Distribution of biophysical habitat and not-eligible biophysical area by scenario in the Chinchaga Sub-Regional Planning Area (Year 0, 50, and 100).

4.5.3 Wandering River Sub-Regional Planning Area

Biophysical Habitat Overview

Table 13 summarizes the percentage of biophysical habitat available by scenario over the 100-year planning horizon. Figure 41 illustrates the proportion of Current Biophysical, Not-current Biophysical, and Not-eligible Biophysical habitat within the Wandering River sub-region with initial levels at year 0 displayed for comparison purposes. Approximately 21% of the area is categorized as Not-eligible Biophysical. At year 0, ~56% of the landscape in the Wandering River sub-region is categorized as Current Biophysical habitat.

Table 13. Total biophysical habitat by scenario in the Chinchaga Sub-Regional Planning Area (0-100 years).

		Year										
Sub-Region	Scenario Name	0	10	20	30	40	50	60	70	80	90	100
East Side Athabasca	WRR_BASE	56.23	55.23	54.76	54.94	57.94	59.55	65.32	65.54	65.81	66.77	67.46
	WRR_S	56.23	55.46	54.89	55.17	58.09	59.75	65.52	65.6	65.86	66.78	67.54
	WRR_M	55.34	55.42	55.72	56.81	60.5	61.9	67.85	68.88	69.2	69.27	69.74
	WRR_L	55.19	55.94	56.08	57.87	61.86	63.67	70.33	70.68	71.13	71.21	71.53
	WRR_VL	55.7	56.53	56.8	58.56	62.72	64.56	71.46	71.73	72.03	72.2	72.43
	WRR_ROAD	56.61	58.12	58.75	60.18	64.13	65.63	71.92	72.05	72.15	72.5	72.89
	WRR_EVEN	55.36	56.08	56.36	57.83	61.41	63.65	70.27	70.59	70.97	71.39	71.9
	WRR_DECADE	56.6	58.18	57.49	59.66	63.91	64.43	71.74	71.96	73.27	72.23	72.46

Compared to the baseline scenario, biophysical habitat increases as harvest patch size increases. The BAU and small patch scenario (WRR_S) resulted in the smallest proportion of biophysical habitat at year 100 (~67%). The scenario targeting large to very large patches in caribou range and using constraints to reduce road building and maintenance to attempt to aggregate harvest (WRR_ROAD) provided the best outcome for biophysical habitat at both year 50 (65.63%) and year 100 (72.89%). All scenarios result in higher levels of biophysical habitat at year 100 as compared to year 0, with the increase ranging from 11-17%.

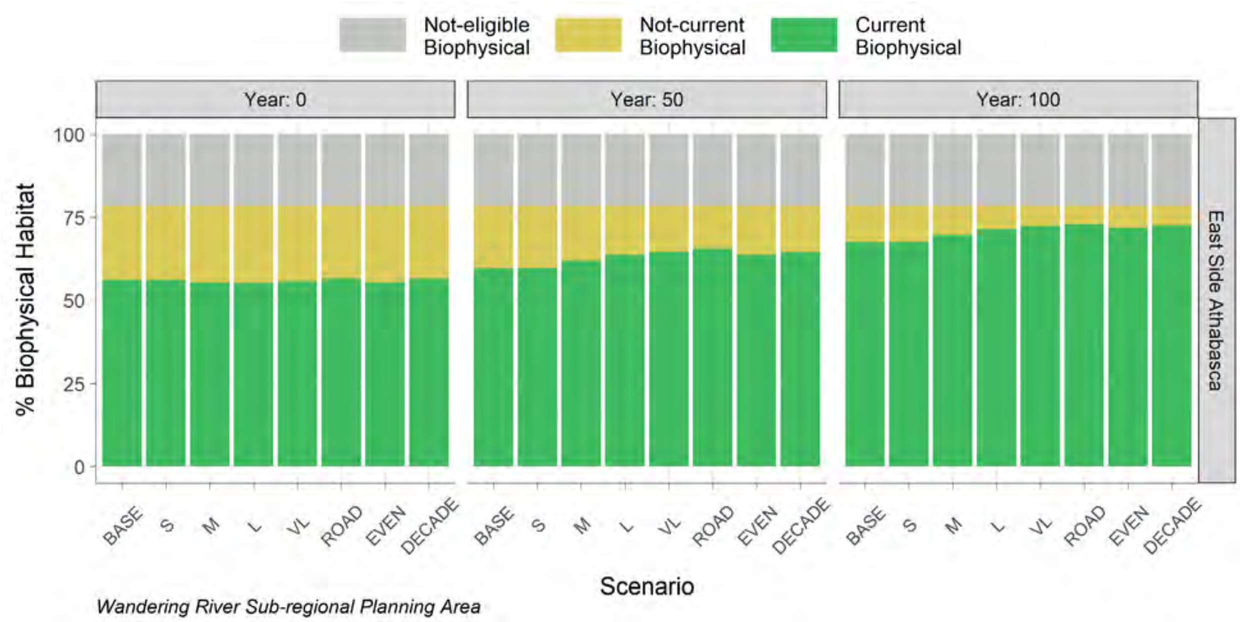


Figure 41. Distribution of biophysical habitat and not-eligible biophysical area by scenario in the Wandering River Sub-Regional Planning Area (Year 0, 50, and 100).

4.6 Other Metrics

The impacts on additional access metrics (including road building, road maintenance, and log haul) and non-timber values (including songbirds, marten, watersheds, and traplines) were examined.

The following conclusions can be drawn from the modeling results:

- The scenarios that place stricter constraints on road building and maintenance (ROAD) result in the lowest relative road building, road maintenance, and log haul road distance.
- Road building levels decrease over the 100-year planning horizon in all scenarios within all sub-regions, with variability between scenarios and by time period. This simply indicates that road construction will naturally decrease over time as more area has access built.
- In the Berland sub-region, road maintenance levels remain at similar levels throughout the planning horizon, with little variability between scenarios. This indicates that the amount of roads used in each decade does not change over time.
- In the Chinchaga and Wandering River sub-regions, road maintenance levels increase logarithmically before plateauing at year 50 and 70, respectively. This indicates that there are relatively few roads used early in the planning horizon and more are used later in the scenario.
- Log haul distance increases over the 100-year planning horizon with the BAU, small, and small-moderate target patch size scenarios resulting in the highest relative log haul distance in all sub-regions.
- Impacts on marten and songbird species vary by sub-region, though the following general conclusions can be made:
    - No species falls below 70% of current levels in any scenario within any sub-region (including BAU).
    - Black throated green warbler is the songbird that decreases the most from current levels and is the only species that fell below the low-risk threshold in all sub-regions.
    - Scenarios constraining access and directing the model to reach >65% undisturbed habitat typically resulted in the best outcomes for all species except ovenbird, where BAU and small aggregation scenarios resulted in the highest species abundance.
    - A decline in any of the species does not necessarily indicate that it is falling below natural levels, as the species are simply being compared to their abundance at time 0. Species may be more abundant currently than their natural levels, due to decades of fire suppression that have resulted in an older forest structure in some regions of the province. Comparing to NRV levels would be a more useful metric, if those data were available.
- Impacts on watershed disturbance were minimal, with only the Berland sub-region showing a slight increase in at-risk area over the 100-year planning horizon. Chinchaga and Wandering River showed a decrease in watershed disturbance over time in all scenarios. Constraining road building and maintenance resulted in the lowest overall impact on watershed disturbance in all sub-regions.
- Nearly all scenarios in all sub-regions resulted in higher levels of trapline disturbance at year 100. The scenarios constraining road building and maintenance resulted in the lowest disturbance levels in the Berland and Chinchaga sub-regions while the scenario constraining harvest timing (DECADE) had the best outcome in Wandering River.

4.6.1 Berland Sub-Regional Planning Area

Road Metrics

Relative road distance was used to compare how each scenario affected the levels of the chosen metrics. The scenario targeting large patches and constraining road building and maintenance (BERR_ROAD) results in the lowest road building, road maintenance, and log haul relative road distance (Figure 42).

The majority of the road building in the model occurs in the first few decades, after which there is relatively little road building. Road maintenance levels remain relatively stable throughout the planning horizon and there is minimal variability between scenarios except for scenario BERR_ROAD. The road construction and maintenance constraints in BERR_ROAD result in it having ~10% less road maintenance at the beginning of the horizon, decreasing to 40-50% lower than other scenarios from year 50 onwards. The scenario constraining harvest timing (BERR_DECADE) results in the highest maintenance levels until year 40 and the scenario targeting small patches (BERR_S) resulting in the highest maintenance levels from year 40-100.

In all scenarios, log haul relative road distance drops steadily until year 60, after which it increases back to or above initial levels. BERR_M has the highest relative log haul distance until year 40, after which it is surpassed by the baseline and BERR_S for the rest of the planning horizon. The scenario targeting large patches and even-flow harvest over time (BERR_EVEN) has the lowest log haul distance (excluding BERR_ROAD).

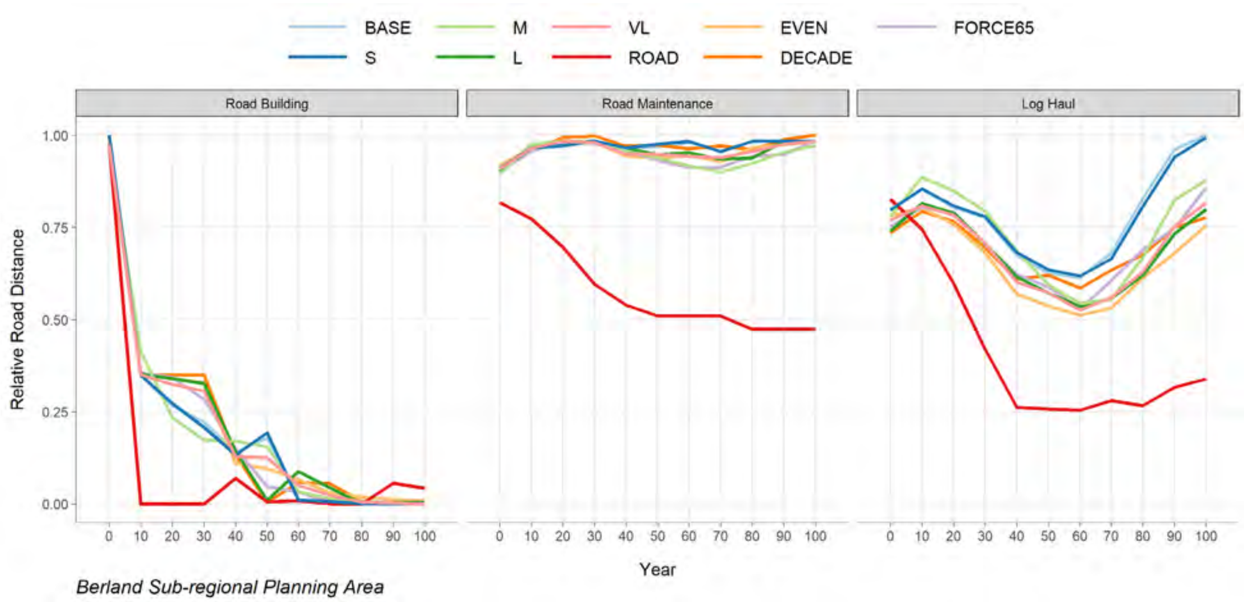


Figure 42. Road metrics (road building, road maintenance, and log haul) in the Berland Sub-Regional Planning Area (0-100 years).

Songbirds and Marten

Relative abundance was assessed over the 100-year planning horizon for marten and the six songbird species. Figure 43 displays the relative abundance of each species over time compared to initial levels, with the green zone representing > 85% of initial levels, the yellow zone representing 70-85% of initial levels, and the red zone representing < 70% of initial levels.

Black-throated green warbler is the only species experiencing significant declines over the 100 year horizon, with the relative abundance decreasing to 70% of initial levels in all scenarios. In general, scenarios with larger patch sizes perform better for most species, presumably due to the reduction in area harvested. The exception to this is ovenbird, where scenarios with higher patch sizes result in slightly lower relative abundance than the baseline or scenarios with smaller patch sizes.

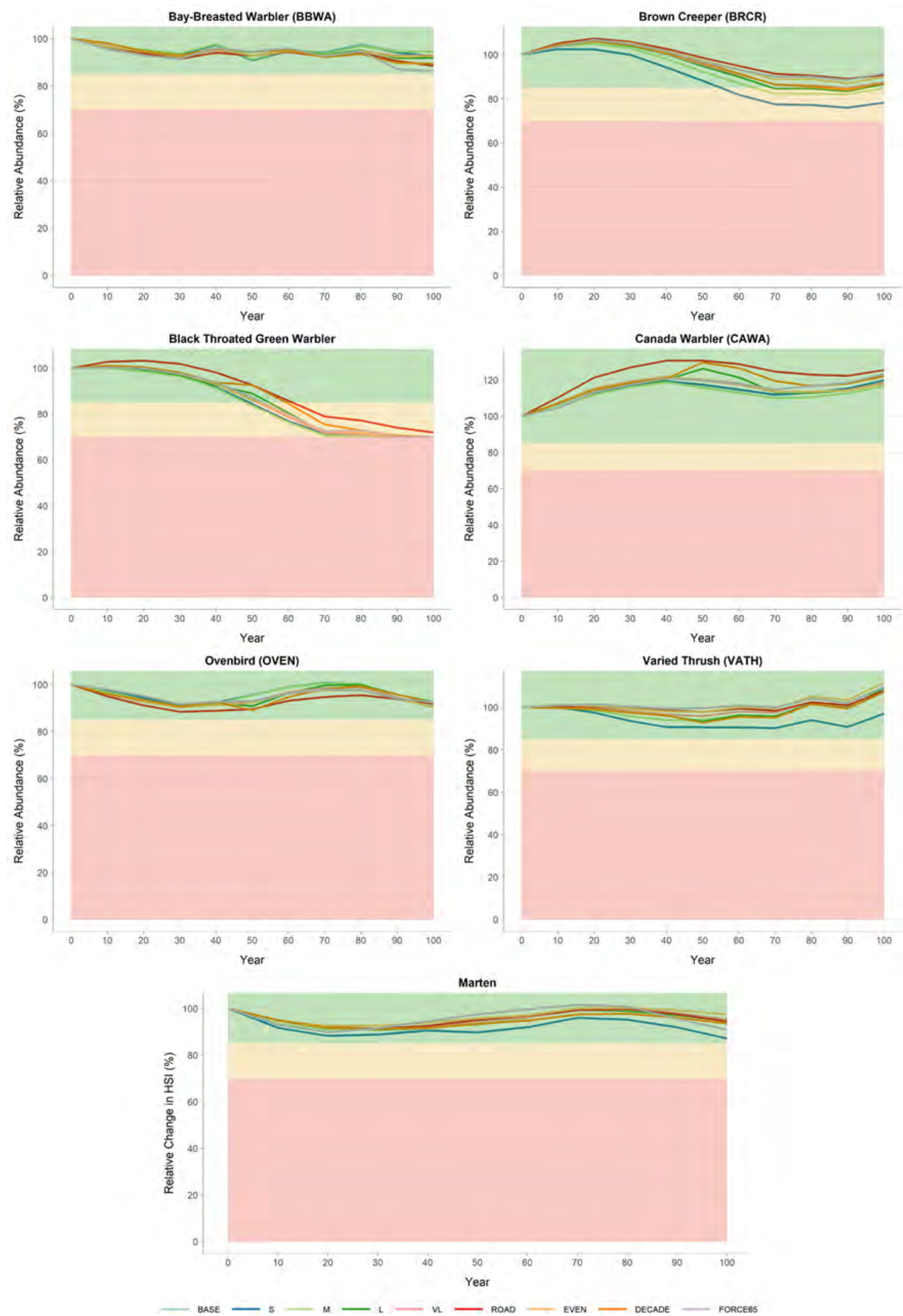


Figure 43. Relative change in abundance (%) for songbirds and marten in the Berland Sub-Regional Planning Area.

Watersheds

The impact of each harvest scenario on watershed disturbance was assessed over a 100-year planning horizon using the Equivalent Clearcut Area (ECA) index (Figure 44). Watersheds are categorized as being very low (0-15%), low (0-30%), moderate (30-50%), or high risk (>50%) according to disturbance level. The Berland sub-region had the lowest initial disturbance levels with only 1% of area categorized as high risk and 99% of area categorized as low or very low risk. All scenarios except for BERR_ROAD resulted in greater watershed disturbance over time, though the increase in at-risk area at year 100 was minimal (4-12%). All scenarios showed an increase in the proportion of very low risk area until year 50 or 60, when it began to drop to reach pre-harvest levels by year 100.

Aggregating harvest and introducing access and timing constraints resulted in lower disturbance levels at year 100 as compared to the baseline scenario (BERR_BASE). The scenario directing the model to achieve >65% undisturbed habitat (BERR_FORCE65) resulted in the greatest area falling into the moderate risk category (13%). The scenario constraining road building and maintenance (BERR_ROAD) resulted in the lowest area falling into the moderate risk category (0%). There was no area categorized as being high risk at year 100 in any of the scenarios.

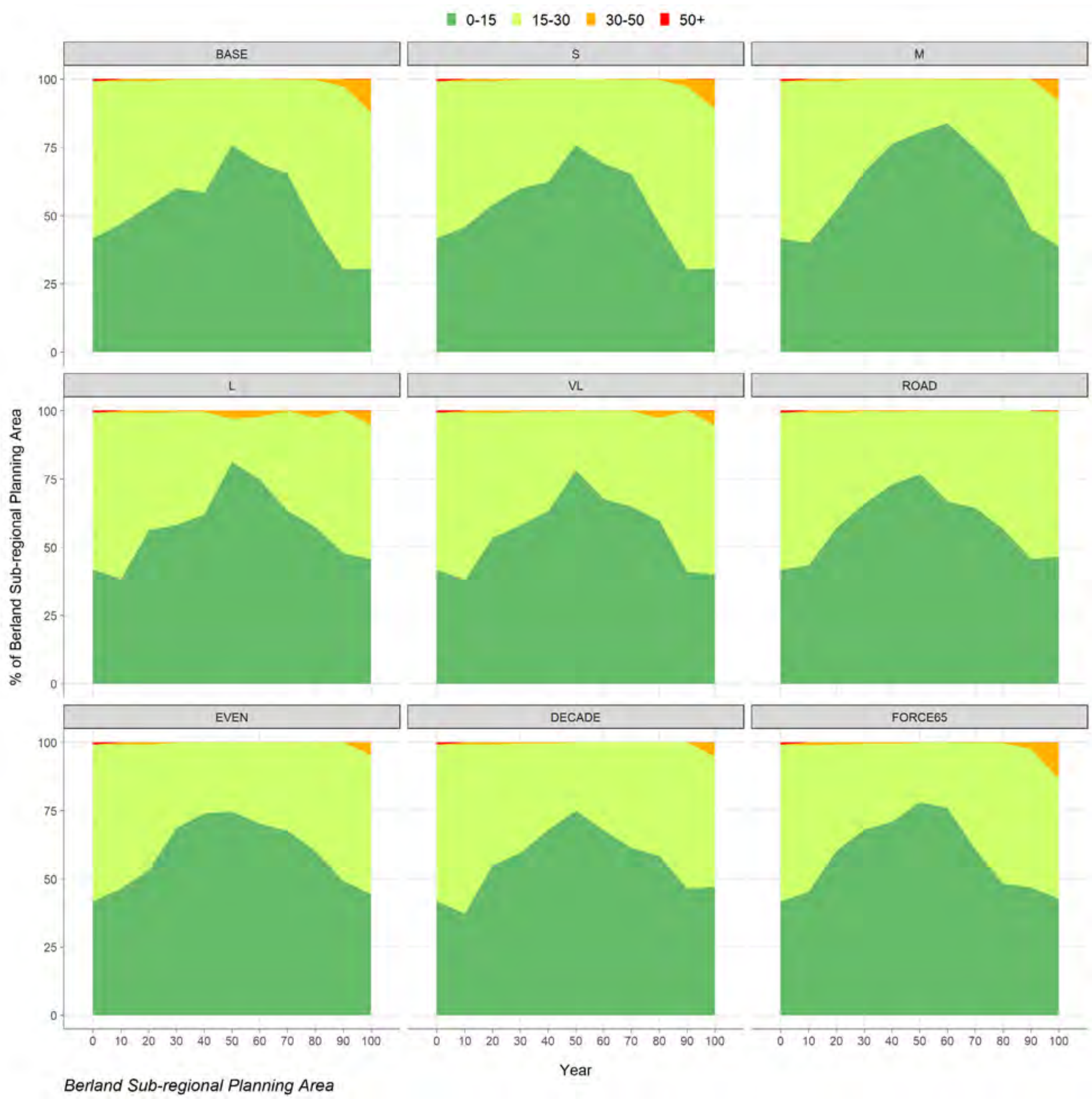


Figure 44. Percentage of area falling within each ECA risk category (very low risk, low risk, moderate risk, and high risk) in the Berland Sub-Regional Planning Area.

Traplines

The impact of each harvest scenario on trapline disturbance levels was assessed over a 100-year planning horizon (Figure 45). Traplines are categorized as having very low (0-15%), low (15-30% disturbed), moderate (30-50%), or high (>50%) disturbance levels. The Berland sub-region had the lowest initial disturbance levels (1% categorized as high disturbance) and all scenarios resulted in a considerable increase in trapline disturbance over time (18-47%). Disturbance levels within traplines increased over time in all scenarios, regardless of aggregation, timing, or access constraints. All scenarios showed a slight increase in disturbance levels around year 40 that recovers within two decades, but by year 60 disturbance levels begin to increase more steadily. The proportion of area categorized as low disturbance increased over time while the area categorized as very low disturbance dropped considerably.

The BAU scenario resulted in a considerable proportion of traplines falling within the moderate (35%) and high disturbance (7%) categories by year 100. All scenarios except BERR_S, which targets small harvest patches, resulted in less disturbance to traplines over time as compared to the baseline scenario. BERR_S resulted in the highest overall level of disturbance at year 100 (41% moderate and 7% high). The scenario directing the model to achieve >65% undisturbed habitat (BERR_FORCE65) also resulted in high disturbance levels that were comparable to the BAU scenario (32% moderate and 6% high), but with an increased proportion of traplines falling within the high risk category at year 70. The scenario constraining road building and maintenance (BERR_ROAD) resulted in the lowest disturbance level at year 100 (19% moderate).

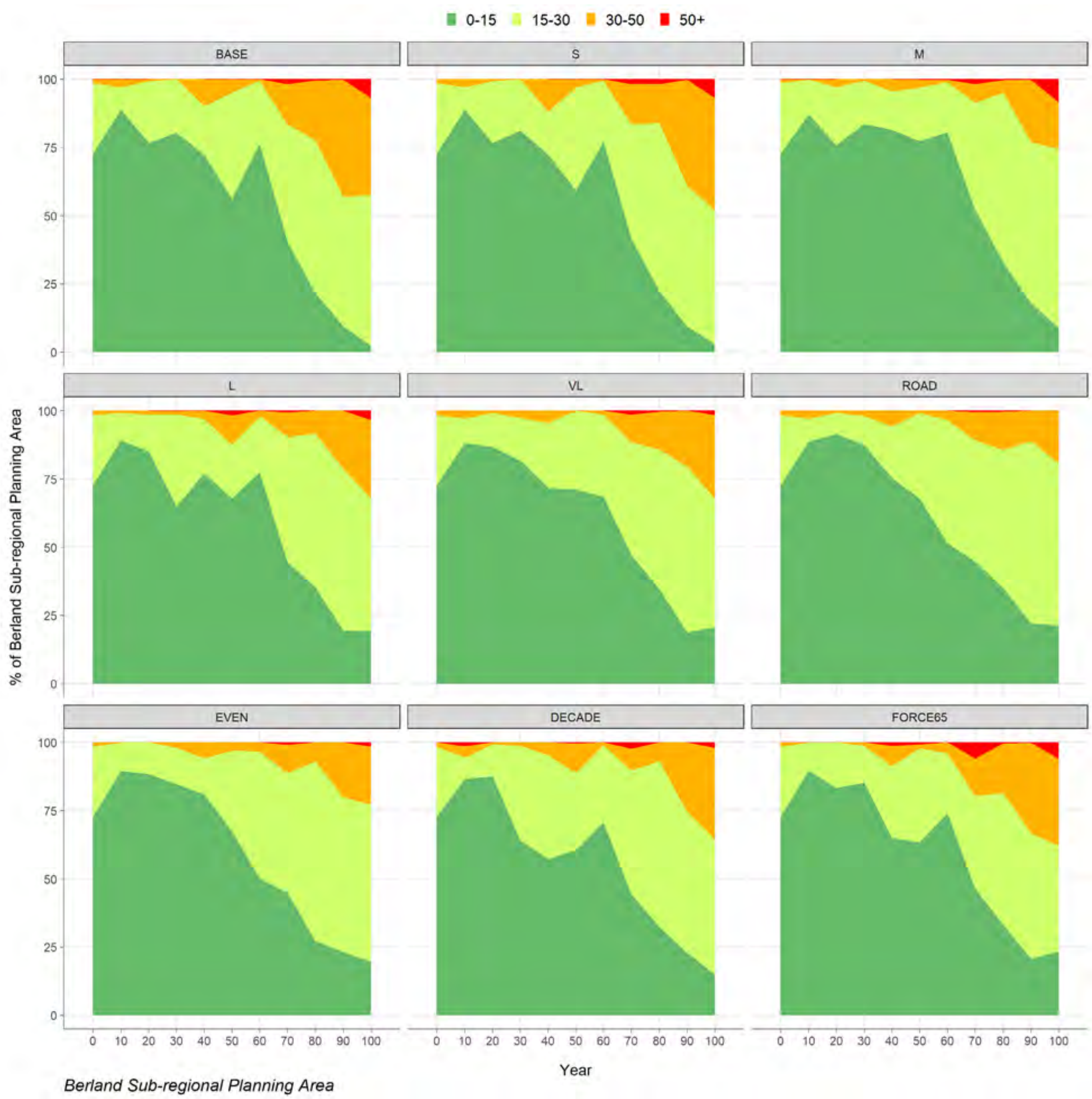


Figure 45. Percentage of area falling within each trapline disturbance category (very low disturbance, low disturbance, moderate disturbance, high disturbance) in the Chinchaga Sub-Regional Planning Area.

4.6.2 Chinchaga Sub-Regional Planning Area

Road Metrics

Relative road distance was used to compare how each scenario affected the levels of the chosen metrics. The scenario targeting large patches and constraining road building and maintenance (CHINR_ROAD) results in the lowest road building, road maintenance, and log haul relative road distance (Figure 44).

Road building levels for all scenarios drop for the first 20-30 years of the planning horizon, somewhat stabilize between years 30 and 60, before dropping again towards 0. Trends are somewhat difficult to discern, though it appears in general that the baseline and small patch scenario (CHINR_S) have the highest overall road building, and the scenario with stricter constraints on road building (CHINR_ROAD) has the least.

Road maintenance shows logarithmic growth for all scenarios before mostly plateauing at their maximum level by year 50 and generally remaining there for the rest of the horizon. The constraints in CHINR_ROAD result in it having ~20% less road maintenance than other scenarios from year 40 onwards.

In all scenarios, log haul distance increases steadily over the planning horizon, with the steepest increases occurring from year 0-40 and 80-100. The baseline, small, and small-moderate patch size scenarios have the highest relative log haul distance throughout the planning horizon. All other scenarios result have less log haul distance than the baseline scenario, and scenarios CHINR_ROAD and CHINR_DECADE have the lowest log haul distance.

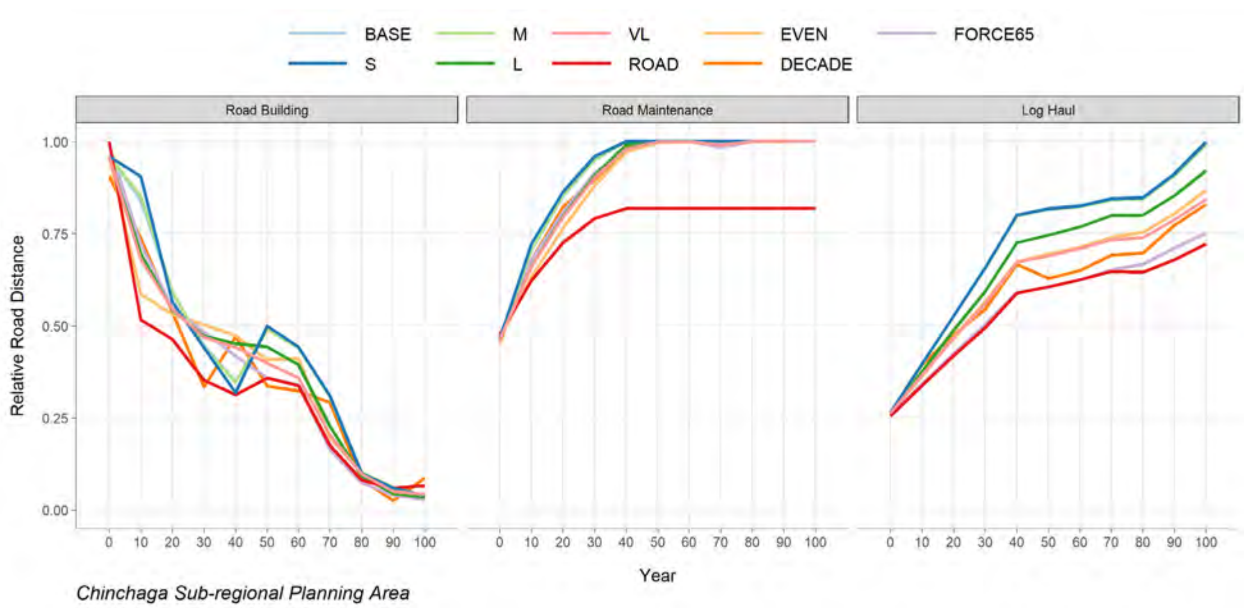


Figure 46. Road metrics (road building, road maintenance, and log haul) in the Chinchaga Sub-Regional Planning Area (0-100 years).

Songbirds and Marten

Relative abundance was assessed over the 100-year planning horizon for marten and the six songbird species. Figure 45 displays the relative abundance of each species over time for all scenarios, with the green zone representing > 85% of initial levels, the yellow zone representing 70-85% of initial levels, and the red zone representing < 70% of initial levels.

The species with the most variable results between scenarios are the brown creeper, black throated green warbler, and the Canada warbler, with scenarios with larger patches generally performing much better than the baseline or scenarios with smaller patches. Other species mostly show similar trends between scenarios, except for ovenbird where the baseline and small patch scenarios perform better than scenarios with larger patch sizes. The general trends are relatively consistent between scenarios, with the bay breasted warbler, black throated green warbler, ovenbird and marten decreasing in abundance over the 100 years, and the Canada warbler and varied thrush increasing in abundance over the 100 years. The brown creeper increases in abundance in most scenarios, except for the baseline and smaller patch scenarios (CHINR_S, CHINR_M).

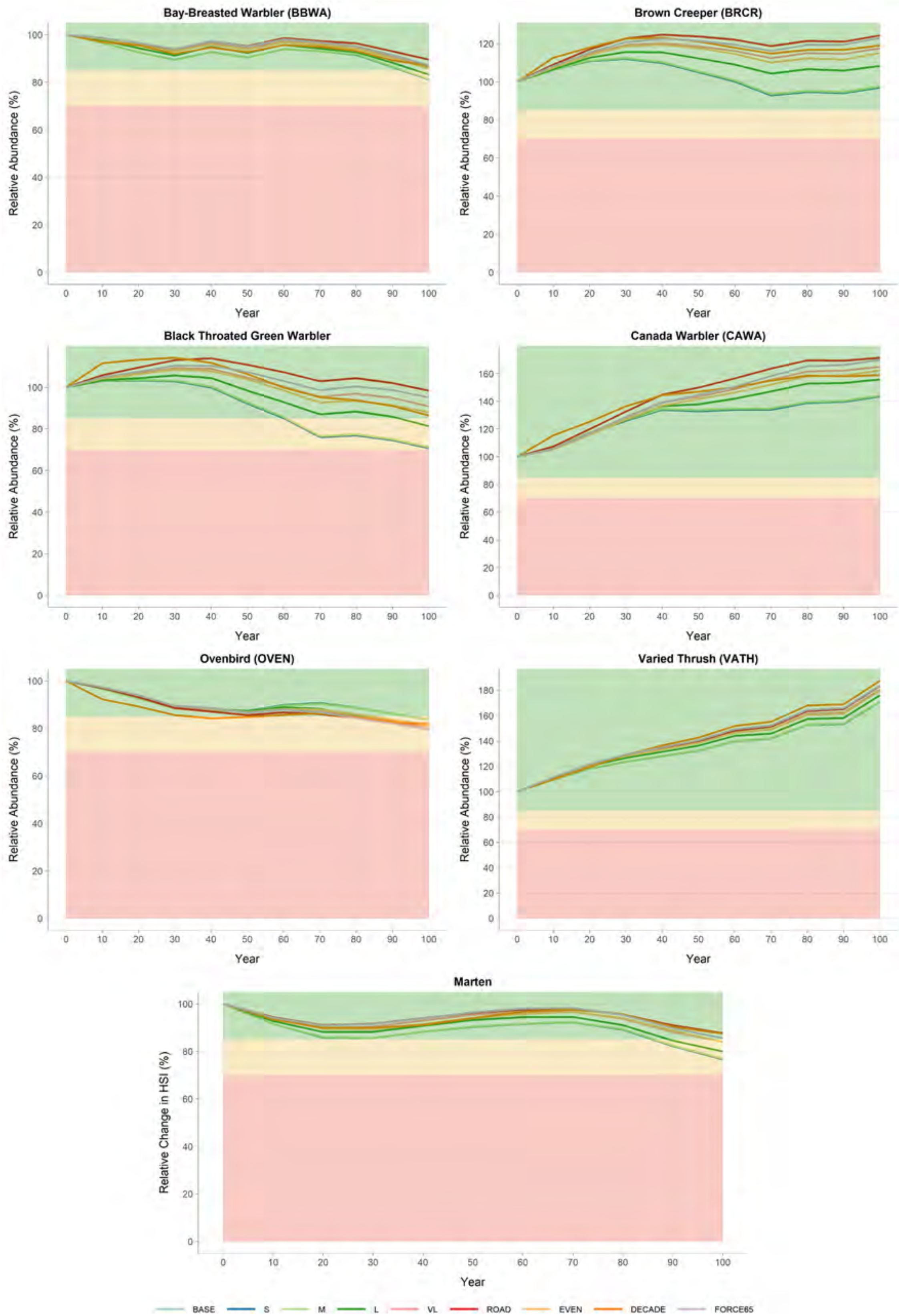


Figure 47. Relative change in abundance (%) for songbirds and marten in the Chinchaga Sub-Regional Planning Area.

Watersheds

The impact of each harvest scenario on watershed disturbance was assessed over a 100-year planning horizon using the ECA index (Figure 48). Watersheds are categorized as being very low (0-15%), low (15-30%), moderate (30-50%), or high (>50%) risk according to disturbance level. The Chinchaga sub-region had a low initial disturbance level with only 6% of area categorized as moderate risk and 94% of area categorized as low or very low risk. All scenarios resulted in less watershed disturbance over time, with four scenarios resulting in 0% of area being categorized as at-risk by year 100. All scenarios showed an increase in the proportion of very low risk area until year 50 or 60, when it began to drop to reach below pre-harvest levels by year 100.

Aggregating harvest and introducing access and timing constraints resulted in lower disturbance levels at year 100, with only the even-flow harvest scenario (CHINR_EVEN) and the scenario directing the model to achieve >65% undisturbed habitat (CHINR_FORCE65) performing slightly worse than the baseline scenario (CHINR_BASE). CHINR_EVEN and CHINR_FORCE65 resulted in the greatest area falling into the at-risk category (3% moderate), though effects were minimal. The scenarios targeting moderate-large patches (CHINR_L), very large patches (CHINR_VL), constraining road building and maintenance (CHINR_ROAD), and constraining harvest timing (CHINR_DECADE) all resulted in 0% of area falling into the at-risk category at year 100. CHINR_ROAD performed the best overall, sustaining low disturbance levels from year 10 onwards (except for 1% of area becoming briefly disturbed at year 70) and having the highest overall proportion of very low risk area over the planning horizon. There was no area categorized as being high risk at year 100 in any of the scenarios.

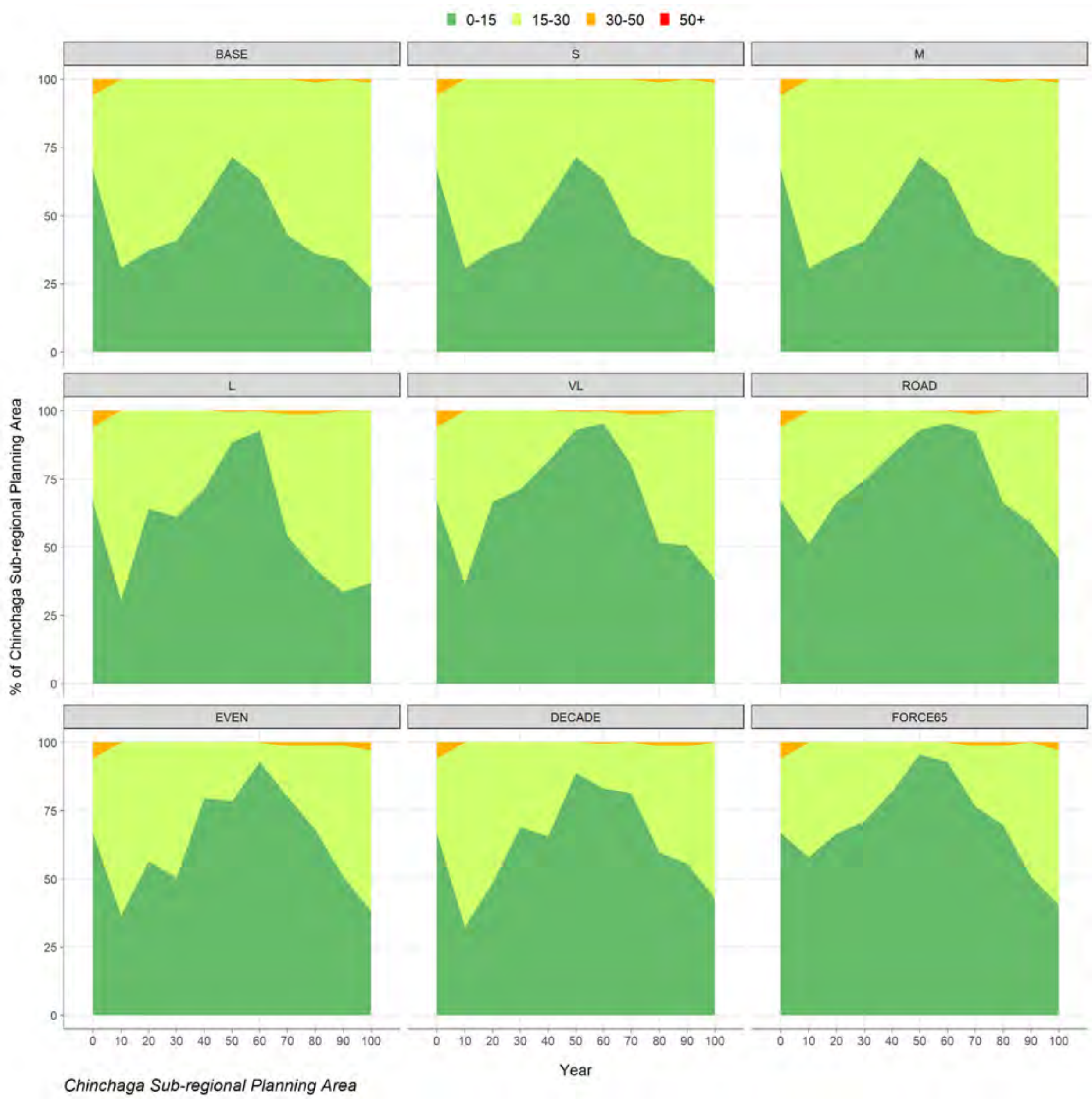


Figure 48. Percentage of area falling within each ECA risk category (very low risk, low risk, moderate risk, high risk) in the Chinchaga Sub-Regional Planning Area.

Traplines

The impact of each harvest scenario on trapline disturbance levels was assessed over a 100-year planning horizon (Figure 49). Traplines are categorized as having very low (0-15%), low (15-30% disturbed), moderate (30-50%), or high (>50%) disturbance levels. The Chinchaga sub-region had a low initial disturbance level and showed a considerable increase in trapline disturbance over time. All scenarios had a minimal amount of area falling into the moderate (3%) disturbance category at year 0. Disturbance levels within traplines increased over time in all scenarios, regardless of aggregation, timing, or access constraints. Disturbance levels in all scenarios showed a steady increase beginning around year 30-40, with the exception of scenario CHINR_DECADE, which peaked at year 30 and recovered before increasing again at year 50. The proportion of area categorized as low disturbance increased initially while the very low disturbance area dropped, followed by levels remaining fairly steady over time.

All scenarios resulted in less disturbance to traplines over time as compared to the baseline scenario. The BAU scenario resulted in the highest proportion of traplines falling within the moderate (50%) and high (12%) disturbance categories at year 100. The scenario constraining road building and maintenance (CHINR_ROAD) resulted in the lowest overall disturbance level at year 100 (33% moderate and 1% high). The scenario directing the model to achieve >65% undisturbed habitat (CHINR_FORCE65) resulted in higher disturbance levels (33% moderate and 2% high) that were an improvement from the BAU scenario but both scenario CHINR_ROAD and CHINR_DECADE resulted in less disturbance at year 100.

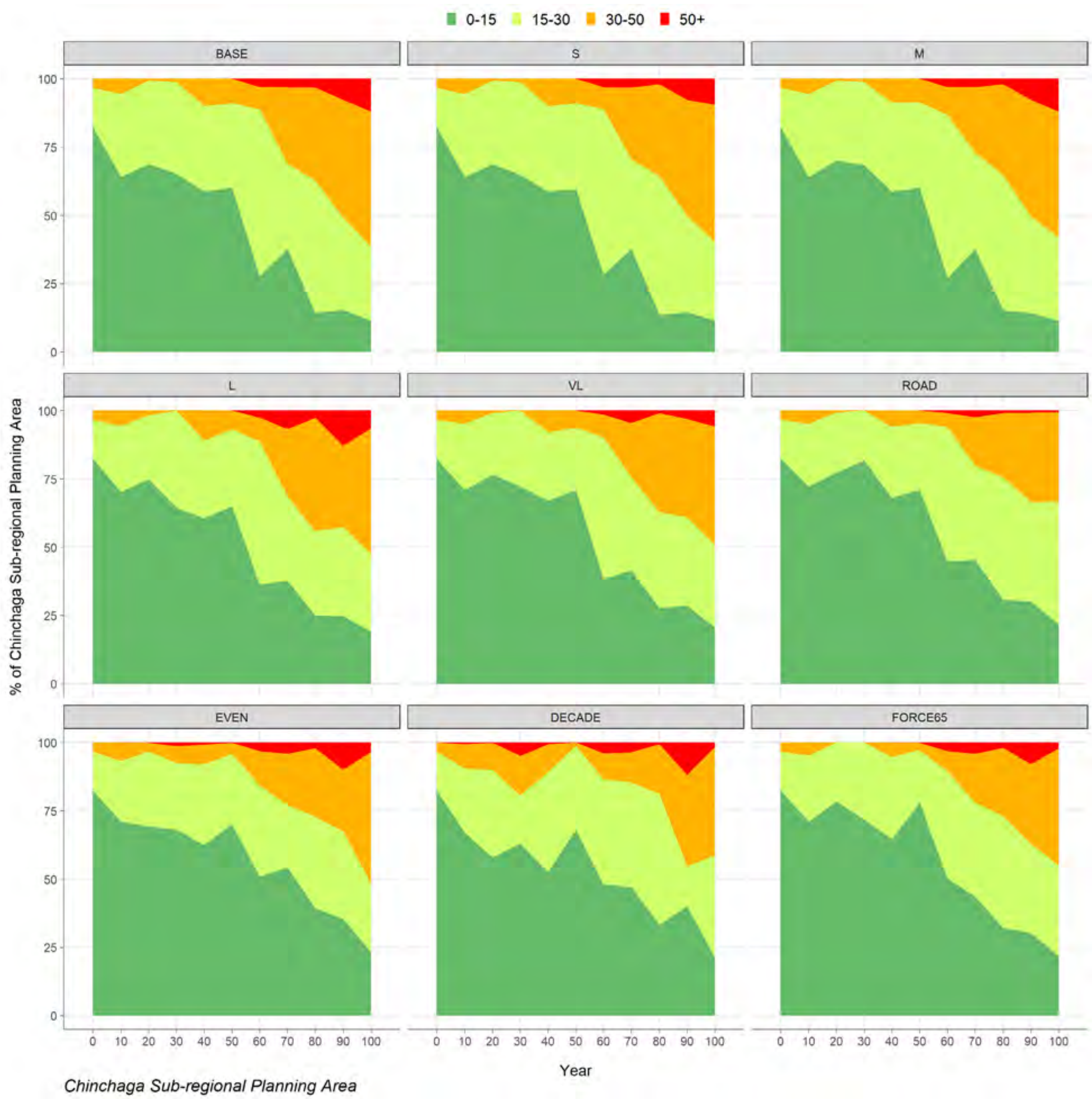


Figure 49. Percentage of area falling within each trapline disturbance category (very low disturbance, low disturbance, moderate disturbance, high disturbance) in the Chinchaga Sub-Regional Planning Area.

4.6.3 Wandering River Sub-Regional Planning Area

Road Metrics

Relative road distance was used to compare how each scenario affected the levels of the chosen metrics. The scenarios in Wandering River have more variable levels of road construction at the beginning of the planning horizon than Berland or Chinchaga, which explain the variable results at year 0 for temporary disturbance and temporary buffers (see Section 4.4.3). Most road building is done in the first few decades and subsequently decreases throughout the planning horizon, and scenario WRR_ROAD has the lowest road building overall (Figure 46).

Road maintenance shows logarithmic growth for all scenarios before plateauing at by year 70, through the baseline scenario and scenarios WRR_S and WRR_M plateau at the maximum level by year 30. The constraints on road maintenance in WRR_ROAD result in it plateauing at ~20% lower than other scenarios.

In all scenarios, log haul distance increases steadily over the planning horizon, with the steepest increases occurring from year 0-40 and 80-100. The baseline and small patch (WRR_S) scenario have the highest relative log haul distance throughout the planning horizon. Other scenarios generally have a trend of decreasing log haul distance as patch size increases, with scenarios WRR_ROAD and WRR_DECADE having the lowest log haul distance.

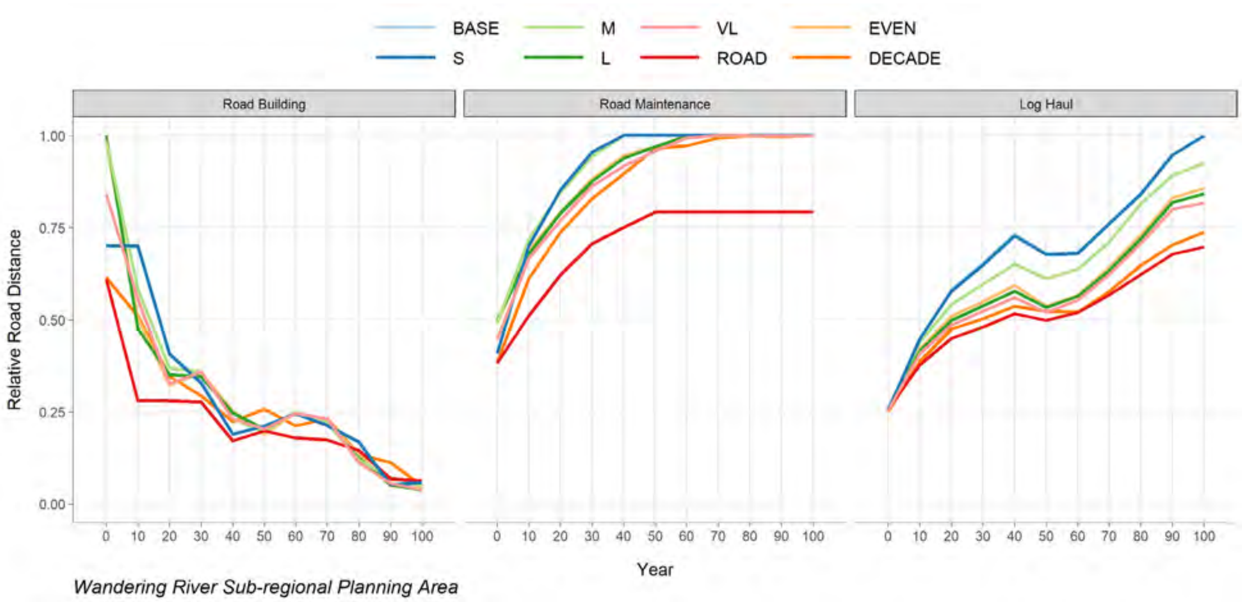


Figure 50. Road metrics (road building, road maintenance, and log haul) in the Wandering River Sub-Regional Planning Area (0-100 years).

Songbirds and Marten

Relative abundance was assessed over the 100-year planning horizon for marten and the six songbird species. Figure 47 displays the relative abundance of each species over time for all scenarios, with the green zone representing > 85% of initial levels, the yellow zone representing 70-85% of initial levels, and the red zone representing < 70% of initial levels.

Results are most variable for the black-throated green warbler, with the baseline (CHINR_BASE) and small patch scenario (CHINR_S) having a more substantial decrease than other scenarios. A similar pattern is observed for most other species as well, where scenarios with smaller patch sizes result in poorer outcomes for the species than scenarios with larger patch sizes, except for ovenbird where the baseline and small patch scenarios perform better than scenarios with larger patch sizes.

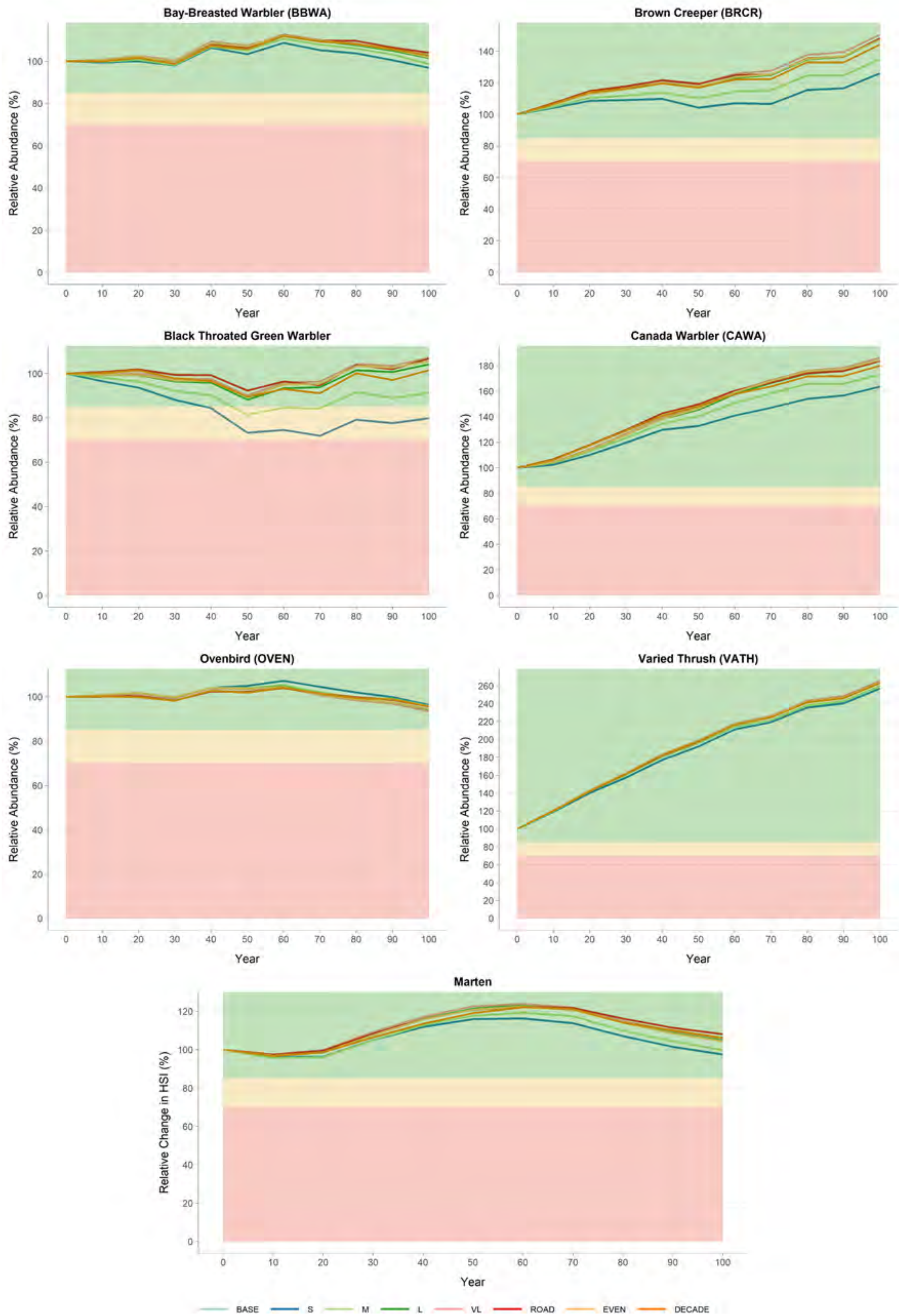


Figure 51. Relative change in abundance (%) for songbirds and marten in the Wandering River Sub-Regional Planning Area.

Watersheds

The impact of each harvest scenario on watershed disturbance was assessed over a 100-year planning horizon using the ECA index (Figure 52). Watersheds are categorized as being very low (0-15%), low (15-30%), moderate (30-50%), or high (>50%) risk according to disturbance level. The Wandering River sub-region had the highest initial disturbance level with 4% of area categorized as high risk, 23% of area categorized as moderate risk, and 73% of area categorized as low or very low risk. All scenarios resulted in a complete reduction of watershed disturbance over time, with all eight scenarios resulting in 0% of area being categorized as at-risk by year 100. All scenarios showed a considerable increase in the proportion of very low risk area over the planning horizon.

Aggregating harvest and introducing access and timing constraints resulted in lower disturbance levels at year 100, though even the baseline scenario (WRR_BASE) achieved 0% at-risk area by year 30 that was sustained until year 100. WRR_ROAD had the fastest results, achieving 0% at-risk area by year 20 and sustaining this disturbance level for the remainder of the planning horizon. The scenarios targeting small-moderate patches (WRR_M), very large patches (WRR_VL), and constraining harvest timing (WRR_DECADE) all resulted in some area (4%) briefly falling into the moderate risk category at year 80. There was no area categorized as being high risk at year 100 in any of the scenarios.

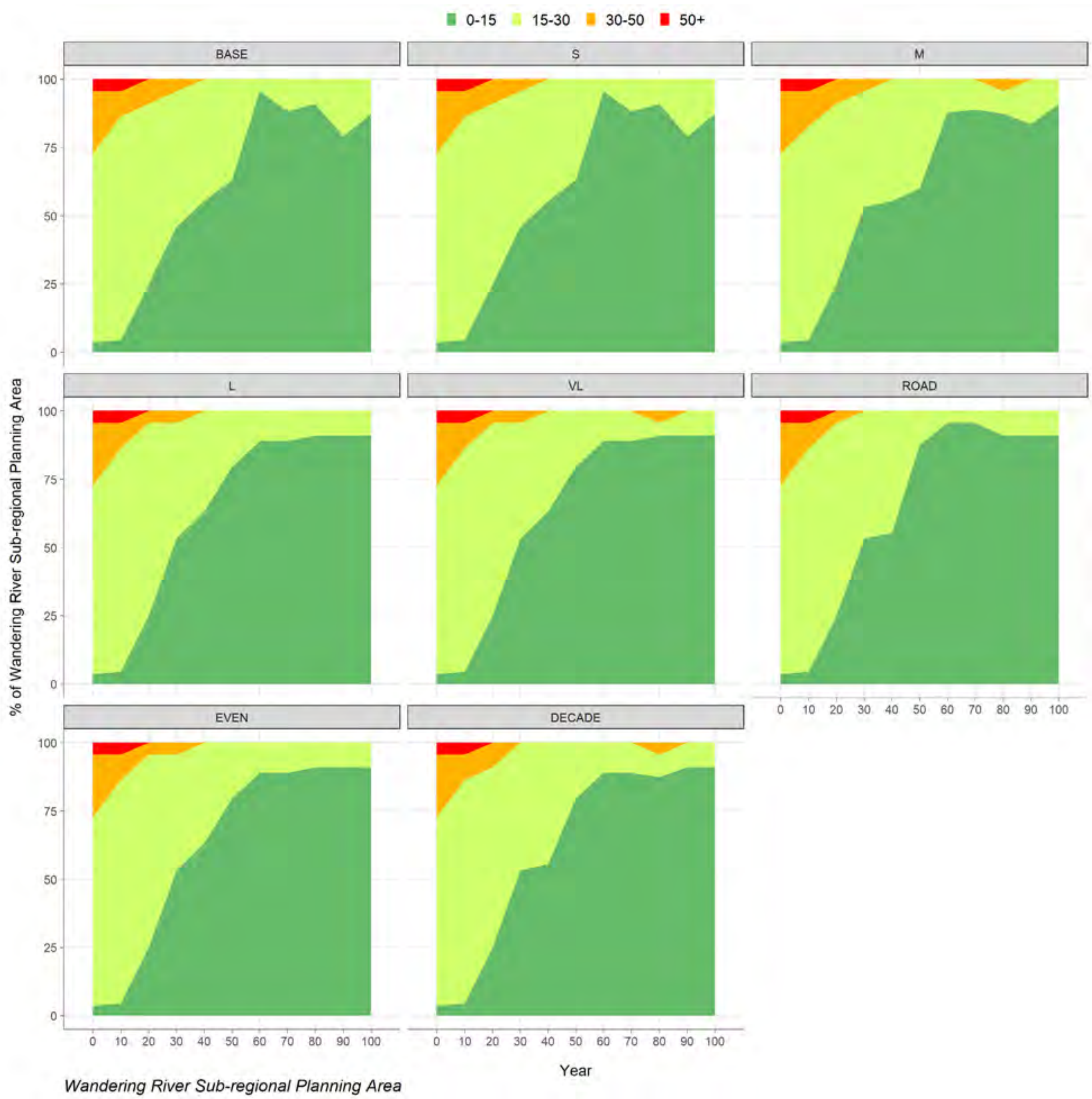


Figure 52. Percentage of area falling within each ECA risk category (very low risk, low risk, moderate risk, and high risk) in the Wandering River Sub-Regional Planning Area.

Traplines

The impact of each harvest scenario on trapline disturbance levels was assessed over a 100-year planning horizon (Figure 53). Traplines are categorized as having very low (0-15%), low (15-30% disturbed), moderate (30-50%), or high (>50%) disturbance levels. The Wandering River sub-region had the highest initial disturbance levels (6% moderate and 19% high) but showed the smallest increase (and in some cases a decrease) in trapline disturbance over time. All scenarios resulted in a 14-18% decrease in the area categorized as highly disturbed. The proportion of area categorized as low disturbance increased over time while the area categorized as very low disturbance decreased. Disturbance levels within traplines sharply decreased in the first decade and remained low until year 50 when they began to increase. This pattern is seen in all scenarios, regardless of aggregation, timing, or access constraints.

The BAU (WRR_BASE), small patch (WRR_S), and moderate-large patch (WRR_L) scenarios resulted in the highest proportion of traplines falling within the moderate (28-30%) and high (4-5%) disturbance categories at year 100. The scenario constraining harvest timing (WRR_DECADE) resulted in the lowest disturbance level at year 100 (17% moderate and 2% high). All scenarios resulted in disturbance levels at year 100 that were comparable to initial disturbance levels, though the proportion of highly disturbed area had decreased.

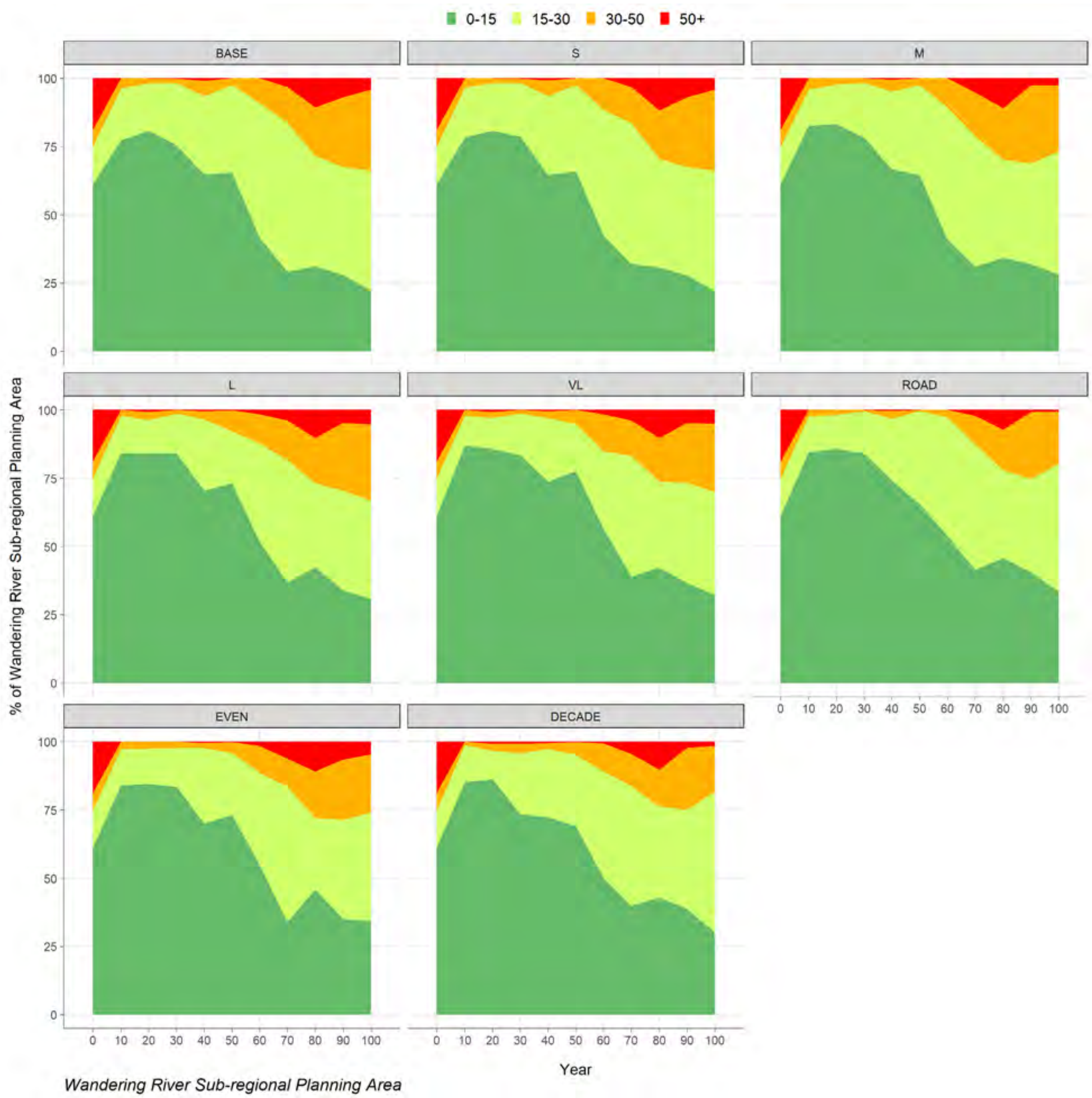


Figure 53. Percentage of area falling within each trapline disturbance category (very low disturbance, low disturbance, moderate disturbance, high disturbance) in the Wandering River Sub-Regional Planning Area.

4.7 NEPTUNE Metrics

NEPTUNE is a tool that can be used to examine how the size, shape, and distribution of disturbance events impacts the total amount and connectivity of disturbed area on the landscape. NEPTUNE metrics capture several key features of disturbance relevant to harvest aggregation. Aggregation has two dimensions; clustering and compactness.

1. Clustering is the degree to which disturbed patches are in close proximity, regardless of position or orientation. NEPTUNE uses a 400 m threshold to gather disturbed patches into events. Clustering is captured by a) event size and b) number of disturbed patches.
2. Compactness is the degree to which disturbed patches in close proximity use space efficiently. The indicators of compactness in NEPTUNE are a) event shape and b) % of event area in total residuals. The most compact event is one that is circular, with very low residual levels.

Neptune metrics were processed and calculated at year 50 and 100 for harvest disturbances within the caribou range(s) in each sub-region. Harvest disturbances include any cutblocks that are less than 40 years of age, as that is the length of time they are considered to be contributing to caribou habitat disturbance within the model. Where possible, they are compared to the natural range of variation (NRV) of the natural disturbance patterns from wildfires. Neptune maps for all scenarios within each sub-region can be found in Appendix IV. The following conclusions can be drawn from the modeling results:

- Total disturbance area and matrix remnant area decreases as target patch size increases.
- Larger patches result in events with a similar distribution to NRV in the Berland and Chinchaga sub-regions. Larger harvest patches in the Wandering River sub-region result in similar or less area in events >2,000 ha as compared to small patches, and all scenario results are quite different from NRV.
- Small patch sizes results in a large range of event sizes, but the large events contain a large amount of matrix when compared to NRV.
- Larger harvest patches create more contiguous and uniform disturbance events:
    - Increasing the size of patch targets results in less area in the matrix.
    - Increasing the size of patch targets results in increased island area.
    - Increasing patch size reduces the number of disturbance patches per event and reduces the event shape index.
- All scenarios result in more matrix area than the NRV.
- Scenarios in Chinchaga and Wandering River result in less island area than NRV while results in Berland are more mixed.

Figure 48 illustrates several of the main findings by presenting a range of harvest patch and disturbance event sizes from scenarios in Berland. Example 2 in this figure demonstrates how many small harvest patches can combine to create a very large disturbance event with many disturbance patches, significant matrix area, and a high shape index. Examples 3 and 4 demonstrate how larger harvest patches result in more contiguous disturbance events with less matrix area, more island area, and a lower shape index. Figure 49 compares the overall results and spatial distribution of a scenario with small harvest patches (BERR_S) to a scenario with larger harvest patches (BERR_L).

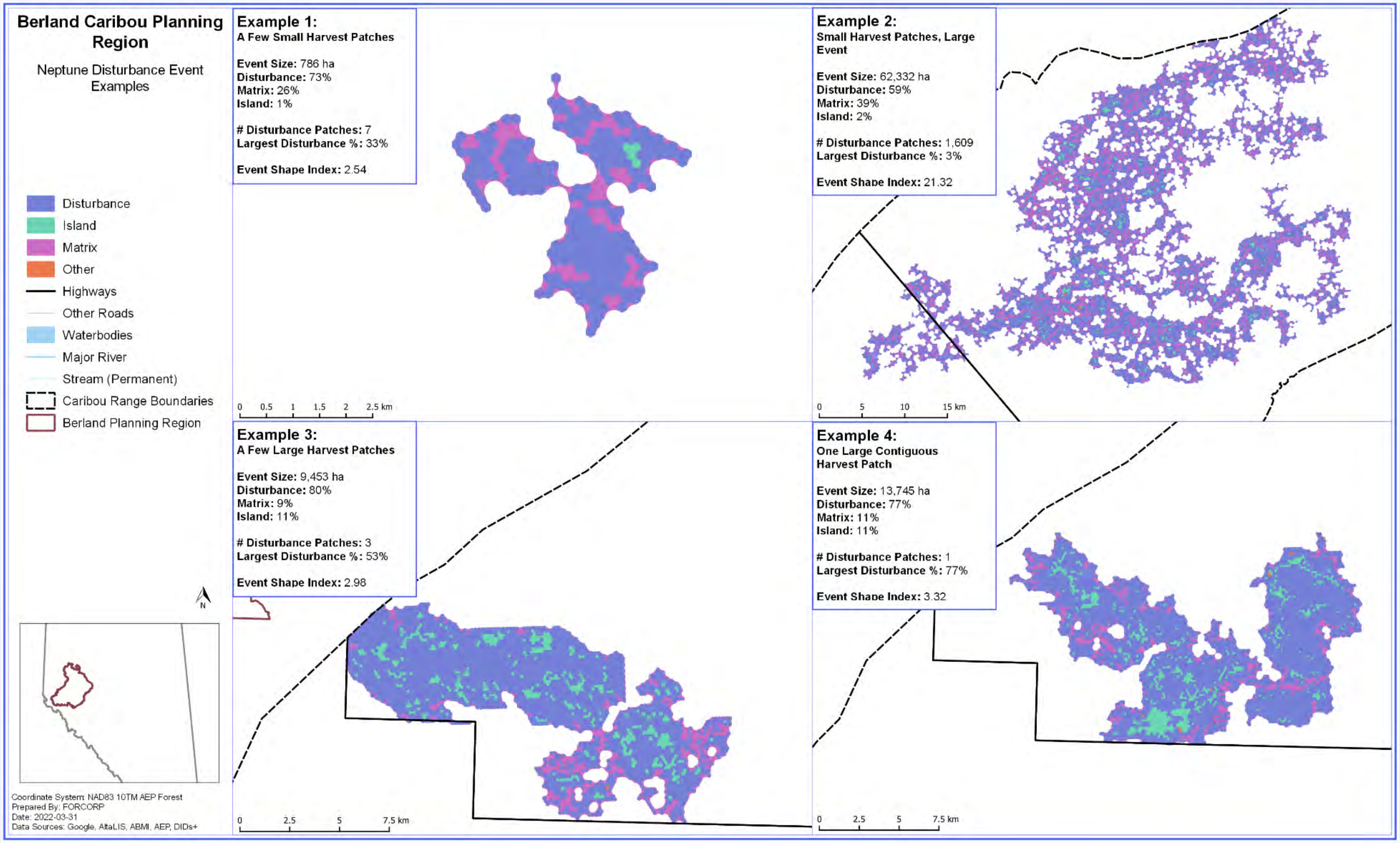


Figure 54. Examples of a range of patch and event sizes in the Berland Sub-Regional Planning area.

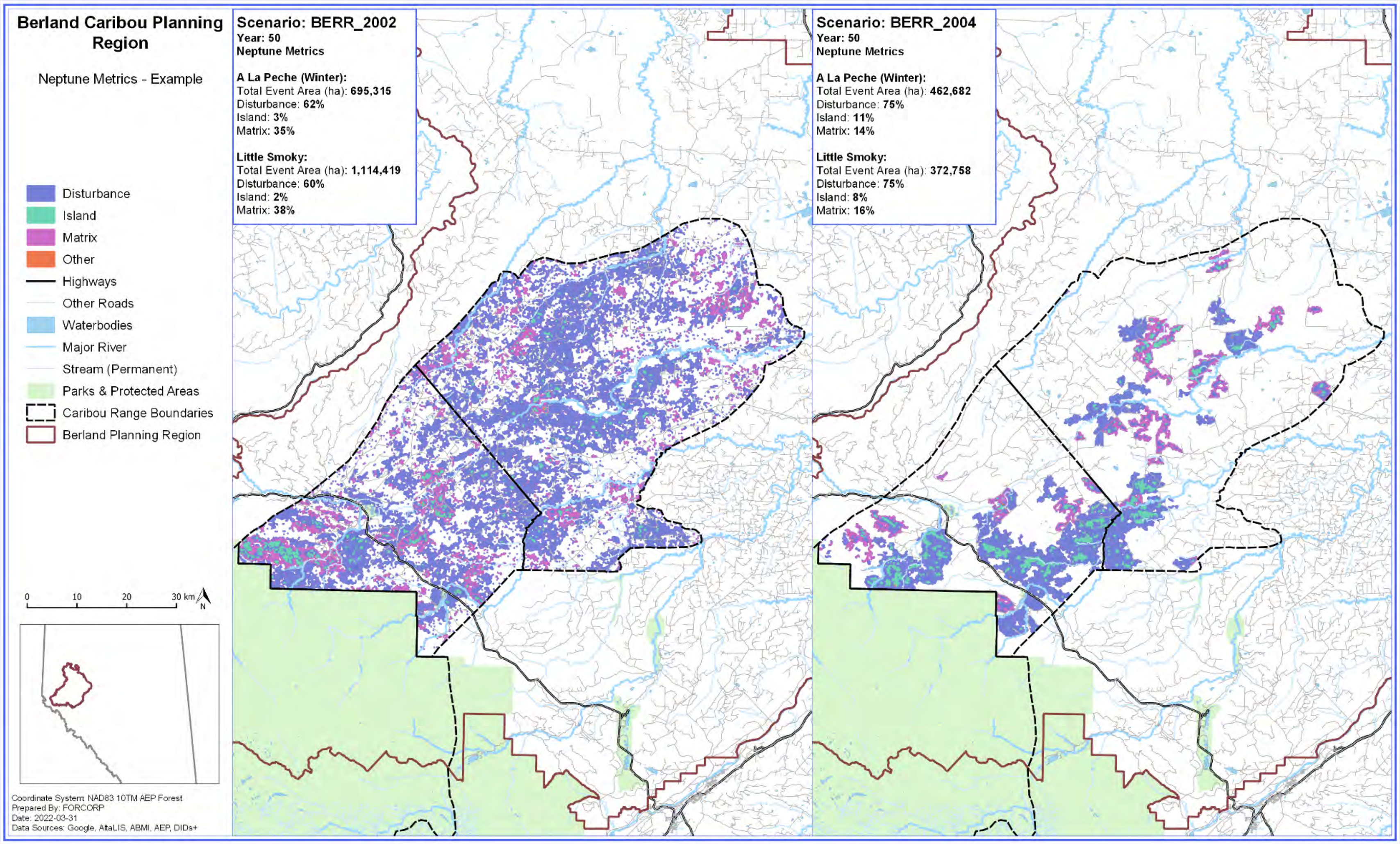


Figure 55. Neptune metrics at year 50 for scenario BERR_S compared to BERR_L.

4.7.1 Berland Sub-Regional Planning Area

Disturbance Events Overview

Neptune results are presented for the whole caribou range and are not separated for A La Peche / Little Smoky in the Berland region, as the two caribou ranges were not processed separately (i.e., disturbance patches, events, and their matrices could go across or link events between the two ranges).

Figure 50 displays the total area of disturbance and the proportion of disturbance, matrix, islands, and other (islands within a disturbance that are waterbodies) created by each of the harvest scenarios. Disturbance area and matrix remnants decrease as target patch size increases. The reduction in matrix is more considerable than the reduction in disturbance area, which is most notable when moving from small to small-moderate to moderate-large patch targets (BERR_S through BERR_L). Island area is more variable, with larger harvest patches typically resulting in a slightly larger area of islands than the baseline scenario.

Of the original eight scenarios (excluding BERR_FORCE65), the scenario targeting large to very large patches with even-flow harvest in caribou range (BERR_EVEN) results in the lowest amount of disturbed area at year 100. The baseline scenario resulted in the highest disturbed area at year 100, with both BERR_S and BERR_M having comparable results.

Figure 56. Area of disturbances, matrix area, islands, and other by scenario in Berland Sub-Regional Planning Unit (Year 50 and Year 100).

Event Size

Event size looks at any contiguous disturbance area linked by matrix remnants. The natural range of variation for event sizes and a summary of total area within each event size class by scenario is displayed in Table 14.

The NRV indicates that the majority of historical disturbance events fall within events larger than 10,000 ha (46.35%) and the proportion of disturbances falling within the smaller size classes progressively decreases. Larger patch size targets typically result in a distribution of event size classes that is more similar to NRV. Smaller harvest patches result in a greater proportion of events being larger than 10,000 ha, due to more events being linked together by matrix remnants. Larger target patches result in less area within really large events (10,000+ ha), but more area within events that are 200 – 1,000 ha in size.

Table 14. Percentage of events (area weighted) within each size class in the Berland Sub-Regional Planning Unit (Year 50 and Year 100).

Year	Scenario	Event Size Class (ha)				
		0-10	10-200	200-2000	2000-10000	10000+
	NRV	0.9	3.84	19.06	29.84	46.35
50	BERR_BASE	1.38	5.62	9.51	10.43	73.07
	BERR_S	1.63	6.46	7.31	11.58	73.02
	BERR_M	2.21	10.79	32.87	25.36	28.77
	BERR_L	0.01	1.25	13.31	23.8	61.63
	BERR_VL	0.49	5.33	26.07	12.71	55.41
	BERR_ROAD	0.96	4.79	28.52	12.12	53.61
	BERR_EVEN	0.52	4.39	27.63	32.16	35.3
	BERR_DECADE	0	1.69	22.28	48.64	27.38
	BERR_FORCE65	0	0	18.49	81.51	0
100	BERR_BASE	1.01	5.59	8.56	6.14	78.7
	BERR_S	1.29	6.13	10.05	4.89	77.63
	BERR_M	0.74	4.16	14.29	19.51	61.3
	BERR_L	0.01	3.25	15.64	17.7	63.41
	BERR_VL	0.32	2.87	13.4	31.08	52.33
	BERR_ROAD	0.83	1.81	20.07	28.38	48.91
	BERR_EVEN	0.46	2.37	24.48	55.73	16.96
	BERR_DECADE	0	0.61	12.99	29.11	57.29
	BERR_FORCE65	0	0	0	65.97	34.03

Matrix Area

The natural range of variation for event area contained within the matrix and a summary of total percentage of event area within the matrix by scenario is displayed in Table 15. Historical natural disturbances have a range of matrix percentages, with over 15% of events by area falling into each of the 0-5, 5-10, 10-20, and 20-30 percentage classes, with the greatest proportion of events being within the 5-10% class (24.53%). Harvest patterns result in a narrower distribution of matrix percentages, with most events in the baseline and small patch scenario (BERR_S) having 30-40% event area within the matrix, and most scenarios with larger patches (BERR_L through BERR_FORCE65) having 10-20% of the event area in the matrix. BERR_FORCE65 has the smallest percentage of the event area falling within the matrix. None of the scenarios have a distribution similar to NRV, though as patch size increases the matrix area is reduced and generally becomes more similar to the NRV.

Table 15. Percentage of events (area weighted) within each matrix percentage class by scenario in the Berland Sub-Regional Planning Unit (Year 50 and Year 100) compared to NRV.

		% of Event Area in Matrix						
Year	Scenario	0-5	5-10	10-20	20-30	30-40	40-50	50-100
	NRV	20.75	24.53	20.75	15.09	11.32	5.66	1.89
50	BERR_BASE	0.38	0.52	0.72	2.79	84.41	10.46	0.73
	BERR_S	0.41	0.58	0.64	2.13	84.78	10.6	0.85
	BERR_M	1.2	0.67	25.88	63.07	8.32	0.86	0
	BERR_L	0.01	13.57	81.72	3.99	0.72	0	0
	BERR_VL	0.19	2.09	83.69	10.82	1.65	1.22	0.34
	BERR_ROAD	0.67	27.58	47.34	20.32	2.92	1.17	0
	BERR_EVEN	0.32	2.2	66.37	29.99	1.11	0	0
	BERR_DECADE	0	1.41	84.24	13.87	0.48	0	0
	BERR_FORCE65	0	55.55	44.45	0	0	0	0
100	BERR_BASE	0.31	0.36	0.36	0.78	90.53	5.86	1.79
	BERR_S	0.44	0.44	0.35	1.62	88.46	6.97	1.72
	BERR_M	0.27	0.29	2.54	86.86	9.76	0.25	0.02
	BERR_L	0	1.16	82.13	15.54	1.17	0	0
	BERR_VL	0.16	6.41	86.87	4.44	1.88	0.24	0
	BERR_ROAD	0.52	0.81	63.22	32.23	2.62	0.58	0.02
	BERR_EVEN	0.29	7.36	71.44	19.99	0.89	0.04	0
	BERR_DECADE	0	12.17	83.61	4.19	0.03	0	0
	BERR_FORCE65	0	23.9	76.1	0	0	0	0

Islands Area

The natural range of variation for event area contained within islands and a summary of total percentage of event area within islands by scenario is displayed in Table 16. Historical natural disturbances have a range of island percentages, with 56% of events have 0-5% of the area within islands, and 16.98% and 13.21% having 5-10 and 10-20% of the area within islands respectively. The baseline and small patch scenario (BERR_S) generally have very little area within islands. As harvest patch size increases, the percentage of event area within islands also increases. None of the scenarios have a similar distribution to NRV, as small patch scenarios generally have more events with 0-5% islands, and larger patch scenarios generally have more events that are 5-20% island.

Table 16. Percentage of events (area weighted) within each island percentage class by scenario in the Berland Sub-Regional Planning Unit (Year 50 and Year 100) compared to NRV.

		% of Event Area in Islands						
Year	Scenario	0-5	5-10	10-20	20-30	30-40	40-50	50+
	NRV	47.06	19.61	17.65	7.84	1.96	0	5.88
50	BERR_BASE	76.81	23.19	0	0	0	0	0
	BERR_S	100	0	0	0	0	0	0
	BERR_M	71.51	12	16.49	0	0	0	0
	BERR_L	20.3	13.75	65.95	0	0	0	0
	BERR_VL	24.37	14.59	61.04	0	0	0	0
	BERR_ROAD	24.97	43.96	31.07	0	0	0	0
	BERR_EVEN	27.77	35.5	36.74	0	0	0	0
	BERR_DECADE	27.96	31.37	40.67	0	0	0	0
	BERR_FORCE65	14.63	18.62	66.74	0	0	0	0
100	BERR_BASE	100	0	0	0	0	0	0
	BERR_S	99.97	0.03	0	0	0	0	0
	BERR_M	33.02	66.18	0.8	0	0	0	0
	BERR_L	16.84	81.75	1.42	0	0	0	0
	BERR_VL	11.18	53.42	35.39	0	0	0	0
	BERR_ROAD	14.6	50.91	34.48	0	0	0	0
	BERR_EVEN	15.2	37.6	41.63	5.57	0	0	0
	BERR_DECADE	10.68	42.29	47.03	0	0	0	0
	BERR_FORCE65	0	51.97	48.03	0	0	0	0

Event Area Within Largest Disturbance Patch

The natural range of variation for event area within the largest disturbance patch and a summary of total percentage of event area within the largest disturbance patch by scenario is displayed in Table 17. The majority of natural disturbances (58.49%) tend to have 80-100% of their area within the largest disturbance patch. In all scenarios, events have a smaller percentage of area taken up by the largest disturbance patch than in the NRV. The baseline and small patch scenario (BERR_S) have most of their events with <10% of the total area within the largest disturbance patch, due to many disturbance patches being linked together by the matrix. Scenarios with larger patches result in a greater percentage of the event area being with the largest disturbance patch pushing the distribution towards NRV, though all scenarios have few events with >80% of the area being within the largest disturbance patch.

Table 17. Percentage of events (area weighted) within each largest disturbance percentage class by scenario in the Berland Sub-Regional Planning Unit (Year 50 and Year 100) compared to NRV.

		% of Event Area in Largest Disturbance Patch							
Year	Scenario	0-10	10-20	20-30	30-40	40-50	50-60	60-80	80-100
	NRV	1.89	1.89	1.89	11.32	3.77	7.55	13.21	58.49
50	BERR_BASE	59.18	27.32	6.64	2.09	2.17	0.79	0.49	1.33
	BERR_S	82.09	8.3	2.9	2.23	1.82	0.88	0.23	1.54
	BERR_M	12.29	20.44	13.51	26.6	5.8	4.75	11.84	4.77
	BERR_L	0	0	7.44	11.23	66.01	2.26	6.82	6.24
	BERR_VL	0	0.36	0.34	0.47	41.39	9.36	39.69	8.39
	BERR_ROAD	0	0.51	0	4.48	35.87	9.74	45.31	4.1
	BERR_EVEN	0	0	14.38	23.9	3.49	10.94	40.03	7.27
	BERR_DECAD	0	0	27.38	23.39	6.91	6.9	29.96	5.47
	BERR_FORCE	0	0	0	0	28.02	30.39	35.84	5.75
100	BERR_BASE	85.92	7.91	2.59	1.14	0.65	0.67	0.23	0.9
	BERR_S	76.53	17.11	1.78	1.29	0.75	0.97	0.45	1.12
	BERR_M	32.01	47.69	5.25	1	4.05	4.09	4.45	1.47
	BERR_L	42.08	0.56	18.37	22.02	2.18	1.75	7.47	5.56
	BERR_VL	0	28.61	0.01	10.87	14.96	17.45	24.86	3.23
	BERR_ROAD	0	0.02	16.09	21.83	30.99	8.18	21.53	1.35
	BERR_EVEN	0	0	0.83	12.01	25.85	18.89	37.7	4.71
	BERR_DECAD	0	0	0	52.01	5.7	12.18	25.79	4.32
	BERR_FORCE	0	0	0	16	25.4	20.56	38.04	0

Disturbance Patches Per Event

As harvest patch size increases, the number of disturbance patches per event within each event size class decreases (Figure 51). Events in the 1,000-10,000 and 10,000+ ha size class from the baseline and small patch scenario (BERR_S) have far more disturbance patches than other scenarios and NRV (note that the Y axis is on a logarithmic scale), with ~1,000 disturbance patches per event for events >10,000 ha in area. Scenarios with larger harvest patch sizes generally perform more similarly to NRV, though with fewer disturbance patches per event for the larger event size classes.

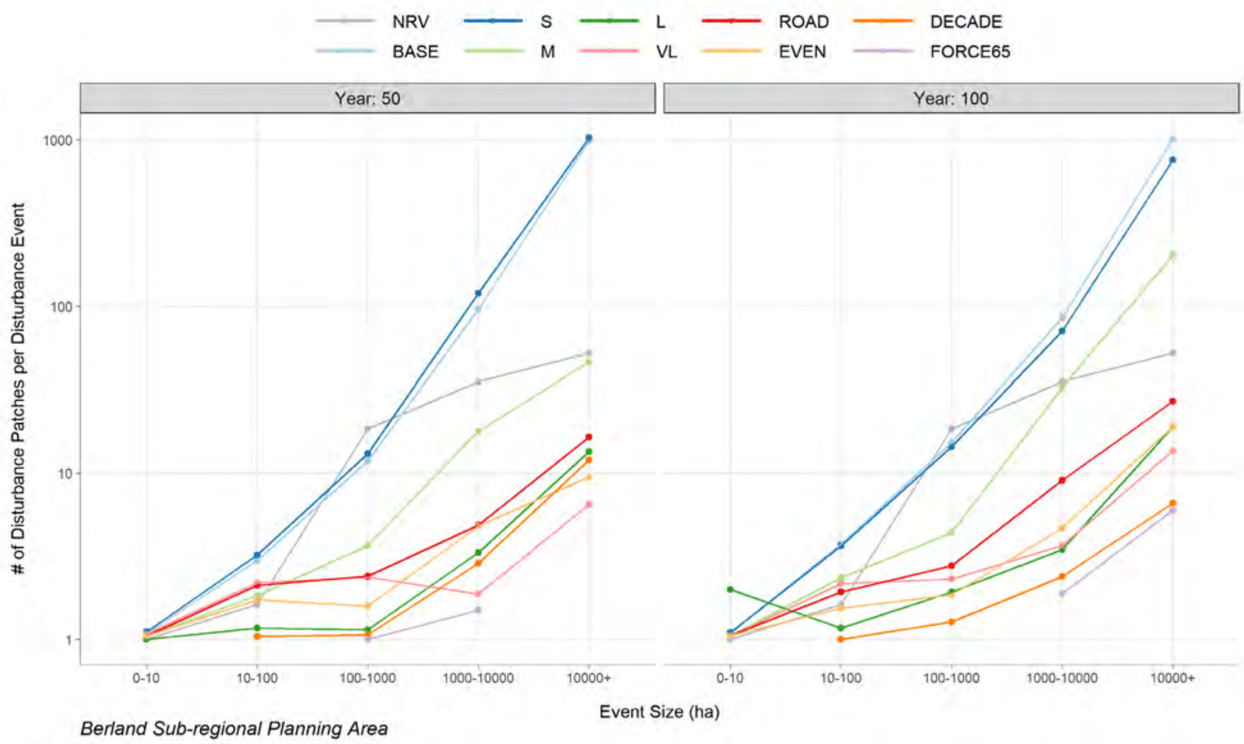


Figure 57. Average number of disturbance patches per disturbance event by event size class (ha) in Berland Sub-Regional Planning Area.

Event Shape Index

The event shape index compares the ratio of the perimeter of the disturbance event to the perimeter of a perfect circle of the same area. The BAU (BERR_BASE) and small patch scenarios (BERR_S) have the highest event shape index (Figure 52). Scenarios with larger harvest patches have a lower shape index and are more similar to NRV, though all scenarios have a higher shape index than NRV for events larger than 1,000 ha.

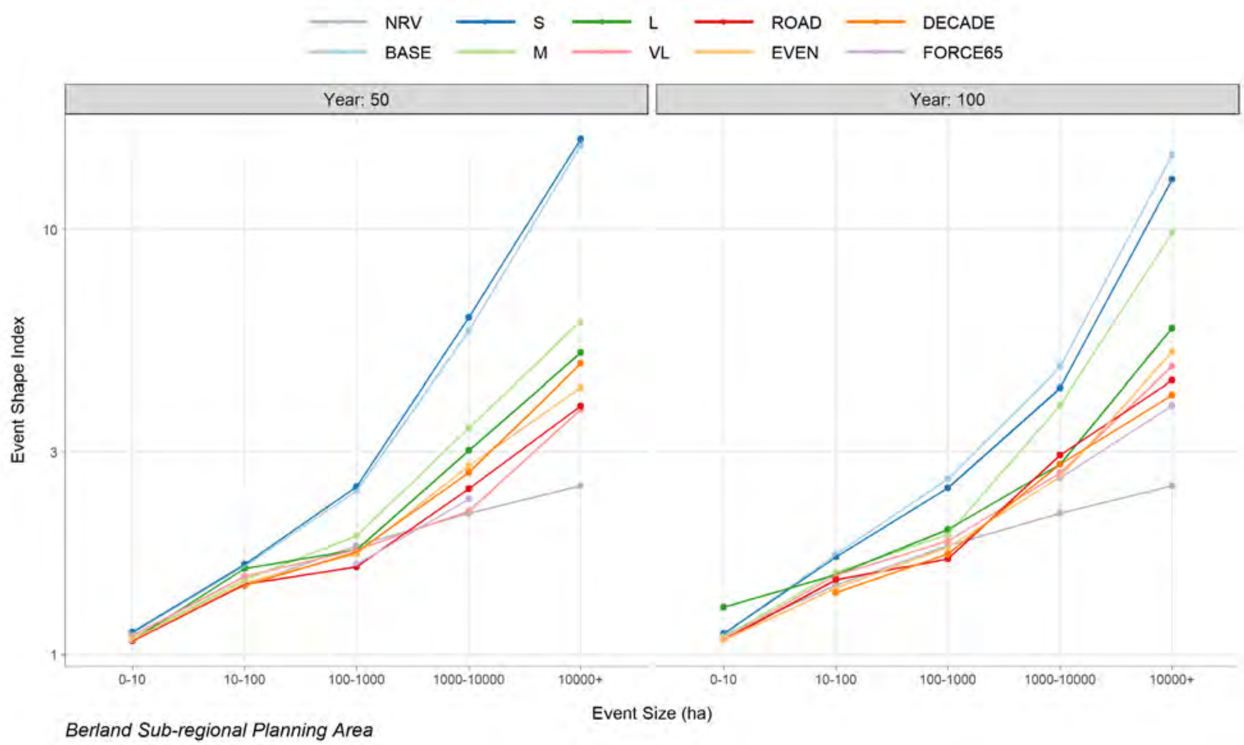


Figure 58. Average event shape index by event size class (ha) in Berland Sub-Regional Planning Area.

4.7.2 Chinchaga Sub-Regional Planning Area

Disturbance Events Overview

Figure 53 displays the total area of disturbance and the proportion of disturbance, matrix, islands, and other (islands within a disturbance that are waterbodies) for each of the harvest scenarios. Disturbance area and matrix remnants decrease as harvest patch size increases. The decrease in in matrix area is fairly proportionate to the decrease in disturbance area as harvest patch size increases. Island area is slightly more variable, with larger harvest patches typically resulting in a similar or slightly larger area of islands than the baseline scenario.

Targeting moderate-large patches (CHINR_L) results in a notable drop in disturbed area at year 50 though the outcomes are comparable to BAU at both year 50 and 100, suggesting that moderate to large aggregation in the Chinchaga sub-region has a positive effect on disturbance are that lasts over time. Constraining access results in a similar amount and proportion of disturbance types as aggregating harvest into very large patches at year 50, but by year 100 no longer provides an additional reduction in disturbed area. Of the original eight scenarios (excluding CHINR_FORCE65), the scenario targeting large to very large patches (CHINR_VL) results in the lowest amount of disturbed area at year 50 and the scenario targeting large to very large patches and even-flow harvest in caribou range over time (CHINR_EVEN) results in the lowest amount of disturbed area at year 100. The scenario targeting small patches (CHINR_S) resulted in the highest disturbed area at year 50 and 100, with both CHINR_BASE and CHINR_M having comparable results.

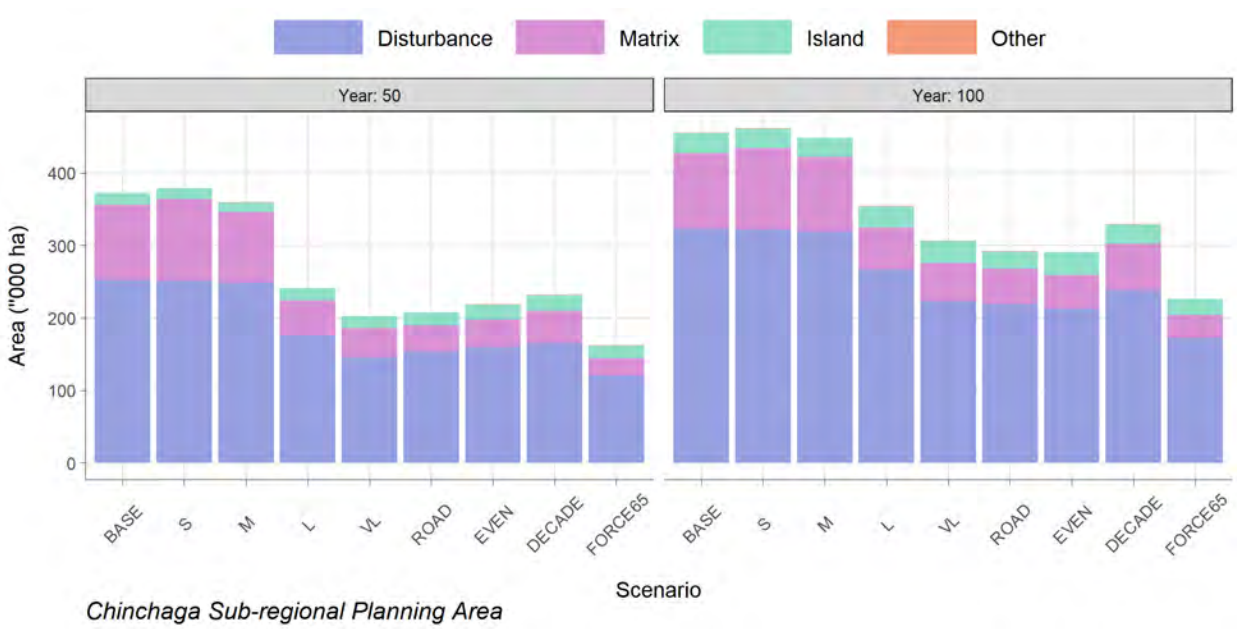


Figure 59. Area of disturbances, matrix area, islands, and other by scenario in Chinchaga Sub-Regional Planning Unit (Year 50 and Year 100).

Event Size

Event size looks at any contiguous disturbance area linked by matrix remnants at year 50 and year 100. The natural range of variation for event sizes and a summary of total area within each event size class by scenario is displayed in Table 18.

Most scenarios achieve relatively similar results to NRV, with more area in events larger than 10,000 ha, and the percentage of events decreasing in each subsequent smaller size class. The scenarios with larger patches tend to be the most similar to NRV at year 100, with scenario CHINR_DECADE having a very similar distribution of event sizes to NRV.

Table 18. Percentage of events (area weighted) within matrix percentage classes in the Chinchaga Sub-Regional Planning Unit (Year 50 and Year 100) compared to NRV.

		Event Size Class (ha)				
Year	Scenario	0-10	10-200	200-2000	2000-10000	10000+
	NRV	1.00	3.00	14.00	25.00	57.00
50	CHINR_BASE	0.84	8.25	19.86	21.21	49.84
	CHINR_S	1.06	8.29	19.60	21.43	49.62
	CHINR_M	0.80	9.43	22.97	20.72	46.09
	CHINR_L	0.13	8.66	28.55	23.37	39.28
	CHINR_VL	0.37	5.22	30.49	27.95	35.97
	CHINR_ROAD	0.42	7.69	33.47	24.71	33.70
	CHINR_EVEN	0.25	4.23	15.08	23.08	57.36
	CHINR_DECADE	0.11	2.95	22.68	21.15	53.11
	CHINR_FORCE65	0.00	0.01	33.13	26.32	40.55
100	CHINR_BASE	0.51	7.09	14.73	5.74	71.94
	CHINR_S	0.57	6.93	14.39	5.44	72.67
	CHINR_M	0.54	7.43	14.82	9.13	68.09
	CHINR_L	0.15	4.44	16.69	10.90	67.82
	CHINR_VL	0.28	3.20	17.78	17.54	61.21
	CHINR_ROAD	0.36	6.03	21.63	16.02	55.96
	CHINR_EVEN	0.26	1.79	12.59	20.20	65.15
	CHINR_DECADE	0.03	2.83	19.43	22.80	54.90
	CHINR_FORCE65	0.00	0.00	20.79	32.86	46.35

Matrix Area

The natural range of variation for event area contained within the matrix and a summary of total percentage of event area within the matrix by scenario is displayed in Table 19. Historical natural disturbances generally have relatively little matrix area, with ~82% of events having less than 10% of their area within the matrix. All scenarios have more event area in the matrix than NRV, though scenarios with larger harvest patches decrease the matrix area moving it closer to NRV. CHINR_FORCE65 has the smallest percentage of the event area falling within the matrix.

Table 19. Percentage of events (area weighted) within each matrix percentage class by scenario in the Chinchaga Sub-Regional Planning Unit (Year 50 and Year 100) compared to NRV.

Year	Scenario	% of Event Area in Matrix						
		0-5	5-10	10-20	20-30	30-40	40-50	50+
	NRV	49.43	32.18	13.79	4.6	0	0	0
50	CHINR_BASE	0.24	0.5	6.09	67	24.21	1.84	0.11
	CHINR_S	0.3	0.52	2.69	60.48	33.06	2.82	0.13
	CHINR_M	0.23	0.57	7.75	70.58	19.53	1.26	0.08
	CHINR_L	0.09	0.64	63.55	29.9	5.28	0.54	0
	CHINR_VL	0.2	0.88	57.86	28.44	12.29	0.29	0.04
	CHINR_ROAD	0.21	3.86	63.86	30.4	1.64	0.03	0
	CHINR_EVEN	0.14	0.04	79.67	14.19	5.8	0.15	0
	CHINR_DECADE	0.1	7.71	65.99	17.04	8.93	0.23	0
	CHINR_FORCE65	0	2.67	82.22	14.86	0.25	0	0
100	CHINR_BASE	0.11	0.42	58.32	26.35	14.07	0.68	0.05
	CHINR_S	0.14	0.38	6.79	75.51	16.12	0.97	0.1
	CHINR_M	0.12	0.5	12.61	74.61	11.43	0.68	0.05
	CHINR_L	0.09	0.47	81.6	16.17	1.67	0	0
	CHINR_VL	0.13	0.33	71.81	23.83	3.7	0.2	0
	CHINR_ROAD	0.13	1.76	79.57	17.16	1.33	0.05	0
	CHINR_EVEN	0.14	0.17	84.99	10.73	3.88	0.1	0
	CHINR_DECADE	0.03	0.78	54.93	35.63	8.55	0.08	0
	CHINR_FORCE65	0	21.69	73.83	4.48	0	0	0

Islands Area

The natural range of variation for event area contained within islands and a summary of total percentage of event area within islands by scenario is displayed in Table 20. Historical natural disturbances have a range of island percentages, with over 15% of events by area falling into each of the 0-5, 10-20, 20-30, and 30-40 percentage classes, with the greatest proportion of events being within the 0-5% class (22.09%). Harvest scenarios have a narrower distribution of island area NRV, with all scenarios having the highest proportion of events either having 0-5%, 5-10% or 10-20% of their area being islands, and almost no events being more than 20% island. Harvesting larger patches generally increases the proportion of event area within islands.

Table 20. Percentage of events (area weighted) within each island percentage class by scenario in the Chinchaga Sub-Regional Planning Unit (Year 50 and Year 100) compared to NRV.

		% of Event Area in Islands						
Year	Scenario	0-5	5-10	10-20	20-30	30-40	40-50	50+
	NRV	22.09	6.98	20.93	17.44	16.28	8.14	8.14
50	CHINR_BASE	50.92	46.04	3.04	0	0	0	0
	CHINR_S	68.23	31.71	0.06	0	0	0	0
	CHINR_M	54.55	42.36	3.09	0	0	0	0
	CHINR_L	31.01	25.75	43.1	0.14	0	0	0
	CHINR_VL	28.59	34.95	36.46	0	0	0	0
	CHINR_ROAD	33.92	28.88	37.2	0	0	0	0
	CHINR_EVEN	14.27	26.47	59.25	0	0	0	0
	CHINR_DECADE	26.25	19.06	54.7	0	0	0	0
	CHINR_FORCE65	15.82	39.03	45.14	0	0	0	0
100	CHINR_BASE	27.77	53.15	19.08	0	0	0	0
	CHINR_S	29.94	55.59	14.47	0	0	0	0
	CHINR_M	28.8	69.57	1.63	0	0	0	0
	CHINR_L	19.69	49.14	31.17	0	0	0	0
	CHINR_VL	14.45	31.13	54.42	0	0	0	0
	CHINR_ROAD	23.6	34.22	42.18	0	0	0	0
	CHINR_EVEN	10.75	25.62	63.63	0	0	0	0
	CHINR_DECADE	26.86	39.19	33.94	0	0	0	0
	CHINR_FORCE65	14.12	43.53	41.12	1.23	0	0	0

Event Area Within Largest Disturbance Patch

The natural range of variation for event area within the largest disturbance patch and a summary of total percentage of event area within the largest disturbance patch by scenario is displayed in Table 21. The majority of natural disturbances (89.66%) tend to have 80-100% of their area within the largest disturbance patch. In all scenarios, events have a smaller percentage of area taken up by the largest disturbance patch than in the NRV. The baseline and small patch scenario (CHINR_S) have most of their events with <20% of the total area within the largest disturbance patch, due to many disturbance patches being linked together by the matrix. Scenarios with larger patches result in a greater percentage of the event area being with the largest disturbance patch pushing the distribution towards NRV, though all scenarios have few events with >80% of the area being within the largest disturbance patch.

Table 21. Percentage of events (area weighted) within each largest disturbance percentage class by scenario in the Chinchaga Sub-Regional Planning Unit (Year 50 and Year 100) compared to NRV.

		% of Event Area in Largest Disturbance Patch							
Year	Scenario	0-10	10-20	20-30	30-40	40-50	50-60	60-80	80-100
	NRV	0	0	0	5.75	0	1.15	3.45	89.66
50	CHINR_BASE	25.11	36.94	14.74	5.62	3.47	3.78	8.37	1.98
	CHINR_S	25.94	39.44	13.65	8.67	4.15	3.11	3.27	1.77
	CHINR_M	20.39	35.39	14.38	11.7	5.42	4.52	5.6	2.6
	CHINR_L	0	0	42.13	9.77	7.47	8.2	26.44	5.98
	CHINR_VL	0.02	0.95	10.27	4.37	21.06	29.49	32.02	1.82
	CHINR_ROAD	0	0	10.14	3.85	35.21	13.25	31.11	6.45
	CHINR_EVEN	0	0	37.1	5.79	26.46	1.66	25.93	3.06
	CHINR_DECADE	0	3.43	13.94	14.47	25.79	6.44	33.09	2.84
	CHINR_FORCE65	0	0	8.76	2.35	22.42	19.17	37.12	10.18
100	CHINR_BASE	13.1	32.78	20.63	14.91	11.94	2.01	3.11	1.52
	CHINR_S	13.72	35.43	29.72	7.07	8.1	2.1	2.49	1.36
	CHINR_M	13.84	29.95	31.16	8.81	9.08	2.65	2.62	1.89
	CHINR_L	0	10.47	7.56	26.61	11.08	22.31	18.91	3.06
	CHINR_VL	0	0.04	0.09	30.28	20.2	20.11	28.19	1.09
	CHINR_ROAD	0	8.99	11.98	26.6	16.66	17.24	13.6	4.93
	CHINR_EVEN	0	0	3.23	20.96	22.23	36.87	15.53	1.17
	CHINR_DECADE	0	18.72	3.35	11.78	38.63	15.87	8.92	2.72
	CHINR_FORCE65	0	0	8.52	28.42	14.38	17.11	26.6	4.97

Disturbance Patches Per Event

As harvest patch size increases, the number of disturbance patches per event within each event size class decreases (Figure 54). The BAU (CHINR_BASE), small (CHINR_S), and small-moderate patch (CHINR_M) scenarios result in significantly more patches per disturbance event than is seen in the natural range of variation. Events in the 1,000-10,000 and 10,000+ ha size class from the baseline, small patch scenario (CHINR_S), and moderate patch scenario (CHINR_M) have far more disturbance patches than other scenarios and NRV (note that the Y axis is on a logarithmic scale), with ~300-500 disturbance patches per event for events >10,000 ha in area. Scenarios with larger harvest patch sizes generally perform more similarly to NRV, though generally with more disturbance patches per event for events > 10,000 ha, except for CHINR_FORCE65 which has slightly fewer patches per disturbance event than NRV in this size class.

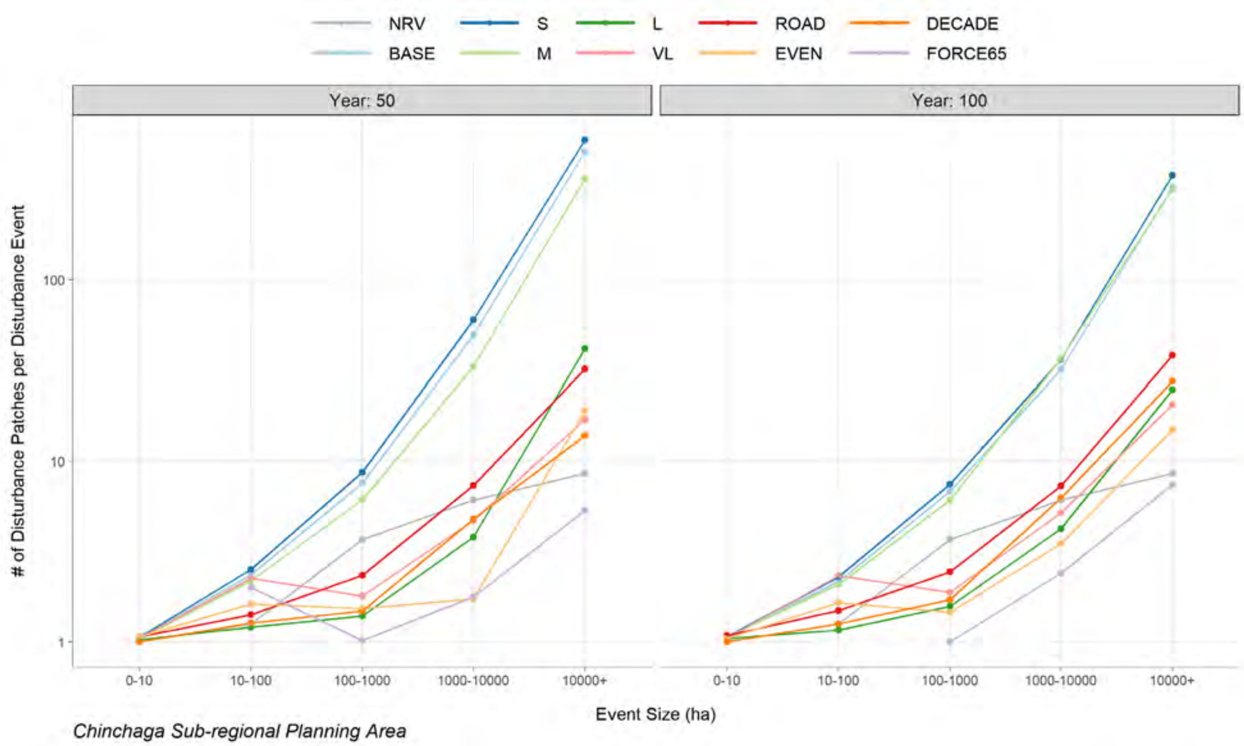


Figure 60. Average number of disturbance patches per disturbance event by event size class (ha) in the Chinchaga Sub-Regional Planning Area.

Event Shape Index

The event shape index compares the ratio of the perimeter of the disturbance event to the perimeter of a perfect circle of the same area. The BAU (CHINR_BASE), small (CHINR_S), and small-moderate patch scenarios (CHINR_M) have the highest event shape index at both year 50 and 100 (Figure 55). All scenarios have a higher shape index than NRV for larger event size classes, with the shape index generally decreasing as harvest patch sizes increases. CHINR_FORCE65 comes the closest overall to the natural range of variation at year 50, while the scenario targeting very large patches (CHINR_VL) is the closest to NRV at year 100.

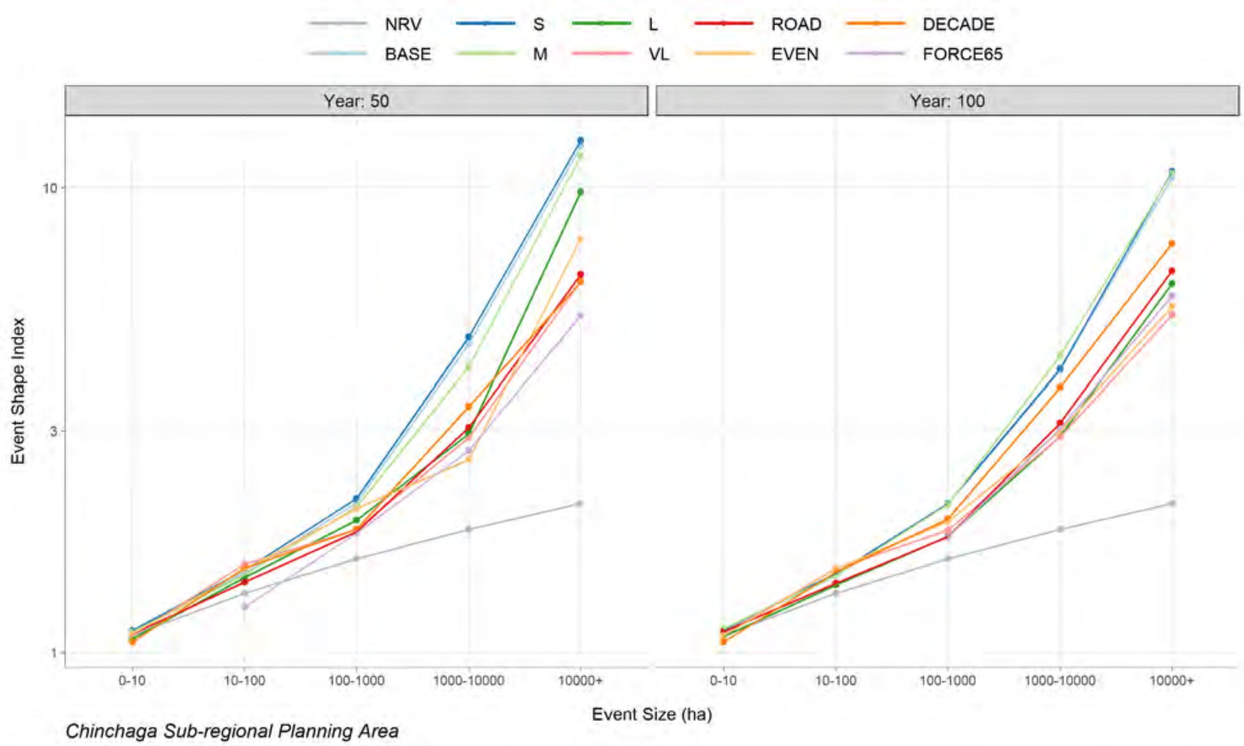


Figure 61. Average event shape index by event size class (ha) in the Chinchaga Sub-Regional Planning Area.

4.7.3 Wandering River Sub-Regional Planning Area

Disturbance Events Overview

Figure 56 displays the total area of disturbance and the proportion of disturbance, matrix, islands, and other (islands within a disturbance that are waterbodies) created by each of the harvest scenarios. Disturbance area and matrix remnants decrease as target patch size increases. The changes in matrix area are more considerable than the changes in the disturbance area, and island area remains fairly consistent in each scenario.

Targeting small-moderate patches (WRR_M) results in a notable drop in disturbed area at year 50 that is even more dramatic by year 100, suggesting that small to minimal aggregation in the Wandering River sub-region has an initial positive effect on disturbance that only increases over time. The scenario targeting very large patches (WRR_VL) results in the lowest amount of disturbed area at both year 50 and 100. The baseline scenario resulted in the highest disturbed area at both year 50 and 100, with the scenario targeting small patches (WRR_S) having comparable results.

Figure 62. Area of disturbances, matrix area, islands, and other by scenario in Wandering River Sub-Regional Planning Unit (Year 50 and Year 100).

Event Size

Event size looks at any contiguous disturbance area linked by matrix remnants at year 50 and year 100. The natural range of variation for event sizes and a summary of total area within each event size class by scenario is displayed in Table 22.

The majority of historical natural disturbance events fall within the very large event size class (57%) and the proportion of disturbances falling within each class decreases as size decreases. Large patch targets result in similar or less area in events >2,000 ha compared to smaller patches. All scenarios result in event sizes with a much different distribution than the NRV, with a very small proportion of events falling within the 10,000+ ha range. This is due to the landbase characteristics discussed in Section 4.1, as the active landbase is scattered and has smaller contiguous patches than the other sub-regions.

Table 22. Percentage of events (area weighted) within matrix percentage classes in the Wandering River Sub-Regional Planning Unit (Year 50 and Year 100) compared to NRV.

Year	Scenario	Event Size Class (ha)				
		0-10	10-200	200-2000	2000-10000	10000+
	NRV	1.00	3.00	14.00	25.00	57.00
50	WRR_BASE	2.80	20.16	43.91	22.09	11.04
	WRR_S	2.98	22.19	42.12	21.44	11.28
	WRR_M	1.83	19.35	57.88	20.93	0.00
	WRR_L	0.03	20.62	55.16	24.19	0.00
	WRR_VL	0.74	8.03	66.07	25.16	0.00
	WRR_ROAD	0.79	25.88	57.12	16.21	0.00
	WRR_EVEN	0.22	21.72	56.98	21.08	0.00
	WRR_DECADE	0.12	9.63	62.31	27.94	0.00
100	WRR_BASE	3.21	26.08	44.86	25.86	0.00
	WRR_S	3.25	26.70	43.74	26.31	0.00
	WRR_M	1.85	25.05	63.38	9.71	0.00
	WRR_L	0.06	20.85	60.70	18.39	0.00
	WRR_VL	0.88	10.53	66.06	22.53	0.00
	WRR_ROAD	0.76	31.37	60.54	7.33	0.00
	WRR_EVEN	0.38	19.48	80.13	0.00	0.00
	WRR_DECADE	0.13	5.55	67.50	26.82	0.00

Matrix Area

The natural range of variation for event area contained within the matrix and a summary of total percentage of event area within the matrix by scenario is displayed in Table 23. Historical natural disturbances generally have relatively little matrix area, with ~82% of events having less than 10% of their area within the matrix. All scenarios have more event area in the matrix than NRV, though scenarios with larger harvest patches decrease the matrix area moving it closer to NRV. WRR_DECADE has the smallest percentage of the event area falling within the matrix.

Table 23. Percentage of events (area weighted) within each matrix percentage class by scenario in the Wandering River Sub-Regional Planning Unit (Year 50 and Year 100) compared to NRV.

Year	Scenario	% of Event Area in Matrix						
		0-5	5-10	10-20	20-30	30-40	40-50	50+
	NRV	49.43	32.18	13.79	4.6	0	0	0
50	WRR_BASE	0.69	1.31	4.9	14.05	52.66	25.6	0.78
	WRR_S	0.75	1.44	5.74	16.55	56.78	17.93	0.82
	WRR_M	0.56	1.98	35.3	49.07	12.36	0.64	0.1
	WRR_L	0.02	6.34	53.85	28.42	11.37	0	0
	WRR_VL	0.5	9.29	63.26	24.81	2.01	0.13	0
	WRR_ROAD	0.43	4.55	36.55	54.35	4.11	0	0
	WRR_EVEN	0.13	1.42	19.25	64.43	13.33	1.43	0
	WRR_DECADE	0.06	5.12	66.63	27.49	0.61	0.09	0
100	WRR_BASE	0.77	1.96	10.02	33.4	46.79	6.72	0.33
	WRR_S	0.8	1.93	10.29	37.47	43.74	5.38	0.39
	WRR_M	0.7	3.04	43.22	46.19	6.78	0.07	0
	WRR_L	0.01	6.57	59.08	23.36	10.48	0.49	0
	WRR_VL	0.74	13.25	64.71	19.25	1.46	0.6	0
	WRR_ROAD	0.43	3.37	63.12	30.13	2.95	0	0
	WRR_EVEN	0.28	4.98	51.78	36.56	5.89	0.5	0
	WRR_DECADE	0.07	3.05	77.36	18.89	0.57	0.05	0

Islands Area

The natural range of variation for event area contained within islands and a summary of total percentage of event area within islands by scenario is displayed in Table 24. Historical natural disturbances have a range of island percentages, with over 15% of events by area falling into each of the 0-5, 10-20, 20-30, and 30-40 percentage classes, with the greatest proportion of events being within the 0-5% class (22.09%). Harvest scenarios have a narrower distribution of island area NRV, with all scenarios having the highest proportion of events either having 0-5% or 5-10% of their area being islands, and almost no events being more than 20% island. Harvesting larger patches generally increases the proportion of event area within islands.

Table 24. Percentage of events (area weighted) within each island percentage class by scenario in the Wandering River Sub-Regional Planning Unit (Year 50 and Year 100) compared to NRV.

		% of Event Area in Islands						
Year	Scenario	0-5	5-10	10-20	20-30	30-40	40-50	50+
	NRV	22.09	6.98	20.93	17.44	16.28	8.14	8.14
50	WRR_BASE	98.21	1.75	0.04	0	0	0	0
	WRR_S	97.99	2.01	0	0	0	0	0
	WRR_M	82.29	17.13	0.58	0	0	0	0
	WRR_L	50.86	42.48	6.67	0	0	0	0
	WRR_VL	32.01	52.8	15.19	0	0	0	0
	WRR_ROAD	81.71	15.42	2.87	0	0	0	0
	WRR_EVEN	65.7	29.71	4.59	0	0	0	0
	WRR_DECADE	47.19	41.33	11.48	0	0	0	0
100	WRR_BASE	88.19	11.52	0.29	0	0	0	0
	WRR_S	88.9	10.84	0.26	0	0	0	0
	WRR_M	82.45	16.23	1.32	0	0	0	0
	WRR_L	40.06	55.79	4.15	0	0	0	0
	WRR_VL	25.88	65.4	2.54	6.18	0	0	0
	WRR_ROAD	69.53	29.72	0.75	0	0	0	0
	WRR_EVEN	63.77	32.46	3.77	0	0	0	0
	WRR_DECADE	40.07	56.85	3.08	0	0	0	0

Event Area Within Largest Disturbance Patch

The natural range of variation for event area within the largest disturbance patch and a summary of total percentage of event area within the largest disturbance patch by scenario is displayed in Table 25. The majority of natural disturbances (89.66%) have 80-100% of their area within the largest disturbance patch. In all scenarios, events have a smaller percentage of area taken up by the largest disturbance patch than in the NRV. The baseline and small patch scenario (WRR_S) have most of their events with <30% of the total area within the largest disturbance patch, due to many disturbance patches being linked together by the matrix. Scenarios with larger patches result in a greater percentage of the event area being with the largest disturbance patch pushing the distribution towards NRV, though all scenarios have few events with >80% of the area being within the largest disturbance patch.

Table 25. Percentage of events (area weighted) within each largest disturbance percentage class by scenario in the Wandering River Sub-Regional Planning Unit (Year 50 and Year 100) compared to NRV.

		% of Event Area in Largest Disturbance Patch							
Year	Scenario	0-10	10-20	20-30	30-40	40-50	50-60	60-80	80-100
	NRV	0	0	0	5.75	0	1.15	3.45	89.66
50	WRR_BASE	27.16	22.48	15.18	13.94	7.64	5.34	4.02	4.25
	WRR_S	27.56	19.85	16.33	13.19	7.65	5.83	5.25	4.34
	WRR_M	0	11.66	9.77	26.33	12.63	8.97	17.6	13.04
	WRR_L	0	0	12.6	6.12	11.43	5.88	51.81	12.16
	WRR_VL	0	0	0	4.67	9.33	4.27	66.1	15.62
	WRR_ROAD	0	5.27	3.09	17.27	16	8.06	32.31	18.01
	WRR_EVEN	0	0	8.78	11.81	10.34	12.79	46.24	10.05
	WRR_DECADE	0	0.05	4.52	2.47	19.86	18.31	38.42	16.38
100	WRR_BASE	6.86	19.37	25.12	14.73	12.03	7.82	8.28	5.79
	WRR_S	6.7	15.6	25.33	21.44	11.02	6.13	8.15	5.63
	WRR_M	2.43	7.65	20.28	5.32	10.01	7.98	27.36	18.97
	WRR_L	0	0	0	12.13	13.29	4.26	56.92	13.39
	WRR_VL	0	0	0.1	0.54	15.47	0.54	71.17	12.19
	WRR_ROAD	0	0	7.35	7.51	11.92	4.97	43.53	24.72
	WRR_EVEN	0	0	0	4.39	4.62	5.77	57.8	27.42
	WRR_DECADE	0	0	0.05	19.38	4.32	7.18	51.51	17.55

Disturbance Patches Per Event

As harvest patch size increases, the number of disturbance patches per event within each event size class decreases (Figure 57). The BAU (WRR_BASE) and small patch scenarios (WRR_S) result in significantly more patches per disturbance event than NRV. Overall, the scenarios targeting small-moderate patches (WRR_M) and the scenario with stricter access constraints (WRR_ROAD) are the closest to the NRV, and scenarios with larger patches (WRR_L, WRR_VL, WRR_EVEN, and WRR_DECADE) tend to have fewer patches per disturbance event than NRV.

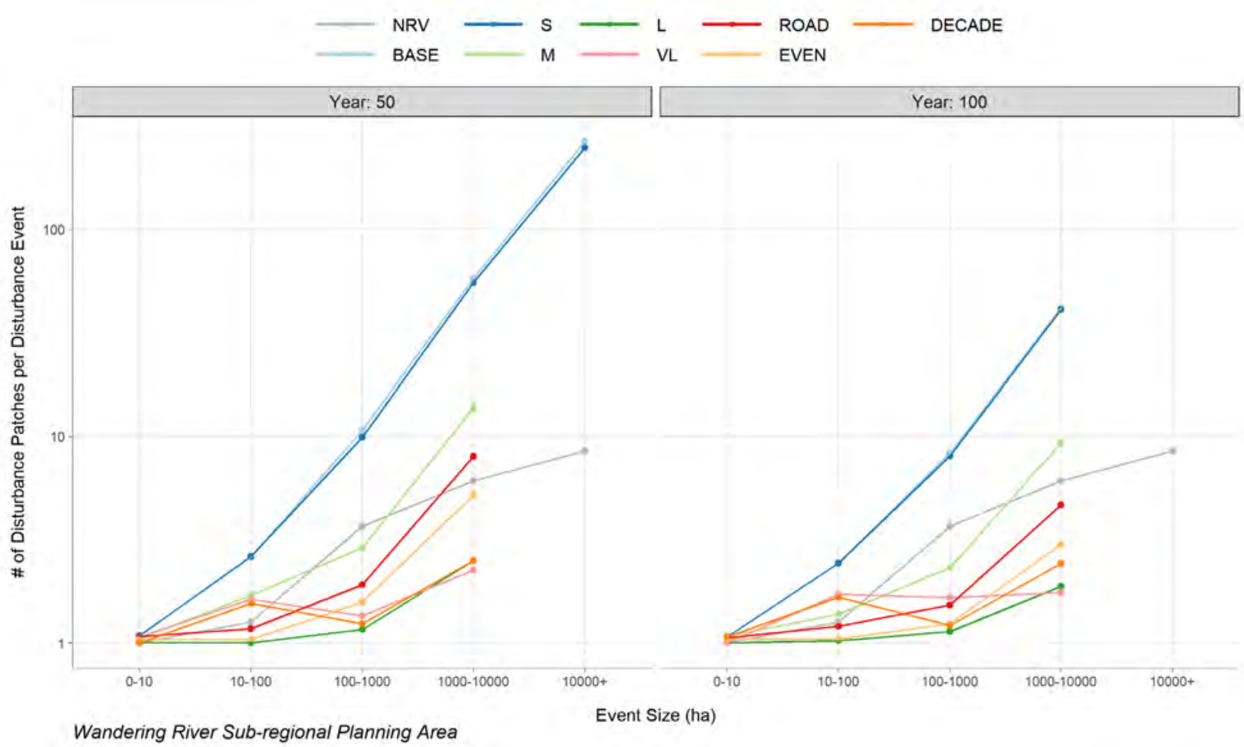


Figure 63. Average number of disturbance patches per disturbance event by event size class (ha) in the Wandering River Sub-Regional Planning Area.

Event Shape Index

The event shape index compares the ratio of the perimeter of the disturbance event to the perimeter of a perfect circle of the same area. The BAU (WRR_BASE) and small patch scenarios (WRR_S) have the highest event shape index at both year 50 and 100 (Figure 58). All scenarios have a higher shape index than NRV, with the shape index generally decreasing as the harvest patch size increases.

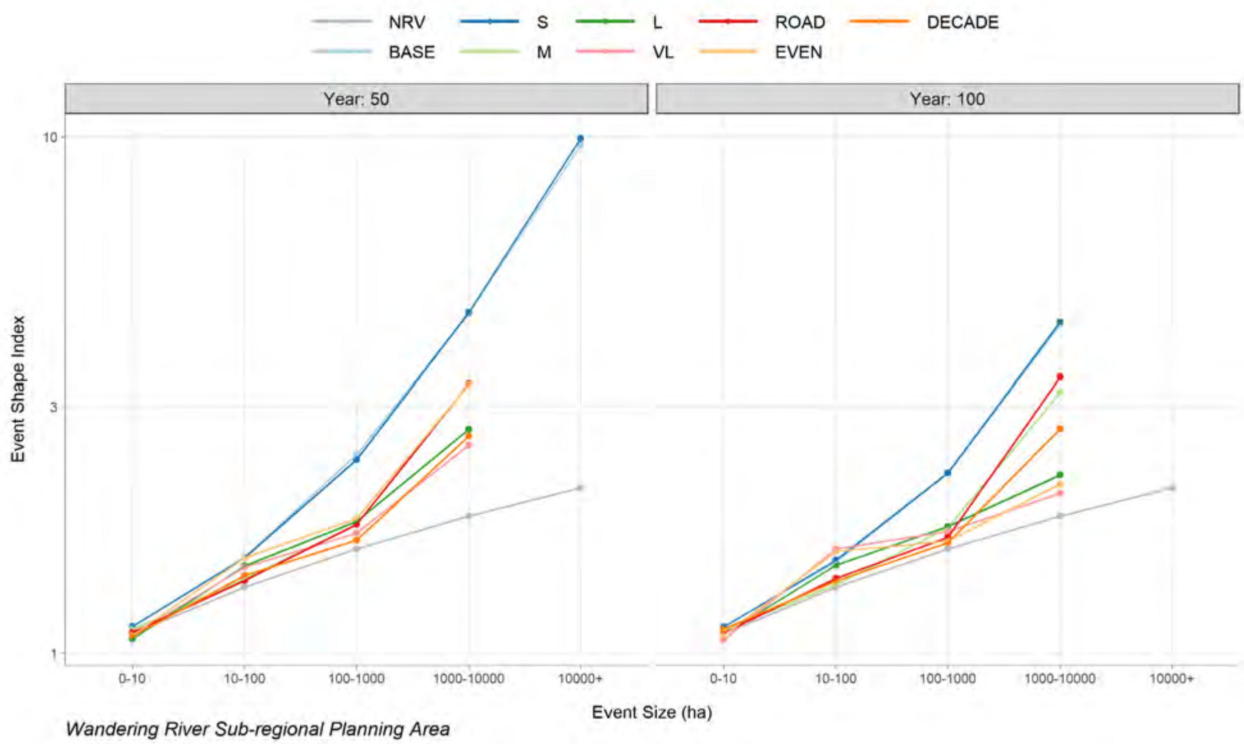


Figure 64. Average event shape index by event size class (ha) in the Wandering River Sub-Regional Planning Area.

5. Discussion

In this study, we have investigated the feasibility and impacts of implementing aggregated harvest scenarios in three of Alberta's regional caribou planning sub-regions. The three regions show varying response to the harvest patterns, caribou habitat metrics, and associated socio-economic values.

5.1 Harvest Patterns

The Berland and Chinchaga regions have large patches of contiguous active landbase (see Section 4.1, Figure 7 and Figure 8), which gave the model flexibility to create numerous large harvest patches with much of the harvested area aggregated in patches larger than 1,000 ha for the larger patch target scenarios. This was more difficult in Wandering River due to the scattered nature of the landbase (Figure 9), and most of the harvested area in the caribou range was aggregated into patches of less than 500 ha in area, even for the larger patch target scenarios.

5.2 Harvest Volumes

A clear tradeoff between harvest aggregation and a reduction in harvest volume can be observed in the scenarios, with harvest volumes decreasing in scenarios with larger harvest patches. When smaller patches are allowed, the model has more flexibility to harvest stands when they are at their optimal volume. As patch size increases, more stands are harvested at either younger or older ages than optimum, resulting in lower volumes per hectare and potentially allowing older stands to break up and become unavailable. All regions showed a reduction in harvest volume as harvest patch sizes became larger, with the degree of reduction varying between the regions. In addition, restricting the harvest of small patches reduces the area of landbase available for harvest, reducing the overall harvest area as well. Volumes in aggregated scenarios decreased by up to 21% for conifer and 12% for deciduous in the Berland sub-region, 24% for conifer and 16% for deciduous in the Chinchaga sub-region, and 19% for conifer and 14% for deciduous in the Wandering River sub-region, as compared to the baseline.

5.3 Undisturbed Caribou Habitat

Similarly, a clear tradeoff between harvest volume and undisturbed caribou habitat can be observed as the harvest pattern becomes more aggregated. The caribou undisturbed habitat metric is directly related to the spatial pattern of disturbances. It is based on the disturbances plus a 500 m buffer, which means that large disturbances and disturbances that are closer together reduce the overall buffered disturbance when compared to the same area distributed more sparsely. Aggregating harvest into larger patches reduces caribou habitat disturbance by reducing the area harvested, and more significantly, by reducing the buffers of harvested areas.

Buffers from harvesting and access roads have the greatest impact on the percentage of undisturbed caribou habitat, with the percentage of disturbance caused by these ranging from 15 to 55% in the modeled scenarios. The lowest ratio between disturbance by forest buffers and disturbance by the actual harvesting footprint at year 100 was 0.79 (BERR_FORCE65, A La Peche Winter range), meaning that even in this highly aggregated scenario there were 790 hectares disturbed by forest buffers for every 1,000 hectares harvested.

The strategy of aggregating harvest within the caribou range into a few decades and excluding harvest in other decades creates much greater variability in caribou habitat metrics. Scenarios BERR_DECADE and CHINR_DECADE both have a decade where the undisturbed habitat exceeds 65% (79.33% in A La Peche winter for year 90 in BERR_DECADE, 65.22% in year 90 for CHINR_DECADE). However, in both cases the undisturbed habitat available drops considerably due to harvesting in the following decade, by 37% to 41.69% in BERR_DECADE, and by 12% to 53.57% in CHINR_DECADE. Harvesting a similar amount from the caribou range in each decade appears to be a better solution to achieve caribou habitat objectives in these ranges. However, the variability caused by the temporal aggregation of harvest is not nearly as significant in the Wandering River sub-region (scenario WRR_DECADE), likely due to the overall reduced impact of harvest on disturbance metrics in this range. The temporal aggregation of harvest seems to be a reasonable strategy to meet caribou habitat objectives in the East Side Athabasca River range.

The impact of roads on harvest levels and caribou habitat disturbance metrics varies between the regions. Harvest aggregation and road metrics are related as harvesting blocks that are larger and closer together require less roads than a harvest pattern that is highly dispersed with smaller harvest patches. In the Berland sub-region, the area of the caribou ranges is smaller (~166,000 ha for the A La Peche Winter range and ~308,000 ha for the Little Smoky range) and the patches of active landbase are more concentrated, meaning less roads need to be built to access harvest blocks. The impacts of roads and their buffers on disturbance levels at year 100 varied from 7-13% in the A La Peche Winter range and 8-12% in the Little Smoky range. The scenario with stricter constraints on road building and maintenance (BERR_ROAD) did not perform better in terms of undisturbed habitat at year 100 than other scenarios with large patch sizes. Thus, controlling the harvest patterns is more important than controlling the roads in order to achieve caribou habitat objectives in these ranges.

Roads and their buffers contributed more to disturbance in the Chinchaga and Wandering River sub-regions, where their level of disturbance was 11-20% and 14-23% at year 100, respectively. These ranges are larger (~1,764,000 ha for Chinchaga and ~1,198,000 for the portion of the East Side Athabasca River range located within the Wandering River sub-region) and the active landbase is more spread out, meaning more roads need to be built to access harvest blocks. For these reasons, the scenarios placing stricter constraints on road building and maintenance in addition to targeting larger patch sizes (CHINR_ROAD, WRR_ROAD) resulted in more undisturbed habitat than scenarios controlling harvest patch sizes alone (other than CHINR_FORCE65). Thus, controlling the pattern of harvest blocks and the roads required to access them are both important to achieving caribou habitat objectives in these ranges.

In the Patchworks models, there was no ability to control roads separately for those within versus those outside of the caribou range. Adding this ability in the modelling environment would make it simpler to reduce the disturbance caused by roads without influencing the harvest from outside the caribou range, which was reduced in the three scenarios with stricter road constraints.

Overall, all three sub-regions required a reduction in harvest compared to the baseline scenario in order to achieve the federal target for >65% undisturbed habitat by year 100. The overall reduction required was largest in the Chinchaga sub-region, with a 22% reduction in conifer harvest and a 13% reduction in deciduous harvest for the entire sub-region (scenario CHINR_FORCE65) and a 48% reduction of each within the caribou range. In the Berland sub-region, conifer harvest needed to be reduced by 19% (scenario BERR_FORCE65), with a 63% reduction of conifer harvest within the caribou range. The impact on deciduous volume in the Berland was minimal, as little of the deciduous volume came from within the caribou ranges. Despite the larger reduction of harvest within the caribou ranges, the overall impact on volume was less in the Berland sub-region than the Chinchaga sub-region due to a smaller proportion of the volume coming from within the caribou ranges.

Impacts on volumes required to achieve the 65% undisturbed habitat target are less significant in the Wandering River sub-region, where several scenarios achieved the target by year 100. Scenario WRR_DECADE had 72.76% undisturbed habitat at year 100, with a 14% reduction of conifer harvest (55% reduction within the range) and a 13% reduction in deciduous harvest (52% reduction within the range). Scenario WRR_M also came very close to achieving 65% undisturbed (64.25% at year 100), with only a 5% reduction in conifer harvest (33% reduction within the range) and a 7% reduction in deciduous harvest (37% reduction within the range). Constraining the road metrics further in this scenario would have likely resulted in the model achieving the >65% target, meaning that habitat objectives in this sub-region can be achieved with relatively little reduction of harvest volumes.

The scenarios modelled in this project use a 100-year planning horizon. Existing disturbances on the landscape prevent any of the scenarios from achieving the federal target of 65% undisturbed habitat prior to year 80, at which point many existing industrial disturbances are considered to be reclaimed. The model does not consider the potential construction of new industrial disturbances, which would increase the disturbance levels if this does occur. Actual harvest patterns and levels required to reach the 65% undisturbed target will be influenced by the other activities occurring on the landscape, including the reclamation of existing industrial disturbances and the potential addition of new disturbances. However, the general trends in harvest volumes and disturbance between scenarios is still useful for assessing what type of harvest patterns and harvest levels will be required to meet federal caribou habitat objectives.

5.4 Biophysical Habitat

The response of biophysical habitat is more related to the amount of area harvested than the spatial arrangement of blocks. For stands that are eligible to be biophysical (coniferous, with high potential for terrestrial and boreal lichen), the age of the forest is the primary determinant of biophysical habitat. Aggregating harvest into large patches reduces the total area harvested, which results in an older forest and thus more biophysical habitat.

5.5 Neptune Metrics

Aggregating harvest into larger patches generally produced harvest patterns that were more similar to those created by natural disturbances. Small harvest patches can produce large disturbance events, but much of the area is taken up by the matrix due to many small patches being linked together. This produces a very irregular shape, resulting in a much higher event shape index than natural disturbances. Larger harvest patches reduce the proportion of event area within the matrix, increase the proportion of event area within islands, and result in more compact disturbance events with a lower shape index.

In Berland and Wandering River, large disturbance events from aggregated scenarios tended to have fewer disturbances per event than NRV. This may be due to scale, as structural retention and operational buffers are not being modelled. The final spatial patterns of harvesting that include these would increase the number of disturbance patches in an event and potentially make it more similar to the spatial pattern of wildfires.

6. Conclusions

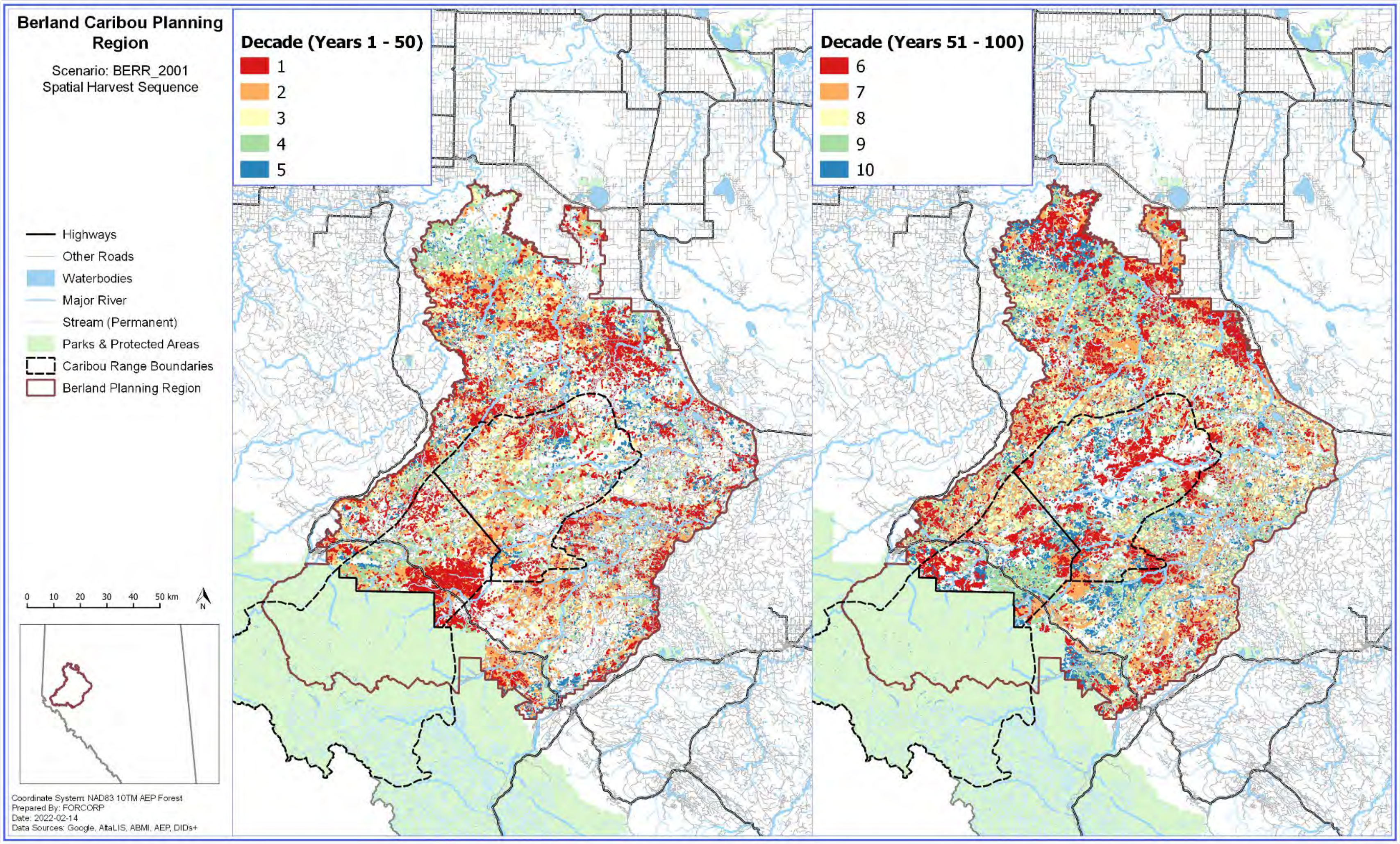
The federal target of >65% undisturbed habitat results in a reduction of harvest within caribou ranges when compared to typical harvest levels and patterns. The purpose of this study was to explore the tradeoffs between increasing undisturbed habitat for caribou and harvest volume by grouping harvest into various size patches and introducing constraints on access and the timing of harvest over 100 years. If traditional harvest patterns are used, the only way to meet the federal target is to decrease the harvested area and associated access roads. To regain a portion of the lost harvest volume, several scenarios explored the options of aggregating harvest patches to reduce the combined harvest area and buffer, which also reduces the amount of access roads for the same area harvested. Increasing harvest patch size does regain harvest volume while still reducing the disturbance of caribou habitat based on a 500 m buffer.

Moving to an aggregated harvest pattern from a traditional pattern has impacts on other metrics:

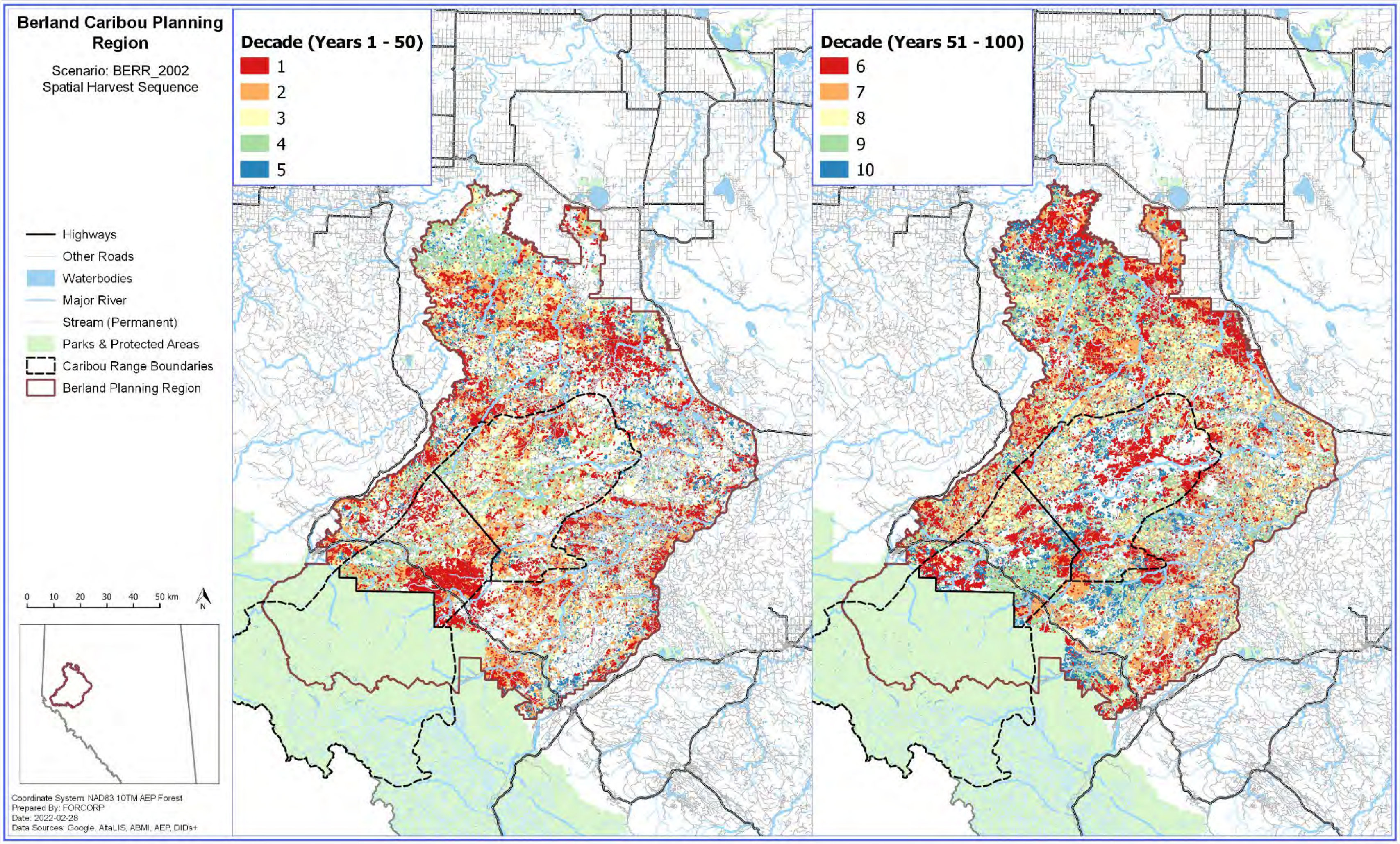
1. Harvest volume per ha usually decreases, due to a larger proportion of the area being harvested when the stand is younger or older than the peak volume per ha.
2. Some stands may never get harvested, due to being isolated or becoming too old and breaking up.
3. Fewer access roads are required, and those that are needed can be reclaimed sooner. This results in less linear footprint and potentially less impacts to other species that are adverse to roads.
4. Larger patches generate patterns that are closer to NRV as they become more similar to larger fire events. This could generate a more natural landscape as compared to traditional harvest patterns.
5. There is a general increase in habitat for other species at large scales, while local scale changes tend to result in an "all or nothing" impact.

There are clear tradeoffs between harvest patch size, harvest volume, and caribou habitat disturbance metrics. Traditional harvest levels and patterns are no longer allowed in caribou ranges and future harvest levels in the ranges will be lower than the status quo. However, volume loss can be mitigated through aggregation and potentially further improved by introducing access and timing constraints, while still aligning with federal caribou targets.

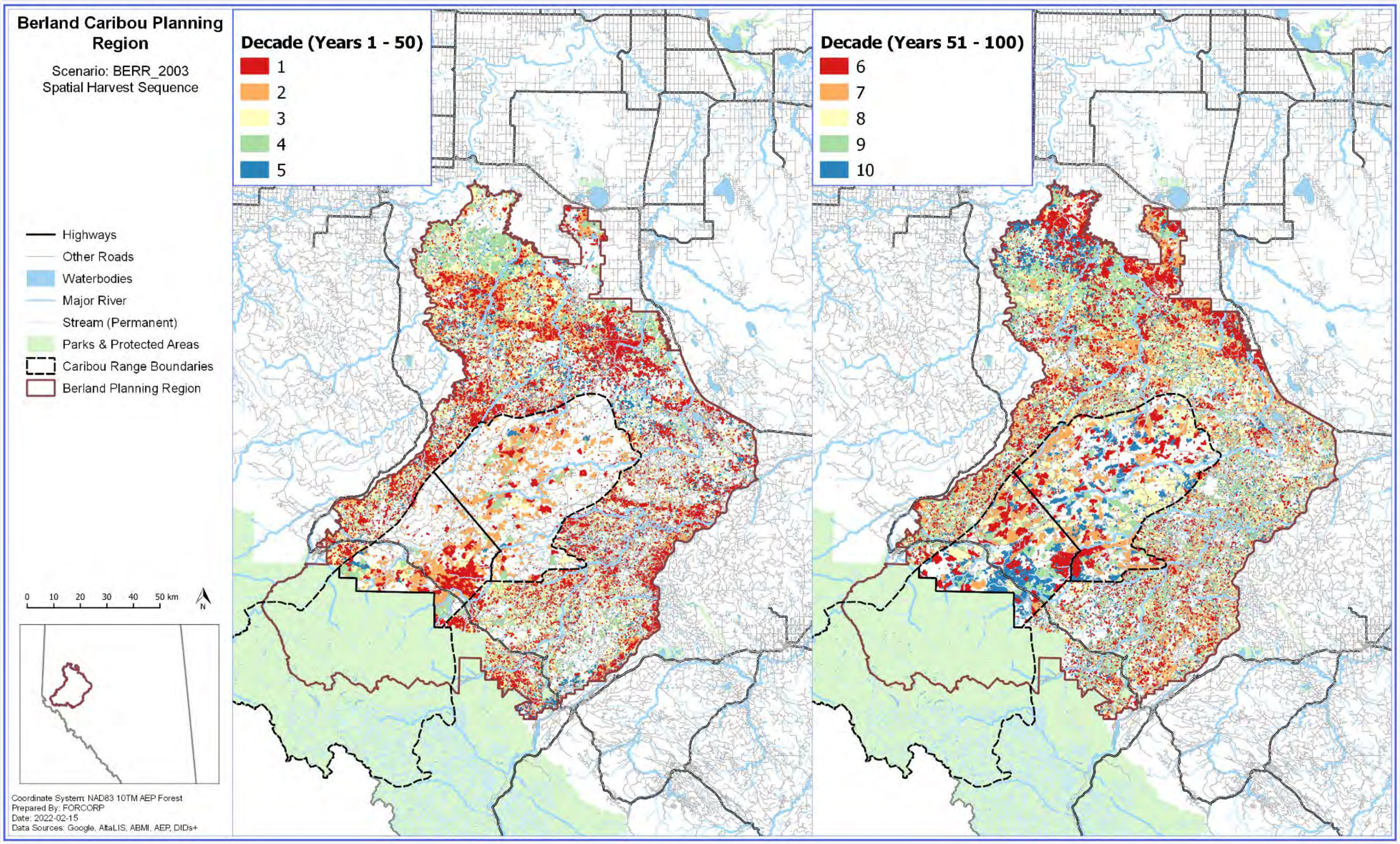
Appendix I Spatial Harvest Sequence Maps

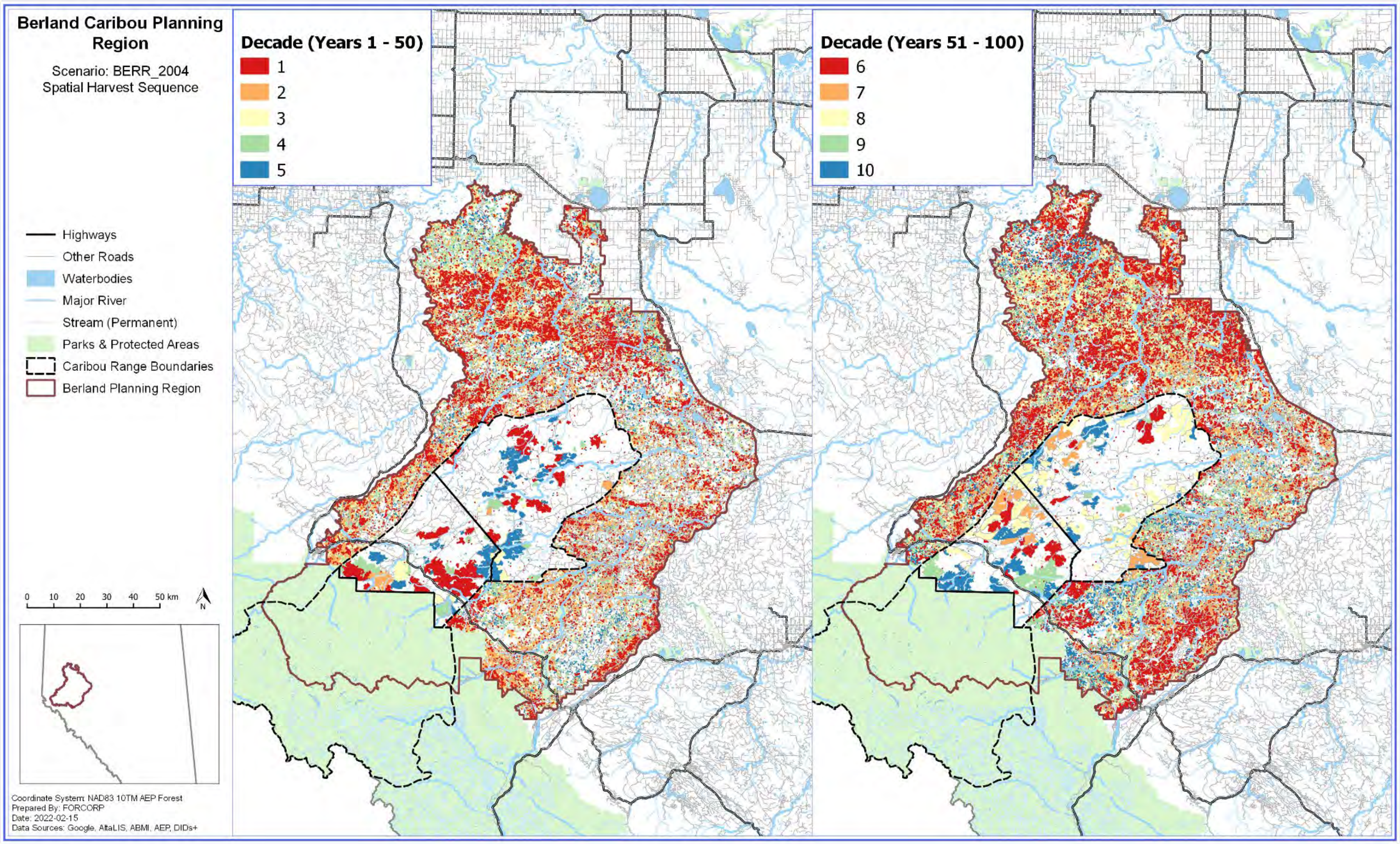


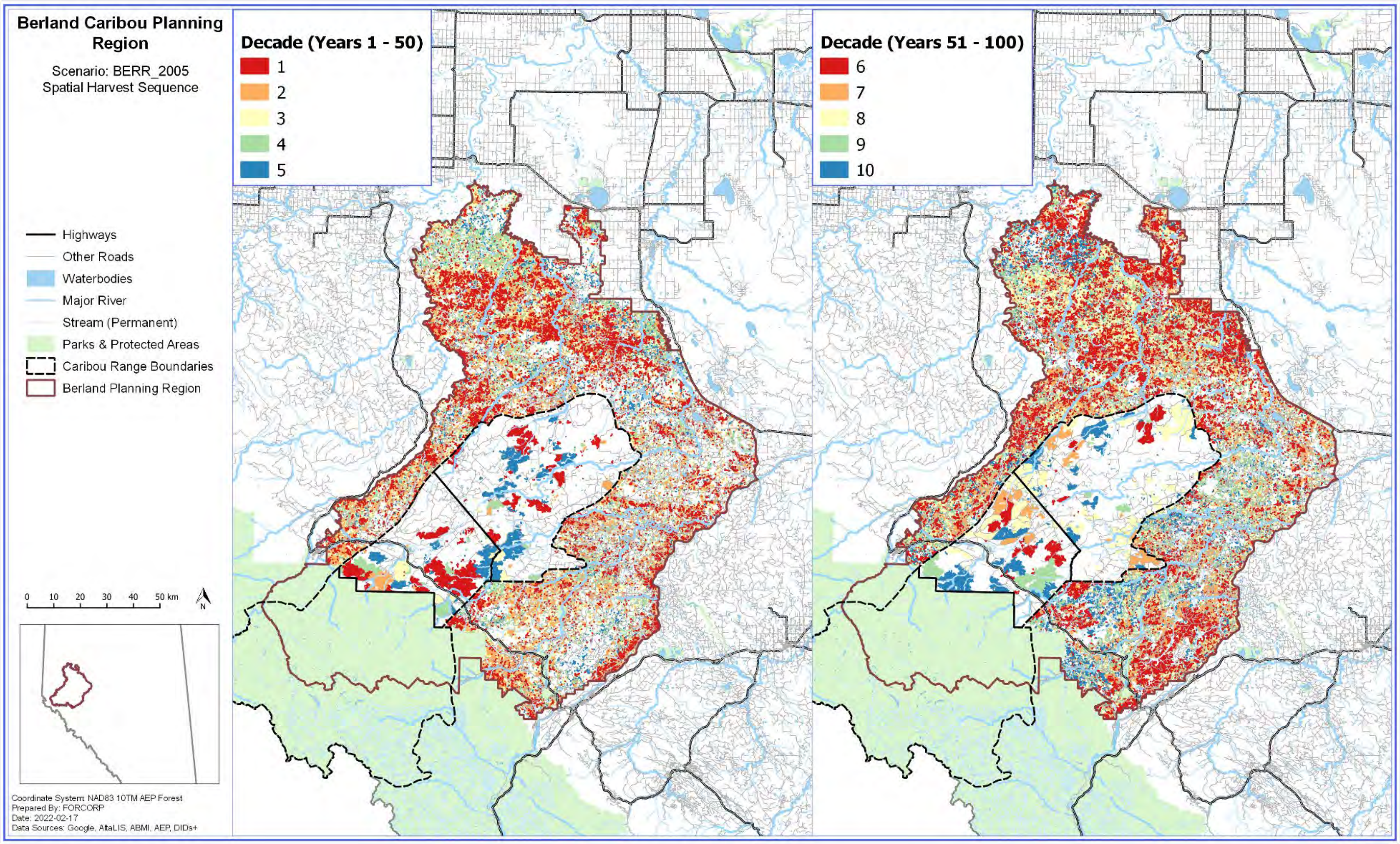
Berland Caribou Planning Region
Scenario: BERR_2001
Spatial Harvest Sequence
Decade (Years 1 - 50)
1
2
3
4
5
Decade (Years 51 - 100)
6
7
8
9
10
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Parks & Protected Areas
Caribou Range Boundaries
Berland Planning Region
0 10 20 30 40 50 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-02-14
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+



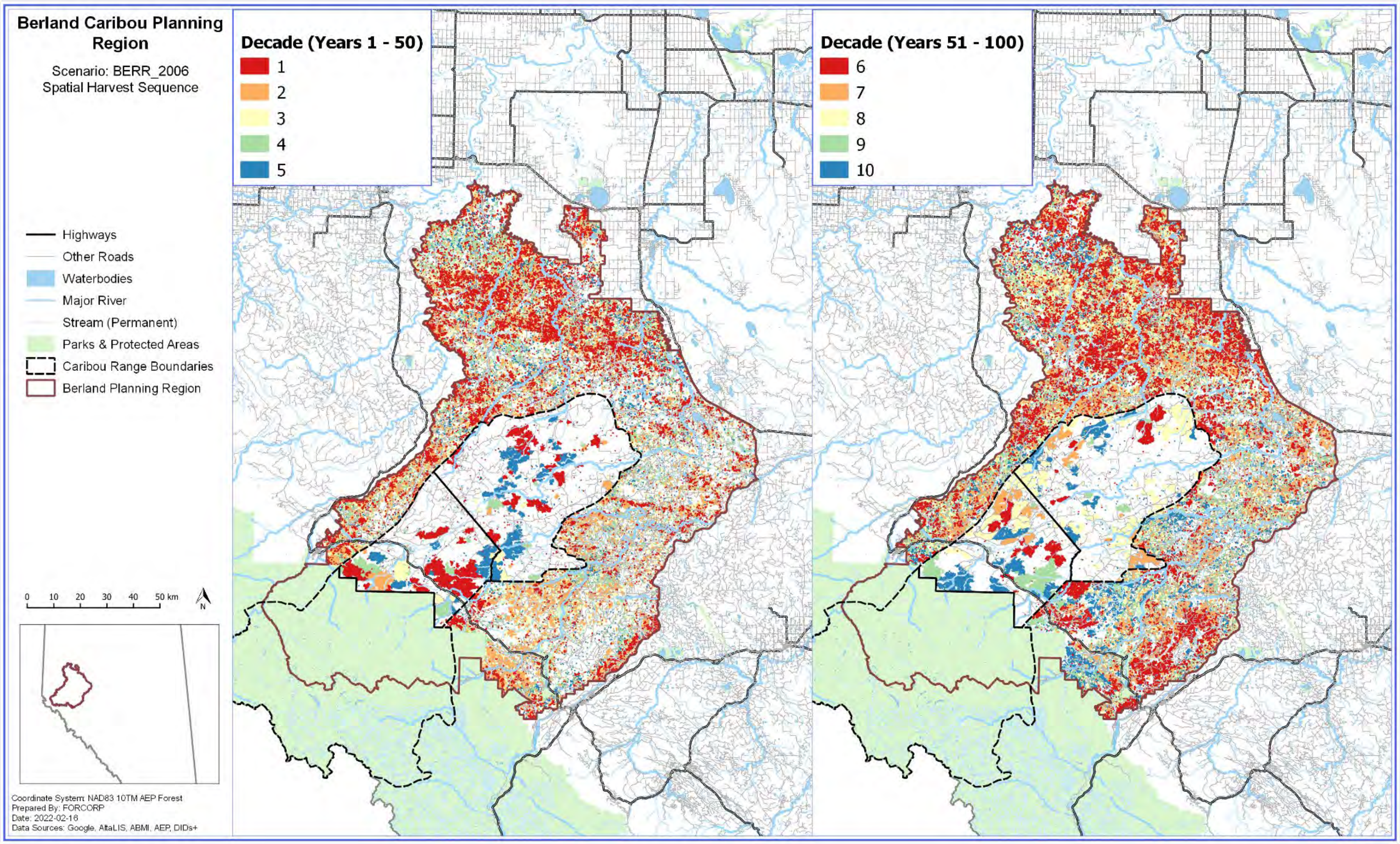
Berland Caribou Planning Region
Scenario: BERR_2002
Spatial Harvest Sequence
Decade (Years 1 - 50)
1
2
3
4
5
Decade (Years 51 - 100)
6
7
8
9
10
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Parks & Protected Areas
Caribou Range Boundaries
Berland Planning Region
0
10
20
30
40
50 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-02-28
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+

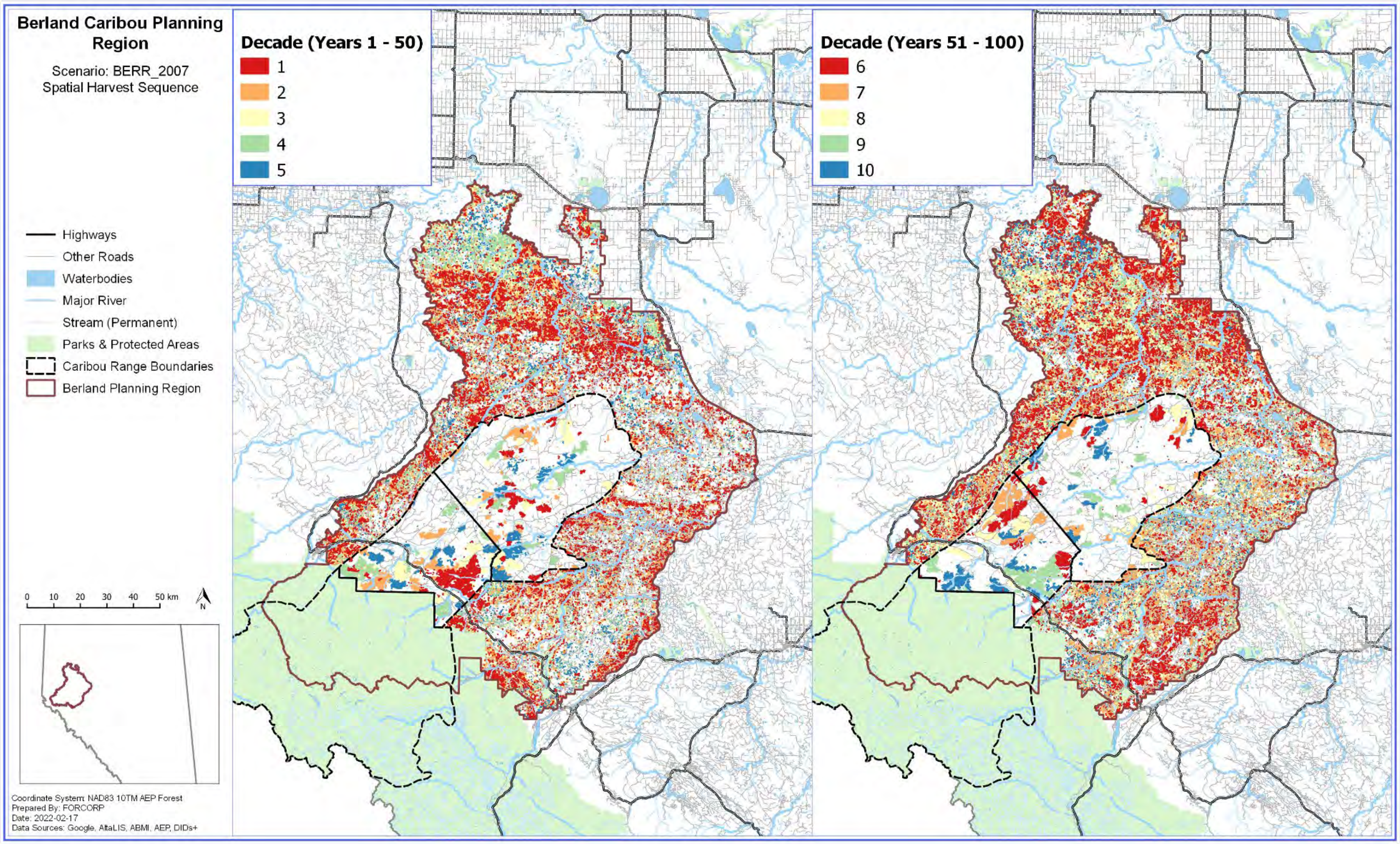

Berland Caribou Planning Region
Scenario: BERR_2003
Spatial Harvest Sequence
Decade (Years 1 - 50)
1
2
3
4
5
Decade (Years 51 - 100)
6
7
8
9
10
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Parks & Protected Areas
Caribou Range Boundaries
Berland Planning Region
0 10 20 30 40 50 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-02-15
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+


Berland Caribou Planning Region
Scenario: BERR_2004
Spatial Harvest Sequence
Decade (Years 1 - 50)
1
2
3
4
5
Decade (Years 51 - 100)
6
7
8
9
10
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Parks & Protected Areas
Caribou Range Boundaries
Berland Planning Region
0 10 20 30 40 50 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-02-15
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+

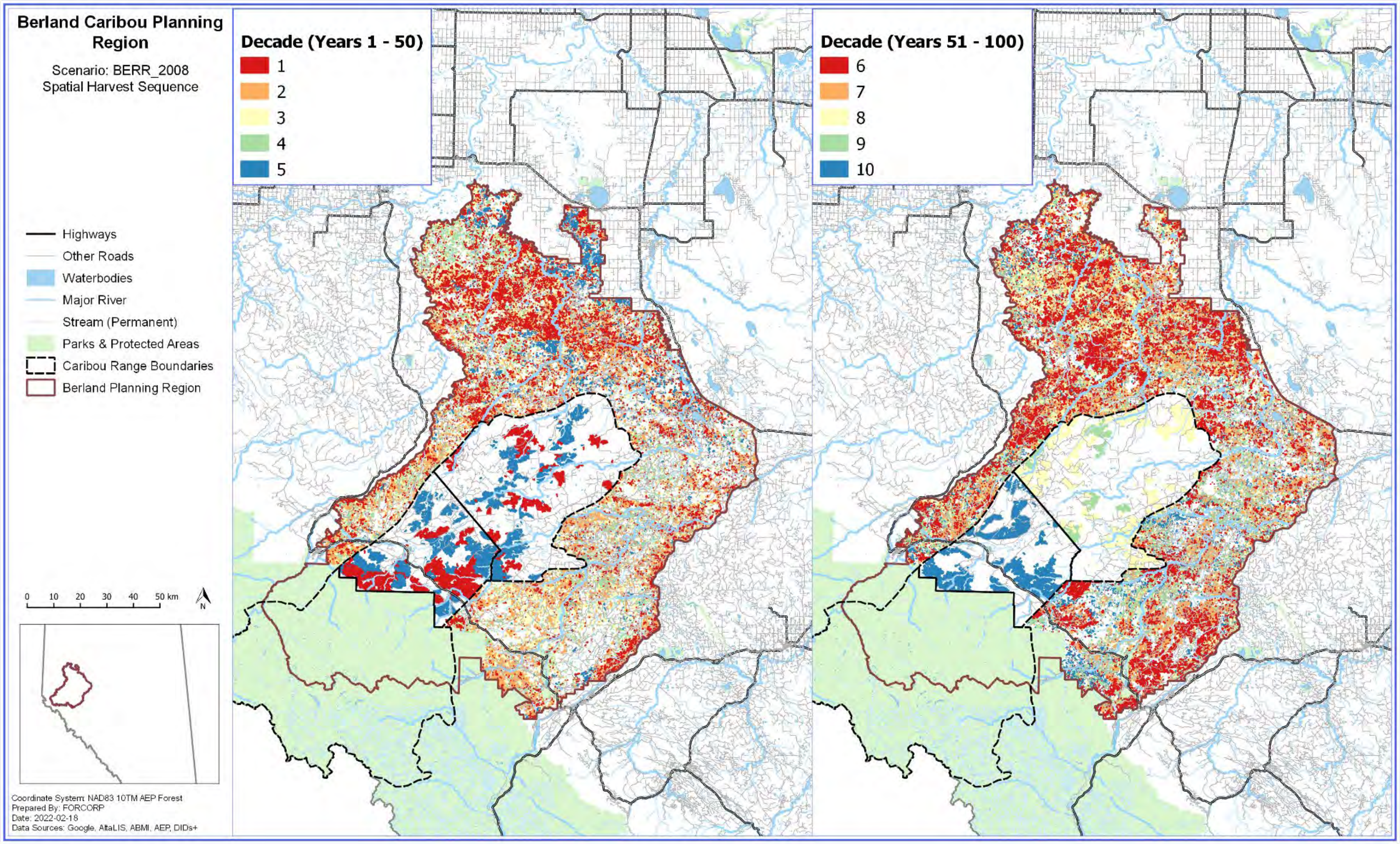


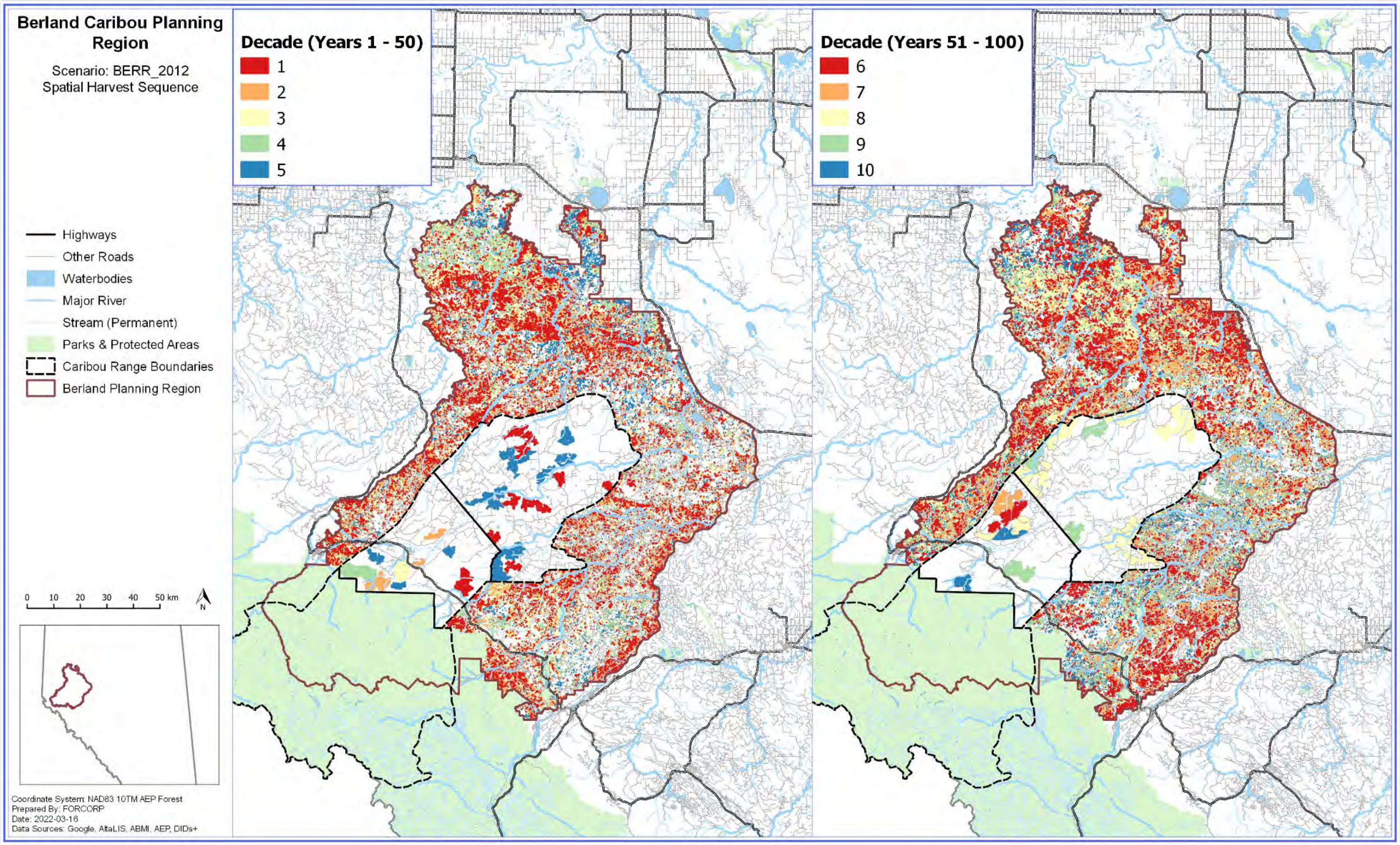
Berland Caribou Planning Region
Scenario: BERR_2005
Spatial Harvest Sequence
Decade (Years 1 - 50)
1
2
3
4
5
Decade (Years 51 - 100)
6
7
8
9
10
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Parks & Protected Areas
Caribou Range Boundaries
Berland Planning Region
0 10 20 30 40 50 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-02-17
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+

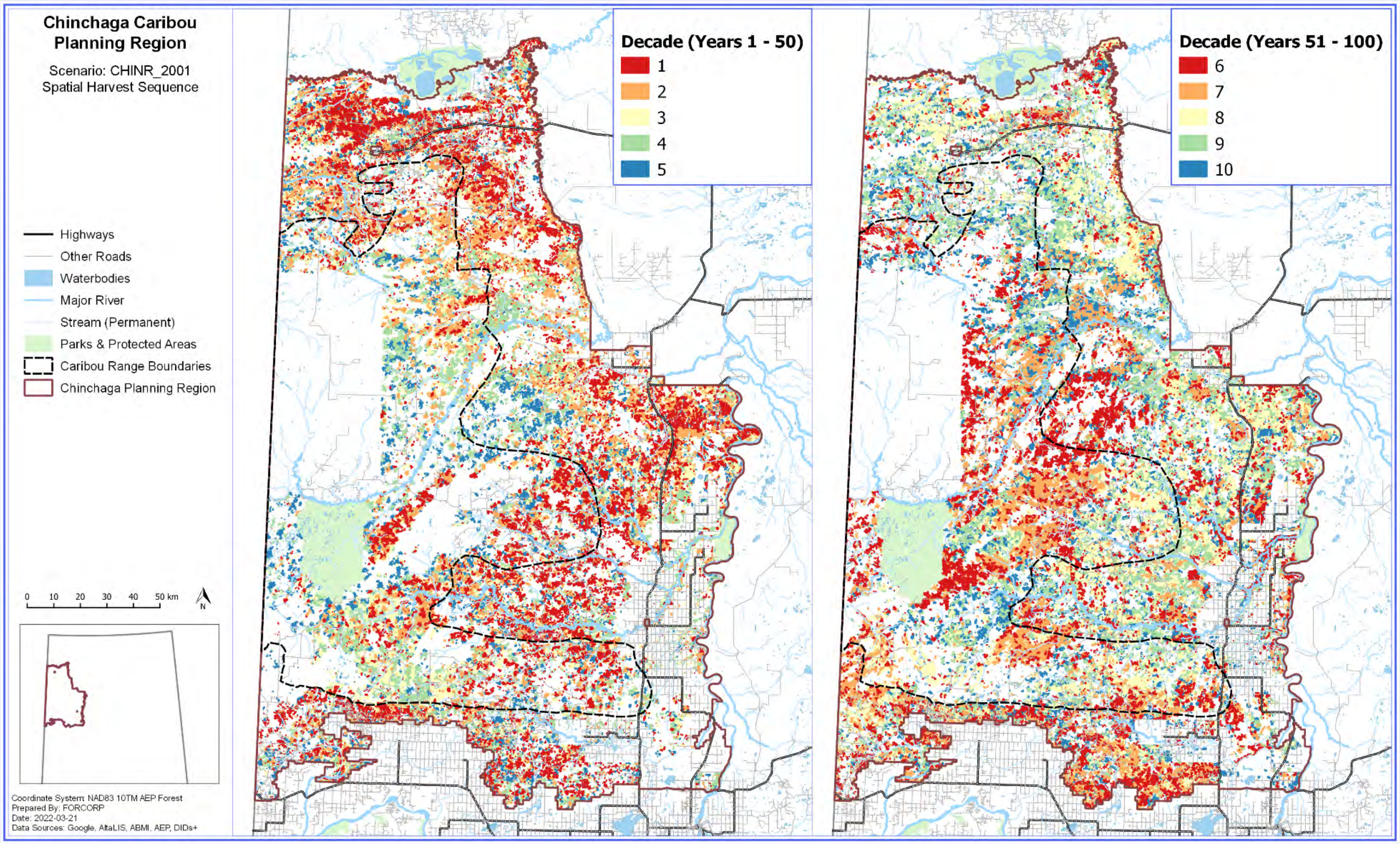

Berland Caribou Planning Region
Scenario: BERR_2006
Spatial Harvest Sequence
Decade (Years 1 - 50)
1
2
3
4
5
Decade (Years 51 - 100)
6
7
8
9
10
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Parks & Protected Areas
Caribou Range Boundaries
Berland Planning Region
0 10 20 30 40 50 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-02-16
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+

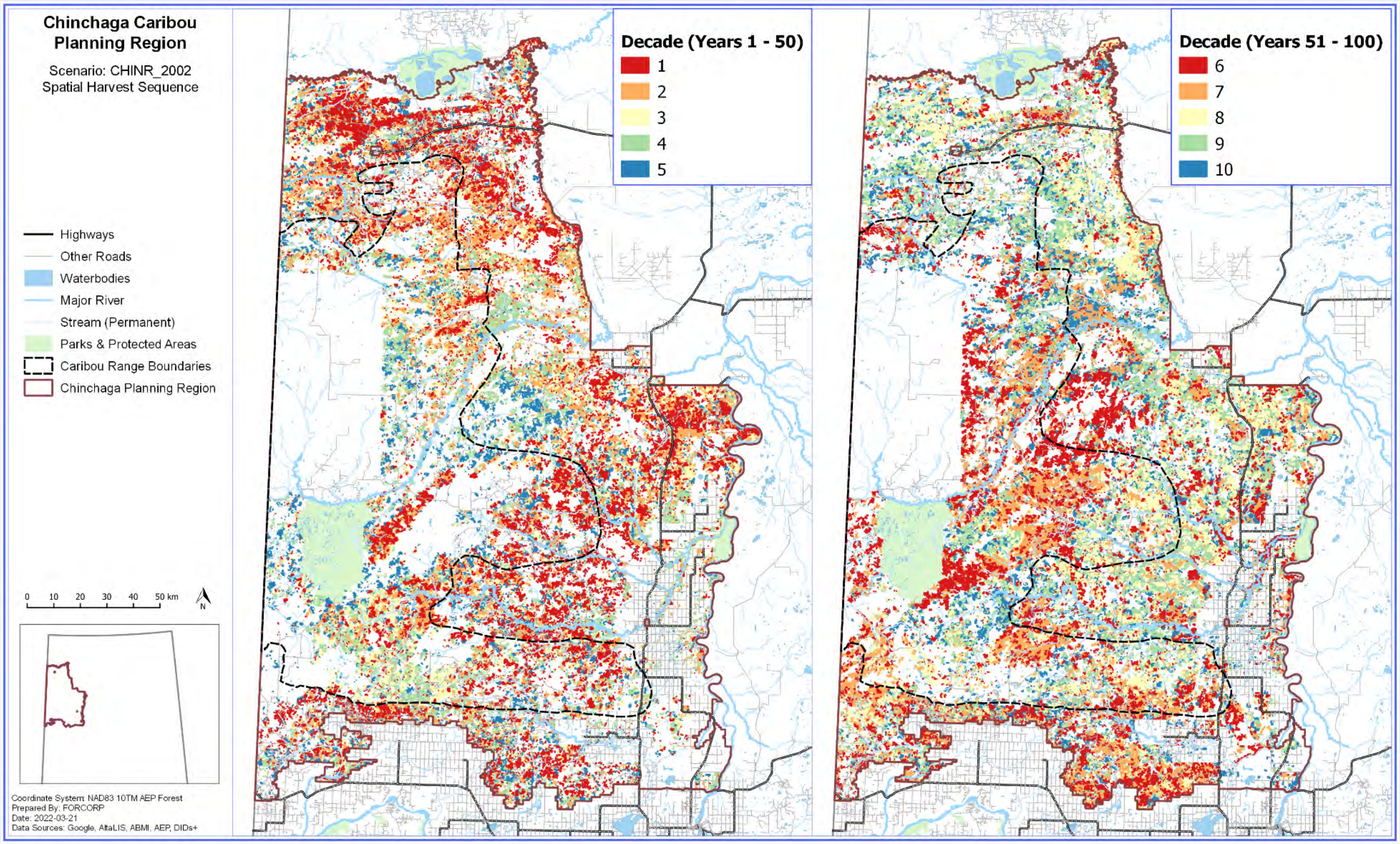


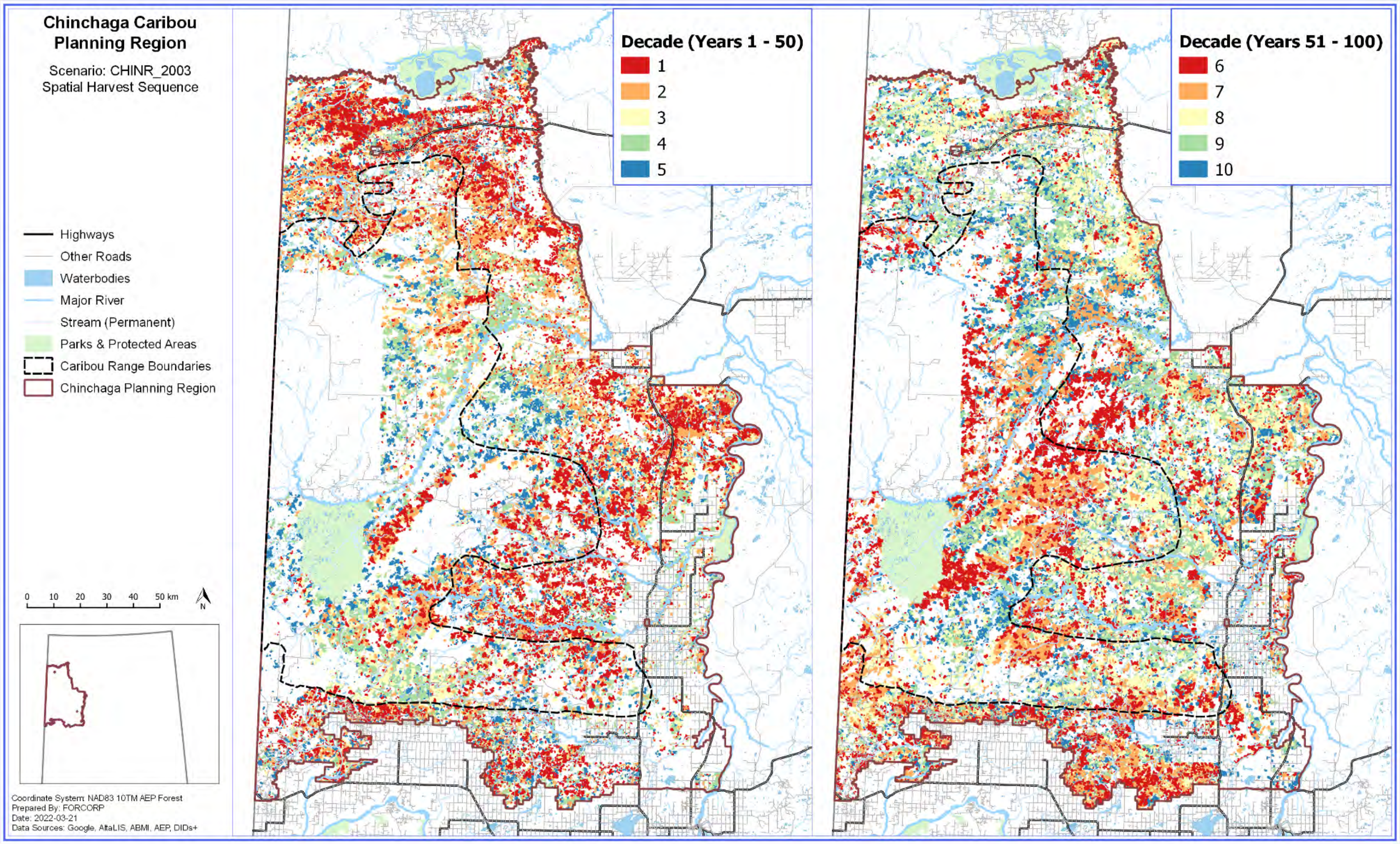
Berland Caribou Planning Region
Scenario: BERR_2007
Spatial Harvest Sequence
Decade (Years 1 - 50)
1
2
3
4
5
Decade (Years 51 - 100)
6
7
8
9
10
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Parks & Protected Areas
Caribou Range Boundaries
Berland Planning Region
0
10
20
30
40
50 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-02-17
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+

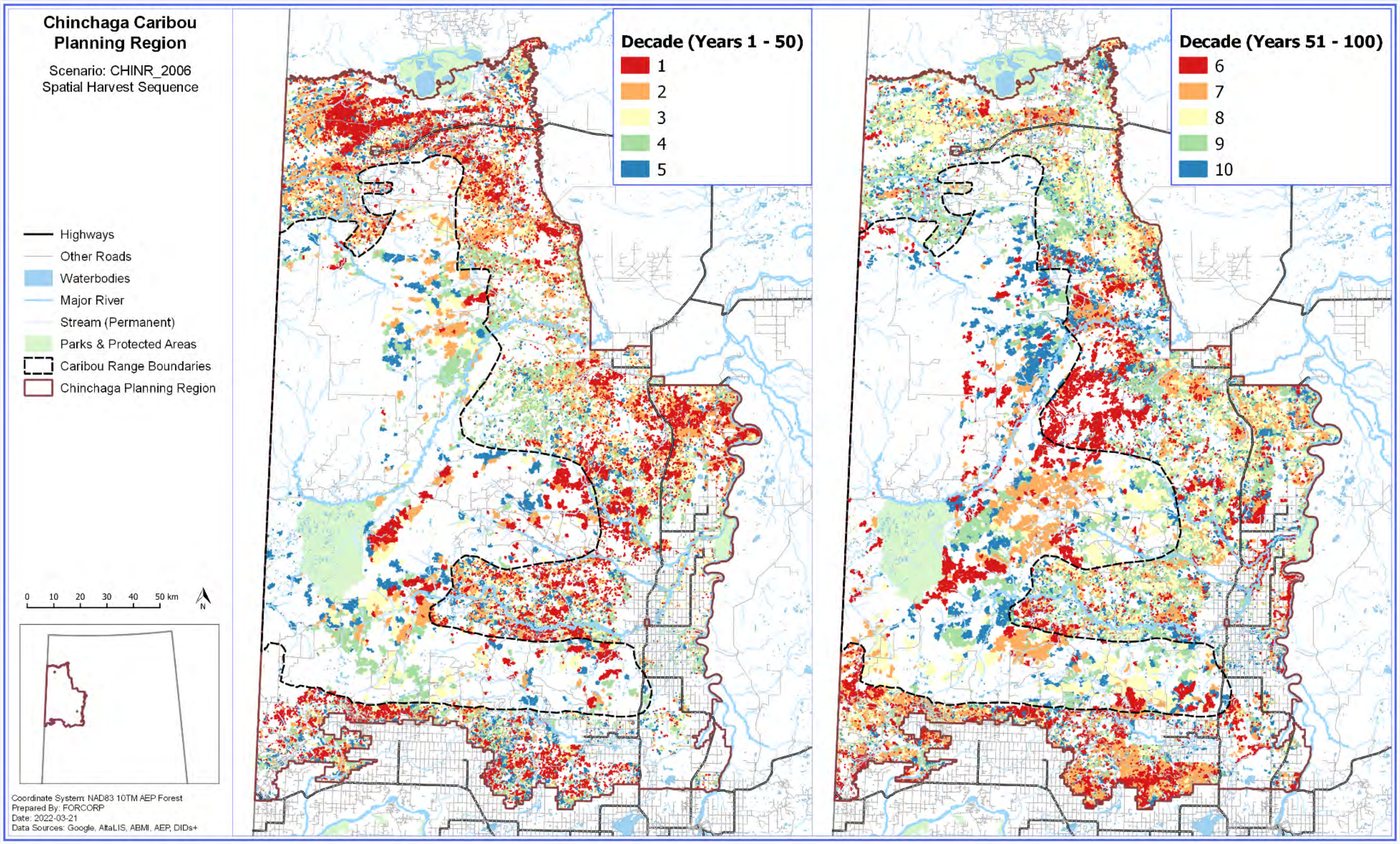

Berland Caribou Planning Region
Scenario: BERR_2008
Spatial Harvest Sequence
Decade (Years 1 - 50)
1
2
3
4
5
Decade (Years 51 - 100)
6
7
8
9
10
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Parks & Protected Areas
Caribou Range Boundaries
Berland Planning Region
0 10 20 30 40 50 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-02-18
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+

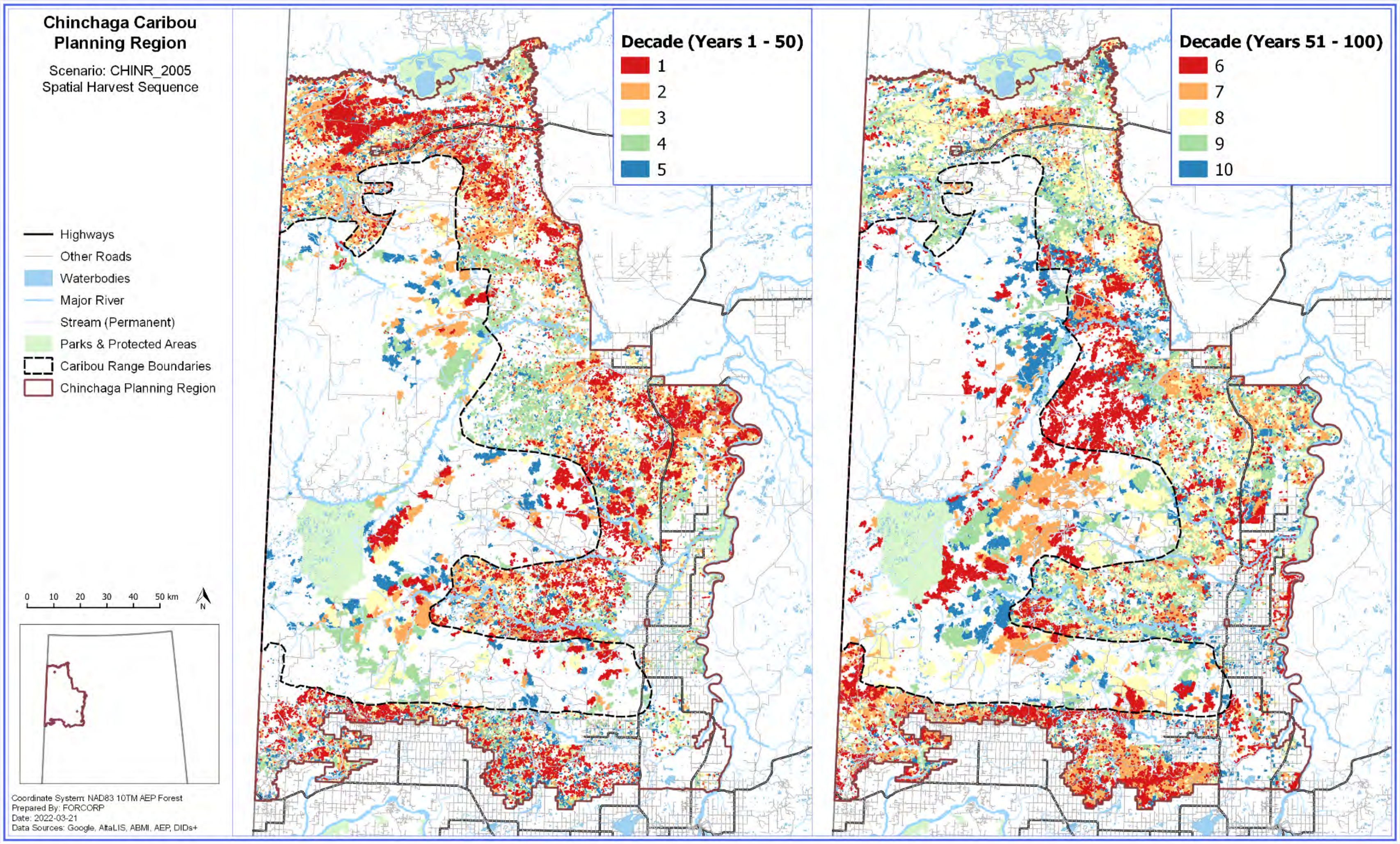

Berland Caribou Planning Region
Scenario: BERR_2012
Spatial Harvest Sequence
Decade (Years 1 - 50)
1
2
3
4
5
Decade (Years 51 - 100)
6
7
8
9
10
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Parks & Protected Areas
Caribou Range Boundaries
Berland Planning Region
0 10 20 30 40 50 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-03-16
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+

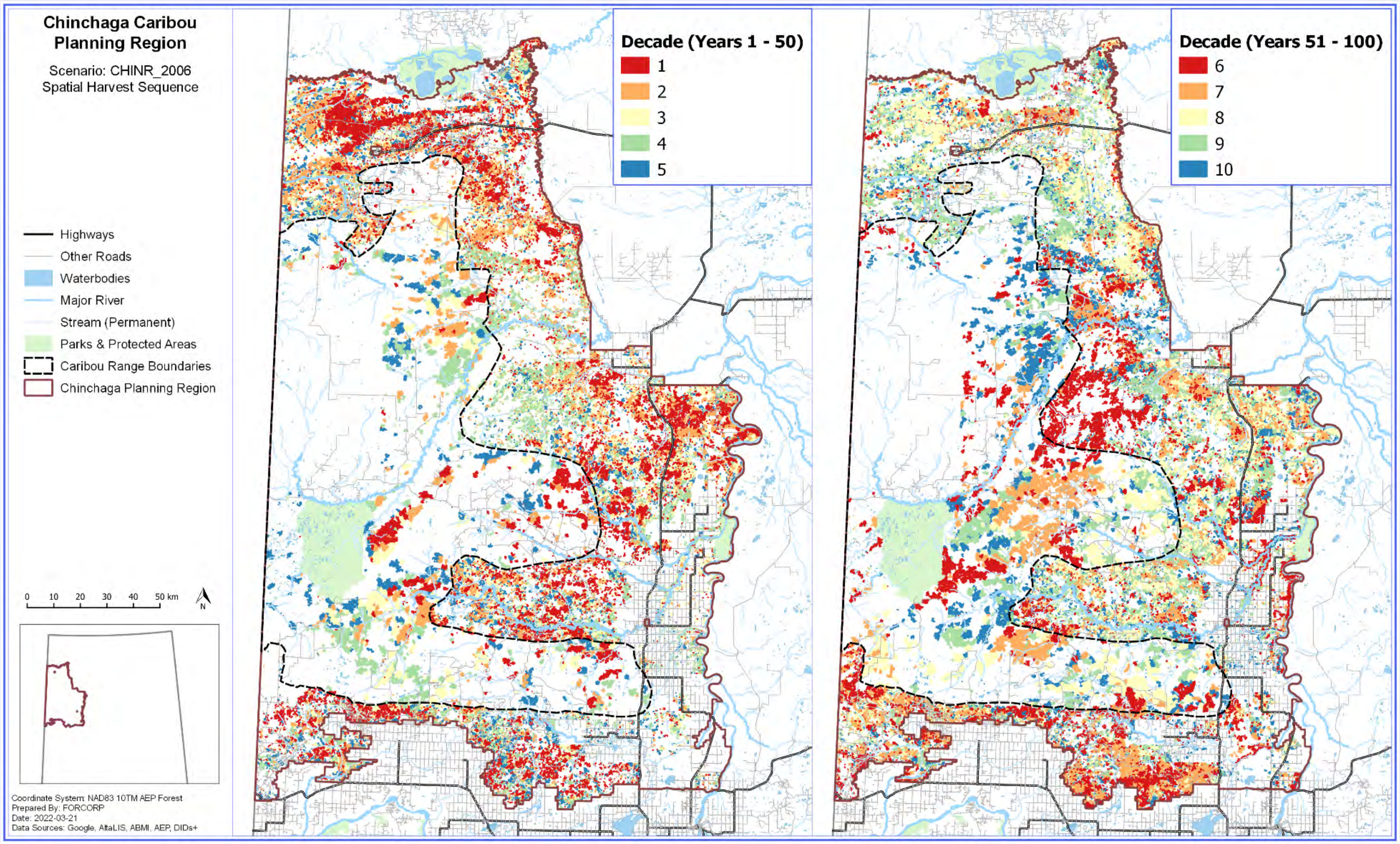

Chinchaga Caribou Planning Region
Scenario: CHINR_2001
Spatial Harvest Sequence
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Parks & Protected Areas
Caribou Range Boundaries
Chinchaga Planning Region
0 10 20 30 40 50 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-03-21
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Decade (Years 1 - 50)
1
2
3
4
5
Decade (Years 51 - 100)
6
7
8
9
10

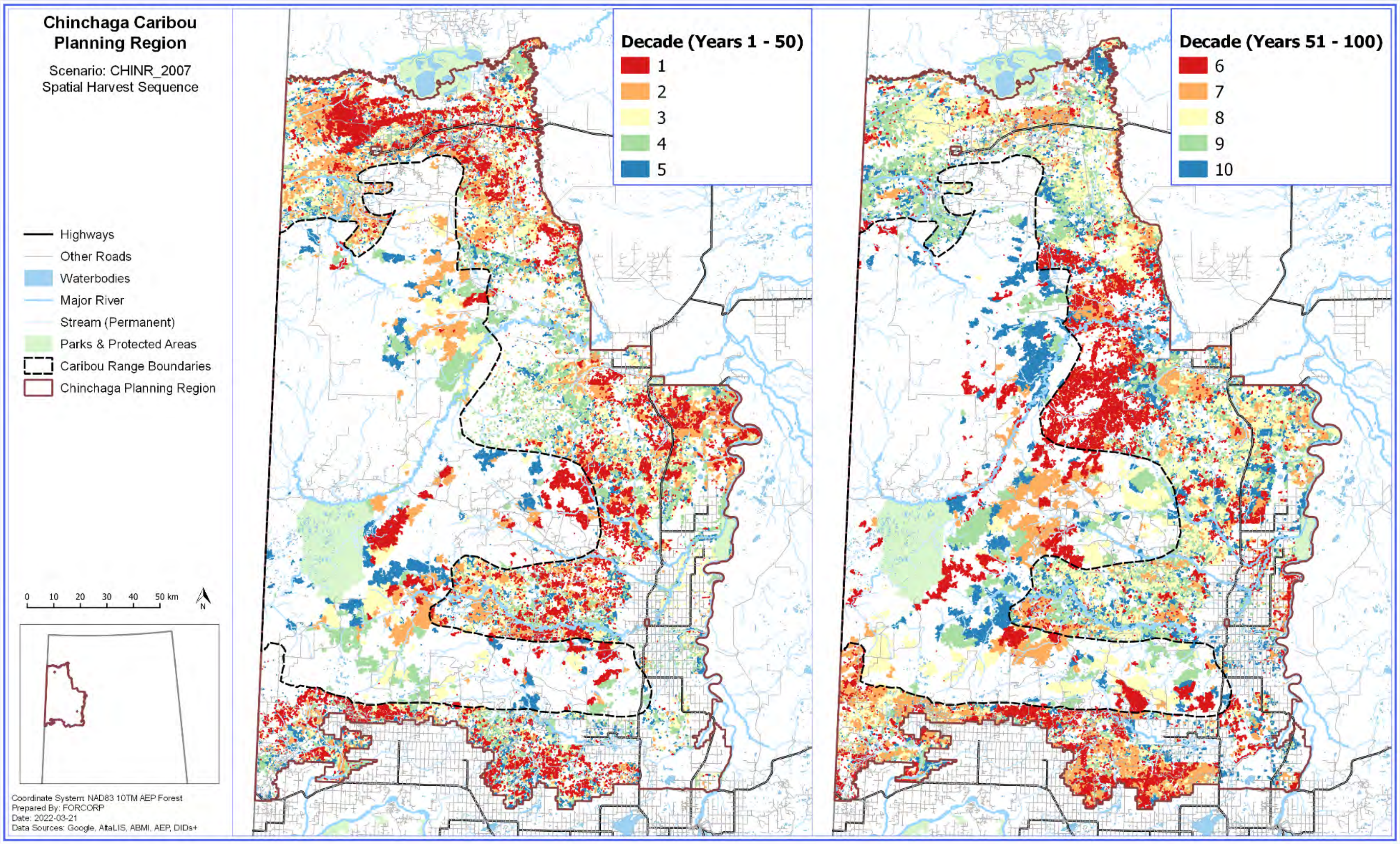

Chinchaga Caribou Planning Region
Scenario: CHINR_2002
Spatial Harvest Sequence
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Parks & Protected Areas
Caribou Range Boundaries
Chinchaga Planning Region
0 10 20 30 40 50 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-03-21
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Decade (Years 1 - 50)
1
2
3
4
5
Decade (Years 51 - 100)
6
7
8
9
10

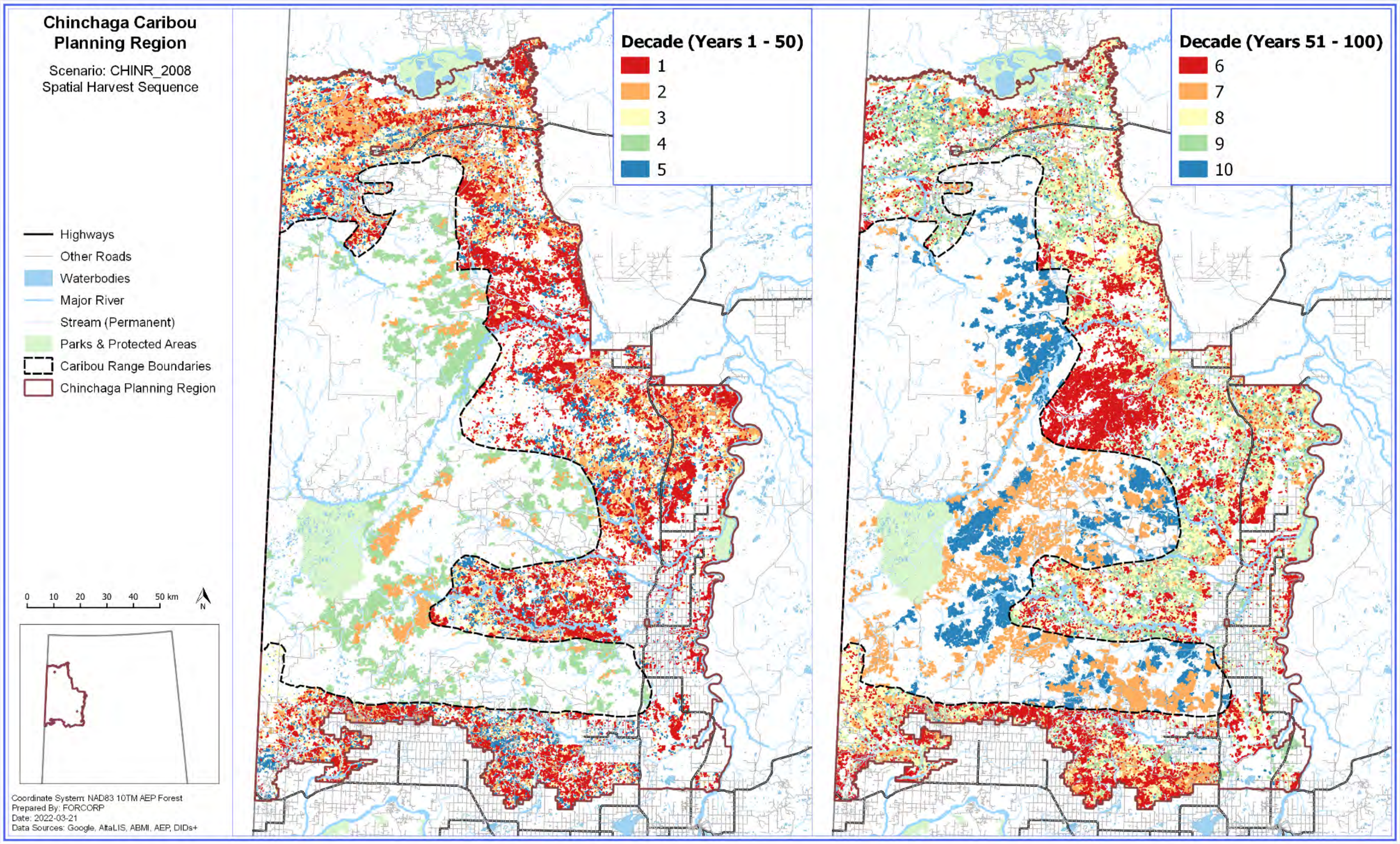

Chinchaga Caribou Planning Region
Scenario: CHINR_2003
Spatial Harvest Sequence
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Parks & Protected Areas
Caribou Range Boundaries
Chinchaga Planning Region
0 10 20 30 40 50 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-03-21
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Decade (Years 1 - 50)
1
2
3
4
5
Decade (Years 51 - 100)
6
7
8
9
10

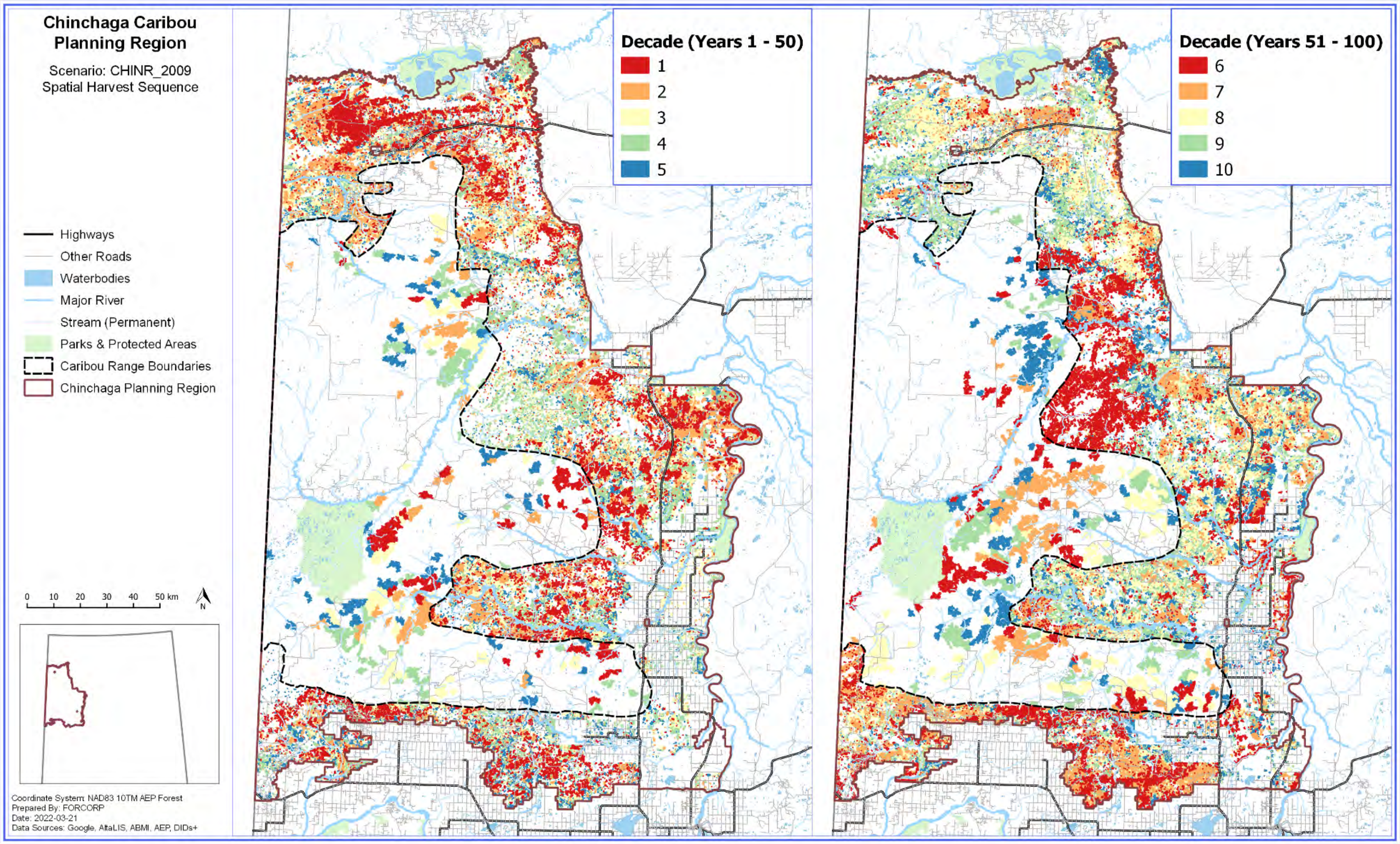

Chinchaga Caribou Planning Region
Scenario: CHINR_2006
Spatial Harvest Sequence
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Parks & Protected Areas
Caribou Range Boundaries
Chinchaga Planning Region
0 10 20 30 40 50 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-03-21
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Decade (Years 1 - 50)
1
2
3
4
5
Decade (Years 51 - 100)
6
7
8
9
10

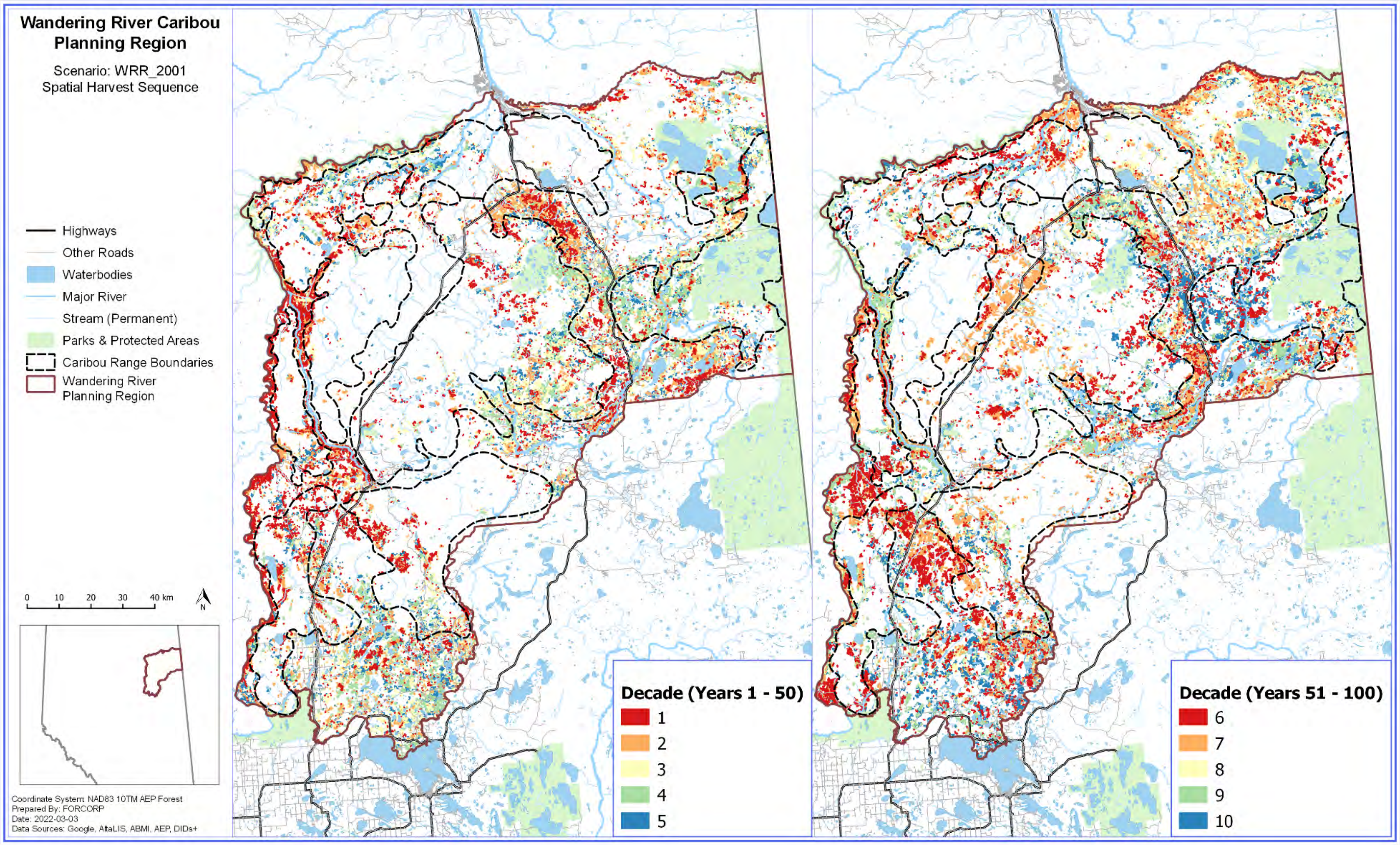

Chinchaga Caribou
Planning Region
Scenario: CHINR_2005
Spatial Harvest Sequence
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Parks & Protected Areas
Caribou Range Boundaries
Chinchaga Planning Region
0 10 20 30 40 50 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-03-21
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Decade (Years 1 - 50)
1
2
3
4
5
Decade (Years 51 - 100)
6
7
8
9
10


Chinchaga Caribou Planning Region
Scenario: CHINR_2006
Spatial Harvest Sequence
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Parks & Protected Areas
Caribou Range Boundaries
Chinchaga Planning Region
0 10 20 30 40 50 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-03-21
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Decade (Years 1 - 50)
1
2
3
4
5
Decade (Years 51 - 100)
6
7
8
9
10

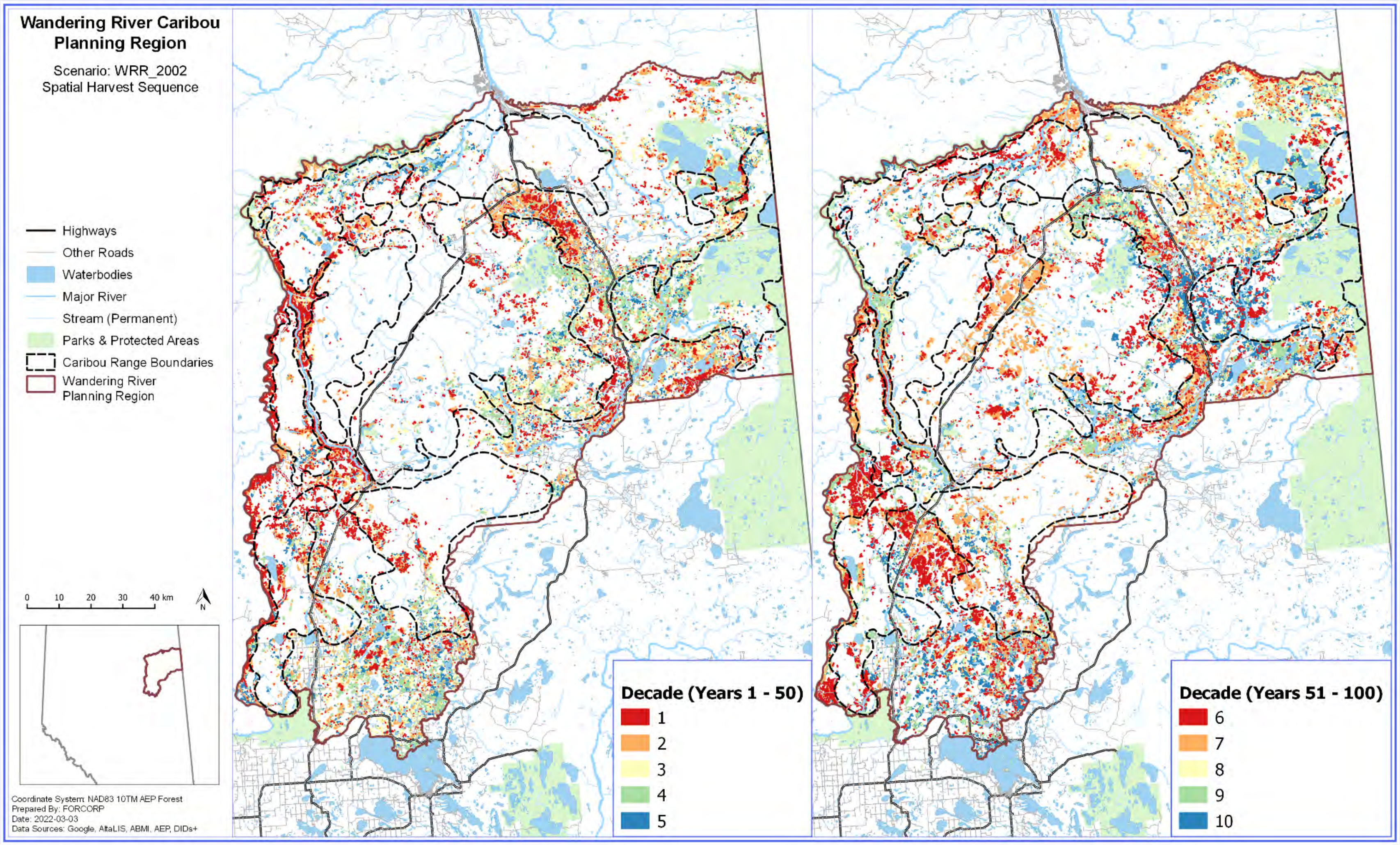

Chinchaga Caribou Planning Region
Scenario: CHINR_2007
Spatial Harvest Sequence
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Parks & Protected Areas
Caribou Range Boundaries
Chinchaga Planning Region
0 10 20 30 40 50 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-03-21
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Decade (Years 1 - 50)
1
2
3
4
5
Decade (Years 51 - 100)
6
7
8
9
10


Chinchaga Caribou Planning Region
Scenario: CHINR_2008
Spatial Harvest Sequence
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Parks & Protected Areas
Caribou Range Boundaries
Chinchaga Planning Region
0 10 20 30 40 50 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-03-21
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Decade (Years 1 - 50)
1
2
3
4
5
Decade (Years 51 - 100)
6
7
8
9
10

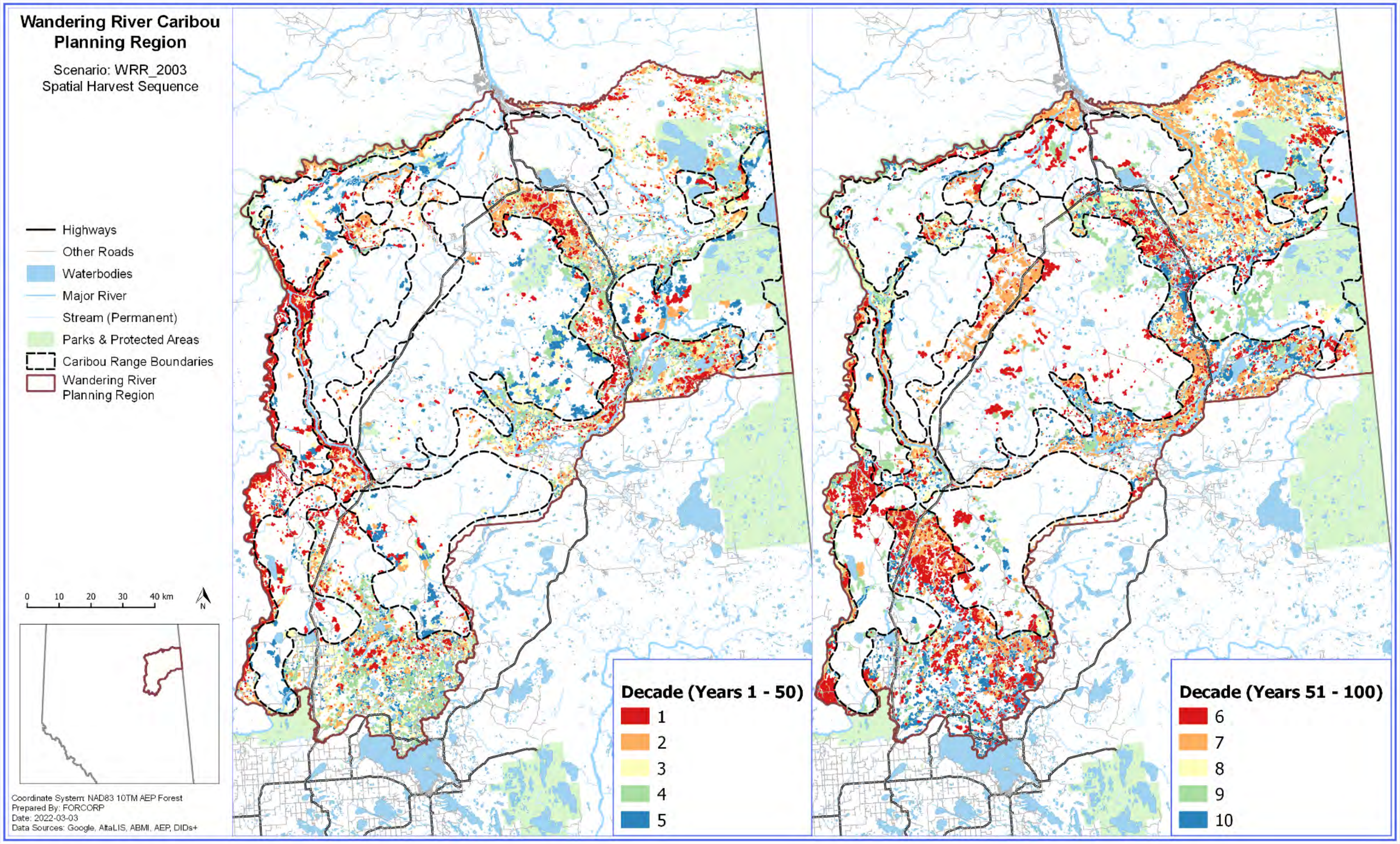

Chinchaga Caribou Planning Region
Scenario: CHINR_2009
Spatial Harvest Sequence
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Parks & Protected Areas
Caribou Range Boundaries
Chinchaga Planning Region
0 10 20 30 40 50 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-03-21
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Decade (Years 1 - 50)
1
2
3
4
5
Decade (Years 51 - 100)
6
7
8
9
10



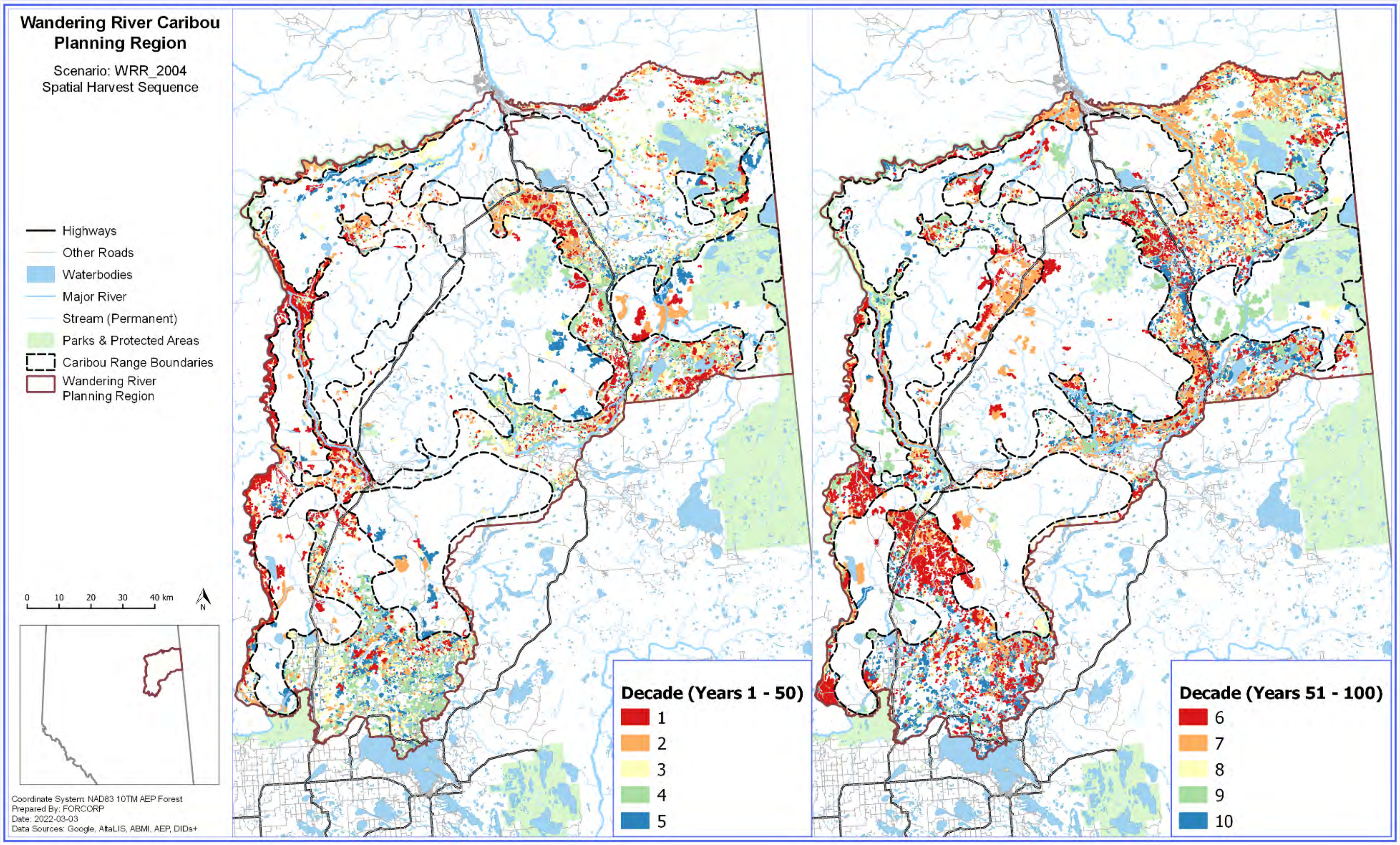
Wandering River Caribou Planning Region
Scenario: WRR_2001
Spatial Harvest Sequence
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Parks & Protected Areas
Caribou Range Boundaries
Wandering River Planning Region
0 10 20 30 40 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-03-03
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Decade (Years 1 - 50)
1
2
3
4
5
Decade (Years 51 - 100)
6
7
8
9
10



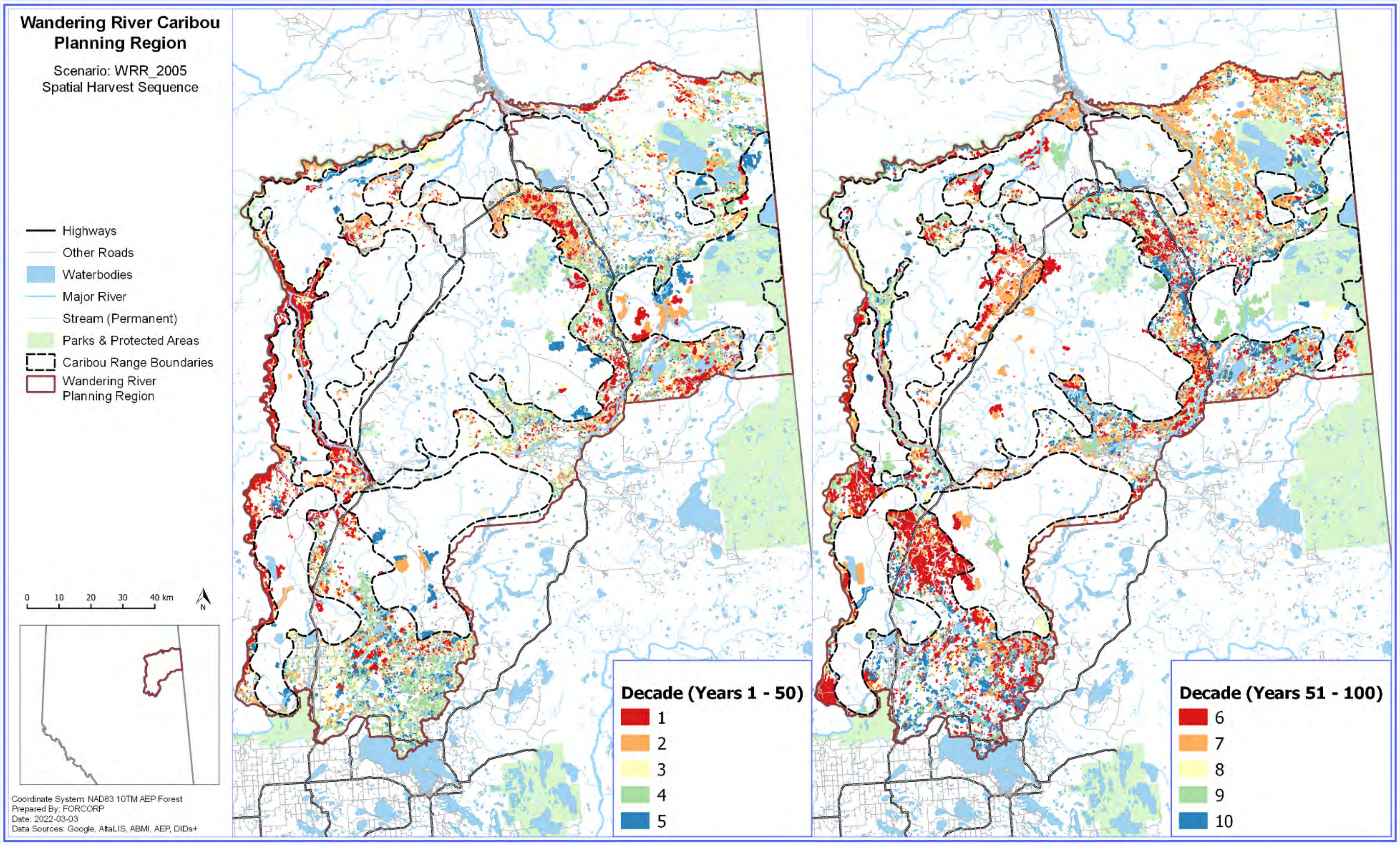
Wandering River Caribou Planning Region
Scenario: WRR_2002
Spatial Harvest Sequence
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Parks & Protected Areas
Caribou Range Boundaries
Wandering River Planning Region
0 10 20 30 40 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-03-03
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Decade (Years 1 - 50)
1
2
3
4
5
Decade (Years 51 - 100)
6
7
8
9
10



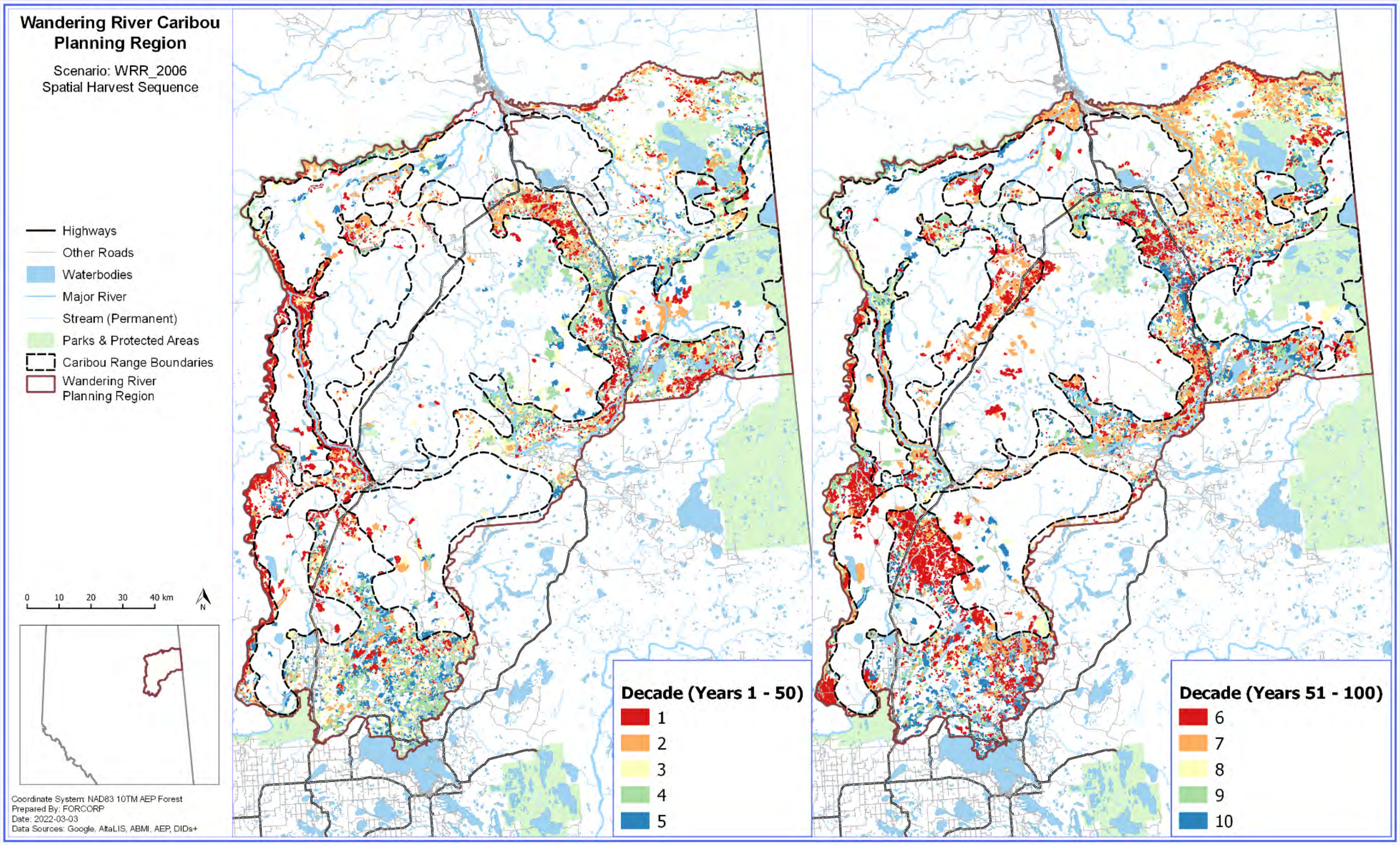
Wandering River Caribou Planning Region
Scenario: WRR_2003
Spatial Harvest Sequence
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Parks & Protected Areas
Caribou Range Boundaries
Wandering River Planning Region
0 10 20 30 40 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-03-03
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Decade (Years 1 - 50)
1
2
3
4
5
Decade (Years 51 - 100)
6
7
8
9
10



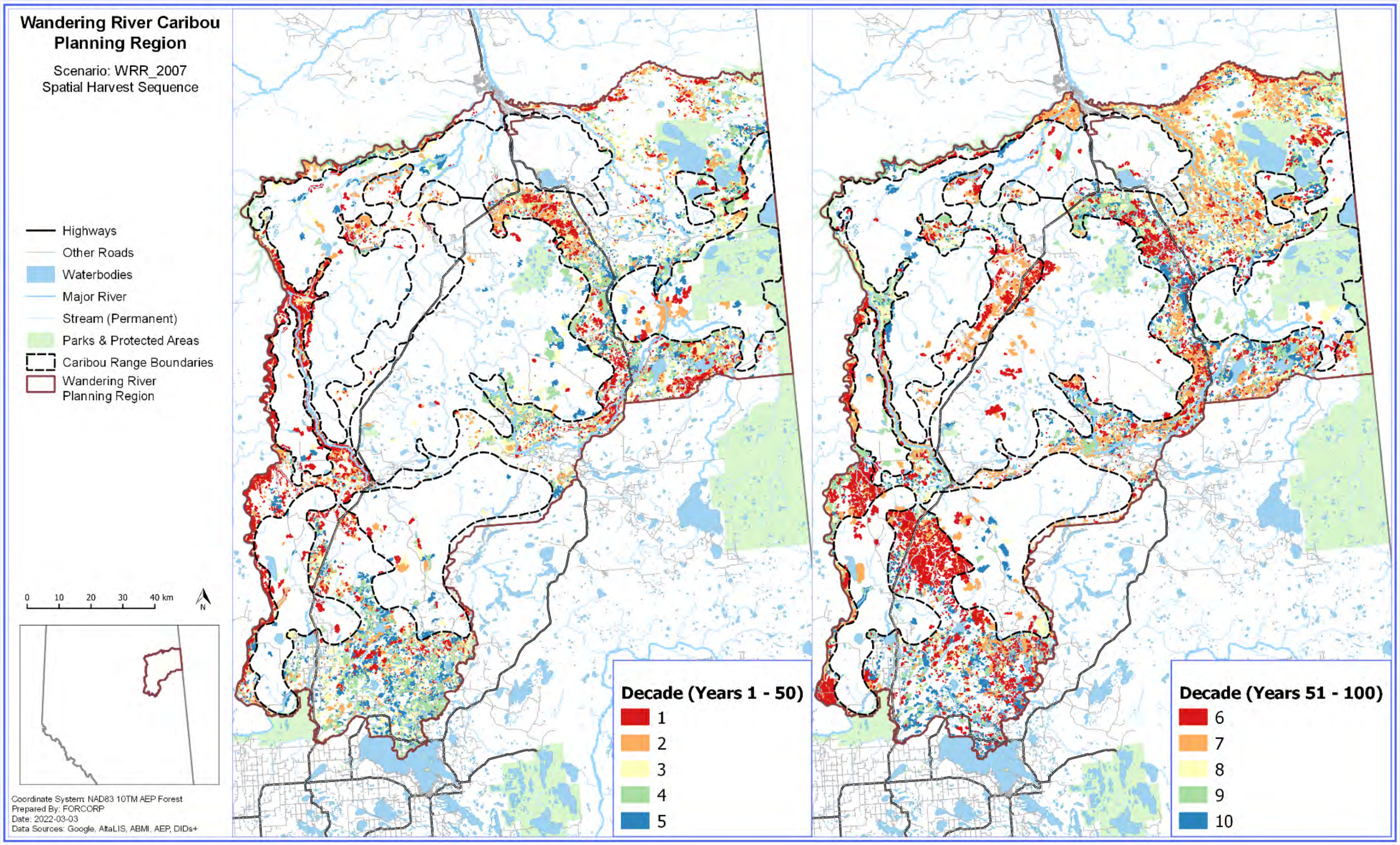
Wandering River Caribou Planning Region
Scenario: WRR_2004
Spatial Harvest Sequence
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Parks & Protected Areas
Caribou Range Boundaries
Wandering River Planning Region
0 10 20 30 40 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-03-03
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Decade (Years 1 - 50)
1
2
3
4
5
Decade (Years 51 - 100)
6
7
8
9
10

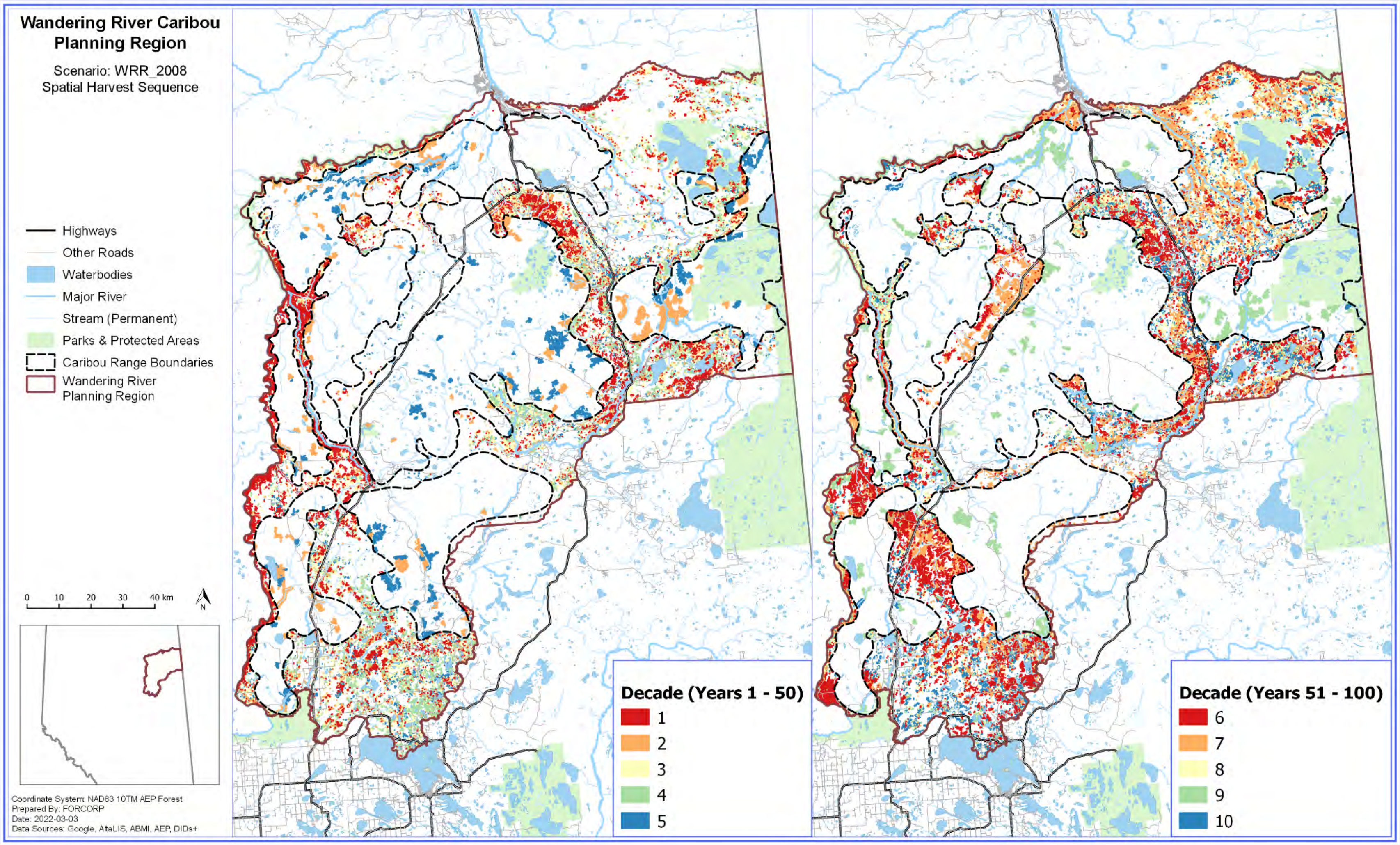


Wandering River Caribou Planning Region
Scenario: WRR_2005
Spatial Harvest Sequence
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Parks & Protected Areas
Caribou Range Boundaries
Wandering River Planning Region
0 10 20 30 40 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-03-03
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Decade (Years 1 - 50)
1
2
3
4
5
Decade (Years 51 - 100)
6
7
8
9
10

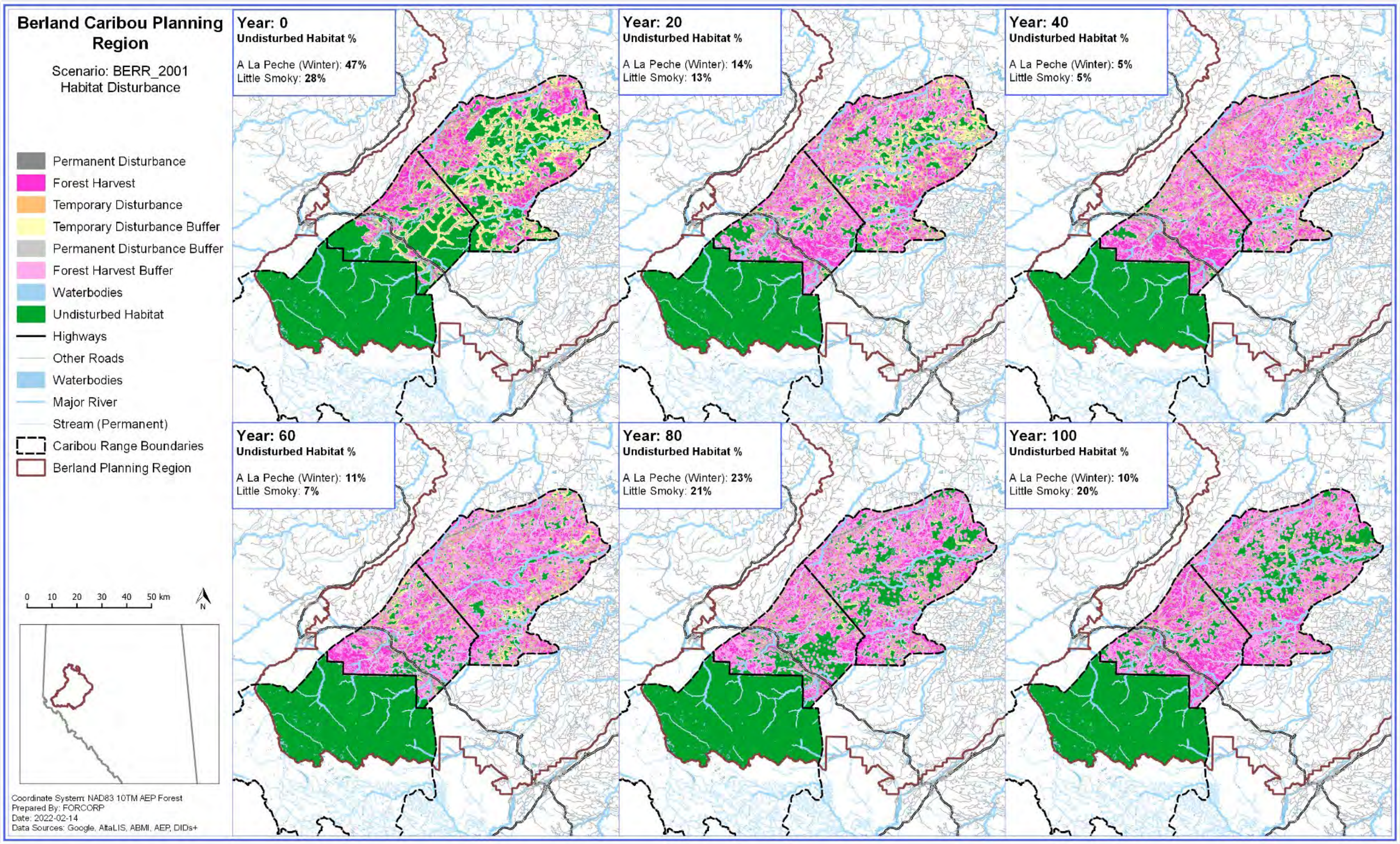


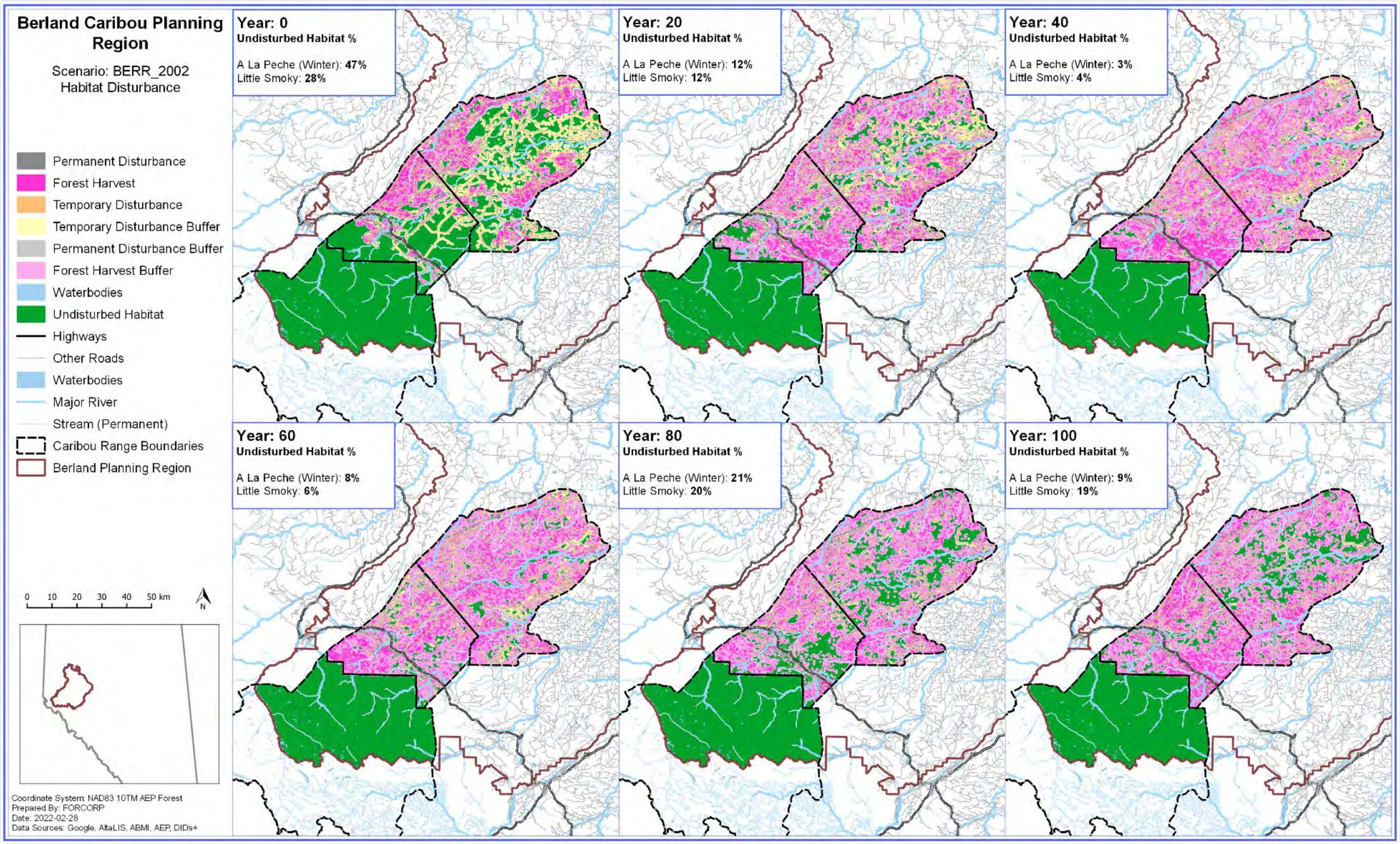
Wandering River Caribou Planning Region
Scenario: WRR_2006
Spatial Harvest Sequence
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Parks & Protected Areas
Caribou Range Boundaries
Wandering River Planning Region
0 10 20 30 40 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-03-03
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Decade (Years 1 - 50)
1
2
3
4
5
Decade (Years 51 - 100)
6
7
8
9
10

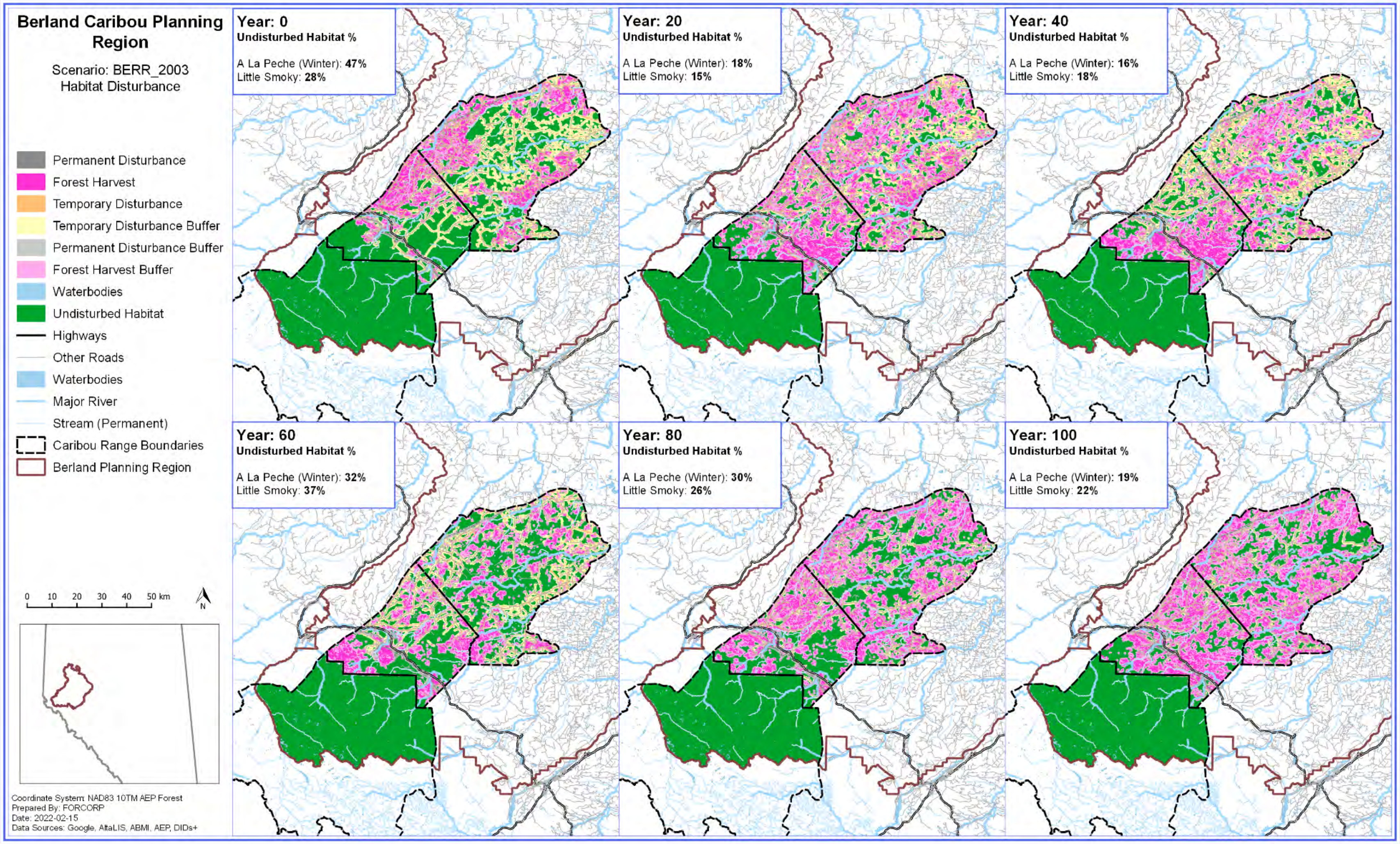

Wandering River Caribou Planning Region
Scenario: WRR_2007
Spatial Harvest Sequence
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Parks & Protected Areas
Caribou Range Boundaries
Wandering River Planning Region
0 10 20 30 40 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-03-03
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Decade (Years 1 - 50)
1
2
3
4
5
Decade (Years 51 - 100)
6
7
8
9
10


Wandering River Caribou Planning Region
Scenario: WRR_2008
Spatial Harvest Sequence
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Parks & Protected Areas
Caribou Range Boundaries
Wandering River Planning Region
0 10 20 30 40 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-03-03
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Decade (Years 1 - 50)
1
2
3
4
5
Decade (Years 51 - 100)
6
7
8
9
10

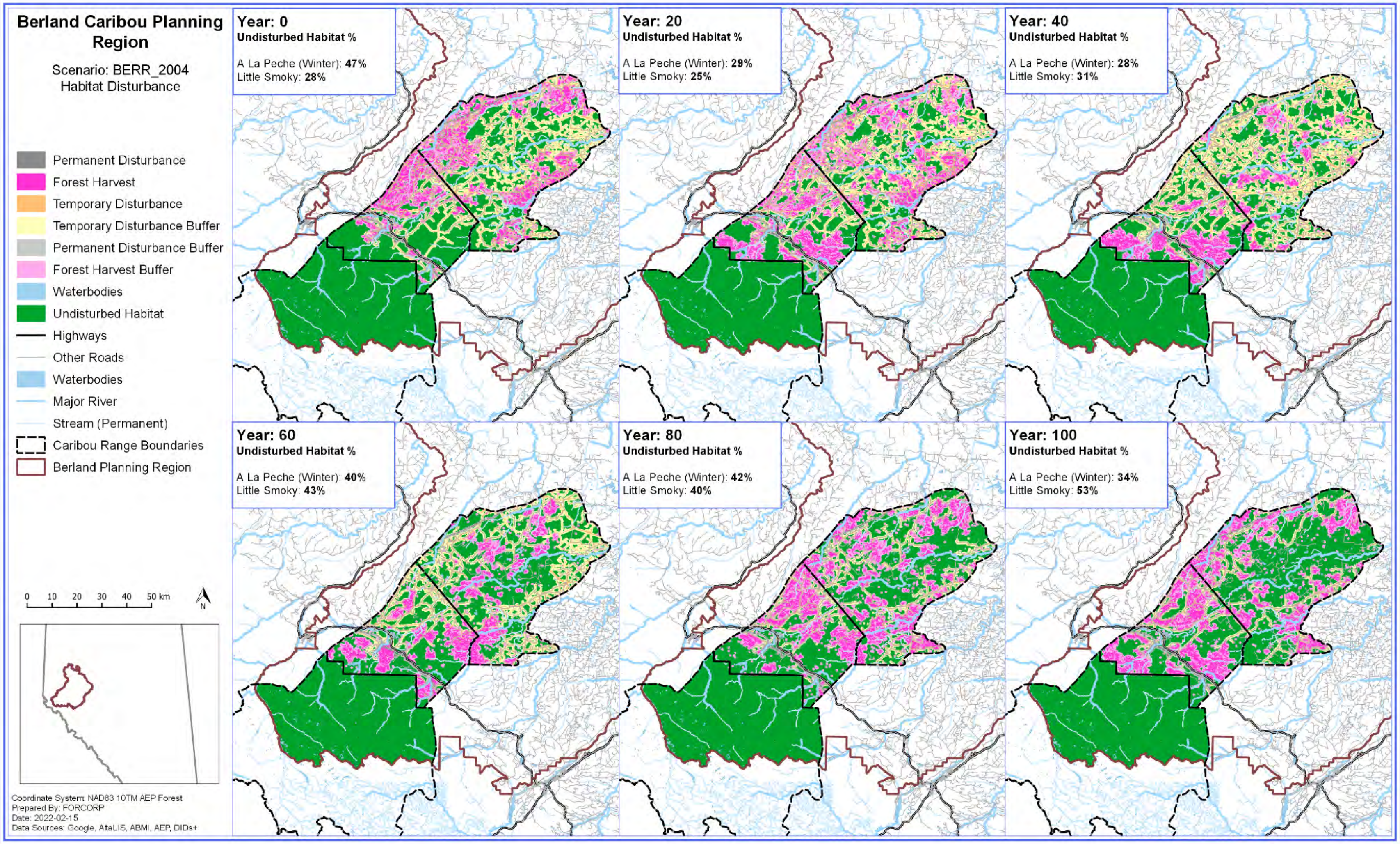
Appendix II Habitat Disturbance Maps


Berland Caribou Planning Region
Scenario: BERR_2001
Habitat Disturbance
Permanent Disturbance
Forest Harvest
Temporary Disturbance
Temporary Disturbance Buffer
Permanent Disturbance Buffer
Forest Harvest Buffer
Waterbodies
Undisturbed Habitat
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Caribou Range Boundaries
Berland Planning Region
0 10 20 30 40 50 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-02-14
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 0
Undisturbed Habitat %
A La Peche (Winter): 47%
Little Smoky: 28%
Year: 20
Undisturbed Habitat %
A La Peche (Winter): 14%
Little Smoky: 13%
Year: 40
Undisturbed Habitat %
A La Peche (Winter): 5%
Little Smoky: 5%
Year: 60
Undisturbed Habitat %
A La Peche (Winter): 11%
Little Smoky: 7%
Year: 80
Undisturbed Habitat %
A La Peche (Winter): 23%
Little Smoky: 21%
Year: 100
Undisturbed Habitat %
A La Peche (Winter): 10%
Little Smoky: 20%

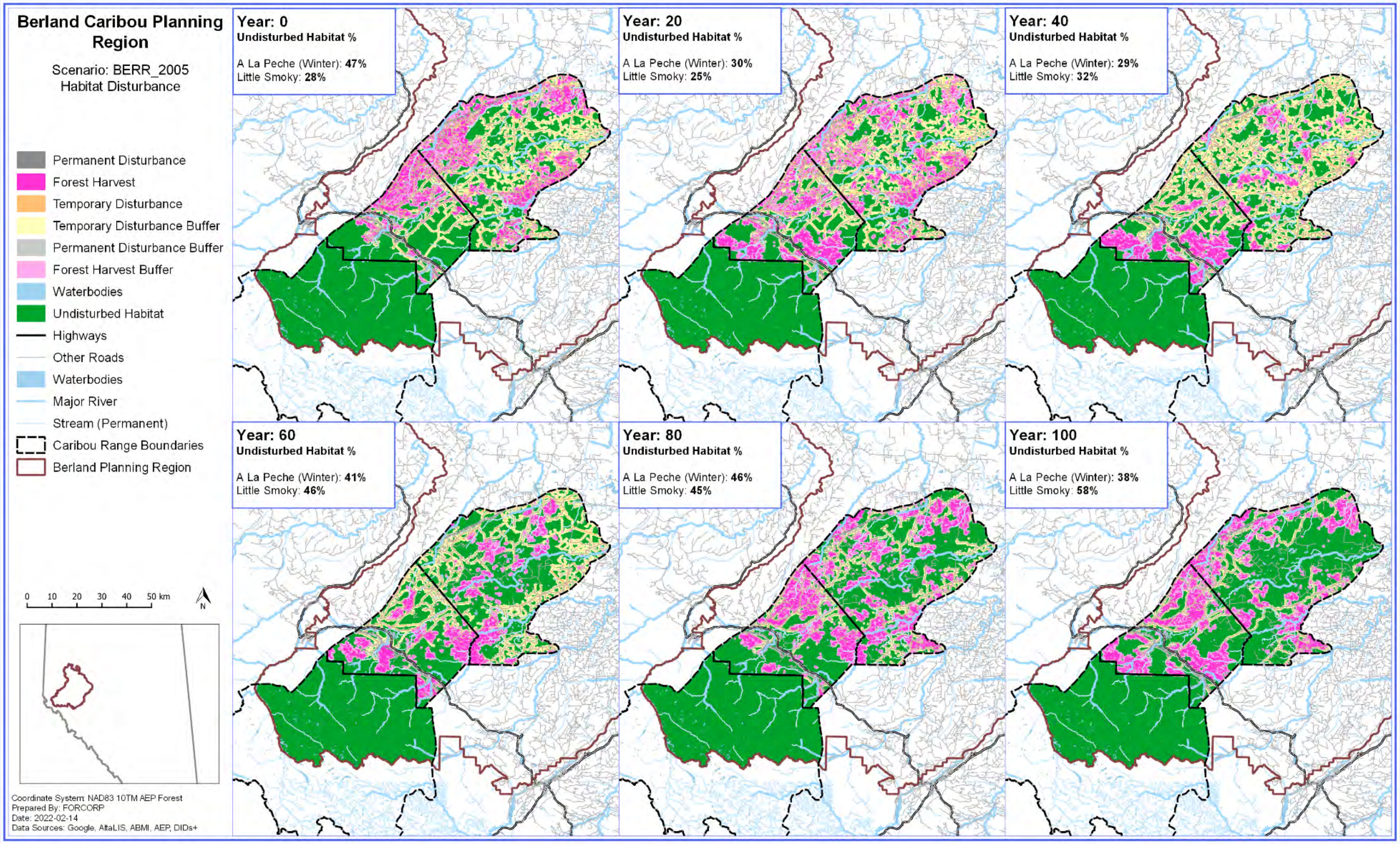

Berland Caribou Planning Region
Scenario: BERR_2002
Habitat Disturbance
Permanent Disturbance
Forest Harvest
Temporary Disturbance
Temporary Disturbance Buffer
Permanent Disturbance Buffer
Forest Harvest Buffer
Waterbodies
Undisturbed Habitat
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Caribou Range Boundaries
Berland Planning Region
0 10 20 30 40 50 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-02-28
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 0
Undisturbed Habitat %
A La Peche (Winter): 47%
Little Smoky: 28%
Year: 20
Undisturbed Habitat %
A La Peche (Winter): 12%
Little Smoky: 12%
Year: 40
Undisturbed Habitat %
A La Peche (Winter): 3%
Little Smoky: 4%
Year: 60
Undisturbed Habitat %
A La Peche (Winter): 8%
Little Smoky: 6%
Year: 80
Undisturbed Habitat %
A La Peche (Winter): 21%
Little Smoky: 20%
Year: 100
Undisturbed Habitat %
A La Peche (Winter): 9%
Little Smoky: 19%

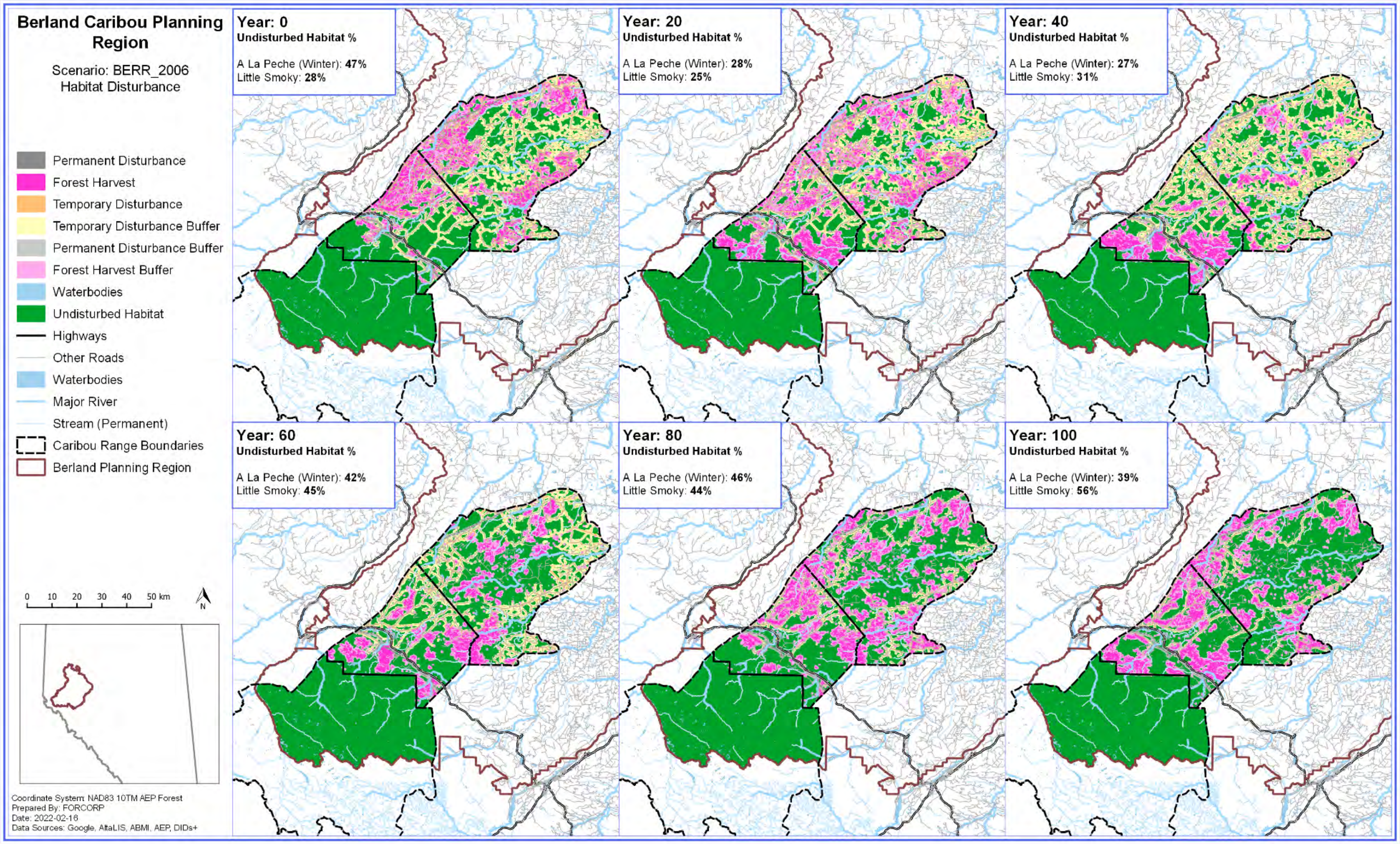


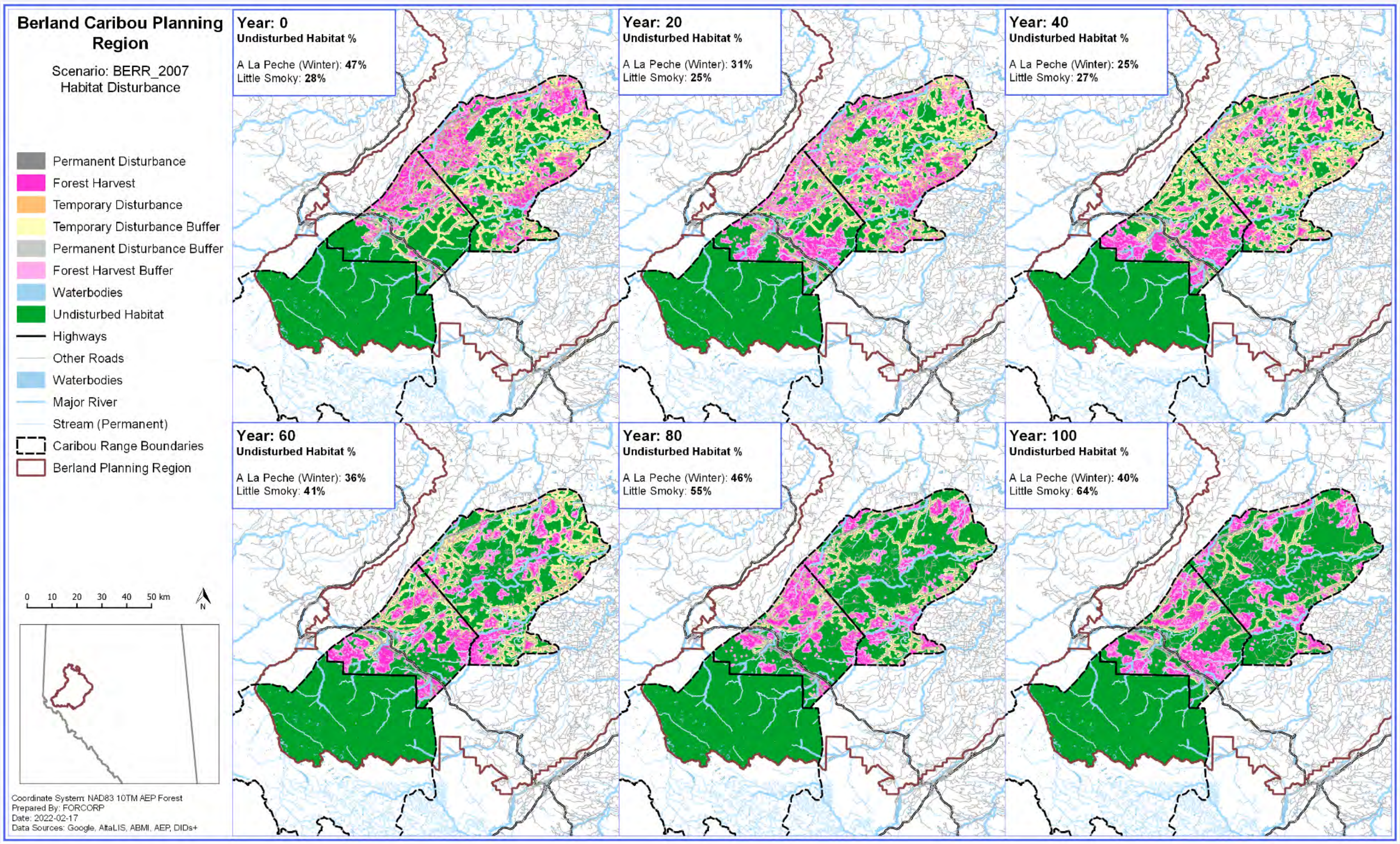
Berland Caribou Planning Region
Scenario: BERR_2003
Habitat Disturbance
Permanent Disturbance
Forest Harvest
Temporary Disturbance
Temporary Disturbance Buffer
Permanent Disturbance Buffer
Forest Harvest Buffer
Waterbodies
Undisturbed Habitat
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Caribou Range Boundaries
Berland Planning Region
0 10 20 30 40 50 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-02-15
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 0
Undisturbed Habitat %
A La Peche (Winter): 47%
Little Smoky: 28%
Year: 20
Undisturbed Habitat %
A La Peche (Winter): 18%
Little Smoky: 15%
Year: 40
Undisturbed Habitat %
A La Peche (Winter): 16%
Little Smoky: 18%
Year: 60
Undisturbed Habitat %
A La Peche (Winter): 32%
Little Smoky: 37%
Year: 80
Undisturbed Habitat %
A La Peche (Winter): 30%
Little Smoky: 26%
Year: 100
Undisturbed Habitat %
A La Peche (Winter): 19%
Little Smoky: 22%

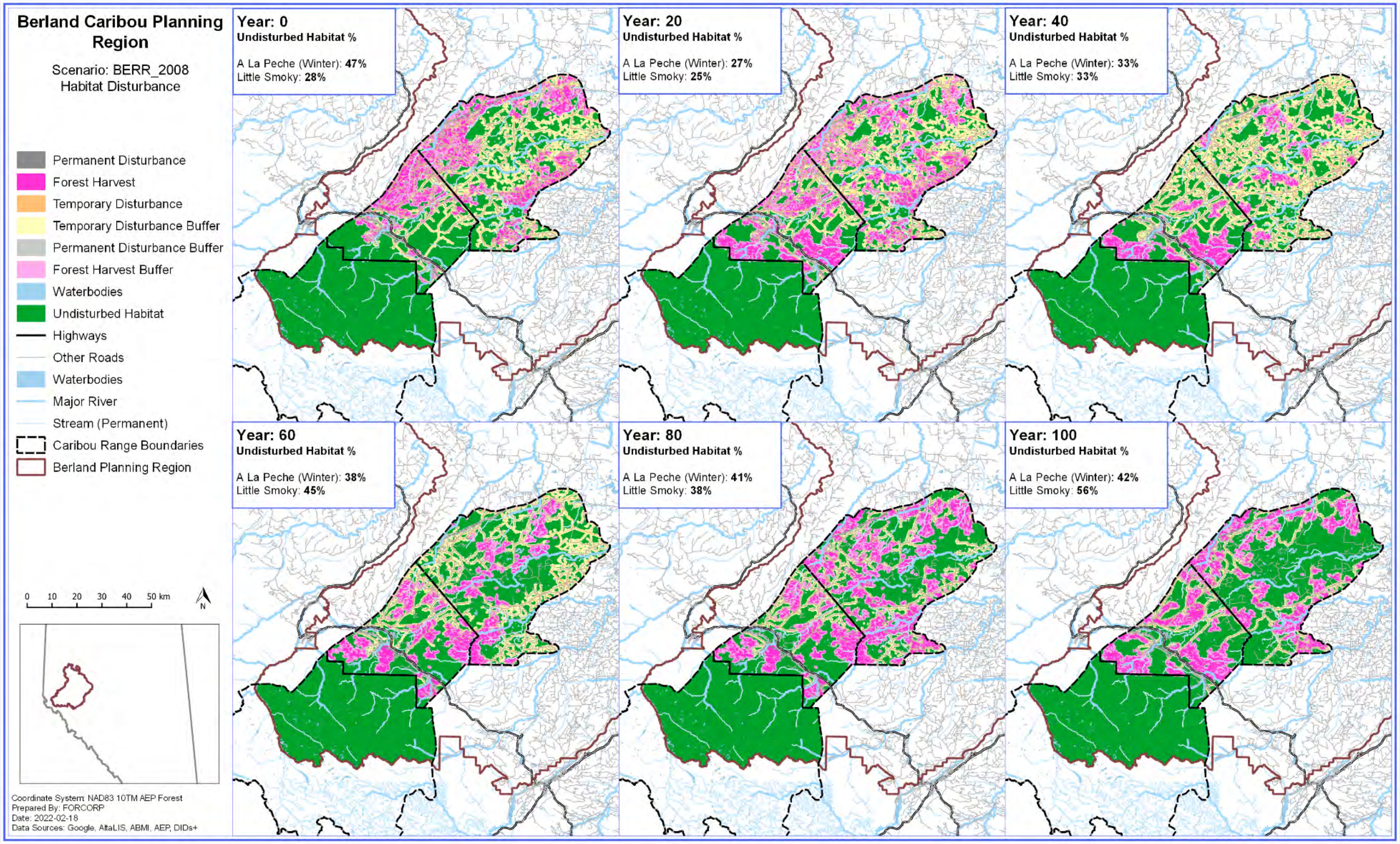


Berland Caribou Planning Region
Scenario: BERR_2004
Habitat Disturbance
Permanent Disturbance
Forest Harvest
Temporary Disturbance
Temporary Disturbance Buffer
Permanent Disturbance Buffer
Forest Harvest Buffer
Waterbodies
Undisturbed Habitat
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Caribou Range Boundaries
Berland Planning Region
0 10 20 30 40 50 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-02-15
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 0
Undisturbed Habitat %
A La Peche (Winter): 47%
Little Smoky: 28%
Year: 20
Undisturbed Habitat %
A La Peche (Winter): 29%
Little Smoky: 25%
Year: 40
Undisturbed Habitat %
A La Peche (Winter): 28%
Little Smoky: 31%
Year: 60
Undisturbed Habitat %
A La Peche (Winter): 40%
Little Smoky: 43%
Year: 80
Undisturbed Habitat %
A La Peche (Winter): 42%
Little Smoky: 40%
Year: 100
Undisturbed Habitat %
A La Peche (Winter): 34%
Little Smoky: 53%

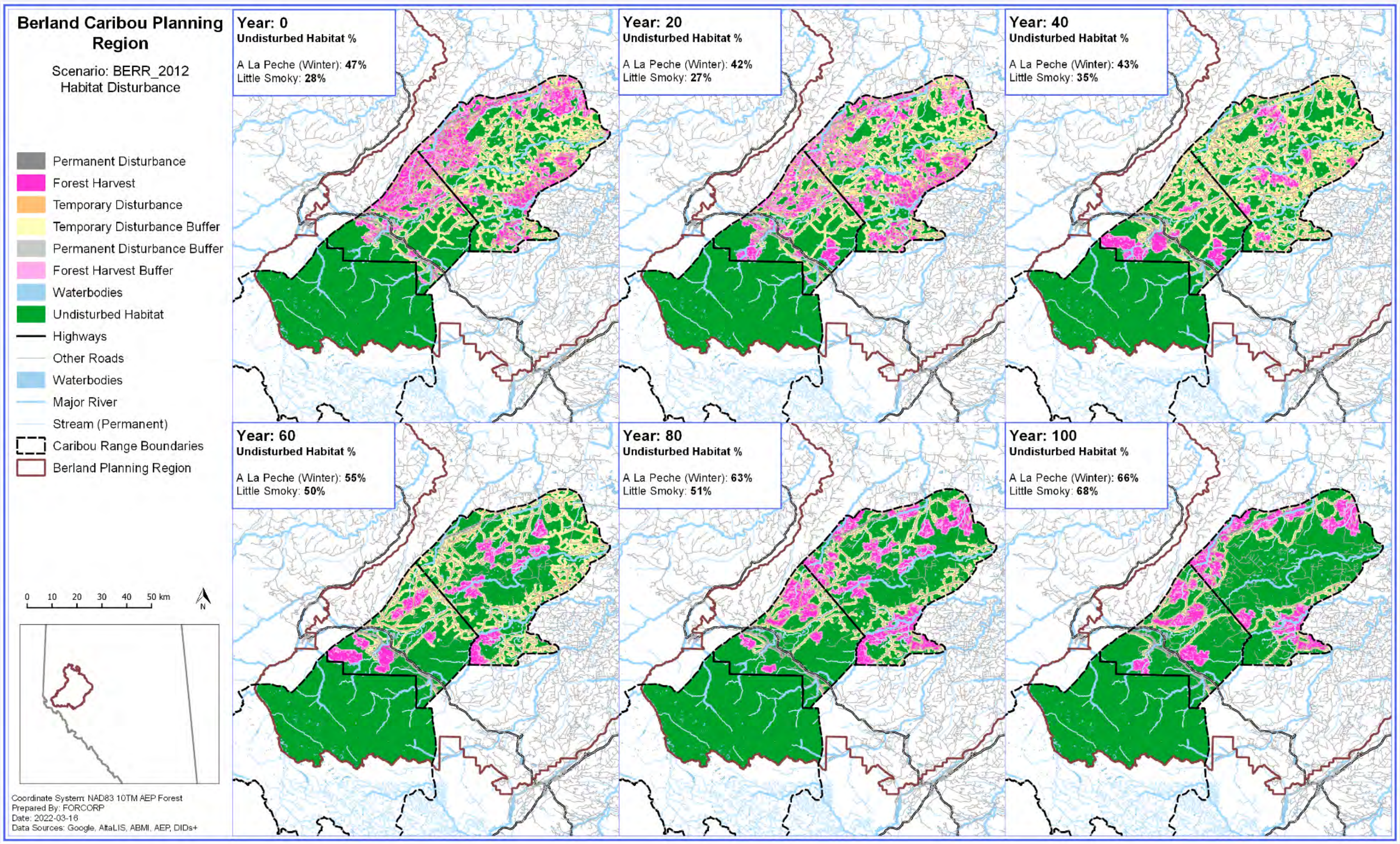

Berland Caribou Planning Region
Scenario: BERR_2005
Habitat Disturbance
Permanent Disturbance
Forest Harvest
Temporary Disturbance
Temporary Disturbance Buffer
Permanent Disturbance Buffer
Forest Harvest Buffer
Waterbodies
Undisturbed Habitat
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Caribou Range Boundaries
Berland Planning Region
0 10 20 30 40 50 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-02-14
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 0
Undisturbed Habitat %
A La Peche (Winter): 47%
Little Smoky: 28%
Year: 20
Undisturbed Habitat %
A La Peche (Winter): 30%
Little Smoky: 25%
Year: 40
Undisturbed Habitat %
A La Peche (Winter): 29%
Little Smoky: 32%
Year: 60
Undisturbed Habitat %
A La Peche (Winter): 41%
Little Smoky: 46%
Year: 80
Undisturbed Habitat %
A La Peche (Winter): 46%
Little Smoky: 45%
Year: 100
Undisturbed Habitat %
A La Peche (Winter): 38%
Little Smoky: 58%

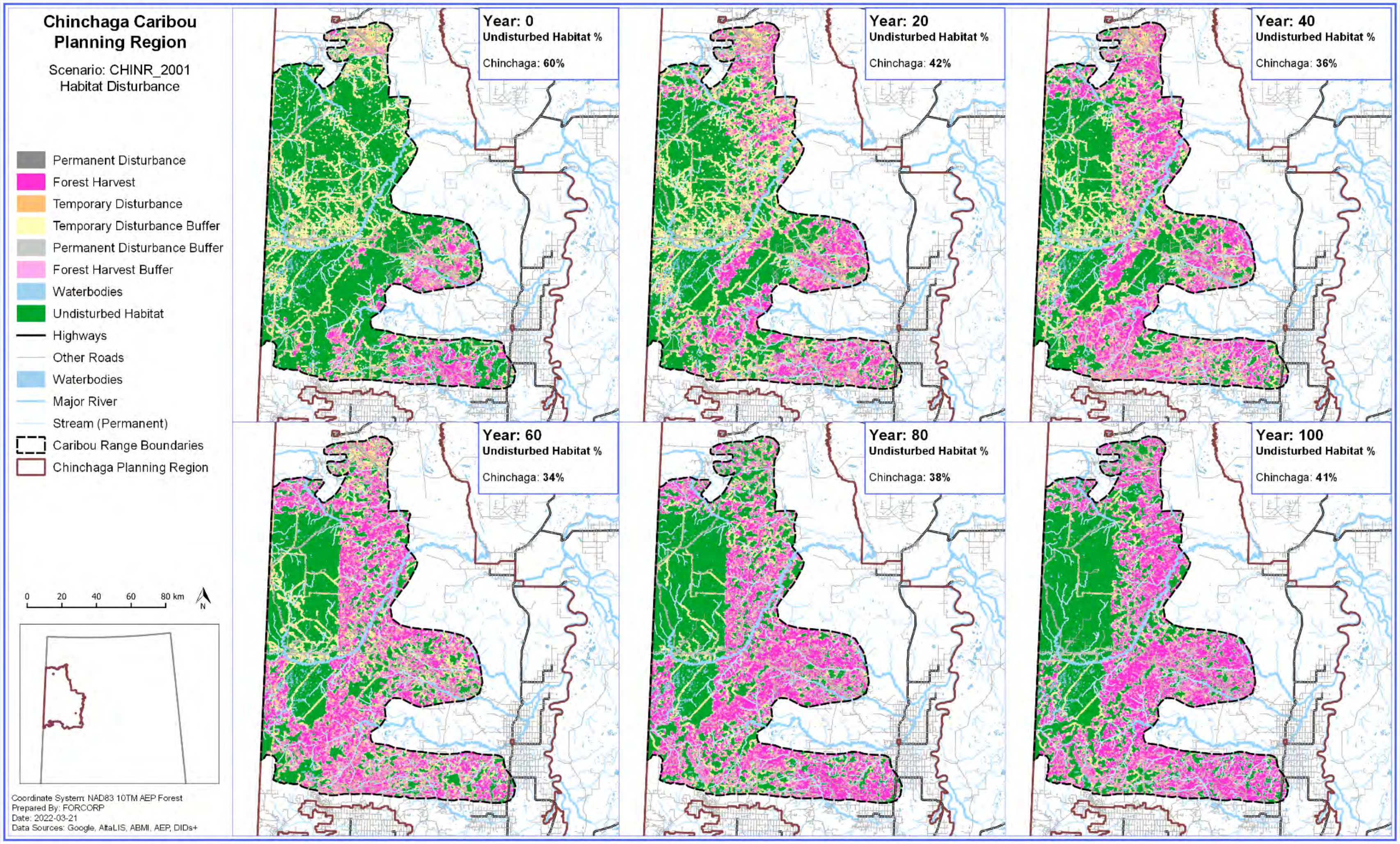

Berland Caribou Planning Region
Scenario: BERR_2006
Habitat Disturbance
Permanent Disturbance
Forest Harvest
Temporary Disturbance
Temporary Disturbance Buffer
Permanent Disturbance Buffer
Forest Harvest Buffer
Waterbodies
Undisturbed Habitat
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Caribou Range Boundaries
Berland Planning Region
0 10 20 30 40 50 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-02-16
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 0
Undisturbed Habitat %
A La Peche (Winter): 47%
Little Smoky: 28%
Year: 20
Undisturbed Habitat %
A La Peche (Winter): 28%
Little Smoky: 25%
Year: 40
Undisturbed Habitat %
A La Peche (Winter): 27%
Little Smoky: 31%
Year: 60
Undisturbed Habitat %
A La Peche (Winter): 42%
Little Smoky: 45%
Year: 80
Undisturbed Habitat %
A La Peche (Winter): 46%
Little Smoky: 44%
Year: 100
Undisturbed Habitat %
A La Peche (Winter): 39%
Little Smoky: 56%


Berland Caribou Planning Region
Scenario: BERR_2007
Habitat Disturbance
Permanent Disturbance
Forest Harvest
Temporary Disturbance
Temporary Disturbance Buffer
Permanent Disturbance Buffer
Forest Harvest Buffer
Waterbodies
Undisturbed Habitat
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Caribou Range Boundaries
Berland Planning Region
0 10 20 30 40 50 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-02-17
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 0
Undisturbed Habitat %
A La Peche (Winter): 47%
Little Smoky: 28%
Year: 20
Undisturbed Habitat %
A La Peche (Winter): 31%
Little Smoky: 25%
Year: 40
Undisturbed Habitat %
A La Peche (Winter): 25%
Little Smoky: 27%
Year: 60
Undisturbed Habitat %
A La Peche (Winter): 36%
Little Smoky: 41%
Year: 80
Undisturbed Habitat %
A La Peche (Winter): 46%
Little Smoky: 55%
Year: 100
Undisturbed Habitat %
A La Peche (Winter): 40%
Little Smoky: 64%

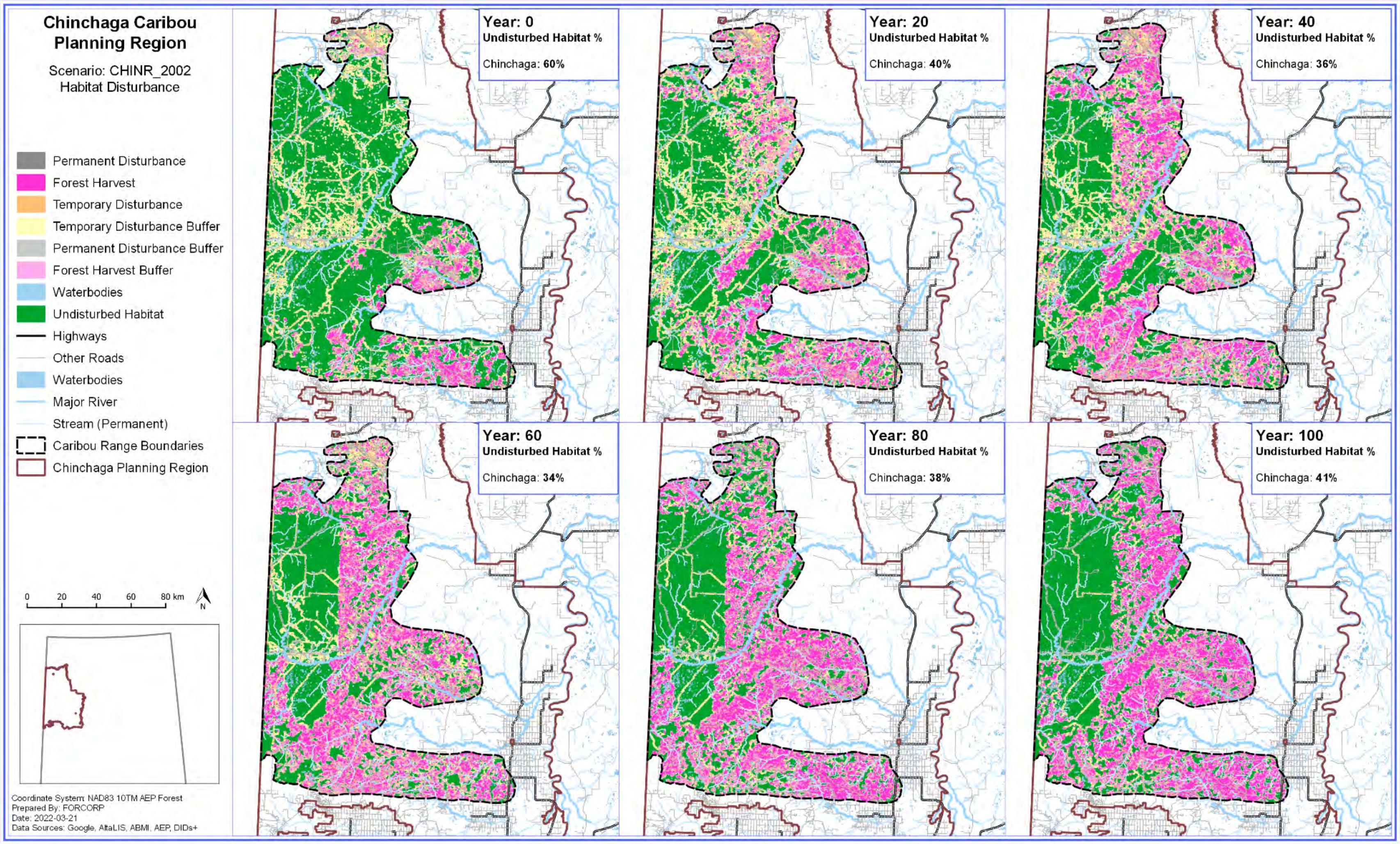


Berland Caribou Planning Region
Scenario: BERR_2008
Habitat Disturbance
Permanent Disturbance
Forest Harvest
Temporary Disturbance
Temporary Disturbance Buffer
Permanent Disturbance Buffer
Forest Harvest Buffer
Waterbodies
Undisturbed Habitat
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Caribou Range Boundaries
Berland Planning Region
0 10 20 30 40 50 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-02-18
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 0
Undisturbed Habitat %
A La Peche (Winter): 47%
Little Smoky: 28%
Year: 20
Undisturbed Habitat %
A La Peche (Winter): 27%
Little Smoky: 25%
Year: 40
Undisturbed Habitat %
A La Peche (Winter): 33%
Little Smoky: 33%
Year: 60
Undisturbed Habitat %
A La Peche (Winter): 38%
Little Smoky: 45%
Year: 80
Undisturbed Habitat %
A La Peche (Winter): 41%
Little Smoky: 38%
Year: 100
Undisturbed Habitat %
A La Peche (Winter): 42%
Little Smoky: 56%

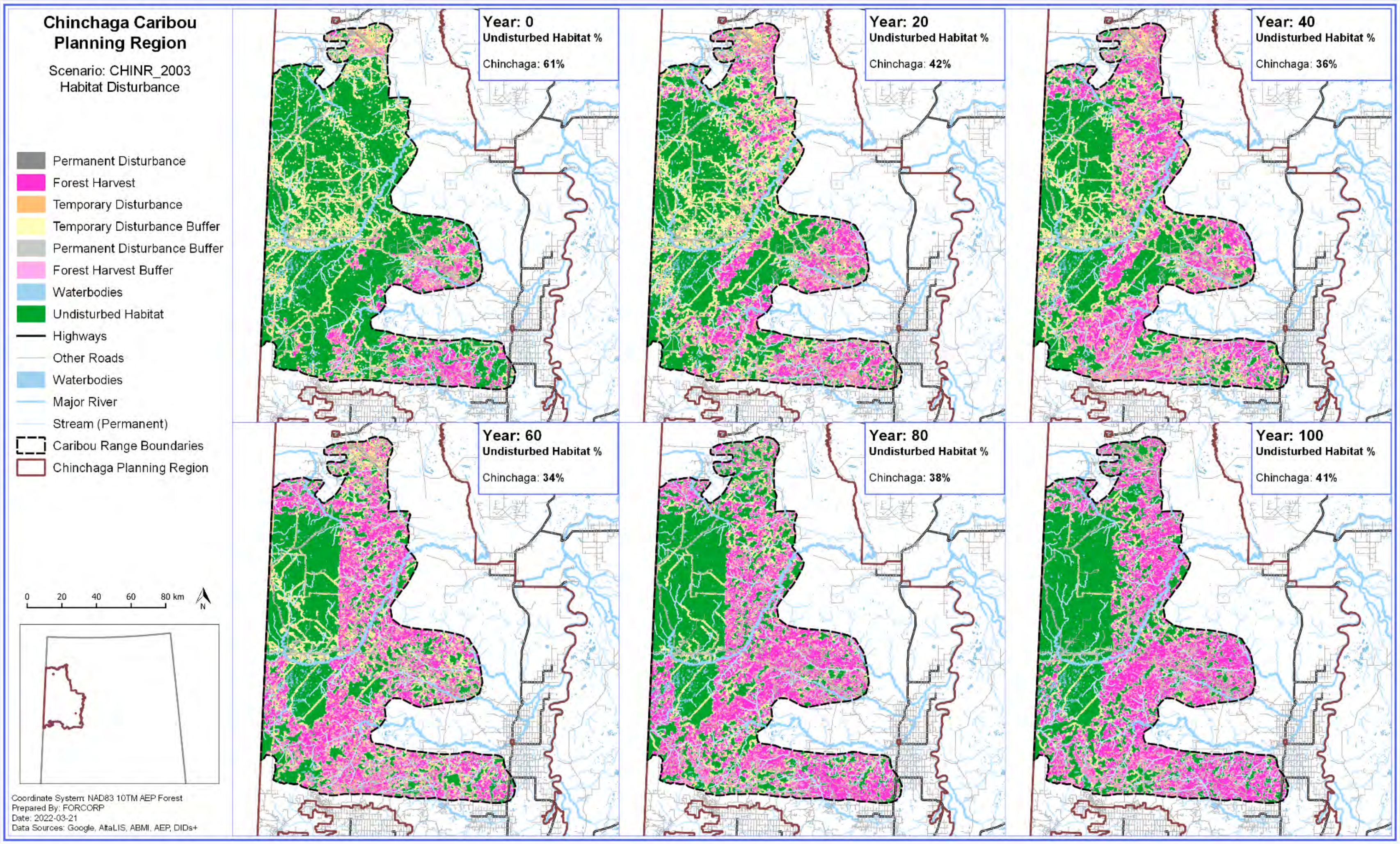

Berland Caribou Planning Region
Scenario: BERR_2012
Habitat Disturbance
Permanent Disturbance
Forest Harvest
Temporary Disturbance
Temporary Disturbance Buffer
Permanent Disturbance Buffer
Forest Harvest Buffer
Waterbodies
Undisturbed Habitat
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Caribou Range Boundaries
Berland Planning Region
0 10 20 30 40 50 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-03-16
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 0
Undisturbed Habitat %
A La Peche (Winter): 47%
Little Smoky: 28%
Year: 20
Undisturbed Habitat %
A La Peche (Winter): 42%
Little Smoky: 27%
Year: 40
Undisturbed Habitat %
A La Peche (Winter): 43%
Little Smoky: 35%
Year: 60
Undisturbed Habitat %
A La Peche (Winter): 55%
Little Smoky: 50%
Year: 80
Undisturbed Habitat %
A La Peche (Winter): 63%
Little Smoky: 51%
Year: 100
Undisturbed Habitat %
A La Peche (Winter): 66%
Little Smoky: 68%

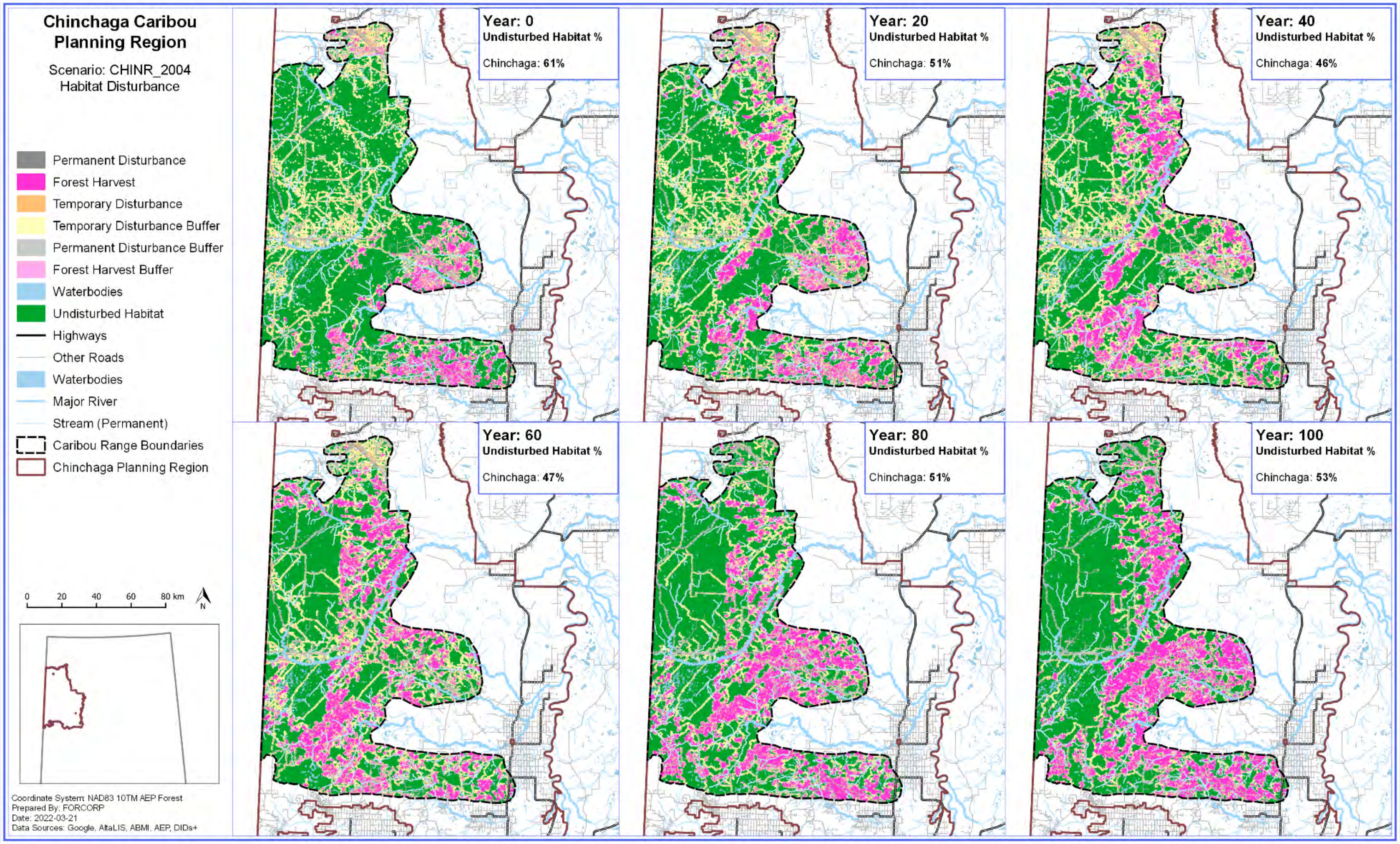


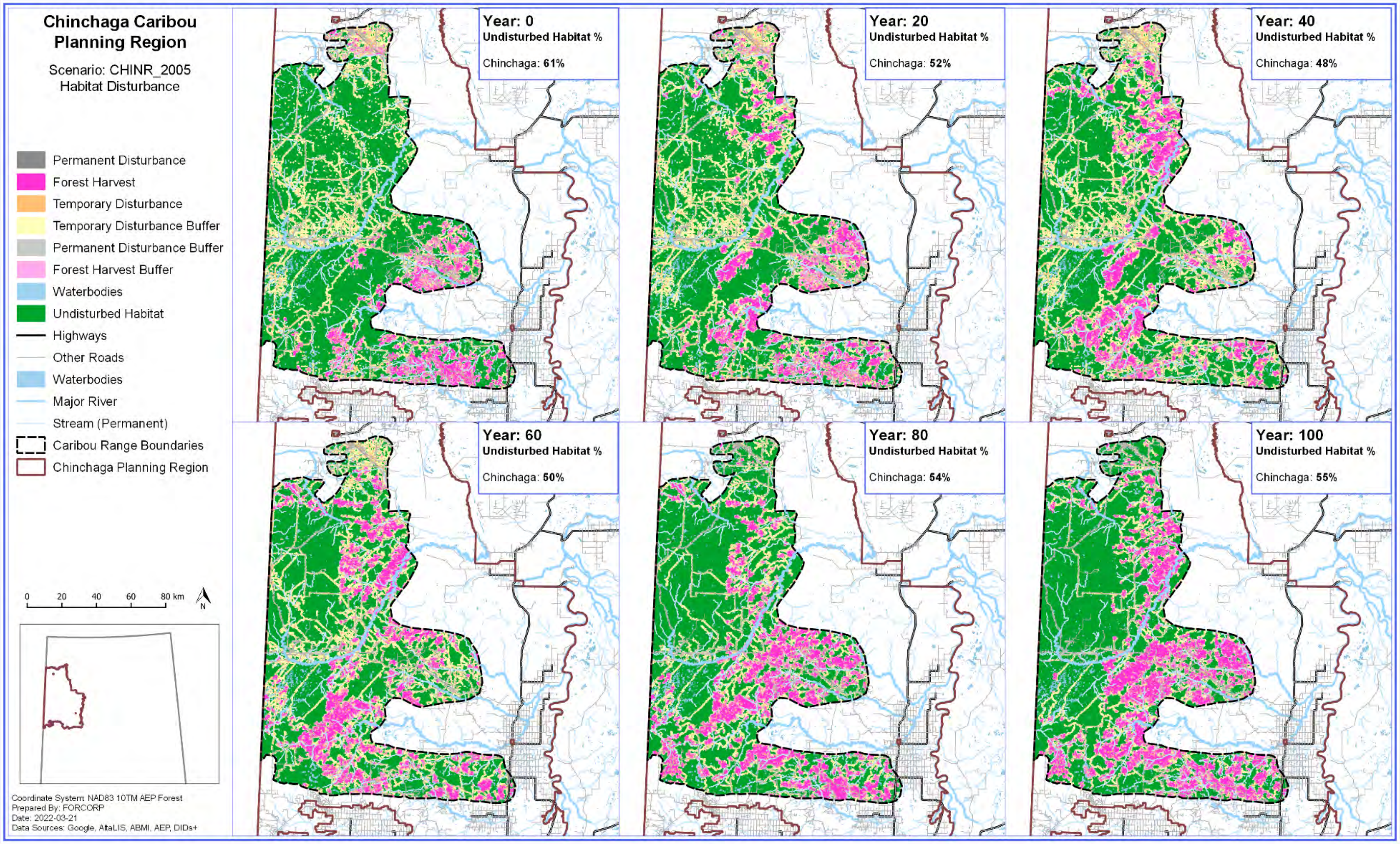
Chinchaga Caribou Planning Region
Scenario: CHINR_2001
Habitat Disturbance
Permanent Disturbance
Forest Harvest
Temporary Disturbance
Temporary Disturbance Buffer
Permanent Disturbance Buffer
Forest Harvest Buffer
Waterbodies
Undisturbed Habitat
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Caribou Range Boundaries
Chinchaga Planning Region
0 20 40 60 80 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-03-21
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 0
Undisturbed Habitat %
Chinchaga: 60%
Year: 20
Undisturbed Habitat %
Chinchaga: 42%
Year: 40
Undisturbed Habitat %
Chinchaga: 36%
Year: 60
Undisturbed Habitat %
Chinchaga: 34%
Year: 80
Undisturbed Habitat %
Chinchaga: 38%
Year: 100
Undisturbed Habitat %
Chinchaga: 41%

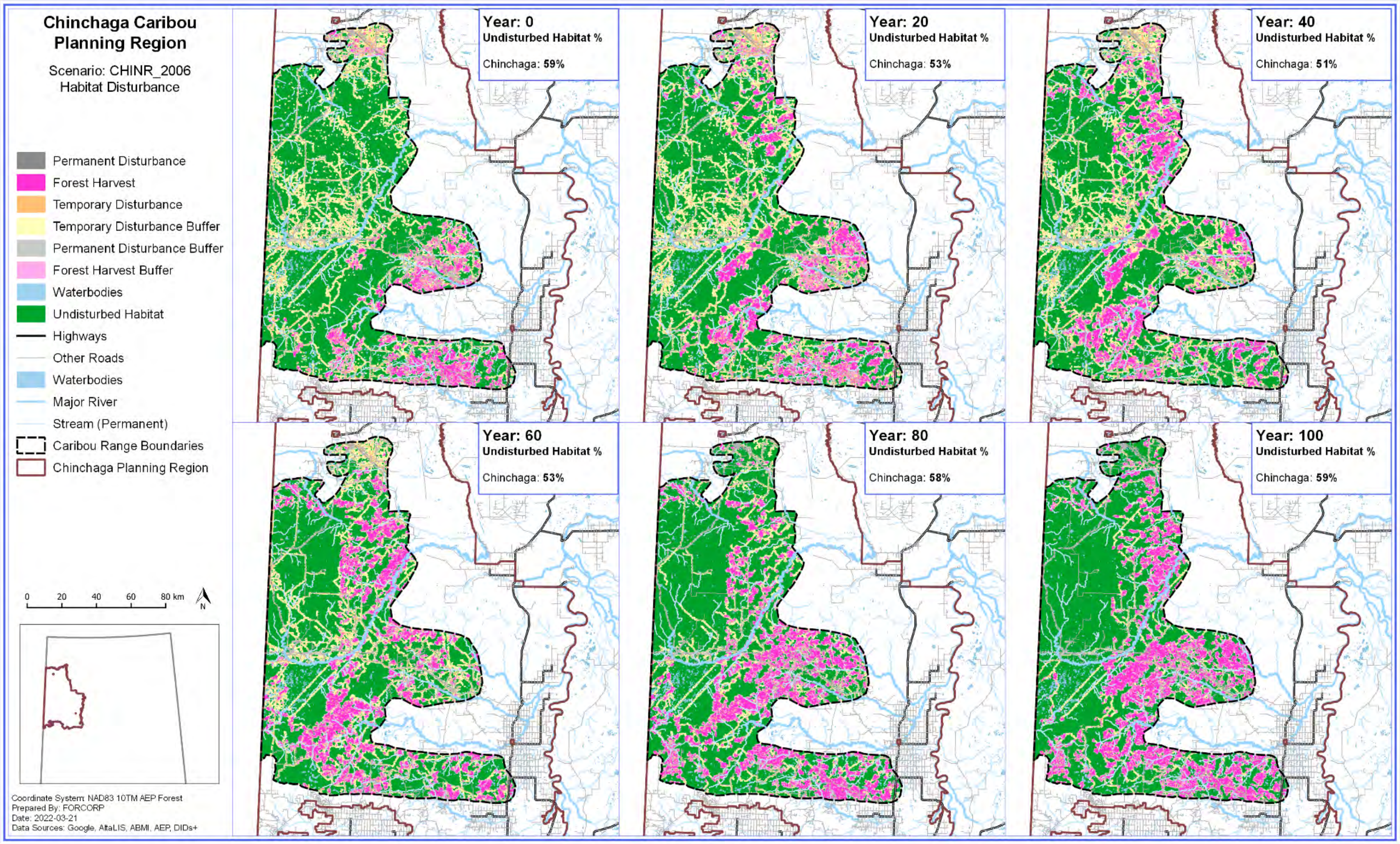


Chinchaga Caribou Planning Region
Scenario: CHINR_2002
Habitat Disturbance
Permanent Disturbance
Forest Harvest
Temporary Disturbance
Temporary Disturbance Buffer
Permanent Disturbance Buffer
Forest Harvest Buffer
Waterbodies
Undisturbed Habitat
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Caribou Range Boundaries
Chinchaga Planning Region
0 20 40 60 80 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-03-21
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 0
Undisturbed Habitat %
Chinchaga: 60%
Year: 20
Undisturbed Habitat %
Chinchaga: 40%
Year: 40
Undisturbed Habitat %
Chinchaga: 36%
Year: 60
Undisturbed Habitat %
Chinchaga: 34%
Year: 80
Undisturbed Habitat %
Chinchaga: 38%
Year: 100
Undisturbed Habitat %
Chinchaga: 41%

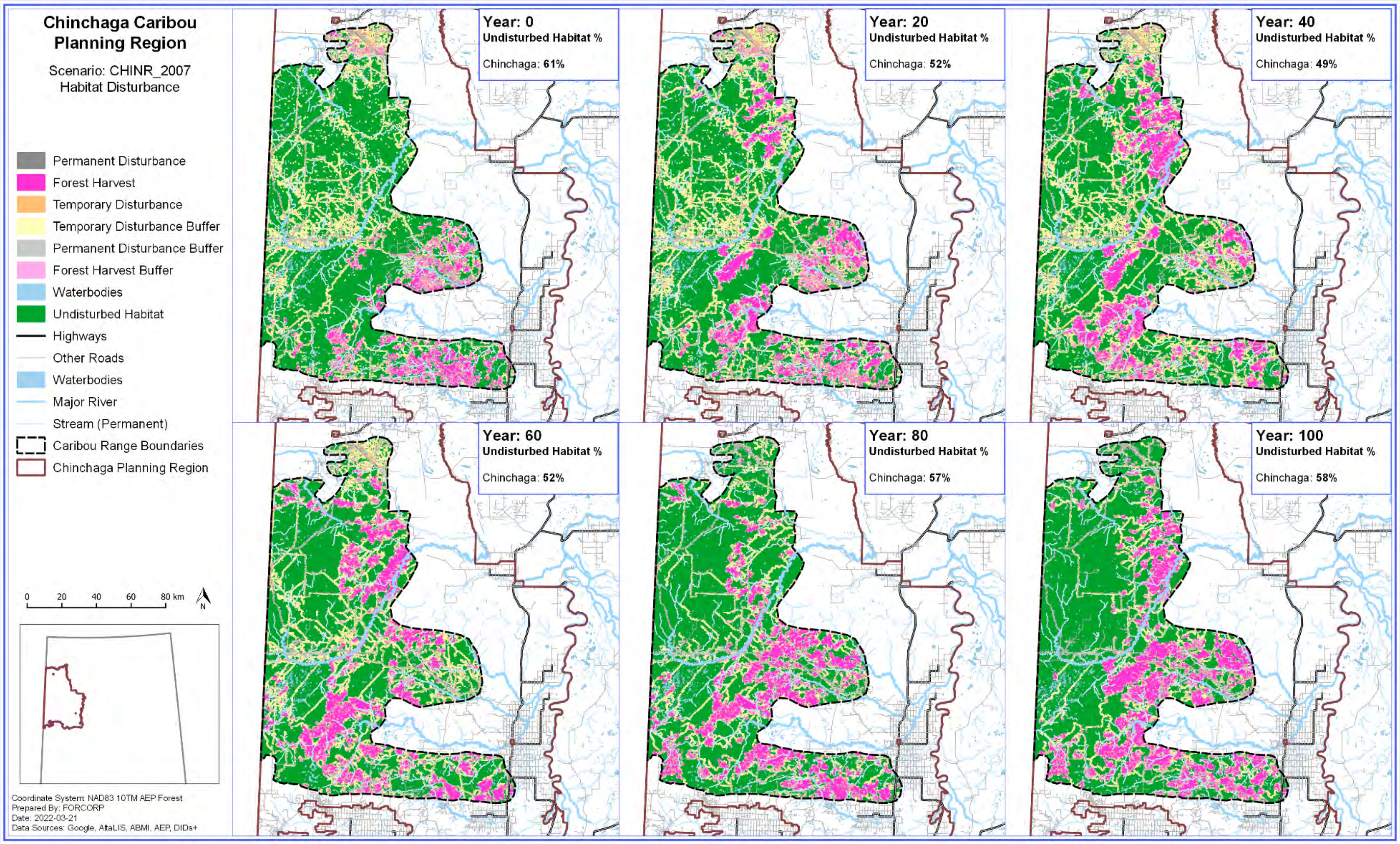

Chinchaga Caribou Planning Region
Scenario: CHINR_2003
Habitat Disturbance
Permanent Disturbance
Forest Harvest
Temporary Disturbance
Temporary Disturbance Buffer
Permanent Disturbance Buffer
Forest Harvest Buffer
Waterbodies
Undisturbed Habitat
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Caribou Range Boundaries
Chinchaga Planning Region
0 20 40 60 80 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-03-21
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 0
Undisturbed Habitat %
Chinchaga: 61%
Year: 20
Undisturbed Habitat %
Chinchaga: 42%
Year: 40
Undisturbed Habitat %
Chinchaga: 36%
Year: 60
Undisturbed Habitat %
Chinchaga: 34%
Year: 80
Undisturbed Habitat %
Chinchaga: 38%
Year: 100
Undisturbed Habitat %
Chinchaga: 41%

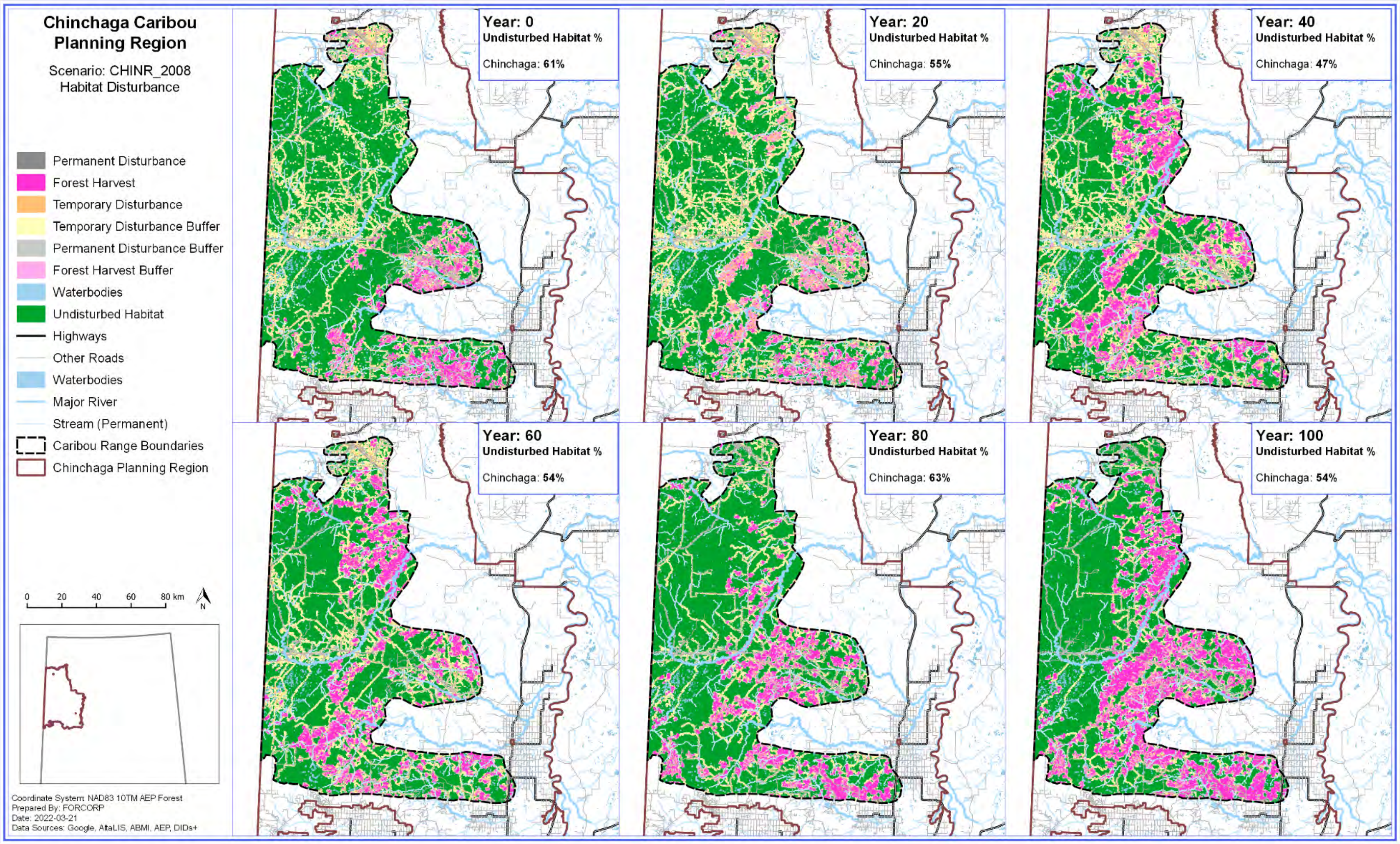

Chinchaga Caribou Planning Region
Scenario: CHINR_2004
Habitat Disturbance
Permanent Disturbance
Forest Harvest
Temporary Disturbance
Temporary Disturbance Buffer
Permanent Disturbance Buffer
Forest Harvest Buffer
Waterbodies
Undisturbed Habitat
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Caribou Range Boundaries
Chinchaga Planning Region
0 20 40 60 80 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-03-21
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 0
Undisturbed Habitat %
Chinchaga: 61%
Year: 20
Undisturbed Habitat %
Chinchaga: 51%
Year: 40
Undisturbed Habitat %
Chinchaga: 46%
Year: 60
Undisturbed Habitat %
Chinchaga: 47%
Year: 80
Undisturbed Habitat %
Chinchaga: 51%
Year: 100
Undisturbed Habitat %
Chinchaga: 53%

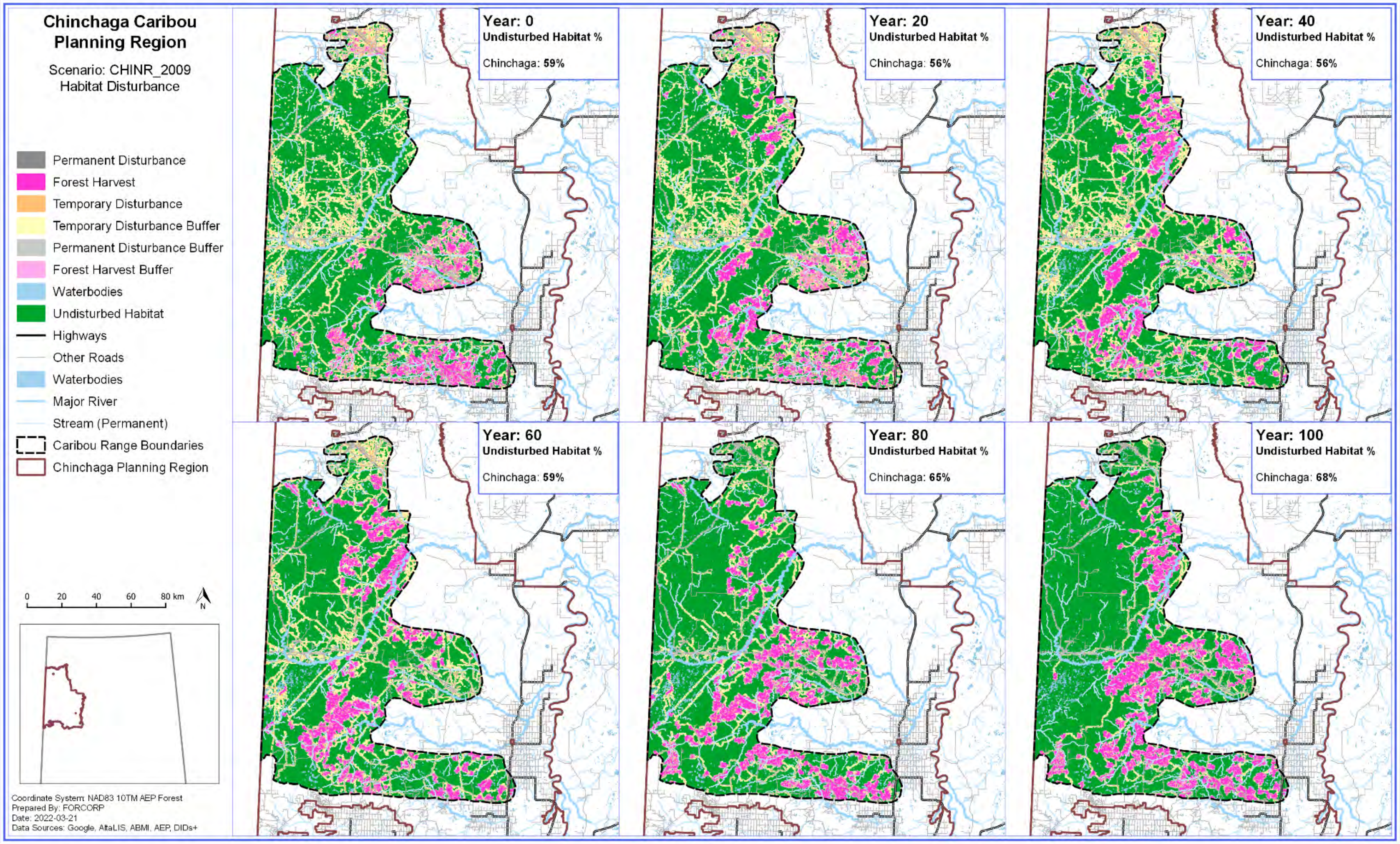

Chinchaga Caribou Planning Region
Scenario: CHINR_2005
Habitat Disturbance
Permanent Disturbance
Forest Harvest
Temporary Disturbance
Temporary Disturbance Buffer
Permanent Disturbance Buffer
Forest Harvest Buffer
Waterbodies
Undisturbed Habitat
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Caribou Range Boundaries
Chinchaga Planning Region
0 20 40 60 80 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-03-21
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 0
Undisturbed Habitat %
Chinchaga: 61%
Year: 20
Undisturbed Habitat %
Chinchaga: 52%
Year: 40
Undisturbed Habitat %
Chinchaga: 48%
Year: 60
Undisturbed Habitat %
Chinchaga: 50%
Year: 80
Undisturbed Habitat %
Chinchaga: 54%
Year: 100
Undisturbed Habitat %
Chinchaga: 55%

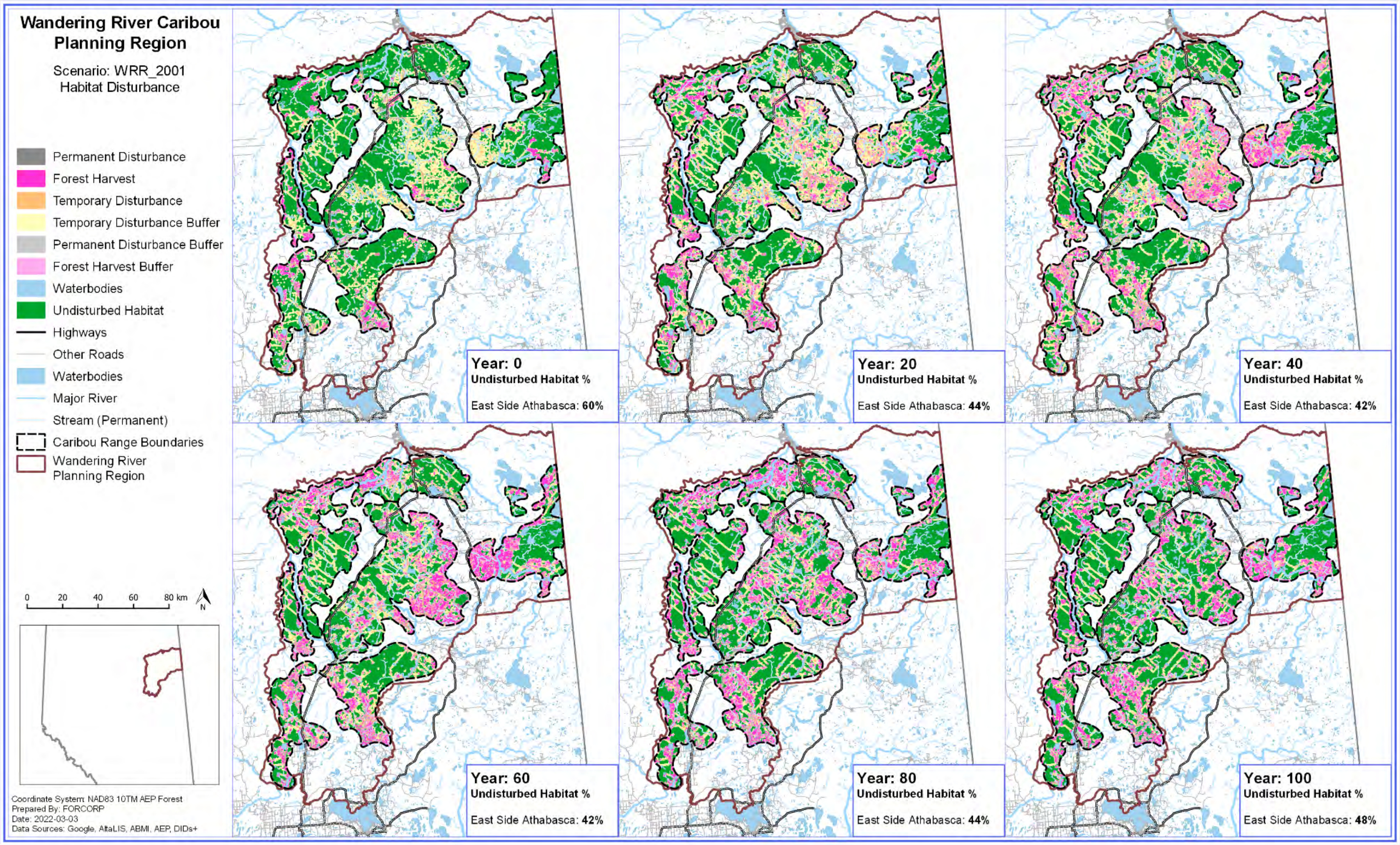


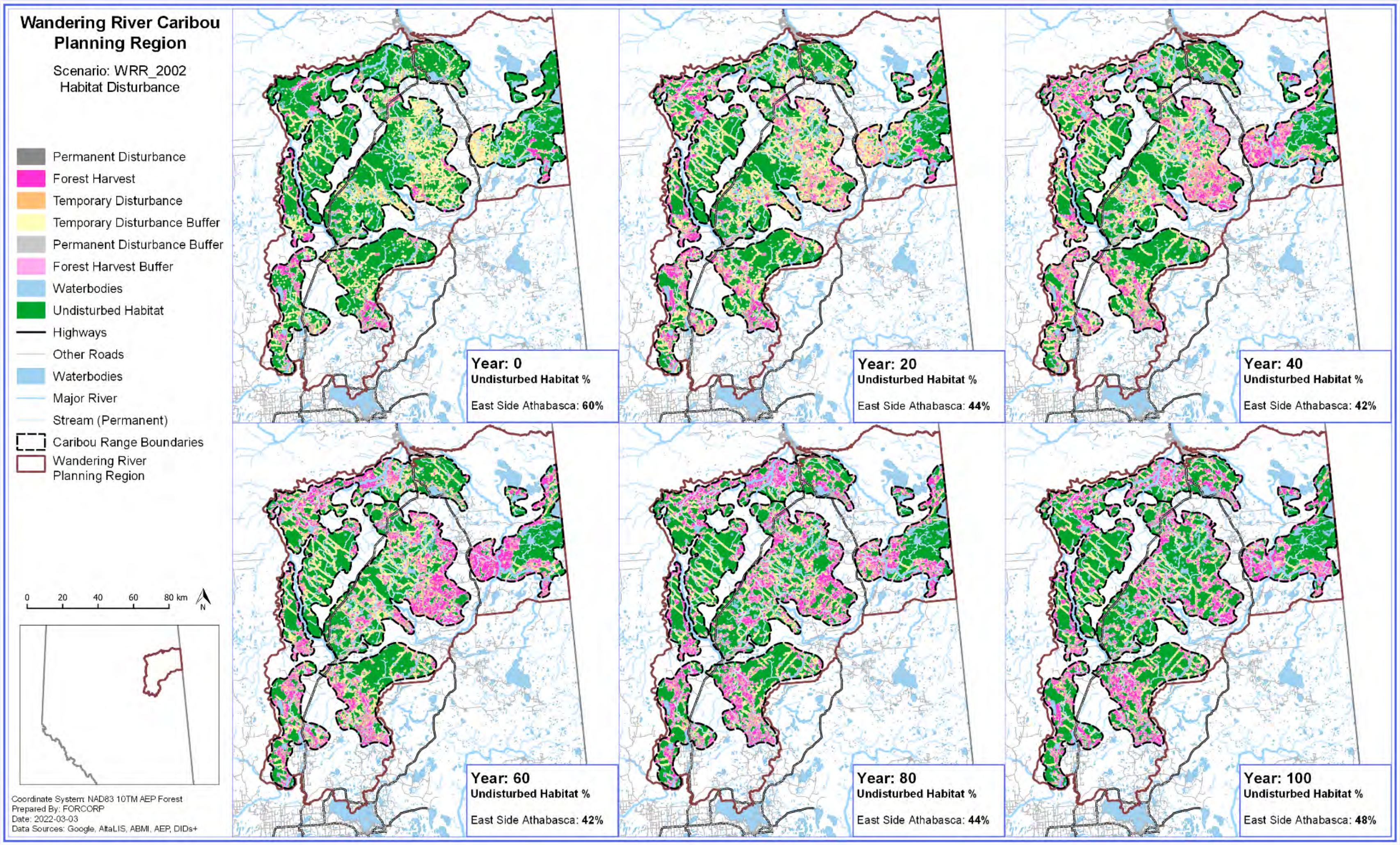
Chinchaga Caribou Planning Region
Scenario: CHINR_2006
Habitat Disturbance
Permanent Disturbance
Forest Harvest
Temporary Disturbance
Temporary Disturbance Buffer
Permanent Disturbance Buffer
Forest Harvest Buffer
Waterbodies
Undisturbed Habitat
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Caribou Range Boundaries
Chinchaga Planning Region
0 20 40 60 80 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-03-21
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 0
Undisturbed Habitat %
Chinchaga: 59%
Year: 20
Undisturbed Habitat %
Chinchaga: 53%
Year: 40
Undisturbed Habitat %
Chinchaga: 51%
Year: 60
Undisturbed Habitat %
Chinchaga: 53%
Year: 80
Undisturbed Habitat %
Chinchaga: 58%
Year: 100
Undisturbed Habitat %
Chinchaga: 59%


Chinchaga Caribou Planning Region
Scenario: CHINR_2007
Habitat Disturbance
Permanent Disturbance
Forest Harvest
Temporary Disturbance
Temporary Disturbance Buffer
Permanent Disturbance Buffer
Forest Harvest Buffer
Waterbodies
Undisturbed Habitat
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Caribou Range Boundaries
Chinchaga Planning Region
0 20 40 60 80 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-03-21
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 0
Undisturbed Habitat %
Chinchaga: 61%
Year: 20
Undisturbed Habitat %
Chinchaga: 52%
Year: 40
Undisturbed Habitat %
Chinchaga: 49%
Year: 60
Undisturbed Habitat %
Chinchaga: 52%
Year: 80
Undisturbed Habitat %
Chinchaga: 57%
Year: 100
Undisturbed Habitat %
Chinchaga: 58%

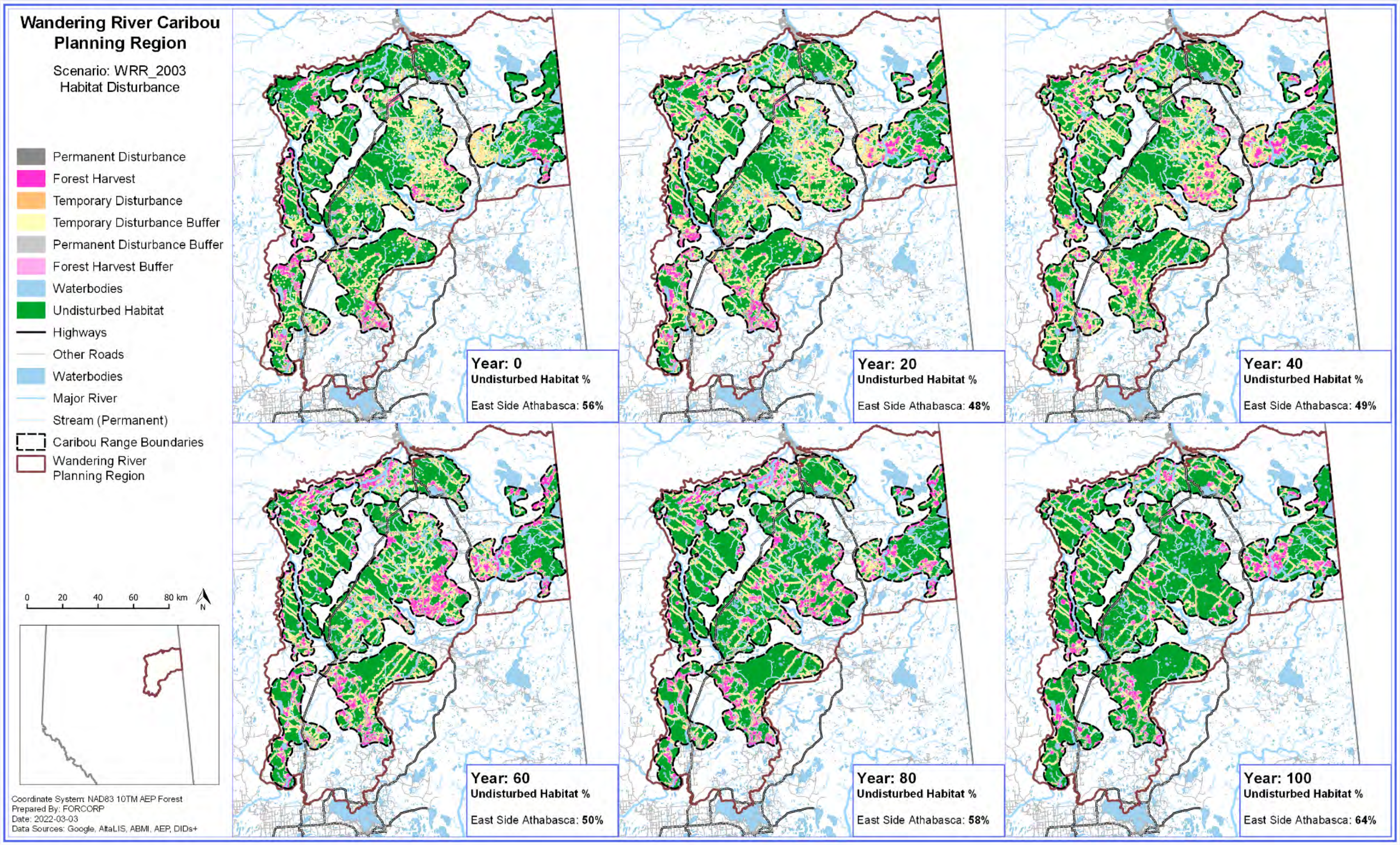

Chinchaga Caribou Planning Region
Scenario: CHINR_2008
Habitat Disturbance
Permanent Disturbance
Forest Harvest
Temporary Disturbance
Temporary Disturbance Buffer
Permanent Disturbance Buffer
Forest Harvest Buffer
Waterbodies
Undisturbed Habitat
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Caribou Range Boundaries
Chinchaga Planning Region
0 20 40 60 80 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-03-21
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 0
Undisturbed Habitat %
Chinchaga: 61%
Year: 20
Undisturbed Habitat %
Chinchaga: 55%
Year: 40
Undisturbed Habitat %
Chinchaga: 47%
Year: 60
Undisturbed Habitat %
Chinchaga: 54%
Year: 80
Undisturbed Habitat %
Chinchaga: 63%
Year: 100
Undisturbed Habitat %
Chinchaga: 54%

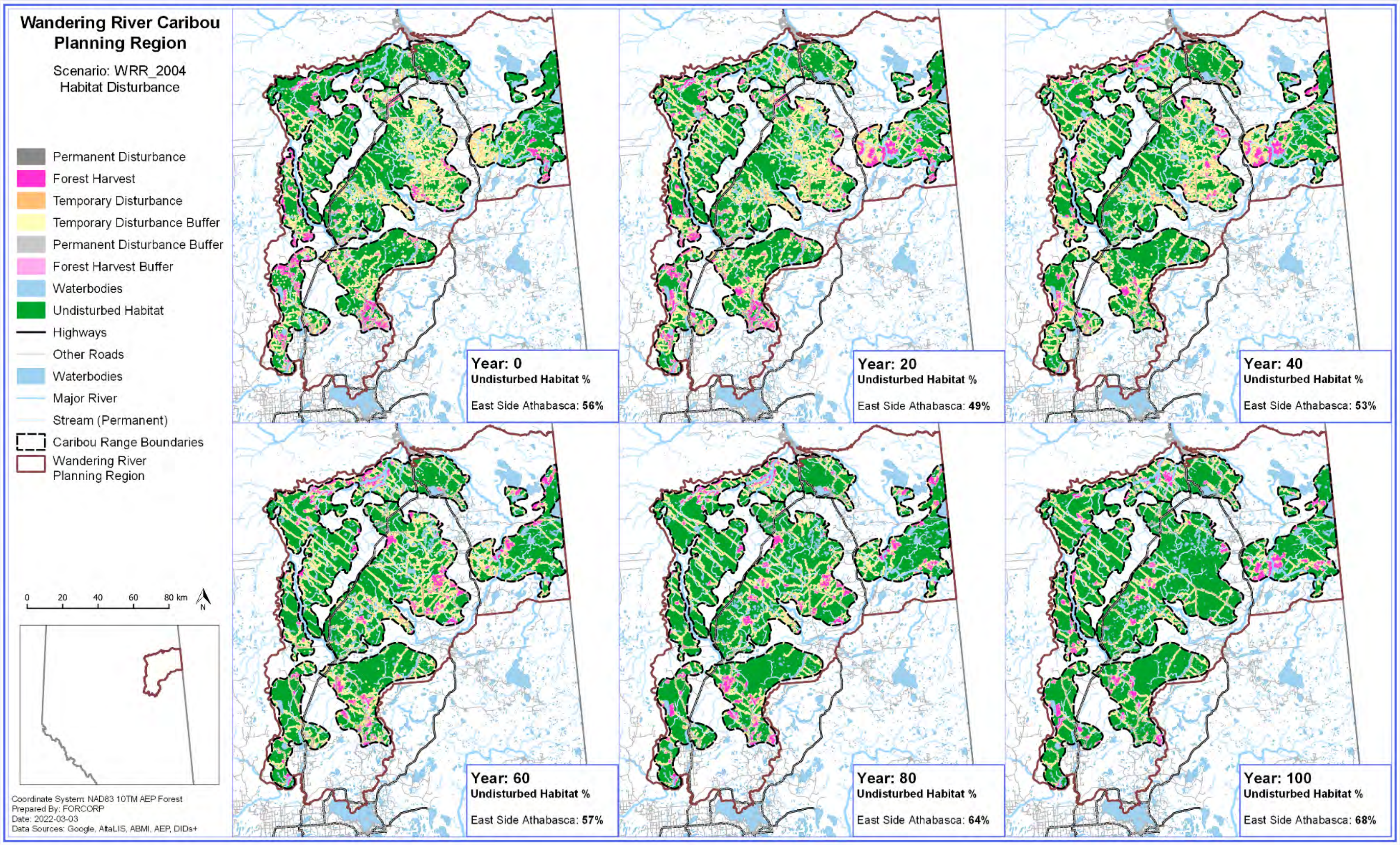

Chinchaga Caribou Planning Region
Scenario: CHINR_2009
Habitat Disturbance
Permanent Disturbance
Forest Harvest
Temporary Disturbance
Temporary Disturbance Buffer
Permanent Disturbance Buffer
Forest Harvest Buffer
Waterbodies
Undisturbed Habitat
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Caribou Range Boundaries
Chinchaga Planning Region
0 20 40 60 80 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-03-21
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 0
Undisturbed Habitat %
Chinchaga: 59%
Year: 20
Undisturbed Habitat %
Chinchaga: 56%
Year: 40
Undisturbed Habitat %
Chinchaga: 56%
Year: 60
Undisturbed Habitat %
Chinchaga: 59%
Year: 80
Undisturbed Habitat %
Chinchaga: 65%
Year: 100
Undisturbed Habitat %
Chinchaga: 68%

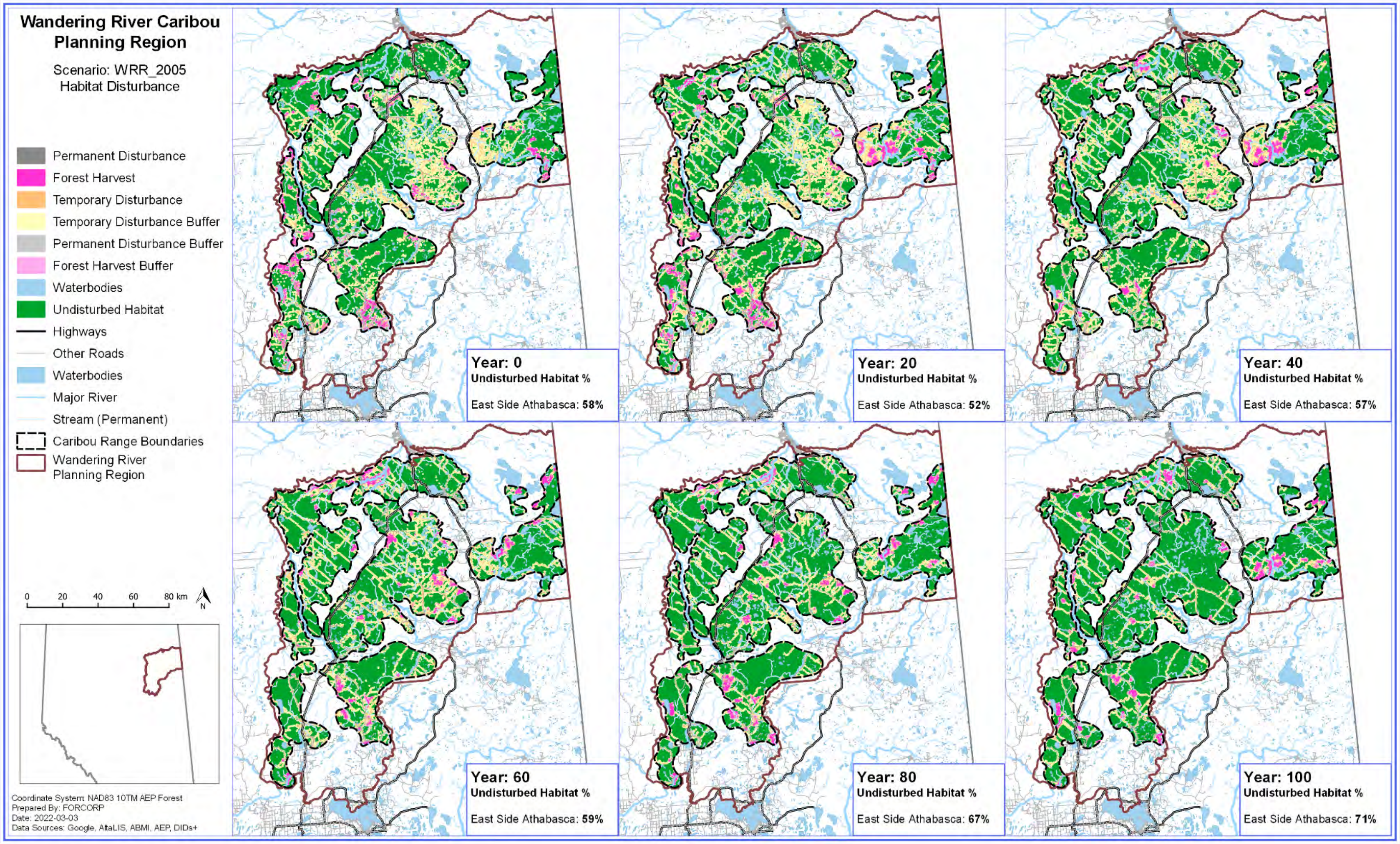

Wandering River Caribou Planning Region
Scenario: WRR_2001
Habitat Disturbance
Permanent Disturbance
Forest Harvest
Temporary Disturbance
Temporary Disturbance Buffer
Permanent Disturbance Buffer
Forest Harvest Buffer
Waterbodies
Undisturbed Habitat
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Caribou Range Boundaries
Wandering River Planning Region
0 20 40 60 80 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-03-03
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 0
Undisturbed Habitat %
East Side Athabasca: 60%
Year: 20
Undisturbed Habitat %
East Side Athabasca: 44%
Year: 40
Undisturbed Habitat %
East Side Athabasca: 42%
Year: 60
Undisturbed Habitat %
East Side Athabasca: 42%
Year: 80
Undisturbed Habitat %
East Side Athabasca: 44%
Year: 100
Undisturbed Habitat %
East Side Athabasca: 48%



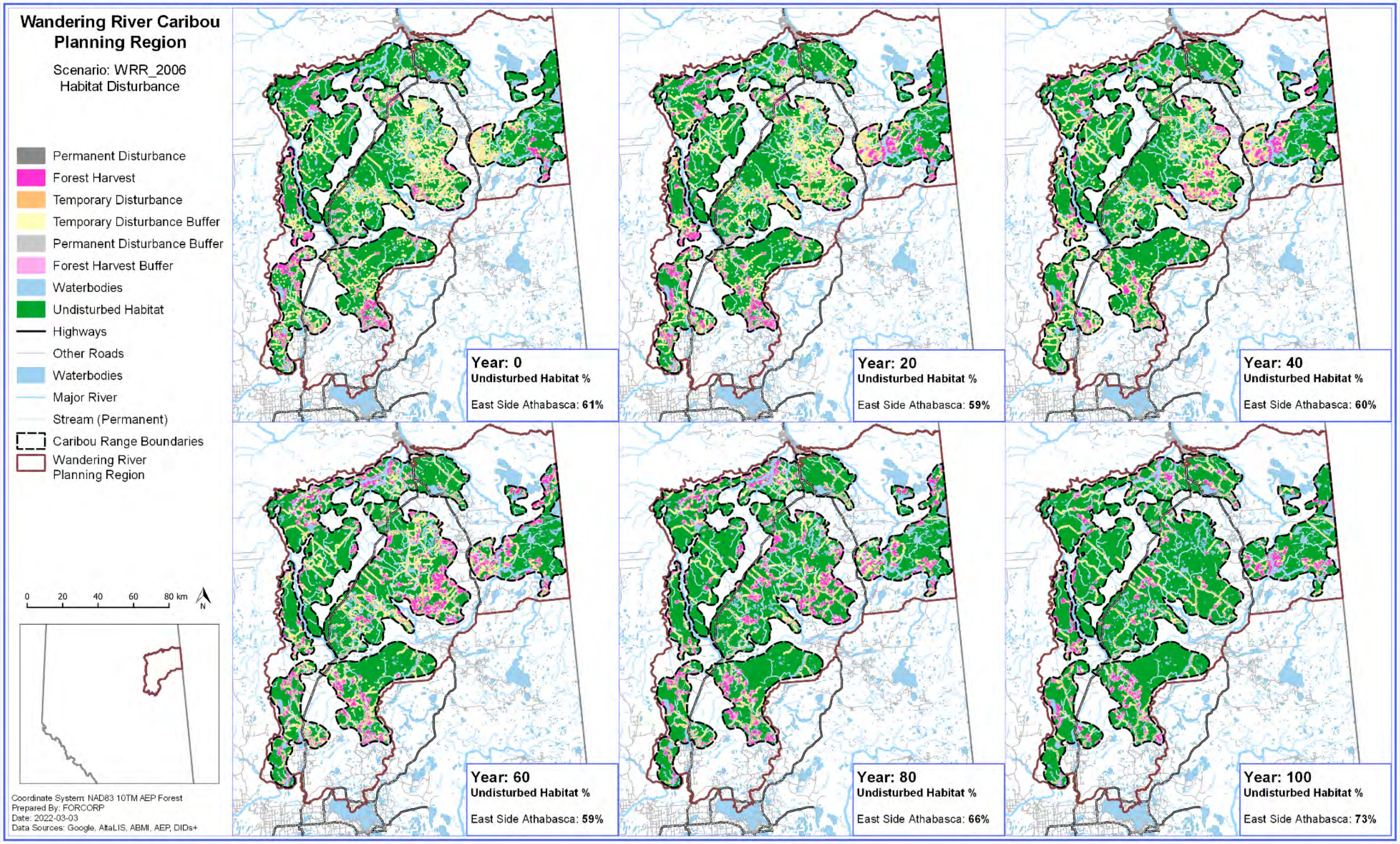
Wandering River Caribou Planning Region
Scenario: WRR_2002
Habitat Disturbance
Permanent Disturbance
Forest Harvest
Temporary Disturbance
Temporary Disturbance Buffer
Permanent Disturbance Buffer
Forest Harvest Buffer
Waterbodies
Undisturbed Habitat
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Caribou Range Boundaries
Wandering River Planning Region
0 20 40 60 80 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-03-03
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 0
Undisturbed Habitat %
East Side Athabasca: 60%
Year: 20
Undisturbed Habitat %
East Side Athabasca: 44%
Year: 40
Undisturbed Habitat %
East Side Athabasca: 42%
Year: 60
Undisturbed Habitat %
East Side Athabasca: 42%
Year: 80
Undisturbed Habitat %
East Side Athabasca: 44%
Year: 100
Undisturbed Habitat %
East Side Athabasca: 48%


Wandering River Caribou Planning Region
Scenario: WRR_2003
Habitat Disturbance
Permanent Disturbance
Forest Harvest
Temporary Disturbance
Temporary Disturbance Buffer
Permanent Disturbance Buffer
Forest Harvest Buffer
Waterbodies
Undisturbed Habitat
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Caribou Range Boundaries
Wandering River Planning Region
0 20 40 60 80 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-03-03
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 0
Undisturbed Habitat %
East Side Athabasca: 56%
Year: 20
Undisturbed Habitat %
East Side Athabasca: 48%
Year: 40
Undisturbed Habitat %
East Side Athabasca: 49%
Year: 60
Undisturbed Habitat %
East Side Athabasca: 50%
Year: 80
Undisturbed Habitat %
East Side Athabasca: 58%
Year: 100
Undisturbed Habitat %
East Side Athabasca: 64%

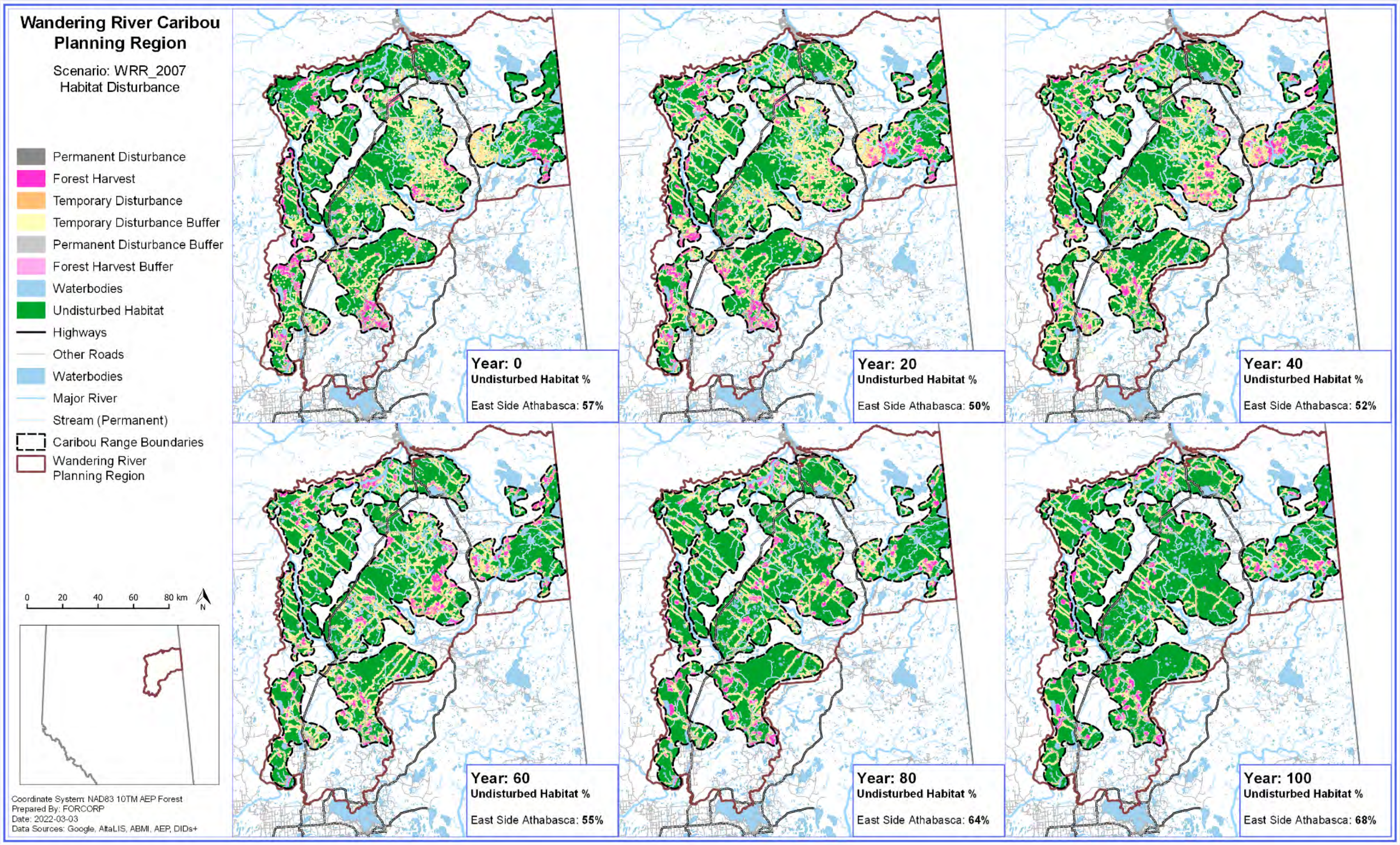

Wandering River Caribou Planning Region
Scenario: WRR_2004
Habitat Disturbance
Permanent Disturbance
Forest Harvest
Temporary Disturbance
Temporary Disturbance Buffer
Permanent Disturbance Buffer
Forest Harvest Buffer
Waterbodies
Undisturbed Habitat
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Caribou Range Boundaries
Wandering River Planning Region
0 20 40 60 80 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-03-03
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 0
Undisturbed Habitat %
East Side Athabasca: 56%
Year: 20
Undisturbed Habitat %
East Side Athabasca: 49%
Year: 40
Undisturbed Habitat %
East Side Athabasca: 53%
Year: 60
Undisturbed Habitat %
East Side Athabasca: 57%
Year: 80
Undisturbed Habitat %
East Side Athabasca: 64%
Year: 100
Undisturbed Habitat %
East Side Athabasca: 68%



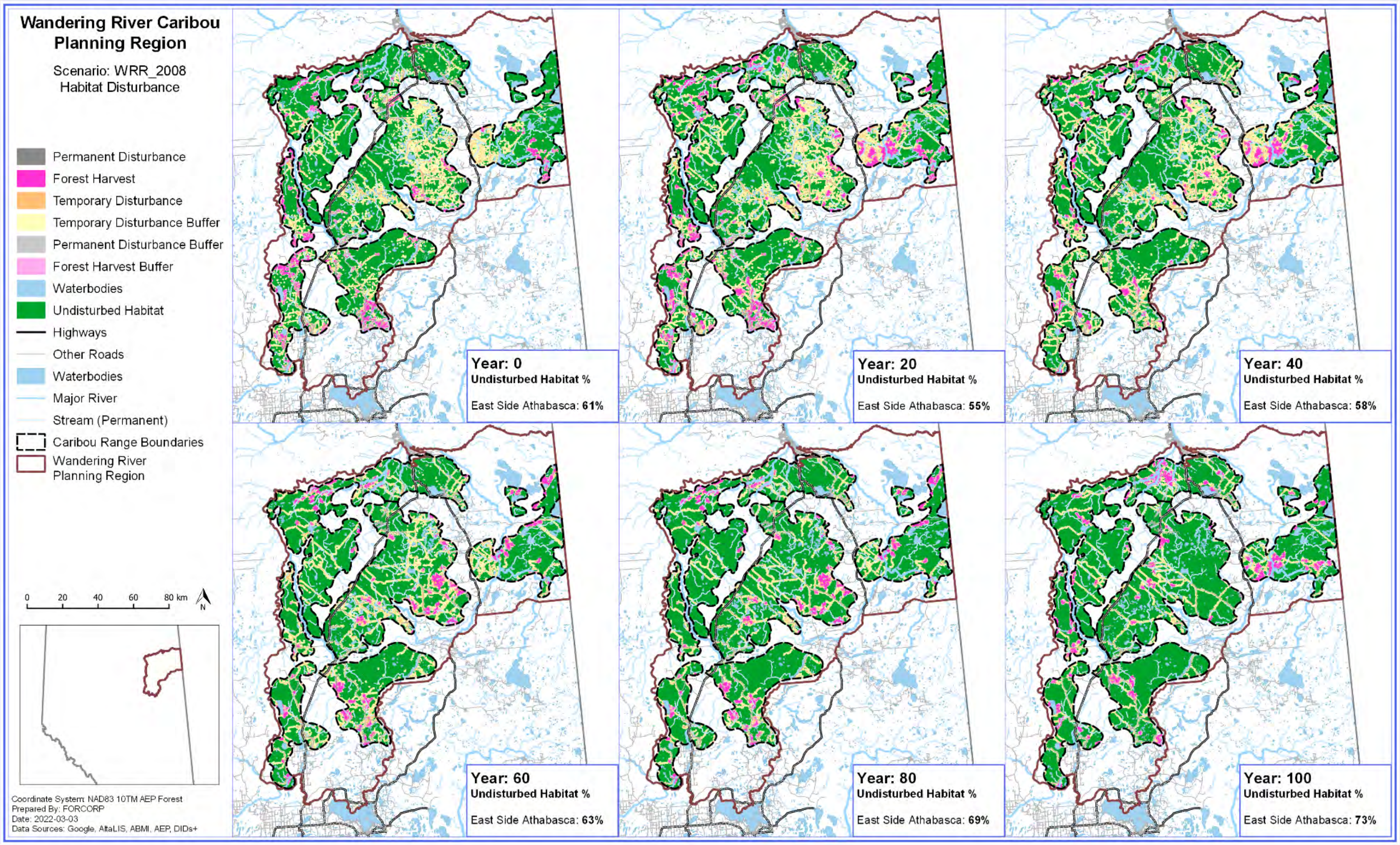
Wandering River Caribou Planning Region
Scenario: WRR_2005
Habitat Disturbance
Permanent Disturbance
Forest Harvest
Temporary Disturbance
Temporary Disturbance Buffer
Permanent Disturbance Buffer
Forest Harvest Buffer
Waterbodies
Undisturbed Habitat
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Caribou Range Boundaries
Wandering River Planning Region
0 20 40 60 80 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-03-03
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 0
Undisturbed Habitat %
East Side Athabasca: 58%
Year: 20
Undisturbed Habitat %
East Side Athabasca: 52%
Year: 40
Undisturbed Habitat %
East Side Athabasca: 57%
Year: 60
Undisturbed Habitat %
East Side Athabasca: 59%
Year: 80
Undisturbed Habitat %
East Side Athabasca: 67%
Year: 100
Undisturbed Habitat %
East Side Athabasca: 71%



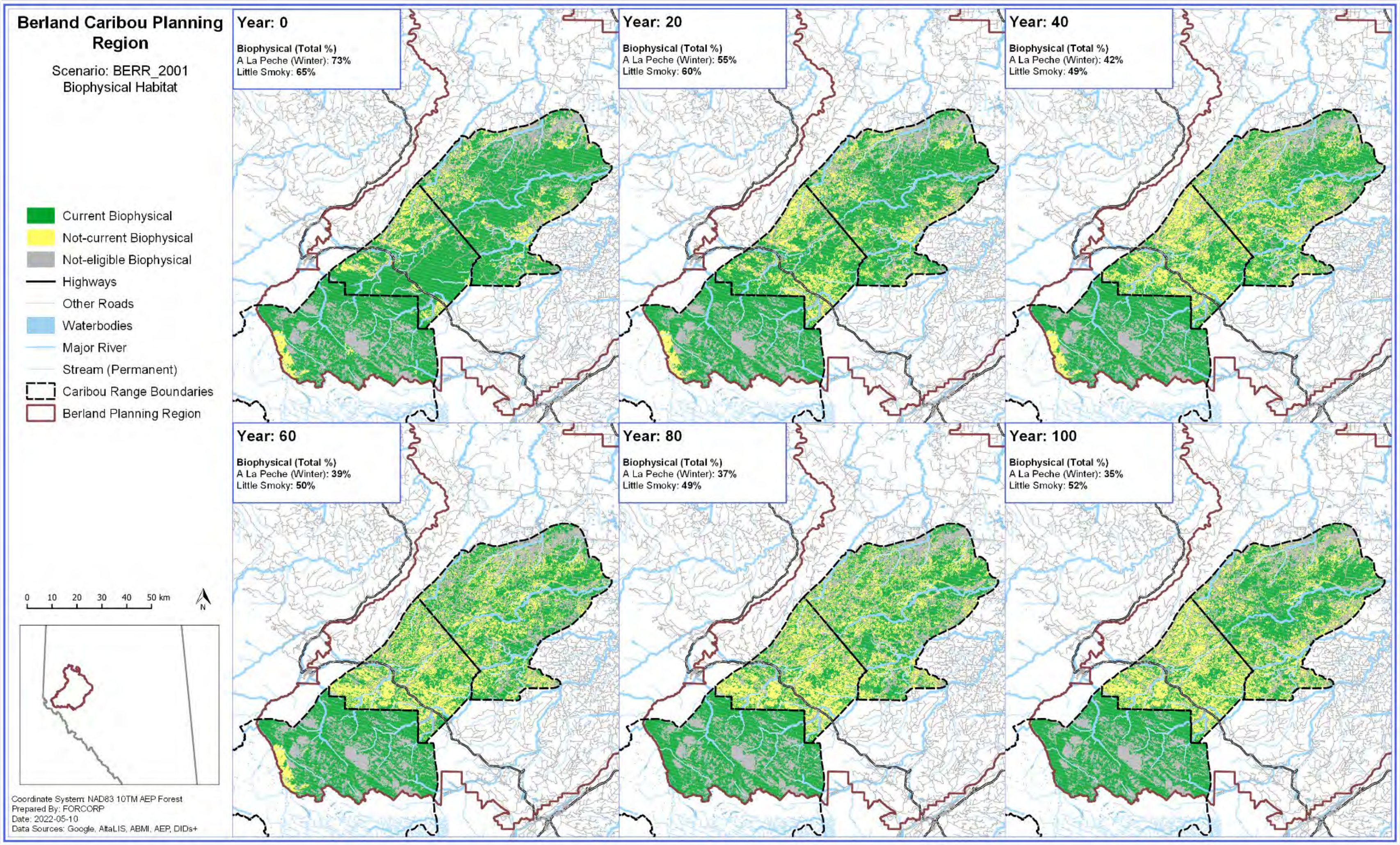
Wandering River Caribou Planning Region
Scenario: WRR_2006
Habitat Disturbance
Permanent Disturbance
Forest Harvest
Temporary Disturbance
Temporary Disturbance Buffer
Permanent Disturbance Buffer
Forest Harvest Buffer
Waterbodies
Undisturbed Habitat
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Caribou Range Boundaries
Wandering River Planning Region
0 20 40 60 80 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-03-03
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 0
Undisturbed Habitat %
East Side Athabasca: 61%
Year: 20
Undisturbed Habitat %
East Side Athabasca: 59%
Year: 40
Undisturbed Habitat %
East Side Athabasca: 60%
Year: 60
Undisturbed Habitat %
East Side Athabasca: 59%
Year: 80
Undisturbed Habitat %
East Side Athabasca: 66%
Year: 100
Undisturbed Habitat %
East Side Athabasca: 73%



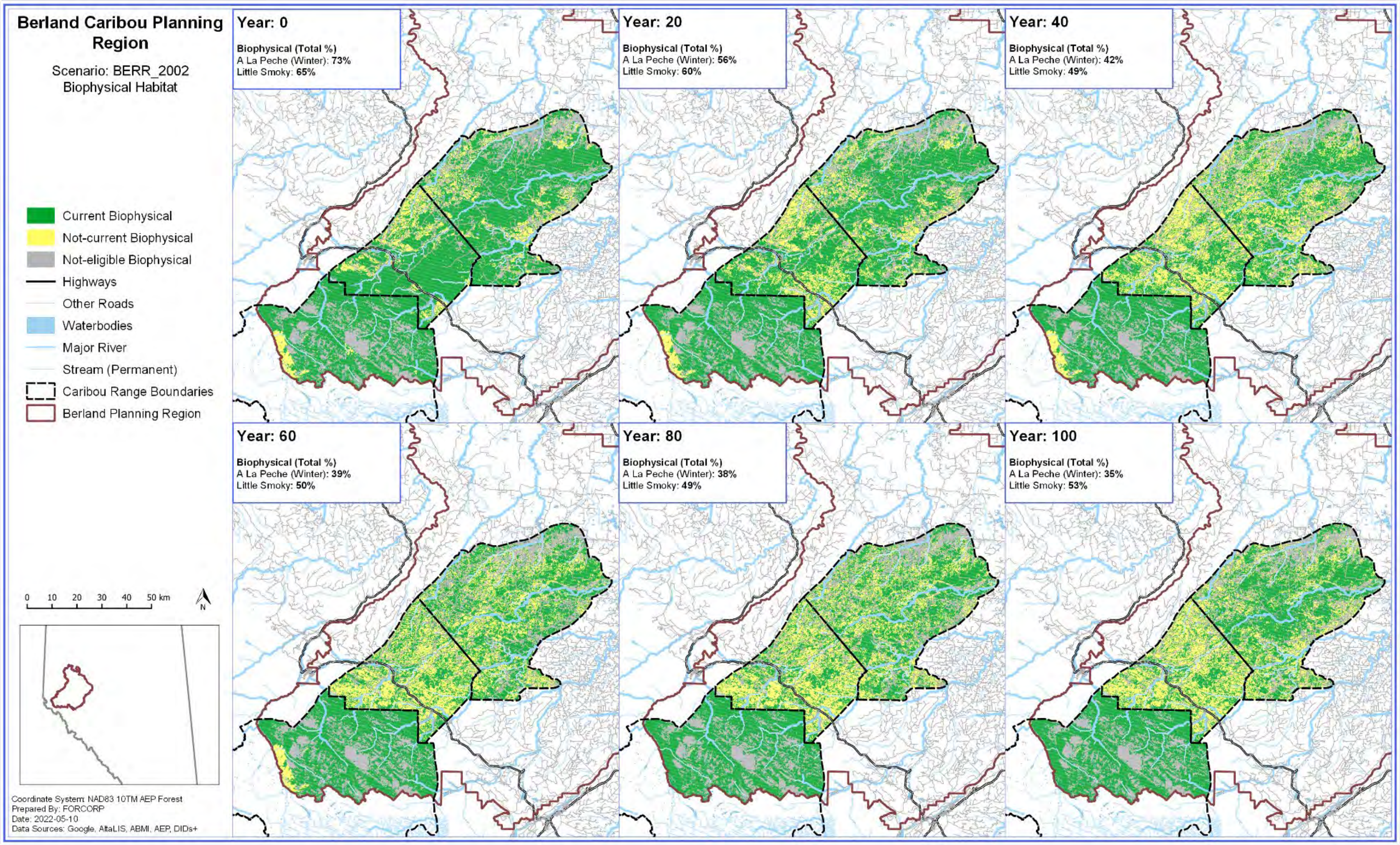
Wandering River Caribou Planning Region
Scenario: WRR_2007
Habitat Disturbance
Permanent Disturbance
Forest Harvest
Temporary Disturbance
Temporary Disturbance Buffer
Permanent Disturbance Buffer
Forest Harvest Buffer
Waterbodies
Undisturbed Habitat
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Caribou Range Boundaries
Wandering River Planning Region
0 20 40 60 80 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-03-03
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 0
Undisturbed Habitat %
East Side Athabasca: 57%
Year: 20
Undisturbed Habitat %
East Side Athabasca: 50%
Year: 40
Undisturbed Habitat %
East Side Athabasca: 52%
Year: 60
Undisturbed Habitat %
East Side Athabasca: 55%
Year: 80
Undisturbed Habitat %
East Side Athabasca: 64%
Year: 100
Undisturbed Habitat %
East Side Athabasca: 68%


Wandering River Caribou Planning Region
Scenario: WRR_2008
Habitat Disturbance
Permanent Disturbance
Forest Harvest
Temporary Disturbance
Temporary Disturbance Buffer
Permanent Disturbance Buffer
Forest Harvest Buffer
Waterbodies
Undisturbed Habitat
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Caribou Range Boundaries
Wandering River Planning Region
0 20 40 60 80 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-03-03
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 0
Undisturbed Habitat %
East Side Athabasca: 61%
Year: 20
Undisturbed Habitat %
East Side Athabasca: 55%
Year: 40
Undisturbed Habitat %
East Side Athabasca: 58%
Year: 60
Undisturbed Habitat %
East Side Athabasca: 63%
Year: 80
Undisturbed Habitat %
East Side Athabasca: 69%
Year: 100
Undisturbed Habitat %
East Side Athabasca: 73%

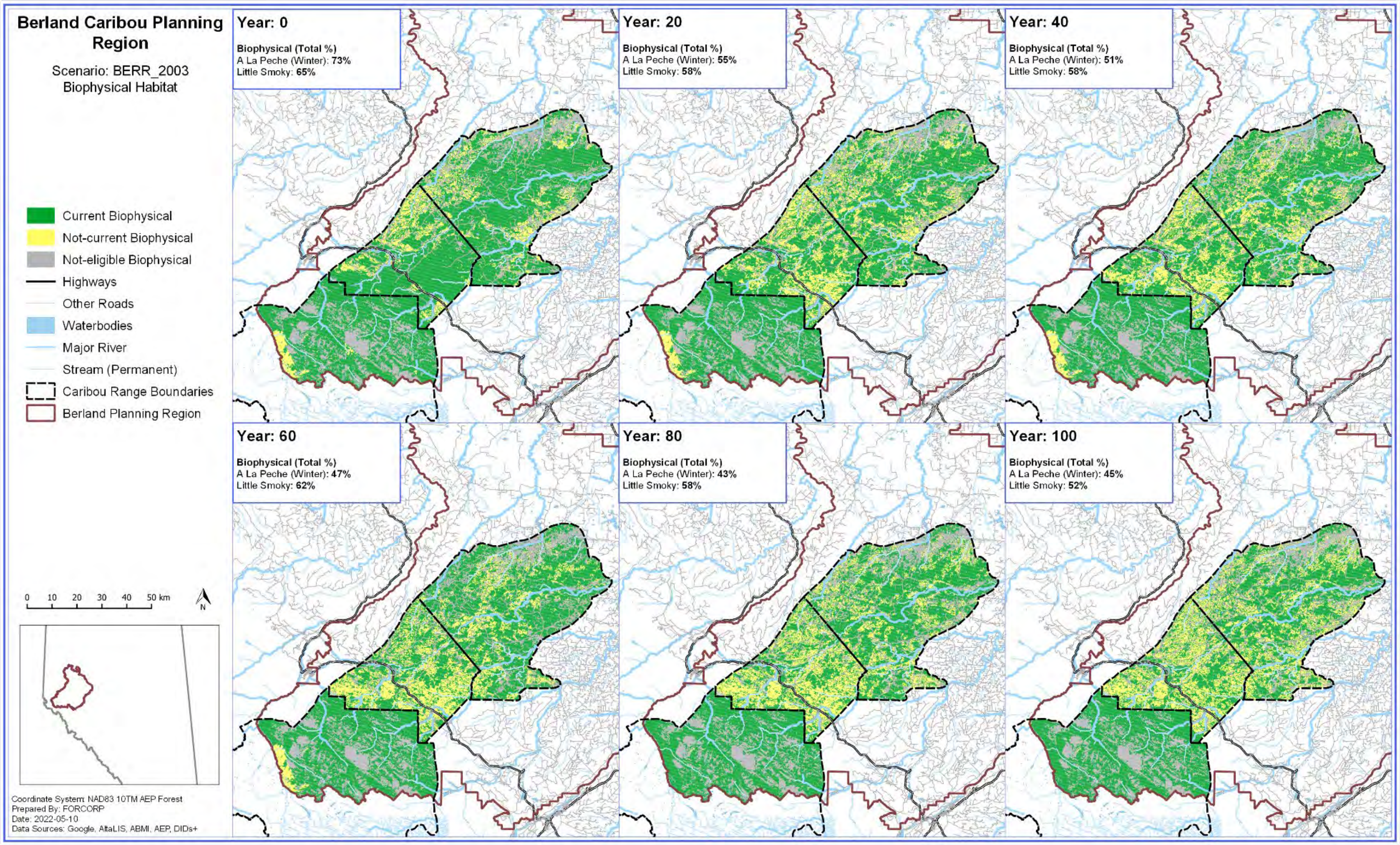
Appendix III Biophysical Habitat Maps

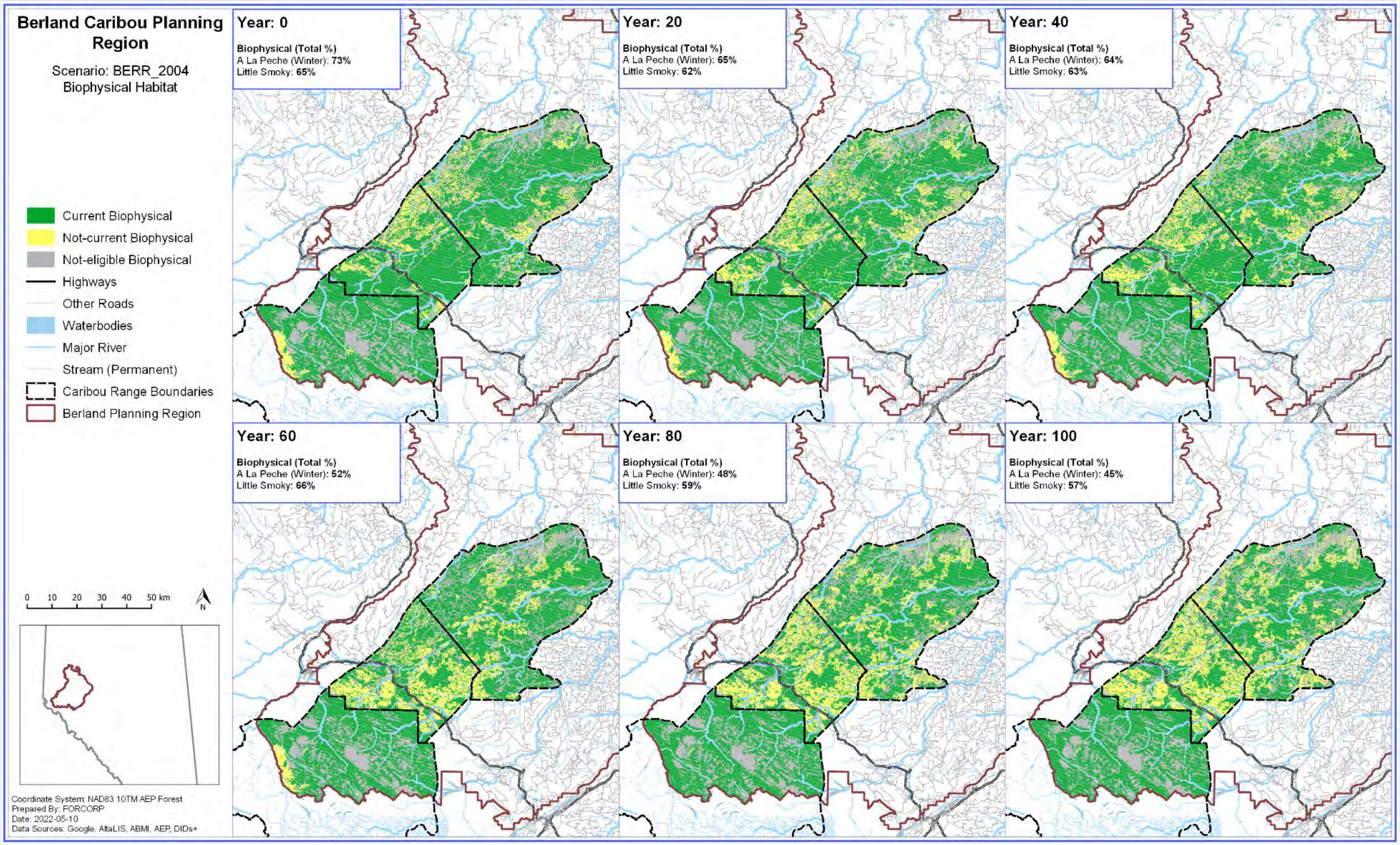


Berland Caribou Planning Region
Scenario: BERR_2001
Biophysical Habitat
Current Biophysical
Not-current Biophysical
Not-eligible Biophysical
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Caribou Range Boundaries
Berland Planning Region
0 10 20 30 40 50 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-05-10
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 0
Biophysical (Total %)
A La Peche (Winter): 73%
Little Smoky: 65%
Year: 20
Biophysical (Total %)
A La Peche (Winter): 55%
Little Smoky: 60%
Year: 40
Biophysical (Total %)
A La Peche (Winter): 42%
Little Smoky: 49%
Year: 60
Biophysical (Total %)
A La Peche (Winter): 39%
Little Smoky: 50%
Year: 80
Biophysical (Total %)
A La Peche (Winter): 37%
Little Smoky: 49%
Year: 100
Biophysical (Total %)
A La Peche (Winter): 35%
Little Smoky: 52%

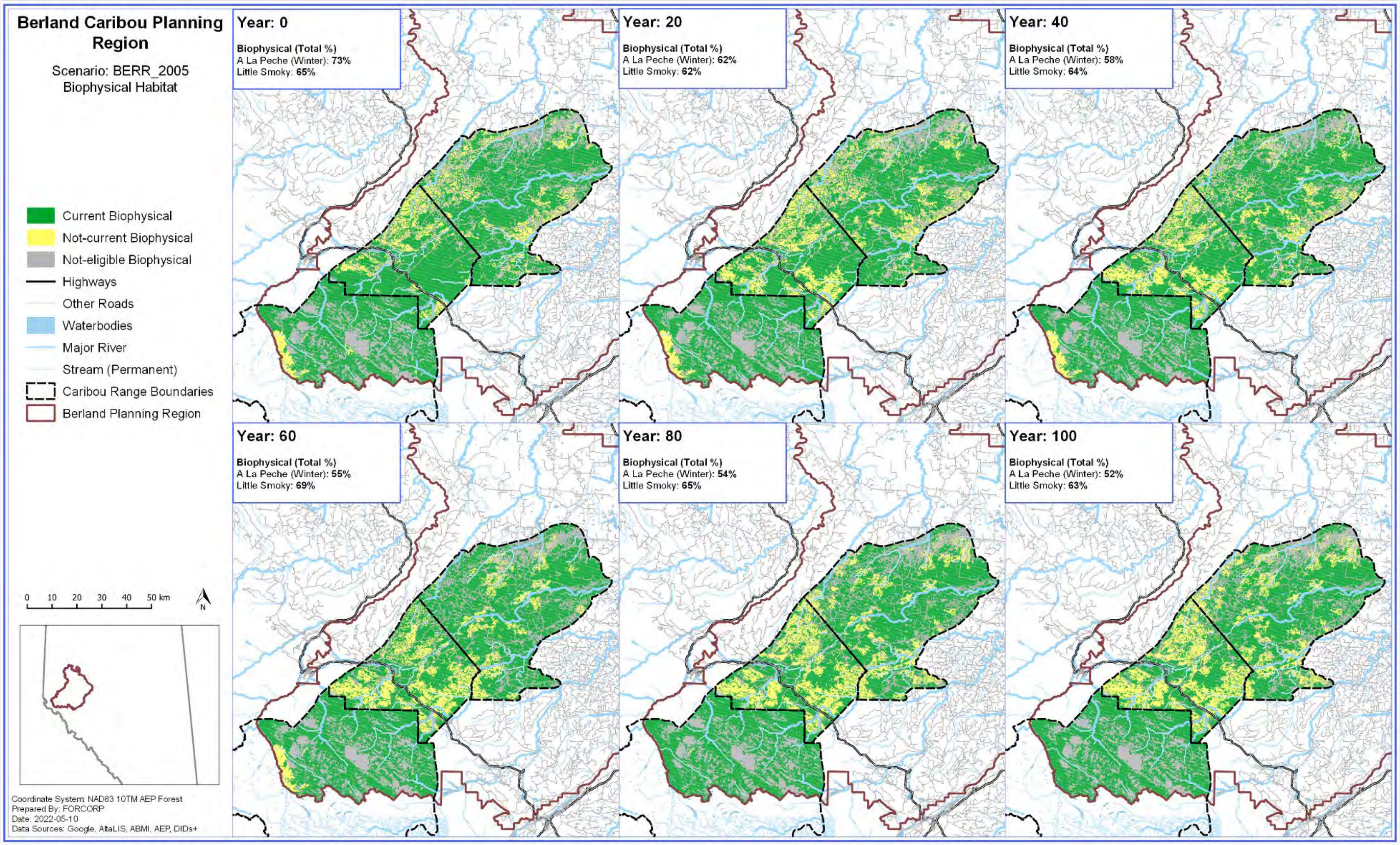


Berland Caribou Planning Region
Scenario: BERR_2002
Biophysical Habitat
Current Biophysical
Not-current Biophysical
Not-eligible Biophysical
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Caribou Range Boundaries
Berland Planning Region
0 10 20 30 40 50 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-05-10
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 0
Biophysical (Total %)
A La Peche (Winter): 73%
Little Smoky: 65%
Year: 20
Biophysical (Total %)
A La Peche (Winter): 56%
Little Smoky: 60%
Year: 40
Biophysical (Total %)
A La Peche (Winter): 42%
Little Smoky: 49%
Year: 60
Biophysical (Total %)
A La Peche (Winter): 39%
Little Smoky: 50%
Year: 80
Biophysical (Total %)
A La Peche (Winter): 38%
Little Smoky: 49%
Year: 100
Biophysical (Total %)
A La Peche (Winter): 35%
Little Smoky: 53%

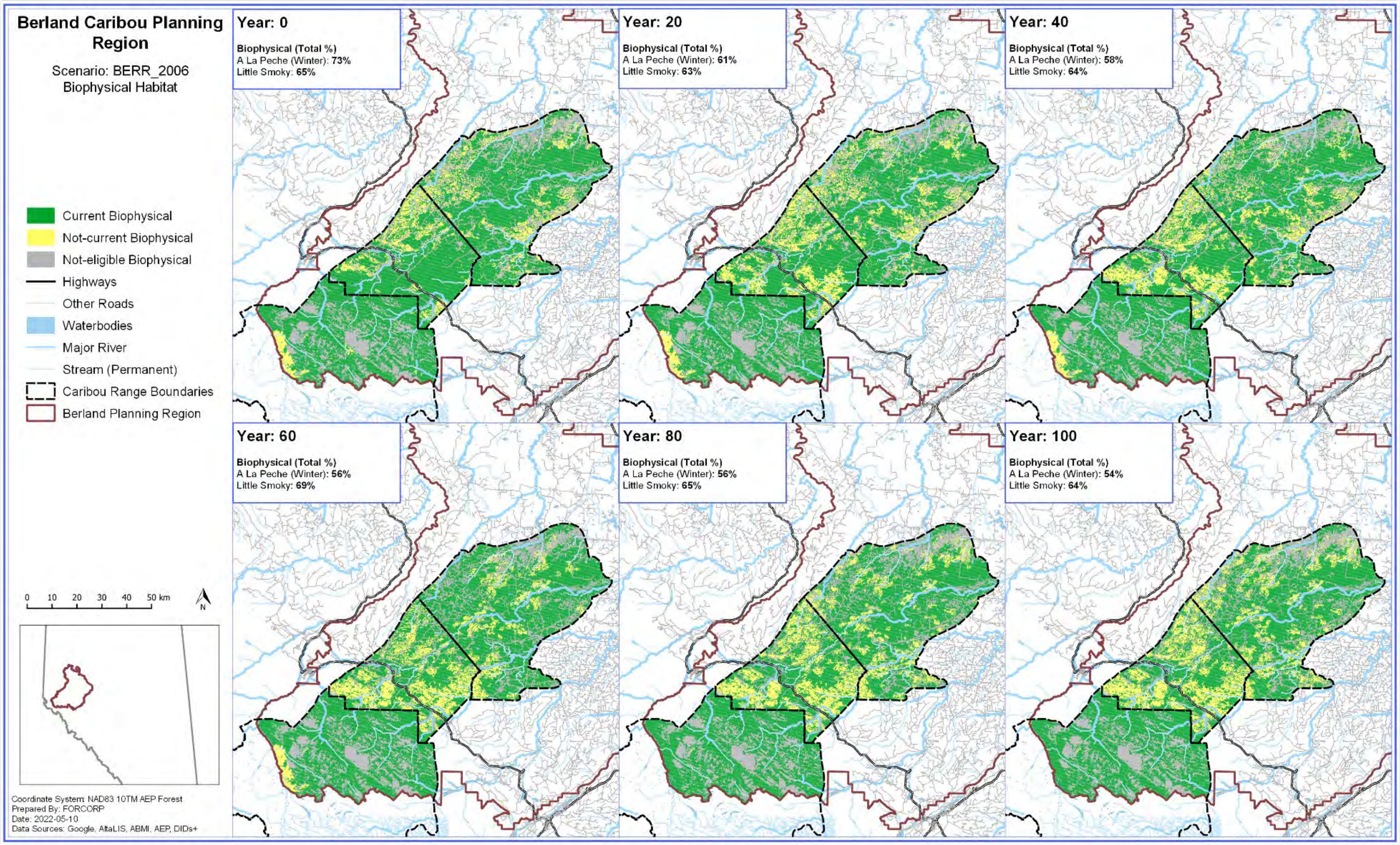

Berland Caribou Planning Region
Scenario: BERR_2003
Biophysical Habitat
Current Biophysical
Not-current Biophysical
Not-eligible Biophysical
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Caribou Range Boundaries
Berland Planning Region
0 10 20 30 40 50 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-05-10
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 0
Biophysical (Total %)
A La Peche (Winter): 73%
Little Smoky: 65%
Year: 20
Biophysical (Total %)
A La Peche (Winter): 55%
Little Smoky: 58%
Year: 40
Biophysical (Total %)
A La Peche (Winter): 51%
Little Smoky: 58%
Year: 60
Biophysical (Total %)
A La Peche (Winter): 47%
Little Smoky: 62%
Year: 80
Biophysical (Total %)
A La Peche (Winter): 43%
Little Smoky: 58%
Year: 100
Biophysical (Total %)
A La Peche (Winter): 45%
Little Smoky: 52%



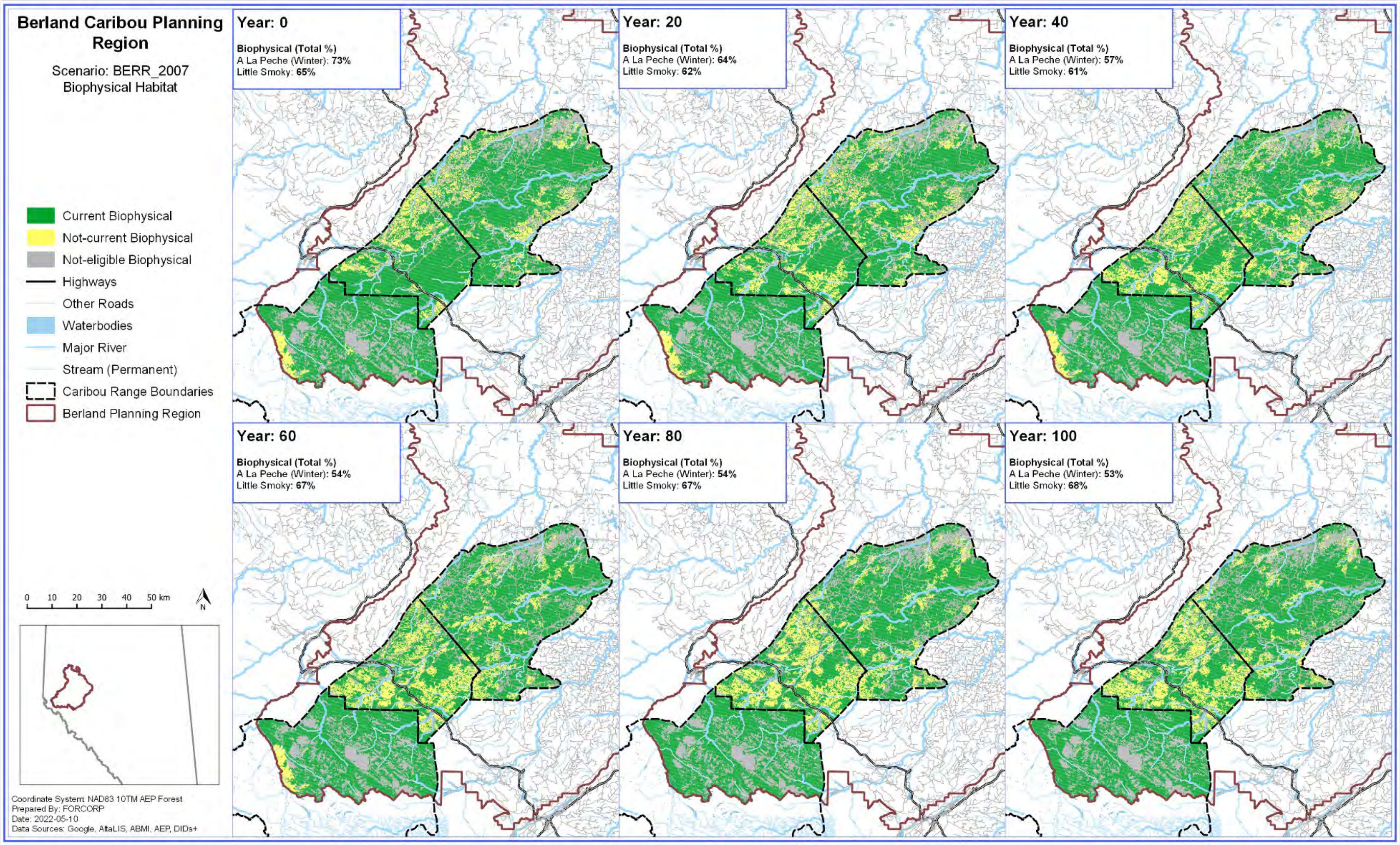
Berland Caribou Planning Region
Scenario: BERR_2004
Biophysical Habitat
Current Biophysical
Not-current Biophysical
Not-eligible Biophysical
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Caribou Range Boundaries
Berland Planning Region
0 10 20 30 40 50 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-05-10
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 0
Biophysical (Total %)
A La Peche (Winter): 73%
Little Smoky: 65%
Year: 20
Biophysical (Total %)
A La Peche (Winter): 65%
Little Smoky: 62%
Year: 40
Biophysical (Total %)
A La Peche (Winter): 64%
Little Smoky: 63%
Year: 60
Biophysical (Total %)
A La Peche (Winter): 52%
Little Smoky: 66%
Year: 80
Biophysical (Total %)
A La Peche (Winter): 48%
Little Smoky: 59%
Year: 100
Biophysical (Total %)
A La Peche (Winter): 45%
Little Smoky: 57%

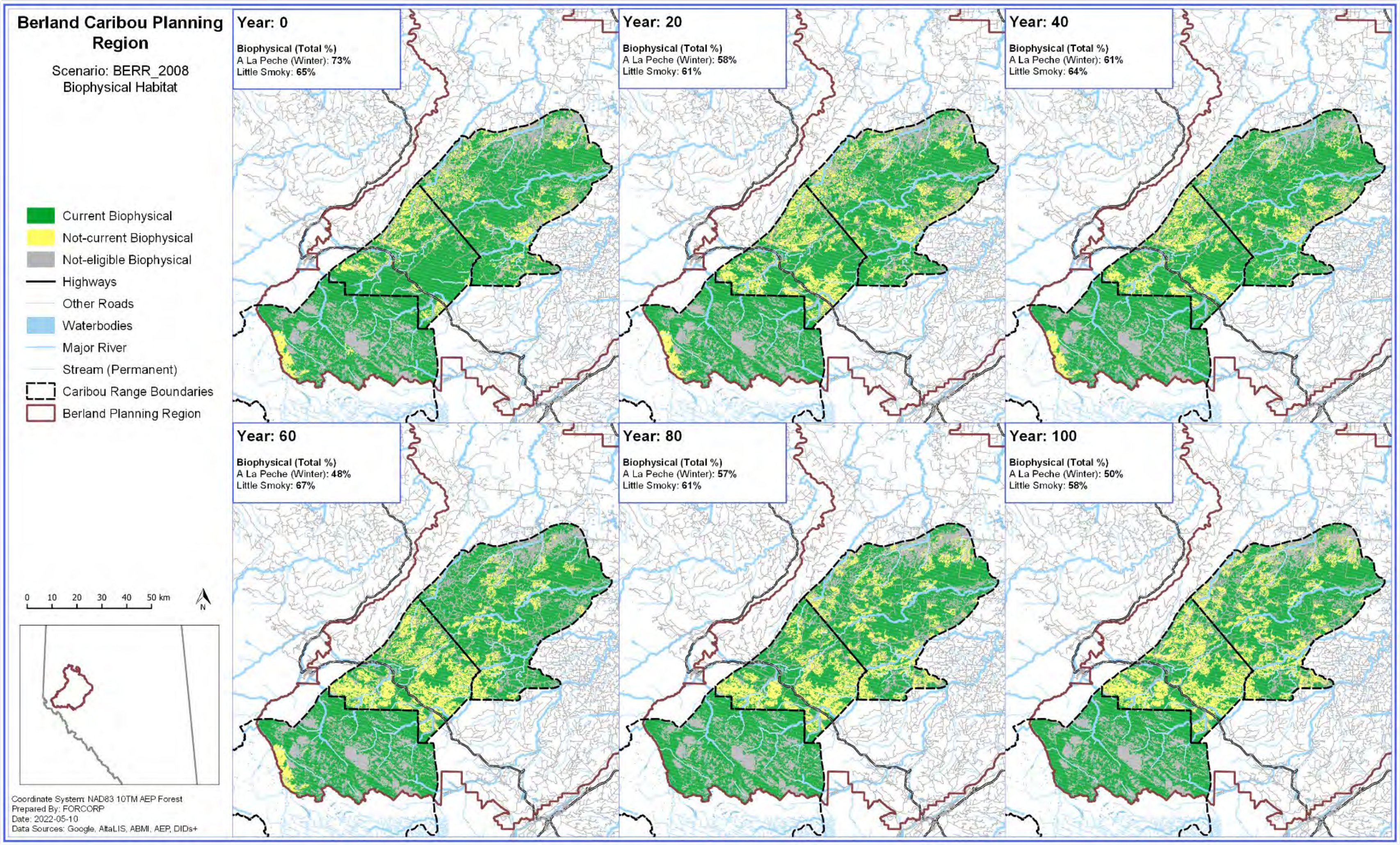


Berland Caribou Planning Region
Scenario: BERR_2005
Biophysical Habitat
Current Biophysical
Not-current Biophysical
Not-eligible Biophysical
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Caribou Range Boundaries
Berland Planning Region
0 10 20 30 40 50 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-05-10
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 0
Biophysical (Total %)
A La Peche (Winter): 73%
Little Smoky: 65%
Year: 20
Biophysical (Total %)
A La Peche (Winter): 62%
Little Smoky: 62%
Year: 40
Biophysical (Total %)
A La Peche (Winter): 58%
Little Smoky: 64%
Year: 60
Biophysical (Total %)
A La Peche (Winter): 55%
Little Smoky: 69%
Year: 80
Biophysical (Total %)
A La Peche (Winter): 54%
Little Smoky: 65%
Year: 100
Biophysical (Total %)
A La Peche (Winter): 52%
Little Smoky: 63%

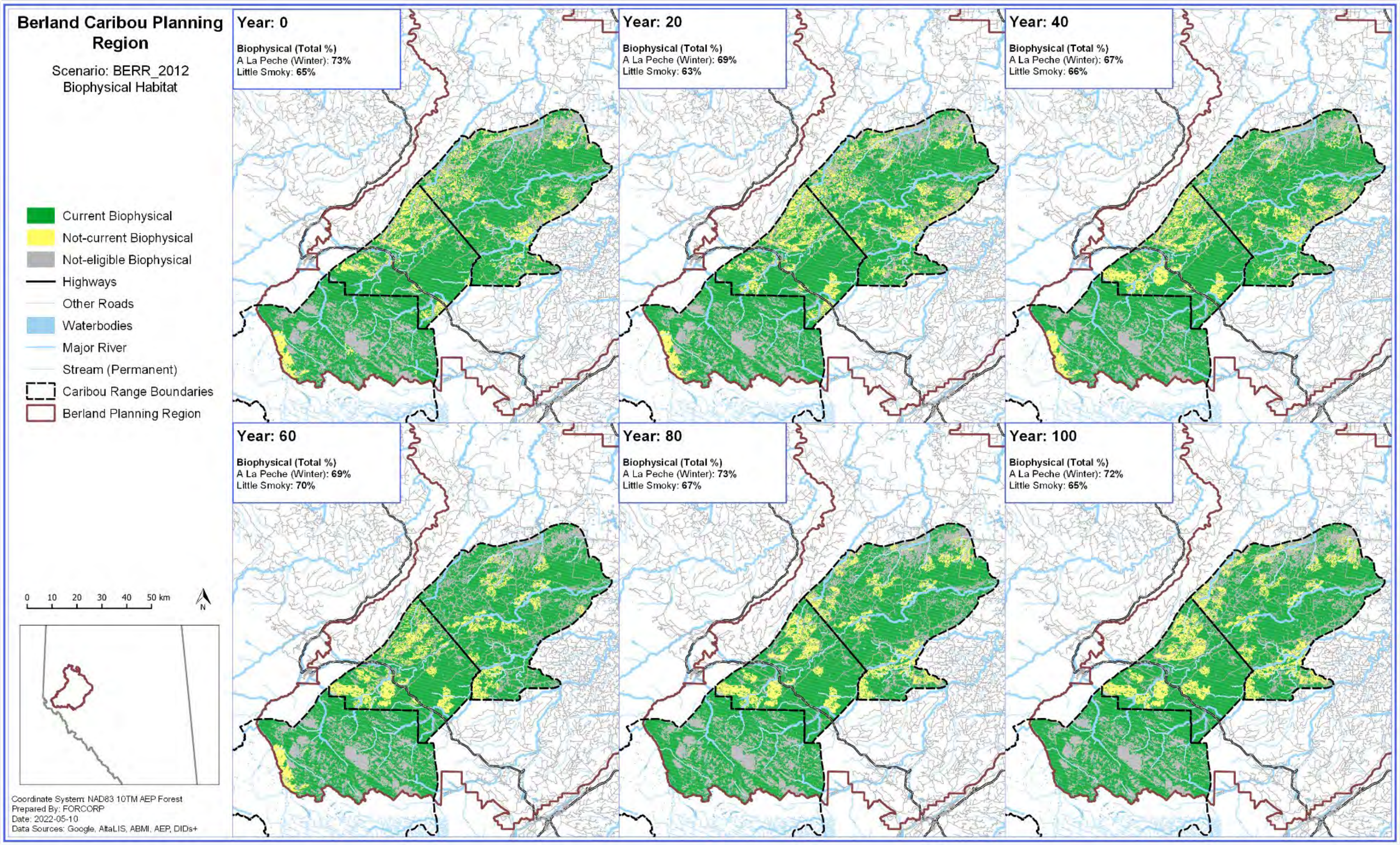


Berland Caribou Planning Region
Scenario: BERR_2006
Biophysical Habitat
Current Biophysical
Not-current Biophysical
Not-eligible Biophysical
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Caribou Range Boundaries
Berland Planning Region
0 10 20 30 40 50 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-05-10
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 0
Biophysical (Total %)
A La Peche (Winter): 73%
Little Smoky: 65%
Year: 20
Biophysical (Total %)
A La Peche (Winter): 61%
Little Smoky: 63%
Year: 40
Biophysical (Total %)
A La Peche (Winter): 58%
Little Smoky: 64%
Year: 60
Biophysical (Total %)
A La Peche (Winter): 56%
Little Smoky: 69%
Year: 80
Biophysical (Total %)
A La Peche (Winter): 56%
Little Smoky: 65%
Year: 100
Biophysical (Total %)
A La Peche (Winter): 54%
Little Smoky: 64%

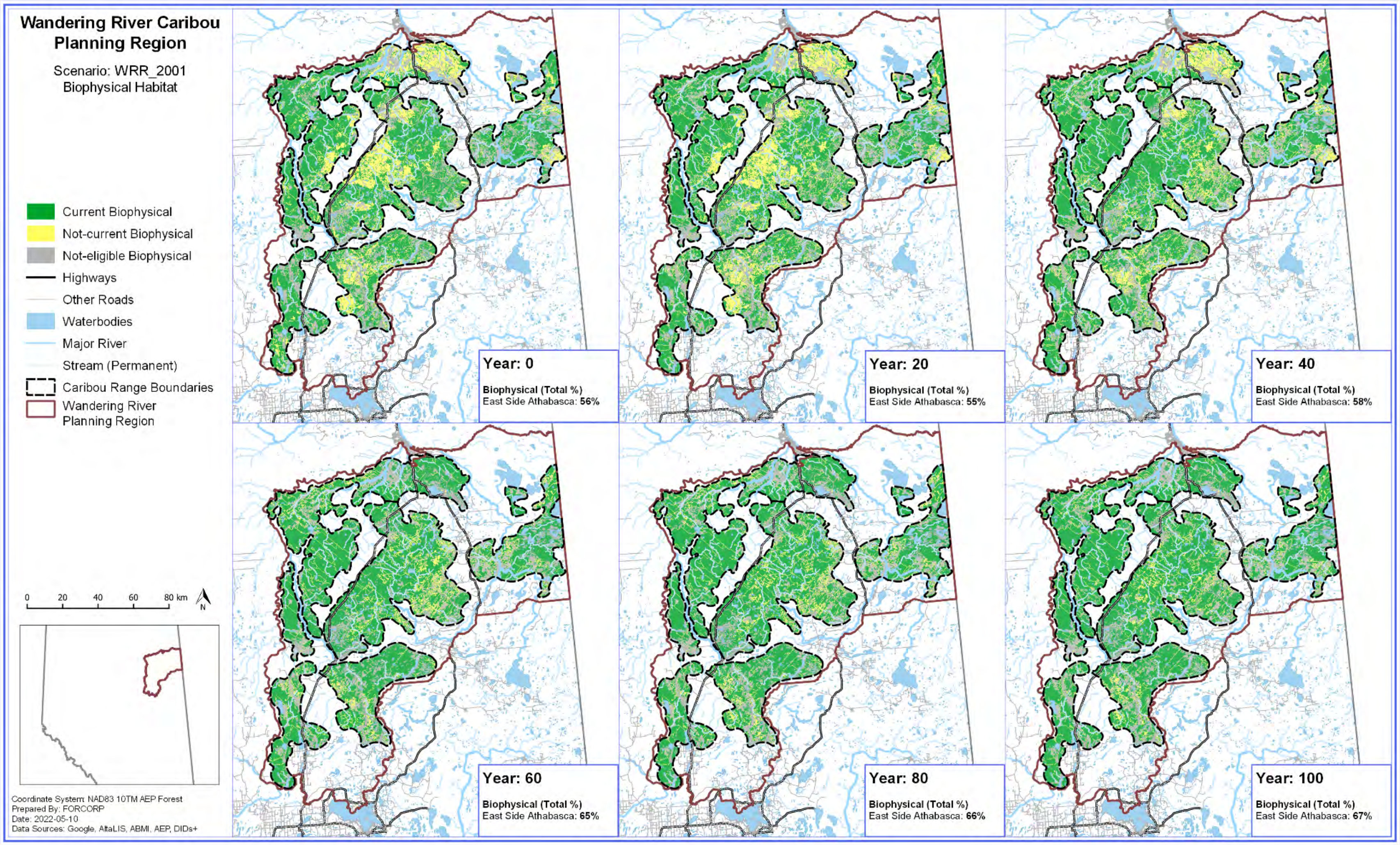

Berland Caribou Planning Region
Scenario: BERR_2007
Biophysical Habitat
Current Biophysical
Not-current Biophysical
Not-eligible Biophysical
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Caribou Range Boundaries
Berland Planning Region
0 10 20 30 40 50 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-05-10
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 0
Biophysical (Total %)
A La Peche (Winter): 73%
Little Smoky: 65%
Year: 20
Biophysical (Total %)
A La Peche (Winter): 64%
Little Smoky: 62%
Year: 40
Biophysical (Total %)
A La Peche (Winter): 57%
Little Smoky: 61%
Year: 60
Biophysical (Total %)
A La Peche (Winter): 54%
Little Smoky: 67%
Year: 80
Biophysical (Total %)
A La Peche (Winter): 54%
Little Smoky: 67%
Year: 100
Biophysical (Total %)
A La Peche (Winter): 53%
Little Smoky: 68%

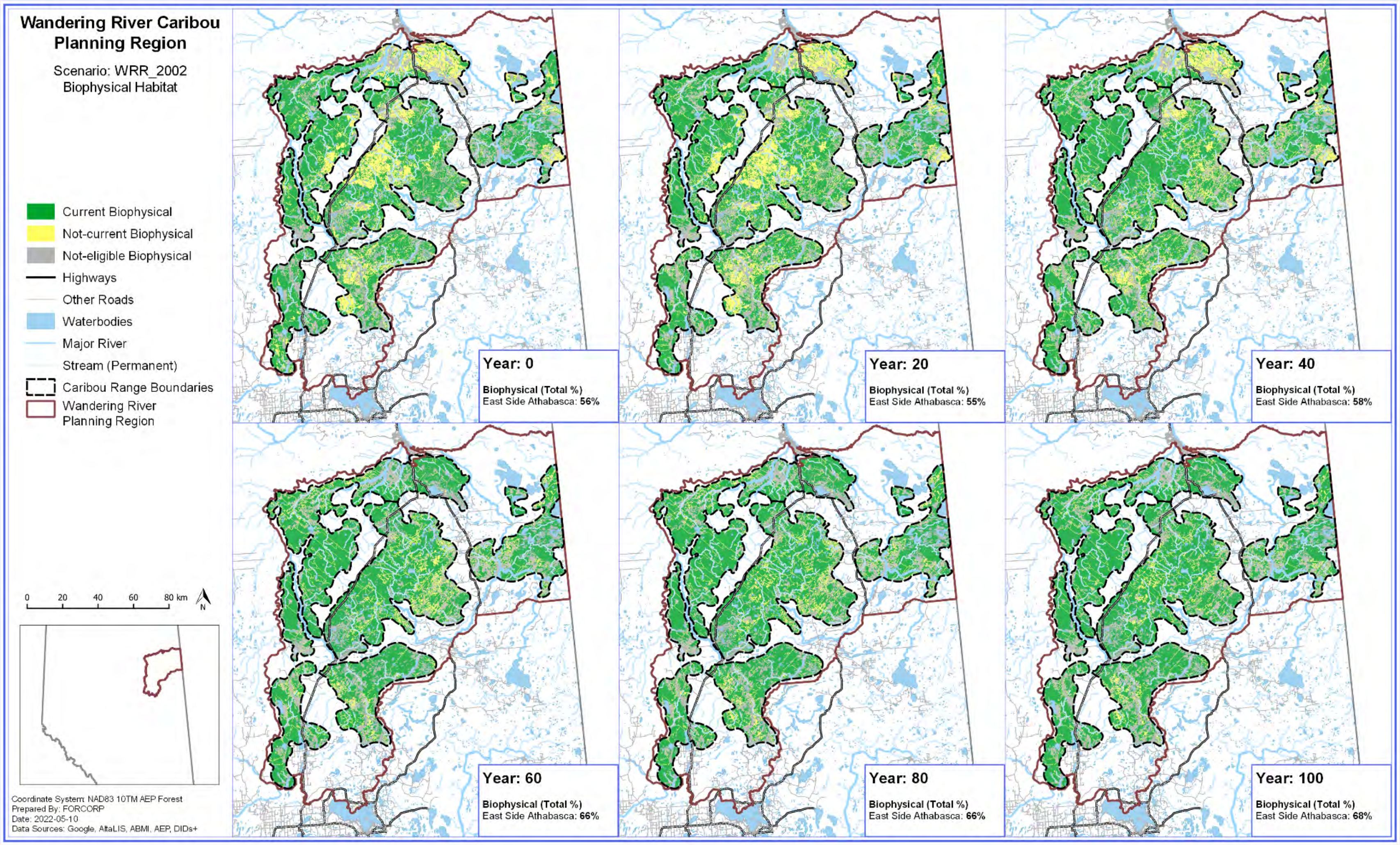


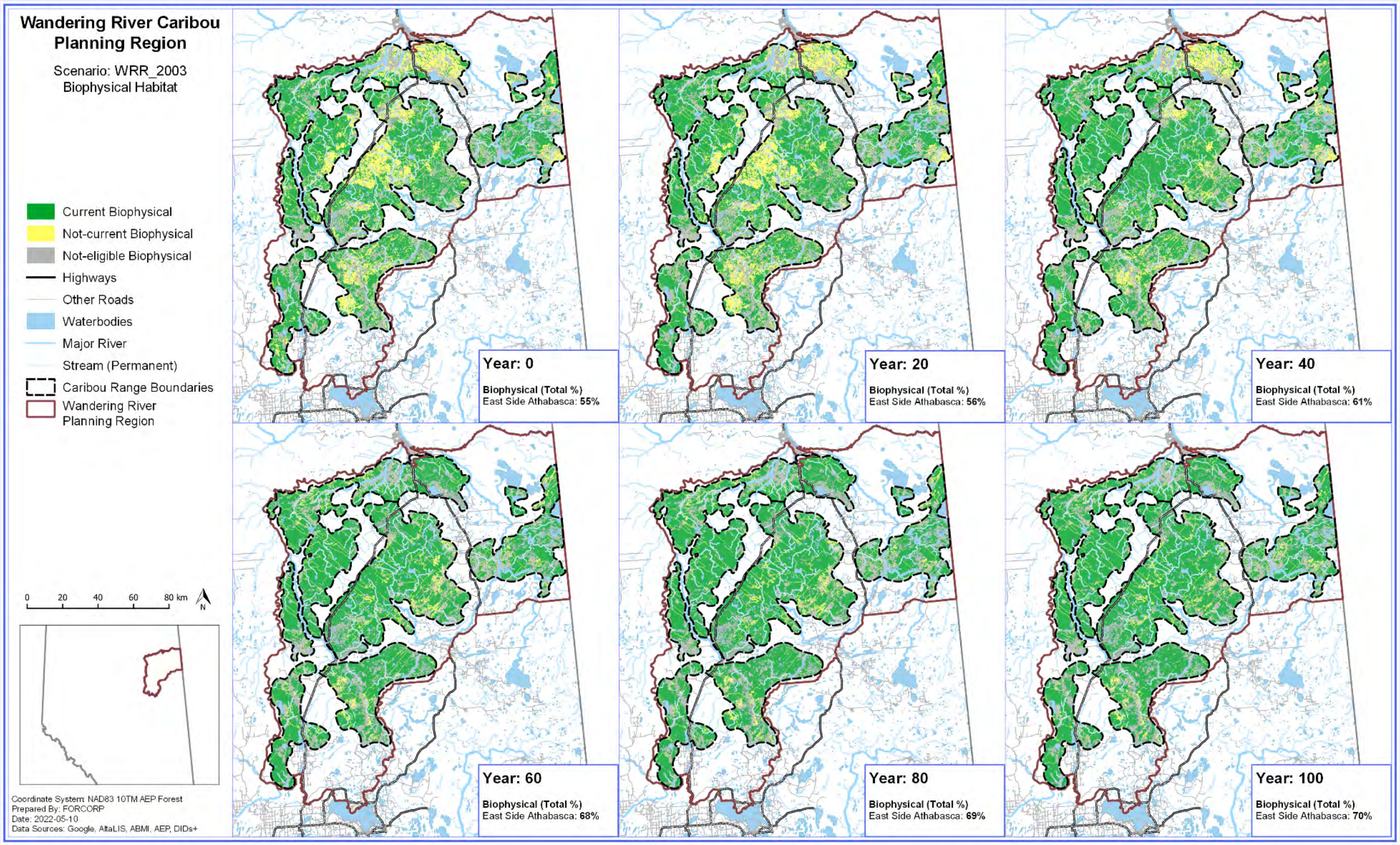
Berland Caribou Planning Region
Scenario: BERR_2008
Biophysical Habitat
Current Biophysical
Not-current Biophysical
Not-eligible Biophysical
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Caribou Range Boundaries
Berland Planning Region
0 10 20 30 40 50 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-05-10
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 0
Biophysical (Total %)
A La Peche (Winter): 73%
Little Smoky: 65%
Year: 20
Biophysical (Total %)
A La Peche (Winter): 58%
Little Smoky: 61%
Year: 40
Biophysical (Total %)
A La Peche (Winter): 61%
Little Smoky: 64%
Year: 60
Biophysical (Total %)
A La Peche (Winter): 48%
Little Smoky: 67%
Year: 80
Biophysical (Total %)
A La Peche (Winter): 57%
Little Smoky: 61%
Year: 100
Biophysical (Total %)
A La Peche (Winter): 50%
Little Smoky: 58%

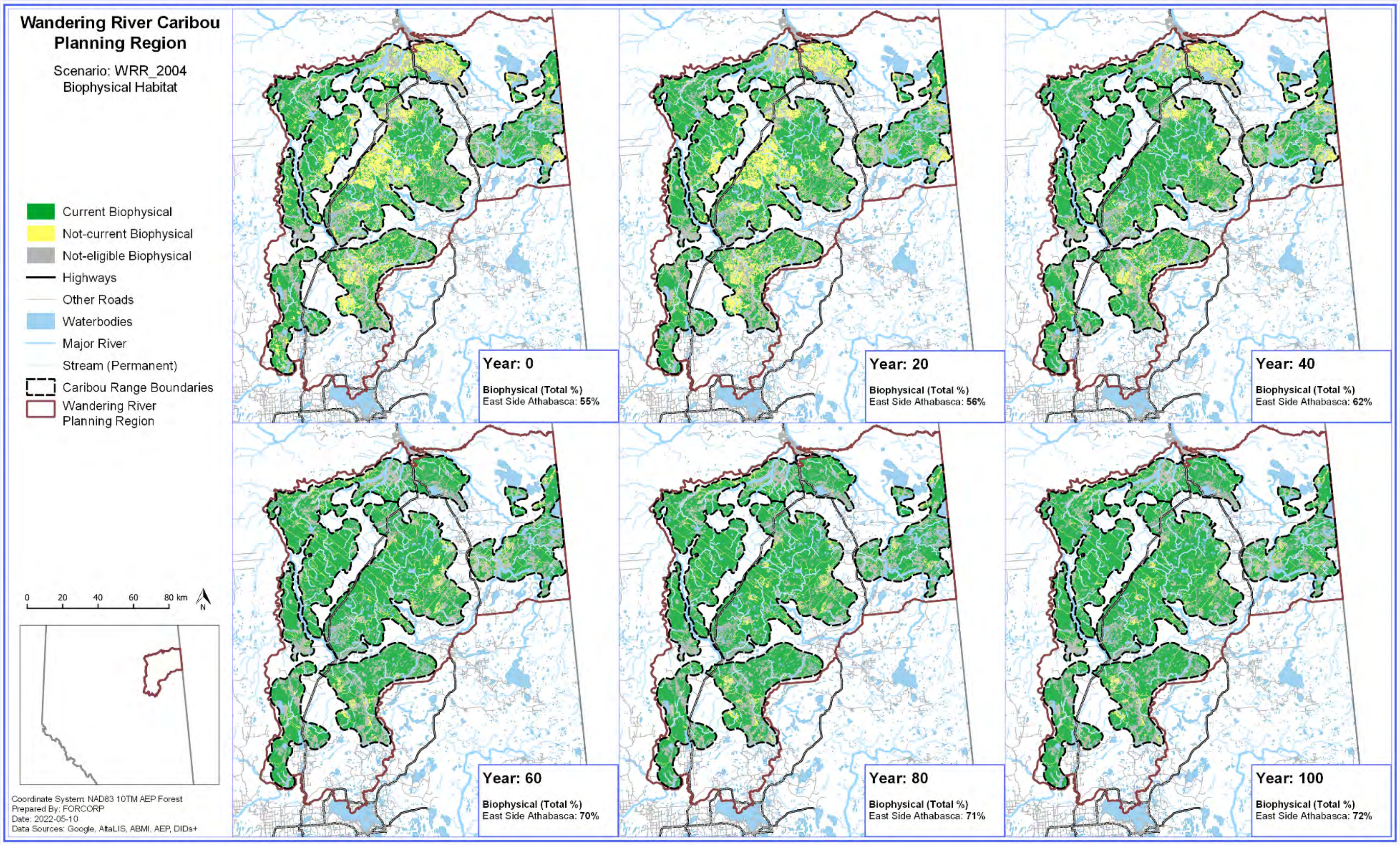


Berland Caribou Planning Region
Scenario: BERR_2012
Biophysical Habitat
Current Biophysical
Not-current Biophysical
Not-eligible Biophysical
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Caribou Range Boundaries
Berland Planning Region
0 10 20 30 40 50 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-05-10
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 0
Biophysical (Total %)
A La Peche (Winter): 73%
Little Smoky: 65%
Year: 20
Biophysical (Total %)
A La Peche (Winter): 69%
Little Smoky: 63%
Year: 40
Biophysical (Total %)
A La Peche (Winter): 67%
Little Smoky: 66%
Year: 60
Biophysical (Total %)
A La Peche (Winter): 69%
Little Smoky: 70%
Year: 80
Biophysical (Total %)
A La Peche (Winter): 73%
Little Smoky: 67%
Year: 100
Biophysical (Total %)
A La Peche (Winter): 72%
Little Smoky: 65%

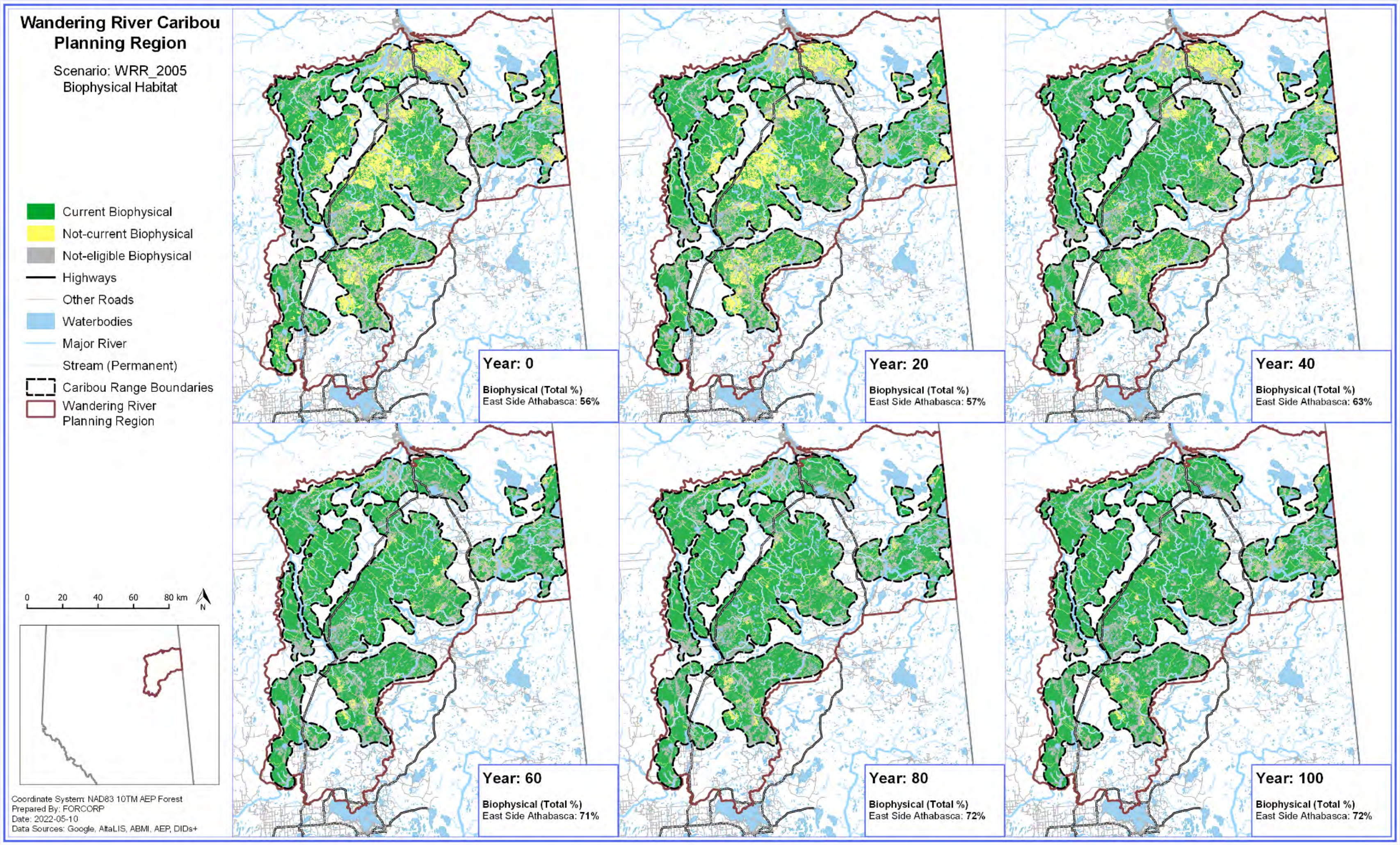

Wandering River Caribou Planning Region
Scenario: WRR_2001
Biophysical Habitat
Current Biophysical
Not-current Biophysical
Not-eligible Biophysical
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Caribou Range Boundaries
Wandering River Planning Region
0 20 40 60 80 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-05-10
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 0
Biophysical (Total %)
East Side Athabasca: 56%
Year: 20
Biophysical (Total %)
East Side Athabasca: 55%
Year: 40
Biophysical (Total %)
East Side Athabasca: 58%
Year: 60
Biophysical (Total %)
East Side Athabasca: 65%
Year: 80
Biophysical (Total %)
East Side Athabasca: 66%
Year: 100
Biophysical (Total %)
East Side Athabasca: 67%

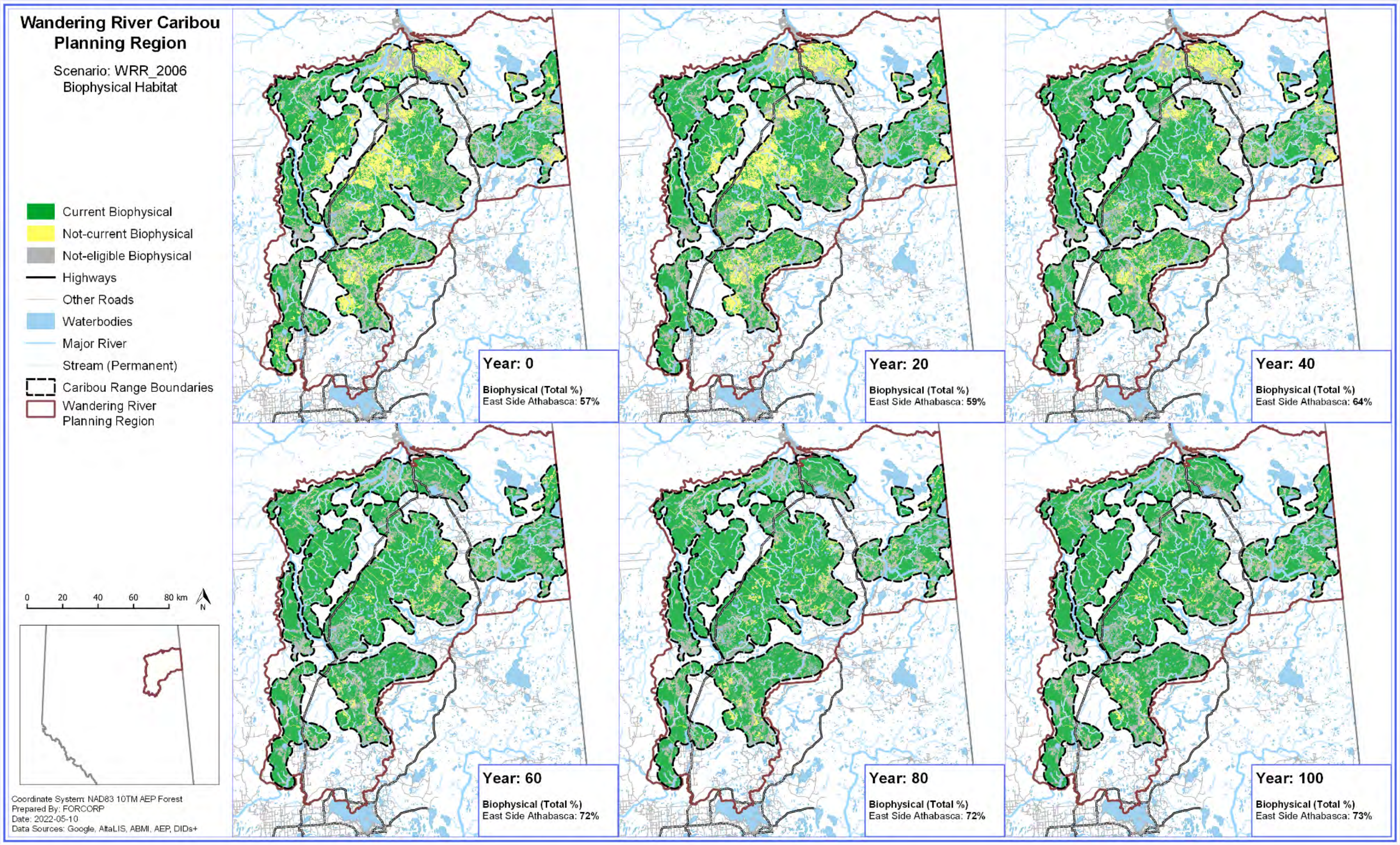

Wandering River Caribou Planning Region
Scenario: WRR_2002
Biophysical Habitat
Current Biophysical
Not-current Biophysical
Not-eligible Biophysical
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Caribou Range Boundaries
Wandering River Planning Region
0 20 40 60 80 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-05-10
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 0
Biophysical (Total %)
East Side Athabasca: 56%
Year: 20
Biophysical (Total %)
East Side Athabasca: 55%
Year: 40
Biophysical (Total %)
East Side Athabasca: 58%
Year: 60
Biophysical (Total %)
East Side Athabasca: 66%
Year: 80
Biophysical (Total %)
East Side Athabasca: 66%
Year: 100
Biophysical (Total %)
East Side Athabasca: 68%

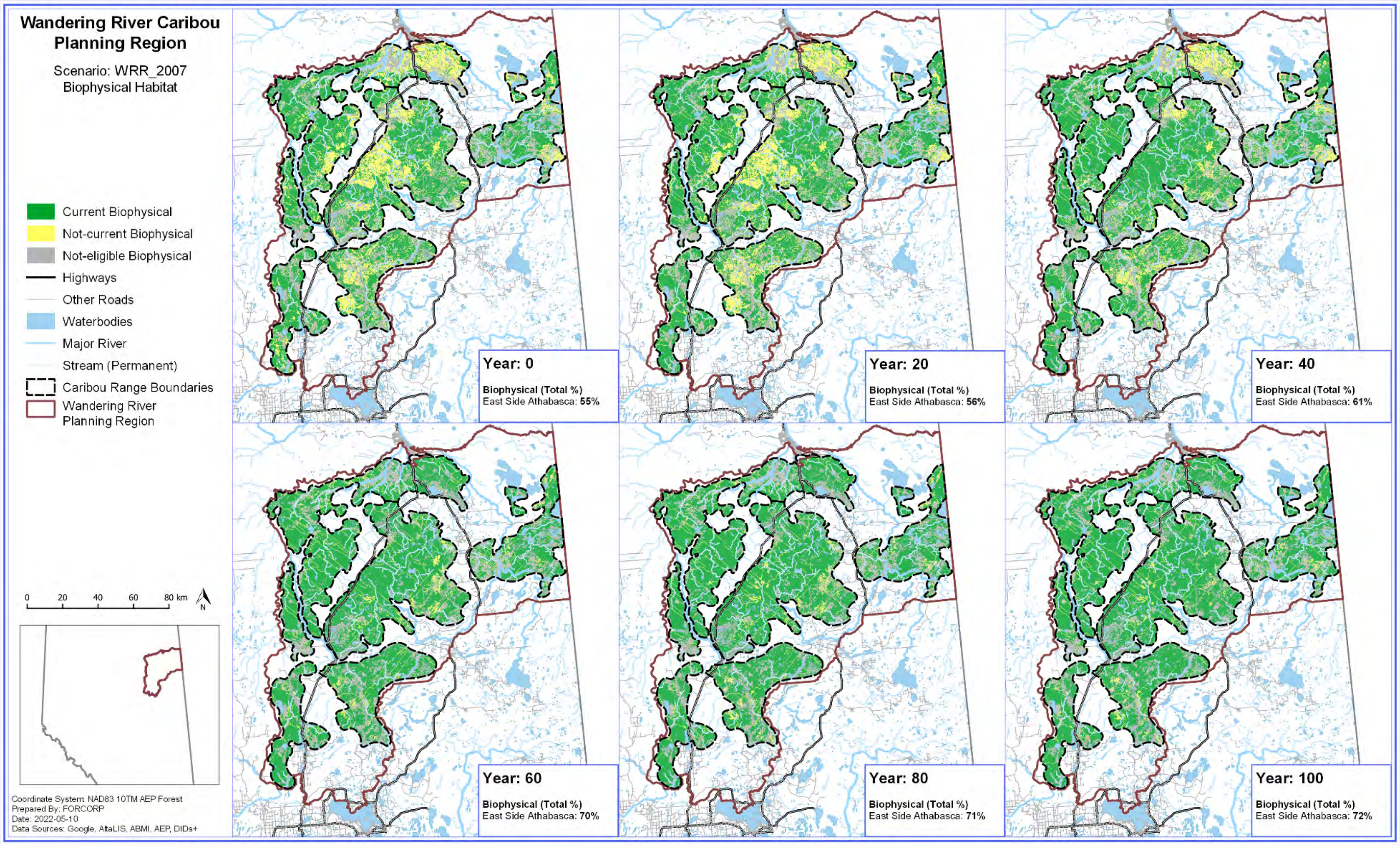

Wandering River Caribou Planning Region
Scenario: WRR_2003
Biophysical Habitat
Current Biophysical
Not-current Biophysical
Not-eligible Biophysical
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Caribou Range Boundaries
Wandering River Planning Region
0 20 40 60 80 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-05-10
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 0
Biophysical (Total %)
East Side Athabasca: 55%
Year: 20
Biophysical (Total %)
East Side Athabasca: 56%
Year: 40
Biophysical (Total %)
East Side Athabasca: 61%
Year: 60
Biophysical (Total %)
East Side Athabasca: 68%
Year: 80
Biophysical (Total %)
East Side Athabasca: 69%
Year: 100
Biophysical (Total %)
East Side Athabasca: 70%

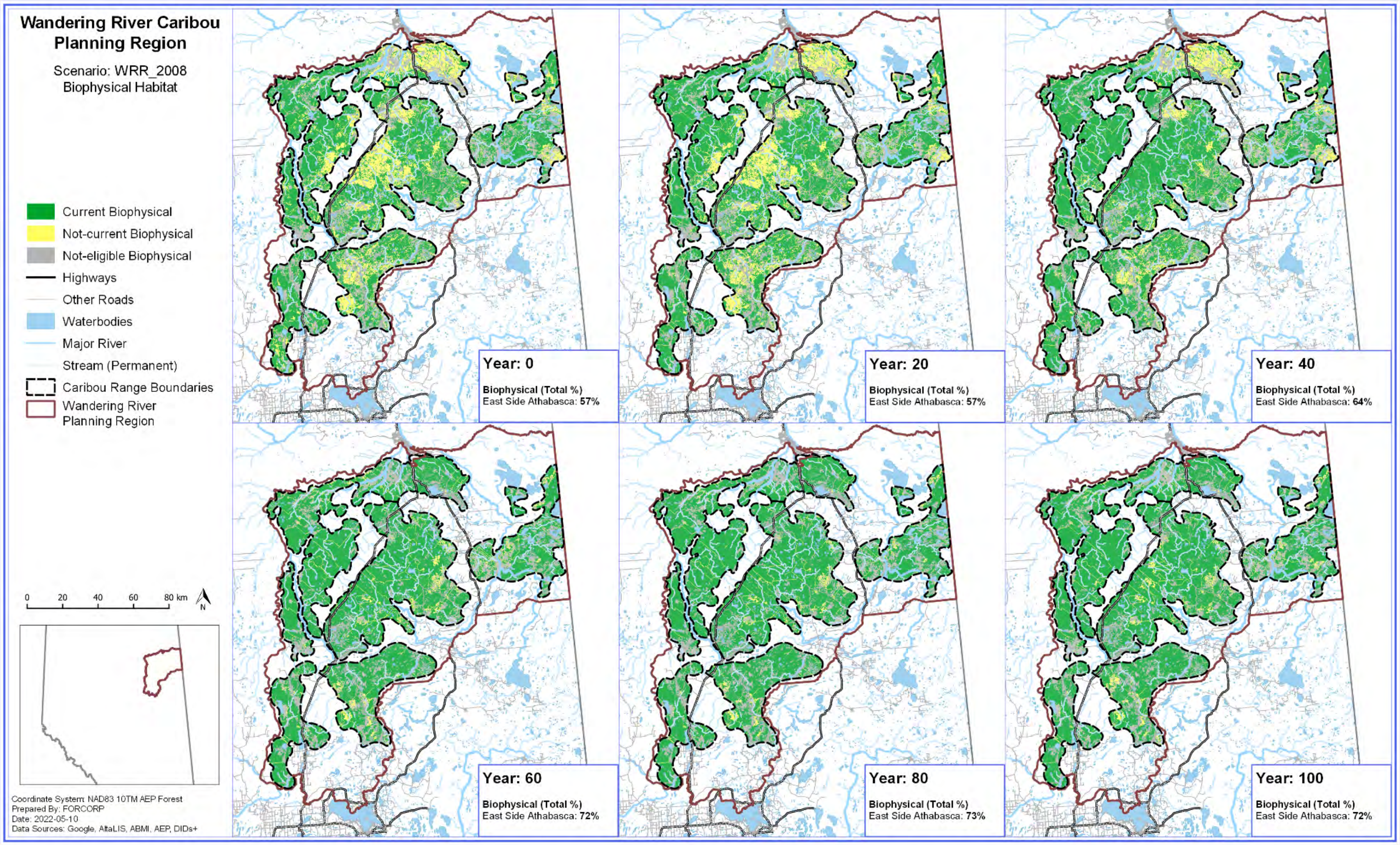


Wandering River Caribou Planning Region
Scenario: WRR_2004
Biophysical Habitat
Current Biophysical
Not-current Biophysical
Not-eligible Biophysical
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Caribou Range Boundaries
Wandering River Planning Region
0 20 40 60 80 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-05-10
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 0
Biophysical (Total %)
East Side Athabasca: 55%
Year: 20
Biophysical (Total %)
East Side Athabasca: 56%
Year: 40
Biophysical (Total %)
East Side Athabasca: 62%
Year: 60
Biophysical (Total %)
East Side Athabasca: 70%
Year: 80
Biophysical (Total %)
East Side Athabasca: 71%
Year: 100
Biophysical (Total %)
East Side Athabasca: 72%

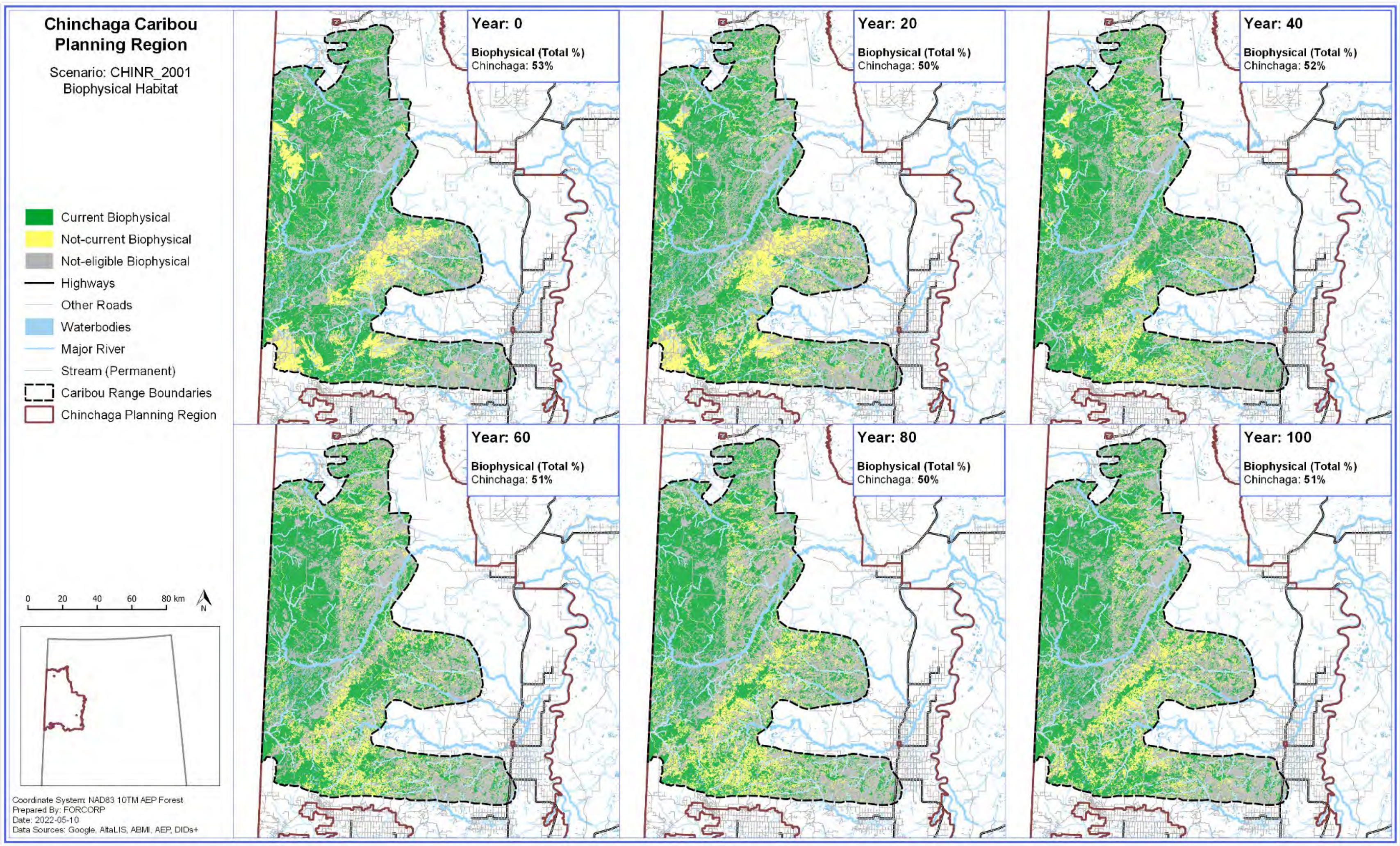

Wandering River Caribou Planning Region
Scenario: WRR_2005
Biophysical Habitat
Current Biophysical
Not-current Biophysical
Not-eligible Biophysical
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Caribou Range Boundaries
Wandering River Planning Region
0 20 40 60 80 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-05-10
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 0
Biophysical (Total %)
East Side Athabasca: 56%
Year: 20
Biophysical (Total %)
East Side Athabasca: 57%
Year: 40
Biophysical (Total %)
East Side Athabasca: 63%
Year: 60
Biophysical (Total %)
East Side Athabasca: 71%
Year: 80
Biophysical (Total %)
East Side Athabasca: 72%
Year: 100
Biophysical (Total %)
East Side Athabasca: 72%


Wandering River Caribou Planning Region
Scenario: WRR_2006
Biophysical Habitat
Current Biophysical
Not-current Biophysical
Not-eligible Biophysical
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Caribou Range Boundaries
Wandering River Planning Region
0 20 40 60 80 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-05-10
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 0
Biophysical (Total %)
East Side Athabasca: 57%
Year: 20
Biophysical (Total %)
East Side Athabasca: 59%
Year: 40
Biophysical (Total %)
East Side Athabasca: 64%
Year: 60
Biophysical (Total %)
East Side Athabasca: 72%
Year: 80
Biophysical (Total %)
East Side Athabasca: 72%
Year: 100
Biophysical (Total %)
East Side Athabasca: 73%

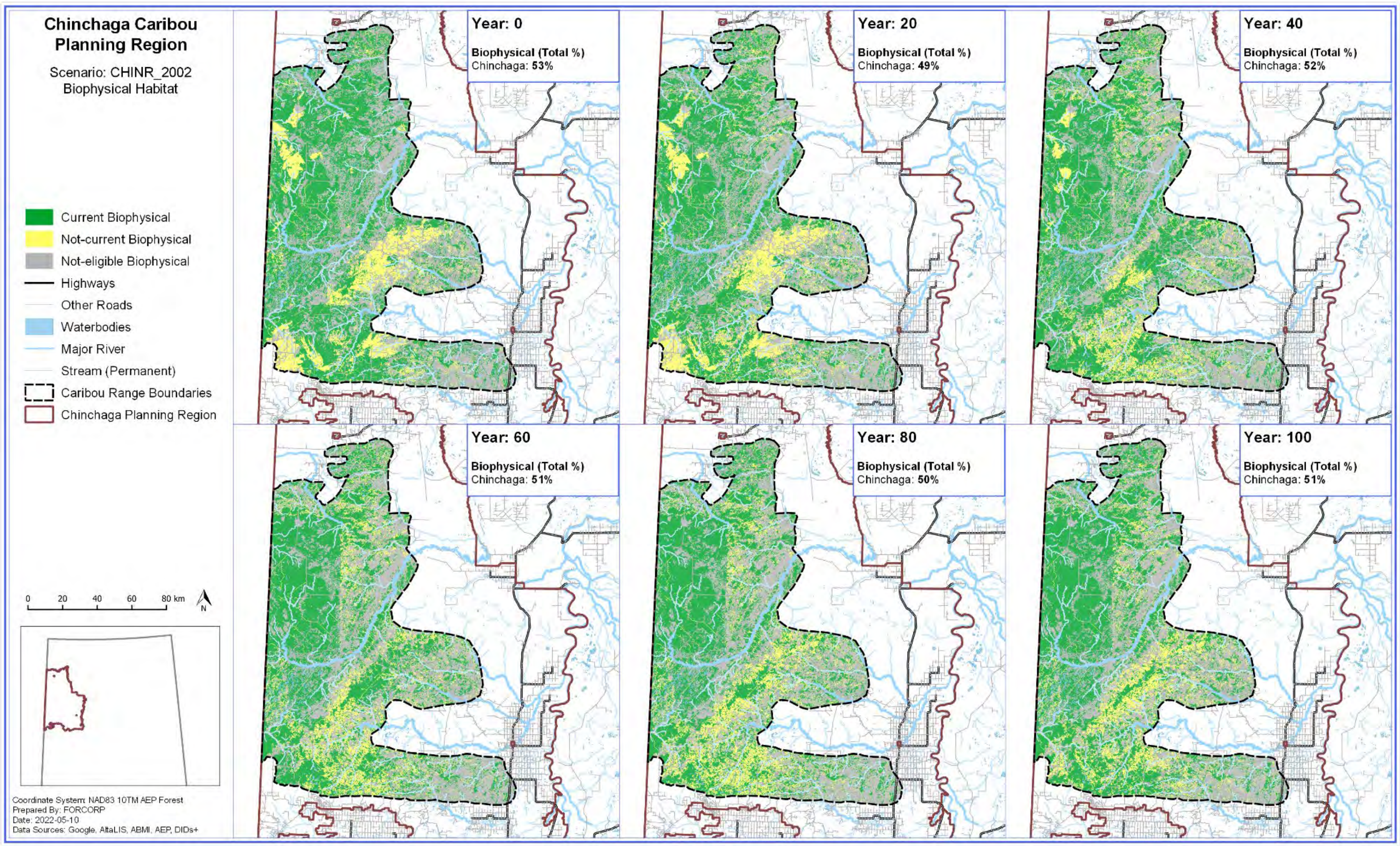

Wandering River Caribou Planning Region
Scenario: WRR_2007
Biophysical Habitat
Current Biophysical
Not-current Biophysical
Not-eligible Biophysical
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Caribou Range Boundaries
Wandering River Planning Region
0 20 40 60 80 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-05-10
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 0
Biophysical (Total %)
East Side Athabasca: 55%
Year: 20
Biophysical (Total %)
East Side Athabasca: 56%
Year: 40
Biophysical (Total %)
East Side Athabasca: 61%
Year: 60
Biophysical (Total %)
East Side Athabasca: 70%
Year: 80
Biophysical (Total %)
East Side Athabasca: 71%
Year: 100
Biophysical (Total %)
East Side Athabasca: 72%



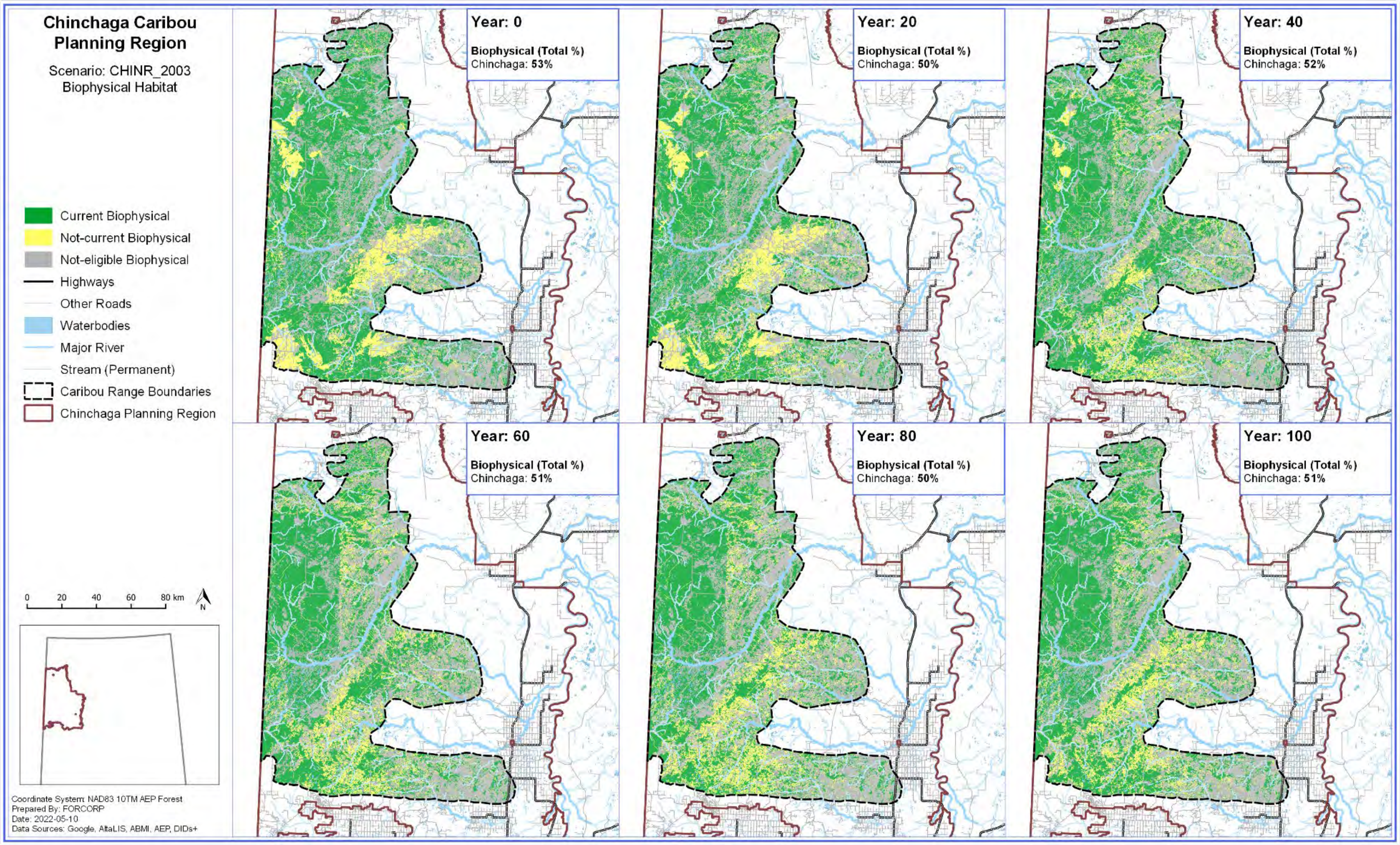
Wandering River Caribou Planning Region
Scenario: WRR_2008
Biophysical Habitat
Current Biophysical
Not-current Biophysical
Not-eligible Biophysical
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Caribou Range Boundaries
Wandering River Planning Region
0 20 40 60 80 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-05-10
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 0
Biophysical (Total %)
East Side Athabasca: 57%
Year: 20
Biophysical (Total %)
East Side Athabasca: 57%
Year: 40
Biophysical (Total %)
East Side Athabasca: 64%
Year: 60
Biophysical (Total %)
East Side Athabasca: 72%
Year: 80
Biophysical (Total %)
East Side Athabasca: 73%
Year: 100
Biophysical (Total %)
East Side Athabasca: 72%



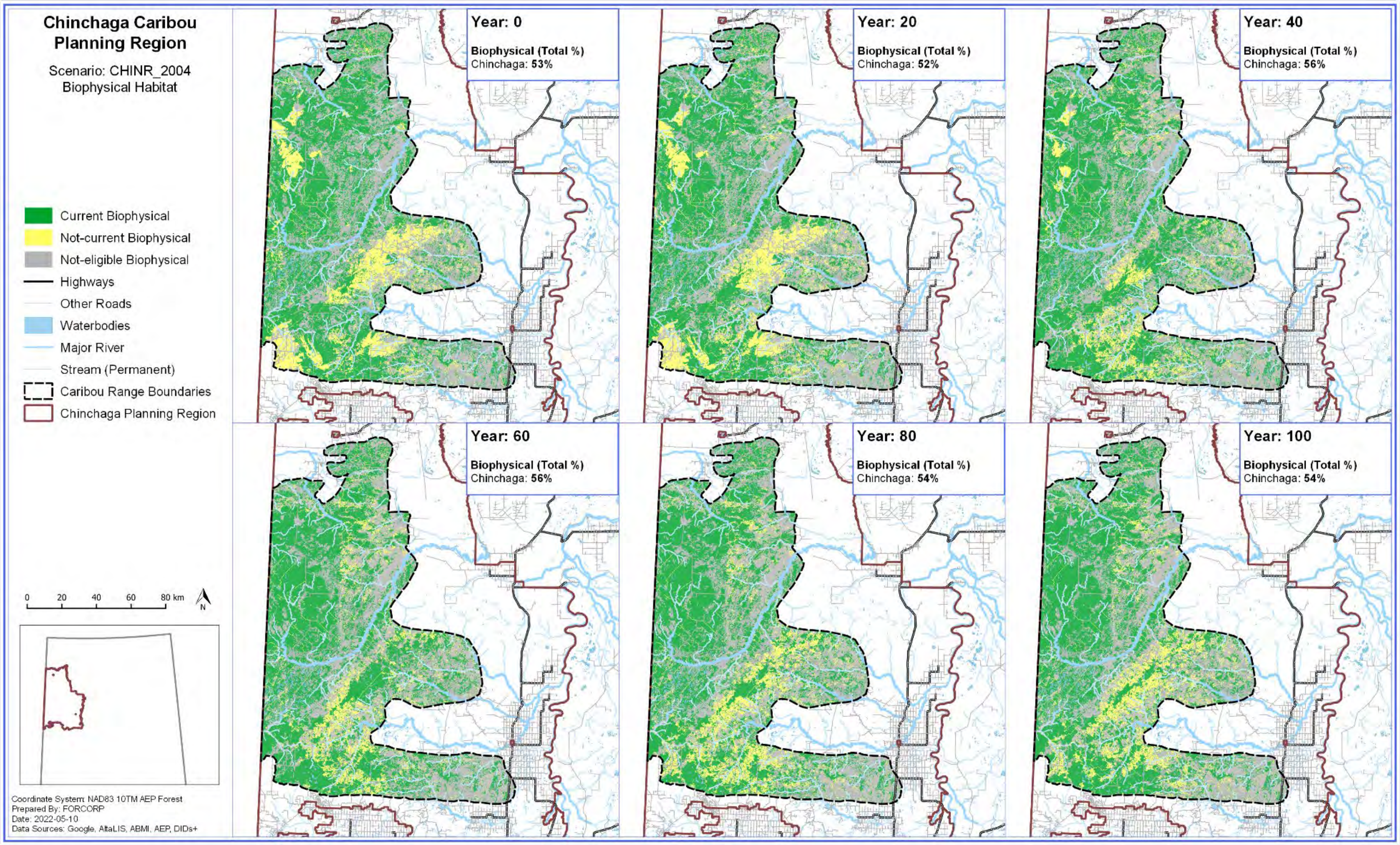
Chinchaga Caribou Planning Region
Scenario: CHINR_2001
Biophysical Habitat
Current Biophysical
Not-current Biophysical
Not-eligible Biophysical
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Caribou Range Boundaries
Chinchaga Planning Region
0 20 40 60 80 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-05-10
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 0
Biophysical (Total %)
Chinchaga: 53%
Year: 20
Biophysical (Total %)
Chinchaga: 50%
Year: 40
Biophysical (Total %)
Chinchaga: 52%
Year: 60
Biophysical (Total %)
Chinchaga: 51%
Year: 80
Biophysical (Total %)
Chinchaga: 50%
Year: 100
Biophysical (Total %)
Chinchaga: 51%



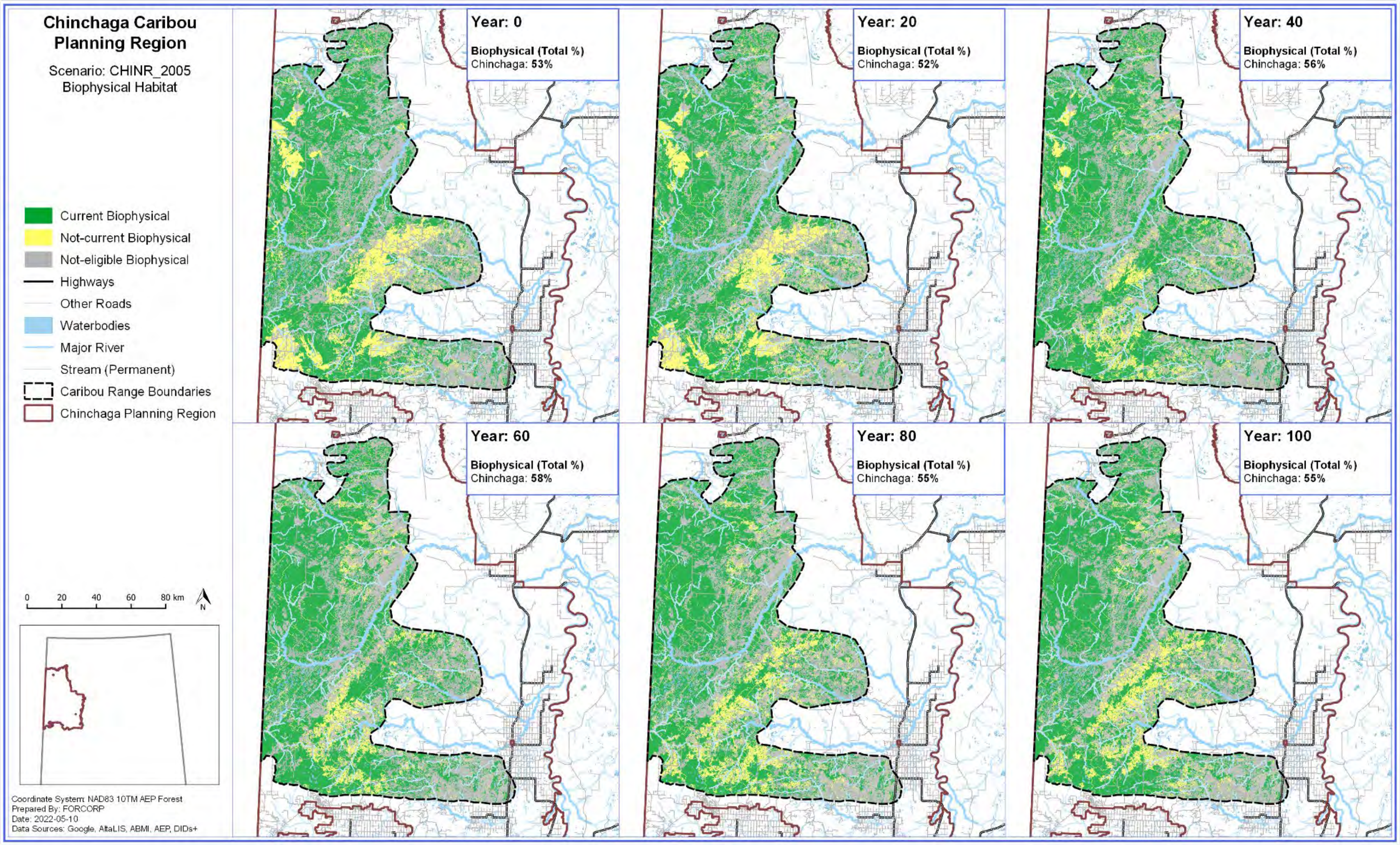
Chinchaga Caribou Planning Region
Scenario: CHINR_2002
Biophysical Habitat
Current Biophysical
Not-current Biophysical
Not-eligible Biophysical
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Caribou Range Boundaries
Chinchaga Planning Region
0 20 40 60 80 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-05-10
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 0
Biophysical (Total %)
Chinchaga: 53%
Year: 20
Biophysical (Total %)
Chinchaga: 49%
Year: 40
Biophysical (Total %)
Chinchaga: 52%
Year: 60
Biophysical (Total %)
Chinchaga: 51%
Year: 80
Biophysical (Total %)
Chinchaga: 50%
Year: 100
Biophysical (Total %)
Chinchaga: 51%

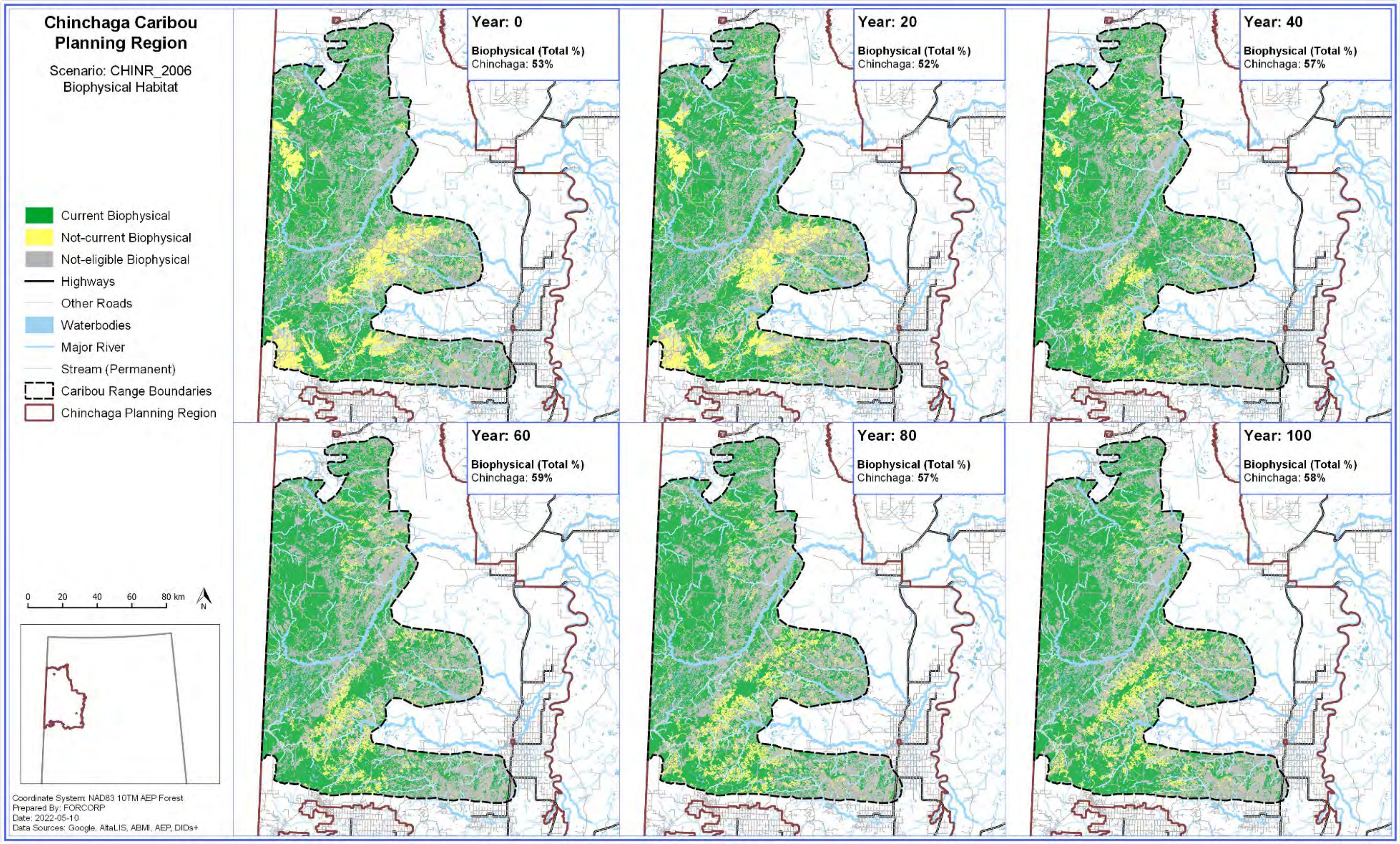


Chinchaga Caribou Planning Region
Scenario: CHINR_2003
Biophysical Habitat
Current Biophysical
Not-current Biophysical
Not-eligible Biophysical
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Caribou Range Boundaries
Chinchaga Planning Region
0 20 40 60 80 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-05-10
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 0
Biophysical (Total %)
Chinchaga: 53%
Year: 20
Biophysical (Total %)
Chinchaga: 50%
Year: 40
Biophysical (Total %)
Chinchaga: 52%
Year: 60
Biophysical (Total %)
Chinchaga: 51%
Year: 80
Biophysical (Total %)
Chinchaga: 50%
Year: 100
Biophysical (Total %)
Chinchaga: 51%

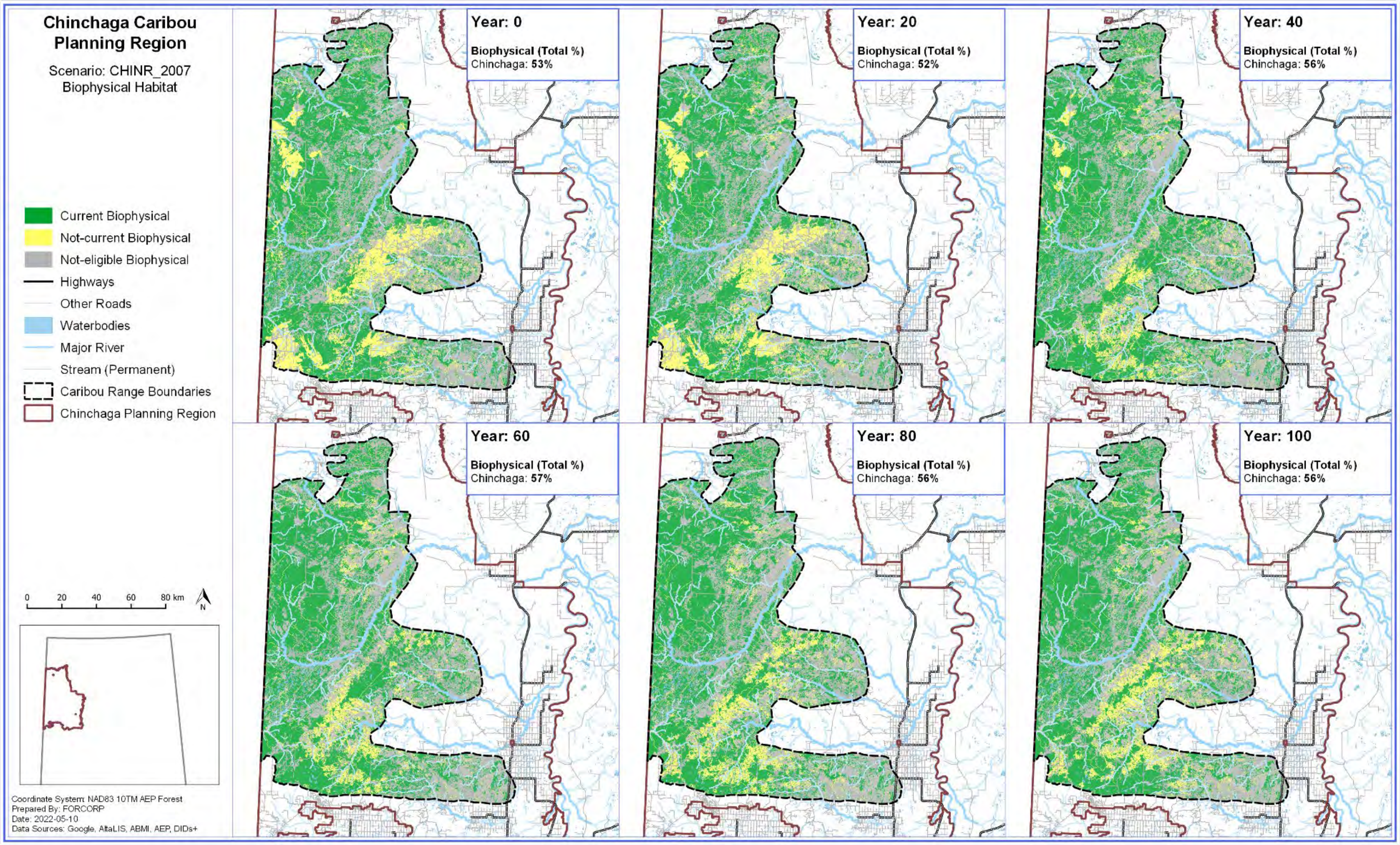


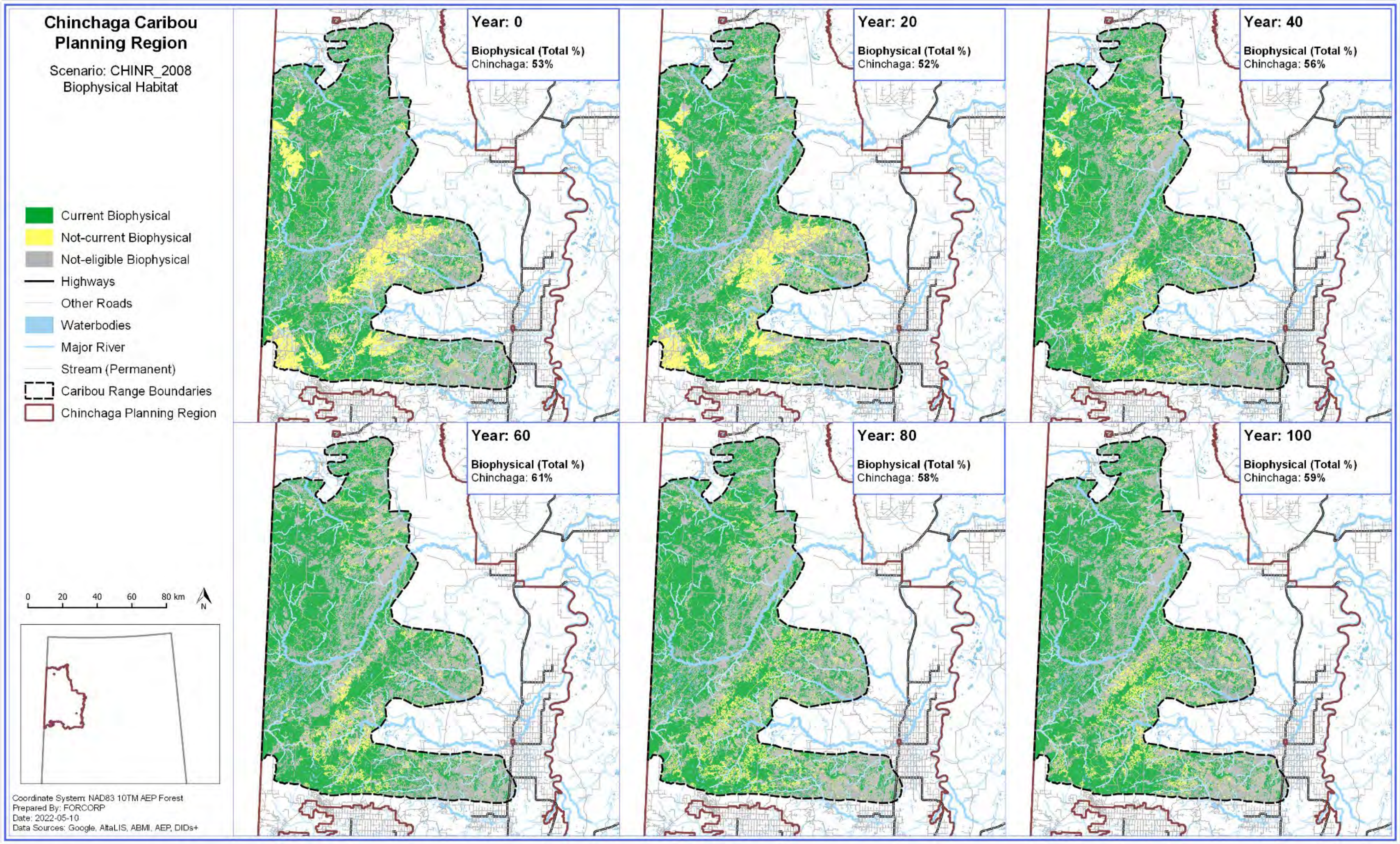
Chinchaga Caribou Planning Region
Scenario: CHINR_2004
Biophysical Habitat
Current Biophysical
Not-current Biophysical
Not-eligible Biophysical
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Caribou Range Boundaries
Chinchaga Planning Region
0 20 40 60 80 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-05-10
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 0
Biophysical (Total %)
Chinchaga: 53%
Year: 20
Biophysical (Total %)
Chinchaga: 52%
Year: 40
Biophysical (Total %)
Chinchaga: 56%
Year: 60
Biophysical (Total %)
Chinchaga: 56%
Year: 80
Biophysical (Total %)
Chinchaga: 54%
Year: 100
Biophysical (Total %)
Chinchaga: 54%

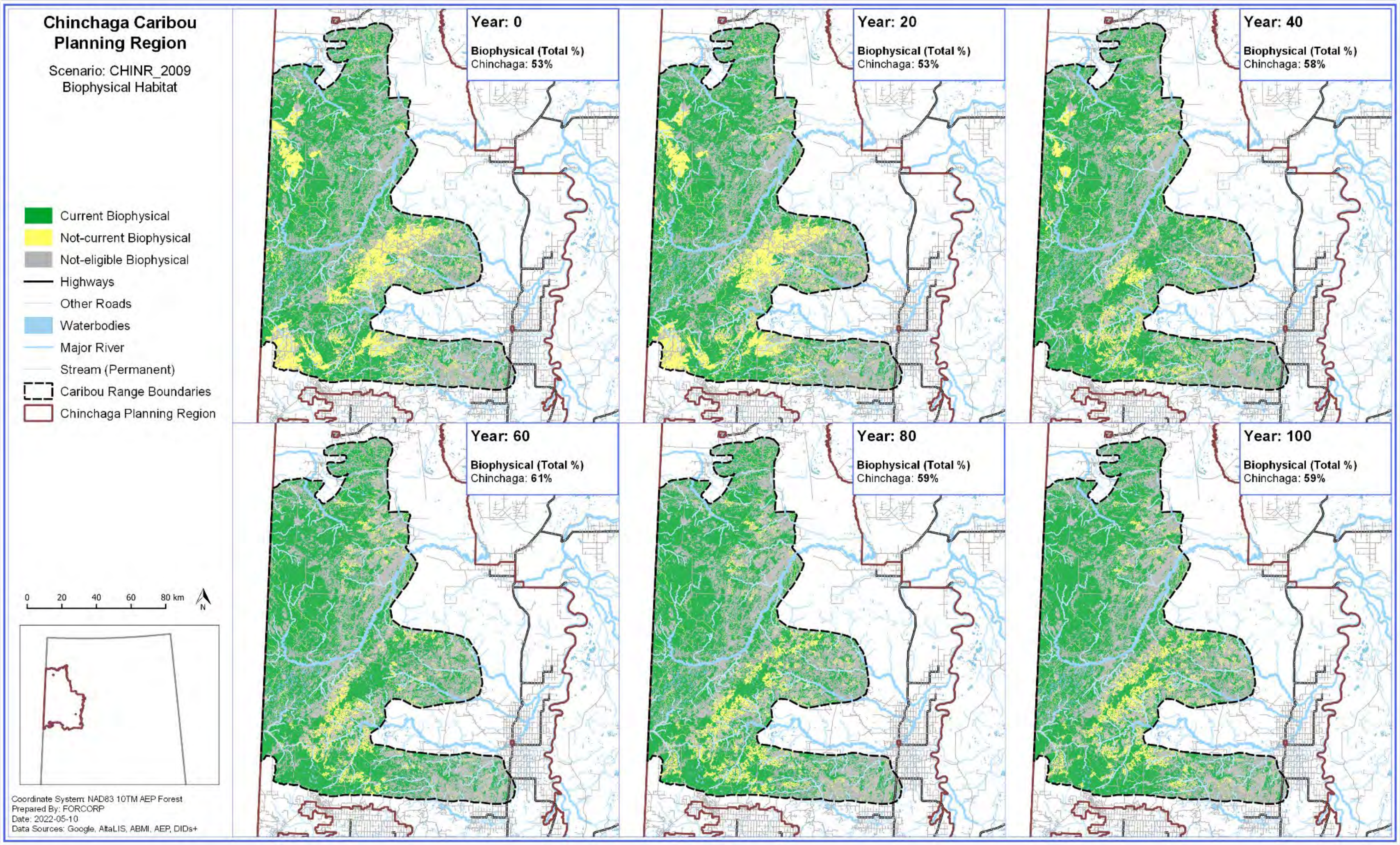

Chinchaga Caribou Planning Region
Scenario: CHINR_2005
Biophysical Habitat
Current Biophysical
Not-current Biophysical
Not-eligible Biophysical
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Caribou Range Boundaries
Chinchaga Planning Region
0 20 40 60 80 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-05-10
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 0
Biophysical (Total %)
Chinchaga: 53%
Year: 20
Biophysical (Total %)
Chinchaga: 52%
Year: 40
Biophysical (Total %)
Chinchaga: 56%
Year: 60
Biophysical (Total %)
Chinchaga: 58%
Year: 80
Biophysical (Total %)
Chinchaga: 55%
Year: 100
Biophysical (Total %)
Chinchaga: 55%



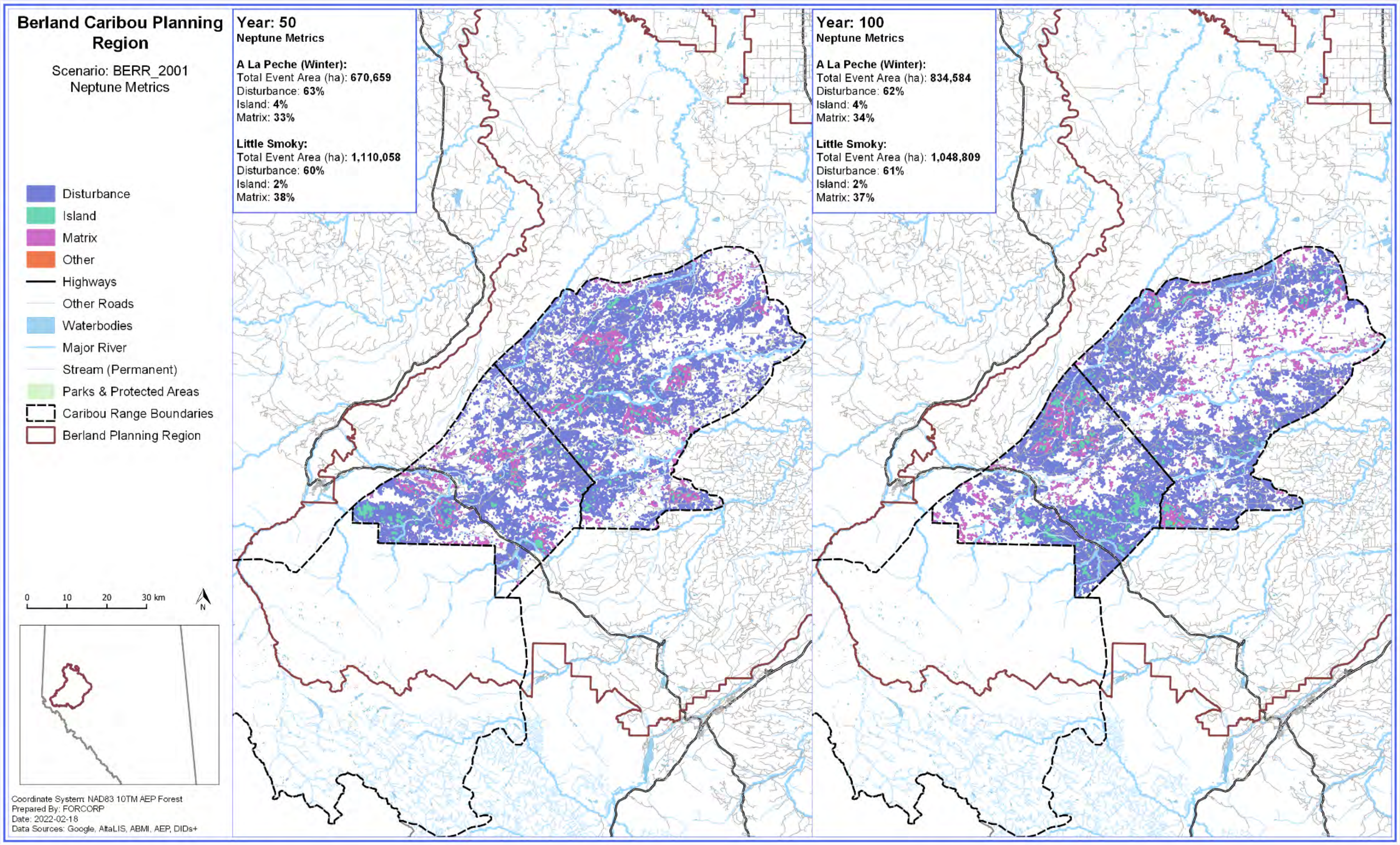
Chinchaga Caribou Planning Region
Scenario: CHINR_2006
Biophysical Habitat
Current Biophysical
Not-current Biophysical
Not-eligible Biophysical
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Caribou Range Boundaries
Chinchaga Planning Region
0 20 40 60 80 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-05-10
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 0
Biophysical (Total %)
Chinchaga: 53%
Year: 20
Biophysical (Total %)
Chinchaga: 52%
Year: 40
Biophysical (Total %)
Chinchaga: 57%
Year: 60
Biophysical (Total %)
Chinchaga: 59%
Year: 80
Biophysical (Total %)
Chinchaga: 57%
Year: 100
Biophysical (Total %)
Chinchaga: 58%

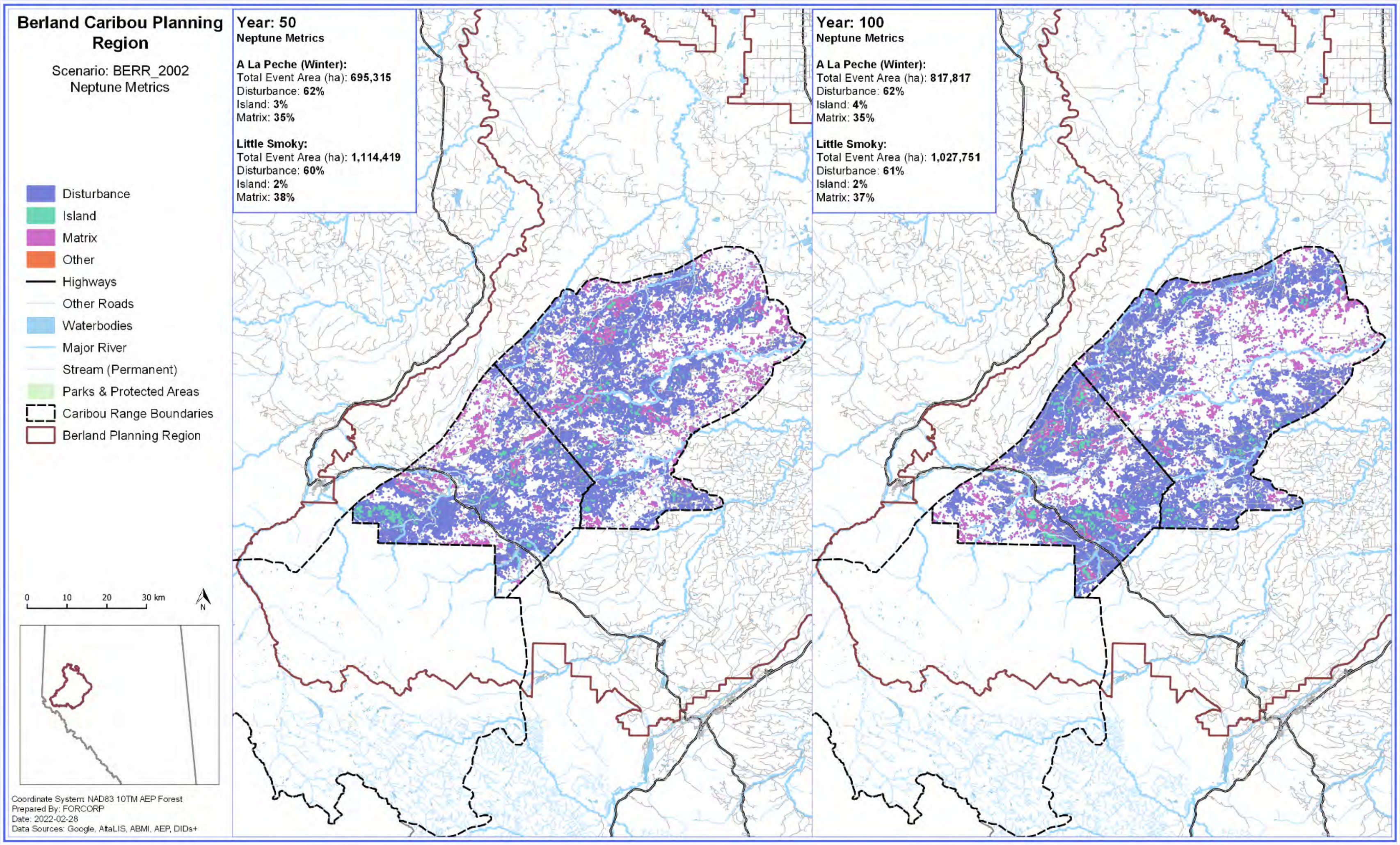

Chinchaga Caribou Planning Region
Scenario: CHINR_2007
Biophysical Habitat
Current Biophysical
Not-current Biophysical
Not-eligible Biophysical
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Caribou Range Boundaries
Chinchaga Planning Region
0 20 40 60 80 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-05-10
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 0
Biophysical (Total %)
Chinchaga: 53%
Year: 20
Biophysical (Total %)
Chinchaga: 52%
Year: 40
Biophysical (Total %)
Chinchaga: 56%
Year: 60
Biophysical (Total %)
Chinchaga: 57%
Year: 80
Biophysical (Total %)
Chinchaga: 56%
Year: 100
Biophysical (Total %)
Chinchaga: 56%

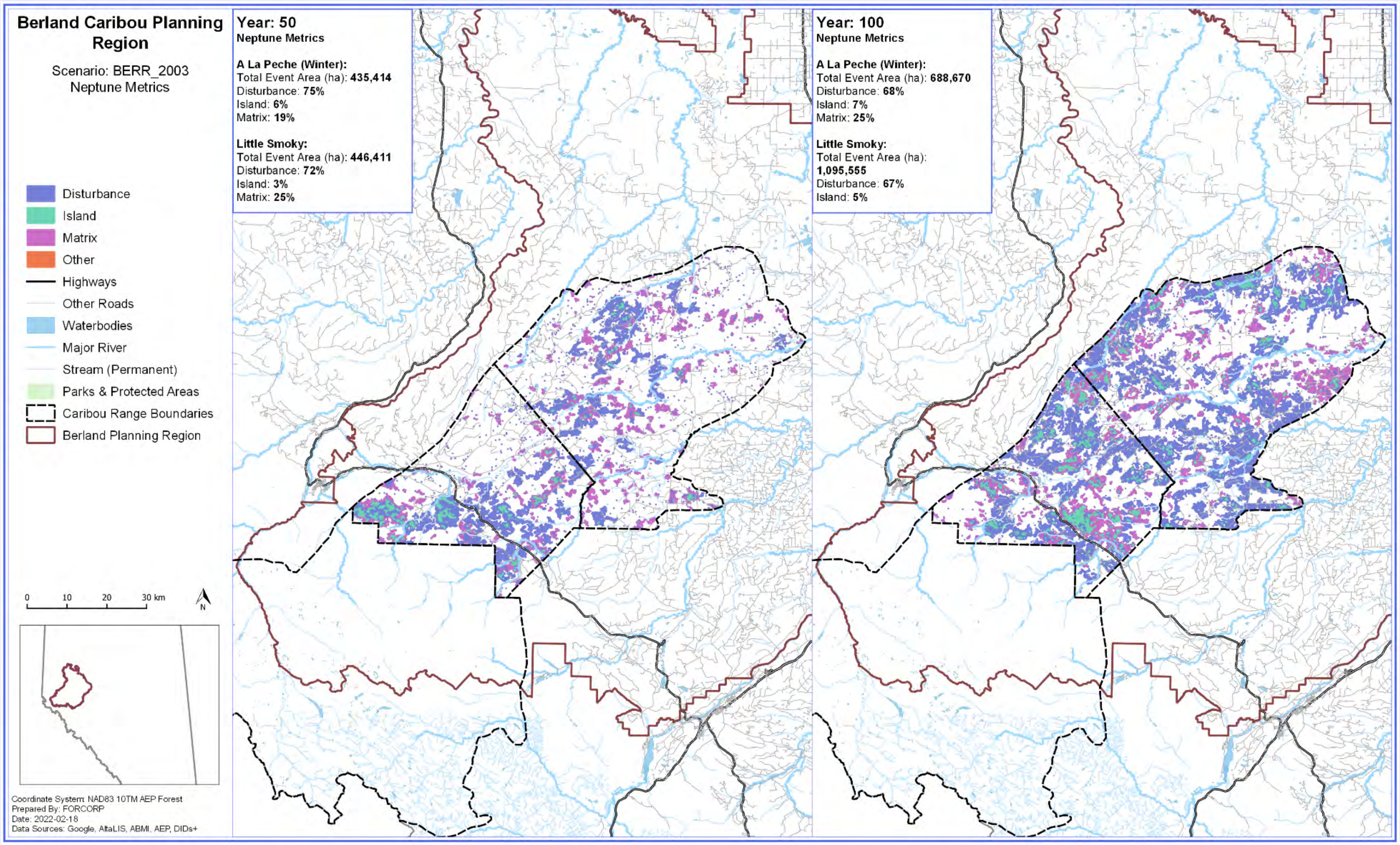

Chinchaga Caribou Planning Region
Scenario: CHINR_2008
Biophysical Habitat
Current Biophysical
Not-current Biophysical
Not-eligible Biophysical
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Caribou Range Boundaries
Chinchaga Planning Region
0 20 40 60 80 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-05-10
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 0
Biophysical (Total %)
Chinchaga: 53%
Year: 20
Biophysical (Total %)
Chinchaga: 52%
Year: 40
Biophysical (Total %)
Chinchaga: 56%
Year: 60
Biophysical (Total %)
Chinchaga: 61%
Year: 80
Biophysical (Total %)
Chinchaga: 58%
Year: 100
Biophysical (Total %)
Chinchaga: 59%


Chinchaga Caribou Planning Region
Scenario: CHINR_2009
Biophysical Habitat
Current Biophysical
Not-current Biophysical
Not-eligible Biophysical
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Caribou Range Boundaries
Chinchaga Planning Region
0 20 40 60 80 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-05-10
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 0
Biophysical (Total %)
Chinchaga: 53%
Year: 20
Biophysical (Total %)
Chinchaga: 53%
Year: 40
Biophysical (Total %)
Chinchaga: 58%
Year: 60
Biophysical (Total %)
Chinchaga: 61%
Year: 80
Biophysical (Total %)
Chinchaga: 59%
Year: 100
Biophysical (Total %)
Chinchaga: 59%

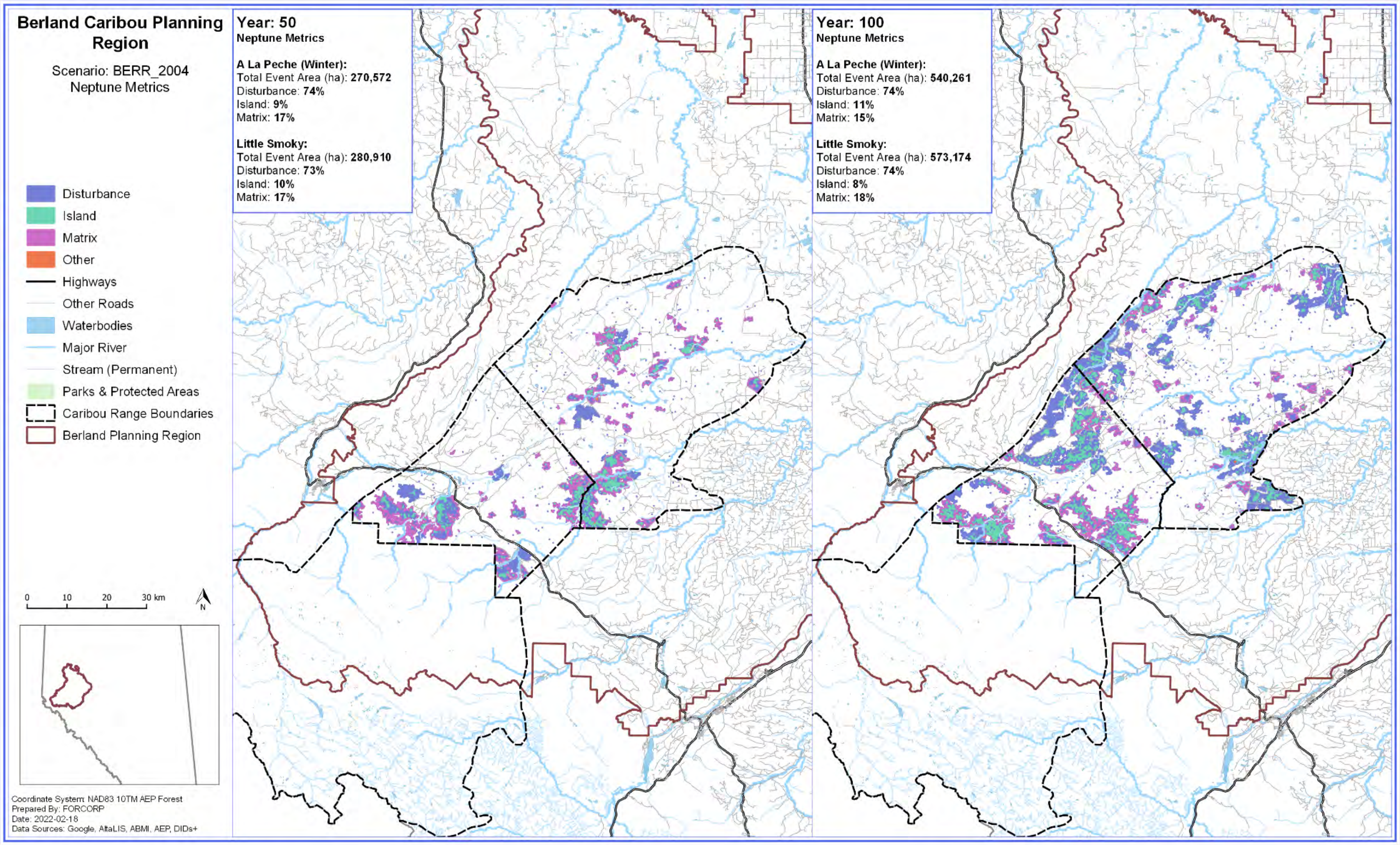
Appendix IV Neptune Metric Maps


Berland Caribou Planning Region
Scenario: BERR_2001
Neptune Metrics
Disturbance
Island
Matrix
Other
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Parks & Protected Areas
Caribou Range Boundaries
Berland Planning Region
0 10 20 30 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-02-18
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 50
Neptune Metrics
A La Peche (Winter):
Total Event Area (ha): 670,659
Disturbance: 63%
Island: 4%
Matrix: 33%
Little Smoky:
Total Event Area (ha): 1,110,058
Disturbance: 60%
Island: 2%
Matrix: 38%
Year: 100
Neptune Metrics
A La Peche (Winter):
Total Event Area (ha): 834,584
Disturbance: 62%
Island: 4%
Matrix: 34%
Little Smoky:
Total Event Area (ha): 1,048,809
Disturbance: 61%
Island: 2%
Matrix: 37%

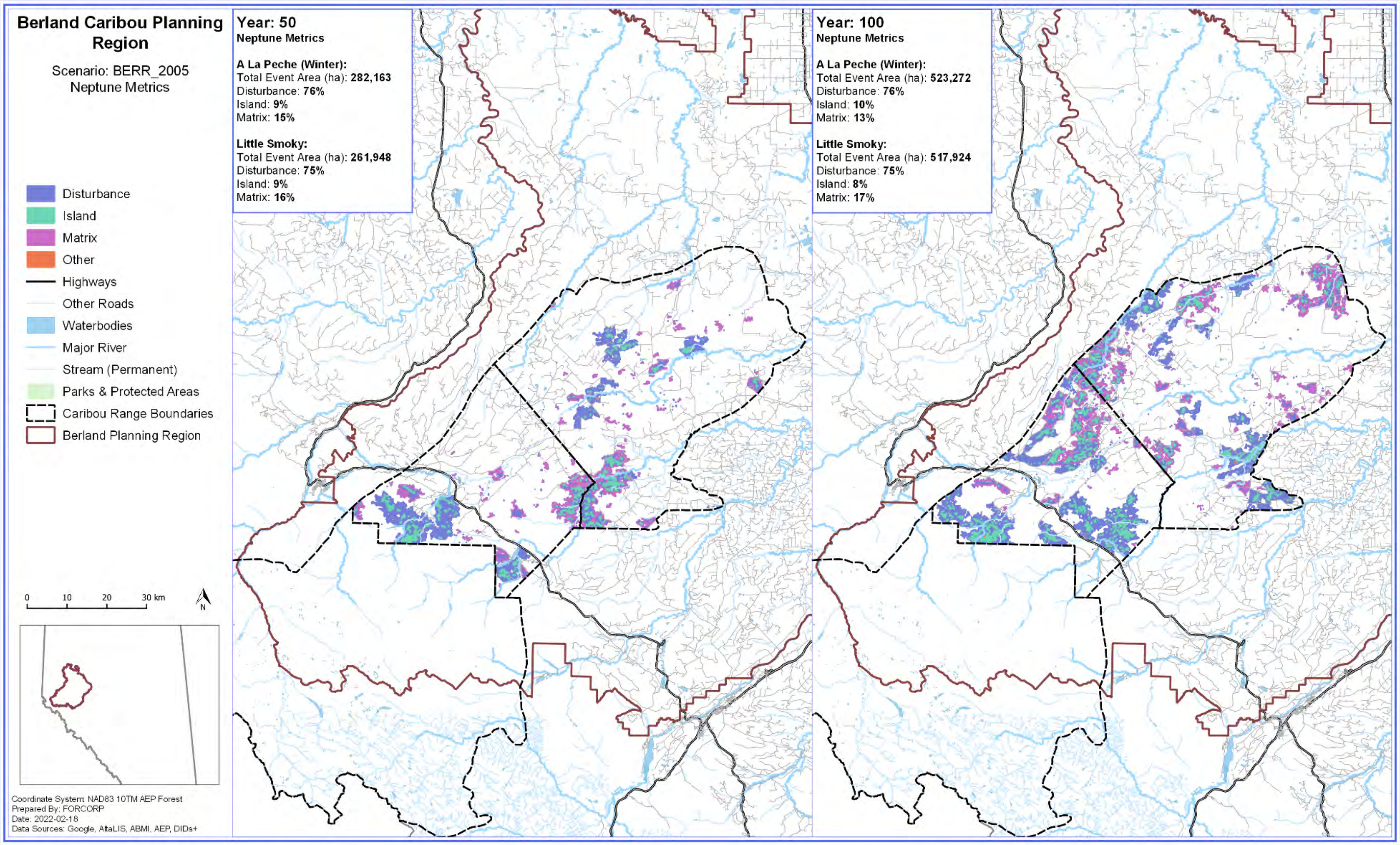

Berland Caribou Planning Region
Scenario: BERR_2002
Neptune Metrics
Disturbance
Island
Matrix
Other
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Parks & Protected Areas
Caribou Range Boundaries
Berland Planning Region
0 10 20 30 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-02-28
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 50
Neptune Metrics
A La Peche (Winter):
Total Event Area (ha): 695,315
Disturbance: 62%
Island: 3%
Matrix: 35%
Little Smoky:
Total Event Area (ha): 1,114,419
Disturbance: 60%
Island: 2%
Matrix: 38%
Year: 100
Neptune Metrics
A La Peche (Winter):
Total Event Area (ha): 817,817
Disturbance: 62%
Island: 4%
Matrix: 35%
Little Smoky:
Total Event Area (ha): 1,027,751
Disturbance: 61%
Island: 2%
Matrix: 37%

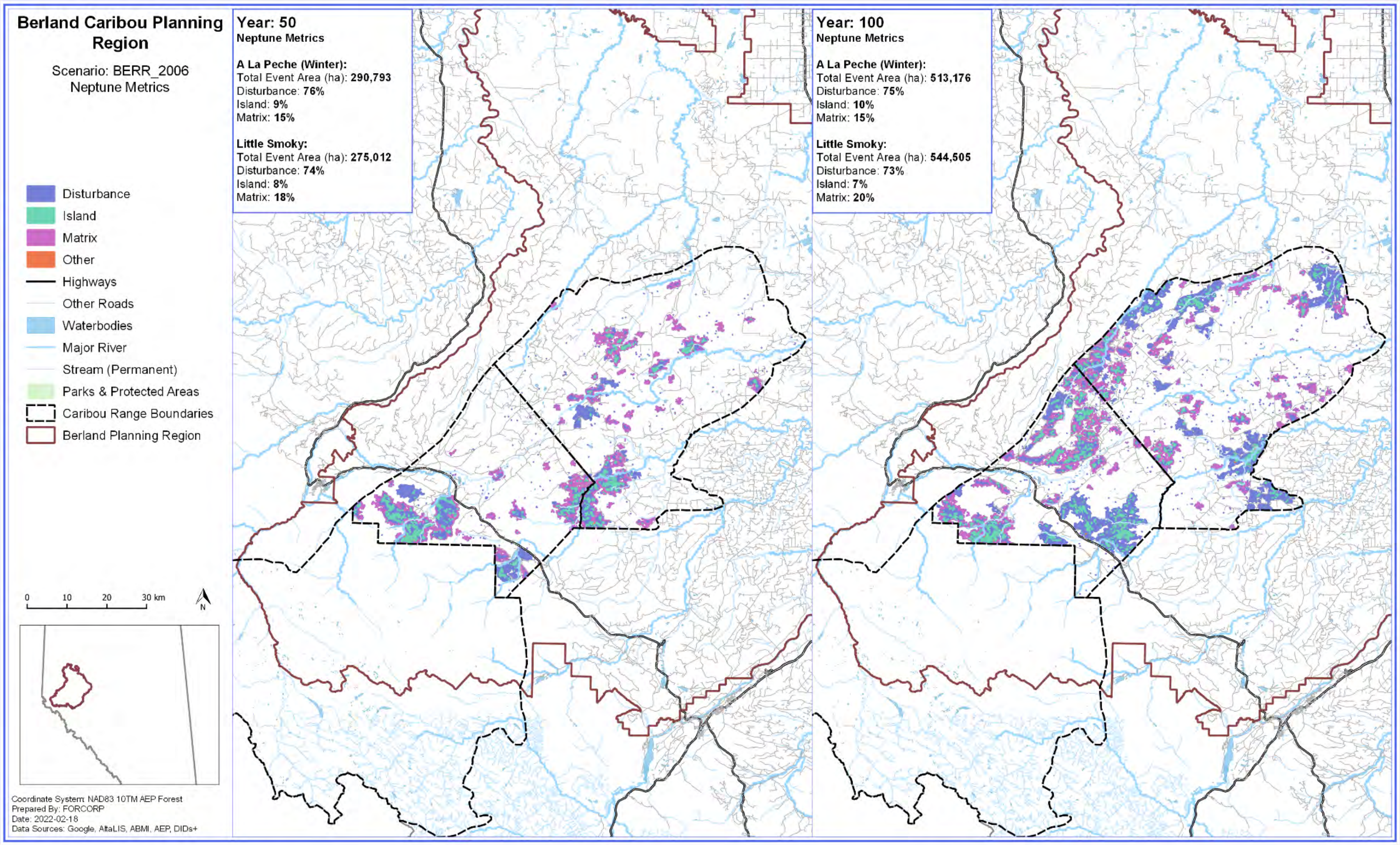


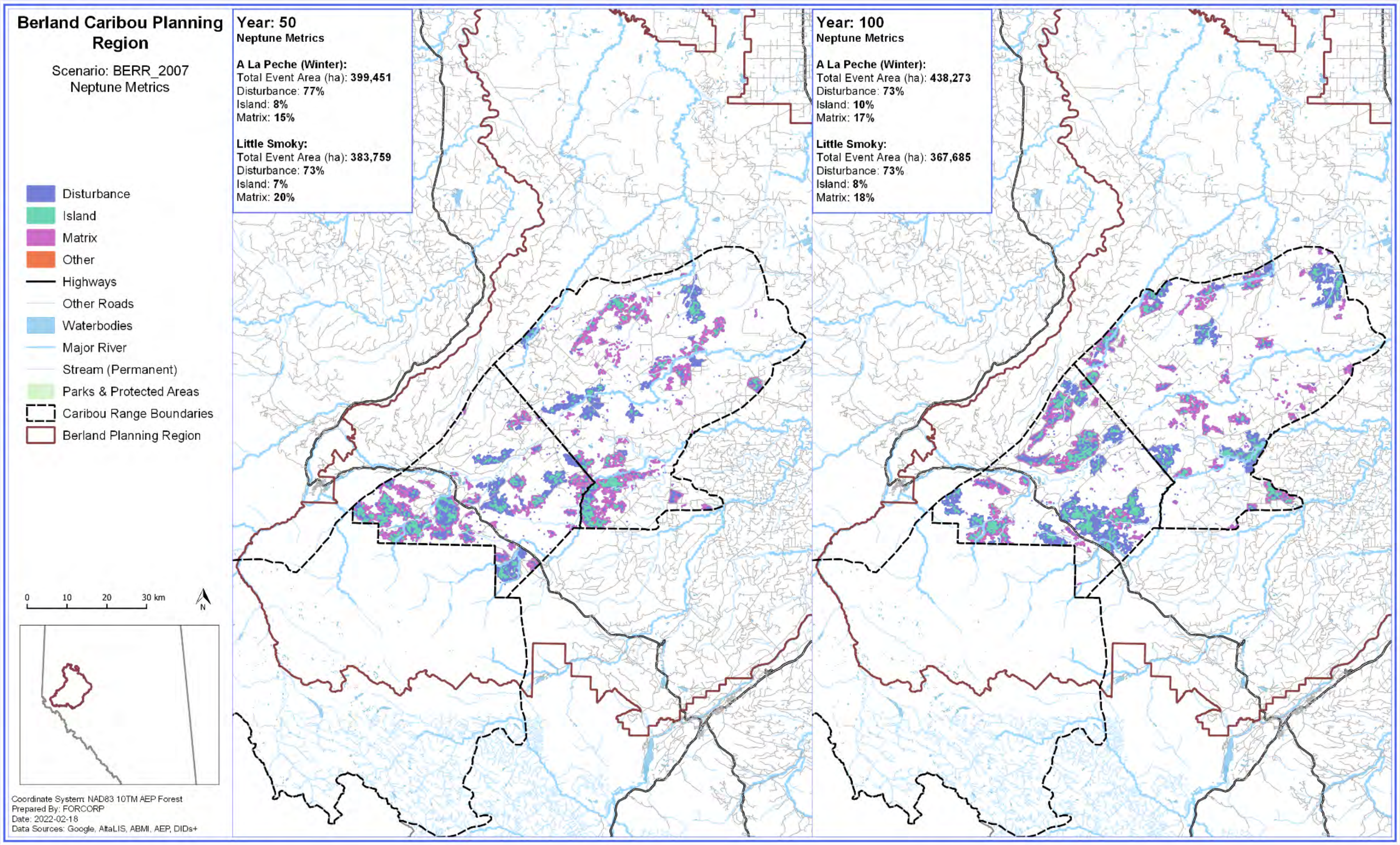
Berland Caribou Planning Region
Scenario: BERR_2003
Neptune Metrics
Disturbance
Island
Matrix
Other
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Parks & Protected Areas
Caribou Range Boundaries
Berland Planning Region
0 10 20 30 km
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-02-18
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 50
Neptune Metrics
A La Peche (Winter):
Total Event Area (ha): 435,414
Disturbance: 75%
Island: 6%
Matrix: 19%
Little Smoky:
Total Event Area (ha): 446,411
Disturbance: 72%
Island: 3%
Matrix: 25%
Year: 100
Neptune Metrics
A La Peche (Winter):
Total Event Area (ha): 688,670
Disturbance: 68%
Island: 7%
Matrix: 25%
Little Smoky:
Total Event Area (ha):
1,095,555
Disturbance: 67%
Island: 5%



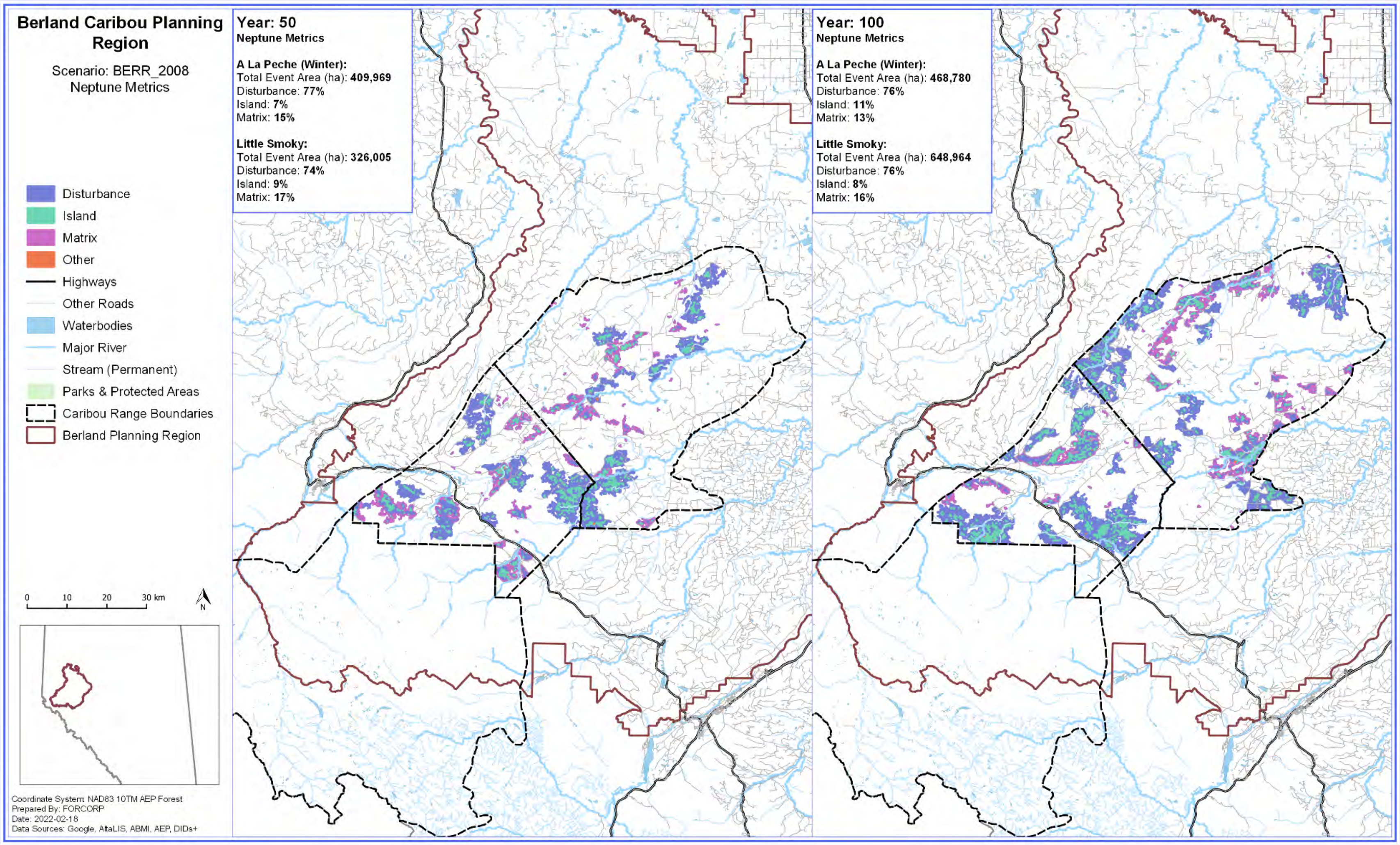
Berland Caribou Planning Region
Scenario: BERR_2004
Neptune Metrics
Disturbance
Island
Matrix
Other
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Parks & Protected Areas
Caribou Range Boundaries
Berland Planning Region
0 10 20 30 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-02-18
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 50
Neptune Metrics
A La Peche (Winter):
Total Event Area (ha): 270,572
Disturbance: 74%
Island: 9%
Matrix: 17%
Little Smoky:
Total Event Area (ha): 280,910
Disturbance: 73%
Island: 10%
Matrix: 17%
Year: 100
Neptune Metrics
A La Peche (Winter):
Total Event Area (ha): 540,261
Disturbance: 74%
Island: 11%
Matrix: 15%
Little Smoky:
Total Event Area (ha): 573,174
Disturbance: 74%
Island: 8%
Matrix: 18%

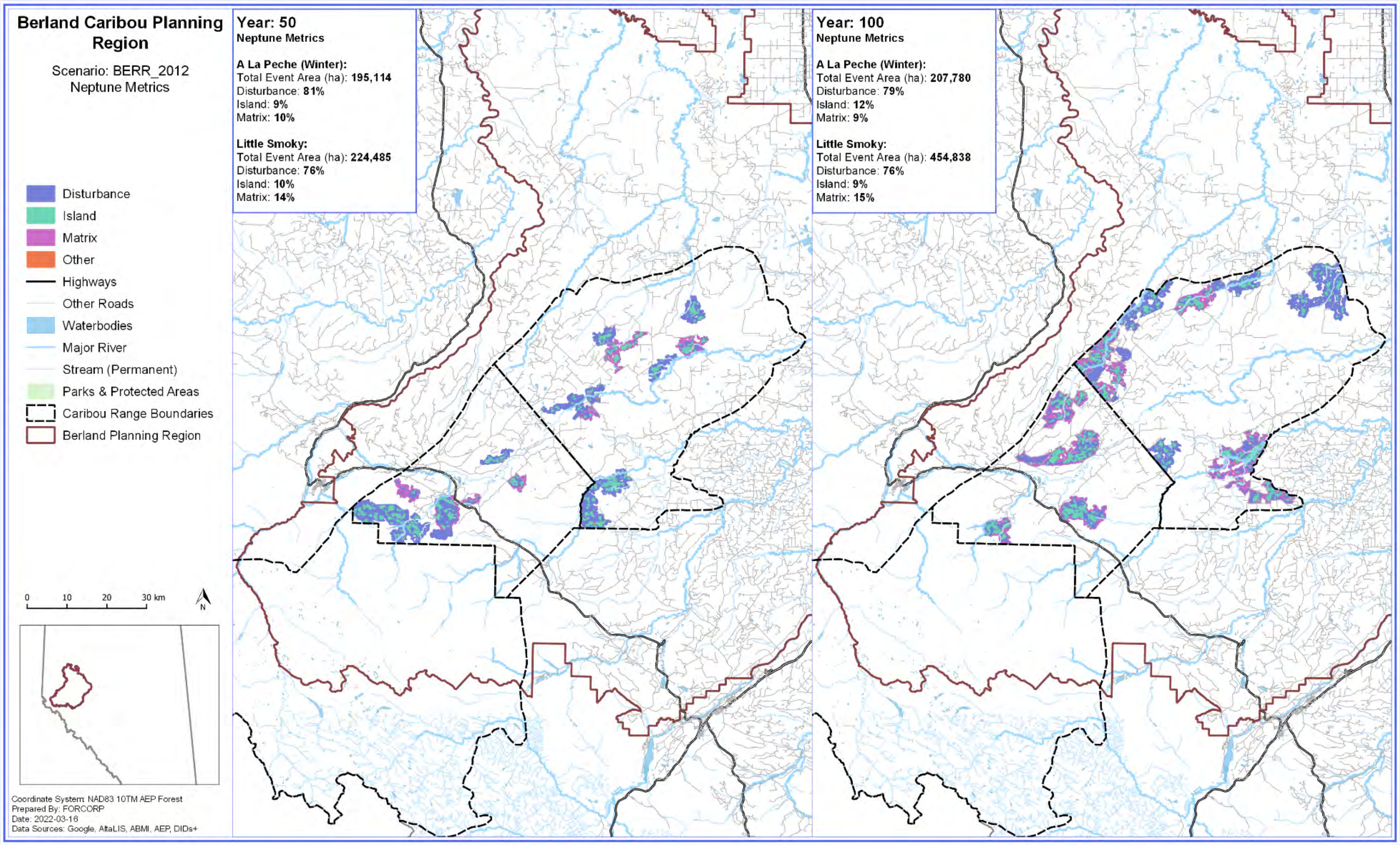

Berland Caribou Planning Region
Scenario: BERR_2005
Neptune Metrics
Disturbance
Island
Matrix
Other
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Parks & Protected Areas
Caribou Range Boundaries
Berland Planning Region
0 10 20 30 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-02-18
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 50
Neptune Metrics
A La Peche (Winter):
Total Event Area (ha): 282,163
Disturbance: 76%
Island: 9%
Matrix: 15%
Little Smoky:
Total Event Area (ha): 261,948
Disturbance: 75%
Island: 9%
Matrix: 16%
Year: 100
Neptune Metrics
A La Peche (Winter):
Total Event Area (ha): 523,272
Disturbance: 76%
Island: 10%
Matrix: 13%
Little Smoky:
Total Event Area (ha): 517,924
Disturbance: 75%
Island: 8%
Matrix: 17%


Berland Caribou Planning Region
Scenario: BERR_2006
Neptune Metrics
Disturbance
Island
Matrix
Other
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Parks & Protected Areas
Caribou Range Boundaries
Berland Planning Region
0 10 20 30 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-02-18
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 50
Neptune Metrics
A La Peche (Winter):
Total Event Area (ha): 290,793
Disturbance: 76%
Island: 9%
Matrix: 15%
Little Smoky:
Total Event Area (ha): 275,012
Disturbance: 74%
Island: 8%
Matrix: 18%
Year: 100
Neptune Metrics
A La Peche (Winter):
Total Event Area (ha): 513,176
Disturbance: 75%
Island: 10%
Matrix: 15%
Little Smoky:
Total Event Area (ha): 544,505
Disturbance: 73%
Island: 7%
Matrix: 20%

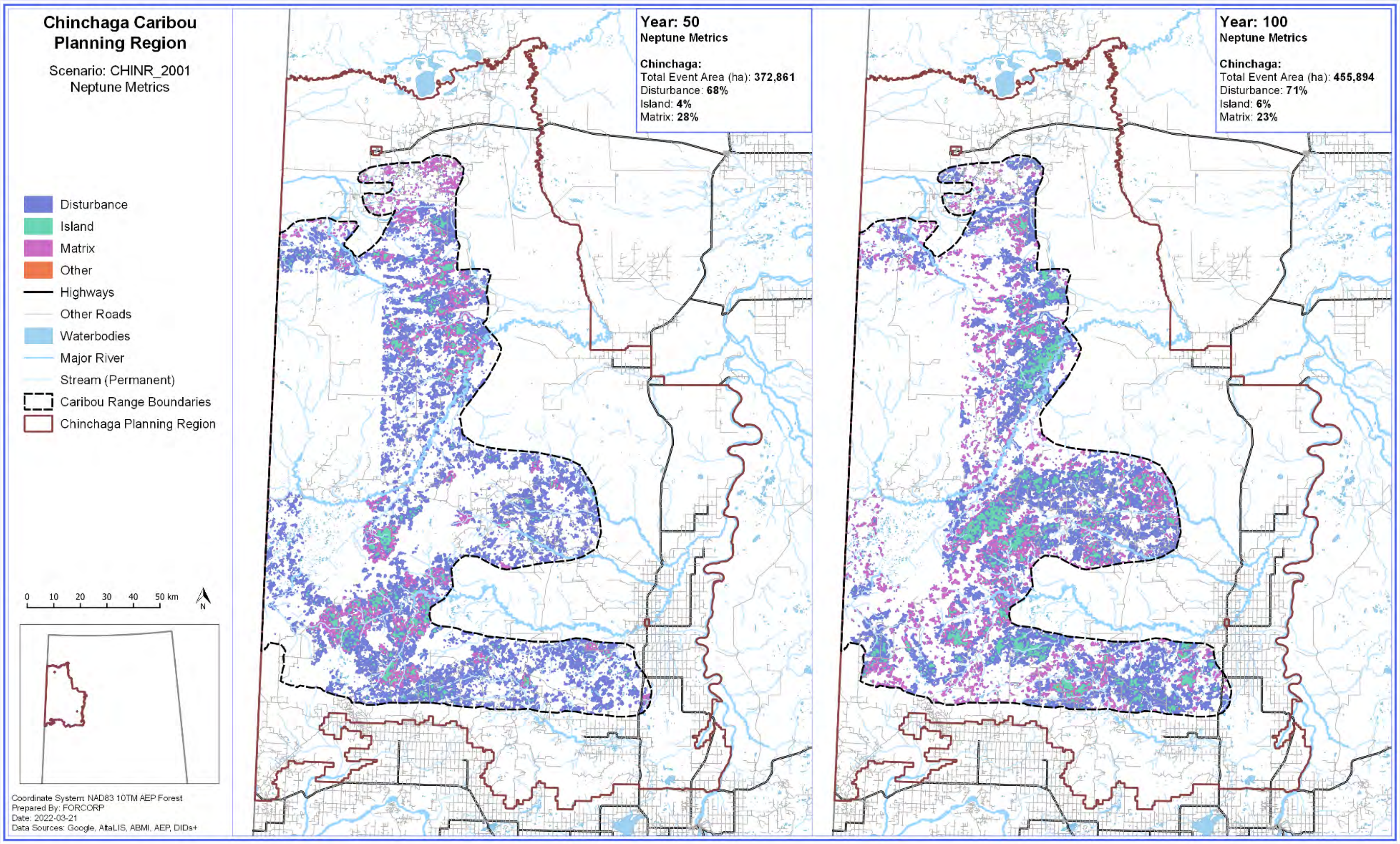


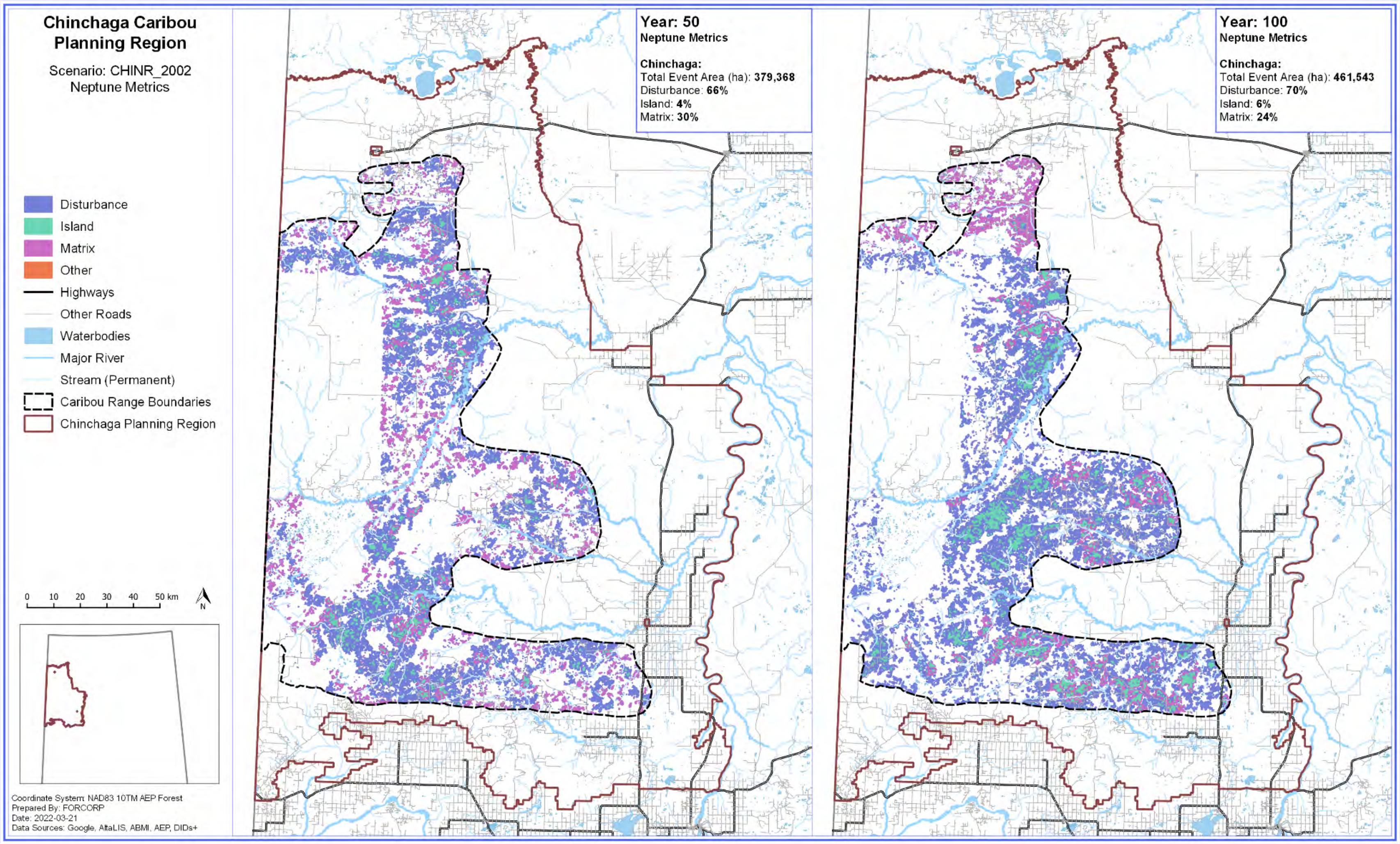
Berland Caribou Planning Region
Scenario: BERR_2007
Neptune Metrics
Disturbance
Island
Matrix
Other
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Parks & Protected Areas
Caribou Range Boundaries
Berland Planning Region
0 10 20 30 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-02-18
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 50
Neptune Metrics
A La Peche (Winter):
Total Event Area (ha): 399,451
Disturbance: 77%
Island: 8%
Matrix: 15%
Little Smoky:
Total Event Area (ha): 383,759
Disturbance: 73%
Island: 7%
Matrix: 20%
Year: 100
Neptune Metrics
A La Peche (Winter):
Total Event Area (ha): 438,273
Disturbance: 73%
Island: 10%
Matrix: 17%
Little Smoky:
Total Event Area (ha): 367,685
Disturbance: 73%
Island: 8%
Matrix: 18%

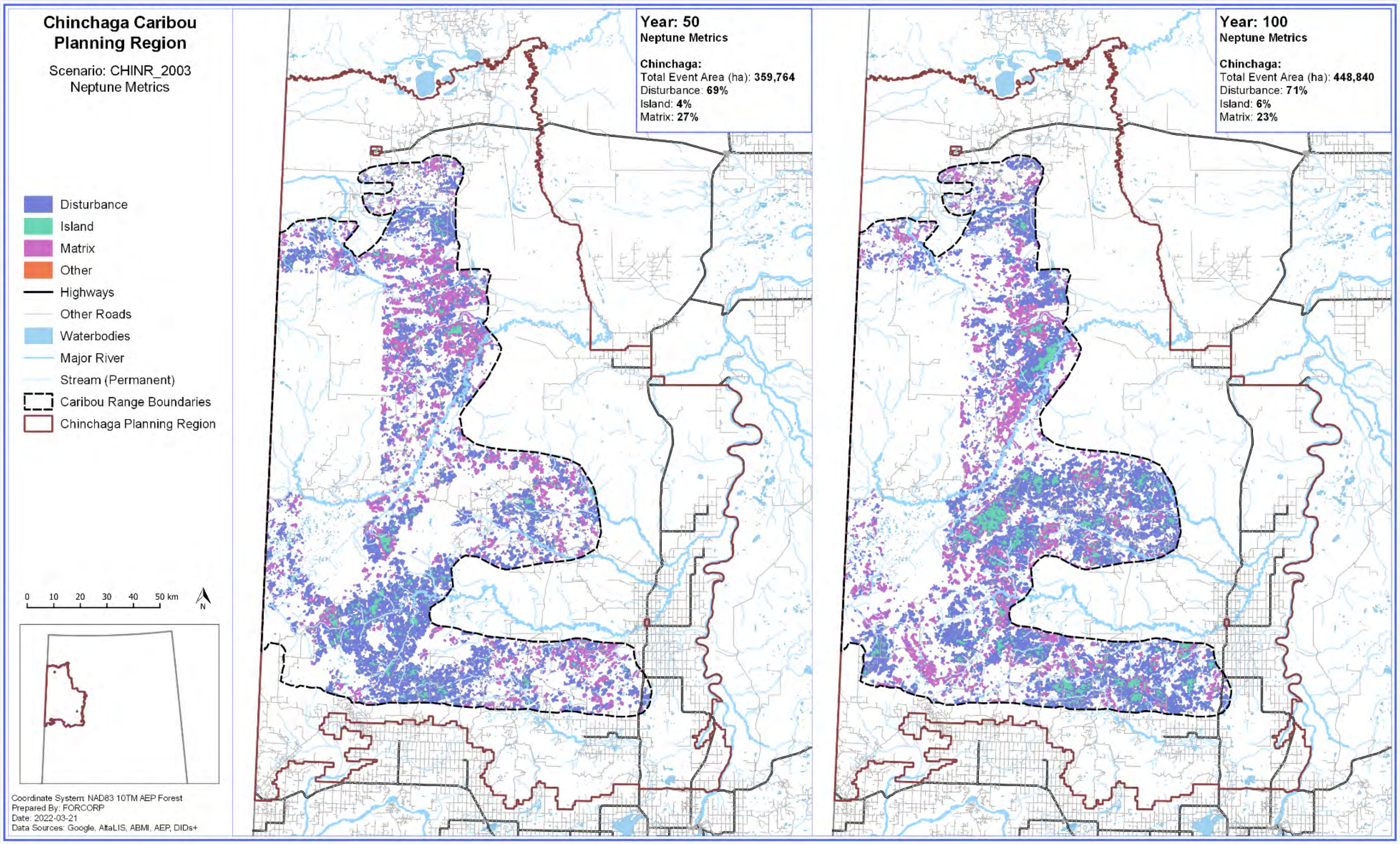

Berland Caribou Planning Region
Scenario: BERR_2008
Neptune Metrics
Disturbance
Island
Matrix
Other
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Parks & Protected Areas
Caribou Range Boundaries
Berland Planning Region
0 10 20 30 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-02-18
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 50
Neptune Metrics
A La Peche (Winter):
Total Event Area (ha): 409,969
Disturbance: 77%
Island: 7%
Matrix: 15%
Little Smoky:
Total Event Area (ha): 326,005
Disturbance: 74%
Island: 9%
Matrix: 17%
Year: 100
Neptune Metrics
A La Peche (Winter):
Total Event Area (ha): 468,780
Disturbance: 76%
Island: 11%
Matrix: 13%
Little Smoky:
Total Event Area (ha): 648,964
Disturbance: 76%
Island: 8%
Matrix: 16%



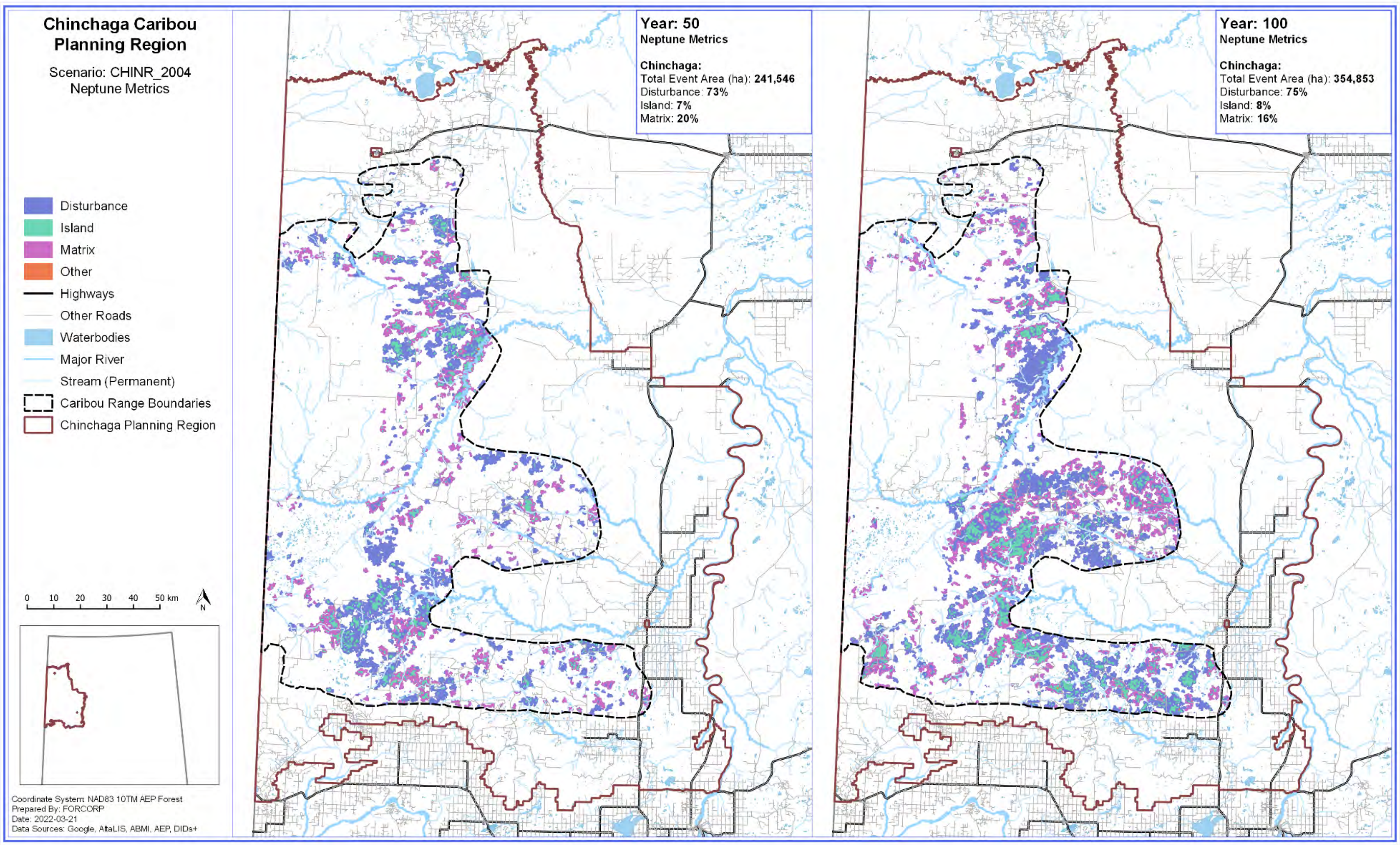
Berland Caribou Planning Region
Scenario: BERR_2012
Neptune Metrics
Disturbance
Island
Matrix
Other
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Parks & Protected Areas
Caribou Range Boundaries
Berland Planning Region
0 10 20 30 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-03-16
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 50
Neptune Metrics
A La Peche (Winter):
Total Event Area (ha): 195,114
Disturbance: 81%
Island: 9%
Matrix: 10%
Little Smoky:
Total Event Area (ha): 224,485
Disturbance: 76%
Island: 10%
Matrix: 14%
Year: 100
Neptune Metrics
A La Peche (Winter):
Total Event Area (ha): 207,780
Disturbance: 79%
Island: 12%
Matrix: 9%
Little Smoky:
Total Event Area (ha): 454,838
Disturbance: 76%
Island: 9%
Matrix: 15%


Chinchaga Caribou Planning Region
Scenario: CHINR_2001
Neptune Metrics
Disturbance
Island
Matrix
Other
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Caribou Range Boundaries
Chinchaga Planning Region
0 10 20 30 40 50 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-03-21
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 50
Neptune Metrics
Chinchaga:
Total Event Area (ha): 372,861
Disturbance: 68%
Island: 4%
Matrix: 28%
Year: 100
Neptune Metrics
Chinchaga:
Total Event Area (ha): 455,894
Disturbance: 71%
Island: 6%
Matrix: 23%

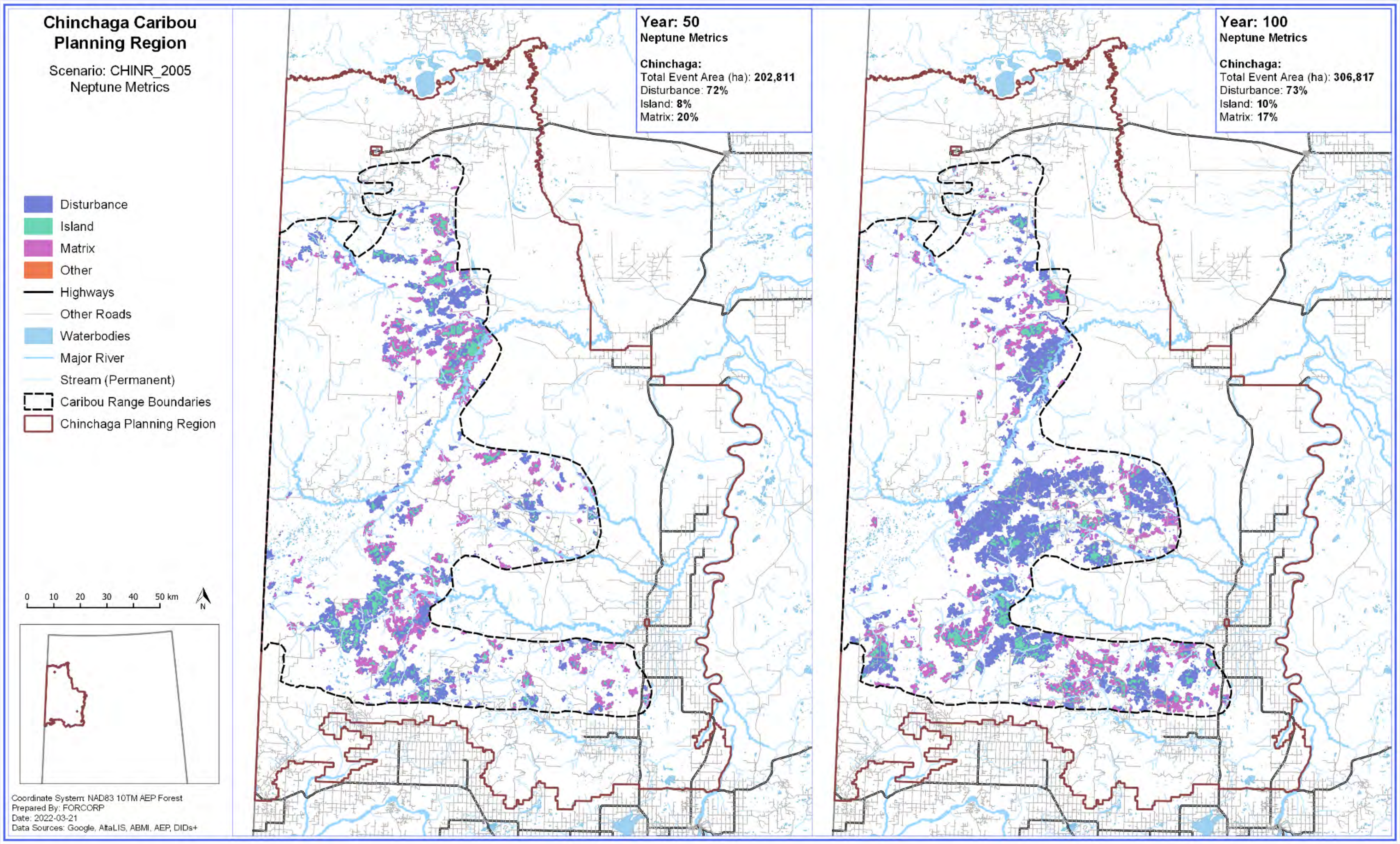

Chinchaga Caribou Planning Region
Scenario: CHINR_2002
Neptune Metrics
Disturbance
Island
Matrix
Other
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Caribou Range Boundaries
Chinchaga Planning Region
0 10 20 30 40 50 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-03-21
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 50
Neptune Metrics
Chinchaga:
Total Event Area (ha): 379,368
Disturbance: 66%
Island: 4%
Matrix: 30%
Year: 100
Neptune Metrics
Chinchaga:
Total Event Area (ha): 461,543
Disturbance: 70%
Island: 6%
Matrix: 24%

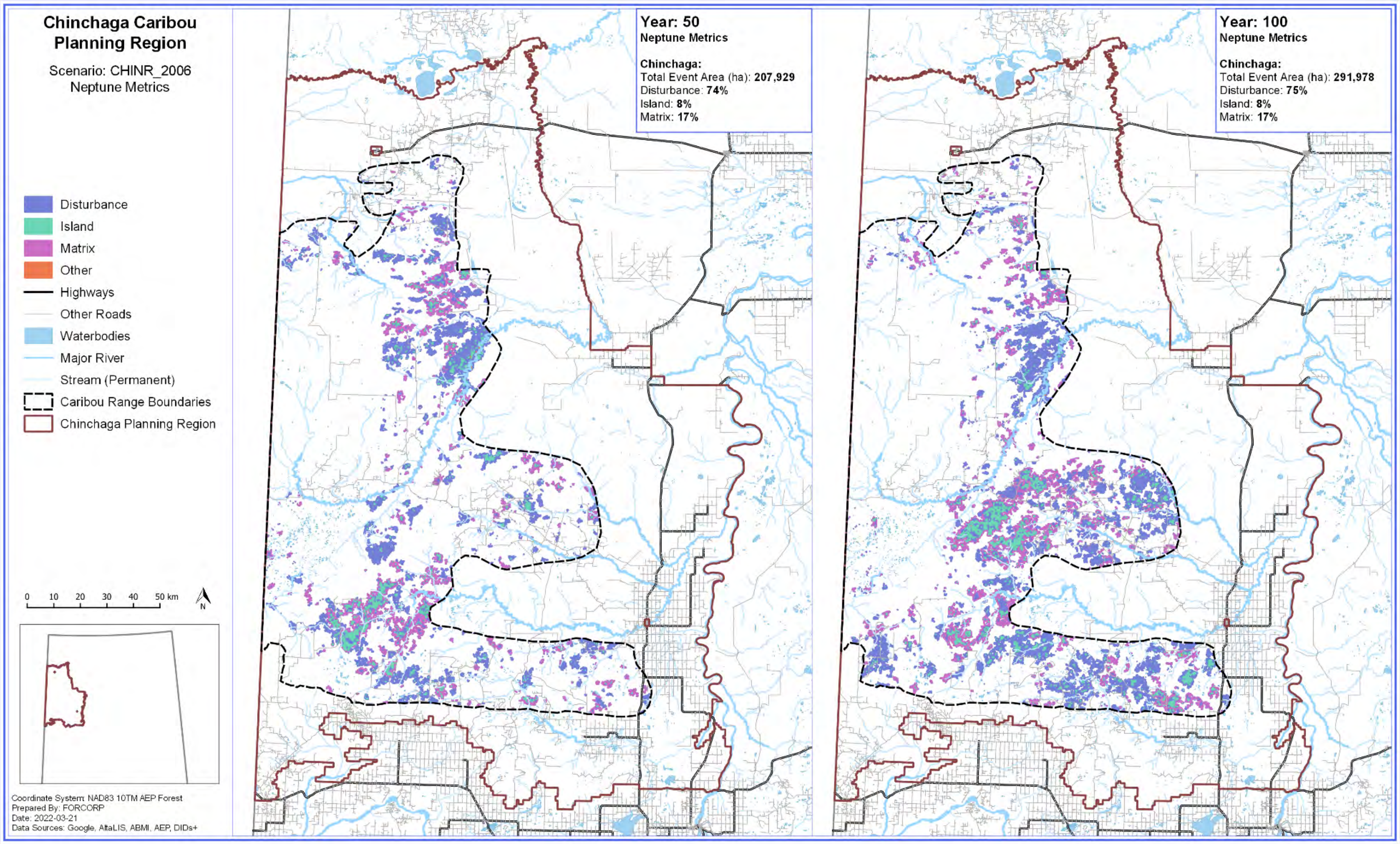


Chinchaga Caribou Planning Region
Scenario: CHINR_2003
Neptune Metrics
Disturbance
Island
Matrix
Other
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Caribou Range Boundaries
Chinchaga Planning Region
0 10 20 30 40 50 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-03-21
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 50
Neptune Metrics
Chinchaga:
Total Event Area (ha): 359,764
Disturbance: 69%
Island: 4%
Matrix: 27%
Year: 100
Neptune Metrics
Chinchaga:
Total Event Area (ha): 448,840
Disturbance: 71%
Island: 6%
Matrix: 23%

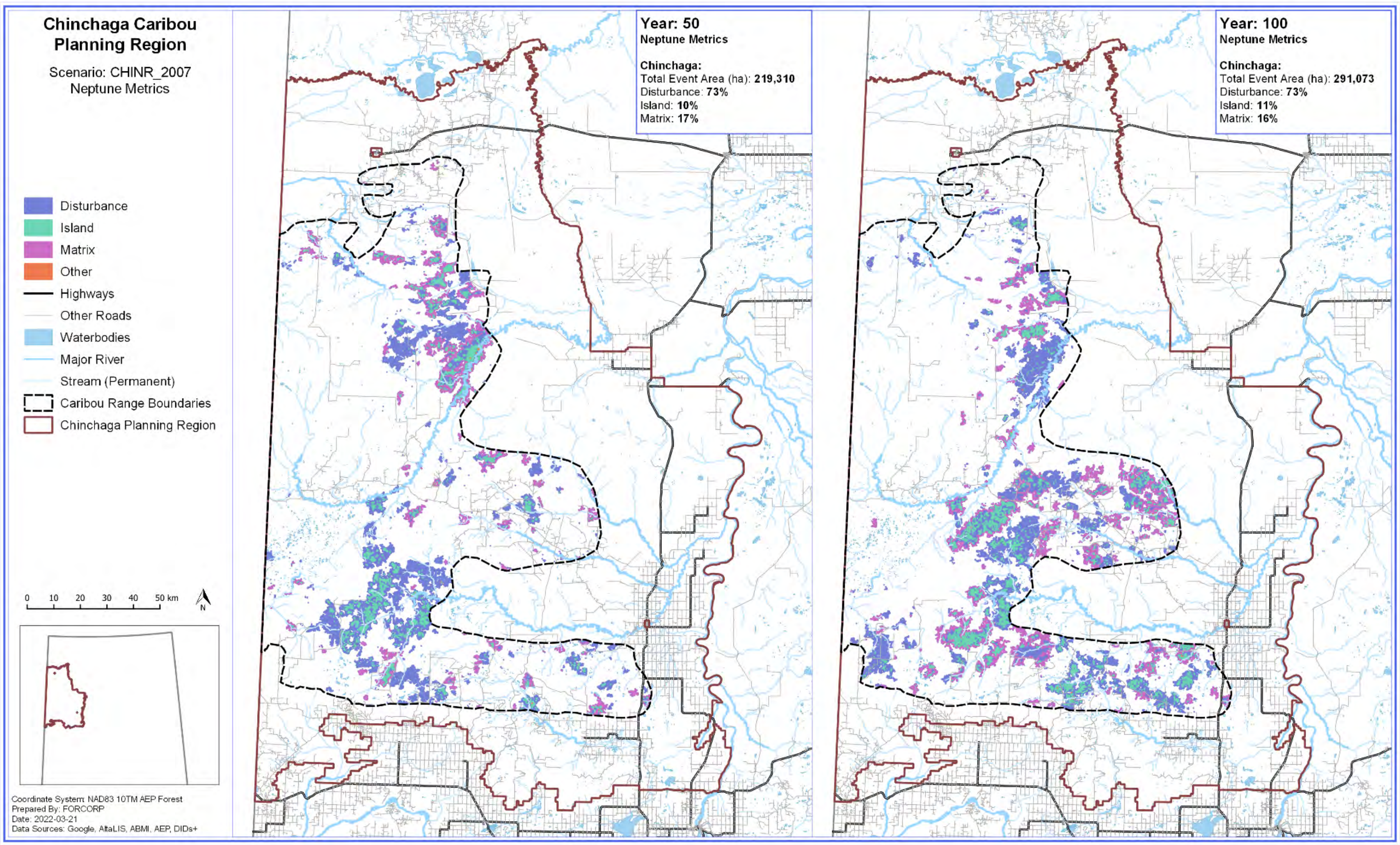


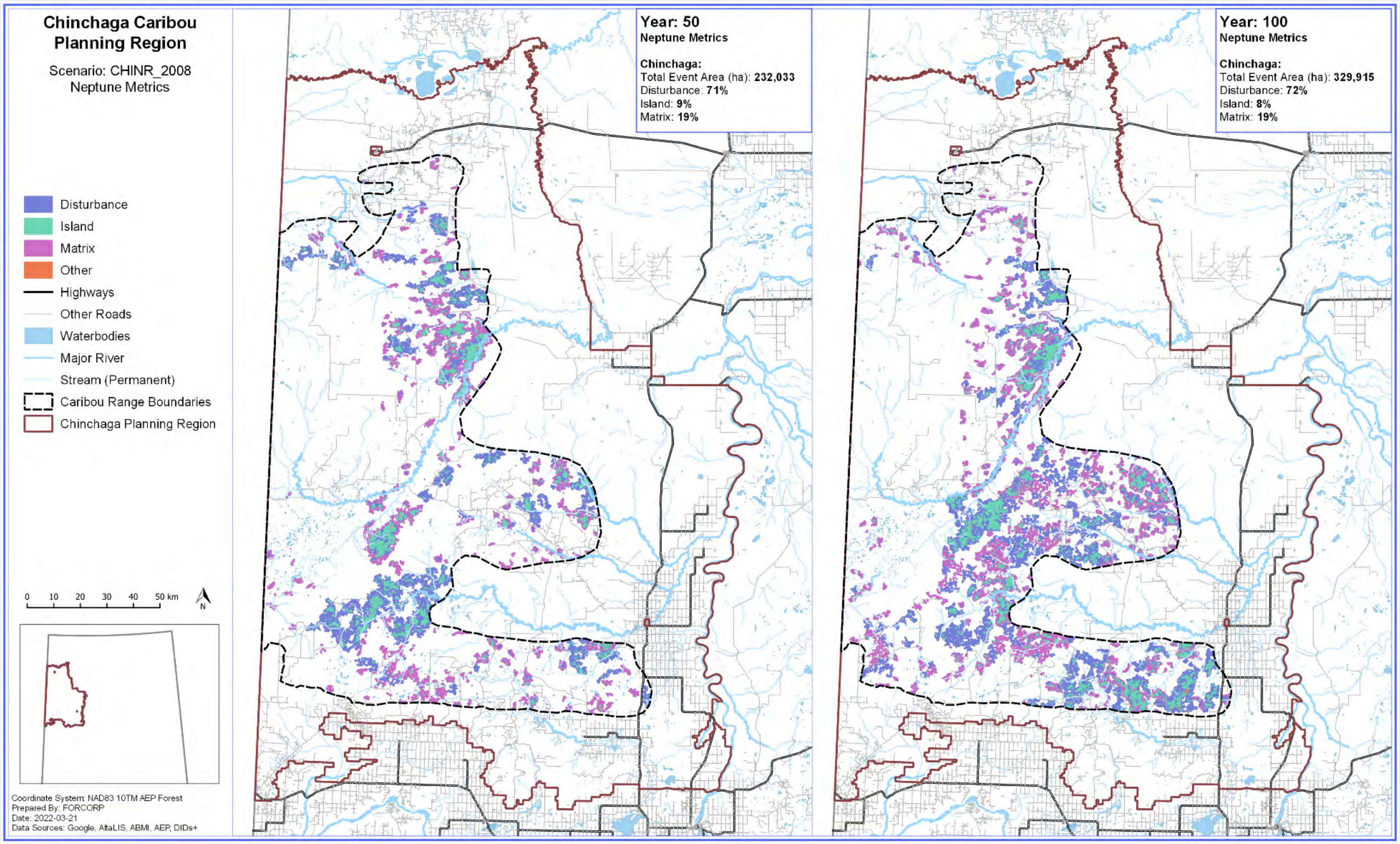
Chinchaga Caribou Planning Region
Scenario: CHINR_2004
Neptune Metrics
Disturbance
Island
Matrix
Other
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Caribou Range Boundaries
Chinchaga Planning Region
0 10 20 30 40 50 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-03-21
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 50
Neptune Metrics
Chinchaga:
Total Event Area (ha): 241,546
Disturbance: 73%
Island: 7%
Matrix: 20%
Year: 100
Neptune Metrics
Chinchaga:
Total Event Area (ha): 354,853
Disturbance: 75%
Island: 8%
Matrix: 16%

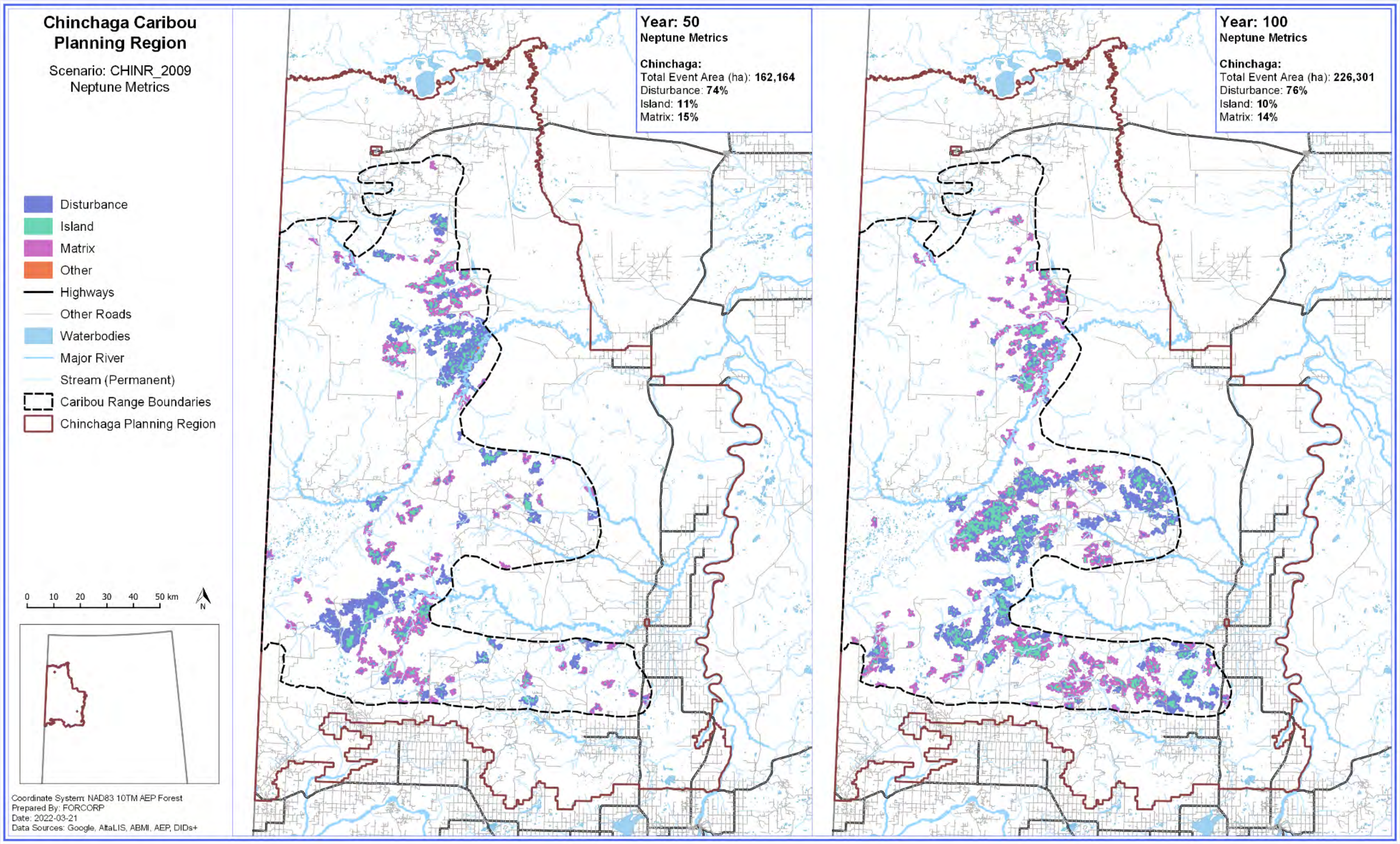

Chinchaga Caribou Planning Region
Scenario: CHINR_2005
Neptune Metrics
Disturbance
Island
Matrix
Other
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Caribou Range Boundaries
Chinchaga Planning Region
0 10 20 30 40 50 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-03-21
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 50
Neptune Metrics
Chinchaga:
Total Event Area (ha): 202,811
Disturbance: 72%
Island: 8%
Matrix: 20%
Year: 100
Neptune Metrics
Chinchaga:
Total Event Area (ha): 306,817
Disturbance: 73%
Island: 10%
Matrix: 17%



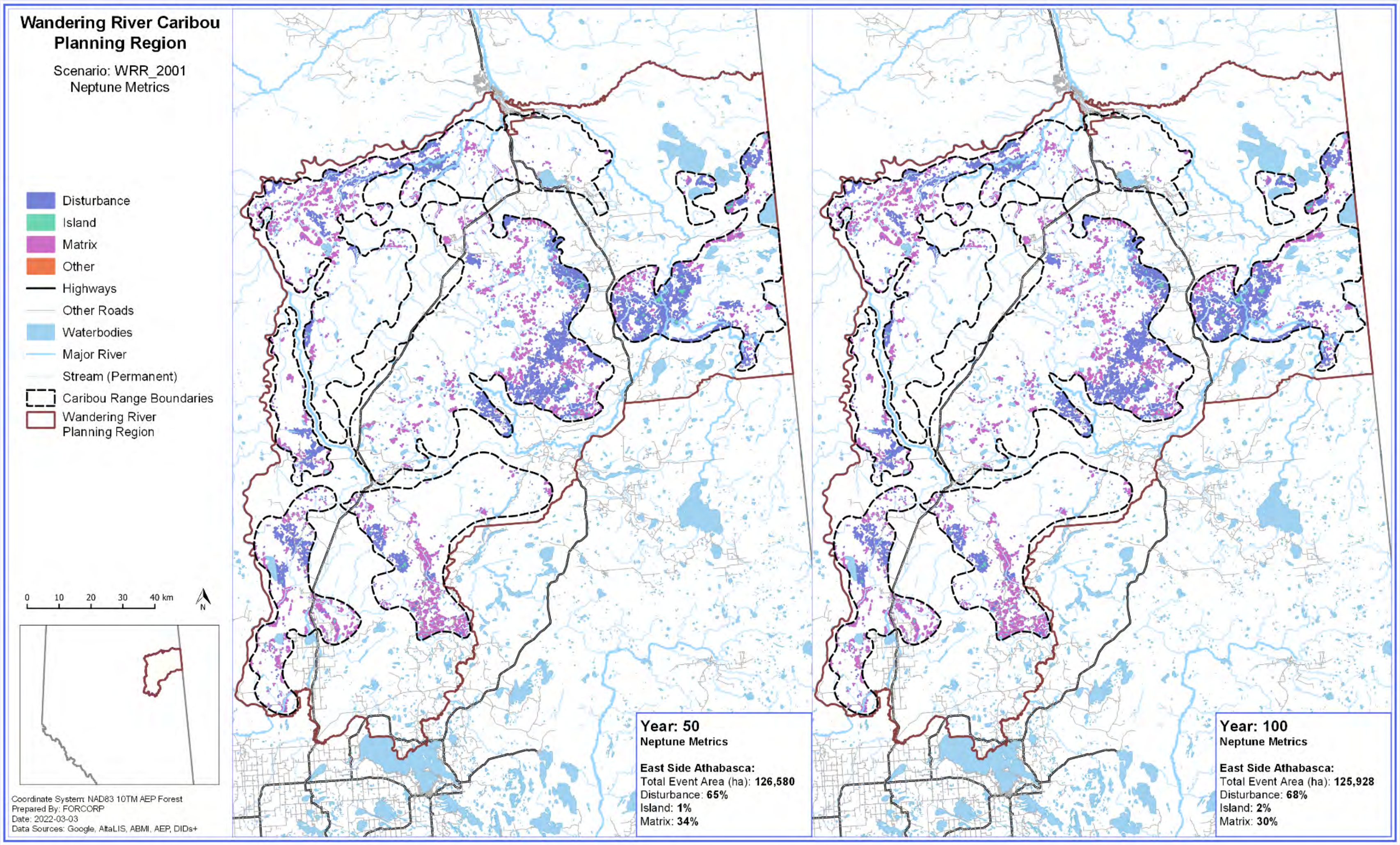
Chinchaga Caribou Planning Region
Scenario: CHINR_2006
Neptune Metrics
Disturbance
Island
Matrix
Other
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Caribou Range Boundaries
Chinchaga Planning Region
0 10 20 30 40 50 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-03-21
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 50
Neptune Metrics
Chinchaga:
Total Event Area (ha): 207,929
Disturbance: 74%
Island: 8%
Matrix: 17%
Year: 100
Neptune Metrics
Chinchaga:
Total Event Area (ha): 291,978
Disturbance: 75%
Island: 8%
Matrix: 17%


Chinchaga Caribou Planning Region
Scenario: CHINR_2007
Neptune Metrics
Disturbance
Island
Matrix
Other
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Caribou Range Boundaries
Chinchaga Planning Region
0 10 20 30 40 50 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-03-21
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 50
Neptune Metrics
Chinchaga:
Total Event Area (ha): 219,310
Disturbance: 73%
Island: 10%
Matrix: 17%
Year: 100
Neptune Metrics
Chinchaga:
Total Event Area (ha): 291,073
Disturbance: 73%
Island: 11%
Matrix: 16%

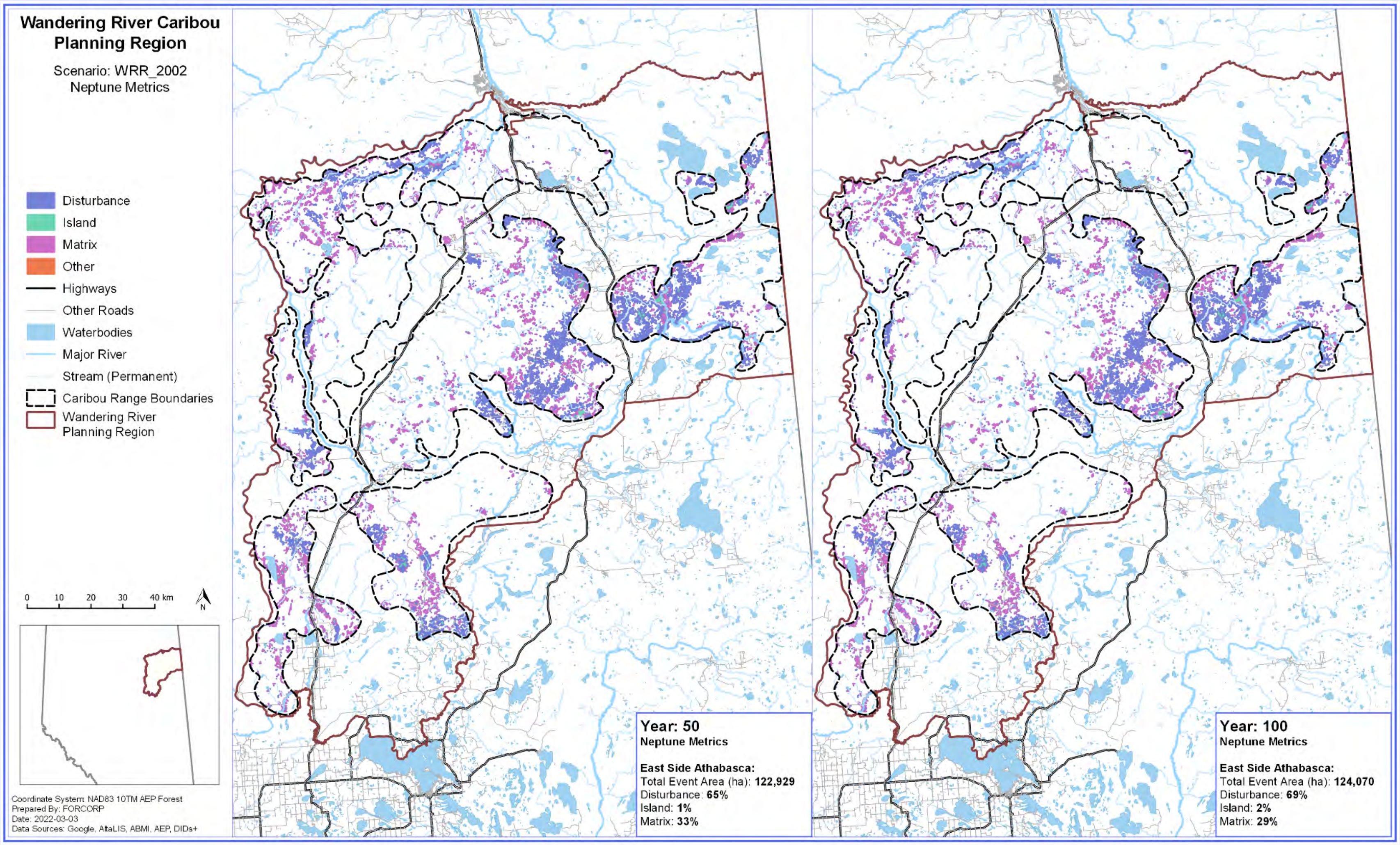

Chinchaga Caribou Planning Region
Scenario: CHINR_2008
Neptune Metrics
Disturbance
Island
Matrix
Other
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Caribou Range Boundaries
Chinchaga Planning Region
0 10 20 30 40 50 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-03-21
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 50
Neptune Metrics
Chinchaga:
Total Event Area (ha): 232,033
Disturbance: 71%
Island: 9%
Matrix: 19%
Year: 100
Neptune Metrics
Chinchaga:
Total Event Area (ha): 329,915
Disturbance: 72%
Island: 8%
Matrix: 19%

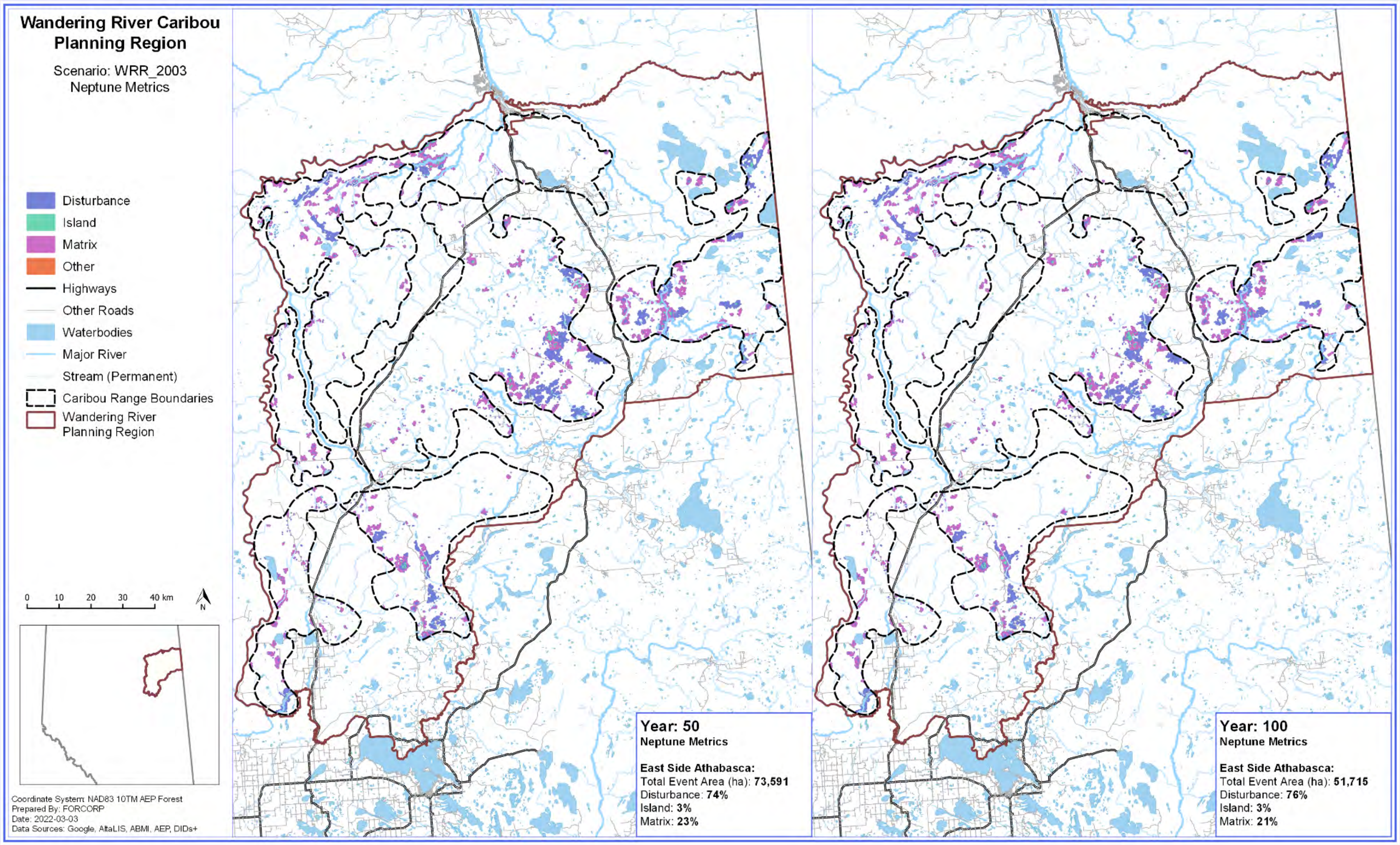


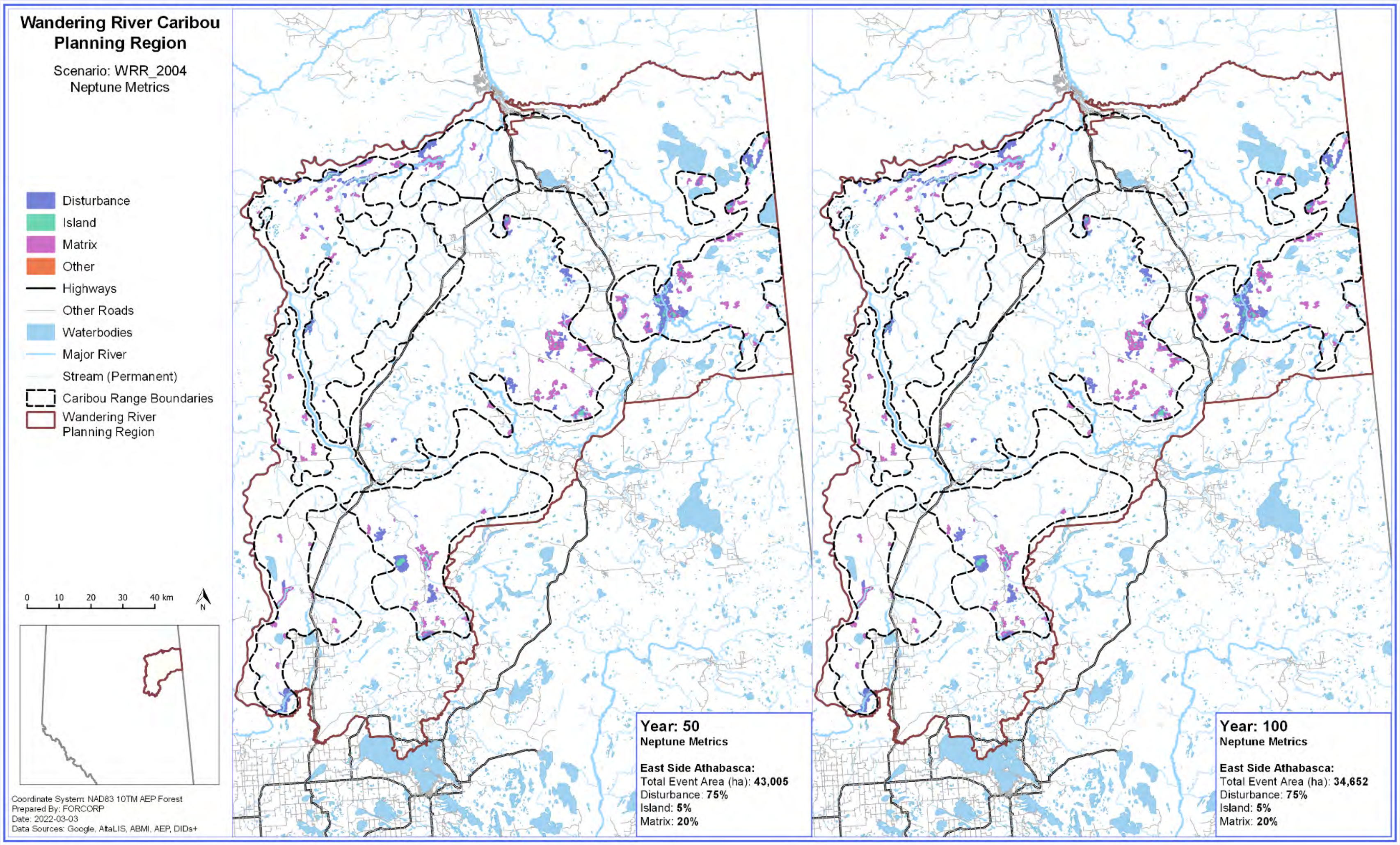
Chinchaga Caribou Planning Region
Scenario: CHINR_2009
Neptune Metrics
Disturbance
Island
Matrix
Other
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Caribou Range Boundaries
Chinchaga Planning Region
0 10 20 30 40 50 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-03-21
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 50
Neptune Metrics
Chinchaga:
Total Event Area (ha): 162,164
Disturbance: 74%
Island: 11%
Matrix: 15%
Year: 100
Neptune Metrics
Chinchaga:
Total Event Area (ha): 226,301
Disturbance: 76%
Island: 10%
Matrix: 14%



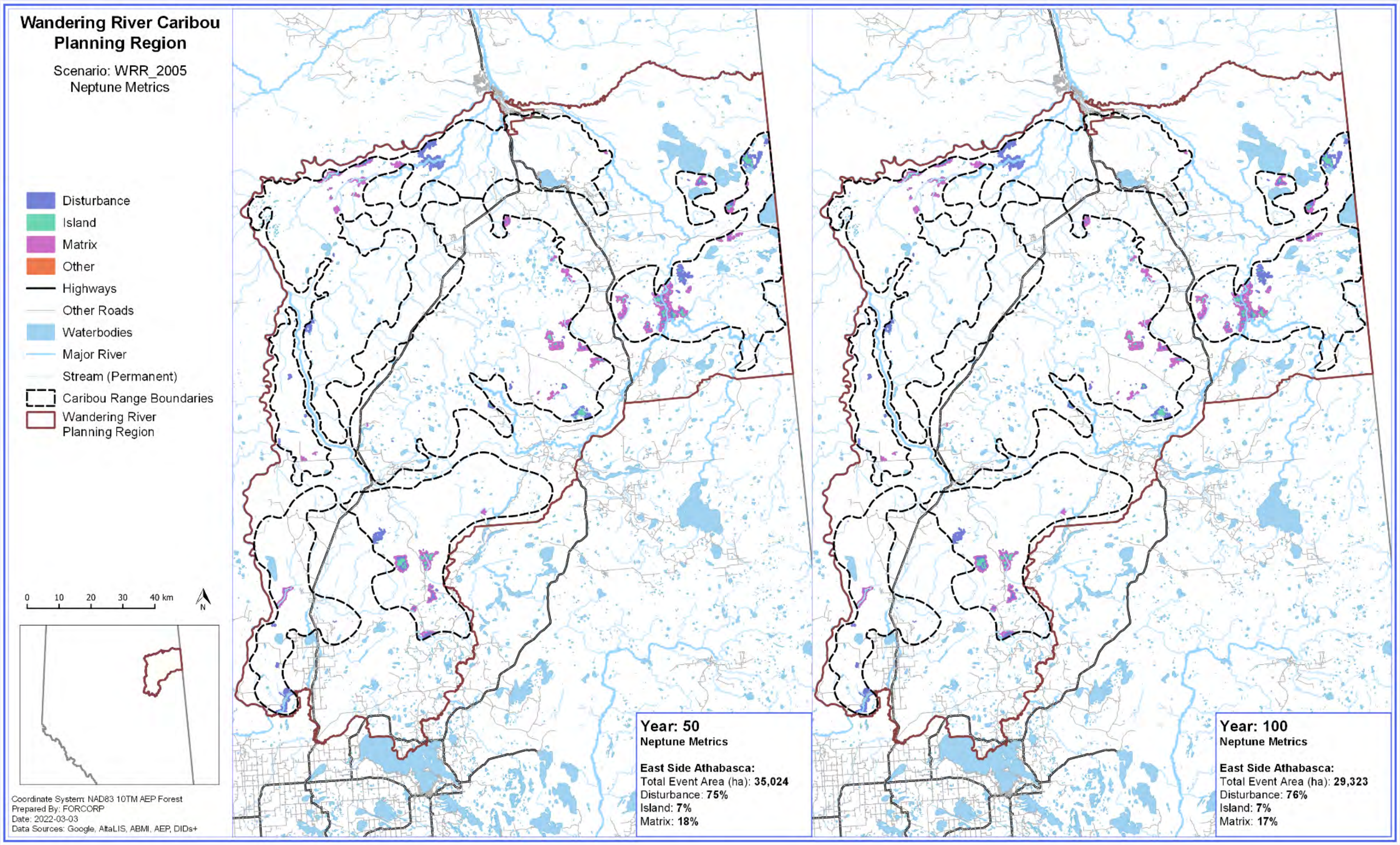
Wandering River Caribou Planning Region
Scenario: WRR_2001
Neptune Metrics
Disturbance
Island
Matrix
Other
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Caribou Range Boundaries
Wandering River Planning Region
0 10 20 30 40 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-03-03
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 50
Neptune Metrics
East Side Athabasca:
Total Event Area (ha): 126,580
Disturbance: 65%
Island: 1%
Matrix: 34%
Year: 100
Neptune Metrics
East Side Athabasca:
Total Event Area (ha): 125,928
Disturbance: 68%
Island: 2%
Matrix: 30%


Wandering River Caribou Planning Region
Scenario: WRR_2002
Neptune Metrics
Disturbance
Island
Matrix
Other
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Caribou Range Boundaries
Wandering River Planning Region
0 10 20 30 40 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-03-03
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 50
Neptune Metrics
East Side Athabasca:
Total Event Area (ha): 122,929
Disturbance: 65%
Island: 1%
Matrix: 33%
Year: 100
Neptune Metrics
East Side Athabasca:
Total Event Area (ha): 124,070
Disturbance: 69%
Island: 2%
Matrix: 29%

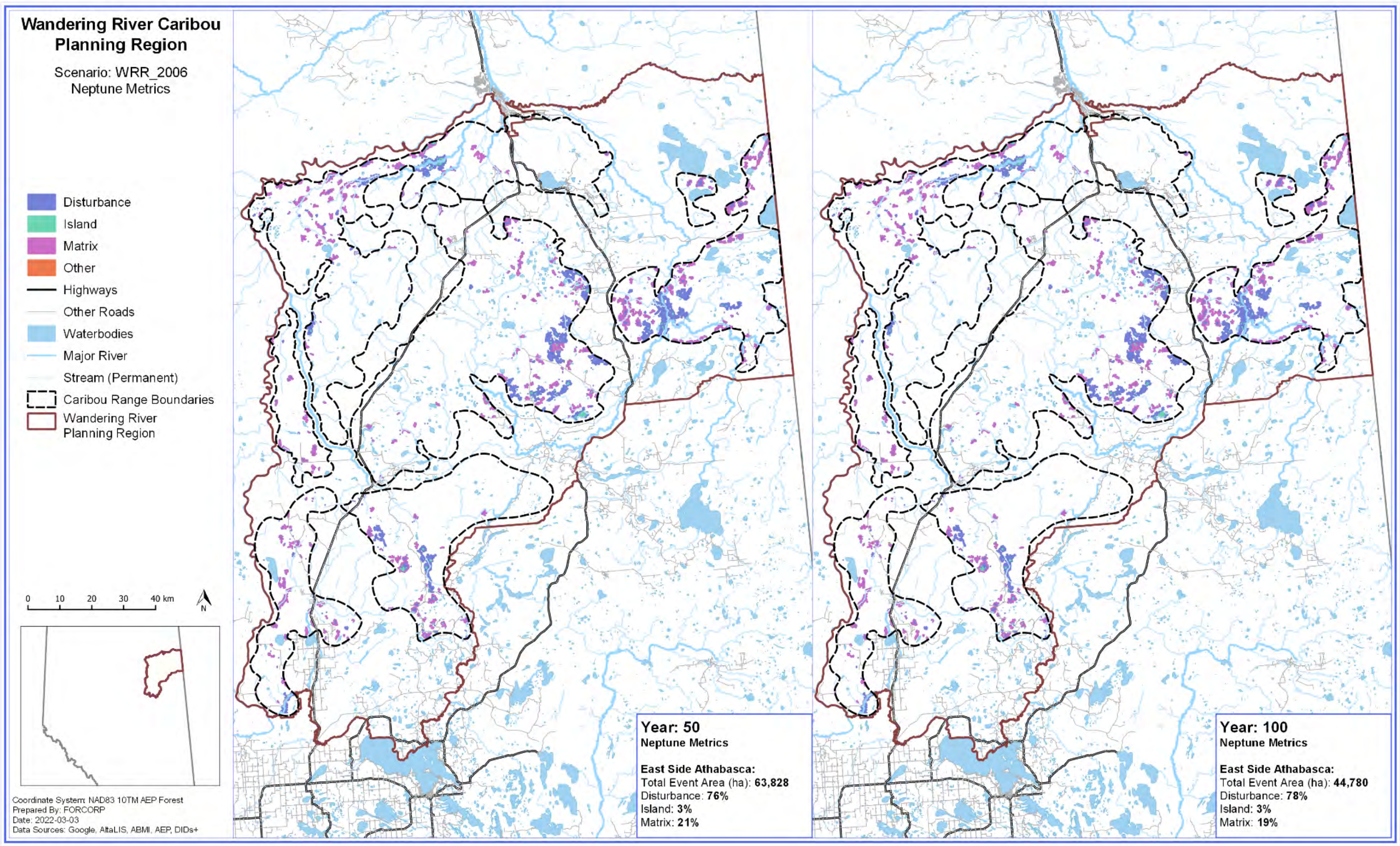

Wandering River Caribou Planning Region
Scenario: WRR_2003
Neptune Metrics
Disturbance
Island
Matrix
Other
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Caribou Range Boundaries
Wandering River Planning Region
0 10 20 30 40 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-03-03
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 50
Neptune Metrics
East Side Athabasca:
Total Event Area (ha): 73,591
Disturbance: 74%
Island: 3%
Matrix: 23%
Year: 100
Neptune Metrics
East Side Athabasca:
Total Event Area (ha): 51,715
Disturbance: 76%
Island: 3%
Matrix: 21%



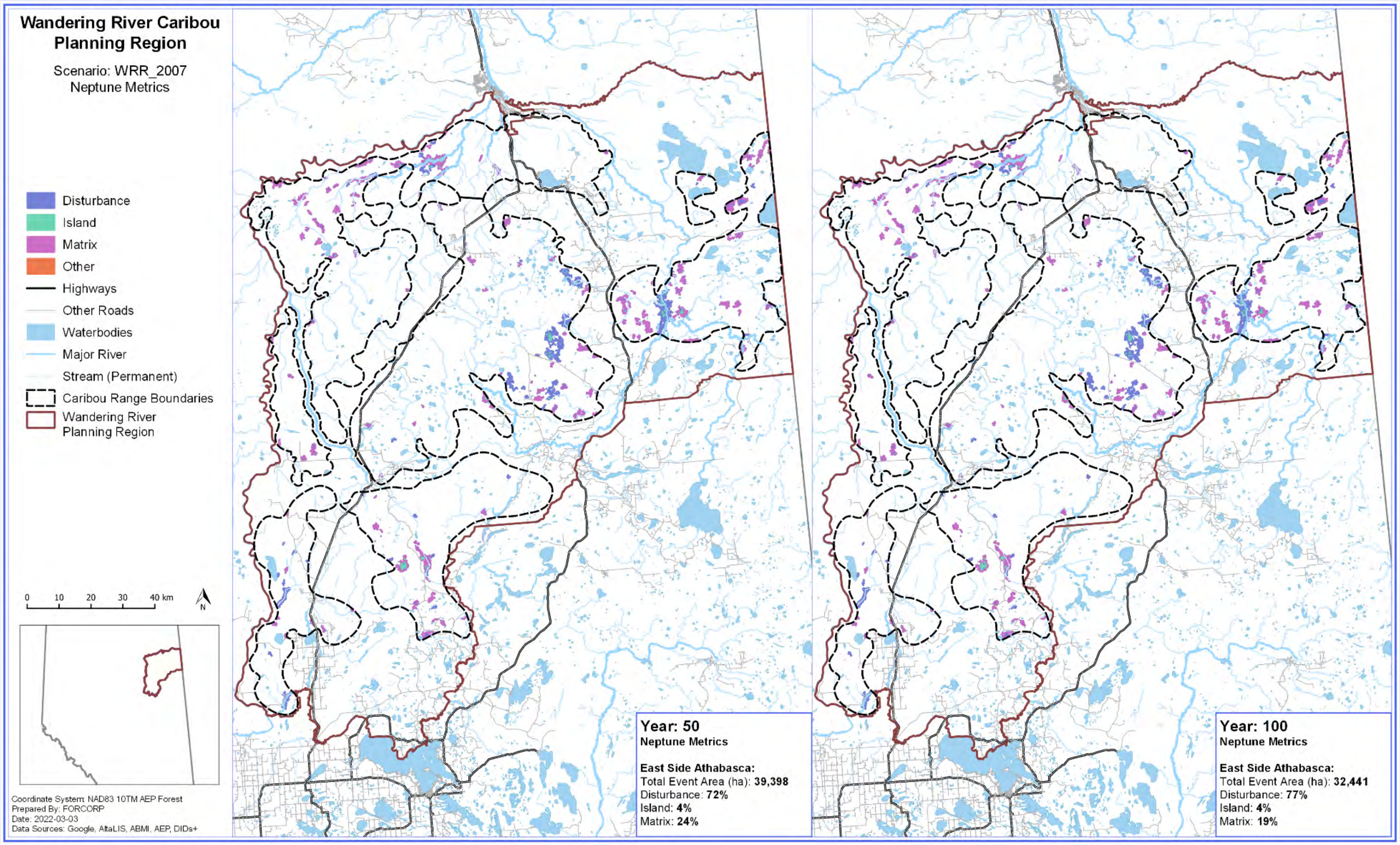
Wandering River Caribou Planning Region
Scenario: WRR_2004
Neptune Metrics
Disturbance
Island
Matrix
Other
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Caribou Range Boundaries
Wandering River Planning Region
0 10 20 30 40 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-03-03
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 50
Neptune Metrics
East Side Athabasca:
Total Event Area (ha): 43,005
Disturbance: 75%
Island: 5%
Matrix: 20%
Year: 100
Neptune Metrics
East Side Athabasca:
Total Event Area (ha): 34,652
Disturbance: 75%
Island: 5%
Matrix: 20%

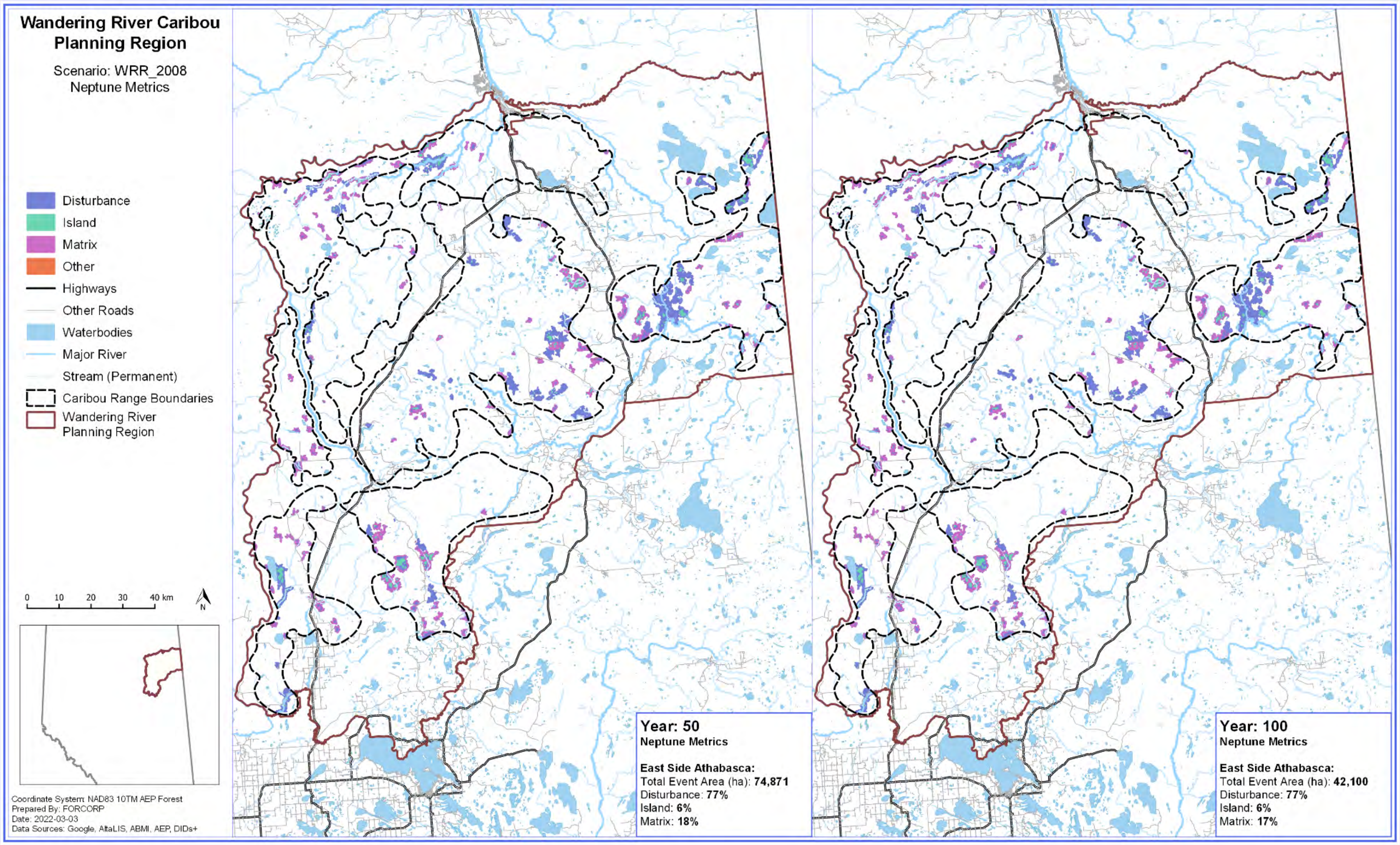


Wandering River Caribou Planning Region
Scenario: WRR_2005
Neptune Metrics
Disturbance
Island
Matrix
Other
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Caribou Range Boundaries
Wandering River Planning Region
0 10 20 30 40 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-03-03
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 50
Neptune Metrics
East Side Athabasca:
Total Event Area (ha): 35,024
Disturbance: 75%
Island: 7%
Matrix: 18%
Year: 100
Neptune Metrics
East Side Athabasca:
Total Event Area (ha): 29,323
Disturbance: 76%
Island: 7%
Matrix: 17%



Wandering River Caribou Planning Region
Scenario: WRR_2006
Neptune Metrics
Disturbance
Island
Matrix
Other
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Caribou Range Boundaries
Wandering River Planning Region
0 10 20 30 40 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-03-03
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 50
Neptune Metrics
East Side Athabasca:
Total Event Area (ha): 63,828
Disturbance: 76%
Island: 3%
Matrix: 21%
Year: 100
Neptune Metrics
East Side Athabasca:
Total Event Area (ha): 44,780
Disturbance: 78%
Island: 3%
Matrix: 19%


Wandering River Caribou Planning Region
Scenario: WRR_2007
Neptune Metrics
Disturbance
Island
Matrix
Other
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Caribou Range Boundaries
Wandering River Planning Region
0 10 20 30 40 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-03-03
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 50
Neptune Metrics
East Side Athabasca:
Total Event Area (ha): 39,398
Disturbance: 72%
Island: 4%
Matrix: 24%
Year: 100
Neptune Metrics
East Side Athabasca:
Total Event Area (ha): 32,441
Disturbance: 77%
Island: 4%
Matrix: 19%


Wandering River Caribou Planning Region
Scenario: WRR_2008
Neptune Metrics
Disturbance
Island
Matrix
Other
Highways
Other Roads
Waterbodies
Major River
Stream (Permanent)
Caribou Range Boundaries
Wandering River Planning Region
0 10 20 30 40 km
N
Coordinate System: NAD83 10TM AEP Forest
Prepared By: FORCORP
Date: 2022-03-03
Data Sources: Google, AltaLIS, ABMI, AEP, DIDs+
Year: 50
Neptune Metrics
East Side Athabasca:
Total Event Area (ha): 74,871
Disturbance: 77%
Island: 6%
Matrix: 18%
Year: 100
Neptune Metrics
East Side Athabasca:
Total Event Area (ha): 42,100
Disturbance: 77%
Island: 6%
Matrix: 17%

Project Number: P857

For additional information, please contact:
FORCORP
200, 15015 123 Ave NW
Edmonton, AB
T5V 1J7
780.452.5878
www.forcorp.com

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