

Effects of 2023 Fires in Alberta: Supplementary Report

David Huggard, prepared for ABMI, Dec 20 2023¹

1.0 INTRODUCTION

Fires are a natural part of forests in Alberta. In boreal and montane forests, fires—along with other natural disturbances like insect outbreaks and disease—result in a mosaic of stands of different ages, supporting wildlife and plants adapted to these frequent disturbances.

However, 2023 was an exceptional year for wildfires in Alberta, burning 3.2 million hectares—15 times the area burned in a typical year. Widespread fires forced people from their homes, destroyed property, and created smoky conditions and poor air quality far and wide.

Ecologically, there is concern about how years with extreme fires affect forest biodiversity, particularly if big fire years become more common in the future. Fires also occur in a landscape that is being affected by human disturbances, such as forestry and energy development. This report looks at ecological changes caused by the fires in 2023 – how they affected forests in Alberta, and the habitats of species that live there – and puts those in the context of typical rates of fire and human disturbances in recent years.

2.0 ABOUT THE DATA

2.1 Fire data:

We used spatial data of 2023 forest fire areas as of Oct. 18, 2023, provided by the Government of Alberta via the Alberta Geospatial Services Platform Portal (https://www.alberta.ca/system/files/custom_downloaded_images/fpt-accessing-wildfire-gis-data.pdf). These polygons include mapped fire areas within the forested portion of Alberta, including the provincial Green Area as well as areas within Wood Buffalo National Park. The data do not include burned areas with the mountain parks in Alberta (i.e., Banff, Jasper, and Waterton National Parks) nor most of the non-forested prairies, grasslands, or parklands. The fire polygon layer was clipped to the provincial boundary, so the resulting data include all burned areas within the Alberta provincial boundary regardless of whether fire origins (ignition points) were inside or outside Alberta. Historic fire data (pre-2010) was based on the Government of Alberta's tabular fire summary data (<https://open.alberta.ca/publications/alberta-wildfire-season-statistics>).

2.2 Vegetation (veg):

ABMI's vegetation mapping provides province-wide ("wall-to-wall") mapping of native forest types and non-forested habitat. Forest is classified as upland deciduous, mixedwood, pine, or spruce (including true firs), treed bogs, treed fens, and treed swamps. Age classes are assigned as 0-9yr, 10-19yr, 20-39yr, continuing in 20-year classes through to the oldest class of 160+ years. Non-forested vegetation

¹ Preferred citation: Alberta Biodiversity Monitoring Institute (ABMI). 2023. Effects of 2023 Wildfires in Alberta: Supplementary Report. Report available at: <https://abmi.ca/home/publications/601-650/642>.

includes: upland grass and shrubs, shrubby fens, bogs and swamps, graminoid fens, marshes, open wetlands and bare areas.

2.3 Human footprint (HF):

Human footprint is mapped across the province in >100 classes, which are grouped for summaries, including forest harvest areas by stand type and the same age classes as native stands, agriculture, urban, rural and industrial areas, various types of energy developments, roads, and other linear features (seismic lines, powerlines, etc). Human footprint is overlaid on the native vegetation map to give province-wide maps of veg+HF.

2.4 Landbase changes due to 2023 fires:

We used the 2021 wall-to-wall veg+HF map, then added fires from 2022 to form the “veg2022+HF2021” layer (generally called “2022 layer”; Figure 1). This is the baseline to assess the effects of the 2023 fires. Fire polygons from the 2023 fire season were downloaded on October 15, 2023, when most of the season’s fires were out or not growing. These fires were overlaid on the veg2022+HF2021 baseline to produce the “veg2023+HF2021” layer (generally called “2023 layer”; Figure 1). The comparison here is just the changes due to the 2023 fires, without any HF in 2023 (or in 2022), because those HF layers are still in production and not yet available. This means that a small proportion of the area that we report as native vegetation affected by fire would have been HF from 2022 or the first 9 months of 2023.

2.5 Limitations

- The 2023 current fire map is approximate, as detailed mapping has not been completed on most large, complex fires, some of which were still active at the time of reporting.
- Fire skips within large fire areas have generally not been mapped yet. However, this may represent minimal area as nearly all fire polygons are estimated by the Government of Alberta to be the highest class of percent burned (>94% burned).
- Fire mapping only covers designated forest areas in Alberta (i.e. the Green Area and Wood Buffalo National Park), about 74% of the province. The coverage excludes Jasper, Banff, and Waterton National Parks, and the predominantly non-forested Grassland Natural Region and most of the Central Parkland natural subregion (although at least one fire was mapped in that parkland area). From available information, the excluded areas had no substantial fires in 2023 (e.g., approximately 5 ha total in Jasper, according to Parks Canada website).
- We report the proportion of each reporting region covered by the 2023 fire map. Some small underestimating of fire area is possible in regions with incomplete coverage.
- Historic burned area reported (before 2010) is based on tabular data from the Government of Alberta and not on summarised polygons (<https://www.alberta.ca/wildfire-maps-and-data>). These tabular results only include fires when ignitions fell within the Forest Protection Area. Fires that ignited outside this area (e.g., Wood Buffalo National Park) are classified as “Mutual Fires” and were not included in that data source. These discrepancies limited our deeper historical comparison.

4. Protected areas (>10km²), and
5. Caribou ranges.

An additional summary calculated average stand age for different stand types before versus after the 2023 fires, with the fires resetting stand age to 0, and unburned stands aging one year over that time span. For comparison, annual rates of disturbance from fires, forestry, and non-forestry footprint were calculated between 2010 and 2021 for the same summary regions and vegetation types, using ABMI wall-to-wall veg+HF maps for those two years.

Example results are shown below. Similar figures and tables are available for many summary regions and subregions. All tabular results and figures mentioned in the results section can be downloaded at <https://abmi.ca/home/publications/601-650/642>, in subfolders corresponding to each results section.

3.0 RESULTS

3.1 Tabular Results for all Reporting Regions

Tabular results for all reporting regions can be found in the following subfolder: **3.1 Tabular Result for all Reporting Regions**. The tables show the area (km²) of each habitat type in the region that burned (“Fire”) or did not burn (“NoFire”) in 2023, and the percent that burned. Habitat types include:

- “OpenWet” includes any non-treed lowland habitat.
- “OpenDry” includes upland herb/grass and shrub habitats.
- “AlienHF” is alienating (non-successional) human footprint, such as roads, agriculture, etc.
- “CC” prefaces harvest areas, including “DecidMixed” (deciduous and mixedwood), “Conif” (conifer), “R1” (age classes <20yr), “234” (age classes ≥20yr). “Old80”, “Old120”, “Old50” refer to stands older than 80, 120, or 50 years, respectively.

3.2 Overall Percent Burned for Broad Regions

Figures below summarize the percent of various large summary regions that burned in 2023 (top barplot = total area of the region, bottom barplot = upland forest only)

- a) Natural subregions within the Boreal natural region,
- b) Natural subregions within the Foothills natural region,
- c) Land-use framework regions,
- d) Forest Management Agreement areas.

Proportions above bars – e.g., “(0.77)” – are the proportions of the region that is covered by the 2023 fire mapping. Percent burned values will be underestimates, to probably only a very small degree, for regions with less than 1.00 map coverage. Figures can be found in the following subfolder: **3.2 Overall Percent Burned for Broad Regions – Figures**.

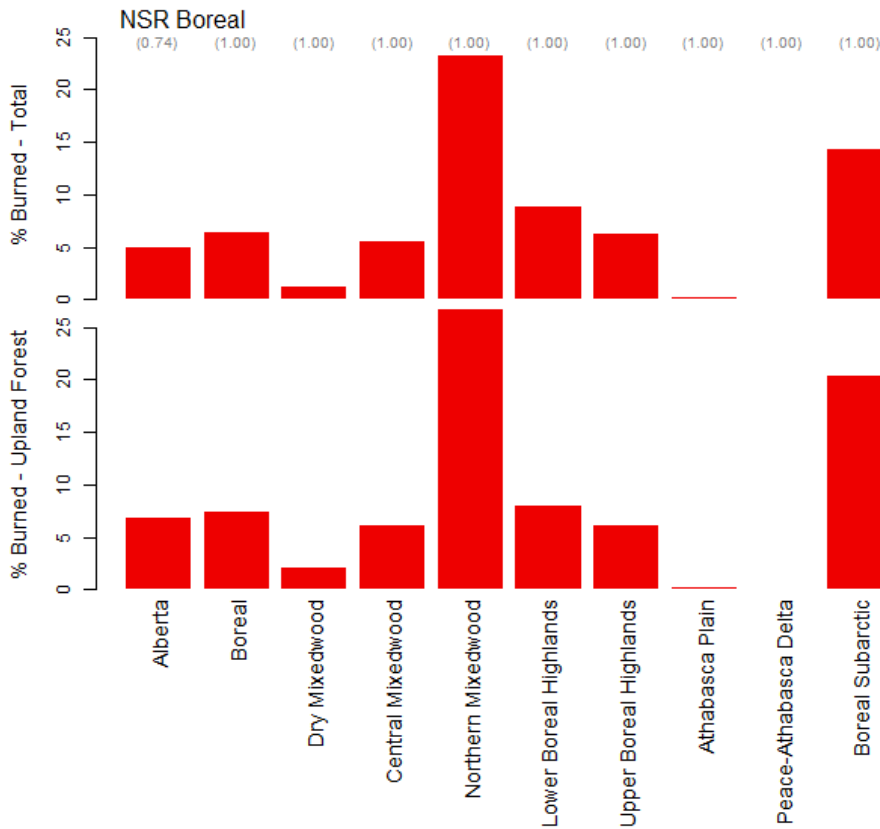
Province of Alberta

- 4.95% of the province burned in 2023 (not accounting for any additional fires outside of the map coverage), 6.43% of the Green Area, and 6.76% of total upland forest (i.e. including Wood Buffalo National Park). This compares to 0.36% per year for the whole province from 2006 to 2021 (<https://open.alberta.ca/opendata/wildfire-data>) or 0.37% per year from 2010 to 2021 (ABMI landbase results). The 2023 fires were the equivalent of 14 years of burning in recent times, or

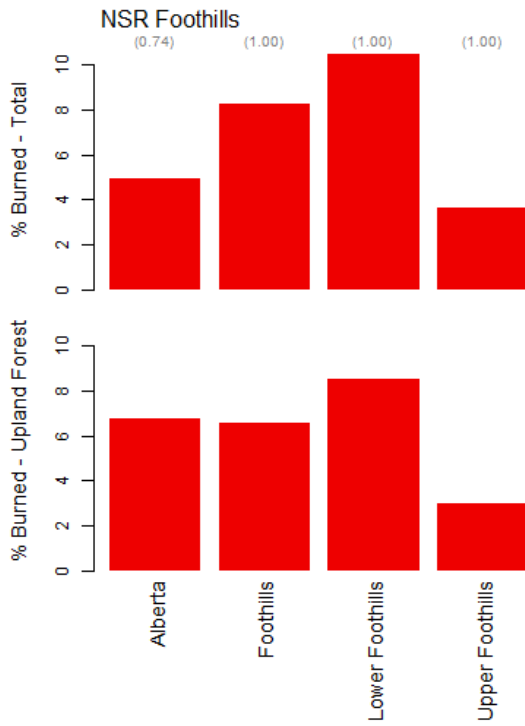
probably about 5 years under natural fire regimes (based on the very rough assumption of a 100-year return interval).

Natural Regions and Subregions

- The fires were distributed mainly in the north and northwest/west-central parts of the province, disproportionately affecting the Northern Mixedwood and Boreal Subarctic natural subregions. The Dry Mixedwood had a lower percentage burned, but still about triple recent yearly averages. Only the Athabasca Plain and Peace-Athabasca Delta subregions escaped extensive fires in the Boreal.

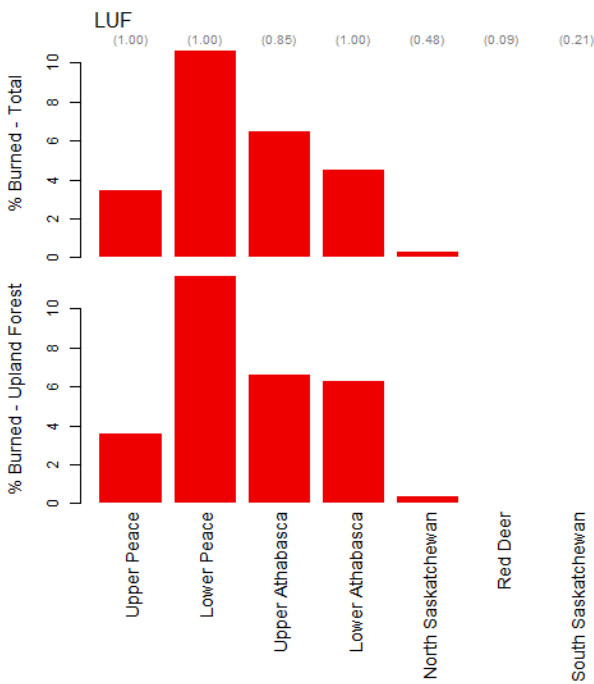


- Burn rates in 2023 were similarly high in the Foothills, especially the Lower Foothills. There were very few fires in the Foothills from 2010-2021, only 0.04%/yr.



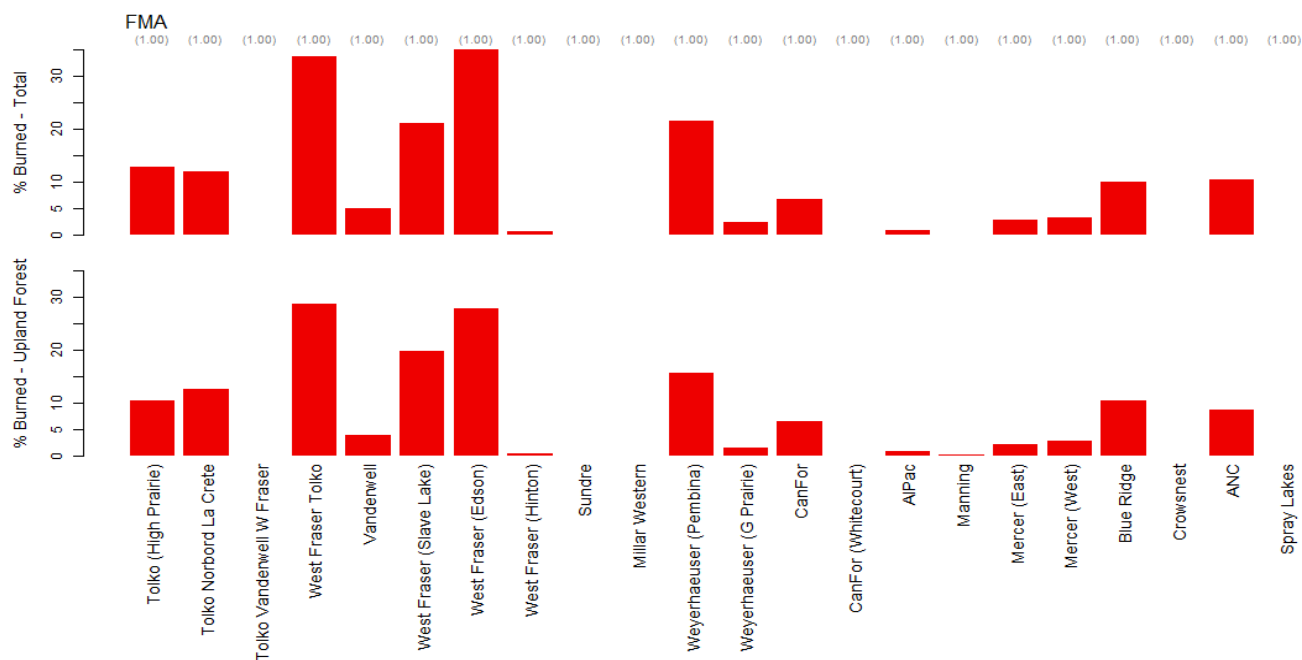
Land-use Framework Regions

- Among LUF regions, the Lower Peace was disproportionately affected, with 10.6% burned in 2023. This region had 0.72%/yr burned from 2010 to 2021.
- Note low or lack of fire map coverage for the southern LUF regions, but also likely no substantial fires there in 2023.



Forest Management Agreement Areas

There were notably large fire effects on several FMAs, while others were almost unscathed. Even FMA's with mid-range burn rates lost the equivalent of several years' harvest area.



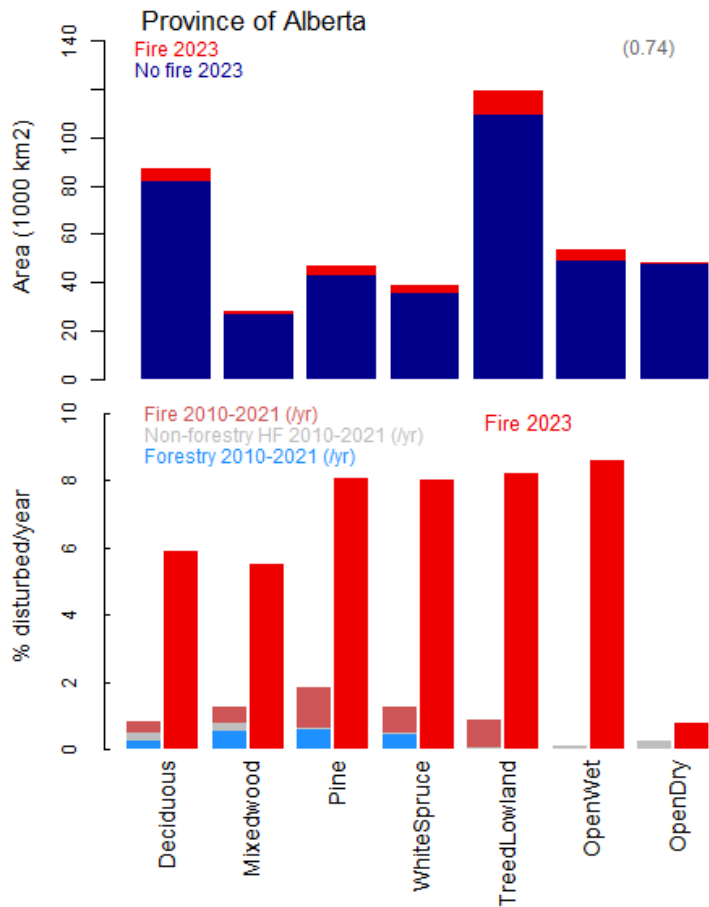
3.3 Area and Percent Burned by Vegetation Type

Figures of percent burned by vegetation type for all the main reporting regions can be found in the following subfolder: **3.3 Area and Percent Burned by Vegetation Type**.

Figures below show:

Top – Area (in km², or 1000km² for big regions) of broad veg types that burned (red) or didn't burn (blue) in 2023.

Bottom – Percentage of the stand type in that region that burned (bigger red bar), along with the annual rates of disturbance (2010 to 2021, but presented on an annual basis) from the ABMI landbase attribution work for that stand type and region (light blue=forestry, grey=non-forestry human footprint, red=fires).

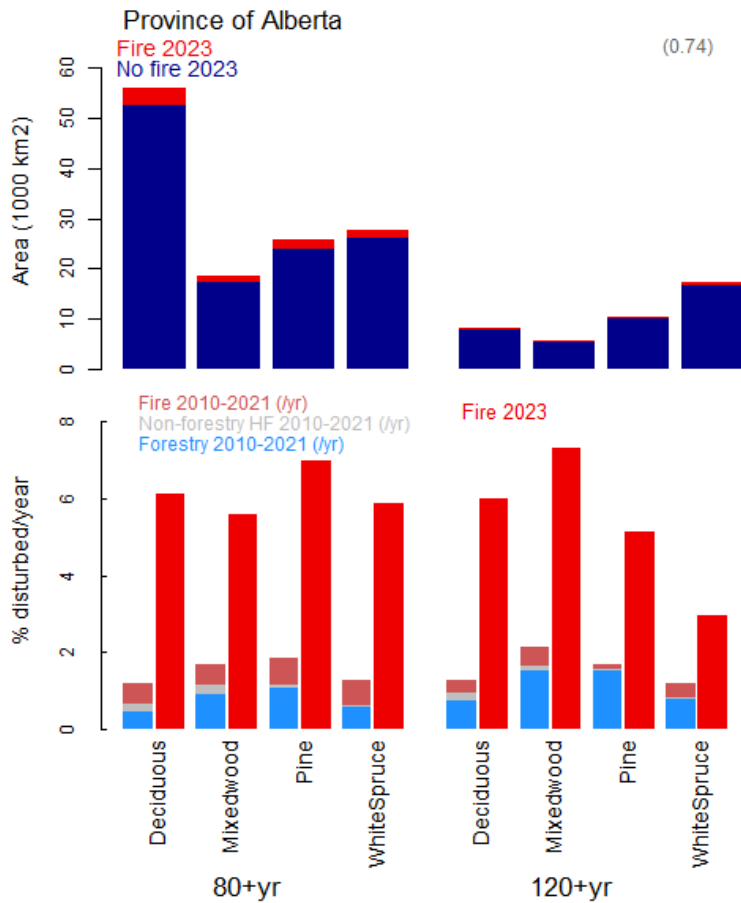


- Fire rates were high in all types except OpenDry (=grass and shrub, hence mostly the prairies, where there is no map coverage, but also where there weren't any notable large fires in 2023).
- Figures show that 2023 fires created disturbance equivalent to several to many recent years of disturbance from 2010 to 2021, even including HF in those recent years.

3.4 Area and Percent Burned for Old Forest

Figures below are the same format as in the previous section, but for old forest (80+ years on left side, 120+ years on right side).

- Province-wide, burn rates of old forest were similar to the overall burn rates for stand types (previous section). The 2023 fires did not show much selectivity for older or younger stands (see more detailed summary below). Old forest types, however, had higher disturbance rates between 2010-2021 because they are the focus of forestry. However, those 2010-2021 disturbance rates from fire and HF are still not nearly as high as from the 2023 fires.

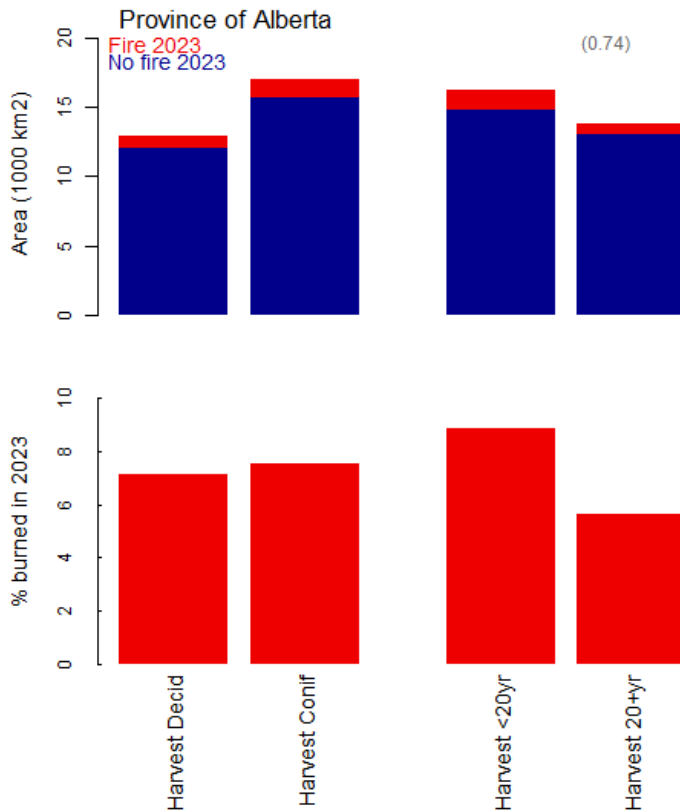


Figures of percent of old forest burned for all the main reporting regions can be found in the following subfolder: **3.4 Area and Percent Burned for Old Forest**.

3.5 Harvest Areas

Figures show the areas (top) and percentage burned in 2023 for four (overlapping) classes of harvest areas: Deciduous (including mixedwood), conifer, recent (<20yr), and older (≥20yr). Comparable information from 2010-2021 is not presented, because very few harvest areas burned in that time, none, of course, had new forestry, and only small amount of harvest area were converted to other footprint types.

- Harvest areas burned in 2023 at similar rates to forest overall, and the rate was similarly variable across the different Forest Management Agreement (FMA) areas.
- One caveat here is that initial fire-mapping does not precisely map fire skips, which potentially include some embedded harvest areas. Recent harvest areas, in particular, may be less likely to burn.



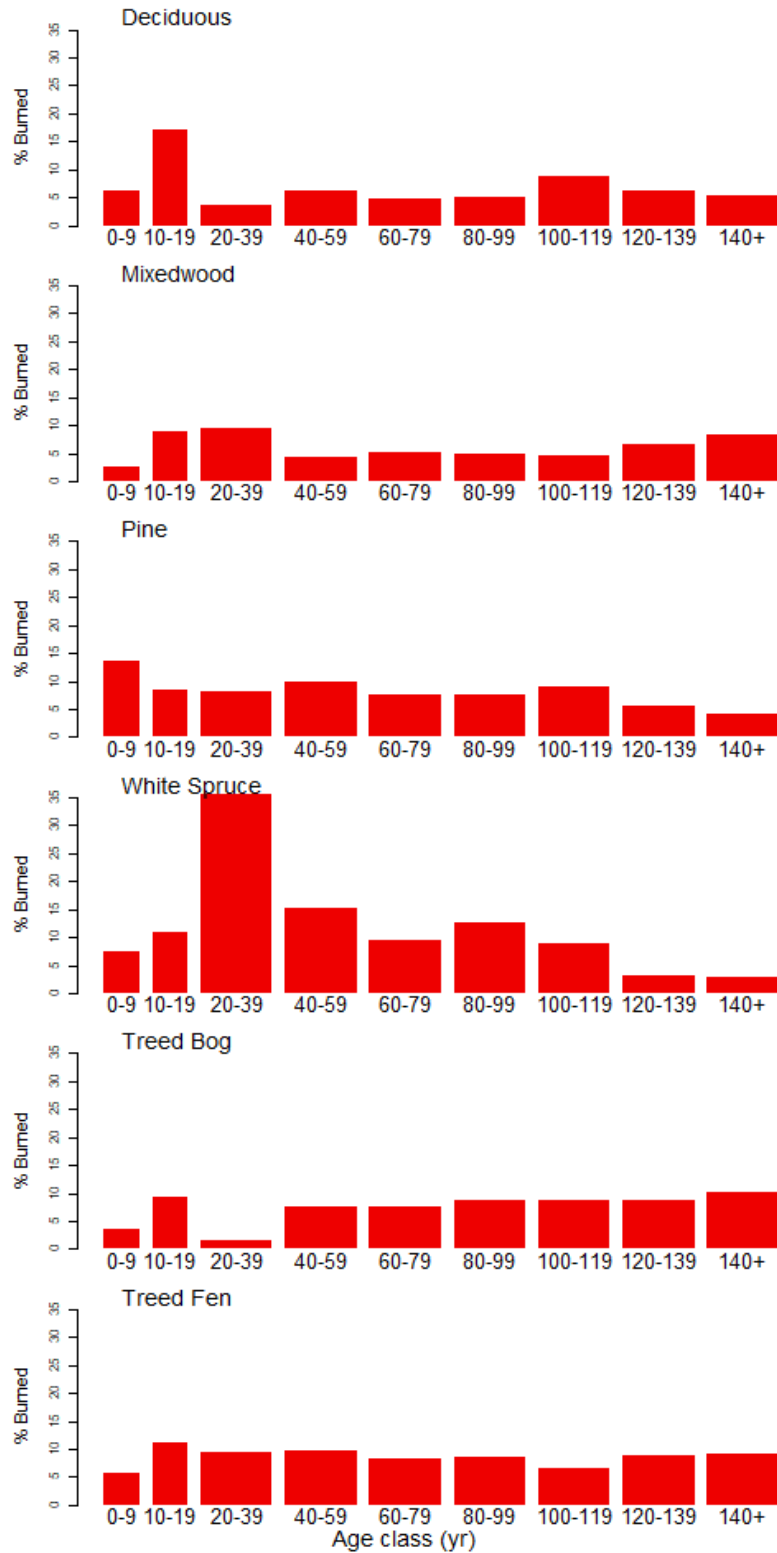
Similar figures of percent of harvest areas burned for individual FMA areas can be found in the following subfolder: **3.5 Harvest Areas – Fire 2023**.

3.6 Percent Burned By Age and Stand Type for the Whole Province

The figure below looks at whether fires burned more in older or younger stands. Figures can be found in the following subfolder: **3.6 Percent Burned by Age and Stand Type for the Whole Province**.

- Overall, the only apparent age selectivity within a stand was very high burn rates for early to mid-seral white spruce compared to older stands. That pattern can reflect landscape-level fire risk: areas that have a higher chance of burning tend to have younger stands, simply because they burn more often. Older stands are old because they are in areas with lower fire risk (“refugia”). The very

youngest stands of all stand types tend to burn less, reflecting less accumulation of fuel. Otherwise, large fires, like most of those in 2023, tend to burn anything in their way, regardless of age.



3.7 Change in Average Stand Age

Average stand age is useful as a coarse indicator of the sustainability of forest disturbances. In particular, substantial and prolonged declines in average forest age do not give a good prognosis for sustainability. Even that needs to be nuanced a bit, because in some cases average forest age can be inflated by successful recent fire suppression, and possibly historical pulses like the Dust Bowl cohort.

Tabular results for average stand age for the whole province and the Boreal Natural Region are below. These results are available in tabular form for all main reporting regions can be found in the following subfolder: **3.7 Change in Average Stand Age**. Age change from 2010 to 2021 is presented as a comparison. Note that this comparison is the total change over 11 years, not annualized.

- Changes in average age of all stand types over 2023 were large and negative. In contrast, there is more variability in the changes from 2010 to 2021, with stands/regions with more intensive forestry and more fires showing negative age changes, and less disturbed areas showing positive. The largest negative changes from 2010 to 2021 are similar, or sometimes greater than, the 2023 change, but remember that the 2010 to 2021 change is the total over 11 years.

Region	StandType	Age2022	Age2023	Age Change	Age Change	Coverage
				2023	2010 to 2021	
Province of Alberta	Deciduous	80.4	76.6	-3.8	2.7	0.74
Province of Alberta	Mixedwood	77.4	73.9	-3.6	-2.0	0.74
Province of Alberta	Pine	69.3	65.3	-4.0	-4.0	0.74
Province of Alberta	Spruce	86.6	82.3	-4.3	-1.9	0.74
Province of Alberta	TreedLowland	82.6	76.5	-6.1	2.5	0.74
Province of Alberta	All	79.9	75.2	-4.7	0.5	0.74

Region	StandType	Age2022	Age2023	Age Change	Age Change	Coverage
				2023	2010 to 2021	
Boreal NR	Deciduous	80.0	75.9	-4.1	2.5	1.00
Boreal NR	Mixedwood	77.8	74.9	-2.9	-2.0	1.00
Boreal NR	Pine	53.0	48.4	-4.6	-6.1	1.00
Boreal NR	Spruce	71.9	65.2	-6.7	-8.4	1.00
Boreal NR	TreedLowland	78.9	73.8	-5.1	1.5	1.00
Boreal NR	All	75.9	71.2	-4.7	-0.2	1.00

Tabular data for all main reporting regions and can be accessed in the following subfolder: **3.7 Change in Average Stand Age > Change in Average Stand Age - Data**.

These tables include columns for:

- 1) Age2010: average age in 2010,
- 2) addNativeAging: the age after aging of natural stands between 2010 and 2021,
- 3) addForestryAging: after the additional effects of aging of harvest areas,
- 4) addFire: after the additional effects of fires between 2010 and 2021,
- 5) addNewForestry: after the additional effects of new harvest areas between 2010 and 2021,
- 6) addNewOtherHF: after the additional effects of new non-forestry footprint between 2010 and 2021,
- 7) Age2021: The resulting average age in 2021,
- 8) Age2023: The resulting age after the fires of 2023 (and aging of undisturbed stands).

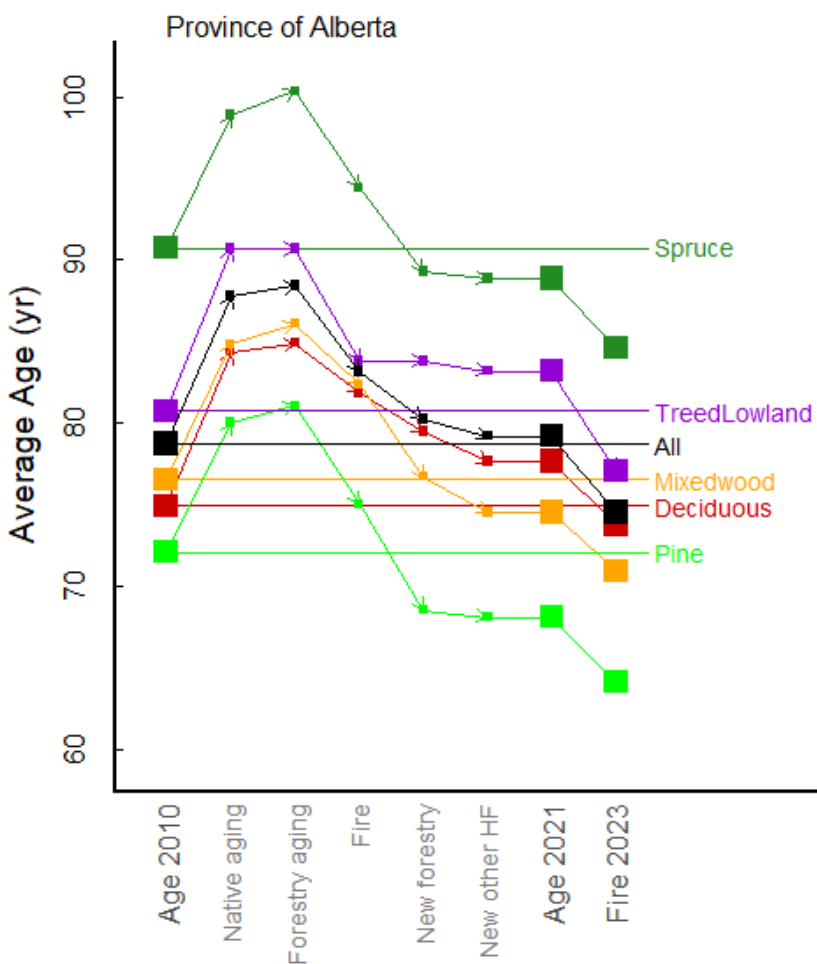
See the example figure and interpretation in the following section for an explanation of these components.

The figures below put the change in average stand age in 2023 into more perspective, with comparisons to the factors that contributed to change in age from 2010 to 2021. The 2010 to 2021 changes are broken down into the change due to:

1. Aging of undisturbed native stands (11 years over that 11-year time span),
2. Aging of harvest areas,
3. Fires (which reset ages to 0),
4. New forestry (which does the same), and
5. New non-forestry human footprint (which sets the age to 0 and keeps it there).

The net change is the sum of all those changes, positive and negative. The 2023 average age follows, reflecting only the 2023 fires plus two years of aging in undisturbed stands and harvest areas (2022 fires, and 2002 and 2023 human footprint are not yet included).

- For all stands (black) in Alberta, average age increased about 9 years due to undisturbed native forest aging, and another year due to harvest areas aging. Fires over that period eliminated about half of that gain, while new forestry reduced average age a further 4 years, and new non-forestry footprint caused a slight further decline. The net result was that average age across all stands stayed almost the same from 2010 to 2021. The fires of 2023 then reduced that average age almost 5 years.
- Different stands showed different net age changes from 2010 to 2021, mainly depending on the intensity of forestry. White spruce, pine, and mixedwood stands both decreased in average age, while deciduous and treed lowlands increased in age. However, all stand types showed a decrease in age in 2023, from 3.6 to 6.1 years. As a result, all stand types in Alberta are younger on average in 2023 than they were in 2010.
- Decreases in average stand ages are quite extreme in stand types and regions with more intensive forestry from 2010 to 2021, and then more fire impact in 2023 (not shown – available in full results).



Similar figures for each main reporting region can be found in the following subfolder: **3.7 Change in Average Stand Age > Change in Average Stand Age - Figures.**

3.8 Protected areas

- Of 124 national and provincial protected areas >10km² in Alberta, 100 fell in the area with 2023 fire map coverage. Eighteen of these had mapped fires. Of 81,016km² protected area within the fire mapping, 11,903km² burned (14.7%). Across the whole province, including areas outside the fire map coverage where fires were rarer in 2023, 11.8% of protected areas in the province burned in 2023.
- Wood Buffalo National Park had by far the largest area burned, contributing 62.7% of the burned area in parks. Large fires also happened in Kazan, Caribou Mountains, and Birch River Wildlands. Most (small) protected areas had no fires.
- Interpretation needs to be tempered by the fact that fires are a natural part of forest ecosystems. In some regions with effective fire suppression and/or widespread salvage after fires, recently burned forest can be an unnaturally rare ecosystem. One role of large parks is to provide space for unsalvaged large fires. However, excessively high rates, particularly over several years, could clearly impact parks' ability to maintain other ecosystem values.

Results for all protected areas are available in the following subfolder: **3.8 Protected Areas > Fires 2023 in protected areas.xlsx.**

3.9 Caribou ranges

For caribou ranges, the table below shows the percent burned of two broad habitat types preferred by caribou, treed lowlands >50yr old and upland conifer forest >50yr old, combining the two as a very crude measure of “caribou habitat”.

- The northeast ranges had 7.9 to 13.7% of this simple definition of “habitat” burned. The central Red Earth range lost 7.7% and the Foothills ranges 3.5 to 6.2%. The Athabasca and Rocky Mountain ranges had little loss of habitat.
- A bigger issue for caribou is the medium-term possibility of more open area → shrub production → deer and moose increases → predation.

Range	Treed Lowland >50yr			Upland Conifer >50yr			"Habitat"	Fire Map
	No Fire (km ²)	Fire (km ²)	% Burned	No Fire (km ²)	Fire (km ²)	% Burned	% Burned	Coverage
Caribou Mountains	3484.0	446.2	11.35	1307.2	311.9	19.26	13.66	100.0
Bischo	3324.3	462.8	12.22	1183.5	194.2	14.10	12.72	100.0
Yates	1763.4	189.1	9.69	176.0	14.7	7.70	9.51	100.0
Chinchaga	4631.1	494.5	9.65	2825.0	143.2	4.82	7.88	100.0
Red Earth	7319.9	558.0	7.08	1619.9	191.8	10.59	7.74	100.0
Slave Lake	443.0	28.8	6.11	38.0	3.2	7.69	6.23	100.0
Little Smoky	959.4	47.5	4.72	1026.6	51.4	4.77	4.74	100.0
Nipisi	668.0	25.4	3.67	65.3	1.0	1.44	3.48	100.0
West Side Athabasca River	8410.6	217.6	2.52	636.7	58.9	8.47	2.97	100.0
Cold Lake	2876.6	29.0	1.00	1135.2	10.2	0.89	0.97	100.0
East Side Athabasca River	5855.5	49.1	0.83	689.1	7.7	1.11	0.86	100.0
Richardson	1354.6	0.4	0.03	967.8	4.0	0.41	0.19	100.0
Redrock-Prairie Creek	216.8	0.0	0.00	2974.0	0.0	0.00	0.00	100.0
Jasper	73.7	0.0	0.00	1122.7	0.0	0.00	0.00	11.4
Narraway	180.0	0.0	0.00	387.6	0.0	0.00	0.00	100.0
Banff (extirpated)	5.0	0.0	0.00	656.1	0.0	0.00	0.00	24.4
A La Peche	357.3	0.0	0.00	3064.7	0.0	0.00	0.00	68.9
All	41923.1	2548.6	5.73	19875.2	992.1	4.75	5.42	

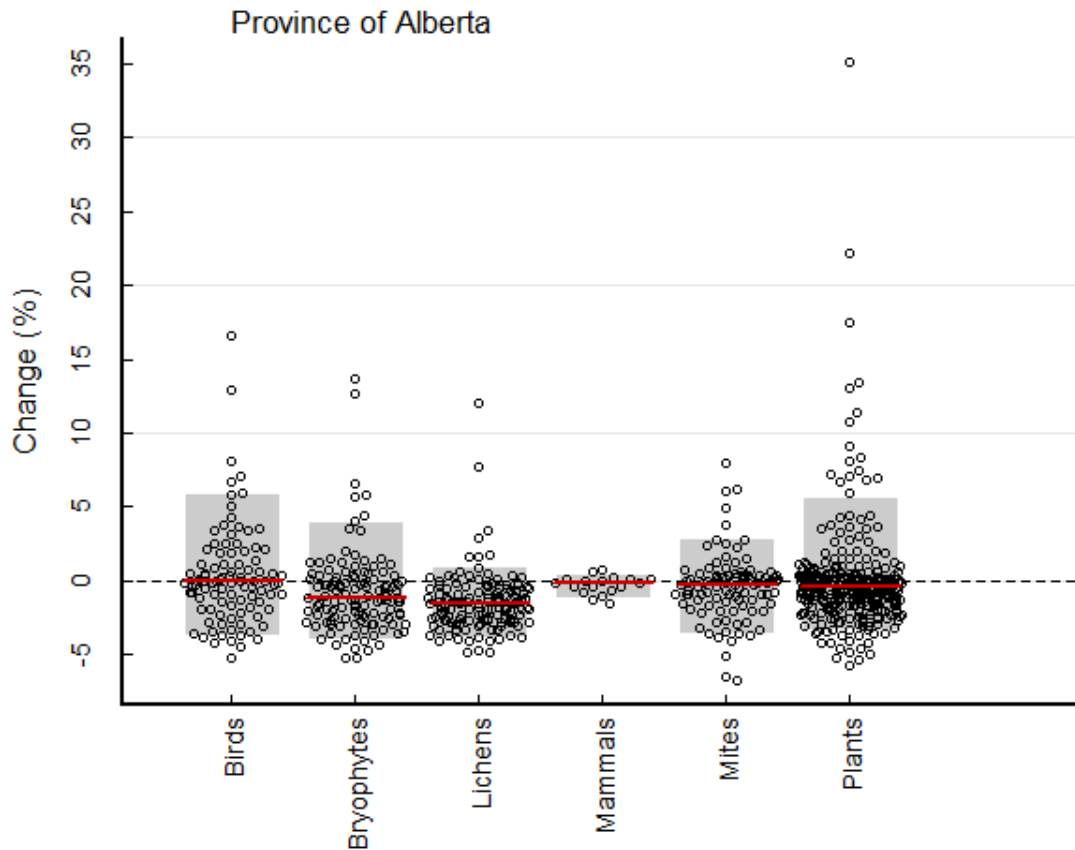
Results for caribou ranges can be found in the following subfolder: **3.9 Caribou Ranges > Percent burned 2023 Caribou habitat by caribou range.xlsx**.

4.0 SPECIES HABITAT

We applied the ABMI species-habitat models to the 2022 and post-2023 fire landbases, to show how the predicted abundance of species changed due to the 2023 fires. We interpret these changes in predicted abundance as changes in the amount of habitat of the species (because they do not reflect any directly measured population changes, or any other processes that might be changing species).

The figure below shows the predicted change in abundance/habitat of each modelled species in the six ABMI taxa. Each point is a species. The grey rectangle delineates the 5% - 95% quantiles. The red line is the median.

- Overall, there are not drastic decreases in any species' predicted habitat across the province due to the 2023 fires. Only a few species are predicted to lose more than the ~5% of the province that burned. The lack of a disproportionate negative effect on species is because the 2023 fires burned roughly equal amounts of all stand types and ages. Additionally, most of the species that ABMI can model have wide ranges across the province (which is why they have enough observations to model). Any localized species, potentially more impacted in high-fire regions, would not be included here because they would not have an ABMI model. Losses of up to 5% of their habitat would, of course, be significant to species if this started to occur frequently.
- Lichens and bryophytes tend to be more associated with old forests and related habitat elements (large trees, snags, logs), and so a majority of species in those taxa showed predicted loss of habitat. Other taxa include a more equal balance of late- and early-seral species, as well as many species indifferent to fire (wetland species, etc).
- A few fire-loving species are predicted to have substantially more habitat after the 2023 fires. For these species, the fires may have alleviated a conservation concern about reduced habitat due to fire suppression and salvage.

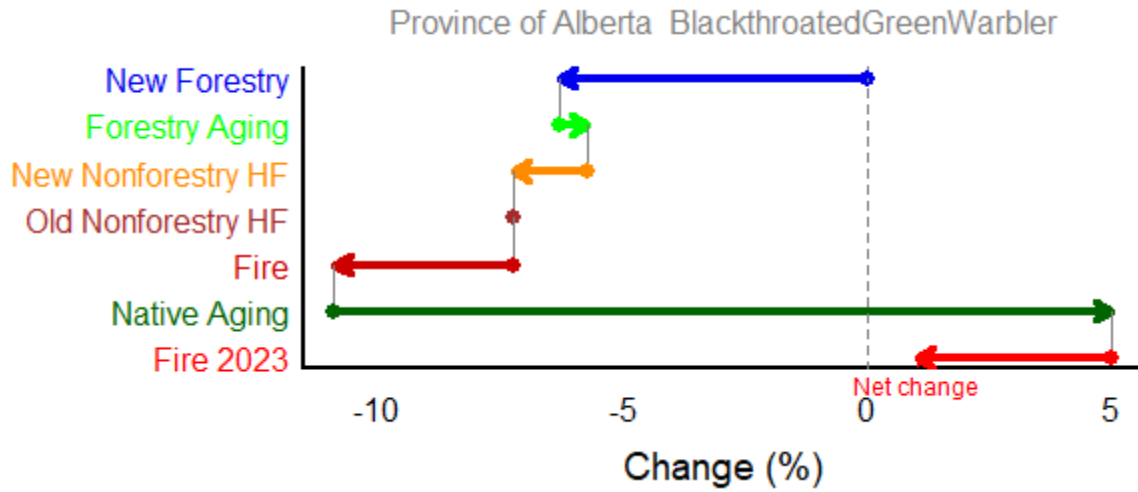


Similar figures for main reporting regions are available in subfolder: **4.0 Species Results > Region summary of species fires 2023**.

We also generated figures for example species showing the how predicted abundance (habitat) for the species was affected by the different landbase change processes from 2010 to 2021, and then the additional effect of the 2023 fires. The example below for black-throated green warbler across the whole province shows:

- Substantial loss of habitat between 2010 and 2021 from new forestry, with little increase in habitat due to existing forestry aging (because harvest areas are too young to be good habitat for this species)
- Some additional loss of habitat from non-forestry footprint, with no effect of changes in footprint type within old non-forestry footprint areas.
- Further moderate losses in habitat due to fires between 2010 and 2021.
- A large increase in habitat suitability due to aging of undisturbed stands in this time span. A large cohort of stands originating in the Dust Bowl era are rapidly increasing in value for black-throated green warblers, according to the ABMI habitat model
- The net result was a predicted increase of 5% in habitat for this species from 2010 to 2021 (end of dark green arrow).
- However, fires in 2023 removed most of that gain, leading to a net gain of only 1% habitat from 2010 through the 2023 fires. [Note: The 2023 fire effect here also includes the benefit of undisturbed

stands aging in 2022 and 2023. It does not include additional (negative) effects of fires in 2022, or HF in 2022 and 2023].



Results for all analysed species are available in tables for each taxon and can be found in the following subfolder: **4.0 Species Results > csv files of species fire 2023 results**. Arrow figures for some highlight species are also available in this subfolder (**4.0 Species Results > Species attribution arrow figures WITH FIRE 2023**).