PAST, PRESENT AND FUTURE FORESTS IN THE INTERIOR DOUGLAS-FIR

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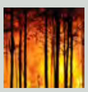
Dry Belt Douglas-fir Committee

The increased severity and frequency of fires, attributed to climate change and accumulating fuel, pose significant threats to our dry-belt Douglas-fir forests and the communities they encompass. Without interventions, drought and frequent wildfire suggest a trajectory toward a substantially non-forested landscape. The explosive nature of current wildfire regimes in the IDF can overwhelm our ability to suppress and our efforts at mitigating wildfire effects in the WUI, putting our communities at serious risk to wildfire.

AGENDA

Fire history and past forests in the Interior Douglas-Fir

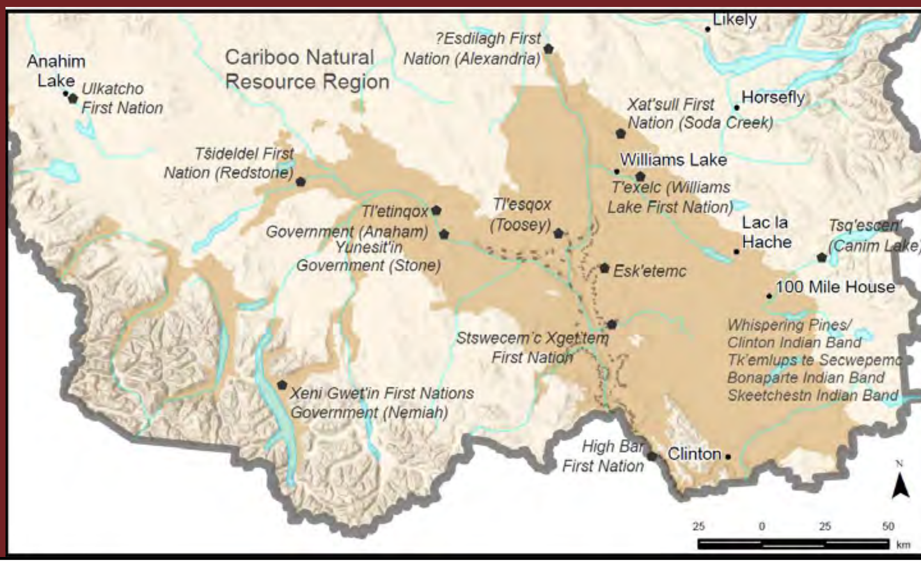
Current forests



Climate change and fire

Future forests

INTERIOR DOUGLAS-FIR IN THE CARIBOO (AKA DRY BELT DOUGLAS-FIR)



2023

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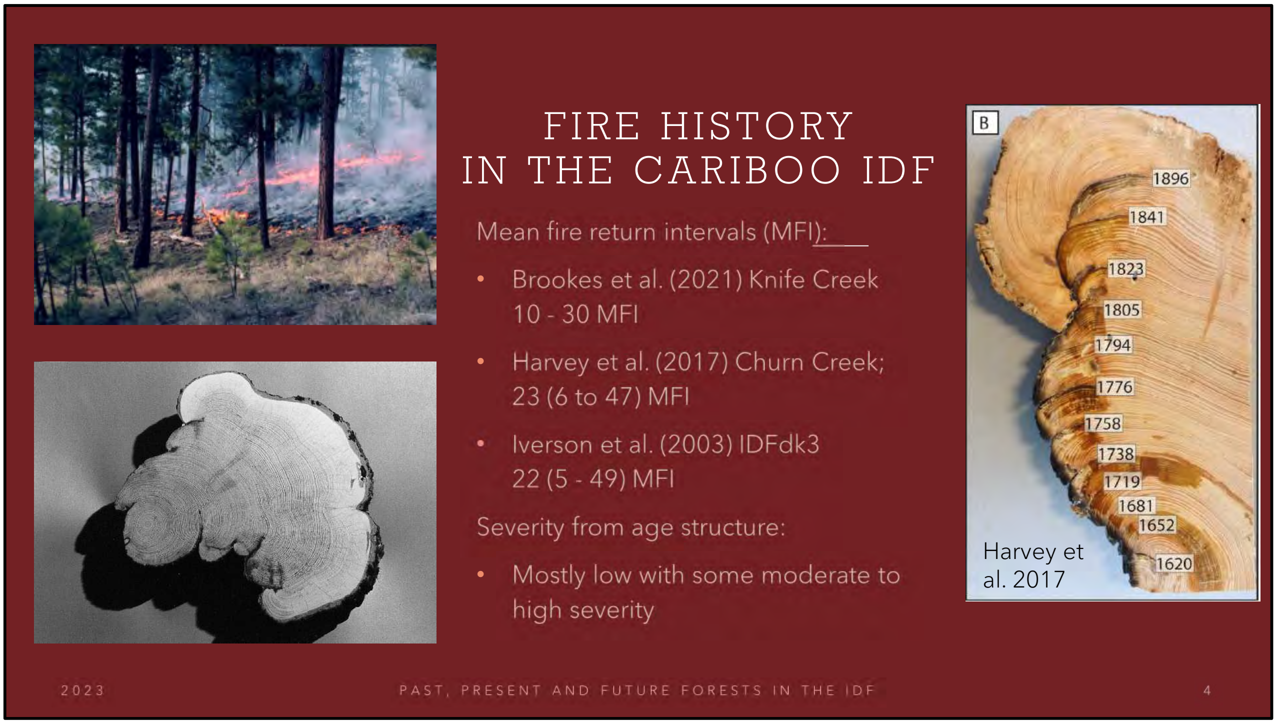
The IDF covers 1.8 million hectares in the Cariboo Natural Resource Region. It also extends into the dry valleys of the Thompson – Okanagan and Rocky Mountain Trench. It has dry, warm climates (around 400 mm precipitation annually); lies in the rain shadow of the coast mountains; is dominated by Douglas-fir and lodgepole pine forests with trembling aspen and spruce and cottonwood on wetter sites. More than 80% of this area is forested, but it also includes many other important ecosystems such as grasslands, lakes and wetlands. It covers 20% of the THLB in the Williams Lake TSA and almost 50% of the 100 Mile TSA. These forests and ecosystems provide a multitude of values, both biological, cultural and economic, including habitat for many different plants and animals, culturally important plants, timber for harvesting, livestock grazing, and recreation.

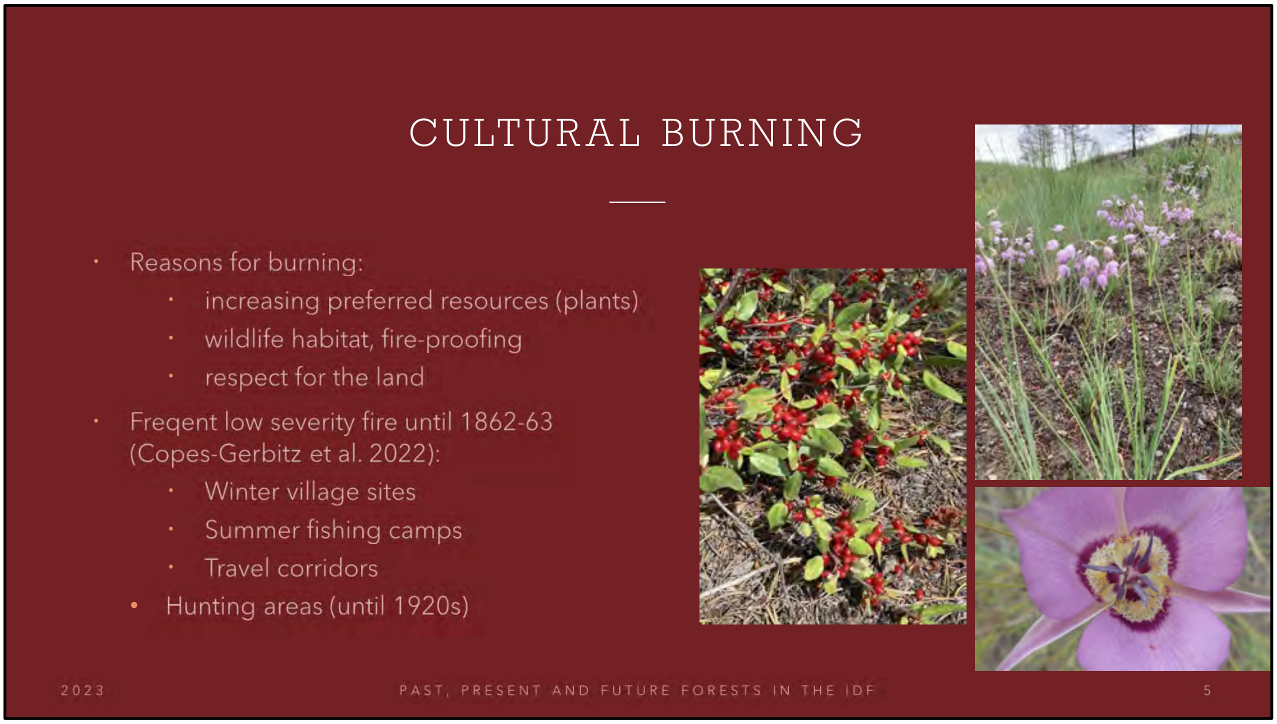


Fire-scarred trees are used to determine fire frequency. Cross-sections of live and dead trees are used together with a master chronology to cross-date fire scars. Seasonality of fires can sometimes be determined. Age structure of forests can be used to infer fire severity – cohorts of trees establish post-fire.

The Mean Fire Return in the Cariboo IDF ranges between 5 and 49 years, with historical fires mostly low to moderate severity and generally smaller patches of high severity, with most trees, especially larger ones, surviving most fires. IDF forests were predominantly open, clumpy stands with few ladder fuels and light surface fuels dominated by grasses, forbs, and shrubs. Historical fires predominantly burned through the understory and killed many small regenerating trees. Areas of moderate or high severity were generally smaller and associated with more extreme fire weather years. At higher elevations there was an increased proportion of moderate to high severity fires (or portions of fires) and more of a mix of even- and uneven-aged lodgepole pine stands. In many areas, lodgepole pine was able to survive one or more fires (up to 5), indicating how light most surface fuels must have been.

Harvey (2017): small fires in forests adjacent to grasslands were associated with wetter years. Widespread fires occurred during warm, dry years and were preceded by warm, dry years.

Daniels, L. D., and E. Watson. 2003. Climate-Fire-Vegetation Interactions in the Cariboo Forests: A Dendrochronological Analysis. Daniels & Watson found that fire occurrence was related to droughts that last 3-5 years and correspond to the onset of strong La Nina events. Fires commonly burned in the 2^{nd} year of drought (after fuels had dried). Ecological Applications 27:1746-1760.



Copes-Gerbitz – Ne Sexstine (Williams Lake Community Forest) – 4-year MFA for whole area; 15 years MFA at the plot level. Fire regime was dominated by low severity fires with some mixed-severity fires indicated by cohorts. 56% of fires were in the dormant season – may be both wildfires and cultural burning in the fall. Burning was more frequent around winter villages and summer fishing camps, and there was burning for berries such as soopolallie.

Douglas-fir landscapes co-evolved with indigenous management including the frequent use of fire. After the devastating smallpox outbreak in the 1862-63 (killing up to 2/3 of people), fires were much less frequent around village sites and fishing areas (warmer/drier bench areas along the Fraser River where campfires were used regularly and berries were picked). On the plateau where hunting was the primary activity, fire frequency dropped off in the 1920s with the advent of industrial scale grazing and logging (settlers may have helped maintained frequent fire for a while). The 1874 BC Bush Fire Act effectively outlawed off-reserve cultural burning.

The contribution of Indigenous stewardship to an historical mixed-severity fire regime in British Columbia, Canada
Kelsey Copes-Gerbitz, Lori D. Daniels, Shannon M. Hagerman
First published: 14 September 2022 Ecological Applications

https://doi.org/10.1002/eap.2736

Ignace et al. (2017): landscape burning was done to enhance the growth of berries and root crops, control insects and invasive plants, and improve forage for deer and elk. Elder J. Jules (cited in Blackstock and MacAllistar (2004)) said that elders used fire to suppress sagebrush and manage tree encroachment on grasslands through landscape burning. Indigenous Nations have shared their knowledge that open forests and grasslands were maintained by aboriginal use of fire based on knowledge and traditions passed down from generation to generation (Moore 2001, Cirque Resources and BC Extension Services 2013, uncited confidential document 2021). As summarized in the Dry Belt Fir strategic plan.

Cultural burning was curbed by both the smallpox epidemic and the outlawing of burning (1874 Bush Fire Act) when people were forced on to reservations.

The gold rush brought settlers and livestock to feed gold miners. Grazing of fine fuels reduced the ability of areas to sustain fires – many grasslands were so heavily grazed they were mostly bare dirt. Fences were built on Becher’s Prairie in the 1930s but forests weren’t grazed much until the 40s. It was a tragedy of the commons situation – everyone was doing it so you would miss out if you didn’t graze the grasslands too. Many setters did some burning.

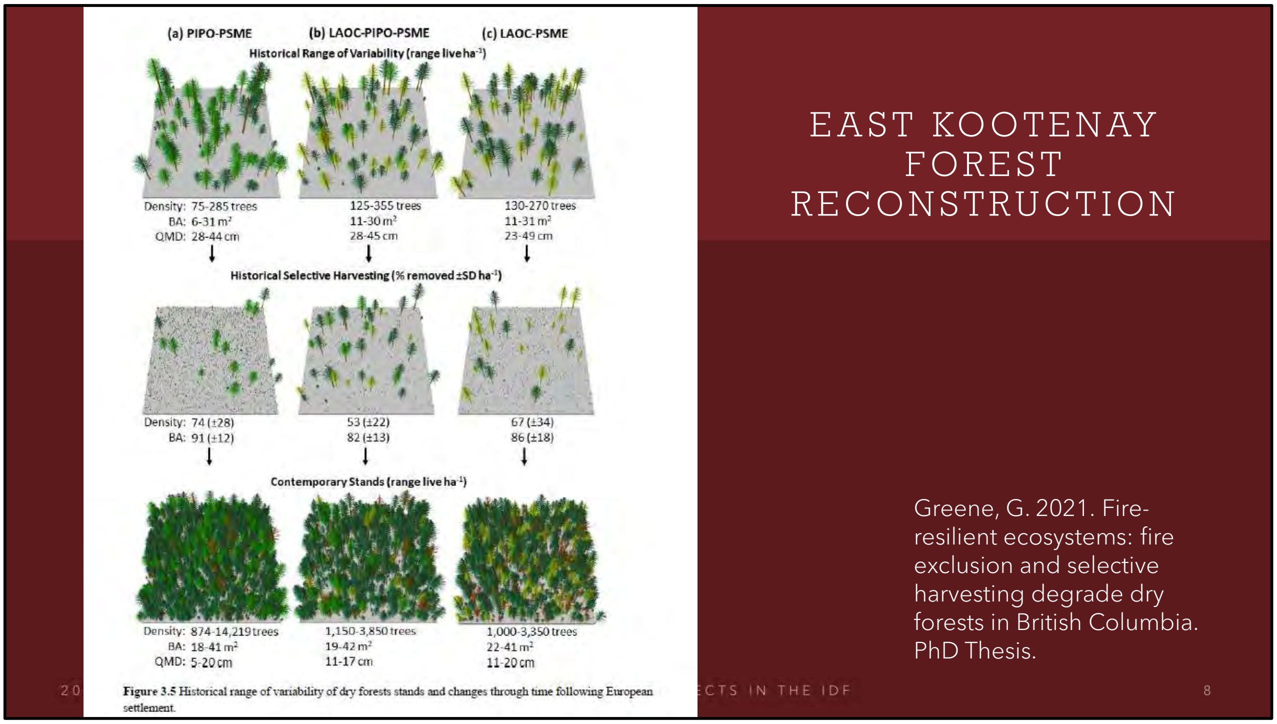
Roads associated with settlement and industrial development created linear barriers to fire movement. Logging altered forest structure and fuels and fire behaviour. Finally, fire suppression put out fires. Now we have climate change interacting with intense accumulation of fuels in forests.

HISTORICAL STANDS

IDFdk3

- Widely spaced Douglas-fir – irregularly arranged in clumps, openings and individuals
- Many regenerating trees killed by frequent fire
- Shrub and grass dominated understories
- With increased elevation, more patches of moderate to high severity and more lodgepole pine
- Pine was a mixture of even- and uneven-aged

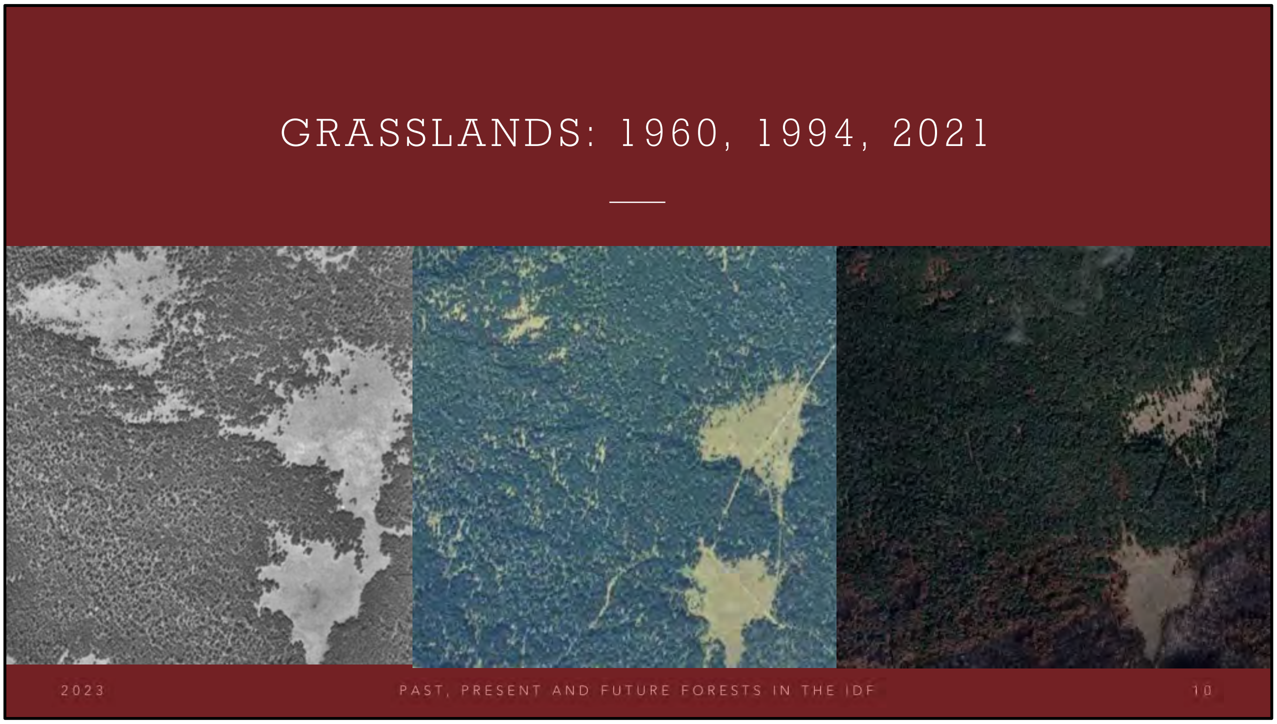
Frequent low and mixed severity fires created stand structures that promoted more similar fires. Trees were mostly widely spaced enough that they could not sustain a crown fire and many regenerating trees were killed by fires. Fires removed many fuels from the shrubby/grassy understory. Lower branches of trees were pruned by fire.



Images depict average structure and composition for stands under the historical range of variability, following historical selective harvesting, and for contemporary conditions. Reconstructions are for stands with the following species assemblages (a) ponderosa pine and Douglas-fir (PIPO-PSME), (b) western larch, ponderosa pine and Douglas-fir (LAOC-PIPO-PSME), and (c) western larch and Douglas-fir (LAOC-PSME). Live/dead ponderosa pine, Douglas-fir and western larch are light green/light brown, dark green/dark brown, and yellow-green/red, respectively. Average regeneration densities are depicted on the surface of selectively harvested stands. (Greene 2021).

Note the irregular individual, clump and opening nature of historical stands (ICO). Stand densities were 75 to 355 stems per hectare.
Compared to the Cariboo, logging happened about 20 years earlier and there likely would have been more advanced regeneration in Cariboo forests at the time of widespread diameter-limit cutting.

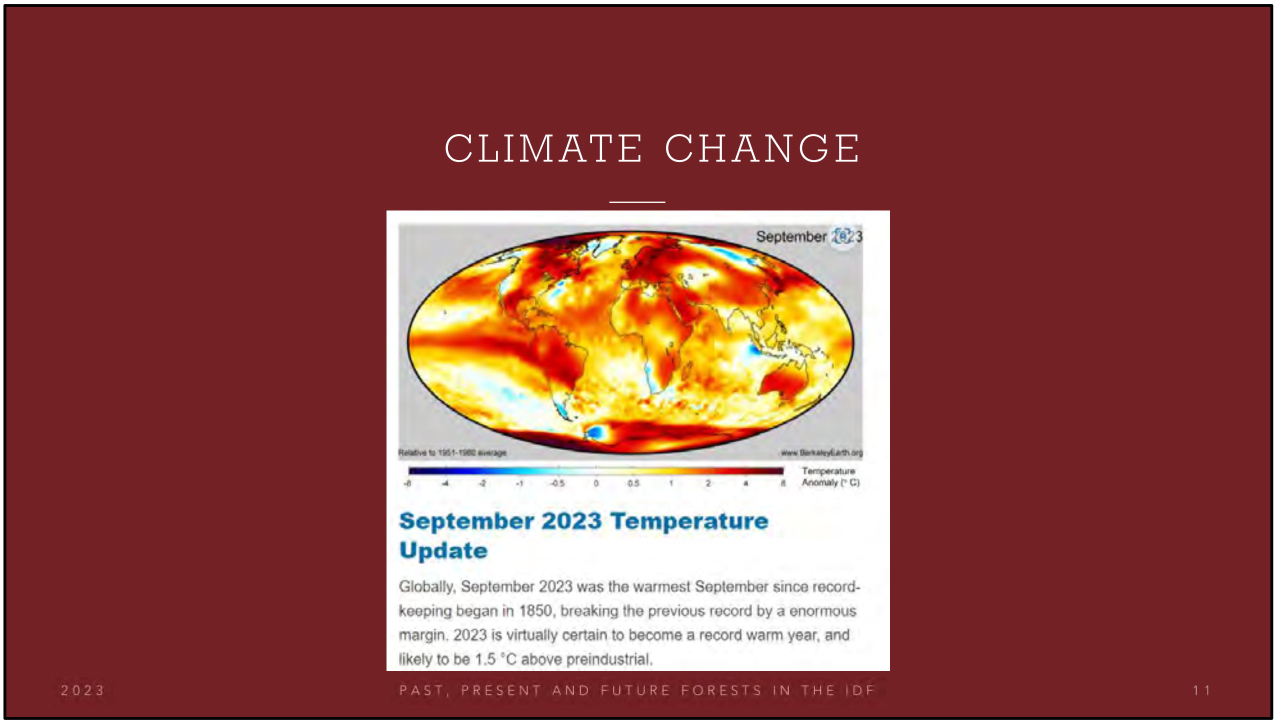
Ingrown stands – the left two photos had diameter-limit cuts and the right-hand photo has no history of harvesting. These show examples of stand structure and understory vegetation in the absence of fire with no recent harvesting or thinning. The photo on top shows the severe fire effects that can result from wildfire in these dense, ingrown stands (from 2021 wildfire in Churn Creek Protected Area in a forest of trees that had encroached on grasslands). In addition to killing the overstory, severe wildfires result in large losses of carbon from the soils and a shift from mycorrhizal fungi to pathogenic fungi (T. Philpott pers. comm.). Many plants that would have survived low or moderate severity fires are killed and these sites are vulnerable to weedy and invasive plants. They are also very difficult to regenerate and future fires are likely to kill regenerating trees before they become fire resistant or surface fuels will be too high or stands will be too thick and susceptible to crown fires.



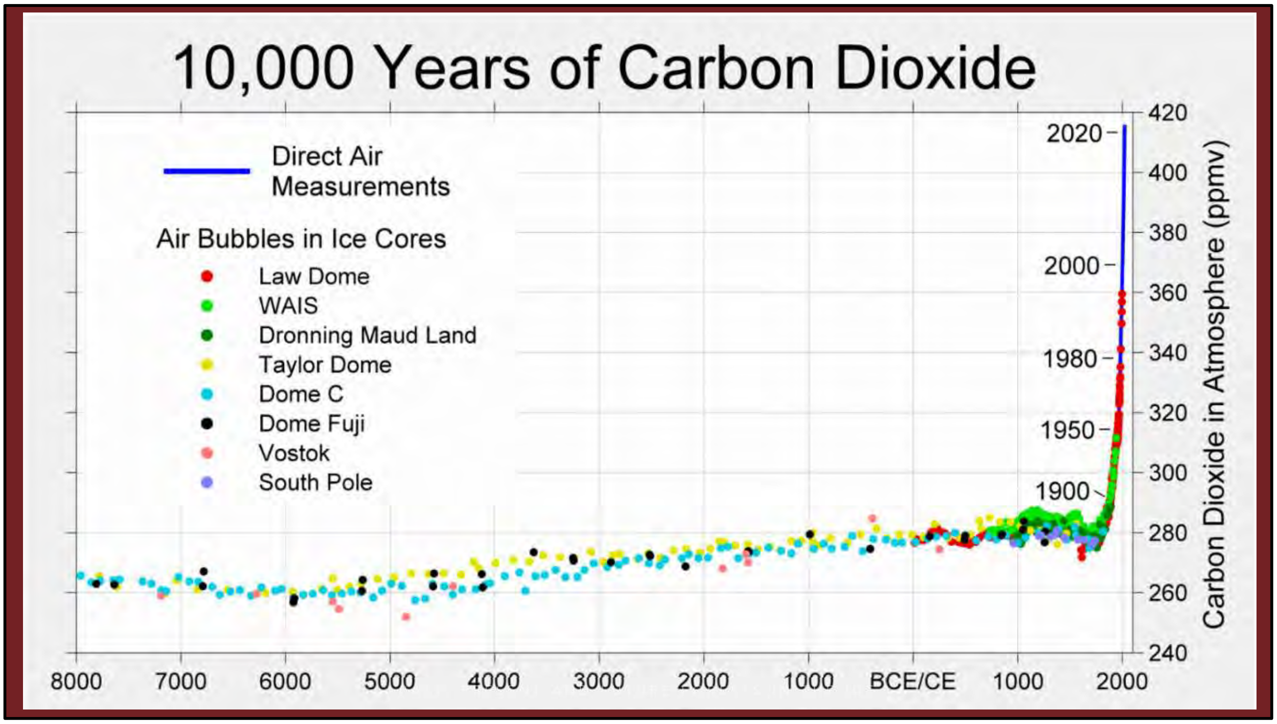
A portion of Churn Creek Protected Area in the 1960s compared to 1994 and 2021. Serious ingrowth (and likely encroachment) have already infilled forests by the 1960s. The northwest patch in these photos has a slightly cooler aspect, making it more susceptible to encroachment. About a third of upper grasslands were lost to encroachment from the mid 1960s to the mid 1990s. Encroachment and ingrowth has occurred in distinct waves.

As of about 2021, 58% of grasslands identified in the Grassland Benchmark have some level of encroachment within them. Approximately 33,000 ha lost since the mid-1990s. Reimer, A. 2023. Forest encroachment in grassland areas of the Cariboo Natural Resource Region.

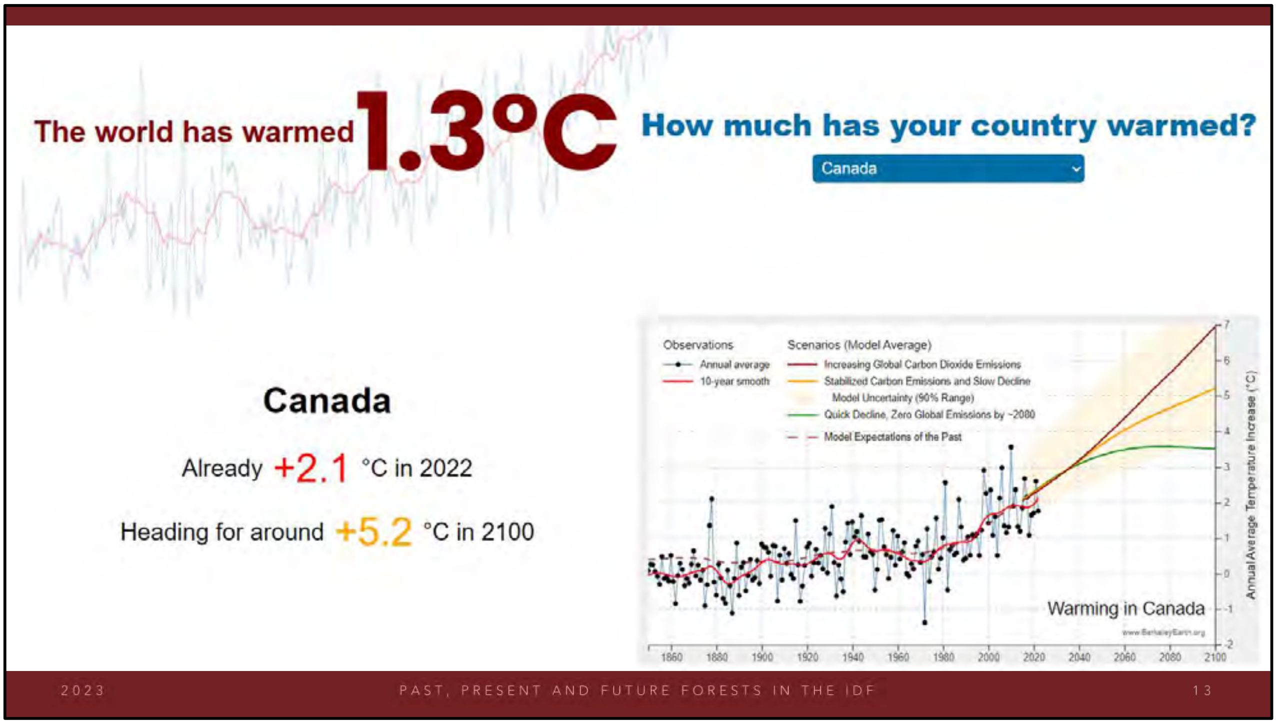
This has resulted in a loss of habitat for many species including species at risk and many culturally important plants. It is difficult to restore grassland plants except in recently encroached areas where grassland plants persist under younger trees in open conditions.



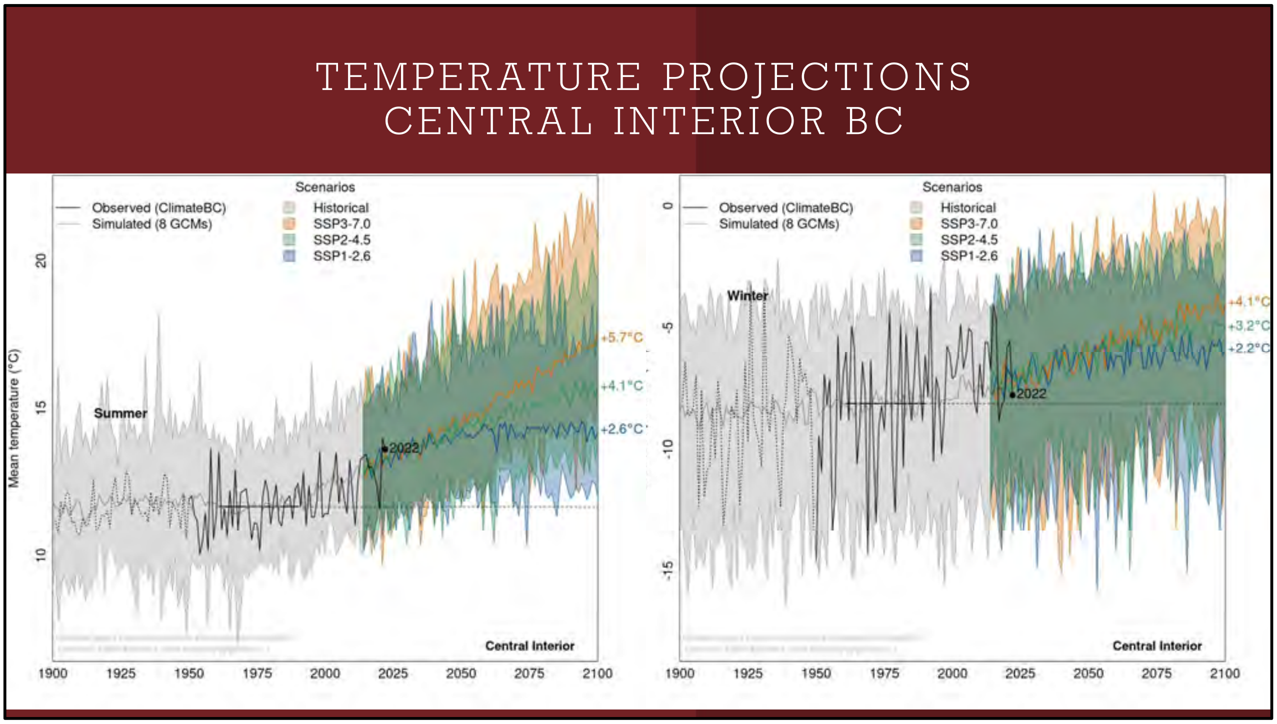
Source: Berkely Earth: [September 2023 Temperature Update - Berkeley Earth]
Berkeley Earth is an independent U.S. non-profit organization focused on environmental data science and analysis.
Shows temperature anomalies in September 2023 relative to the 1951-1980 average



Source: Berkely Earth (10,000 Years of Carbon Dioxide - Berkeley Earth)
Radiation enters as short-wave radiation and exits as long-wave radiation; CO2 traps long-wave radiation
CO2 has a long residence time; warming will continue even if emissions end
CO2 levels are believed to be the highest in the last 800,000 years (historical range of 180-300 ppm)
Methane is the 2nd most important greenhouse gas

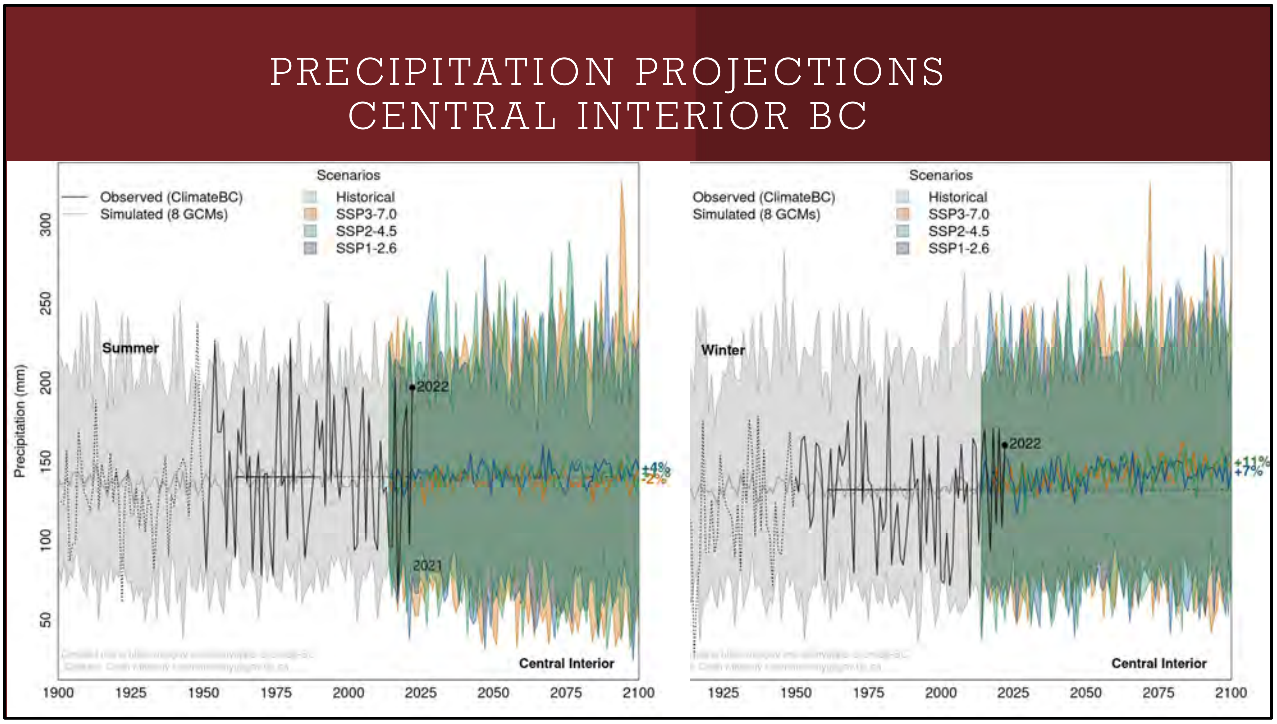


Source: www.BerkeleyEarth.org
[Policymakers - Berkeley Earth]



ClimateBC_Map https://bcgov-env.shinyapps.io/cmip6-BC/ global climate model simulations, the 6th Coupled Model Intercomparison Project (CMIP6)
Mahony, C.R., T. Wang, A. Hamann, and A.J. Cannon. 2022. A global climate model ensemble for downscaled monthly climate normals over North America. International Journal of Climatology. In press. doi.org/10.1002/joc.7566

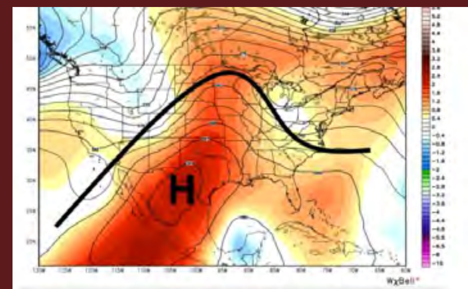
SSP245 1961-1990
SSP245 2041-2070
SSP = Shared Socioeconomic Pathways
SSP1-2.6 strong reductions consistent with the Paris Climate Accord to limit warming to 2.0 degrees C, SSP2-4.5 moderate mitigation consistent with current trends and policies, SSP3-7.0 no mitigation
Temperature rise will bring more drought, less snowpack, worse fire weather, insect/disease outbreaks, ecological maladaptation, less frost. There will be uncertain ecological responses.
The temperature in the central interior of BC has increased 0.98 degrees C from 1970-2021 (Pariesen et al. 2023). Colin Mahoney (research climatologist, MoF) makes the point that SSP1-2.6 is the only scenario that we can adapt to, other scenarios will result in ecological and societal collapse.



Central Interior Ecoprovince
- need 15% increase in precipitation for each degree of warming to compensate for drier fuels (Flannigan et al. 2015 Fuel moisture sensitivity to temperature and precipitation: climate change implications). Precipitation increases are not currently nor predicted to be sufficient to compensate for warming; fine fuels will be much drier.

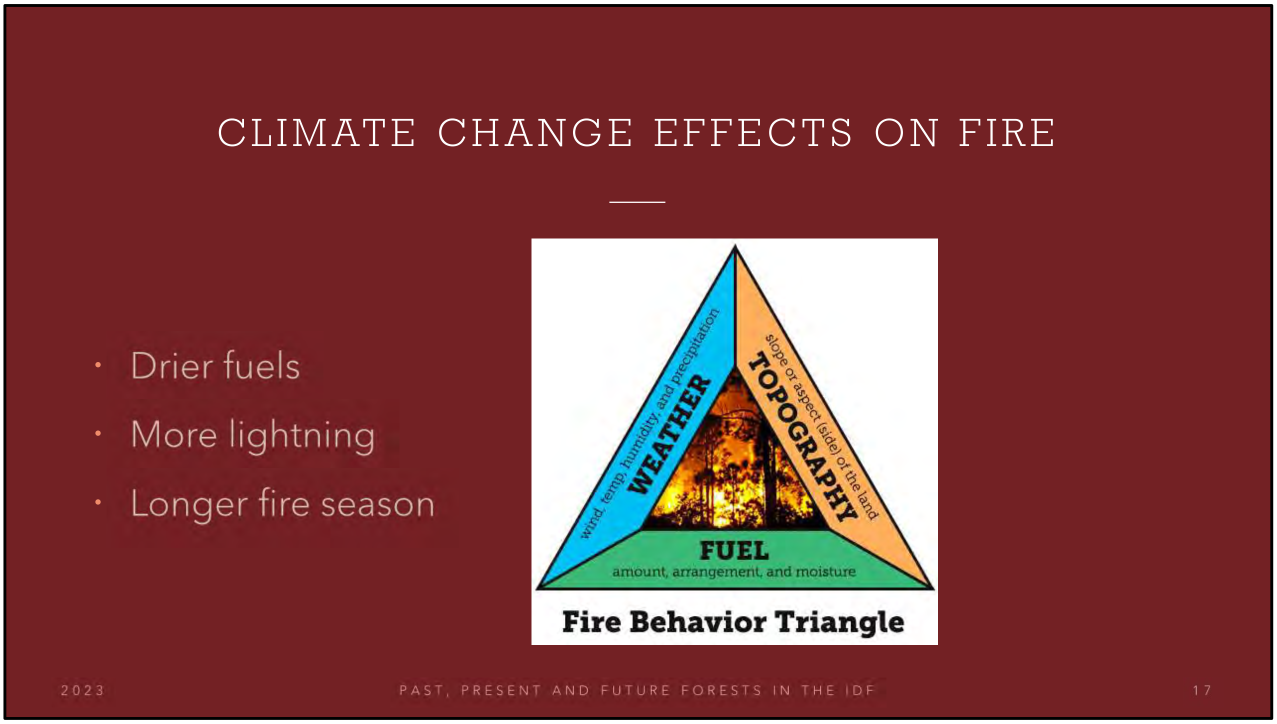
We are coming into modes of unfamiliarity in climate:
- novel climates (some areas with no current analogs in BGC units)
- more extremes
- smoky summers

JET STREAM



High-pressure ridge over Texas, 2018. *(Weatherbell)*

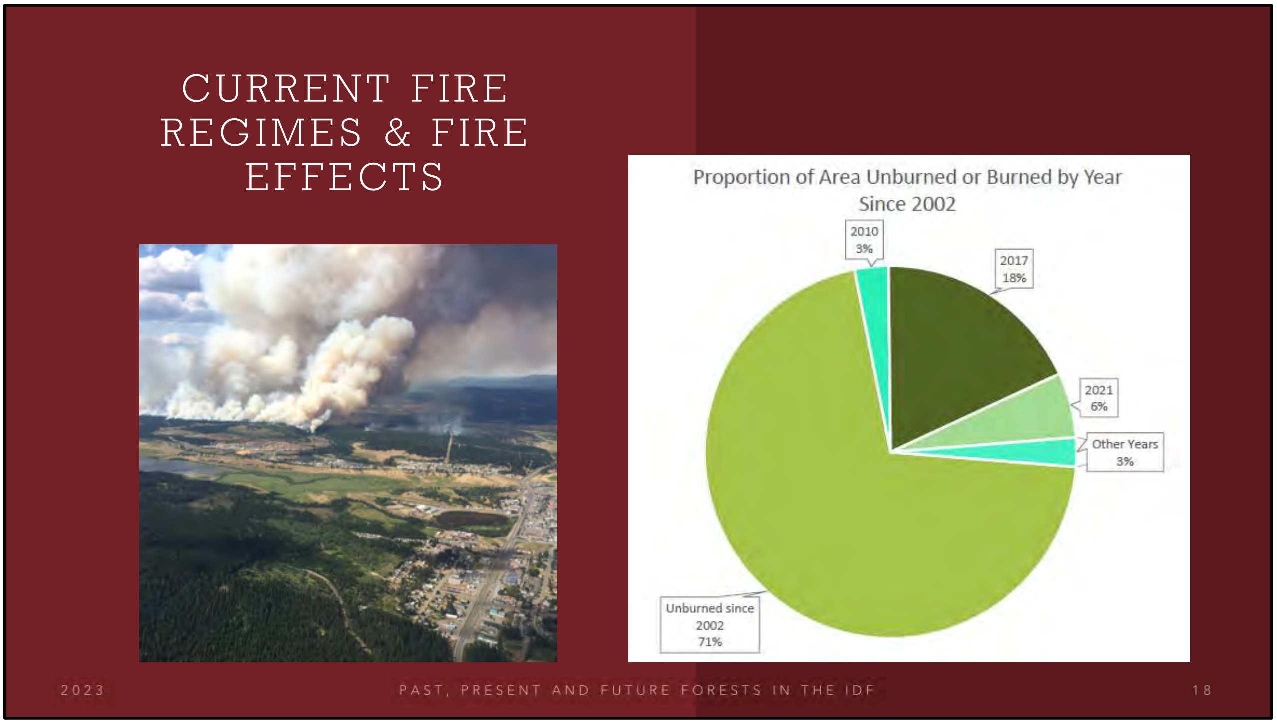
Warming is occurring more at northern latitudes; Canada warmed 1.8 deg C between 1948 – 2020 (twice the global rate)
Temperature increases are as expected; extreme weather impacts have been more severe than expected. The jet stream is band of fast-moving air generated from the temperature difference between equatorial and polar regions. Climate change is causing a weaker jet stream (the north has warmed faster, and the reduced temperature differential weakens the jet stream). The jet stream can meander more and stagnate leading to greater extremes – droughts, floods, heat, cold. One example is the 2021 heat dome setting temperature records.



Changes in wildfire trends relate to both climate and other anthropogenic changes. There were many small, human-ignited fires in the early part of the 20th century up to the 1950s. A cooler/wetter climate and effective suppression let to few fires from the 1950s to about 2000. Three years with >0.5 Mha burned from 1919-2016; four years from 2017-2023 >1 Mha burned.

- Drier fuels – almost exponential increase with warming, easier for fires to start, easier to burn, easier to spread.
- Reduced winter snowpack and earlier spring snowmelt lengthen the fire season
- Increased tree mortality leads to greater accumulations of dry forest fuel
- Higher intensity fires that are harder to extinguish, faster rates of spread
- Need 15% increase in precipitation to compensate for 1 degree warming
- More lightning including lightning generated by fires

2023 Fire season: generated 1.42 billion tonnes of CO_2 released by fires vs. 670 million tonnes from Canada's economy. Everything we can do to mitigate severe wildfires will help reduce this feedback loop where wildfires produce CO_2 and exacerbates climate change.



Current Forests: Since 2002, 71% of the Cariboo Region IDF is unburned, and there have been megafires in 2017, 2018, 2021 and 2023 in the province. Climate change will overwhelm fire suppression capabilities. Current stands are in-grown and will promote crown fires instead of burning through the understory. Frequent fires, loss of soil carbon and nutrients, drought, and grass competition will reduce our ability to regenerate forests. This figure represents the area burned in the Cariboo Region IDF up to 2022. Some additional area was burned in 2023. This area is from fire perimeters; there is variable severity and some unburned patches within these perimeters.

Climate change has and will continue to overwhelm our fire suppression capabilities. Bad fire years are more likely to have many fires occurring at the same time. Very severe wildfires are unsafe for any direct suppression activities. 2021 Sparks Lake wildfire NW of Kamloops shown on the left. West Kelowna (McDougall Ck) wildfire shown on the right. Every $ spent on prevention and mitigation can save $4-11 Every $1 Spent on Natural Disaster Preparedness is $11 in Return | 2019-01-16 | Security Magazine

There are now many examples of catastrophic wildfires that exceed our suppression abilities and have severe fire effects making it difficult to reforest.

Fires in areas with high fuel loads/dense forests in the IDF send embers far beyond that can lead to structural loss even in areas with good fire smarting. The fire in West Kelowna ignited Kelowna on fire – a 2 km wide lake did not stop its spread.

A short-interval reburn (9 years between high-severity fires) in Wood Buffalo National Park. A dead jack pine sapling with a non-serotinous cone is visible in the foreground, representing the trees that were regenerating after the first fire. After two fires, the site has changed from a jack pine forest to an open aspen woodland with a grass understory.

Whitman, Ellen. 2019. Burn severity and fire history in the northwestern Canadian boreal forest: drivers and ecological outcomes. PhD Thesis University of Alberta.

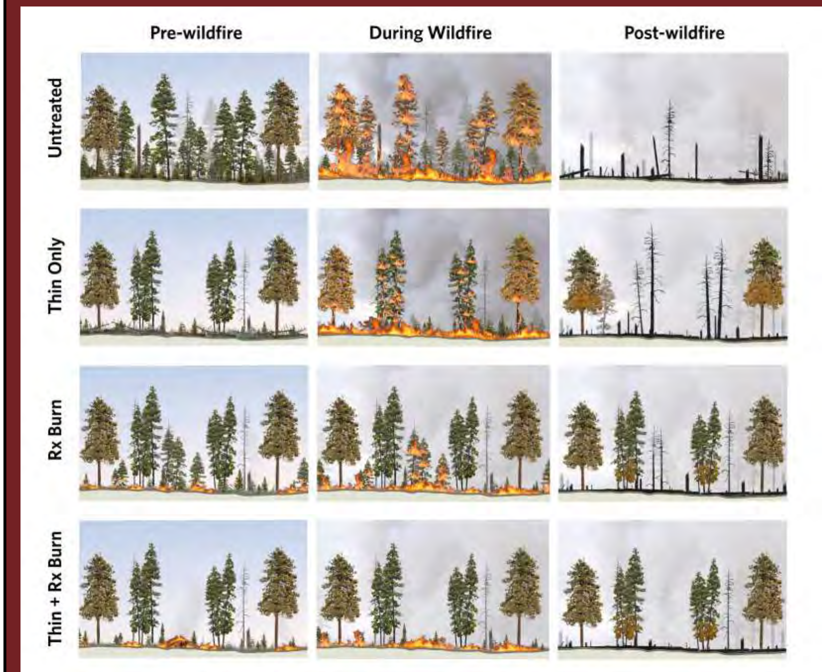
Loss of carbon and nutrients, grass competition, exposure, drought, and frequent fire all reduce our ability to regenerate forests.

Whitman, Ellen. 2019. Burn severity and fire history in the northwestern Canadian boreal forest: drivers and ecological outcomes. PhD Thesis University of Alberta.
What happens when sites reburn? How much fuel is on the ground – depending on the salvage or not and material left, this will affect fire severity. Are the trees on the site large to resist fire (thick enough bark)? Are they spatially distributed so it won't be a crown fire?

Hoecker, T.J., Parks, S.A., Krosby, M. *et al.* 2023. Widespread exposure to altered fire regimes under 2 °C warming is projected to transform conifer forests of the Western United States. *Commun Earth Environ* **4**, 295. https://doi.org/10.1038/s43247-023-00954-8 Fire-induced loss of forest is documented across the range of Douglas-fir and ponderosa pine, where drought affects regeneration. Adaptation to more frequent fire is possible if burn severity is low and cone-bearing trees are able to persist. It may be difficult to expand the range of Douglas-fir given regeneration challenges. Frequent fire may kill young regenerating trees if their bark is not thick enough, if fuels are too high, or if regenerating stands are too thick.

The compounded effects of increased fuels and climate-altered moisture reductions mean we are facing more frequent intense, widespread, and prolonged fires.

Of the three components of fire behaviour, fuel is the only one we have control over. Forest structure and fuels need to be thought of through a fire lens to ensure we have stands and landscapes resistant to fire.



FOREST THINNING & SURFACE FUEL TREATMENT

Davis, K.T., J. Peeler, J. Fargione, R.D. Haugo, K.L. Metlen, M.D. Robles, and T. Woolley. 2024. Tamm review: a meta-analysis of thinning, prescribed fire, and wildfire effects on subsequent wildfire severity in conifer dominated forests of the Western US. Forest Ecology and Management 561:121885

Comparison of how wildfire would behave in an ingrown forest compared to a thinned forest, and treatment of surface fuels. The treatment of surface fuels is important to prevent crown scorch and survival of the overstory in a wildfire. In thinning treatments, many larger more fire-resistant trees are retained. These trees are the most important for wildlife habitat. Veteran trees often have heart-rot which allows for more cavity nesters. Larger trees intercept more snow for mule deer winter use and their foliage is more nutritious.
https://doi.org/10.1016/j.foreco.2024.121885

Two blocks at Farwell Canyon in the IDF were treated in 2002 with three treatments – untreated control, logged and thinned, logged, thinned, and burned. Small untreated retention patches were retained within both treatments. Basal area retention was about 15 m2.

Block size: 44 ha and 71 ha;

- Pretreatment large tree density: 40 -50 sph >40 cm DBH
- Started with approximately 130 – 210 m3 merchantable volume and retained 55 – 105 m3
- Many small diameter trees died within the untreated control
- 10 years after harvesting – volume increased by 10-20 m3 except in control where volume declined by 20 m3 (and one area of Fd bark beetle)
- New waves of regeneration between 2008-2015 in the treated areas (some in the control where many layer 3-4 trees died and spruce budworm reduced leaf area)
- Logged by Riverside – was a profitable enterprise; they were not responsible for prescribed burning

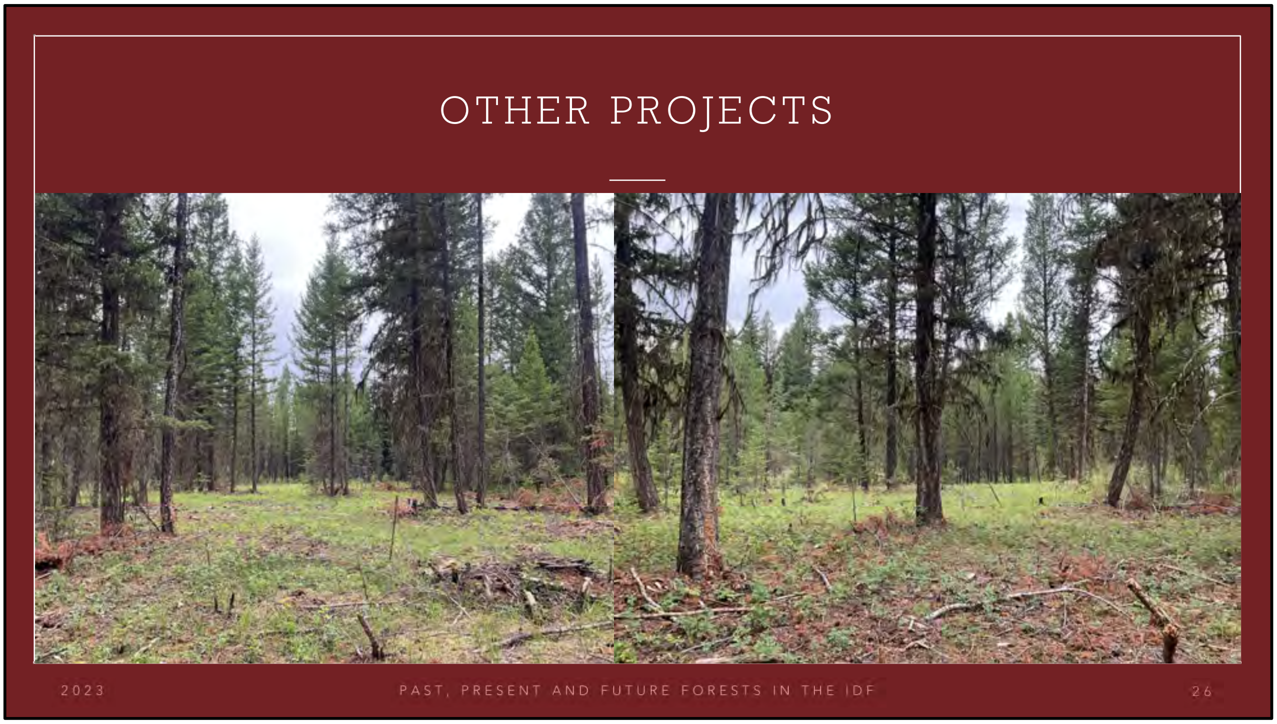
TREATMENT AREA

2023

24

Overview of one of the two blocks. Retained unthinned clumps are visible in this picture.

In 2017 BC Wildfire had a planned ignition along the road that started as a crown fire and dropped to a surface fire when it came to Block 1 of the treatment area. The overstory in patches that were not thinned burned but otherwise there was very little overstory mortality.



Williams Lake First Nation restoration harvest block near Brunson Lake.

- There was profit from this restoration harvesting.
- The treatment is within mule deer winter range and met basal area targets (22-25 m2)
- The treatment left a nice irregular and clumpy structure.
- Used a feller buncher in a meandering pattern to avoid creating linear skid trails. Openings provided space for the buncher to maneuver
- Used landings rather than roadside processing to minimize disturbance.
- Removed small biomass with an excavator to the pulpmill/cogen/pellets (FES funded).
- Planning a cultural burn after understory grasses respond.

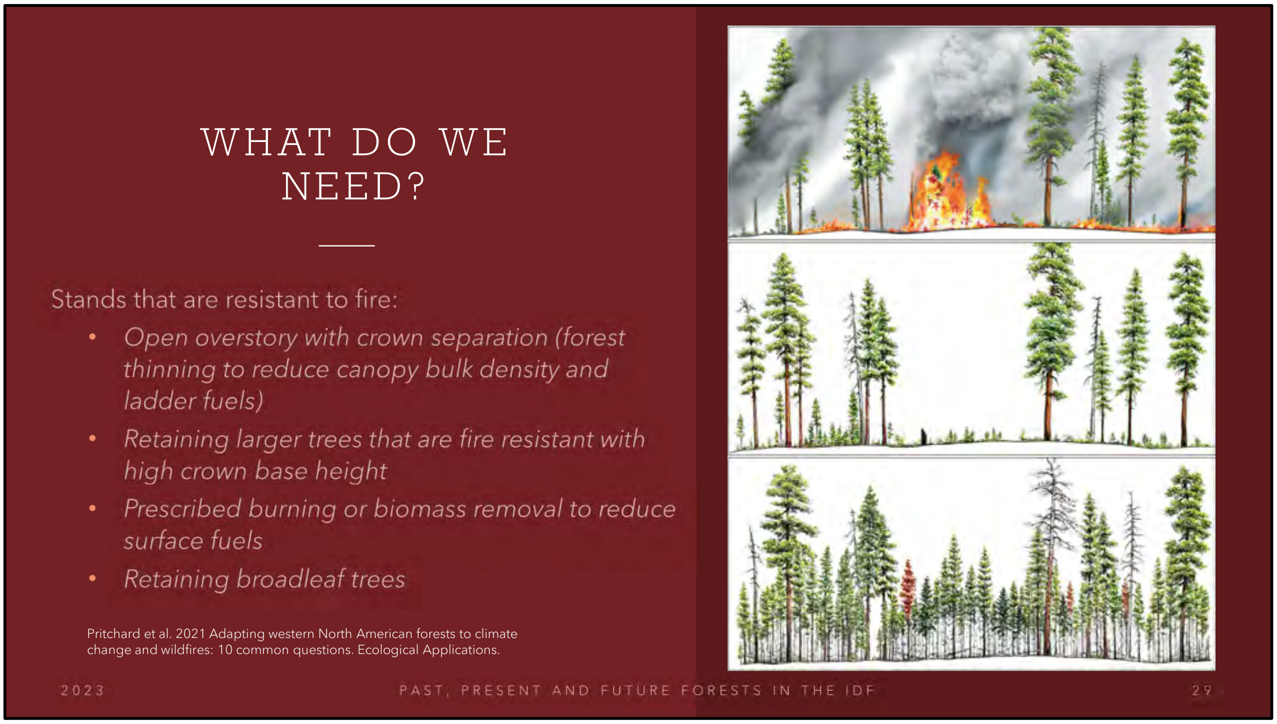
BC Ministry of Forests and WLRS are working on an adaptive management research trial with Esketm (ARM) in the IDF

Aerial view of Brunson Lake restoration treatment from previous slide.

Other ongoing project – Adaptive Management Trial with Alkali Resource Management and BC MoF and WLRS – logging and thinning and cultural burning – looking at tree, vegetation (including culturally important plants) and wildlife response. This is a replicated research trial with three blocks in the IDFdk3. One block is being treated this winter (2023-24).

Large openings from current harvesting practices are making regeneration difficult (from frost and heat/sun exposure) and remaining trees are still likely to be killed by fire with consumption of surface fuels and may sustain crown fires unless they are thinned.

1) Clearcuts – retained surface fuels, difficult to regenerate – both frost and heat/sun exposure, loss of habitat, may not become forests in future climate and wildfire regimes (regenerating trees likely to be killed by a future fire with heavy surface fuels or, if older, likely to sustain a crown fire unless they are thinned.
2) Thinning of OGMA/MDWR where roads and skid trails were the only removals. Trees/fuels in strips that will readily burn as a crown fire. Trees have not been thinned so that they can release and grow. Has not improved conditions for old trees that will still be stressed and susceptible to pest/disease/fire
3) Clearcut with reserves as per OGMA example: no fire resistance and no release of smaller diameter stems. Not setting up for a future harvest. Openings large enough to be difficult to regenerate. Remaining slash will attract Douglas-fir beetle
4) Overview of an area harvested just along skid roads.



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We need stands that are resistant to fires: open overstory with crown separation (forest thinning to reduce canopy bulk density and ladder fuels), larger tree retention with high crown base height, prescribed fire/biomass removal to reduce surface fuels, retention of broadleaf trees.

Without the reduction of surface fuels fires are often still too intense – can result in overstory mortality through scorch even without a crown fire; the more open sites also will result in drier fuels and windier conditions. Surface fuels will also affect fire impacts on soils.

These stands can modify fire behaviour and reduce the intensity of wildfires arriving at our communities (even under extreme conditions). Stands may need to be similar densities to the next warmer climate (e.g. IDFdk3 may need to look more like the historical forests in the IDFxm including conversion of pine stands to Douglas-fir).

Broadleaf trees can sometimes moderate fire behavior where they occur next to thinned stands. However, severe wildfires will burn aspen as well. With more drought from climate change, aspen may become more restricted to moister sites/climates.

There is a concurrent need for landscape level planning (FLP) to identify and target the most effective areas to treat and to design a mosaic of patches – forest and non-forest ecosystems.

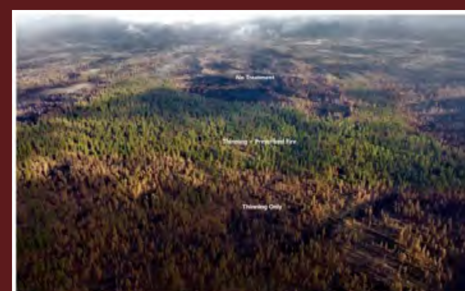
Adapting western North American forests to climate change and wildfires: 10 common questions

Susan J. Prichard, Paul F. Hessburg, R. Keala Hagmann, Nicholas A. Povak, Solomon Z. Dobrowski, Matthew D. Hurteau, Van R. Kane, Robert E. Keane, Leda N. Kobziar, Crystal A. Kolden, Malcolm North, Sean A. Parks, Hugh D. Safford, Jens T. Stevens, Larissa L. Yocom, Derek J. Churchill, Robert W. Gray, David W. Huffman, Frank K. Lake, Pratima Khatri-Chhetri

Ecological Applications 2021 https://doi.org/10.1002/eap.2433

NEXT STEPS

- Land Act Order amendment
- Best Management Practices
- More pilot projects
- Landscape level planning



A summary of ongoing initiatives in government