# INTACT FORESTS, SAFE COMMUNITIES

Reducing community climate risks through forest protection and a paradigm shift in forest management

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# EXECUTIVE SUMMARY

B.C.'s Strategic Climate Risk Assessment identifies 15 climate risks, several of which have the potential to create catastrophic impacts for B.C.'s communities. Overall, the assessment found that the greatest climate-related risks were severe wildfire, seasonal water shortage, and heat wave events. It also found that events such as severe river flooding were of "high consequence," though less likely to occur.

There is a large body of scientific literature that documents the impact that industrial logging has on the severity and frequency of many of these events, yet the Assessment did not consider this information. This presents a major blind spot that could undermine the assessment's findings and the effectiveness of the Province's response in defending communities from worsening climate impacts.

This report attempts to address this gap in order to understand the role that forests in B.C. can play in either mitigating or exacerbating those risks, depending on how we manage them. It finds that nine of these risks are substantially affected by forest management, some of which could have catastrophic consequences for the health and safety of local communities.

The climate risks that are most affected by forest management include:

1. **Long-term water shortage**
2. **Seasonal water shortage**
3. **Riverine flooding**
4. **Moderate flooding**
5. **Extreme precipitation and landslide**
6. **Severe wildfire season**
7. **Heat wave**
8. **Loss of forest resources**
9. **Reduction in ecosystem connectivity**

Just as climate change is expected to generate more extreme weather, intensive forest management, namely clearcutting, creates extreme conditions locally and at the landscape level. Clearcutting increases the frequency and intensity of forest fires, due to the significant proportion of dead biomass left behind, sun-exposed and flammable, and the extensive network of roads involved that increases the likelihood of human-caused ignition. Younger trees are extremely flammable due to dense spacing, thin bark,



*Photo by Orlova Maria.*

and low-hanging branches. They are also more susceptible to insect outbreaks, leading to dead standing trees that are susceptible to fire.

Clearcut logging disrupts local hydrology, increasing the risk of flooding at peak periods, but also resulting in higher peak temperatures and periods of drought. Roots of stumps begin to decay, losing their grip on soil, causing erosion and water turbidity, slope instability, and increasing the likelihood of landslides.

In contrast, old intact forests act as a moderating influence on the landscape, creating their own microclimate that is cooler and wetter year-round. The shade they provide allows for the development of a rich understory and soil development, which acts as a sponge, absorbing and releasing water slowly throughout the year, mitigating against both drought and flood conditions. It shelters snow from the sun, slowing the release of snowmelt. Extensive and mature root networks support soil structure and maintain slope stability. Older trees have fewer flammable low-hanging branches that can lead fire up to the canopy. They also have thicker bark, and are spaced wide apart, all of which allow them to withstand a low-intensity fire.

The previously held belief that strict protection of forests can lead to fuel loading and an increase in fire severity has been thrown into question by recent research. In fact, it appears that intact forests act as safe havens within the landscape, supporting ecosystem function and resilience, and lowering risk to surrounding communities.

Second-growth forests can be managed to increase resiliency, reduce vulnerability, and mitigate climate risks identified in the Assessment. This may include reducing harvest intensity and extending harvesting cycles, thereby allowing the forest to recover to its full potential. In addition, pre-commercial thinning, brush removal and pruning can reduce the severity and extent of burns. Re-introducing Indigenous fire management systems could also reduce fuel load and insect outbreaks, and restore resilience in many ecosystems.

While many of the findings are specific to forest type, and will necessarily be different for coastal and inland rainforests versus dry interior and boreal, the policy recommendations for reducing climate risk are remarkably similar. Measures required to

*Photo: An ancient cedar stands alone in a cutblock (Sierra Club BC).*

address the role that forest management plays in either increasing or decreasing these risks are consistent with recommendations that have been made in both the 2020 Old Growth Strategic Review, and proposed "*Renewal and Resilience*" amendments to the Forest and Range Practices Act. As called for in the strategic review, a fundamental paradigm shift is required to reform forest management in B.C.

Remaining old-growth in rare ecosystems must be protected, and forest that has already been degraded by logging should be restored and managed to increase resiliency. Most importantly, a "climate risk impact test" should be applied to all forest management decisions, to determine if a given action will increase the vulnerability of the forest and adjacent communities to identified climate risks. Key forest decision makers, including the chief forester and district managers, should be mandated to monitor and report on the state of these risks. Harvest levels should reflect measures required to ensure that health and safety risks have been mitigated, using a precautionary approach.

While this report and accompanying literature review provide a good start, more work needs to be done to independently assess the impact that logging has on community climate risks.

Efforts to defend communities from climate risks can be strengthened by incorporating Indigenous perspectives, cultural values, and traditional knowledge into forest management decisions. The Government of B.C. has the opportunity to demonstrate their commitment to reconciliation and uphold the Declaration on the Rights of Indigenous Peoples Act, while also addressing climate risks, by ensuring that Indigenous peoples are included as joint decision-makers in all relevant processes.

B.C. has entered a new era of climate emergency that is marked by risks to communities, and forest management must be adapted to mitigate these. This presents an opportunity to right the wrongs of the past, transition to a more sustainable model of forestry, and build more resilient communities. However, time is running out, as these threats will only increase in magnitude with further warming and logging of intact forests.

*Photo: A patchwork of cutblocks fragment an inland rainforest near Prince George (Dominick DellaSala).*

# INTRODUCTION

In July 2019, the B.C. Government released preliminary results from the Strategic Climate Risk Assessment, which identifies 15 climate risks that have the potential to create catastrophic impacts for B.C.'s communities by mid-century. The Assessment is intended to help government better understand and prioritize climate-related risks based on their likelihood and consequence, and develop appropriate measures to address them. It is also intended to be used to inform decisions made by the Deputy Ministers' Council and Cabinet relating to government priorities that may be at risk due to climate change. It acknowledges that additional work is needed, most notably the consideration of Indigenous perspectives and cultural values.

Overall, the assessment found that the greatest climate-related risks were severe wildfire, seasonal water shortage, and heat wave events. In addition, events such as flooding were of "high consequence," though less likely to occur. This report draws upon scientific studies to examine the role that forest management can play in either mitigating or exacerbating these risks, and presents policy recommendations that offer the best hope of building resilience and ensuring the long-term health and safety of local communities.

While it is well established that primary forests are capable of serving as stable reservoirs of carbon, and continue to sequester more carbon well into their old age,[1] this report focuses on the role they can play in reducing the health and safety risks that are expected to threaten B.C.'s communities under even the most optimistic climate scenarios. Conversely, if poorly managed, they are at risk of not only contributing to climate change by releasing carbon, but would exacerbate the health and safety impacts that local communities experience as a result of climate change.

In the past century, forests in B.C. have been logged at an unsustainable rate, starting with the most accessible and merchantable stands. A recent analysis has revealed that only three percent of B.C.'s high-productivity old-growth forests remain intact.[2] Intact forests—largely



*Photo by TJ Watt/Ancient Forest Alliance.*

| RISK EVENT | RISK | INFLUENCED BY FORESTRY |
|---|---|---|
| Severe wildfire season | High | ▲ |
| Seasonal water shortage | High | ▲ |
| Heat wave | High | ▲ |
| Ocean acidification | High | |
| Glacier mass loss | High | |
| Long-term water shortage | High | ▲ |
| Reduction in ecosystem connectivity | Medium | ▲ |
| Saltwater intrusion | Medium | |
| Loss of forest resources | Medium | ▲ |
| Increase in invasive species (knotweed) | Medium | |
| Moderate flooding | Medium | ▲ |
| Severe riverine flooding | Medium | ▲ |
| Severe coastal storm surge | Medium | |
| Extreme precipitation and landslide | Medium | ▲ |
| Increased incidence of vector-borne disease (Lyme disease) | Low | |

*FIGURE 1: B.C.'s Strategic Climate Risk Assessment identifies 15 climate risks. Forest management has the potential to affect at least nine of these risks (highlighted above), yet is not considered in the assessment.[3] The original table is from the provincial assessment while the "Influenced by forestry" column and highlights were added by the author.*

free from roads and infrastructure—are recognized as the most carbon-dense and biodiverse terrestrial ecosystems on the planet.[4]

Forests occupy nearly two-thirds of B.C., and are extremely diverse, with 16 distinct biogeoclimatic (BEC) zones.[5] The amount of intact forest remaining varies considerably between different types of forests, particularly depending on whether they have lower or higher levels of natural disturbance (e.g. fire).[6] This diversity must be taken into consideration in tailoring prescriptions for maximizing climate resiliency and reducing vulnerability and risk. For example, areas with coastal and inland temperate rainforest should be considered separately from dry interior forests, and the boreal forest in the north, where fire plays a more important role in maintaining ecosystem dynamics. Price, Holt and Daust (2020) provide a detailed analysis of B.C.'s remaining forest according to BEC zone, site index, and natural disturbance type.[7]

Both of these factors, the proportion of B.C.'s forests that are intact and the diversity of forest types, are important to consider in reading this report and associated policy recommendations.

There are, however, limits to mitigating climate risks, and unless greenhouse gas emissions (GHGs) are not reduced to net zero globally in the near future, it will be nearly impossible to prevent catastrophic impacts to forests. Around the world, scientists are already witnessing widespread climate-induced forest die-off, creating a dangerous carbon cycle feedback, both by releasing large amounts of stored carbon and by reducing the extent of the future forest carbon sink.[8]

*Photo: Clearcutting intact rainforest eliminates ecosystem resiliency, generates large volumes of flammable debris, and makes landscapes more vulnerable to landslides and flooding (TJ Watt/Ancient Forest Alliance).*

# FIRE, DROUGHT AND HEAT WAVES

***RISK: Severe Wildfire Season:*** **At least one million hectares burned that affect human settlements and significant infrastructure.**

***Key Findings of B.C.'s Strategic Climate Risk Assessment:*** **Recent years have seen record-breaking wildfires, and the annual area burned in B.C. is projected to increase by 2050. Severe wildfires could contribute to negative health outcomes due to exposure to smoke, particulate matter, and other hazardous substances. Displacement due to wildfires, along with loss of possessions and livelihoods, could contribute to extreme psychological distress as well as economic losses to thousands of citizens. Severe wildfires may also disrupt operations and damage infrastructure across multiple sectors.[9]**

## THE RESILIENCE OF INTACT FORESTS

Forest fire severity and frequency are associated with warm and dry conditions, which are predicted to increase in a warming climate. These conditions lower fuel moisture, extend fire seasons and lead to drought and insect outbreaks.[10] A recent study determined that climate change has already had a major effect, contributing to an additional 4.2 million hectares of forest fire area in the Western U.S. between 1984 and 2015, nearly double the expected area.[11]

Temperate rainforests create their own cool, moist microclimate as they age, and this helps prevent forest fires.[12] The development of high, complex canopies creates shade and catches coastal mist, allowing the creation of deep moss beds and lush understory vegetation with rotting biomass, and rich soil development. This all serves to make these old-growth forests into giant sponges, readily absorbing and retaining water, sheltering snow from melting, then slowly releasing the water over a long period of time. As a result, some temperate rainforests have not seen fire in several thousand years.[13] [14]

The same holds true to a lesser extent for other forest types in B.C., even though they



*Photo by U.S. Forest Service—Pacific Northwest Region.*

face different natural disturbance regimes with more frequent fires. The dry forests of the interior are adapted to frequent low-intensity fires (burning the undergrowth but not mature trees), but also moderate to high-intensity fires. Forests in the boreal region in northern B.C. grow slowly and are also more fire-prone, rarely reaching the size and age of trees in wetter BEC zones.[15] However, even forests that are adapted to fire are less likely to burn when they are left intact, providing a cooler microclimate, retaining moisture for longer into the dry season, with mature trees that are less flammable.

These dynamics are borne out by many scientific studies. For example, Frey et al. (2016) highlight that old-growth appears to have an insulating effect, lowering spring temperatures by 2.5°C, meaning these forests have the potential to mitigate the impacts of climate change at the local level.[16] Another study in southwest Oregon demonstrated that old-growth spotted owl habitat proved to be more resistant to fire than surrounding young forest during a period of drought, and recommended that large blocks of old forest be protected.[17]

Scientists have identified the importance of "refugia" in the face of climate change.[18] These are landscape elements that remain unburned or minimally affected by fire, thereby supporting ecosystem function and resilience, and lowering risk to surrounding communities. They are strongly associated with old and intact forests, which tend to be cooler, moister, and less subject to drought and desiccation than younger forests. As a result, they contain high levels of biodiversity, structural complexity, and soil development.

During a fire, these old-growth refugia provide an island of safety for species, but also a firebreak that can reduce risk to communities. Following a severe fire, old-growth refugia provide a boost to adjacent ecosystems as they recover, including a source of seed and biodiversity in general, as well as moderating the local microclimate and hydrology.

Maintaining diversity at multiple scales offers the best insurance for forests facing an uncertain climate future. Biodiversity, including genetic diversity, determines the range of adaptive capacities available to an ecosystem, thereby increasing resiliency.[19]

*Photo: Tree islands forming amidst lowering water levels in the Peace River Valley. As climate change increases the frequency and severity of droughts, heat waves and fires, intact forests naturally help mitigate these risks by acting as giant sponges (Louis Bockner/Sierra Club BC).*

These characteristics are extremely helpful in the face of variable climate scenarios and uncertain impacts. Conversely, homogenous and even-age planted forests are less biodiverse, offering fewer options in terms of adaptation.

Protecting old and intact forests offers B.C. the best chance of maintaining such refugia and lowering the risk of wildfire in these areas. However, there are limits to how much a forest can adapt to changing climatic conditions, beyond which refugia may give way to conditions that support and facilitate fire spread into a previously persistent patch.[20] In dryer forests, such as those in the B.C. Interior, managers may need to eventually consider allowing conversions to vegetation other than what is currently dominant.[21]

While some have argued that strict protection of forests from logging can lead to fuel loading and an increase in fire severity, new research suggests that this is not necessarily the case. A study of 1,500 fires that occurred in western U.S. forests (pine and mixed conifer) between 1984 and 2014, found that higher levels of forest protection were associated with lower fire severity values, even though this was also associated with higher levels of biomass and fuel loading. In fact, it found support for the opposite—that burn severity tended to be higher in areas with less protection and more intense forest management.[23] [24] One hypothesis is that larger, mature forests create shadier, cooler conditions, and keep surface fuels moist and less flammable during fire season. They are also less likely to support fire-prone vegetation in the understory.[25]

*Photo: A water bomber prepares to fight a fire spreading through a clearcut (B.C. Wildfire Service).*

> **Wildfire Service incident updates commonly note the impact of logging slash in clearcuts that makes fires burn more intensely and dangerously.**
>
> *- Dave Broadland*[22]

## CLEARCUTS INCREASE THE RISK OF FOREST FIRES

Conditions following clearcut logging contrast sharply with those found in intact forests. Newly exposed to prolonged periods of direct sun, the forest floor experiences more extreme temperatures and is more likely to dry out, and may no longer support understory species that require shade. Logging operations, particularly clearcuts, generate a large amount of unused wood, including whole trees and slash: an estimated 40 to 60 percent of a forest's biomass is left behind in a clearcut.[26] Although this is supposed to be burned according to "open burning smoke control" regulations, the material often sits for years, creating a large amount of dry fuel on the ground that is vulnerable to desiccation and fire. This is supposed to be burned in a controlled fashion within 30 months, but even then the level of

dry flammable waste exacerbates forest fire risk. In 2018 this led the B.C. Wildfire Service to file a complaint with the Forest Practices Board, following the Shovel Nose fire. Despite finding that the debris-covered cutblocks presented a serious fire risk, the Board had to conclude that all licensees were actually in compliance with regulations.[27]

## SECOND GROWTH FORESTS: YOUNG AND DANGEROUS

Most of B.C.'s Timber Harvesting Land Base has been logged and replaced with second-growth forests. Young trees are more susceptible to fire due to their smaller size, thinner bark, and low branches that provide flammable "ladder fuel" towards the canopy.[28] This can lead to young stands burning before they are sexually mature and producing seeds, resulting in regeneration failure.[29]

A study of a major fire in southwest Oregon in 2013 found that younger forests were a significant driver of wildfire severity, due to this susceptibility combined with dense and homogenous spacing.[30] Older forests, by contrast, had greater variability in terms of tree size and spacing, and were less likely to burn. Preliminary reports indicate that during Oregon's record-breaking fire season in 2020, more than 70 percent of the area burned had been recently clearcut and was in various stages of regrowth.[31]

*Photo: Young trees in second-growth forests are more susceptible to fire due to their smaller size, thinner bark, denser spacing, and low branches (Jens Wieting).*

> **We need a paradigm shift in fire-prevention planning across the entire landscape. Climate change is loading the dice... demands for more thinning and prescribed fires on public lands are insufficient since clearcut rotation forestry surrounds our communities.**
>
> *- Dr. Daniel Glavin, University of Oregon*[32]

## HEALTHY FIRE: RESTORING NATURAL DISTURBANCE

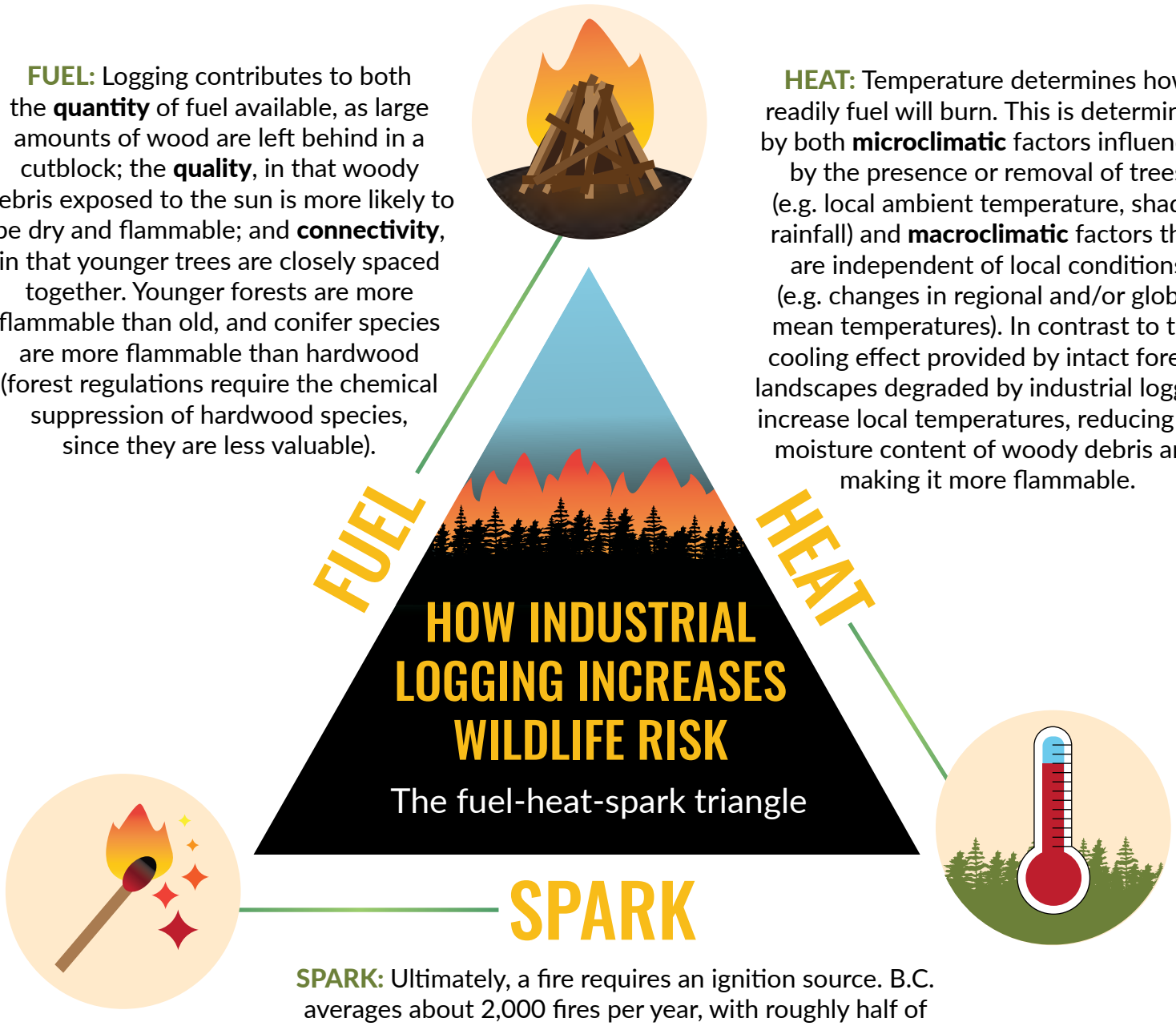
Historically, fire has played an important role in maintaining ecosystem health for many types of forests, and restoring natural fire regimes can be an important part of achieving balance. This must be done according to natural disturbance type, and may include low-intensity fires that clear out deadfall and other fuels (while leaving large trees), but could also include moderate, and even high-intensity fires, where appropriate. This will require a fundamental shift in public and institutional attitudes towards fire management. It must happen in collaboration with Indigenous decision-makers and will certainly benefit from the incorporation of Indigenous knowledge. Given that climate change has already altered disturbance regimes, it may be a challenge to establish what should be considered "natural" in terms of fire frequency and intensity.

# CONCLUSION

The best available science indicates that unlogged forests offer the best protection for communities, and that forests degraded by logging can be managed to restore resilience and reduce risk. However, this does not mean protecting all forests from fire, and may in fact involve the re-introduction of ecosystem-appropriate fire regimes.

**FUEL:** Logging contributes to both the **quantity** of fuel available, as large amounts of wood are left behind in a cutblock; the **quality**, in that woody debris exposed to the sun is more likely to be dry and flammable; and **connectivity**, in that younger trees are closely spaced together. Younger forests are more flammable than old, and conifer species are more flammable than hardwood (forest regulations require the chemical suppression of hardwood species, since they are less valuable).

**HEAT:** Temperature determines how readily fuel will burn. This is determined by both **microclimatic** factors influenced by the presence or removal of trees (e.g. local ambient temperature, shade, rainfall) and **macroclimatic** factors that are independent of local conditions (e.g. changes in regional and/or global mean temperatures). In contrast to the cooling effect provided by intact forest, landscapes degraded by industrial logging increase local temperatures, reducing the moisture content of woody debris and making it more flammable.




**SPARK:** Ultimately, a fire requires an ignition source. B.C. averages about 2,000 fires per year, with roughly half of them caused by humans, and the rest by lightning strikes. The continual expansion of B.C.'s resource road network has introduced fire risk to previously remote areas.

*FIGURE 2: There are three main variables that affect the frequency and severity of wildfires: fuel, heat and spark. All of these factors are negatively impacted by industrial logging. Topography plays a significant role in forest fire behaviour, but is independent of forest management. Wind speed, which also plays a role, is known to increase as a result of clearcutting.*[33]

# WATER: SHORTAGES, FLOODING, EXTREME PRECIPITATION AND LANDSLIDES

The Climate Risk Assessment identifies several risks associated with changes in the water cycle that are expected with climate change, including **seasonal and long term water shortages, flooding**, and **extreme precipitation and landslides**. There are many ways in which these risks are affected by forest management.

Climate change models predict that extreme hydroclimatic events will become more prominent with a warming climate.[34] This includes increased frequency of floods, erosion and landslides due to precipitation and runoff, but paradoxically, drought and low-flow conditions as well.[35] Precipitation is expected to be concentrated in more intense storms, leading to increased erosion and landslide risk.[36]

## HEALTHY FORESTS: EVERYTHING IN MODERATION

Natural infrastructure has increasingly been recognized for the role it can play in regulating the flow of water and reducing associated risks.[37] Forests play a vital role, and left intact, serve as giant sponges, absorbing, storing, and then releasing water slowly, providing for year-round moisture, cool micro-climates, and water purification. Water may evaporate directly, or be absorbed by roots, reducing overland flow. Well-developed networks of roots and layers of organic matter hold soil to steep slopes, and the canopy reduces raindrop impact and erosion. Interception and storage of precipitation by forests has a major impact on the climate and hydrology of watersheds and is an important component of global climate and hydrologic cycles.[38]

Clearcut logging reduces a watershed's ability to moderate the flow of water, and is associated with faster runoff and higher peak flows. Where logging occurs on steep slopes, top soil and root structures are compromised, leading to erosion and landslides.[39] For example, a study in the Swiss Alps found that five years following logging in a subalpine forest, root reinforcement had been reduced to 40 percent, and that 15 years after logging, it had lost all reinforcement capacity.[40]



*Photo: Kettle River flooding near Manly Meadows, B.C. (Regional District of Kootenay Boundary).*

Another study in Japan found that the volume of landslides increased by four times following clearcutting, and the volume of sedimentation 10 times, and that this persisted for up to 45 years after logging. This follows the process by which tree roots decay and lose their strength to retain soil, and then slowly re-establish as new trees grow.[41]

Excessive sedimentation can shrink river channels and their ability to carry water without flooding.[42] Road construction that cuts into hillsides can cause debris slides and concentrate water runoff.[43]

One study in B.C.'s interior found that a watershed that had been 30 percent clearcut experienced an increase in annual and monthly water yields and annual peak flows, as well as earlier annual peak flow, compared to a similar watershed that had not been logged.[44]

Another study in Washington State found that clearcut logging increased the amount of water seeping into the ground by as much as 51 percent, and increased the risk of landslides by up to 30 percent.[45]

Forests also provide shade that moderates the rate at which snow melts, which is an important factor in the hydrology of many B.C. forests. A study that compared logged and unlogged watersheds found that deforestation consistently causes more floods—both big and small, and up to almost four times as often, during spring runoff.[47]

*Photo: A washed out logging road. Road construction on steep slopes can cause debris slides and concentrate water runoff (Louis Bockner/Sierra Club BC).*

> **They [logging] contribute to how the water comes off of the mountain. They contribute to flooding. They contribute to the degradation of our water.**
>
> *- Chris Eneas, a Penticton Indian Band elder, reflecting on the impact that logging has had on Peachland's watershed in the interior of B.C.*[46]

In 2015, a property owner in B.C.'s interior raised concerns about potential flooding that could result from logging to be carried out in his watershed, but the company proceeded despite this, stating that there is no legal requirement for them to consider downstream private property or road infrastructure.[48] As predicted, the first big storm washed out culverts, damaged roads, and resulted in erosion.

The bigger picture is that logging in B.C. is increasingly taking place on landslide-prone steep slopes and high elevation terrain, since the forest industry has depleted the more profitable and easier-to-access timber. This trend, known as going after the "guts and feathers"[49] has been recognized by the industry for decades,[50] but will now be exacerbated by the extreme precipitation that is expected to occur due to climate change. There is also reason to believe that reduced harvesting options have led to operations increasingly taking place in community watersheds.

# IMPACT ON COMMUNITY WATERSHEDS AND DRINKING WATER

Flooding events can have a major impact on community watersheds, resulting in turbidity that can make water unsafe to drink, since pathogens from animal and human sources are able to attach to fine sediment particles, reducing the effectiveness of water treatment. As other sources of accessible timber have been depleted, logging in these watersheds has become increasingly common, which has resulted in an increase in conflicts with locals concerned with their water quality and risk of flooding.

B.C. has approximately 4,800 drinking water systems, with 90 percent classified as small (serving less than 500 people). An investigation by B.C.'s independent Forest Practices Board found that between 2006 and 2014, logging occurred in 131 of 466 community watersheds, but that almost half of the area logged was located in just 10 of these.[51]

In 2019 a report by B.C.'s Auditor General found that no drinking water protection plans have been established in the province in the past 16 years, since the provincial government first committed to ensuring safe, reliable and accessible drinking water.[52] The Drinking Water Protection Act also allows the Public Health Officer to recommend a drinking water protection plan to ensure source watersheds are protected, but the Auditor General's report found that this tool has not been used in the 16 years since the Act was amended.[53]

In 2017, the town of Peachland in the Okanagan experienced high runoff in the watershed behind the town, which had been hit hard by logging in recent years. This led to erosion and landslides that muddied the town's water supply for months. The town was forced to spend $24 million on a water treatment plant, since the forest was no longer providing natural filtration.[54]

In 2019, the town of Glade, B.C., sought an injunction to stop logging within their

*Photo: Clearcuts increase the risk of landslides, erosion and flooding events—as seen in this washed out clearcut. This in turn can result in watercourses becoming turbid and making the water unsafe to drink (TJ Watt/Ancient Forest Alliance).*

watershed, but this was denied by a Supreme Court Judge, who specifically noted in his judgment that the right to clean water was not guaranteed in Canadian law.[55]

Logging activity has had similar impacts on many more B.C. communities, and will only get worse if the climate continues to change as predicted. Yet logging companies aren't legally required to consider downstream impacts such as flooding when they harvest trees in watersheds.

> **Community watersheds comprise only 1.5 percent of the land base, yet there is such a frenzy for getting into these places.**
>
> *- Will Koop, B.C. Tapwater Alliance*[56]

*Photo: Logging without proper buffers around riparian zones increases the risk of community water sources being contaminated. Clearcut logging reduces a watershed's ability to moderate the flow of water, and is associated with faster runoff and higher peak flows. This increases the risk of flooding and landslides, and in turn threatens the safety of the water supply (TJ Watt/Ancient Forest Alliance).*

# CLIMATE RISKS: COMPOUNDED AND CUMULATIVE IMPACTS

The Risk Assessment recognizes that climate change can compound hazard events. For example, it describes the scenario of "a seasonal or long-term water shortage followed by wildfire, which in turn primes the landscape for severe landslides following heavy precipitation" as very plausible, posing significant risk.[57]

The impacts of climate change combine to exacerbate and increase risks, including the risks introduced by logging. For example, the spread of insects, most notably the pine beetle, has increased by having fewer winters cold enough to control populations. The dead standing trees pose a greater risk of fire, and combined with salvage logging operations, the resulting landscapes are now more prone to higher rates of runoff and landslides during heavy rainfall and spring runoff. Surface runoff and erosion in severely burned areas may result in sediment, debris and ash getting into water bodies, which in turn threatens local communities with flooding and water turbidity. In the dry season, water is more scarce, as the landscape's capacity to retain moisture has been reduced.

It is notable that in an independent review of the record 2017 flood and wildfire seasons in B.C., stakeholders cited overlogging as a concern for both of these risks, and called for a review of logging practices.[58]

The identified climate risks are also affected by the cumulative impact that industrial activities have had on a landscape over time, including multiple forest licensees, as well as other sectors (e.g. mining and agriculture). It is essential that a cumulative impacts approach be taken for each given landscape and watershed, as this is the unit which is most applicable to addressing forest-related climate risks such as fire, flooding and drought. For example, the total percentage of a drainage that is clearcut and in various stages of regrowth must be taken into consideration before permitting more development to occur, regardless of sector.

> **In fires that burn really hot, it burns off all of that organic material that is mixing into the soil and it leaves behind just the mineral soil, the kind of gritty sand salts. This can lead to water runoff and severe erosion.**
>
> *- Lori Daniels, University of British Columbia*[59]

*Photo: A dried riverbed in the boreal forest. Drought risks are compounded in landscapes degraded by industrial logging (Louis Bockner/Sierra Club BC).*

# PROTECTING AND RESTORING RESILIENCE

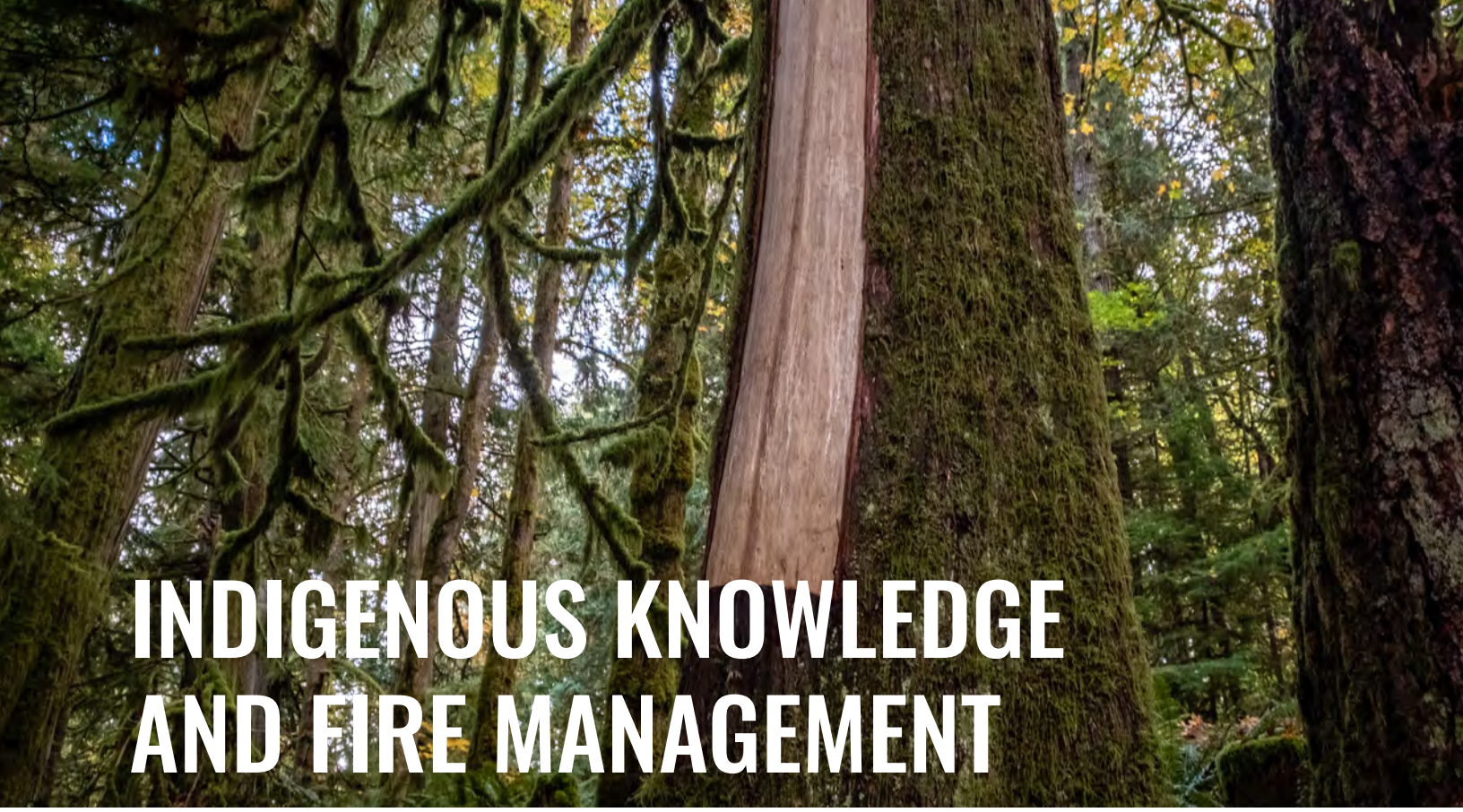
Fortunately, the same actions required to address one forest-related climate risk will also serve to address others. By protecting the small amount of intact forest we have left, and managing second-growth forests to restore ecosystem function, we can maximize their resilience to fire, as well as control flooding, improve water quality, and reduce pest outbreaks.

Young second-growth forests may be more prone to fire than old-growth, but they can be managed to restore resilience and reduce risk.[60] There is a large and rapidly evolving body of literature that explores what this entails, and is highly specific to the type of forest in question.[61] This may include reducing harvest intensity and extending logging rotations, allowing the forest to recover and grow to its true potential.[62] In addition, selective logging, thinning, brush removal and pruning can reduce available fuel, thereby reducing the severity and extent of burns. Removing the flammable lower limbs of younger trees can prevent low-intensity fires from reaching into the canopy. Less crowded stands will also grow faster and attain old-growth attributes sooner, including higher quality of timber.

Encouraging species and genetic diversity through plantings and during thinning treatments will help increase resilience to a changing climate.[63] Landscape-scale restoration activities that retain and promote large trees (both living and snags), and complex canopied forest in topographically appropriate areas, could minimize short-term effects on species of concern so that the long-term benefits of restored forest ecosystems are achieved.[64] Fire-resistant deciduous trees and shrubs should be retained and promoted: according to a 2001 study in Alberta's boreal region, pine forests are 8.4 times more likely to burn compared to deciduous forests.[65] Yet current regulations require licensees to use the herbicide glyphosphate to limit deciduous growth, to prevent competition with more valuable conifer species.[66]

Reforestation of a clearcut can help restore hydrological function, as root structures, understory, and canopies develop. However, this can take multiple decades, and recovery is measurably delayed if the area is repeatedly treated with herbicide to control competing regrowth, a common practice in industrial forestry.[67] And unless restoration is geared towards restoring ecosystem function and resilience, the emergent forest will continue to pose the risks noted above.

 *Photo: A spirit bear crosses a river in the Great Bear Rainforest (Andrew S. Wright).*



# INDIGENOUS KNOWLEDGE AND FIRE MANAGEMENT

Prior to colonization by Europeans in the late 19th century, fire was frequently used as a management tool by Indigenous people in B.C.'s interior.[68] Restrictions imposed on this practice by settlers, coupled with suppression of naturally-occurring fires, has encouraged the spread of forest cover, but also the accumulation of woody surface fuels and ladder fuels that help fire reach the forest canopy, reducing resistance to high-severity fire and insect outbreaks. Understanding these changes and re-introducing Indigenous systems of fire management will be important in restoring resilience.[69] As acknowledged in the risk assessment, additional work must be done in order for the risk assessment and any response to consider Indigenous perspectives and cultural values.

*Photos: Indigenous communities, including those of the Yunesit'in and Xeni Gwet'in First Nations, are re-introducing the practice of cultural burning to their lands. In addition to reducing the risk of wildfires, this practice aims to promote the growth of medicinal and food plants and maintain biodiversity. To learn more about this work, visit: www.gatheringvoices.com/tsilhqotin1 (Josh Neufeld/Gathering Voices Society).*

# A MATTER OF PRIORITIES

One thing that stands out within the Preliminary Strategic Climate Risk Assessment is its level of concern for how climate change may impact the forest industry and its timber supply. This is not only considered within two ***consequence categories*** ("loss of natural resources" and "economic productivity") that climate events could have an impact on, but as a ***risk event*** itself ("loss of forest resources"). Yet despite an abundance of evidence that logging has an impact on most of the risk events identified, it is not considered anywhere in the assessment. This reflects B.C.'s current timber-centric paradigm, one that the recent Old Growth Strategic Review has identified as being outdated and problematic.[70] It recommends shifting towards prioritizing ecosystem health and biodiversity, which would help protect communities from climate risks as well. In order for this to work, the annual allowable cut of timber must be a secondary consideration to the health and safety of B.C.'s communities and maintaining the health of forest ecosystems.

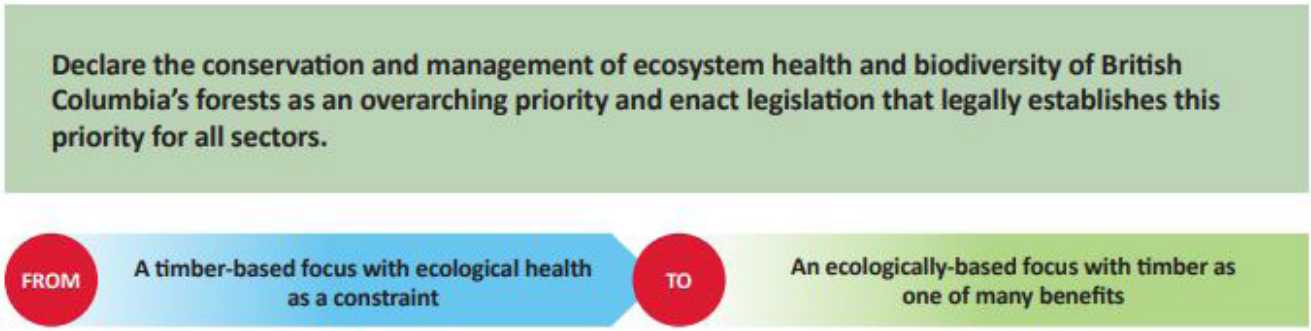
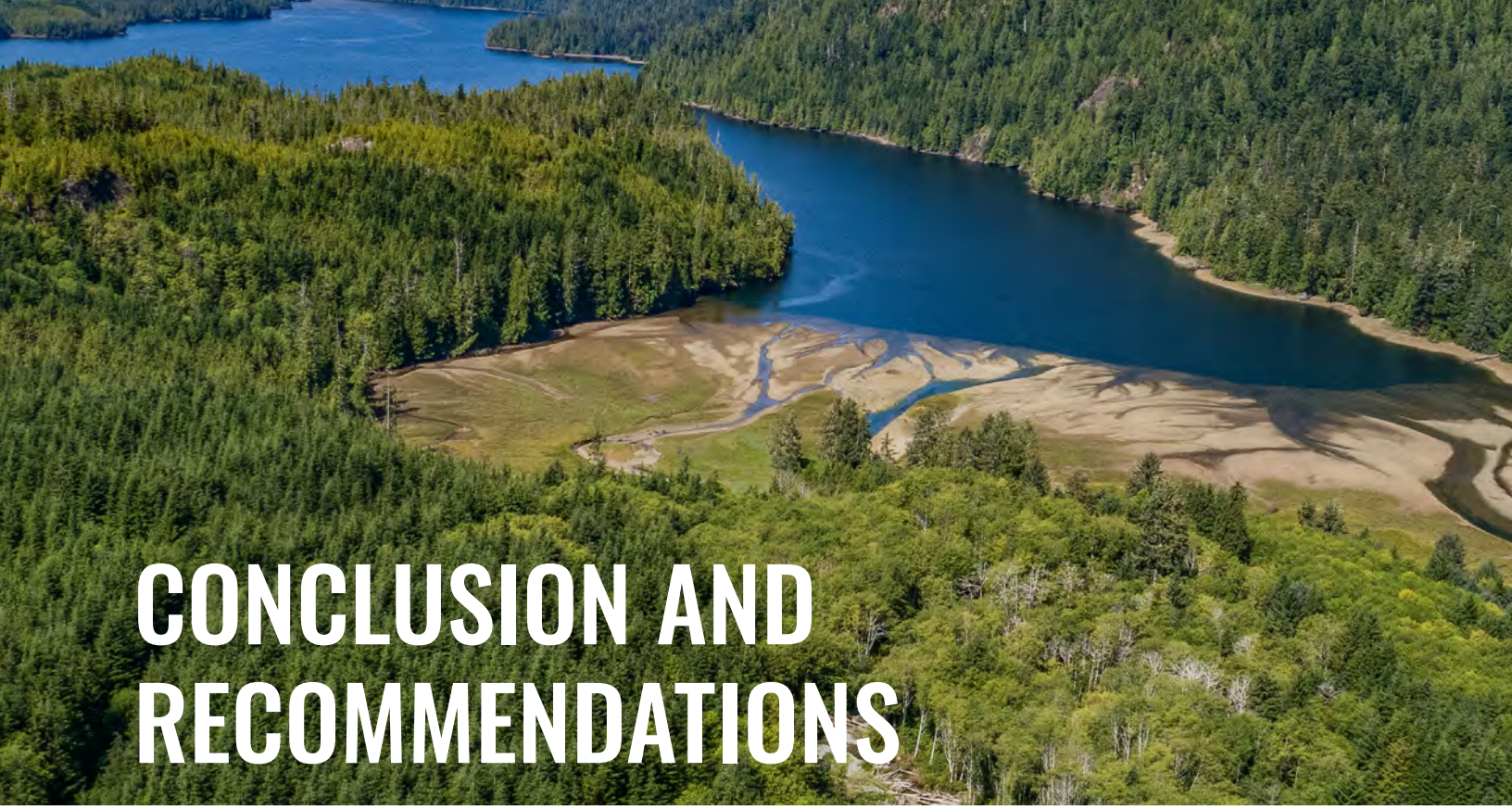



*FIGURE 3: The Old Growth Strategic Review (2020) recommends a change in paradigm for forest management.*[71]

 *Photo: A student learns about culturally modified trees in an old-growth stand (Mya Van Woudenberg/Sierra Club BC).*



# CONCLUSION AND RECOMMENDATIONS

The vast majority of forests in B.C. have been degraded to some extent by logging, replaced by younger, less diverse second-growth that is more susceptible to the effects of climate change. As a result, these forests, and the communities that depend on them, are more vulnerable to associated risks, including wildfire, flooding, and landslides. Managing these forests with a view to restoring climate resiliency offers great potential for reducing health and safety risks to surrounding communities, while also providing employment opportunities and economic diversification.

There are, however, limits to resiliency. Under runaway climate change scenarios many forests in B.C., most notably in the dry interior, may no longer be able to support forest ecosystems. Thus, efforts to reduce risks posed by poor forest management must be coupled with efforts to reduce greenhouse gas emissions in all sectors. Fittingly, the same actions required to reduce community vulnerability to risks like flood and fire, namely protecting intact forest and restoring ecosystem resilience, will also enhance the total carbon carrying capacity of these forests, and their role in fighting climate change.

If the B.C. Government is serious about reducing the risk to human health and safety posed by climate change, current forest practices will have to be fundamentally changed. The actions required are congruent with recent recommendations to government from the Old Growth Strategic Review[72]; it is now a matter of implementing them.

## POLICY RECOMMENDATIONS

1. **Engage with Indigenous decision-makers in a government-to-government process, and revise all legislation with a DRIPA lens:** B.C. has an opportunity to simultaneously implement the B.C. Declaration on the Rights of Indigenous Peoples Act, address community climate risks and improve forest protection and management. This will allow for the incorporation of Indigenous perspectives, cultural values, and traditional knowledge in a way that respects and upholds Indigenous jurisdiction.


*Photo: An aerial view of the Nuchatlaht's Shoomart estuary and Salmon Park (Sierra Club BC).*

2. **Implement all the recommendations from the Old Growth Strategic Review:** The strategic review contains several important recommendations that would help address climate risks. These must be fully enacted within the recommended three years in order to be relevant to addressing this urgent crisis. This includes:

   - A fundamental shift in paradigm to prioritizing forest health and resilience above timber supply, and amending the Forest and Range Practices Act to codify this. Climate change considerations should be integrated into forest planning and practices to enhance the health, resilience and adaptability of forest and range ecosystems. The 2018 joint submission by 33 environmental groups on FRPA reform provides concrete suggestions for what changes are required, including removing constraints related to not "unduly reducing the supply of timber" from all FRPA legal objectives and the Government Actions Regulation.[73]

*Photo: Trees cling to the edge of an eroded clearcut hillside. Climate change calls for stronger precaution to reduce the risk of severe erosion (Louis Bockner/Sierra Club BC).*

   - Immediately deferring logging in old forests where ecosystems are at risk of irreversible biodiversity loss. This is necessary to safeguard some of the most climate change-resilient forests, and mitigate risks to communities, such as fire and flooding.

   - Adopting new silviculture systems as alternatives to clearcutting to help manage for multiple values and ecosystem services, such as water filtration, and reduce climate change risks for nearby communities.

   - Provide adequate funding for implementation of recommendations. Preventing climate-related disasters by protecting and restoring forests will save money (and lives) in the long run, but will require an up-front investment to facilitate the transition and mitigate local economic impacts. The strategic review's section on "Transition Support for Communities" provides helpful guidance on how to undertake this work.

3. **Incorporate forest protection and restoration into B.C.'s climate preparedness and risk adaptation strategy.** While the Preliminary Strategic Climate Risk Assessment is well-intended, it fails to consider how logging can increase risks to communities, while prioritizing timber production. Further work must be done to address this blind spot, building on findings in this report. This must be done in an independent manner, using expertise from outside the forestry sector, with the primary mandate of protecting the health and safety of communities. It should take a holistic approach and be tailored to regional and ecosystem-specific characteristics.

4. **Introduce a "climate risk impact test,"** to be applied to all forest management decisions, and prior to approving logging plans, to determine if a given action will make the forest and surrounding communities more (or less) vulnerable to climate risks. Logging plans must be modified or cancelled to address these dangers and defend community health and safety.

5. **Require key decision-makers** (including the Chief Forester and district managers) to monitor and evaluate forest-related community climate risks, and report on this publicly, as a key performance indicator. The Forest Practices Board should be mandated to provide a periodic independent assessment of progress made towards mitigating these risks.

6. **Reduce greenhouse gas emissions:** All measures designed to protect communities from the risks considered in this report will be overshadowed by the impacts of climate change if we do not act quickly to lower emissions across all sectors of the economy, including emissions from forestry. In 2018, the Intergovernmental Panel on Climate Change warned that in order to prevent catastrophic outcomes, we must cut global greenhouse gas emissions in half by 2030, and achieve net zero emissions by mid-century.[74]

Implementing these recommendations would help address multiple challenges and fulfill existing commitments that have been made by this government, including fostering a better relationship with Indigenous decision-makers, protecting old-growth, reducing greenhouse gas emissions, and reducing climate risks that B.C.'s communities face. However, little time remains to act, given the rate at which logging is currently occurring in these forests, and the expected trajectory of climate change. The health and safety of British Columbians depends on the ability of government to act quickly, and in a manner that prioritizes communities over timber harvest levels.

> **Integrating climate change considerations into planning and practices would enhance the health, resilience and adaptability of forest and range ecosystems and landscapes to natural disturbance events such as wildfires, insect infestations, disease, drought and floods.**
>
> *- Forest and Range Practices Act Improvement Initiative*[75]

*Photo: Protecting intact old-growth forests means protecting the health of our communities (Mya Van Woudenberg).*

# WORKS CITED


1. Pojar, J. (2019). Forestry and carbon in BC. Accessed at: https://skeenawild.org/wp-content/uploads/2020/05/Pojar-7mythsfinal-2019.pdf
2. Price, K., Holt, R., & Daust, D. (2020). BC's Old Growth Forest: A Last Stand for Biodiversity. British Columbia. Accessed at: https://veridianecological.files.wordpress.com/2020/05/bcs-old-growth-forest-report-web.pdf
3. B.C. Ministry of Environment and Climate Change Strategy (2019). Preliminary Strategic Climate Risk Assessment for British Columbia. Accessed at: https://www2.gov.bc.ca/gov/content/environment/climate-change/adaptation/risk-assessment
4. Moomaw WR, Masino SA, Faison, EK. (2019). Intact forests in the United States: Proforestation mitigates climate change and serves the greatest good. Frontiers in Forests and Global Change 2(27).
5. Meidinger, D. and Pojar, J. (1991). Ecosystems of British Columbia. Special Report Series, Ministry of Forests, BC.
6. This is categorized according to five Natural Disturbance Types, or NDTs. See Ecological Restoration Guidelines for B.C.: http://www.env.gov.bc.ca/fia/documents/TERP_eco_rest_guidelines/defgoals/natdisturb.htm
7. Price, Holt, and Daust (2020), Op cit.
8. Anderegg et al. (2020). Climate-driven risks to the climate mitigation potential of forests. Science 368, 1327.
9. B.C. Ministry of Environment and Climate Change Strategy (2019), Op. cit.
10. Halofsky JE, Peterson DL, Harvey, BJ. (2020). Changing wildfire, changing forests: the effects of climate change on fire regimes and vegetation in the Pacific Northwest, USA. Fire Ecology 16(4).
11. Abatzoglou, J. and Williams, P. (2016). Impact of anthropogenic climate change on wildfire across western US forests. PNAS October 18, 2016 113 (42) 11770-11775.
12. Parisien, Marc-Andre; Moritz, Max A. (2009). Environmental controls on the distribution of wildfire at multiple spatial scales. Ecological Monographs. 79(1): 127-154.
13. Lertzman, K.; Gavin, D.; Hallett, D.; Brubaker, L.; Lepofsky, D.; Mathewes, R. (2002). Long-term fire regime estimated from soil charcoal in coastal temperate rainforests. Conservation Ecology 6(2).
14. Daniels LD and Gray RW. (2006). Disturbance regimes in coastal British Columbia. Journal of Ecosystems and Management 7(2): 44-56.
15. Kneeshaw D., et al. (2018). Is Management or Conservation of Old Growth Possible in North American Boreal Forests? In: Barton A.M., & Keeton W.S. (Eds) Ecology and Recovery of Eastern Old-Growth Forests (pp. 139-157). Washington, DC: Island Press.


 *Photo: An ancient cedar in Avatar Grove on Pacheedaht territory (Mya Van Woudenberg/Sierra Club BC).*

16. Frey SJ, Hadley AS, Johnson SL, Schulze M, Jones JA, Betts MG. (2016). Spatial models reveal the microclimatic buffering capacity of old-growth forests. Science Advances 2(4): e1501392.

17. Lesmeister DB, Sovern SG, Davis RJ, Bell DM, Gregory MJ, Vogeler JC. (2019). Mixed-severity wildfire and habitat of an old-forest obligate. Ecosphere 10(4): e02696.

18. Meddens AJ, Kolden CA, Lutz JA, Smith AM, Cansler CA, Abatzoglou JT, Meigs GW, Downing WM, Krawchuk MA. (2018). Fire refugia: what are they, and why do they matter for global change? BioScience 68(12): 944-954.

19. Kolden, C. A., Bleeker, T. M., Smith, A., Poulos, H. M., and Camp, A. E. (2017). Fire effects on historical wildfire refugia in contemporary wildfires. Forests, 8(10), 400.

20. Ibid

21. Halofsky JE, Peterson DL, Harvey BJ. (2020). Op cit.

22. Broadland, D. (2020). The forest-industrial complex's Molotov clearcuts. Focus on Victoria. Accessed at: https://www.focusonvictoria.ca/focus-magazine-march-april-2020/the-forest-industrial-complexs-molotov-clearcuts-r15/

23. Bradley CM, Hanson CT, DellaSala DA. (2016). Does increased forest protection correspond to higher fire severity in frequent-fire forests of the western United States? Ecosphere 7(10): e01492.

24. Ibid. This study used four categories of protection, derived from the 2012 U.S. Geological Survey Gap Analysis Program: GAP1: protected lands managed for biodiversity where natural disturbance events, such as wildfire, are allowed to occur; GAP2: protected lands managed for biodiversity where disturbance events are often suppressed; GAP3: lands managed for multiple uses and are subjected to logging; GAP4: lands with no mandate for protection.

25. Odion, D.C., Frost, E.J., Strittholt, J.R., Jiang, H., Dellasala, D.A. and Moritz, M.A. (2004). Patterns of fire severity and forest conditions in the western Klamath Mountains, California. Conservation Biology, 18(4), pp.927-936.

26. Pojar, J. (2019), Op cit.

27. B.C. Forest Practices Board (2019). Fire Hazard Abatement and the Shovel Lake Wildfire (Complaint Investigation #18061).

28. Menning and Stephens (2007). Fire Climbing in the Forest: A Semiqualitative, Semiquantitative Approach to Assessing Ladder Fuel Hazards, Western Journal of Applied Forestry, Volume 22, Issue 2,88–93.

29. Girard, F. et al. (2020). "Rapid expansion of lichen woodlands within the closed-crown boreal forest zone over the last 50 years caused by stand disturbances in eastern Canada." Journal of Biogeography 35.3 (2008): 529-537.

30. Zald HSJ and Dunn CJ. (2018). Severe fire weather and intensive forest management increase fire severity in a multi-ownership landscape. Ecological Applications 28(4): 1068-1080.

31. Glavin, D. (2020). In Oregon's 2020 fires, highly managed forests burned the most. Spotfire, Sep 25, 2020. Accessed at: https://fusee.org/fusee-blogs-1/oregons-2020-fires-highly-managed-forests-burned-the-most

32. Ibid

33. Spittlehouse, David, and Stathers, Robert (1990). Seedling Microclimate. BC Ministry of Forests.

34. O'Gorman, P.A., and Schneider T. (2009). Scaling of precipitation extremes over a wide range of climates simulated with an idealized GCM. Journal of Climate 22.21: 5676-5685.

35. Haughian SR, Burton PJ, Taylor SW, Curry CL (2012). Expected effects of climate change on forest disturbance regimes in British Columbia. Journal of Ecosystem Management, 13:1–24.

36. Vose, J et al. (2012). Effects of Climate Variability and Change on Forest Ecosystems: a Comprehensive Science Synthesis for the U.S. US Forest Service, PNW-GTR-870.

37. Glick, P., E. Powell, S. Schlesinger, J. Ritter, B.A. Stein, and A. Fuller (2020). The Protective Value of Nature: A Review of the Effectiveness of Natural Infrastructure for Hazard Risk Reduction. Washington, DC: National Wildlife Federation.

38. Klamerus-Iwan, A., Link, T. E., Keim, R. F., and Van Stan II, J. T. (2020). Storage and Routing of Precipitation Through Canopies. In Precipitation Partitioning by Vegetation (pp. 17-34). Springer, Cham.

39. Cheng, J.D. (1989). Streamflow changes after clear-cut logging of a pine beetle-infested watershed in southern British Columbia, Canada. Water Resources Research 25: 449-56.

40. Vergani, C. et al. (2016). Root reinforcement dynamics in subalpine spruce forests following timber harvest: a case study in Canton Schwyz, Switzerland. Catena, 143, 275-288.

41. Imaizumi, F., Sidle, R. C., and Kamei, R. (2008). Effects of forest harvesting on the occurrence of landslides and debris flows in steep terrain of central Japan. Earth Surface Processes and Landforms: The Journal of the British Geomorphological Research Group, 33(6), 827-840.

42. Anderson, Henry W.; Hoover, Marvin D.; Reinhart, Kenneth G. (1976). Forests and water: effects of forest management on floods, sedimentation, and water supply. General Technical Report PSW-018. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station.

43. Reid, M. E., et al. (2003). "Debris-flow initiation from large, slow-moving landslides." In Rickenmann, D., and Chen, C.-l., eds., Debris-Flow Hazards Mitigation: Mechanics, Prediction, and Assessment, Volumes 1: 155-166.

44. Cheng, J.D. (1989), Op cit.

45. Miller, D.J. and Sias, J. (1998). Deciphering large landslides: linking hydrological, groundwater and slope stability models through GIS. Hydrolological Processes, 12: 923-941.

46. Hayes, Kelly (2019). Okanagan watershed forum held near lake above Peachland. Global News, Marc 22. Accessed at: https://globalnews.ca/news/5087358/okanagan-watershed-forum-held-near-lake-above-peachland/

47. Green, K. and Alila, Y. (2012). A paradigm shift in understanding and quantifying the effects of forest harvesting on floods in snow environments. Water Resources Research, Vol. 48, W10503.

48. Forest Practices Board (2019). Response Re: Resolution of Complaint 17053 – Yates Creek Flooding.

49. Pacific Analytics (2004). Revitalizing British Columbia's Coastal Economy: A New Economic Vision For The North and Central Coast and Haida Gwaii. Prepared for BC Ministry of Forests. Accessed at: https://www.for.gov.bc.ca/hfd/library/Documents/bib93615.pdf

50. Parfitt, B. (2019b). Thousands of B.C.'s endangered whitebark pine logged on private land. The Narwhal, September 19, 2019. Accessed at: https://thenarwhal.ca/thousands-of-b-c-s-endangered-whitebark-pine-logged-on-private-land/

51. Forest Practices Board (2014). Community Watersheds: from objectives to results on the ground. Special Investigation.

52. Auditor General of British Columbia (2019). The protection of drinking water: An Independent Audit. Victoria: Office of the Auditor General of British Columbia.

53. Cox, S. (2019). B.C. failing to protect drinking water: auditor general. Accessed at: https://thenarwhal.ca/b-c-failing-to-protect-drinking-water-auditor-general/

54. Parfitt, B (2019a). Muddied waters: how clearcut logging is driving a water crisis in B.C.'s interior. The Narwhal, May 22, 2019. Accessed at: https://thenarwhal.ca/muddied-waters-how-clearcut-logging-is-driving-a-water-crisis-in-b-c-s-interior/

55. CBC (2019). 'We're going to see more of this': Spring flooding in B.C. may be worsened by logging practices. Accessed at: https://www.cbc.ca/news/canada/british-columbia/we-re-going-to-see-more-of-this-spring-flooding-in-b-c-may-be-worsened-by-logging-practices-1.5386323

56. Parfitt, B (2019a), Op cit.

57. B.C. Ministry of Environment and Climate Change Strategy (2019), Op cit, p. 99, 103.

58. Abbott, George and Chapman, Maureen (2018). Addressing the New Normal: 21st Century Disaster Management in British Columbia. Report and findings of the BC Flood and Wildfire Review: and independent review examining the 2017 flood and wildfire seasons.

59. Balcerzak, Natalia (2020). How the Williams Lake flood in B.C. is linked to wildfire and deforestation. The Narwhal, May 5. Accessed at: https://thenarwhal.ca/how-the-williams-lake-flood-is-linked-to-wildfire-and-deforestation/

60. Keeton W.S., et al. (2018). Silviculture for Eastern Old Growth in the Context of Global Change. In: Barton A.M., & Keeton W.S. (Eds) Ecology and Recovery of Eastern Old-Growth Forests (pp. 237-265). Washington, DC: Island Press.

61. Hessburg P.F. et al (2019). Climate, environment, and disturbance history govern resilience of western North American forests. Frontiers in Ecology and Evolution 7(239).

62. Halofsky, J. and Peterson, D. (2016). Climate change vulnerabilities and adaptation options for forest vegetation management in the northwestern USA. Atmosphere 7.3: 46.

63. Ibid.

64. Stephens SL et al. (2020). Fire and climate change: conserving seasonally dry forests is still possible. Frontiers in Ecology and the Environment 18(6): 354-360.

65. Cumming, S. G. (2001). Forest type and wildfire in the Alberta boreal mixedwood: what do fires burn? Ecological applications 11.1: 97-110.

66. CBC (2018). 'It blows my mind': How B.C. destroys a key natural wildfire defence every year. Accessed at: https://www.cbc.ca/news/canada/british-columbia/it-blows-my-mind-how-b-c-destroys-a-key-natural-wildfire-defence-every-year-1.4907358

67. Hornbeck, J. W., et al. (1993). Long-term impacts of forest treatments on water yield: a summary for northeastern USA."Journal of Hydrology 150.2-4: 323-344.

68. Christianson A. (2015). Social science research on indigenous wildfire management in the 21st century and future research needs. International Journal of Wildland Fire 24(2): 190–200.

69. Hessberg et al. (2019), Op cit.

70. Gorley, A. and Merkel, G. (2020). A New Future for Old Forests: A Strategic Review of How British Columbia Manages for Old Forests Within its Ancient Ecosystems. Accessed at: https://engage.gov.bc.ca/app/uploads/sites/563/2020/09/STRATEGIC-REVIEW-20200430.pdf

71. Ibid.

72. Ibid.

73. FRPA Phase II Changes – Joint ENGO Submission (2018). Accessed at: https://organizingforchange.org/our-priorities/improving-bcs-forest-practices/

74. IPCC (2018). IPCC special report on the impacts of global warming of 1.5 °C above pre-industrial levels. Accessed at: https://www.ipcc.ch/sr15/

75. B.C. Ministry of Forests, Lands, Natural Resource Operations and Rural Development (2019). Forest and Range Practices Act Improvement Initiative: Renewal and Resilience. Discussion Paper. Accessed at: https://engage.gov.bc.ca/app/uploads/sites/487/2019/05/DISCUSSION_PAPER_FRPA_May-27.pdf

**For a full list of references consulted, please visit: www.sierraclub.bc.ca/climate-risk-report**

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***- Peter Wood***

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Peter Wood completed his PhD in Forestry at the University of Toronto, with a focus on the impacts of sustainable forest management certification in Canada. Over the past two decades he has worked on a variety of issues related to forests and climate change, both internationally and within Canada, including the United Nations, the International Institute for Sustainable Development, and the B.C. Ministry of Forests.

*Photo by Caitlyn Vernon.*

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