



COVID-19 and Forests in Canada and the United States: Initial Assessment and Beyond

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Information on the initial effects of a novel coronavirus, COVID-19, during 2020 on forests in Canada and the United States was derived from existing published studies and reports, news items, and policy briefs, amplified by information from interviews with key informants. Actions taken by governments and individuals to control the spread of the virus and mitigate economic impacts caused short-term disruptions in forest products supply chains and accelerated recent trends in consumer behavior. The COVID-19 containment measures delayed or postponed forest management and research; a surge in visitation of forests near urban areas increased vandalism, garbage accumulation, and the danger of fire ignitions. Forests and parks in remote rural areas experienced lower use, particularly those favored by international visitors, negatively affecting nearby communities dependent upon tourism. Physical distancing and isolation increased on-line shopping, remote working and learning; rather than emerging as novel drivers of change, these actions largely accelerated existing trends. On-line shopping sales had a positive effect on the packaging sector and remote working had a negative effect on graphic paper manufacturing. More time at home and low interest rates increased home construction and remodeling, causing historically high lumber prices and localized material shortages. The response to the pandemic has shown that rapid social change is possible; COVID-19 presents a once-in-a-lifetime opportunity to shift the global development paradigm toward greater sustainability and a greener, more inclusive economy, in which forests can play a key role. In both Canada and the United States, the notion of directing stimulus and recovery spending beyond meeting immediate needs toward targeting infrastructure development has momentum.

Keywords: coronavirus, social distancing, supply chain, forest management, pandemic, green recovery

INTRODUCTION

The pandemic caused by a new coronavirus that emerged in 2019 (COVID-19) has disrupted society and global economies. Corona viruses are primarily spread through the air by coughing and sneezing and close personal contact (NIAID, 2020). Until the development of effective vaccines, the only way to prevent spreading was by reducing human contact. Social distancing, either voluntary or imposed by different levels of government, was the primary public health response. Self-isolation, travel restrictions, and shutting down some forms of economic activity for varying lengths of time, along with mask wearing, were undertaken to try to reduce transmitting the virus. Historically the

border between Canada and the United States has been relatively open, with much cross-border traffic and trade. In the face of the pandemic, however, the border was closed for most traffic in March 2020, and remained a barrier to non-essential travel into 2021¹. Essential travel, including movement of goods, was exempted from border closure.

Besides the tragedy of hundreds of thousands of deaths, normal social interactions have been curtailed by individuals and governments in an effort to stem the spread of the virus. The resulting cascade of impacts on individual lives, shuttered businesses and unemployment, over-stressed public health providers, and reduced fiscal capacity of governments to respond and provide safety nets has created enormous hardships in the short-term (Lund et al., 2020; Walmsley et al., 2020), with likely but uncertain long-term impacts (Nikolopoulos et al., 2020). Even though effective vaccines were developed by December 2020, by June 2021, only 12% of the world population was vaccinated (at least one dose) and the rate in the United States and Canada was 51% and 63%, respectively².

Forests and the natural world have not gone unscathed by the pandemic. The COVID-19 pandemic affected forests and forest-dependent people globally in multiple ways. The COVID-19 pandemic initially caused short-term disruptions in the supply chains of the forest products industry and accelerated recent trends in consumer behavior (FAO, 2020; ILO, 2020; Lund et al., 2020). In addition to the uncertainty of long-term effects, forecasting how the COVID-19 pandemic will affect forests and forest industry is difficult because of the entanglement with other threats and influences on forests such as wildfires and climate change (Phillips et al., 2020).

We undertook to assess the potential effects of COVID-19 on forest management and the forest products industry in Canada and the United States based on what was observed in 2020, the first year of the pandemic. Importantly, the early response of both countries to the pandemic was to declare forest management and forest products manufacturing as essential activities. This allowed most management and manufacturing to continue, while taking measures to protect workers and the public. Our results can provide a framework for assessing long-term effects over the next decade. COVID-19 is not as deadly as Ebola nor as contagious as measles; worse pandemics will come and already new, apparently more contagious variants of COVID-19 have emerged (Davey, 2020). A current baseline, followed-up with longitudinal studies, provides a science basis for policy recommendations because many COVID impacts will be long-term and entangled with other drivers and ongoing trends. Additionally, we suggest the pandemic provides some opportunities for a shift in the global development paradigm toward greater sustainability and a greener, more inclusive economy.

¹Land border restrictions for travel to the United States from Canada remain in effect through June 21, 2021 and may be extended (<https://ca.usembassy.gov/covid-19-information-canada-3/>).

²Our World in Data website, https://ourworldindata.org/covid-vaccinations?country=OWID_WRL; based on Mathieu et al. (2021). Data accessed June 9, 2021.

MATERIALS AND METHODS

Information on the effects of COVID-19 and the initial responses of impacted sectors during 2020 was derived from existing published studies and reports, news items, and policy briefs, amplified by information from interviews. Industry publications, financial blogs, government and NGO websites, gray literature, and popular literature were accessed from Google and Google Scholar. The peer reviewed literature provided background information to establish a baseline in an effort to assess the magnitude of the effects of the pandemic apart from ongoing trends. Existing published studies and reports, news items, policy briefs were identified by searching on Google (COVID-19 effects forest industry, COVID-19 effects forest, COVID-19 impact on forests), (Canada COVID-19 impact on forests, United States COVID-19 impact on forests) and Google Scholar (search terms included United States COVID-19 impact on forests, Canada COVID-19 impact on forests, COVID-19 forest fires). Interviews were conducted with 16 stakeholders (listed in **Supplementary Material**), including civil society, local community and forest associations, private sector, academia and research practitioners, development partners, intergovernmental and other regional/sub-regional organizations, and relevant international organizations. A questionnaire (see **Supplementary Material**) was used to solicit information from interviewees. The questionnaire was developed by several consultants to the UN Forum on Forests examining COVID-19 effects on forests in North America and Europe and provided in advance to interviewees, as detailed in Stanturf (2020). All contacts were interviewed on-line and some contacts provided additional written responses, including surveys and meeting notes. More people were asked for an interview than responded.

RESULTS

Initially the Canadian and United States governments responded to the COVID-19 pandemic by limiting social interactions including travel. These restrictions severely impacted economic activity and both governments provided financial relief measures to offset economic impacts of unemployment and business closures. These measures, and responses by society, have impacted forest health and management, and the forest products industry in Canada and the United States (FAO, 2020; ILO, 2020).

How Governments Responded

Governments, employers and trade organizations developed general and specific safety and health regulations and advice for the workplace relative to COVID-19 (FRA, 2020a; PEMAC, 2020). In the United States, for example, medical experts from the Department of the Interior, United States Forest Service (USFS), the Centers for Disease Control and Prevention (CDC), and state public health representatives developed COVID-19 safety guidelines for field operations, particularly firefighters (NWCG, 2020). The United States Forest Service canceled in-person training required for fire crews (USDOI, 2020; USFS, 2020) and pre-season meetings of fire teams held for information

sharing and preparation were canceled (USDOJ, 2020). More vehicles were required to reduce personnel density when traveling to sites; agencies provided personal protective equipment, as well as mandating increased isolation and self-sufficiency in the field camps (Thompson et al., 2020). Overall levels of communicable diseases in firefighter camps were reduced (Crockett, 2021). These measures were implemented widely throughout federal government agencies.

The 2020 fire year in the United States was severe, with over 5.5 million ha burned across all jurisdictions (NIFC, 2020). Safety protocols kept the number of COVID 19 cases low early in the season but they increased late in the year, reaching 600 by year’s end (Figure 1). The experience and lessons gained from this fire year should reduce future sicknesses in fire camps (Crockett, 2021). Nevertheless, by September, one person was in critical condition and there was one fatality related to COVID (Wildfire Today, 2020).

The Government of Canada worked with provinces, territories (P&Ts), industry, and communities to help prevent the spread of COVID-19 between natural resources workers and the communities where they work. In forested areas, Natural Resources Canada (NRCan) in collaboration with the Public Health Agency of Canada established guidance to safeguard the health and safety of communities and minimize the potential transmission of COVID-19. Specific guidelines for tree planters and other in-forest activities (silviculture, harvesting) were developed for workers who often reside in camps away from their homes (NRCan, 2020a). Physical distancing measures imposed by provincial governments in Canada similarly complicated how firefighters were housed and transported when traveling to regions affected by fires (Stanturf, 2020). Indigenous communities in Canada in particular were potentially at increased risk from transmission of COVID-19 by workers coming in from other parts of the country to plant trees and

conduct other forest management activities. Addressing these safety concerns was a priority for NRCAN in the early days of the pandemic, and P&Ts agencies developed rigorous protocols to protect rural communities, especially Indigenous peoples (Stanturf, 2020). The importance of these measures was borne out by the several returning Canadian wildland firefighters who tested positive for COVID-19 after assisting in the extreme fire season in the United States under mutual-aid agreements (Stanturf, 2020).

Financial support from government to businesses and agencies to help survive the COVID-19 pandemic included direct subsidies, favorable interest rates, tax reductions and delayed payments, additional credit lines, and regulatory changes. The federal government in the United States provided financial relief to some sectors of the economy through the CARES Act (Coronavirus Aid, Relief, and Economic Security Act) that was followed by the smaller Emergency Coronavirus Relief Act of 2020 package signed on 28 December 2020 (US Congress, 2020; US Senate, 2020). The second act added timber to supported commodities and included US\$200 million in funding for logging and log trucking businesses who saw a greater than 10% loss in revenues in 2020 related to the COVID-19 pandemic (American Loggers Council, 2020). Small businesses in the forest sector qualified for assistance programs under these and other acts such as the Paycheck Protection Program that provided forgivable loans to help businesses retain their employees (FRA, 2020b).

The CARES Act provided the USFS with US\$70.8 million in supplemental funding to cover extraordinary costs of the pandemic. This included US\$3 million to re-establish scientific experiments impacted by travel restrictions, such as the Forest Inventory and Analysis program. The National Forest System received US\$34 million for daily cleaning and disinfecting of recreation facilities, increased supply of personal protective equipment, and baseline testing for first responders. Facilities

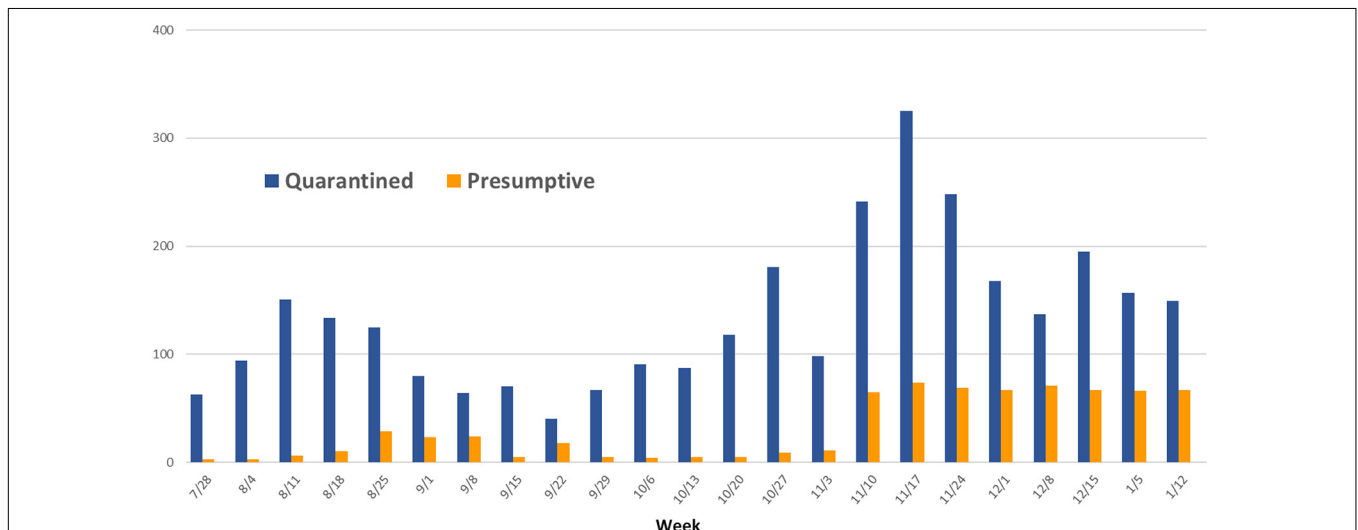


FIGURE 1 | Numbers of United States wildland firefighters quarantined and presumed infected with COVID-19 during the 2020 fire year. The number of cases was less than 200 between March and October, rising to 600 around the beginning of 2021 (Source: Nicole Williams, Deputy Pandemic Coordinator, United States Forest Service).

received capital improvement and maintenance funding of US\$26.8 million for cleaning needs related to the coronavirus (Senate Committee on Appropriations, 2020). An additional US\$1.9 trillion financial package was passed in March 2021 (New York Times, 2021).

The USFS allowed loggers more time to fulfill their contracts on national forests, extending more than 1000 timber sale contracts as a result of the pandemic (Crockett, 2021). Contractors were allowed to continue harvesting during the pandemic in order to support employment. The risk was low since the activities were conducted outside, following safety protocols. Similarly, tree planting contracts proceeded.

The Canadian government provided a similar suite of financial assistance programs to businesses and individuals. The Canada Emergency Wage Subsidy provided limited benefit to the forestry sector. Compared to other industries, the forest industry did not face a large change in employment from April to August 2020. Forestry ranked fourth last in terms of share of private sector workers covered by the subsidy (Nighbor, 2020). Indigenous tourism faced unique economic and social/cultural impacts from COVID-19. Indigenous tourism growth has outpaced overall Canadian tourism activity (Fiser and Hermus, 2019), but with the pandemic, it came almost to a complete standstill. In response, Indigenous Services Canada partnered with a trade association to stand up a COVID-19 Stimulus Development Fund. Since March, 678 tourism businesses have received grants from the fund, of up to C\$25,000 per applicant, totaling C\$16.21 million (ITAC, 2020). These grants have gone to export-, market- and visitor-ready Indigenous tourism businesses in Canada. Responding to the scarcity of personal protective equipment for health care workers and the public, the Canadian government is funding development of paper-based protective masks (Pulp and Paper Canada, 2020).

The Canadian government on 30 November 2020 released an economic plan that included funding for the forest sector (Department of Finance Canada, 2020). The Nature Based Solutions to Climate Change provides C\$3.16 billion over 10 years, starting in 2021–2022, to NRCAN to partner with provinces, territories, and other stakeholders to plant two billion trees. An additional C\$30 million is to help small and medium-sized forest businesses to manage increased costs of safe operations, including tree-planting operations during the pandemic. In support of gender-centric provisions, the funding for commercial tree planting in 2020 and 2021 seeks to create opportunities for younger planters, as well as increased female representation. Beginning in 2021–2022, C\$631 million will be provided over 10 years to restore degraded ecosystems, protect wildlife, and improve land and resource management practices.

How Society Responded

Consumers in both countries responded to actions taken to counter the pandemic by self-isolating and increasing their on-line shopping, and working and learning remotely (Gupta et al., 2020). Online shopping sales in 2020 in the United States was projected to increase by 32% over 2019, to US\$795 billion, causing delays in delivery services (Lerman, 2020). Rather than emerging as novel drivers of change affecting

forest industry, these actions largely accelerated existing trends. Whether or not these changes in consumer behavior are sustained, the immediate positive effect on the packaging and negative effect on graphic paper have been significant. One short-term response was hoarding some paper products, for example toilet paper (Janda, 2021). Self-isolation and shelter-in-place orders spurred home repair and renovation (DIY) activity that increased demand for construction materials (Hancock Natural Resources Group, 2020).

Forests and parks near urban areas have experienced impacts from greater visitation (Dormer, 2020; Grima et al., 2020; Stanturf, 2020), increasing pressure on ecosystem services. This surge in utilization has led to increased vandalism, garbage accumulation, and the danger of fire ignitions (Stanturf, 2020). As USFS Chief Victoria Christiansen said about impacts on USFS recreation sites, “Every day is like a weekend, and every weekend is like the Fourth of July” (Charnley, 2020). Relatedly, there has been an upsurge in the sale of hunting and fishing licenses and outdoor equipment (Miller, 2020).

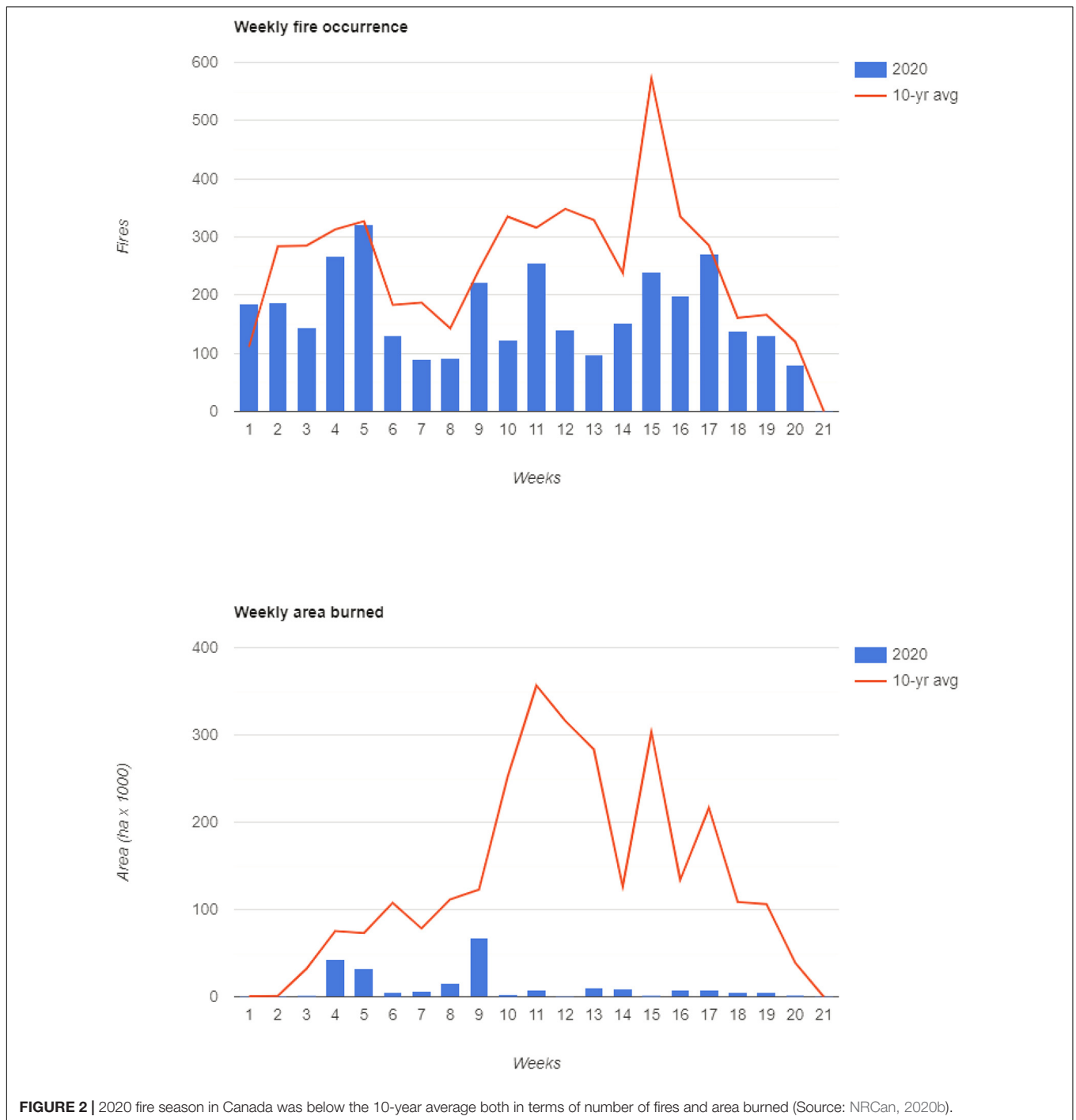
The rise of telecommuting and remote work enabled more people to seek the open space and lower housing costs of rural areas. A poll (Harris Poll, 2020) suggested that nearly two in five urban residents in the United States considered moving to a less crowded place. Outmigration from cities into rural areas due to the COVID-19 pandemic could have multiple impacts on rural communities near forests by further stressing services (Mueller et al., 2021), as well as on forest management, specifically from exacerbating the impacts of expanding the wildland-urban interface (WUI) on wildland firefighting, wildlife conflicts, and changing expectations of forest management (Radeloff et al., 2005; Hammer et al., 2009; Abrams et al., 2014; Mansuy et al., 2019). A recent survey of the rural western states in the United States is an example of changing expectations; it showed weak support for logging (41%), as opposed to 81% who supported traditional farming and ranching (Farrell et al., 2020).

Effects on Forest Health

Closing borders and confining populations to their houses drastically reduced the consumption of fossil fuels. By one estimate, daily global CO₂ emissions decreased by –17% by early April 2020, compared to 2019 mean level (Le Quéré et al., 2020). The reduction of short-lived chemical species in the United States, however, had minimal impact on global levels (Forster et al., 2020). The overall impact was limited and probably won't last as many travel restrictions were lifted by 2021.

Despite expecting an above average fire season (NRCAN, 2020b), by September most of Canada was experiencing below average numbers of fires and area burned (Figure 2) and the national wildfire preparedness level was at Level 1 for most of the summer. Nevertheless, fire prevention policies such as fire bans were applied more frequently in anticipation of an above-average fire season (Stanturf, 2020).

The wildfire picture in the United States was quite different, with California experiencing the worst fire year on record; 9,639 fires burned 1,779,730 ha (NIFC, 2020). California has in the past relied on well-trained prisoner crews to augment other firefighters but COVID-19 disease clusters



in crowded prisons impacted the state’s ability to rely on inmate fire crews (Insider, 2020). In response, the state turned to the United States Army (Sierra News Online, 2020). The situation was so dire that national forests and parks in California and state forests and parks in Oregon and California were closed to visitors for some weeks. Smoke from wildfires caused significant air quality hazards in western metropolitan areas such as the San Francisco Bay Area in California (SFGATE, 2020).

Smoke from wildland fire poses a significant health hazard to vulnerable populations, most concerning to those with respiratory problems (Naeher et al., 2007; Henderson, 2020). Guidance for reducing transmission of the SARS COV-2 virus conflicts with health advice for smoke. Because distancing guidelines limit the number of people who can access community shelters, sheltering at home with portable air cleaners has been emphasized, along with closing windows and doors. Being outdoors and improving indoor ventilation, however, is

recommended for avoiding COVID-19. Mask wearing is another method for reducing virus transmission but cloth masks provide almost no protection from particulates in smoke (PM_{2.5}) that cause respiratory distress. Well-fitting N95 respirators offer protection but they were in short supply and potentially increased risk to the most vulnerable populations because of breathing fatigue (Henderson, 2020).

Effects on Forest Management and Research Activities

Canada and the United States are both developed economies with significant forest resources and vibrant forest products industries. Ownership patterns differ, with implications for forest management and the regulatory environment; most forests in Canada are the responsibility of provinces and territories (defined as Crown land), with operational management done under concession (NRCan, 2018; Gilani and Innes, 2020). Forest ownership in the United States varies substantially with private ownerships dominant in the East and public ownership in the West. Nationally, 58% of forests are privately owned and account for 89% of the timber harvested annually (Oswalt et al., 2019). Canada is the third-most forested country in the world by area with its 347 million ha comprising nearly 9% of the world's total forest area (NRCan, 2018). Canada is the world's largest producer of newsprint, the largest producer of northern bleached softwood kraft pulp, and the second-largest producer of softwood lumber (Table 1). The United States ranks fourth globally in forest area with 333 million ha of forests and woodlands (Oswalt et al., 2019). The United States forest products industry accounted for more than 20% of the 2018 global production of pulp for paper, recovered paper, and pellets and a significant share of other products (Table 2).

In Canada, forest management operations are seasonal and occur mostly in remote areas. Early in the pandemic, operations were delayed by COVID-19 to ensure the health and safety of workers and nearby communities but also in response to slack

TABLE 1 | The United States and Canada share of global forest products production in 2018.

Product category	United States percentage of global production	Canada percentage of global production	Combined percentage of global production
Industrial roundwood	18	7	25
Wood pellets	20	8	28
Sawnwood	17	10	27
Wood-based panels	9	3	12
Pulp for paper	25	8	33
Recovered paper	21	No data	21
Paper and paperboard	18	No data	18
Wood fuel	4	No data	4

Source: FAOSTAT (2020).

TABLE 2 | The United States and Canada share of global forest products consumption in 2018.

Product category	United States percentage of global consumption	Canada percentage of global consumption	Combined percentage of global consumption
Industrial roundwood	18	7	25
Wood pellets	5	<1	<6
Sawnwood	21	4	25
Wood-based panels	12	<1	<13
Pulp for paper	24	4	28
Recovered paper	13	No data	13
Paper and paperboard	17	No data	17
Wood fuel	<1	No data	<1

Source: FAOSTAT (2020).

demand and volatile market prices (EDC, 2020). The Ontario Ministry of Natural Resources and Forestry canceled a jack pine budworm aerial spray program. Some provinces operated their programs at reduced capacity; Saskatchewan, Manitoba and Nova Scotia prioritized forest pest survey and control activities, focusing on areas that could be accessed within day trips. Others, including Alberta and New Brunswick, conducted their regular forest health protection programs (Stanturf, 2020). Many jurisdictions banned prescribed burning. Salvage operations in western Canada following wildfires and bark beetle outbreaks proceeded (Vice, 2020). Tree planting was supported by a new government program that provided financial support to help the forest sector adjust to the new safety requirements; over 600 million seedlings were planted. Tree planting camps reported no cases of COVID-19 because of the physical distancing measures in place (Stanturf, 2020).

Worker safety measures imposed to reduce contagion affected forest management in the United States. Risk reduction activities, such as prescribed burning and trimming vegetation near power lines, slowed due to social distancing policies; prescribed burning was suspended in most regions (Heller, 2020). Meetings were held online or virtually for activities such as grazing permits, but timber sales, harvesting inspections, timber surveys, permit inspections, prescribed fires, scientific surveys and forest health monitoring were postponed or halted (Souza, 2020). Forest certification audits were adjusted to be done remotely. For example, in April the FSC announced options of postponing audits or conducting desk audits in order to avoid certificate holders losing their certification status because auditors and staff were unable to conduct on-site audits (FSC, 2020).

National forests are subject to extensive planning that requires much public participation; it is unclear how to accomplish that virtually, especially given that many of the public meetings are held in rural communities that are underserved with internet connectivity. One potential impact of concern is how moving from in-person to virtual meetings will impact project implementation, litigation, and objections to forest

management or harvesting activities (Charnley, 2020). As has been demonstrated by several cooperative conservation partnerships with other public and private sector actors, building trust is critical to effective cooperation, a process that is best accomplished by multiple, in-person interactions (Walpole et al., 2017).

Federal land management agencies in the United States collect significant revenues for resource extraction and other activities on forest lands that require personnel on-site for permitting, monitoring, and fee collection (Table 3). These activities are likely to be affected by COVID-19. For example, the major land management agencies collected US\$442 million in 2019 for recreation fees and US\$217 million in timber receipts. The National Park Service has about 500 concessionaires in 100 park units, employing around 25,000 full-time and seasonal employees. Delayed park openings, services limited in order to comply with federal, state and local health guidelines, and reduced international and domestic travel have caused an estimated 70% decline in revenues for January through July 2020, projected to be more than US\$1.1 billion nationally for 2020 (NPHA, 2020).

Forestry research is heavily dependent on field measurements and the pandemic reduced the length of the field season and added costs and time, for example sending multiple vehicles instead of a single vehicle to transport crews to the field. In addition, access to research labs was also reduced that negatively impacted work. The Government of Canada softened the impact by adjusting the current suite of forest sector specific programs. For example, an additional C\$5.6 million was allocated in 2020–2021 to forest sector research and development to compensate for lost industry contributions and accelerated

COVID-19 related research (e.g., facemasks and filtration). Other programs increased flexibility of the application process and reduced industry cost-share requirements (Stanturf, 2020).

In the short-term, students, postdoctoral researchers, and early-career faculty are likely to be impacted by shifts toward virtual or hybrid classes without field labs or by interrupted research. The longer-term impact of canceled scientific and technical conferences and the inability to gather and share knowledge is harder to gauge. Some conferences are continuing virtually although the critical informal exchanges of information that happen at such gatherings will not occur. Over 45 technical conferences were canceled or postponed as of August 13, 2020 (CFI, 2020) including key forest policy meetings such as the Convention on Biological Diversity post-2020 targets and the 2020 UN Climate Change Conference (Corlett et al., 2020). Many scientific organizations are contemplating a permanent move to a hybrid conferencing model (Kleine, 2020). It is also likely that the shift of research funding to accelerate virus recovery will significantly reduce funding for forest related programs and conservation (Bates et al., 2020).

Effects on Forest Industry

The immediate economic disruption of COVID-19 on the forest products sector was due to reductions caused by the closure of non-essential industries and workers not being able to remotely perform their activities. Physical distancing was a critical safety and health measure imposed on manufacturing facilities, but it was often difficult to maintain the recommended 2-meter distance between workers in facilities such as sawmills. Demand increased immediately for hygiene products such as toilet paper, due in part to panic buying by consumers and by employees

TABLE 3 | Revenue generating programs and activities of United States federal land management agencies.

Activity	Agencies	Revenue basis	Collected amounts (US\$ millions)	Allocation of receipts
Recreation fees	BLM, FS, FWS, NPS	Fees for entrance and/or use of amenities	442.0 ^a	100% to collecting agency
Concessions and commercial visitor services	BLM, FS, FWS, NPS	Fees for concession franchises, permits, leases	134.3 ^b	For NPS concession franchise fees, 100% to NPS Allocation of other fees is variable; some agencies can only retain cost-recovery amounts ^c
Energy production and mineral extraction (onshore)	BLM, FS	Rents, bonuses, royalties, permit fees, material disposal	4,850 ^c	Varies by applicable authorization
Livestock grazing	BLM, FS	Permit/lease fees	21.0 ^d	Split among agency, Treasury, and state (to benefit counties where receipts were generated)
Timber harvesting	BLM, FS	Sale	217.1 ^a	Varies by individual sale, with options for 100% agency retention; revenue-sharing requirements with communities also varies

Source: CRS (2020a), BLM, Bureau of Land Management; FS, Forest Service; FWS, Fish and Wildlife Service; NPS, National Park Service.

^aFY 2019.

^bFY 2019 in NPS concession franchise fees; amounts in other collections unavailable.

^cThis amount does not include funds recovered in FY 2019 for exploration, material disposal, and wind and solar rights-of-way as data not available. In FY 2018, this amounted to US\$ 103 million.

^dFY 2018.

^eFor example, in FY 2019 the USFS returned US\$55 million to the Treasury from revenue generated by ski resorts on NFS lands.

working from home (Fortune, 2020). On March 12, 2020, toilet paper sales in the United States were 734% compared with the same day the previous year and shortages continued through the summer. The immediate response was to increase production and switch to producing only large consumer packages. Nevertheless, the ability to increase production had limited effect as toilet paper machine capacity could only be increased from 92% to 99.8% (Fortune, 2020).

Anticipating a decline in demand due to the pandemic, sawmills reduced production and wood raw material consumption between January–July 2020 in the United States was 6.7% lower than the same period in 2019, resulting in a US\$1.83 billion (13%) reduction in value of delivered wood (Greene, 2020). That loss in value had a significant impact throughout the forest supply chain, from timberland owners to loggers and truckers (Del Rio-Chanona et al., 2020). The impact of these reductions on timber markets varied by region; the impact was greater in the United States West than South because lumber is a larger component of total solid wood timber demand in the West. Oversupply of southern United States stumpage delayed the response of stumpage prices to increased lumber demand. In the Northwest, lumber demand increased with spruce, pine, and fir lumber composite prices rising 239% (Culbertson, 2020). Canadian producers are highly price sensitive and because fully 80% of Canada's forest products exports are to the United States, price volatility in the United States affects Canada's forest industry (EDC, 2020).

With people spending more time at home, along with stimulus payments that provided greater support for consumer income and spending, there was a jump in remodeling and demand for DIY wood products, leading to steeply higher lumber prices

and local shortages through the summer of 2020 that was expected to decline in the fall as sawmills increased production and the construction season typically winds down (Greene, 2020). Following record highs, prices then sharply declined. For example, southern yellow pine lumber price was \$US 569/MBF on October 16, a drop of 17% from the \$US690/MBF the previous week (Greene, 2020). This price decline was short-lived; demand has since increased substantially and lumber prices again hit seasonal high prices (Figure 3).

Although the economic shock of the pandemic caused United States housing starts to sharply decline by 30% in April, demand rebounded but with more emphasis on single family rather than multiple family units in both the United States and Canada (Nighbor, 2020; Greene, 2021). United States housing starts continued to increase even into December, to their best pace since late 2006 (Greene, 2021). An estimated 1.380 million housing units were started in the United States in 2020, a 7% increase over 2019 (US Census Bureau, 2021).

The pulp and paper sector showed mixed response. The demand for sanitary paper products was exceptionally strong but markets for finished paper and containers declined from 2019 levels (Hancock Natural Resources Group, 2020). The pandemic accelerated trends toward on-line instruction and reduced photocopying, thereby decreasing demand for finished papers. Some pulp and paper mills have been re-purposed from paper to make fluff or containerboard (Miller, 2020).

More than 130 mills (out of 225 total mills) in Canada shut down or reduced production in response to the pandemic and other factors including lingering effects of wildfires from the previous year (Forisk Consulting, 2020; Stanturf, 2020). British Columbia had been particularly hard hit by the economic

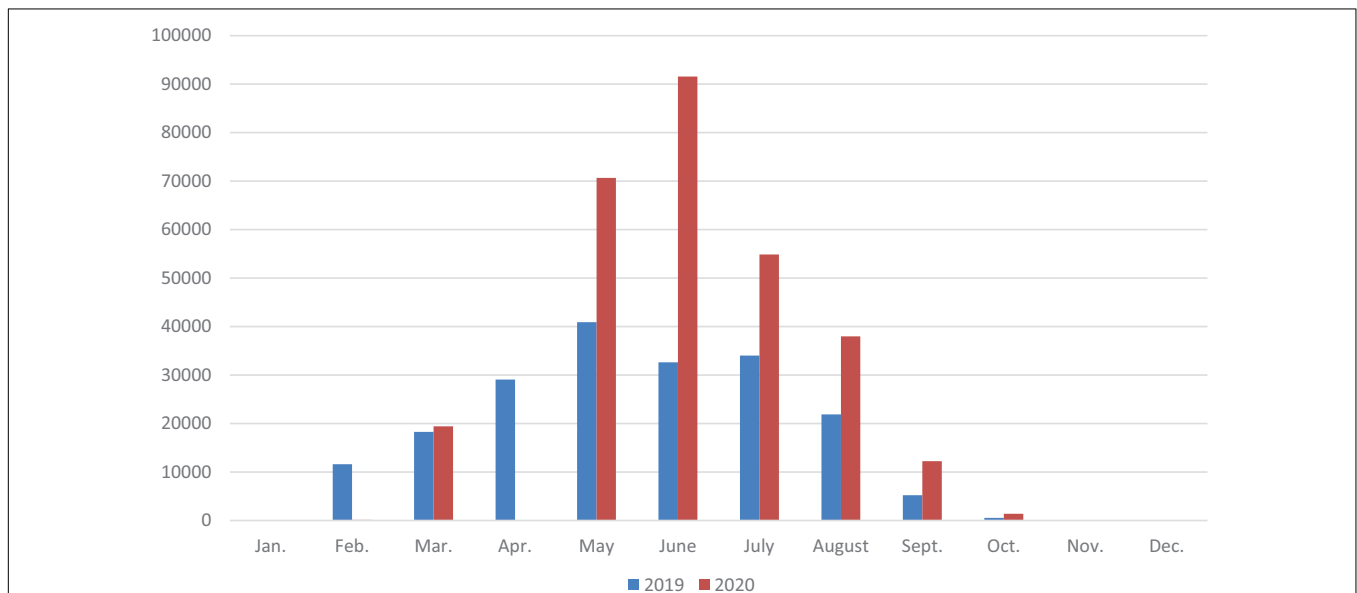


FIGURE 3 | Campground reservations in Alberta provincial parks increased in 2020 as people sought respite from isolation. Individual campsites, group camping areas, comfort camping and backcountry camping reservations are included. Numbers reflect the month the reservation was made, and not the date of stay. All reservations made in Jan–March were canceled and refunded due to COVID-19. On May 14, reservations were relaunched at 50% capacity; on June 12, campgrounds began moving toward 100% capacity across the system by July 1 (Source: Alberta Tourism, 2021).

recession, with almost 30% of production capacity idled or closed due the drop in prices for lumber (EDC, 2020). As of August 2020, three lumber mills and five pulp/paper mills in Western Canada closed or reduced capacity. Two pulp/paper mills, 6 sawmills, and a newsprint plant in eastern Canada reduced capacity due to reduced demand and/or COVID restrictions (Table 4). Most of the temporary restrictions were lifted by the end of 2020, but five mills remained idle (Table 4). In the United States, most of the impact of COVID-19 was on pulp and paper mills with temporary idling, and closure or conversion of selected machines (Table 5).

The Canadian pellet industry has been minimally impacted by the COVID-19 pandemic. About 90% of the pellet production is exported (mainly to Europe) and the and pellet exports have increased by 8% compared to 2019 (Canadian International Merchandise Trade, 2021). Domestic demand for pellets has remained stable because there is almost no domestic consumption for electricity generation. The southern United States accounts for 98% of wood pellet manufacturing capacity nationally (Wang et al., 2015) with six million metric tons exported in 2018 of the 7.5 million metric tons of wood pellets produced (FAO, 2019). Renewable energy is likely to expand post-COVID-19, with biomass energy companies expected to do well (Gayed, 2020).

Effects on Forest Recreation

The economic impact of limiting travel to, and to some extent within, the United States significantly affected local economies of Gateway Communities in and around national parks and forests. The reduced visitation caused by international travel restrictions in particular reduced spending on services as well as state and

TABLE 4 | Mill closures in Canada due to the COVID-19 pandemic.

Facility type	Region	Second quarter	Fourth quarter
Lumber	West	Filed for bankruptcy, indefinitely idling	Idle
Lumber	West	Permanently closing sawmill	Closed
Lumber	West	Temporary production curtailment	Open
Pulp/paper	West	Curtailed two pulp and a paper mill due to BC's timber shortage and the COVID-19 crisis	Open
Pulp/paper	West	Additional downtime, due to COVID-19 related sawmill curtailments and stumpage fees	Open
Pulp/paper	West	Curtailed until midsummer	Idle
Pulp/paper	West	Closing pulp mill due to lower demand for pulp	Closed
Pulp/paper	West	Curtailed until mid-summer	Idle
Newsprint	East	Curtailed production for 2 weeks	Open
Lumber	East	Curtailed production for 2 weeks	Open
Pulp/paper	East	Curtailed because of weakened demand for newsprint and specialty papers	Idle
Pulp/paper	East	Curtailed because of weakened demand	Idle

Source: Forisk Consulting (2020).

TABLE 5 | Mill closures in the United States due to the COVID-19 pandemic.

Product	Region	Second quarter	Fourth quarter
Lumber	North	Short-term drop in production and logging due to unemployment extra benefits	Open
Pulp/paper	North	Closed for 2 months due to declining demand for freesheet paper	Open
Pulp/paper	North	Permanently closing one machine and redistributing production to other mills	Closed
Pulp/paper	North	Indefinitely idling two mills due to COVID effects on printing and writing paper	Closed
Lumber	South	Temporary downtime	Open
Pulp/paper	South	Closing paper machine, transitioning to fluff pulp production	Idle/converted
Pulp/paper	South	Uncoated freesheet machine closed, to be converted to linerboard	Closed/converted
Pulp/paper	South	Paper machine idled	Idle
Pulp/paper	South	Cellulose mill to scale back production	No change
Pulp/paper	South	Reduced production due to COVID.	Open
Pulp/paper	South	Containerboard machine closed	No change
Pulp/paper	South	Production curtailed	Open
Lumber	West	Curtailed production	Open
Pulp/paper	West	Mill idled	Idle
Pulp/paper	West	Temporary downtime	Open
Pulp/paper	West	Indefinitely shut down paper mill	Closed

Source: Forisk Consulting (2020).

local sales and tourism taxes bases on concessioner sales (America Outdoors, 2020a). The impact extended beyond the peak summer vacation season. There are 460 ski areas in 37 states, many in the western United States located on National Forest System lands; most were deemed non-essential and closed in March 2020. The impact has been estimated at US\$2 billion from revenue losses at the end of the 2019–2020 season and an expected drop in future season pass sales (Bruton, 2020). In Canada, ski resorts remained open, except in Ontario. However, the occupancy rate has fallen to around 20 to 30% for international ski resorts in Western Canada (Xu, 2021). Many small seasonal recreational businesses that provide outdoor recreation services or equipment are at risk of bankruptcy. These include outfitters and guides whose customers come from outside the local area, usually by air. Reservations in March declined by over 25%. Longer-term impacts are expected, due to reduced or delayed spending on equipment, marketing and recruitment of seasonal employees (America Outdoors, 2020b).

Urban residents flooded into nearby rural areas including public lands. For example, during the early months of the pandemic, 26% of people visiting parks around Burlington, Vermont had rarely, if ever, visited nature in the previous year (Grima et al., 2020). States saw increased usage of parks; for example, attendance at Pennsylvania state parks increased from 37 million in 2019 to more than 46.9 million in 2020, a 26.6% increase (Dunn, 2021). State parks in the United States are facing multiple threats to their funding as COVID-19 strains budgets. Pennsylvania state parks, for example, are contemplating user

fees, a departure from long-standing tradition of free access (Howard, 2020). Visitors on national forests and grasslands increased by 12% in 2020 when compared to 2019; the greatest increase occurred between May and October. More than 80% of recreation sites were kept open over the year, with dispersed recreation sites and wilderness areas seeing the most significant increases (USFS, 2021).

There has been a similar upsurge in use of outdoor facilities in Canada, specifically in urban and peri-urban areas as well as provincial and national parks. For example, campground reservations in provincial parks in Alberta increased almost 200% between May and September 2020 versus 2019 (Figure 4).

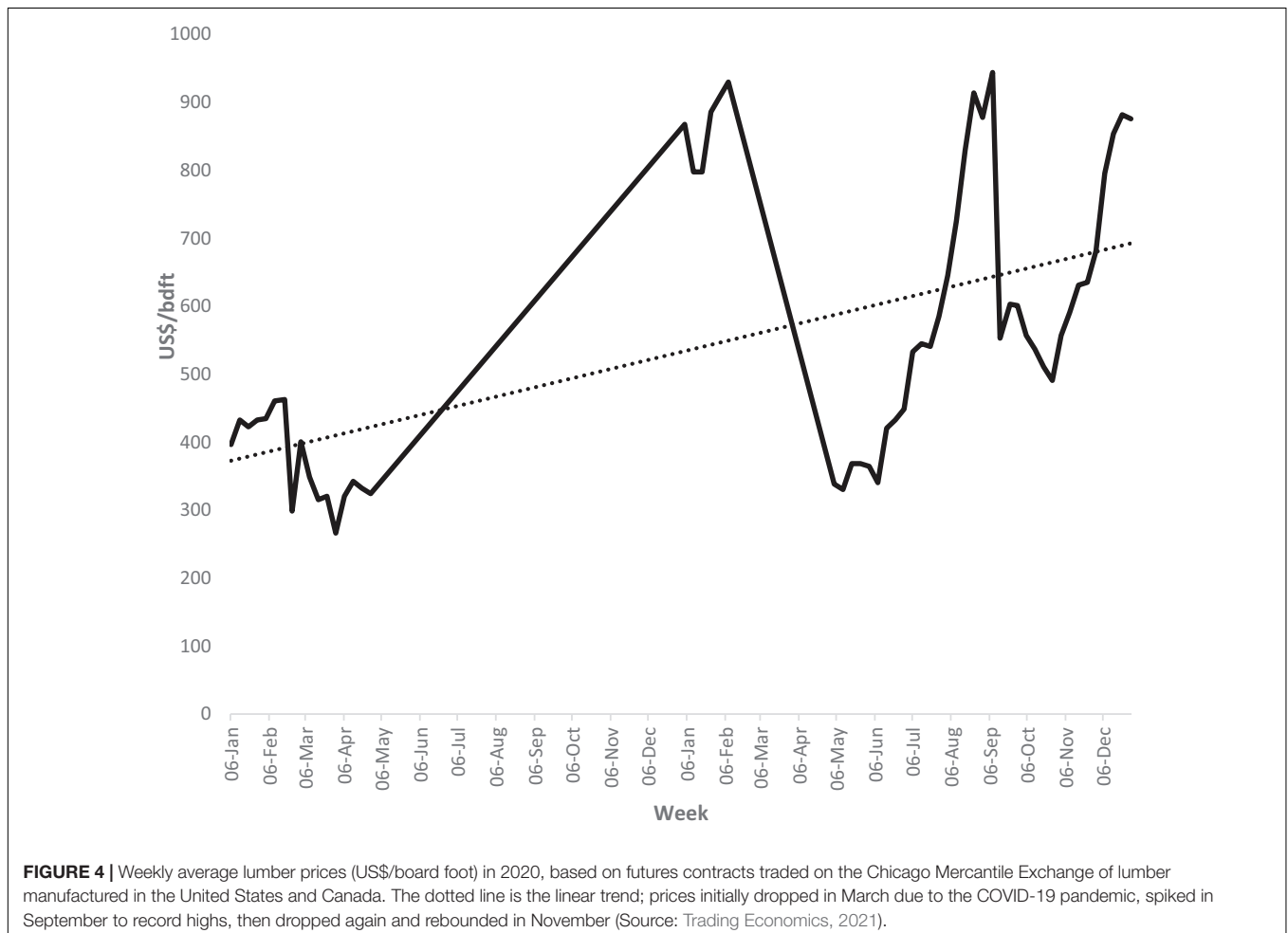
DISCUSSION

The forests of Canada and the United States are globally important, comprising almost 700 million ha of boreal and temperate forests (NRCan, 2018; Oswalt et al., 2019). The two countries together account for significant percentages of global production of pulp, paper, and solid wood products (Prestemon et al., 2015; FAOSTAT, 2020). The COVID-19 pandemic has affected forests through the social distancing,

worker safety measures, travel restrictions, and business closures, both voluntary and imposed, that were implemented to attempt control spread of the virus (Del Rio-Chanona et al., 2020; FAO, 2020; Walmsley et al., 2020). Importantly, both Canada and the United States early on declared the forest sector essential, allowing most work to continue although worker safety measures increased costs and delayed or postponed some forest management and manufacturing activities.

The pandemic disrupted forest management and research activities in both countries (CRS, 2020a; Stanturf, 2020), caused mill closures and production pauses, and impacted employment and livelihoods (Tables 4, 5). Uncertainty delayed capital investments and responding to the pandemic incurred significant incremental costs to implement health and safety measures in order to protect workers and local communities (Miller, 2020; Nighbor, 2020). Long-term effects will depend on whether control measures permanently change consumer behavior and whether government responses are directed toward green infrastructure investments (FAO, 2020; Forster et al., 2020; Hancock Natural Resources Group, 2020; Janda, 2021).

Along with market forces, any lingering or continuing effects of COVID-19 on forests and the forest sector will be determined by the nature and scale of government actions. Government



spending is a larger factor than any other economic sector; immediately the question is whether emergency economic interventions will continue to provide economic stability. Future government budgets will undoubtedly be subject to contentious debates about the deficits incurred in recent years and there may be less discretionary funding available for forest management and forestry research and development (CRS, 2020b).

The voluntary and imposed social measures intended to control virus spread accelerated existing trends in consumer behavior, specifically remote working and learning and on-line buying. Major companies in the United States and other countries have announced plans to continue remote working arrangements well into 2021 or even permanently for some employees (Loten, 2020). Open spaces such as forests have taken on increased value for recreation and leisure (Derks et al., 2020). The imposed isolation increased interest in natural surroundings, motivating increased visitation to urban and peri-urban parks (Dormer, 2020; Grima et al., 2020) and inducing migration from urban to rural areas (Harris Poll, 2020).

Building construction is the primary driver of demand for lumber, plywood and related materials. The housing market is a major driver and if remote working and learning continue to grow, demand for solid wood and panel products will increase. People relocating to suburbs and rural areas, where housing is less expensive or simply to access more outdoors, will fuel this demand. Continued government intervention to keep interest rates low will support new home buyers. The effect on lumber demand should be substantial as a median-sized single-family home uses about three times more lumber than the median multi-family building (Coskren, 2020). In addition, continued United States tariffs on Canadian lumber imports will constrain supply as will the loss of timber from wildfires in the Pacific Northwest. If government stimulus to support consumers and businesses is discontinued, however, there is the risk of a collapse similar to the one in 2008 (Prestemon, 2020; Zhang, 2020).

Effects of the virus were entangled with other factors affecting forests and their management, particularly wildfires. The experience with wildfires in the United States and efforts to control COVID-19 outbreaks in firefighter camps highlights the potential implications of outbreaks beyond the health effects in the camps. Disease outbreaks could also affect the ability of the firefighting community to respond to multiple fires in an active season (Thompson et al., 2020). Large wildfires have been the norm in recent years and resources have been strained when several fires occur simultaneously (Belval et al., 2020). Infected personnel who leave a fire are not easily replaced or worse; infected but asymptomatic individuals may leave one fire and spread the infection to another camp. A large proportion of the workforce recovering or quarantined significantly stresses the entire system (Thompson et al., 2020).

The potential health effects extend beyond the firefighting community. Indigenous communities already experience poor access to healthcare, significantly higher rates of communicable and non-communicable diseases, lack of access to essential services, sanitation, and other key preventive measures, such as clean water, soap, disinfectant, etc. (UN, 2020). The historical

health and social inequalities facing Indigenous communities before COVID-19 have only been magnified during the pandemic. Rates of COVID-19 are elevated among Indigenous communities globally, including Native Americans in the United States (Yellow Horse et al., 2021). The rate of COVID-19 for Indigenous communities in Canada was lower than that for the general population during the first months of the pandemic (Richardson and Crawford, 2020). However as of June 2021, the rate of reported cases of COVID-19 in First Nations living on reserves was 188% higher than the rate in the general Canadian population and the COVID-19 case fatality rate among First Nations people living on a reserve was 61% of the case fatality rate in the general Canadian population (ISC, 2021). In Canada, almost all Indigenous communities have pre-existing emergency preparedness plans, and they have been updated and implemented to deal with the current pandemic. Furthermore, innovative educational materials and public health campaigns have been created by many different First Nations, Inuit and Métis communities (Richardson and Crawford, 2020). During COVID-19 many Indigenous communities have shown self-determination by articulating and enforcing rules on who can enter their communities, often implementing far stricter measures than those enacted by local municipalities, such as closures and checkpoints (Richardson and Crawford, 2020).

On the whole, the forest sector—forest management, industry and communities—demonstrated remarkable resilience to the COVID-19 pandemic. Early restrictions on travel and social distancing requirements elicited significant shifts in public behavior (Chetty et al., 2020; Gupta et al., 2020) that caused short-term disruption in supply chains, quickly illustrating the downside of lean supply-chain management (Fortune, 2020). Increased levels of on-line shopping and remote working and learning resulted from self-isolation and social distancing requirements accelerated existing trends, rather than emerging as novel drivers of change. These trends were supported by fiscal policy, including immediate stimulus, historically low interest rates, and potentially longer-term support for infrastructure construction (Hancock Natural Resources Group, 2020). These trends, and on-going responses to COVID-19 (and emerging variants), will continue to challenge and pose new opportunities in the ways that forests in Canada and the United States are utilized, including both commodities and services flowing from the forests.

Building Back Better

The response to the pandemic has shown that rapid social change is possible; COVID-19 presents a once in-a-lifetime opportunity to shift the global development paradigm toward greater sustainability and a greener, more inclusive economy, in which the forest sector can play a key role. Canada has taken the lead in planning for this transition and has shown the political will to go down this path. In December 2020, the Canada-World Bank Clean Energy and Forests Climate Facility was established with C\$400 million in loans and C\$10 million in grant contributions. The Facility will support transformational climate actions of World Bank

projects, specifically with C\$75 million directed toward co-financing World Bank projects aimed at reducing carbon emissions from deforestation and forest degradation and those fostering conservation, sustainable management, and enhancement of forest resources (World Bank, 2020). The new Biden administration in the United States is reversing many policies of the previous Trump administration, including rejoining the Paris climate accords, supporting the World Health Organization, and signing on to the global vaccination effort (COVAX). A major infrastructure spending package has been proposed but not yet passed.

In both countries there is momentum for directing stimulus and recovery spending beyond meeting immediate needs toward targeting infrastructure development. Three interrelated themes are in play: Build Back Better, Green/Low-Carbon Economy, and Forest Restoration. Directing stimulus and recovery spending toward infrastructure that supports a more progressive future, rather than a return to business as usual, could follow the guidelines set out in Stark (2020) to invest in COVID 19 recovery with a view toward climate change adaptation; this is compatible with the approach of the Canadian government (Stanturf, 2020). Additionally, fiscal policies could transition to zero carbon rather than supporting carbon intensive industries in the transport, energy, land use sectors (Rosenbloom and Markard, 2020). Investing in a sustainable recovery could be funded by pricing reforms including taxing carbon and removing fossil fuel subsidies (World Economic Forum, 2020). The Forest Products Association of Canada has proposed \$C 1.5 billion in “shovel ready” projects for the recovery budget that focus on environmental improvements in the forest products sector (FPAC, 2020).

A transition to a Green or Low-Carbon Economy is already taking place to an extent in both countries. A low-carbon recovery could initiate significant emission reductions and also create more jobs than would be created by a high-carbon recovery program (McKinsey, 2020). Many estimates of the mitigation effect of low-carbon programs that focus on the energy sector ignore bioenergy, although combining forest biomass conversion with carbon capture and storage technology has great potential (Hanssen et al., 2020). Further potential for carbon sequestration in the forest products sector is being realized with the emergence of innovations such as mass timber construction and cross laminated timber (Smart Cities, 2020). Other innovations in packaging and containers, paper-based face masks, and utensils are contributing to this transition. Advanced products can be manufactured from cellulose nanocrystals or filaments extracted from woody biomass (CCFM, 2017; Biomass, 2020; Nasser et al., 2020). The forest products industry has great potential to lead the movement to Build Back Better in a Circular Economy. Wood is a renewable resource, and can be harvested sustainably and processed into materials with low embedded energy and high carbon content, substituting for other energy-intensive materials. The existing infrastructure can be upgraded to wood-based refineries producing high-value biomaterials and biochemicals (Menon and Rao, 2012).

Restoring degraded forests in the United States and Canada could potentially contribute to the Green Economy, reduce

carbon emissions, sequester carbon, adapt to climate change and create jobs (Stanturf et al., 2015; Mansuy, 2020; Mansuy et al., 2020). Currently the Green/Restoration economy in the United States is estimated to directly employ about 126,000 jobs and indirectly an additional 95,000 jobs with \$US 24.5 billion in total economic activity (Bendor et al., 2015). Both countries have proposed to scale-up tree planting, on the order of billions of trees (Mansuy, 2020; Mansuy et al., 2020; White House, 2020). An estimated \$US4–4.5 billion annual investment over 20 years, planting 60 billion trees, mostly on private lands, could create 150,000 jobs per year (\$US one million invested in reforestation creates 40 jobs (Edwards et al., 2013). The United States Forest Service is contemplating how to respond to an Executive Order on the Trillion Trees Initiative (Dumroese, 2020).

The pandemic shone bright lights on two aspects of forests—one, forests are important for social wellbeing and quality of life (Ikeda et al., 2021; Kobayashi et al., 2021), and two, that deforestation and loss of forest habitat increases the risk of zoonotic diseases (Everard et al., 2020; Tollefson, 2020). Because the greatest threat of zoonoses is habitat loss in the tropics, one measure suggested for pandemic recovery packages is to swap the debt of developing countries, where debt is reduced so that capital can be redirected toward climate and biodiversity programs (Steele and Patel, 2020). Studies have pointed out that it is less expensive to prevent viral pandemics than fix them (Dobson et al., 2020; Tollefson, 2020).

Many of the increased visitors to forests were there for the first time, accompanied by increases in vandalism, damage, and conflicts between user groups. The United States Forest Service recognizes that there is an opportunity to capitalize on new visitors and educate them on proper use of their public land, especially since there are many health benefits that could result from use (Crockett, 2021). Natural areas in Europe experienced similar challenges from increased use and new visitors; in response, McGinlay et al. (2020) proposed managing visitor numbers in order to avoid overcrowding through careful spatial planning, introducing educational campaigns, particularly targeting a new profile of visitors, and promoting sustainable tourism models, which do not rely on large visitor numbers. Perhaps the pandemic has provided an opportunity to increase understanding of the importance of sustainably managed forests for the myriad benefits they provide, including health benefits (Colfer et al., 2006).

ETHICS STATEMENT

Ethical review and approval was not required for the study with human participants, in accordance with the local legislation and institutional requirements.

AUTHOR CONTRIBUTIONS

JS and NM wrote and edited the manuscript. JS collected interview data. Both authors contributed to the article and approved the submitted version.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/ffgc.2021.666960/full#supplementary-material>

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The remaining author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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