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North American Forest Futures 2018–2090: Scenarios for Building a More Resilient Forest Sector

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Abstract

North American forests and forest management institutions are experiencing a wide range of significant ecological disturbances and socioeconomic changes, which point to the need for enhanced resilience. A critical capacity for resilience in institutions is strategic foresight. This article reports on a project of the North American Forest Commission to use Futures Research to enhance the resilience of forest management institutions in North America. The Aspirational Futures Method was used to develop four alternative scenarios for the future of North American forests and forestry agencies: (1) an extrapolation of current trends into the expectable future titled Stressed Forests, (2) a scenario of growing desperation titled Megadisturbances Call for Military Intervention, (3) a high aspiration future titled High Tech Transformation and Cooperation, and (4) an alternative pathway to a highly preferable future titled Cultural Transformation Embraces Indigenous Values. These scenarios will be used in discussions and futures exercises with forestry leaders to develop foresight and assure that plans are responsive to the challenges and opportunities ahead.

Keywords

scenarios, Aspirational Futures, North American Forest Commission, forestry, forest service, resilience

Introduction: The Changing Context for North American Forests and Forestry Institutions

North American forests are experiencing a wide range of significant ecological disturbances, including climate change, nonnative invasive species, severe wildfires, and forest fragmentation (Bengston and Dockry 2014). Millar and Stephenson (2015) have identified the emergence of megadisturbances—multiple and interacting disturbances such as hotter droughts—that are pushing some temperate forests beyond thresholds of sustainability. Government forestry institutions are also experiencing the effects of many significant challenges, in addition to the barrage of ecological disturbances, such as

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shrinking budgets, a growing societal disconnect with nature, shifting environmental values, and accelerating pace and complexity of change.

Emerging megadisturbances, accelerating social and economic change, and growing complexity and uncertainty all point to the need for enhanced resilience in North American forests and forestry institutions. Ecological definitions of resilience emphasize the ability of a system to absorb or accommodate disturbances *without* experiencing fundamental changes to the system (Davidson 2010). For example, Walker et al. (2006, 2) define resilience as ". . . the capacity of a system to experience shocks while retaining essentially the same function, structure, feedbacks, and therefore identity." But the potential ecological disturbances facing North American forests are so significant that they will likely cause fundamental changes in the structure and function of forest ecosystems. Forest management institutions are facing the clear possibility of fundamental shifts in organizational structure and culture to adapt to change. Therefore, traditional ecological definitions of resilience may be less appropriate for North American forestry in the twenty-first century than broader definitions, which include notions of adaptation and adjustment, for example, "the ability of groups or communities to cope with external stresses and disturbances as a result of social, political, and environmental change" (Adger 2000, 347). This broader definition includes the social and institutional adaptations that occur with changing ecosystems.

A critical capacity for resilience in institutions is alertness to patterns of change, especially those that challenge the underlying assumptions that drive current strategies and programs (Berkes et al. 2003). Alert institutions strive to anticipate change, spot emerging threats and opportunities quickly, and shape robust policies and programs that work under a wide range of future conditions. They develop the essential capacity for strategic foresight, that is, "the ability to create and maintain a high-quality, coherent, and functional forward view and to use the insights arising in organizationally useful ways; for example, to detect adverse conditions, guide policy, [and] shape strategy" (Slaughter 2002, 104).

This article reports on a project to apply concepts and methods from Futures Research to enhance the ability of the North American Forest Commission (NAFC) agencies—the national forestry agencies of Canada, Mexico, and the United States—to plan and operate within an environment of growing uncertainty and rapid change. The NAFC is one of six Regional Forestry Commissions of the Food and Agriculture Organization of the United Nations (FAO 2016). The mission of the NAFC is to provide a policy and technical forum for Canada, Mexico, and the United States to discuss and address North American forest issues. The NAFC also supports research and sustainable natural resource management activities through working groups that explore issues of concern to the three countries. This article is a product of the NAFC's Ad Hoc Resilience Working Group (RWG), charged with using Futures Research to enhance the resilience of forest resource management institutions in North America.

The Aspirational Futures method, described in the following section, was used to develop four alternative scenarios for the future of North American forests and forest management agencies. The complete scenarios are presented, followed by a summary of how they will be used as a catalyst for discussions and exercises with NAFC leaders.

The Aspirational Futures Method

The Aspirational Futures approach was developed by the Institute for Alternative Futures to address both the inherent uncertainty that scenarios should encompass and the ability of leaders to use vision, which can alter trajectories toward more favorable futures (Bezold 2009). The method uses forecasts of drivers of change that fall into three zones that define a set of four scenarios (Figure 1). These drivers and their forecasts are anticipated to force change with complex interactions that make a single prediction unrealistic. The distinct zones encompass a larger degree of uncertainty than a simple prediction, making the scenarios helpful for developing strategies for maintaining institutional agility in the context of multiple possibilities and fundamental uncertainties.

The three zones depicted in Figure 1—conventional expectations, growing desperation, and high aspiration—are a key to the Aspirational

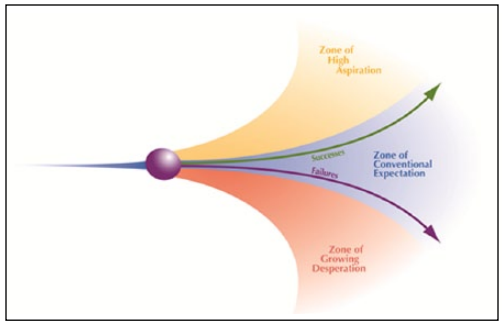

Figure 1. Aspirational Futures model (Bezold 2009).

Futures method. Organizations, like individuals, often lose touch with their higher aspiration. Dealing with all the changing circumstances and problems coming at them day to day puts them in a reactive mind-set. It is easy for an organization to become a victim of circumstances rather than focusing on actions to shape the circumstances to achieve their aspirations. An effective way to counteract this tendency is to refocus attention on aspirations. Having two highly aspirational scenarios for discussion forces people in organizations to think about what they really want and what is possible to achieve.

The first step in developing the NAFC scenarios was to identify a set of drivers that are likely to be important in shaping the future of North American forests and forest management agencies to the year 2090. A more than seventy-year time horizon was chosen because of the long-term nature of forestry—foresters routinely use exceptionally long time frames in planning. Research was done by RWG members to identify broad North American drivers that are not specific to individual countries (see appendix). More detailed, country-specific drivers and scenarios will be developed in subsequent work. The following broad categories of drivers were selected (Table 1): social change drivers (social values, relation to nature, economy), climate change drivers (temperature increase, impacts on forests), North American forest management agency drivers (wildfire and mission shift, organizational form, leadership culture), and technology.

Trends in these drivers were used to develop forecasts for expected, challenging, and two visionary paths for each driver corresponding to the three zones in Figure 1. See the appendix for a brief summary of each driver and key references related to the forecasts. The forecasts (i.e., the range of possibilities for each driver) were built into four alternative scenarios for North American forests. Table 1 summarizes, in outline form, how the drivers might plausibly develop and interact in the future.

Scenario 1 falls in the "zone of conventional expectation" (Figure 1), which reflects the extrapolation of known trends into the expectable future. This scenario was titled *Stressed Forests*. A second scenario, *Megadisturbances Call for Military Intervention*, sits squarely in the "zone of growing desperation," which presents a set of plausible challenges that North American forests and forest services may face over the next seven decades. Scenario 3, *High Tech Transformation and Cooperation*, offers one of two futures in the "zone of high aspiration." This scenario emphasizes science-and-technology-based solutions that can address twenty-first-century challenges. Scenario 4, *Cultural Transformation Embraces Indigenous Values*, describes a cultural shift that shapes how people change their relationship to forests and the way society values nature. In both aspirational scenarios (3 and 4), a critical mass of stakeholders pursues visionary strategies and achieves surprising success on two alternative pathways to highly preferable futures.

It should be stressed that the scenarios are not predictions. They are research-based descriptions of a range of possible futures that intentionally span a broader range of future circumstances than are usually considered in planning. The idea is to encompass a large "possibility space" to engage stakeholders to think about how serious the situation could become and about what bold action might achieve. The scenarios are presented in the following section.

Alternative Scenarios for North American Forests—2018 to 2090

Scenario 1: Stressed Forests

Surveying the prospects for North American forests in 2090, the NAFC Commissioners look worried. Budget cuts, political turmoil forcing turnover, and angry legislators who fail

Table 1. Scenario Matrix: Key Drivers of Change for North American Forestry and Forest Management Agencies, and Forecasts for Each Scenario.

	Zone of conventional expectation	Zone of growing desperation	Zone of high aspiration	
Key drivers of change	Scenario 1: Stressed forests	Scenario 2: Megadisturbances call for military intervention	Scenario 3: High tech transformation and cooperation	Scenario 4: Cultural transformation embraces indigenous values
Societal values	Similar to today	Strongly heightened emphasis on security	Emphasis on meaningful activities, friendships, quality of life	Emphasis on welfare of future generations, entire community of life
Relation to nature	People increasingly disconnected from nature	Growing alienation from nature; nature viewed as hostile, failing	Harmonizing human design and technology with nature	Growing influence of native people's worldview; humans part of nature
Economy	Moderate growth; job loss due to robotics and AI	High growth until climate catastrophes of 2070s, then collapse, insecurity	Moderate growth with large investments in technical innovation	Moderate to low growth
Climate change: temperature increase	3°C increase from the preindustrial level by 2090	4°C increase by 2090	Collapse of West Antarctic ice sheet spurs global efforts; 2°C increase by 2090	Largest peacetime effort in history limits temperature rise to 1.5°C by 2090
Climate change: impacts on forests	Worsening wildfires, invasive species, insect pests and pathogens; some forests convert to new forest types	Megadisturbances push many forests beyond thresholds, some convert to shrublands and grasslands	Renewable energy technology and geoengineering breakthroughs limit impacts	Impacts on North American forests are modest in most areas
Forest agencies: wildfire and mission shift	Most resources devoted to firefighting; severe budget constraints; low innovation	Military takes over firefighting; role of forest services declines sharply	Global Reforestation Initiative restores agencies' finances and range of activity	Wildfire paradigm shift, learning to live with fire
Forest agencies: organizational form	Bureaucratic/ hierarchical	Military	Network and ecosystem model	Ecological
Forest agencies: leadership culture	Technical	Military/technical	Adaptive	Visionary
Technology	Sensors to monitor forests; wood nanomaterials; GMOs	Synthetic biology; advanced technologies for the wealthy	Environmentally advanced and renewable energy technologies	Quantum biology; biomimicry

Note. AI = artificial intelligence; GMO = genetically modified organism.

to fund forest services and then blame agency heads for the results mark the political landscape while forests decline.

The average global temperature increased 2°C beyond the preindustrial level by 2065 and is now nearing 3°C. This led to a sharp increase in wildfires, the spread of invasive species, and a host of insect pests and pathogens more destructive than even the most devastating forest fires. Some thresholds of forest adaptability have been crossed, and many forests have converted to novel forest ecosystems. The changes have been large enough to cause a serious decline in forest ecosystem services, including a vast release of forest carbon into the atmosphere.

Public attention turns to forests sporadically as ever more frequent and severe natural disturbances threaten the growing population of squatters and landowners who have moved into the wildland–urban interface (WUI) over the decades. The paradox of degrading forests interwoven with an increasing population living in the WUI and demanding fire protection barely registers with most politicians and the majority of the public living in cities. As a result, the forest services face relentless pressure to fight wildfires while funding for other work shrinks to the point where most of their capacity is absorbed by the demands of fire management. During their quarterly holoconference meetings (travel for in-person meetings was eliminated long ago), the Commissioners regularly commiserate over their inability to address the fundamental stressors that threaten the forests of Mexico, the United States, and Canada.

Early in the twenty-first century, strategic thinkers in each of the North American forest services could see most of the emerging threats that have now become so serious. While shelves full of studies and reports forewarned the agencies, they were not forearmed. Governments had other priorities, and citizens were too preoccupied with economic insecurities, fears of terrorists, and lost ways of life to have made forest health a priority. The great forests have not disappeared in 2090, but they are diminished and fragmented so that many fear for the loss of most forests in the twenty-second century.

The most promising developments for North American forests come from the private sector, nongovernmental organizations (NGOs), and networks of academic scientists rather than from forest services. The academics and NGOs bring a commitment to sustainability that influences corporate policy and moderates the tendency to overexploit forest resources for short-term profit. The forest services play a small role in regulating this tension between competing interests but are forced to devote most of their inadequate resources to fighting the wildfires that grow larger and more destructive each decade.

With the weakening public sector role in promoting forest health, industry leads the development of new approaches and technologies for forest management. Forest products follow a path similar to agriculture as commercialized genetic variants enable faster growing species to be farmed in forestlands. This has accelerated the fragmentation into ecological niches that turned forests into a checkerboard of remnant natural stands of trees, private lands open for development, and commercial forests where soils and plants are managed to optimize profits. This drive for profits does bring new technologies for water management and fire suppression that subsequently became available to forest services. However, the technological innovations of the twenty-first century have, at best, enabled better adaptation to the warming climate and degradation of North American forests. Sure, smart forest sensors identify threats, and computer models based on predictive analytics show what will result. Yet the forest services are unable to mobilize resources to maintain well-functioning forests. Few people in North American forest services in 2090 see any technological fixes that might bring about a return to the thriving wildlands of centuries past.

The economic shifts in North America offer part of the explanation for why many promising technologies have not been deployed to protect forest health. Workers across many fields have been displaced in the shift to knowledge-based economies. Whether people

worked in extractive (farms, mines, and forests), manufacturing, or service sectors, they lost jobs to disruptive innovations—robots and artificial intelligences. This trend hit a take-off point in the mid-2020s, and by the 2050s, many knowledge workers were at risk for having their jobs taken by smart machines. Only by pursuing new knowledge and entering domains where emotional intelligence still offered human advantage could workers maintain middle-class or elite jobs. For those who fall behind, the insecurity was heightened by the large number of ecological refugees coming from Africa, Asia, Latin America, and the Caribbean where the economic prospects of working in agriculture and manufacturing turned bleak. In a world of 12.6 billion people, the great majority struggle to find work and live where community economics forms the basis of livelihood marked by barter and do-it-yourself production.

While bad for workers, many smart investors saw that the efficiency gains from disruptive innovations, such as wood-based nanomaterials, would make forest products more valuable. Throughout the 2030s, investor groups bought large swaths of timberlands and lobbied effectively to minimize the intrusion of government regulations, which could reduce profitability of forest products. By the 2070s, the concentration of ownership in global conglomerates meant that there were few wildlands held by small companies. Entrepreneurial businesses over recent decades have even made urban forests profitable. In 2084, the boutique urban forest chain Ectopia won a global business of the year award for its combination of ecotourism, exotic wood crafts, and "homes for the stars," which were featured on entertainment channels focused on the lives of rich and beautiful people. For this stratum, natural wood products are prized, and living in urban forests is romantic.

Scenario 2: Megadisturbances Call for Military Intervention

It was worse than anticipated, worse for humans, forests, and wildlife. Only a few Cassandras expected average temperatures worldwide would rise by 4°C, and nobody but forest "bugs and crud" scientists foresaw how pests and pathogens would prey on forests as well as humans. Over the decades leading to 2090, North American forests suffered many megadisturbances—hotter droughts and more frequent and severe megafires interacting with other stressors—that grew in scale and pushed many forests beyond thresholds of sustainability. Many forested areas converted into nonforest ecosystems such as shrublands and grasslands. Forest ecosystem services such as flood control, carbon storage, and wildlife habitat severely declined. The effects of the ecological damage cascaded through North American societies, disrupting communities, wrecking economies, and undermining political stability. Nobody could have known how fully the resource heritages of the United States, Canada, and Mexico could erode in just a matter of decades. Yet most historians in 2090 blame the global failures to act early in the century when evidence became clear that climate and other environmental changes would have massively destructive consequences.

Take an elder into a forest today, and what they note first is the silence. "What happened to the birds that used to fill the air with their songs?" The same thing that happened to the frogs, salamanders, bees, and many species of wildlife that used to populate the now degraded and fragmented forests of North America. Many native species disappeared, and most animal populations diminished, except for the growing numbers of humans, many of whom sprawled into the forests from expanding cities and towns during the roaring decades from the 2020s to the 2060s. But in the disastrous 2070s, with climate change passing tipping points and the world population ballooning to 10.3 billion, death rates soared from pandemics, searing droughts, food system failures, wars, and relentless onslaughts from storms that devastated coastal areas while disrupting inland agriculture with large-scale flooding. The global population shrunk to 9.5 billion by 2080. A quarter of these people lead precarious lives. Many have become ecological refugees. Tens of millions of them crossed North American borders, and many migrated into North America's forests and wilderness areas

where they scratch out marginal existences. However, many of these forests that were once used for recreation are off-limits in 2090 for most citizens without armed escorts. Wooded wastelands are now battlegrounds between migrants trying to eke out a life, robotic loggers reaping profits, and forest hackers who wage their war of ecoterrorism against the robots they claim are raping Mother Earth for corporate overlords.

In many forests, invasives and alien species outcompeted native species to create strange plant monocultures, some of which are economically valuable as energy feedstocks. Corporations also engineered new species for their purposes. One report describes a barrier of virulent poison ivy with thorns, designed to keep humans away from remaining natural stands and tree farms of genetically engineered trees. These are now the domain of robots that harvest the natural resources forests still offer. Fragmentation has redefined much of the woodlands that now quilt rural lands across the North American landscape. Agriculture and forestry compete to define the different parcels, with developers building new luxury homes designed to retain the illusion of undisturbed nature. Many of the larger structures were built during the economic boom times and are now in ruins. Still, there are wealthy people with the ability to build quickly using 3D printers. This means developers still push against forested areas despite the constant danger from wildfires.

The unrelenting rise of large wildfires led the U.S. government to reorganize the U.S. Forest Service in 2044, following the lead of Mexico, which gave the military responsibility for protecting forests a decade earlier. Both countries sought to ameliorate the anger of influential citizens whose homes were destroyed by megafires and who felt threatened by the growing number of migrants and ecological refugees in the forests. The underfunded forest services had seen their budgets taken completely over by the need to fight megafires, losing their other functions entirely. Politicians blamed the agencies and put the military in charge. The argument was, "we need a mega-firefighting force to fight the megafires," and only the Department of Defense could mobilize and sustain such a force. Canada alone retained its forest service under Natural Resources Canada. In 2090, across North America, different uniforms face the same overwhelming problems. In the sprawling urban areas that dominate Mexico, the United States, and southern Canada, the worries about North American forests seems remote and unimportant. Daily life grew increasingly insecure for the growing number of urban poor over the past generation. Personal safety is the number one concern as drug cartels and terrorists grab headlines most days, and criminals prey on vulnerable people every day. Decaying infrastructures also bring daily worry as sewage and waste disposal problems hit more cities, making potable water more difficult to obtain for those without means. The degradation of forests has also made drinking water scarce in many areas of North America. Air pollution from forest fire smoke and other particulates from drying wildlands have led to chronic respiratory diseases throughout the population. National power grids proved vulnerable to both storms and terrorists, so regional and local grids increasingly took over starting in the 2030s. Now many of these grids fail frequently so people adapt to intermittent power. Government services tend to be no more reliable, except for those who are well connected. Such people live in protected high rises and gated communities where surveillance drones and patrolling robots assure safety, public order, and surveillance against pathogens. These areas are safer than the sprawl where slum dwellers live, but life in the cities always feels like it is one megastorm, bomb blast, kidnapping, or microbe away from catastrophe.

Economic insecurity also pervades despite the glittering world of the megawealthy who still show what life can be when technology makes new possibilities come to life. Their dazzling lifestyles include personal robots that combine the functions of valet, body guard, and personal assistant. Their homes change constantly as the latest design downloads feed into their 3D printers to make home remodeling a continuous function. Nanotechnology

filtration assures their air is pathogen free and their water safe from toxins. Their children are provided with the stimulating environments that incorporate neuroscience findings, which are modified according to the genetics of a child to assure they fulfill their potential in a competitive world. The competition to get into the best schools is fiercer in 2090 than ever before, because there are only so many jobs in the corporate world, and nobody wants to get off the upward path. There are too many people who have been blown off that path and fallen into the masses where the chances of success diminish to near zero.

Scenario 3: High Tech Transformation and Cooperation

Historians of 2090 note the paradox that the century's greatest threat eventually proved to be a boon. The catastrophic potential of climate change both ignited and united global efforts on many fronts, from technical innovation to cultural change. The Great Turning, as it has come to be called, occurred in the late 2020s, propelled by the collapse of the West Antarctic Ice Sheet, the complete summer melting of Arctic Ice, and the sharp increase in all the impacts of climate change, from heat waves, droughts, and wildfires to more intense storms, flooding, and the spread of tropical diseases into temperate zones.

By that time, solar, wind, and other renewable sources of energy were already rapidly displacing fossil fuels in most countries. However, a burst of innovation over the next decade changed the whole energy picture. Advanced renewables such as artificial photosynthesis for hydrogen production and the breakthrough in small-scale fusion made it possible to move away from fossil fuels faster than nearly anyone had anticipated. But even this rapid transformation of the energy infrastructure was not enough to head off serious climate impacts. It was massive geoengineering programs that transformed the role of humans in ecological systems over the past half-century. Many geoengineering approaches were rejected as too dangerous, but others have proven both workable and safe. In the past, up to a fifth of greenhouse gas emissions worldwide had come from deforestation and forest degradation, and more emissions from megafires had turned global forests into a net emitter of carbon dioxide. But starting in the early 2030s, the Global Reforestation Initiative began to restore global forests as a carbon sink rather than a source. A widespread shift to no-till farming along with breeding plants with larger root systems has absorbed large amounts of carbon from the atmosphere and stored it by building topsoil. The massive growth of seaweed farming has sequestered huge amounts of carbon and provided a major new food source for the world's growing population. Microbubble generators installed in all the thousands of ships plying the world's seas every day have made the ocean brighter, reflecting away sunlight and cooling the climate.

These efforts not only limited the negative impacts of climate change but also helped foster a greater acceptance of our responsibility for the welfare of future generations and the well-being of the larger community of life. Values and goals shifted from growth on the pattern of the past to a focus on improving all the aspects of quality of life. This was done by using resources more efficiently, and restoring wildlands and other natural systems back to health. At the same time, demographic changes slowed population growth around the world. Certainly, the economic transition from goods and services to knowledge and arts also played a key role in changing values and goals. This was particularly true as artificial intelligence systems and robots took over so many of the tasks that once employed humans. As the physical, digital, and biological worlds continued to converge, new technologies and platforms enabled citizens to engage with governments, voice their opinions, and coordinate their efforts. As a result, we find ourselves today in a world of abundance, efficiency, and rapid ecological recovery.

North American forests were in a process of rapid decline before the Great Turning got underway. Warming temperatures, drought, wildfires, invasive species, insects, and diseases were taking a heavy toll, and public funding for dealing with these problems was declining. But the Global Reforestation Initiative was a turning point. The global

commitment to a cooperative effort that crossed both national and sectoral boundaries finally allowed North American forest service leaders to make forest health a public priority in the minds of urban voters and public officials. Mexico, the United States, and Canada worked together to develop approaches to forest protection and renewal customized to local climates and ecologies. By the mid-2030s, the NAFC was effectively influencing rapid change in forest policies throughout North America. These policies aimed at restoring forests and taking advantage of the dramatic progress in synthetic biology to implement new biological controls on insect pests and develop fast-growing, climate-hardy variants of different tree species.

The record of NAFC meetings over the decades tells a story about changing government agencies as clearly as a tree's growth rings. Each decade marked organizational transitions as failing government bureaucracies increasingly gave way to new and more effective forms for mobilizing public and private resources to address major problems. The devastations of megastorms and megafires in the 2020s focused attention on the inability of central authority in the hierarchies of government agencies to respond with agility and bring workable programs to scale. Efforts to decentralize government authority to provinces and states in the early 2030s brought little improvement. Those departments and agencies that developed extensive cross-organizational collaborative networks proved more effective, and the NAFC achieved recognition for helping foster new networks that linked public and private sector hubs with nonprofit agencies and citizen groups dedicated to healthy forests. By the 2040s, these networks were politically effective in mobilizing people across many boundaries. Government agencies effectively evolved into an ecosystem model of organization that emphasized diversity of niche interests and speed of propagation for new ideas to spread across niches. The thought leaders of forest management became viewed as organizational gurus in the 2040s when business schools and consultancies taught the new management mantras of cross-organizational leadership. By now, governance at every level has become highly networked, integrating activities of citizen-volunteers and public employees with business entrepreneurs.

People who live in the WUI play a large role in assuring that people in the city understand and support efforts to improve forest health while moderating climate change. The pattern of life in the WUI shifted strikingly during the second half of the century. Rather than fixed homes on deeded properties, a growing number of people came to prefer a more nomadic life with small, modular houses assembled and disassembled on temporary sites that are leased. Both public and private leases are based on stewardship principles that lead people in the WUI to work collaboratively with the forest services and natural resource companies to assure healthy forests. Forest eco-lodges have become a popular recreation/service activity for urban dwellers of all ages, but especially for young people who go through rites of passage that initiate them into eco-defender clans that help maintain urban forests as well as wildlands.

Many social commentators believe that the shift in values has been every bit as determinative as technological innovation in moving North America toward sustainability. With material needs satisfied for nearly everyone in North America, people increasingly seek opportunities for meaningful activity, friendships, a sense of community, loving relationships, learning, and experiences of beauty, joy, and awe. And people increasingly seek these things in nature and in urban spaces that harmonize human design with nature. As a result, forests are valued in a way that people at the century's start could hardly imagine.

Scenario 4: Cultural Transformation Embraces Indigenous Values

When the North American Forest Conclave of 2090 began, Chief Henriquez Lavarius Dowd spoke first:

> Elders, guardians and stewards of our forests, I bring good news! My zeppelin tour has travelled across Canada, the United States and Mexico to bring me here. I can report that everywhere I saw

> our forests are replenished so they help our land and skies improve each year. I can look back over the decades we have worked to restore our continent's natural resources, knowing the work of my mother and her father before her is now moving rapidly toward fulfillment. I thank you for all you have done to bring this renewal to our lands, and ask those of you who are younger, especially, to pledge yourselves to this sacred trust. We must always ensure that our children know the obligation they hold to the trees and the life they sustain. I will step down as Chief when this conclave ends, full of thanks for what you all accomplished over the last decade and full of confidence that the Great Restoration of our forests will endure for generations to come.

"As some of you know," Chief Dowd continued,

> My grandfather was a forest steward, though that's not what they called them back in the days when each nation had its own forest service. He was there in the early days when the North American Forest Commission formed under the United Nations. Early in his career, the views of indigenous people who saw themselves as an integral part of the Circle of Life were still subordinated to the views held by so many of the European transplants to our hemisphere who tended to see themselves as outside of or above nature. This led them to treat our natural heritage, including our great forests, as mere resources to exploit.
>
> He was a scientist, a forest ecologist, who understood that this way of looking at the world would eventually destroy the ecological foundations on which human societies are built. He was also a spiritual man who saw that science and spirituality both climb the same mountain to the insight that we are all one, all life is interconnected and interdependent, we are nature, not outside of it, and the damage we do to the forests, prairies, deserts and tundra, the waters and the air, are damage to ourselves. He was one of the people who led the Great Integration of science and spirituality that changed how most of us view the world and helped propel the largest peacetime mobilization in human history, the successful effort to stabilize the global climate.
>
> This deep change in viewpoint led to profound changes in the practice of forestry. Many people today do not even know that wildfire used to be treated as an enemy, something to be prevented at all costs and snuffed out as soon as possible when it did occur. This is what led to the enormous buildup of forest fuels that produced the terrible conflagrations of the 2020s. That approach seems so unnatural today, but it dominated until more people felt themselves a part of nature and aspired to "go with the flow" of natural processes. Then foresters began to treat fire as a natural part of the landscape with important ecological functions. They learned to live with fire rather than waging war against it. They fostered the development of fire-resilient communities, learned to guide fires more skillfully, and gradually eliminated the buildup of fuels that was contributing to more and more megafires.
>
> Of course, our forests have always given us fuel to keep us warm and cook our food and today we continue to draw energy for our communities and economies from the forest. However, we have learned to do this by harnessing the more fundamental power of plants by learning how photosynthesis works at the molecular level. Now we draw our energy directly from plants using quantum biology rather than crude combustion so that instead of adding carbon to our air we are adding oxygen while we sequester carbon into new forms of biomass. As more of our people have moved to smaller communities, some vertical and inside big cities, they have learned how to make the urban forests as vital to their lives as forests were to the indigenous peoples of North America and the early European settlers.
>
> In my mother's time, there was still a divide between those who lived their lives in cities and people who joined the rural renewal movement. After the devastating time when so many people in the rural lands lost hope, turning to drugs that blighted their lives as surely as the pests were destroying the woodlands, people found their way. We whose parents and grandparents stayed close to the forests, who cared about forest health, played a great role in bringing the science of ecology into the culture of health that leaders from many different walks of life said we could achieve. Many of you in this room were part of the change as people in our cities and towns reunited human nature with Mother Nature when they married the natural and social sciences. This brought us through a period of great

> experimentation in which we learned to recreate old ways of living with our forests, both in wildlands and urban areas. Where the old ways fit with new technologies, social innovations helped guide our people to culturally healthy ways of living.
>
> The visionaries who blazed the trail are still among our elders today, and we must listen to them and heed the wisdom they still offer in so many areas: the importance of every generation of young people having formative experiences in nature, of always basing policies on both a strong land ethic and the best available science, of avoiding excessive bureaucracy and developing ecological forms of organization highly adapted to local conditions, of leadership that facilitates collective learning, experimenting, and cooperating across bureaucratic silos and organizations. Above all, they call us to tend the flame of the spirit, to never forget that all life is one and that we ourselves are the forest's way of restoring and protecting the forest.

Using the Scenarios to Enhance Foresight and Build Resilience

These scenarios will be used to "stretch the canvas" of possibilities for the future that NAFC leaders are willing to consider. The ultimate goals for this foresight project are to enhance strategic foresight capabilities and build organizational resilience in the three North American forest services. To achieve these goals, facilitated discussions and interactive exercises using the scenarios are planned with NAFC leaders. These will include small group discussions focusing first on the positive elements in the scenarios that reflect each participant's personal sense of the preferred future, and then identifying negative elements and possible positive alternatives. Discussions will also explore the implications of the scenarios for organizational goals, strategies, and services, as outlined by Lum (2016):

- How might each scenario affect your organization's strategic goals? What new aspirational goals are possible under the scenarios?
- How might each scenario affect current strategies? What new strategies are possible or necessary?
- How would the scenarios affect your organization's products and services?

These discussions begin the exploration of alternative futures, which will be followed by using the scenarios in one or more formal exercises to increase organizational agility and resilience. Exercises with leaders could include visioning to facilitate the explicit articulation of preferred futures (e.g., Dator 2009; Lippett 1998), and backcasting to bridge the gaps between the developments in a preferred future and the present (Quist and Vergragt 2006; Vergragt and Quist 2011). Futures wheel exercises may also be used to explore possible implications of specific developments in depth (Bengston 2016).

Hoped for outcomes of these discussions and exercises include:

- Expanding leaders' field of view: People tend to see only the things they are trained to see and expect to see. This has been termed the *educated incapacity* of experts with respect to perceiving the future: experts generally "know so much about what they know that they are the last to see that future differently" (Weiner and Brown 2005, 2). Looking at current developments through several different images of how the future may unfold allows us to notice more of what is occurring.
- Achieving a strategic perspective: We tend to be preoccupied with daily news and immediate pressing issues. Scenarios allow us to think about the big picture of "what's happening" and "where things are going."
- Identifying fundamental uncertainties: Uncertainties are often "swept under the rug," resulting in poor decisions. Scenarios highlight uncertainties so they can be acknowledged, studied, and taken into account.
- Identifying and evaluating assumptions: Underlying assumptions are frequently

taken for granted to the point that they become invisible. Scenarios make people more aware of their assumptions by posing situations that call them into question.

- Creating a basis for strategic conversation and ongoing learning: Peter Schwartz (1996, 221) has observed that ". . . people at resilient companies continually hold strategic conversations about the future." Scenario thinking can spark ongoing conversations that make people more aware of their underlying assumptions, more open to rethinking future possibilities, and more focused on long-term goals and strategies.
- Creating a framework for ongoing horizon scanning: "Signposts" or "early indicators" of movement toward one or another scenario can be developed as a framework for scanning to identify emerging threats and opportunities.
- Clarifying and elevating aspirations: The two aspirational scenarios explore different pathways to positive futures. These scenarios can be used to help leaders develop a clear direction around high aspirations (Bezold 2009).
- Evaluating initiatives to identify robust options: Strategies can be tested against a set of scenarios (Marcus 2009). The best strategies should be robust enough to work in most or all the scenarios, and should lead to a preferred future.
- Enhancing participation and engagement in strategic planning: Conversations and planning exercises developed around vivid scenarios grab people's interest and make it easier to involve more stakeholders in strategic planning efforts.
- Improving the outcomes of planning: Futures thinking enables people to work back to the present from scenarios and identify surprising possibilities, while planning moves from the past to the present and projects expectations. The combination of futures and planning enables strategic thinking that goes beyond conventional assumptions and invites a more creative use of resources when budgets are examined in the context of broader possibilities than plans typically encompass.

Concluding Comments

Given the challenges of climate change, social and economic change, and the many other drivers that will likely shape North American forestry in the future, agility and creativity will be vital for North American forest management agencies. Organizational resilience and the ability to adapt rapidly to changing circumstances are essential for these agencies to fulfill their mission of maintaining sustainable and healthy forest ecosystems that provide life-supporting benefits to people. Leaders and planners will find that the alternative scenarios pose challenges to assumptions that served in the past but may need to be questioned as change emerges. The ability to question assumptions is fundamental to flexible thinking and creative ability to find options when challenges defy standard approaches. We expect the NAFC and the forest services of North American governments will benefit from their planned use of the scenarios presented in this article to assure that plans are responsive to the challenges and opportunities ahead.

Appendix

Drivers for North American Forest Futures 2018 to 2090

Drivers of change are forces expected to play a powerful part in shaping futures. The drivers described in this appendix will likely shape how North American forests change over the next seven decades and are, thus, the basis for the set of four alternative scenarios presented in the article. Complex and dynamic change always means high and irreducible uncertainty. Therefore, the interactions between the drivers over time can be best described through a range of forecasts and scenarios that encompass the unknowns to illuminate likely, undesirable, and positive futures. Our four scenarios explore the plausible range of variation in the drivers.

The drivers described below were identified by the authors as most likely to shape North American forests and forest management agencies in the decades ahead. The list of drivers—which corresponds to those in Table 1—is not specific to one country. The drivers are broadly defined and intended to be applicable across the continent. Subsequent work will explore country-specific drivers and scenarios for forestry and forest management agencies in North America.

Societal change drivers

Social values. Values and worldviews are important drivers of change in the relationship between people and the rest of nature. Environmental and forest values have shifted and evolved in the past, and will very likely continue to change in the future. Across North America, European transplants who tended to view themselves as outside of nature subordinated the views of indigenous populations who saw themselves as an integral part of nature. This dominant view contributed to overexploitation and serious environmental damage. But values that stress human responsibility for the welfare of the community of life of which we are a part have been reemerging, driven largely by the science of ecology, the emergence of sustainability as a guiding concept, and the cultural and psychological role that indigenous peoples continue to play as a fulcrum for environmental value shifts. How strongly and rapidly these shifts occur will have a large impact on the future of forests and forestry.

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Relation to nature. Recent studies have confirmed a growing disconnect with nature and the replacement of outdoor activities with time spent playing video games ("videophilia") and plugged into the Internet. Implications of a growing disconnect with nature include a shift in forest values toward indifference or negative values, and decreased political and budgetary support for forestry. Turning to indigenous values, environmental ethics, and models of sustainable development are a possible avenue for reversing these trends.

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Economy. Economics affects forests directly in terms of wood products and ecosystem services, as well as indirectly when large-scale economic shifts shape land use, redefine the terms of employment for people, and create many other significant impacts. Over time, our understanding of the economic value of forests has expanded from market-valued goods to a wide range of nonmarket values, including life-supporting ecosystem functions and services. Long-term forecasts of economic growth range from economic collapse to rapid and sustained growth surpassing historical rates. This wide range of possibilities is explored in our four scenarios.

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Climate change drivers

Climate change:Temperature increase. Scientific consensus is clear that the Earth's climate will warm over the coming decades. Since the mid-nineteenth century, the planet's average surface temperature has increased by 0.85°C. Since the 1950s, many of the observed changes are unprecedented compared with previous decades and millennia. Climate scientists from around the world, working on the Intergovernmental Panel on Climate Change (IPCC), have concluded with 95 percent certainty that the dominant cause of this observed warming is the increasing concentration in the atmosphere of carbon dioxide and other greenhouse gases (GHGs) released by human activities.

Regardless of future GHG emissions, we are already committed to substantial further warming due to past emissions and inertia in the climate system. No matter what actions we take, they will have little effect on global temperatures over the generation ahead. But the effects of what we do will begin to be noticeable by midcentury and can have a decisive effect by the century's end.

Forecasts of future climate change are uncertain, mainly because what happens depends so much on how quickly GHG emissions are reduced. To take this uncertainty into account, the IPCC's recent Fifth Assessment Report contains alternative scenarios with different cumulative emission levels. Climate models suggest that the lowest emission scenario, which requires an epic scale of action globally beginning immediately, might hold further warming by 2100 to 1.5°C or less. At the other extreme, if the world continues down its present carbon-emitting course, the temperature could rise by up to a staggering 4.8°C (8.6 degrees Fahrenheit) by the end of the century. These are average global temperature estimates. Temperature changes would vary in different locations. For example, the temperature rise in Canada at high northern latitudes would be considerably higher than the global average.

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Climate change: Impacts on forests. Uncertainty about the vulnerability of forests to climate change is substantial. Some research

has emphasized the adaptive capacity of forests, highlighting factors such as CO_2 fertilization, water-use efficiency, genetic variability, and a variety of other compensatory mechanisms that can help forests deal with heat stress, drought, and other disturbances. But other research suggests that mortality processes associated with growing heat stress and drought are already overcoming these buffering mechanisms, that significant forest growth declines are already underway in many regions, and that the projected large and rapid increase in "hotter droughts" is likely to exceed thresholds of adaptive capacity in many areas, leading to extensive tree mortality and ecosystem change.

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North American Forest Management Agency Drivers

Forest agencies: Wildfire and mission shift. Hotter and dryer climate and decades of fuel accumulation in many areas have resulted in wildfires growing in size, severity, frequency, and firefighting costs in recent decades. The rise of high-impact megafires has increased fire suppression costs to the point that they now consume 50 percent of forest agency budgets in some years. Entrenched disincentives to change forest fire management will make it extremely difficult to make substantive changes to fire policy and management. Fire management has become a larger and larger part of the mission of forest services in North American and globally. If this trend continues unchecked, wildfire suppression and management could eventually become the sole mission of the North American forest services, crowding out other aspects of forest conservation and management.

A paradigm shift in wildfire management could avert this mission shift by leading to a dramatically different and sustainable approach to fire management. This approach would be based on an appreciation of the self-regulating processes in nature and an aspiration to "go with the flow" of those processes. It would accept fire as a natural part of the landscape with important ecological functions and emphasize learning to live with fire rather than waging a war against it. The central goal of this approach would be to create fire resilient communities, both ecological and human. This emerging fire resilience paradigm is based on the notion of comanagement of risk, with individuals, communities, governments, and other organizations learning together what they can each do to create a sustainable approach to wildland fire management.

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Forest agencies: Organizational form. Since the founding of national forest management agencies in Mexico, the United States, and

Canada, the focus of forest management has broadened significantly from custodial management, to an emphasis on the production of wood products and other commodities, and most recently to evolving forms of ecosystem management. Despite these significant changes in mission focus, a hierarchical organizational form and structure has remained largely unchanged for many decades. Bureaucratic inertia and restricted budgets could cause forest agencies to cling to hierarchical organizational forms that limit their ability to respond to rapid change in the social and ecological environments. Or budgetary crises, rapid change in the external environment, and a continued broadening of agency missions could drive innovation toward flatter, more decentralized organizational forms that combine hierarchy with network structures, including networks that span internal organizational boundaries and link to other public, private, and nonprofit organizations. Advantages of a boundary-spanning network structure include greater agility in times of rapid change, less "siloed" operations with a freer flow of communication, and greater opportunities for learning and innovation. Finally, an ecological organizational form would be most highly adapted to local niches and enable the most successful innovations to spread rapidly with maximum sensitivity to local conditions as well as change across an ecosystem.

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Forest agencies: Leadership culture. The organizational and leadership culture of North America's forest services has traditionally emphasized technical leadership, which is appropriate for technical problems where existing expertise and established procedures and technologies can provide an adequate response. Technical leadership is inadequate when the nature of problems changes. A shift from technical to adaptive leadership—where leaders do not have all the answers and one of their central tasks is to facilitate people learning together, experimenting, and cooperating to develop and apply successful approaches—would represent a significant shift in leadership and organizational culture in response to rapid change and the need to adapt quickly to address new challenges. This new leadership paradigm would include developing "net-centric leaders" able to provide facilitative leadership across organizations and bureaucratic silos. The roles, methods, and skills needed for this kind of boundary-spanning leadership are quite different from those required for effective leadership within hierarchical organizations. Finally, visionary leadership is another possible basis for a transformative leadership culture. Visionary leadership encourages innovation and inspires the impossible through communication and empowerment.

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Technology. Technologies have the potential to destroy, protect, or renew forests. The broad

definition of technology is "how humans get things done." Within this broad perspective, the most important development today is a science-driven revolution underway in our society's "foundational technologies," the information-biological-nanotech-cognitive/neuroscience and other technologies that enable progress in every other sphere of technology. Some of the developments likely to be important for forest health over the next seven decades include "smart forest" sensors to monitor forest health; information technology to support organizational learning; synthetic biology and ecological design to restore species diversity, control pests, and rehabilitate damaged ecosystems; quantum biology for a new understanding of photosynthesis; and nanotechnology and materials science, where the development of high-strength, light weight, and low cost wood-based nanomaterials is likely to find a wide range of applications and may have profound implications for forestry.

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