7. SCENARIOS TO PROVIDE CONTEXT FOR HORIZON SCANNING: BACKCASTING NORTH AMERICAN FOREST FUTURES FROM 2090 TO 2035

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Abstract.—A scenario backcasting project, an offshoot of the Forest Futures Horizon Scanning system, was carried out for the USDA Forest Service, Northern Research Station's Strategic Foresight Group. The horizon scanning team, from the University of Houston Foresight program, sought to provide context for the scanning hits and emerging issues identified through scanning by linking them to a set of scenarios. Scanning hits and emerging issues could then be analyzed and understood in relation to the scenarios; the ways that emerging issues might develop under different scenarios could be explored. A baseline scenario and three alternative scenarios for the year 2035 were backcast from existing 2090 scenarios. These 2035 scenarios provide a context from which policymakers can track the emergence of scenarios and craft responses to avoid scenarios they consider undesirable and work toward scenarios they consider preferable.

INTRODUCTION

This paper reports on a scenario backcasting project carried out for the USDA Forest Service (hereafter, Forest Service), Northern Research Station's Strategic Foresight Group by the University of Houston Foresight program. The project is an offshoot of an ongoing horizon scanning system created by the two organizations to identify emerging issues in forestry (Hines et al. 2018). The horizon scanning team determined that it would be useful to provide context for the emerging issues by crafting a set of scenarios. The emerging issues could then be analyzed and understood in terms of how they related to the scenarios; that is, one could explore how the emerging issues identified through horizon scanning might fare in different scenarios.

Before embarking on developing new scenarios, we learned that a recent project had developed a set of scenarios for the North American Forest Commission (NAFC) out to the year 2090 (Bengston et al. 2018). While this long-term outlook makes sense given the generally long time horizon of forestry, it can be challenging for policymakers in the present to know what to do relative to this distant future. And the emerging issues identified by the horizon scanning system are likely to be influential well before 2090. Our experience is that a time horizon needs to be within the planning scope of an organization in order to be effective. Thus, a set of scenarios closer to the present would be more effective in terms of stimulating useful responses. The work of the NAFC scenario team was quite good and useful, but we needed a way to work the 2090 scenarios back toward the present in order to be helpful in providing context for horizon scanning hits and emerging issues.

METHODS

The team decided to try a backcasting approach. Lovins (1977) first employed the method in his search for achieving an energy-efficient future, although Robinson (1982) is generally credited with naming and codifying the method. In backcasting, one looks back from the viewpoint of specific images of the future (Kok et al. 2011, Quist et al. 2011, Robinson 1990). Forecasting extrapolates trends from the present into the future, whereas backcasting starts from the future and works back to the present. The typical approach in backcasting involves identifying a preferred future—a future that the client aspires to or would like to achieve (Bezold 2009)—and then specifying a pathway with milestones connecting to the present (Government Office for Science

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2017). The backcasting literature emphasizes developing the preferred future and working backwards from it to identify the pathway in order to suggest potential policy actions in the present. But there are generally few specifics on how to develop the pathway. Dreborg (1996) even suggested that backcasting should be thought of as a general approach rather than a method. The essence of the various approaches to backcasting is developing the pathway from the future back to the present. For example, Kok (2011) suggests three steps in constructing the backcast:

1. Select a vision used as the endpoint.
2. Indicate obstacles and opportunities.
3. Define milestones and interim objectives.

Strong et al. (2007) suggested that the key element for constructing the pathway back from the future involves the identification of signposts. They define a signpost as a "recognizable potential future event that signals a significant change." A "recognizable" event is one that reasonable people would agree has happened. The term "signals" is used because the signpost may embody the significant change, or it may only predict or enable it (Strong et al. 2007: 2). Signposts are identified at particular points in time to construct the pathway.

The literature provided only general guidance for backcasting and we had to craft a backcasting approach that fit our specific needs. Some of the major differences that set our approach apart were as follows:

- Our backcast started from three alternative scenarios (plus the baseline scenario) set in the year 2090, rather than starting from a single preferred future.
- Our backcast aimed at the year 2035, rather than backcasting all the way to the present.
- We needed to map the pathway back from the distant future to 2035, rather than directly identify specific policy actions.

To map the pathway, we used the broad drivers of change that were the fundamental building blocks of the 2090 scenarios. Each of 12 drivers was articulated in each of the three scenarios but, of course, they played out differently in each. The following list shows the 12 drivers of change[1]:

- Societal values
- Relation to nature
- Economy
- Climate change: temperature increase
- Climate change: impact on forests
- Forest agencies: wildfire and mission shift
- Forest agencies: organizational form
- Forest agencies: leadership culture
- Technology
- Ecosystems
- Industry
- Stewardship

To ensure the faithfulness of the trajectories along the timeline between the two scenario sets (2035 and 2090), midway descriptions were identified to act as beacons in 2060. Thus, the first "stop" in the backcast was 2060, 30 years before 2090. The scenario backcast team started with the first driver in the first 2090 scenario. It then imagined the status of that driver in 2060. After that, the team once again imagined the history of that driver, but this time in 2035, 25 years before 2060. The test, then, was to start with the driver from 2035, move to 2060, and finally 2090, and evaluate whether that pathway was plausible.

Next, that same driver was identified in the second 2090 scenario. The scenarios are by definition distinct stories, so the outcome of the driver would be different in this second scenario. The same process was followed: The team imagined this driver first in 2060, described its status, and then did the same for 2035. The plausibility of this pathway from 2035 to 2060 to 2090 was then evaluated and any needed adjustments were made. Finally, the first driver was identified in the third scenario, and worked back to 2060 and 2035, then tested for plausibility. With the three

[1] The last three drivers—ecosystems, industry, and stewardship—were not specifically identified in the NAFC 2090 scenarios, but were added to the backcasting analysis. These drivers were identified in the horizon scanning project.

pathways for the driver now sketched out, the team looked across the pathways to make sure that the drivers were set in a manner consistent with their outcome in the 2090 scenarios. This process was repeated for each of the 12 drivers in each of the 3 scenarios.[2] Once the team was satisfied with the consistency and plausibility of the pathways back to 2035, these 2035 drivers were used to craft a set of scenarios for the year 2035.

2035 Scenarios

This section presents the baseline scenario and the three alternative scenarios for 2035. Each of the three alternative scenarios is positioned on its own distinct trajectory, exploring the possible impacts on forestry and the Forest Service. A different author prepared the first draft of each alternative scenario. One scenario envisions an increased military presence in the environmental and forestry context, one focuses on the utilization of technology ("tech") to mitigate climate change, and a third scenario focuses on a radical cultural shift.

The three 2035 scenarios are alternative futures. But how do we get from the present to 2035? The team used the concept of the baseline future from the "Framework Foresight" method (Hines and Bishop 2013), which projects or extrapolates from the present situation into the future, without any major disruptions or surprises. The team's view was that the baseline forest future could plausibly extend out to about 2025. By this time, the baseline is likely to begin breaking down; that is, alternative futures would start to emerge in part or in whole. We called this baseline Stressed Forests. It is projected to ultimately give way to one or more of the three 2035 alternative futures. Of course, we do not know which one of these futures, or which variations of them, will emerge and eventually become the next baseline. It should also be noted that the dates of 2025 and 2035 are rough estimates—the alternative could emerge more quickly or more slowly than forecast.

[2] Contact the authors for a copy of tables describing the projected drivers for each scenario.

We wrote the baseline from the viewpoint of the present, because it is rooted in the present, and we describe the alternatives from the vantage point of the future. The following subsections discuss these scenarios: (1) Baseline: Stressed Forests; (2) Government Intervention: Curfew, Stay Inside; (3) High-tech Transformation: the Internet of Trees; and (4) Cultural Transformation: Nurture Nature.

Baseline Scenario: Stressed Forests

The prospects for North American forests for the next decade are not looking promising. Forestry decisionmakers confront a likely future of budget cuts and political turmoil. They are also likely to confront a worsening ecological situation. At current rates, average global temperature is projected to increase 2 °C (3.6 °F) beyond the preindustrial level by 2065, nearing 3 °C (5.4 °F) by 2090. Instead of being a sink for carbon dioxide, deforestation has actually led to a net release of forest carbon into the atmosphere. Forest leaders are likely to continue to be put in a position of "doing more with less," and being blamed for deteriorating conditions despite their best efforts.

Climate change is the overwhelming issue stressing forests. The expected steady increase in temperature is likely to lead to increases in wildland fires, the spread of invasive species, and a host of insect pests and pathogens. Some thresholds of forest adaptability are likely to be approached. Some say that in the more distant future many forests may convert to new types of ecosystems such as shrubland.

Growing public apathy toward forests is likely to continue. Forests are out-of-sight, out-of-mind, as visits to the forest are projected to gradually decline. The exception to the dwindling number of forest visitors is a not necessarily desirable growth in squatters: People increasingly desperate for a place to live are likely to migrate to public forest land in the wildland-urban interface (WUI). Even more challenging, they demand protection from wildfires; can a squatter lawsuit be far behind?

Numerous studies are warning about the looming trouble. Forest management agencies will almost

certainly face a growing number of wildfires as funding shrinks. Fire management will be the biggest part of the budget, but it is also likely to face cuts. Threats are clearly ahead, but will there be political will and budget support to confront them? Probably not. Governments have other priorities and citizens are too preoccupied with economic insecurity, fear of terrorists, and lost ways of life to make forest health a priority.

Forestry agencies are not likely to escape the automation of the workforce in North America and elsewhere. Robots and artificial intelligence are likely to increasingly replace forestry workers in the field, and they will be programmed to serve interests concerned primarily with cost savings and profits. There is some hope that automation will increase the productivity of the forest products sector, and that increased profits could be fed back into forest management and health. But not many are holding their breath for that. More likely is a growing incursion of investor and corporate groups buying up large swaths of private timberland and lobbying to keep government regulators "out of the forest."

The picture is not totally bleak. Although a weakening public sector role in promoting forest health is most likely ahead, there are positive signs. The forest products industry could follow a path similar to agriculture by taking advantage of developments in genetics that could allow faster growing species to be farmed in forest lands. This could accelerate fragmentation of forests into ecological niches—a checkerboard of remnant natural stands of trees, private lands open for development, and commercial timberlands where soils and plants are managed to optimize profits. This drive for profits does bring new technologies, such as sensor networks for water and fire management, which should subsequently become available to public forest agencies.

Scenario 1. Government Intervention: Curfew, Stay Inside

Sporadic societal insecurity due to the consequences of severe environmental changes demands permanent government and military intervention.

In the first quarter of the century, efforts to address climate change lagged. Immediately before 2020, the government's main priority was job creation, job security, and economic growth while growing concerns about climate were ignored. With strong support from small-town populations and the countryside to grow local economies, government strategy relied on traditional industries, which often played a substantial role in inducing climate change. Generally, the petroleum industry had newfound favor despite the global shift—even by China—toward the promise that the renewable energy industry held.

The momentum of the United States to address climate change began to significantly increase only in the late 2020s, when citizens became more directly affected by frequent natural disasters and experienced the impact that climate change had on some agricultural products such as coffee. Despite great advances in climate policies internationally, global efforts were too little too late. During this time there was a tremendous spike in nature tourism and public interest in the outdoors as people were starting to notice radical changes in nature and realized what they were about to lose. However, this spike was a short-term phenomenon as technology-related entertainment increasingly dominated consumer markets, drawing attention away from nature's transformation.

Fortunately, the growth of indoor entertainment did not deny nature its place on the political agenda. As new generations emerged in the mid-2020s and gained voting power, they shifted environmental issues and their consequent economic implications to the top of the political agenda. By then, the trajectory of climate change had become evident as an unseen tipping point had already been passed. The average temperature of the Earth was well on its way toward an expected increase of almost 2 °C in the 10 years that were to follow (at around 2035). Severe climate-induced catastrophes resulted in tremendous financial losses. The situation was aggravated when government's initial reaction to climate change was to promote policies favoring environmental protection. These actions inflated

the already sizable green economy bubble as well as local high-tech innovations and alternative food production methods. However, frequent bouts of protest erupted as the disconcerted public vented its anger against government for not acting sooner. Federal power consequently faded and the national ability to address climate change in a coordinated manner was hampered in the process.

The Forest Service itself had to deal with the increased intensity of heatwaves, droughts, and forest fires. By 2025, the government restructured the Forest Service to solely focus on "managing" and adapting to the inevitable outcome of climate change instead of prevention. The new structure effectively pivoted the whole organization around its newly created Climate Change Division.

Two great and ever-present threats had to be managed. First, frequent and massive forest fires proved traditional firefighting approaches to be inadequate and unsustainable. The National Interagency Fire Center and National Multi-Agency Coordinating Group's fire-suppression efforts now also involved permanent military participation and organization, with the military's stake increasing every year.

A second threat was the spread of tropical diseases and other harmful pathogens, as insects migrated into new ecosystems. Protecting humans from potential forest-borne pandemics became an increasingly important mission for the Forest Service. A productive partnership among forestry, the Centers for Disease Control and Prevention, the Department of Health and Human Services, and the World Health Organization in the 2020s initially included paramilitary organizations. But later, strong military involvement was called upon in efforts to quickly isolate compromised zones and mitigate potential outbreaks. Sadly, attention to fire mitigation and disease control in a frequent state-of-emergency context redirected valuable resources away from traditional ecosystem services such as flood control, carbon storage, wildlife conservation, and economic resilience of nearby communities.

The decade leading up to 2035 was characterized by an increase in the magnitude of severe natural disasters causing havoc. Along the Gulf and East Coasts, one or two high-category hurricanes made landfall each year. In late summer, flooding in the Southeast was commonplace, and despite constant military aid, the frequent California fires were extremely difficult to contain. Heavy and erratic snowstorms in the Northeast also caused frequent power outages. These disasters resulted in the frequent declarations of states of emergency by State governments requesting Federal support and official disaster declaration on a presidential level. Responses by the Federal Emergency Management Agency increasingly required a more substantial military involvement to assist civilian authorities, in close cooperation with the Forest Service, with regard to wildfires and forest-borne disease control.

Besides the growing economic impact of natural disasters, the economies of many breadbasket states were disrupted as crops favored new geographical areas while production in traditional areas dwindled. Simultaneously, new zones were conducive to reforestation efforts while some long-established forests increasingly struggled to persist. The latter were often left behind, taken over by invasive species due to a lack of funds and immediate focus on disaster management.

In 2029, the National Defense Act of 2008 was amended to accommodate the permanent return of a substantial section of the armed forces operating internationally. These troops were to be permanently deployed on U.S. soil and would be known as the Military Task Force for Public Protection. They would primarily reinforce the National Guard in its continual activities during the now frequent natural disasters, while also protecting U.S. borders if needed.

With the Forest Service beset by the magnitude of climate change management and adaptation responsibilities, it also had to strengthen its corporate relationships to fulfill its mission. Wood products corporations utilized CRISPR (clustered

regularly interspersed short palindromic repeats) genome-editing technology to modify tree species to be faster growing and less susceptible to fire. The rise in homogeneous genetically modified tree farms also served a carbon storage function. Corporate interests now demanded the fierce protection of forests with drones and high-tech fire monitoring systems, while public access was increasingly denied, often enforced by paramilitary organizations employed by corporations. By 2035, suburban expansion continued as the population generally migrated to metropolitan areas. People predominantly remained indoors as smart homes, entertainment technology, and effective global connectivity functioned as a shelter from the unforgiving and partially militarized outdoors.

Scenario 2. High-tech Transformation: the Internet of Trees

Technological innovation substantially mitigates the effects of climate change and gradually produces a hopeful future.

The aphorism that people mobilize only in response to crisis held true. Some said that the climate-induced disasters of the 2020s took humanity to the brink; regardless, these catastrophes provided a wake-up call and led to a mobilization that began to make a difference. There were plenty of signals that the climate was being seriously affected. Some saw the signals and raised the alarm. Some denied. Most just hoped that it would go away, or not be as bad as predicted. It took a devastating storm surge and sea-level rise in Manhattan, New York—as well as other global cities (e.g., Amsterdam, the Netherlands and Jakarta, Indonesia) and even entire countries (e.g., Mauritius)—to build enough consensus that something was really wrong. The water frequently flooded the subway and traffic tunnels. Some would say that when the New York Times building flooded, the media's interest really accelerated. It may have seemed like a wild card, but only for those not looking. The sea-level rise had been taking place for many years. Each disruptive storm and storm surge wreaked more havoc. The effects of a changing climate showed up in forestry in many ways but especially in increasingly destructive megafires. The insurance industry, which had made some attempts to warn about impending disaster, tabulated a bill that even the most hardline "business first" folks could not ignore. The failure to invest in infrastructure, despite repeated and frequent calls to do so, raised the total bill due. Temporary fixes and stopgaps were eventually overwhelmed.

It was not exactly smooth sailing at first. Awareness was the first step, but organizing coalitions for effective response to climate change was not easy and was not likely to get any easier. By 2035, however, ad hoc regional coalitions of countries with strong leaders became widespread. Yet there was still not enough support for global-scale action. This was challenging given the global-scale issue of climate change, but suspicion toward international organizations such as the United Nations and the various environmental nongovernmental organizations (NGOs) remained strong. The coalitions were similar to trading blocs; it is easier to leverage existing arrangements than to build new ones, after all. In the United States, for instance, the Pacific Northwest states and Canada worked together closely and provided a good model for climate change action coalitions.

But there were encouraging signs. For example, a flourishing of small-scale climate-related projects flew under the radar in the 2020s. Venture capitalists saw "green in green," and began funding climate- and resource-related projects. Of course, the impact of crowdsourcing approaches reshaped the nature of being a venture capitalist—social entrepreneurship ventures were as likely to get funded as standard money-making schemes. When the panicked calls to "do something" rang out, these projects were highlighted, funded, and perhaps a little overhyped as evidence that something was being done. There were some really exciting experiments going on. A key theme was land and forest restoration. Swarms of "farmer drones" could seed, fertilize, and water large swaths of remote land in a matter of days. Many cities had long participated in large-scale urban forest experiments that revealed several key benefits, such as stormwater mitigation, energy

savings from shading, greater aesthetic value, and improved air quality. Perhaps most importantly they seemed to account for an increase in community members spending time outdoors.

The role of forests as sources of drinking water was recognized and became part of the overall revival of interest in the value of forests. The problem with these efforts, well intentioned and productive as they were, was that they were piecemeal and not coordinated. They needed to be scaled up, and that is where government came in.

Perhaps the most significant technological interventions were related to information technology. One could argue that issues relating to forests and climate were fundamentally information issues, albeit very complex ones. Better data were needed to understand what was going on and what could be done. While many in the Forest Service or involved in forestry preferred a more hands-on and boots-on-the-ground approach to nature, there was a cadre who saw the power of information tools. Some laughed at these geeks, and in the 2020s it often seemed that a lot of data were gathered and not a lot of insight was produced. It took time for the information revolution to hit critical mass, but it finally got there. The Internet of Things for the forest—dubbed "the Internet of Trees"—effectively wired up the forest to produce an amazing volume of data about what was happening. Sensors everywhere (some wired, some smart dust, some drones, some robots, some satellite) provided enough coverage for the collection of sufficient data for assessing, monitoring, and eventually predicting what was going to happen.

The Internet of Trees also provided inventory and tracking systems that dramatically cut down on illegal logging. "Stolen" trees could be tracked. The impact of providing these monitoring technologies to countries with rampant illegal logging was huge. Predictive analytics gave managers the tools to simulate multiple courses of action and make more informed choices.

This suite of smart technologies also became a valuable partner in dealing with the rise of megafires. In addition to the better remote sensing, monitoring, and predictive analytics for tracking potential wildfire movement, there were significant technological advances in managing wildfire. Sensors immediately indicated when a fire started so that it could be managed—allowed to burn, put out, or watched—as appropriate. The firefighters themselves would hardly be recognizable to their predecessors; with full-body military exoskeletons, it was sometimes hard to tell them apart from their robot colleagues. Technology certainly helped with managing fires near population centers. But the biggest anticipated advances would use artificial intelligence, Big Data, and analytics to develop models that would help restore more normal fire patterns—knowing when to let nature do what it knows best how to do.

New biotech approaches to natural resource problems were also widely employed. The CRISPR genome-editing technology was used for creating biological responses to new pests in experiments carried out quietly during the 2020s, sometimes with overseas partners, where there were less public scrutiny and objection. Among the successful experiments were rather "simple" gene-splicing activities to improve tree health. Further, genetically modifying insects to eat so-called "bad" bugs or pests was becoming increasingly common. Alongside these efforts, however, experiments were going on in synthetic biology to engineer entirely new life forms designed for specific tasks. These efforts were tightly regulated at the moment over fear of potential unintended consequences of releasing new life forms. But given the serious condition of the biosphere, these efforts were gaining more attention and funding. There were also hundreds of small-scale biomass approaches using various wood-based inputs, from the nano-scale (wood-based nanomaterials with thousands of applications) to wood skyscrapers that were much more environmentally friendly than steel and concrete.

While technology was front-and-center as the world furiously scavenged for technological fixes, the evolution of social values was also influential, if somewhat below the surface. Above all, "modern values" that support competition

and achievement provided the motivation and entrepreneurial zeal to develop new technologies (Fig. 1). There was an immense proliferation of competitions, prizes, incentives, crowdsourcing, and open-source collaborations. Some complained that modern values were short-sighted, but they could definitely generate innovation when properly aligned. Postmodern and integral values also had some, albeit far less, influence. One way that this change became evident was the trend in diet away from meat. Vegetarians, vegans, and a complicated array of other dietary arrangements gradually became the mainstream. This reduced some pressure on resources, and combined with more effective distribution that reduced food waste, actually started "moving the needle," if ever so slightly. The values evolution had been very slow and gradual. Post-crisis, people became more vocal about what individuals could do.

The forest world of 2035 might best be described as entering "rehab." The stress of climate change and related impacts, such as nonnative invasive species, drought, increasingly intense storms, and more frequent ice storms, as well as inadequate budgets to deal with these stresses, had weakened the forests. Some approaches promised and might deliver remarkable results. Some would have unintended consequences. The jury was out on whether this approach would work. Comparing things to where they stood 10 or 20 years before, however, most people preferred this high-tech experiment over the alternative.

Scenario 3. Cultural Transformation: Nurture Nature

The environmental crisis really gained momentum in the 2020s in a continual stream of natural disasters that wreaked havoc. Besides the increased frequency of forest fires all over the United States, coastal regions also suffered severely. As global average temperatures continued to rise and sea levels followed suit, hurricanes became stronger and more frequent. These catastrophes prompted a set of additional regulations regarding homes and infrastructure along the coast in order to prevent flooding and provide added protection from hurricanes. The increased frequency of extreme weather events and consequent additional regulations had a severe, negative effect on the real estate market along the East, West, and Gulf Coasts.

Grassroots support was central to the growing environmental crisis. A long and failed track record of institutional fixes, policy initiatives, and other mechanisms associated with the status quo, led to the realization that the underlying values or culture was key. Until people's minds changed, nothing significant was likely to change.

Changing minds was not enough by itself—it had to translate into behavior. A sign of a new general cultural mindset, for example, was that people began generating solar and wind power at home and became more environmentally friendly with transportation. This "sustainability first" mindset

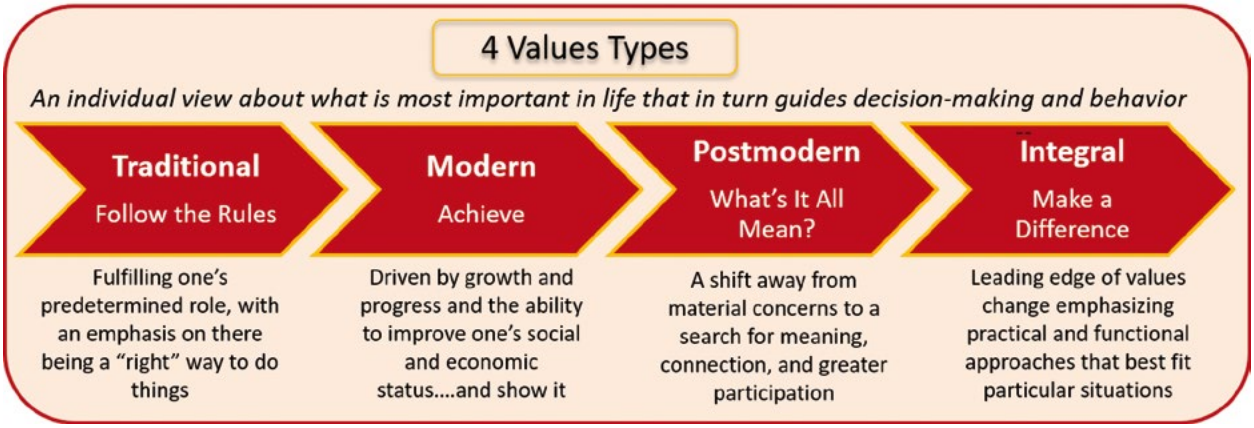

Figure 1.—Four value types that a person or organization may espouse. Source: Hines (2011).

permeated neighborhoods and cities as residents and planners promoted parks and small forests in city centers. Some cities were even rezoned as forests, similar to UNESCO heritage sites, as an official carbon capture method.

New social entrepreneurship initiatives blossomed. Many projects were funded through crowdsourcing campaigns. Even Silicon Valley became a venue for social entrepreneurs and funding initiatives for the burgeoning climate-tech industry. A perhaps subtle shift in values was toward seeing technology as a vital ally in the campaign for sustainability. While most foresters were not anti-technology, they could be classified as skeptics. Indeed, many had joined the Forest Service because they enjoyed nature and did not want to be technology saturated.

Part of the values shift was recognizing that technology could be an incredibly useful tool, thus the look to crowdsourcing sites and Silicon Valley for tech ideas that might help. The Forest Service took note of these developments and, thanks to the cultivation of local partnerships, many innovative technologies developed through these initiatives were tested in American forests. Within the timber industry, wood products enjoyed a renaissance as part of a move away from plastics, such as wooden sunglass frames, watches, and external casings of tech devices and displays.

Early on, the Forest Service and most other government agencies were divided about what the response to the growing environmental crisis should be. They recognized the need for action, but faced conflict and a stalemate around exactly what to do. Whenever there was agreement, the predominant focus was on scientific and technological solutions. For instance, the Forest Service began a nanosensor trial in the Apalachicola National Forest in Florida. However, the test met setbacks and took longer than expected due to the difficulty of tagging so many trees with sensors. There were not enough employees to effectively implement the trial. Agencies' commitment to this and other efforts was insufficient, and they abandoned the projects when they encountered obstacles.

An emerging wave of projects refocused attention on the human element. Rather than humans serving technology, the focus shifted to how technology could serve people in the field. For the Forest Service, this shift reinvigorated the ranks. They felt like their expertise was valued once again. After years of declining budgets, personnel numbers, and morale, being a forest ranger became cool again. Ideas that had been on the shelf for years were dusted off, revisited, and put into action. Forest Service employees would be able to make a difference.

This was not just an American phenomenon. There were also geo-regional advances, such as cooperative alliances. In 2031, Canada, Mexico, and the United States entered into a North American Fire Mitigation Treaty. Although still in its infancy, this coalition would be essential should a mega-wildfire threaten to expand over the border at locations such as the Superior National Forest in northern Minnesota. Since its ratification, all three parties had taken several preventive measures.

Native American protesters of the Dakota Access Pipeline through North Dakota, South Dakota, Iowa, and Illinois in 2017 and countless subsequent protests inspired many communities to be more active in working alongside environmental NGOs and government agencies. Initially such protesters were still in the minority, but a decade later, their values were at the center of the cultural transformation that reinvigorated the Forest Service and the Nation to actively deal with climate change.

Though climate change was the key focus, it was not the only problem. The high level of disturbance in urban and rural forest ecosystems alike diminished the productivity of these lands. It also resulted in a substantial decline in visitors to public lands. As a result, land management agencies were now highly focused on rehabilitating these natural habitats. At the same time, private companies set their goal to decrease waste and improve the efficiency of manufacturing processes so that limited availability of raw materials would not affect them as severely. It turned out that the shift in values showed up

everywhere: in government, business, education, and nonprofit organizations. The shift in mindset enabled the Nation to turn the corner.

DISCUSSION

It was noteworthy that the first drafts of each 2035 scenario, prepared by different authors, came back with a similar story of responding to a crisis. Whether government intervention, high-tech fix, or values-based cultural transformation, none was judged likely to emerge without first passing through a crisis threshold. It was clear that the team envisioned a common baseline heading to crisis, with various responses to that crisis being plausible.

Forestry and the forest products industry are particularly vulnerable to the effects of climate change. The analysis suggested that climate change—the "800-pound gorilla"—is such a big driver that to some degree it overshadows others. As a result, the scenarios explore the various responses to climate change-driven crisis and the impacts on forestry. The baseline scenario was tweaked slightly to emphasize the path to crisis. The three alternative scenarios assume the baseline crisis, and suggest three different responses: the first response, Government Intervention: Curfew, Stay Inside, is a worst-case scenario of policy failure; the second, High-tech Transformation: the Internet of Trees, mobilizes technology and the entrepreneurial spirit to get on with "fixing" nature and the forests; the third, Cultural Transformation: Nurture Nature, rethinks the approach to nature and rebalances the human approach primarily through a value shift.

These 2035 scenarios are waystations on the path to the long-term future. As we reprojected them forward—having arrived at them from a backcast in the first place—we slightly recharacterized the 2090 scenarios to tell a consistent story across time. The dystopic Curfew, Stay Inside scenario carried forward evolves into "Wasteland," a survival-of-the-fittest approach in the forest in which robots serving neo-lumber barons battle with squatters and scavengers for ever-scarce forest resources. The high-tech Internet of Trees scenario takes on a tech-fix mentality that sees no problem that technology cannot fix. In terms of the forest, large-scale restoration projects have been successfully launched and the latest move is into technological forest enhancement, a view that technology can improve upon nature. The values-driven Nurture Nature scenario evolves into "Holistic Stewardship," in which nature is once again valued as sacred and worthy of protection in its natural state, with technology in a supportive role and with humans as partners and stewards in a Triple Bottom Line approach.

These societal responses act as drivers to establish three different trajectories that provide disparate images of the future. All three scenarios have practical implications for present decisionmaking in forestry. Among many possibilities, the following three implications offer some perspectives on how these scenarios have current relevance and could help guide decisionmaking processes:

- *How can conservation-related technological innovation be fostered?* The forest sector can foster major technological innovation if it collaborates with entrepreneurs, tech companies, and venture capitalists in a timely manner.
- *How could society be influenced toward a value change?* The power of ideas should not be underestimated as the future first and foremost occurs in the hearts and minds of people. Increasing evidence of climate change will make it easier to leverage social media to influence societal values and attitudes for forest stewardship in a changing world. Technology can also be used as a creative gateway to nature, encouraging people to engage. If this route is not actively pursued, a dichotomy between the outdoors (which will increasingly be perceived as hostile) and indoors (increasingly high-tech and insulated) could grow.
- *How could our policies and actions foster a positive relationship with nature?* A reactive approach to climate change is increasingly likely to be built on fear and feeling threatened

by the growing impacts of a changing climate. This approach has the potential to alienate humanity from nature. An early, proactive approach will prevent a sense of victimhood and increase the odds of a favorable, hopeful environmental future.

Using Scenarios in Horizon Scanning

The 2035 forest scenarios described in this paper represent a set of plausible futures for forestry and forests in the United States. The reason for developing the scenarios was to use them to provide context and meaning for scanning hits and emerging issues identified through the Forest Futures Horizon Scanning system. Individual scanning hits often lack context, and a large database of scanning hits may appear to be a random collection of disjointed bits and pieces. The same is true for emerging issues based on multiple scanning hits. Tagging scanning hits with descriptive terms (see the domain map of tags in Figure 2, paper 1 and Figure 1, paper 2, this volume) is a first step in providing context. The tags show the connection between scanning hits and broader themes of interest within the forestry domain.

A useful and often neglected second step to create context is to link scanning hits or emerging issues to plausible scenarios for the domain. Scanners can tag hits with the appropriate scenario, and the database of scanning hits can then be sorted by scenario and analyzed to reveal which scenarios may be gaining traction or failing to emerge over time. Linking scanning hits and emerging issues to scenarios can help identify broader patterns of change and promote sensemaking out of what was an amorphous database of horizon scanning hits. This helps foster expansive thinking about the results of horizon scanning and allows us to track the early emergence of a scenario or disconfirm it.

The Forest Futures Horizon Scanning database contains many scanning hits that relate to one or more of the 2035 forest scenarios, including the following examples of confirming scanning hits for each scenario:

Government Intervention: Curfew, Stay Inside

"Water, climate and conflict: security risks on the increase?" is a scanning hit supporting this scenario. This hit summarizes a report exploring the relationship between increasing water- and climate-related stressors, and increasing conflict at multiple scales. One of the main conclusions of the report was that "[t]he complexity of the climate-water-conflict interaction requires policy development processes integrating economic, mitigation, adaptation, social, and security policies" (p. 1). A possible implication for forest management agencies is the potential for military involvement to deal with increasing security risks and the need to safeguard resources and the public, consistent with the Government Intervention scenario. Also supporting this scenario are scanning hits related to the growth of technology-related indoor entertainment, the spread of tropical diseases and forest-borne pandemics, and increased intensity of heatwaves, droughts, wildfires, and other extreme weather events and natural disasters.

High-tech Transformation: the Internet of Trees

Many hits in the Forest Futures Horizon Scanning database support this scenario. An example is "Report calls for national parks to get smart", an article summarizing a research report titled "Smart Parks: Bringing Smart Technologies to National Parks." The article describes how real-time information from environmental sensors could soon inform public land managers and decisionmakers about everything from the effects of climate change to when trash bins are full. Also supporting the High-tech Transformation scenario are scanning hits describing the development or application of a wide range of advanced technologies in forestry and natural resources, including drones, robots, and artificial intelligence.

Cultural Transformation: Nurture Nature

A scanning hit supporting this scenario is "A once and future forest". The article discusses the Coquille Indian Tribe of southwest Oregon preparing to manage its forest land by its own rules. Under Federal legislation signed in January

2018, the tribe is no longer required to follow the "standards and guidelines" of Federal agencies. This is one of many scanning hits in the Forest Futures database reflecting an emerging issue of growing indigenous empowerment (see paper 6, this volume). Also supporting the Cultural Transformation scenario are scanning hits that describe shifting environmental values and behaviors, rapid growth in environmentally friendly technologies, and a renaissance in the use of renewable materials such as wood.

Tagging scanning hits for the scenarios as they are entered into the database may be challenging for many scanners. An alternative would be to have a team of scanners or analysts to assign scenarios to scanning hits after they have been posted in the database, as part of the analysis phase of the horizon scanning process.

CONCLUSIONS

As the history of our engagement with climate change proves, the consciousness of a society is akin to a bulky cruise ship that is unable to quickly change course. Two of the scenarios, those relating to technological and cultural shifts, point to strong leverage points useful to shift society toward a favorable outcome in dealing with environmental change. Time is needed, however. The other scenario provides a warning: The more delayed our engagement, the more difficult it will be to handle our climate issues, potentially leading to our alienation from nature, and even from one another and ourselves.

These 2035 scenarios provide a context from which policymakers can craft responses to avoid scenario(s) they consider undesirable and work toward scenario(s) they consider preferable. For the horizon scanning team, the scenarios provide further context for scanning. A scanning hit or emerging issue can be evaluated for how it relates to the scenarios. A scanning hit may be tagged to indicate that it suggests movement toward a particular scenario. In providing further context for horizon scanning, as well as a more useful planning horizon for policymakers, we believe this backcasting process to be a promising approach.

LITERATURE CITED

Bengston, D.N.; Peck, J.; Olson, R. [et al.]. 2018. **North American forest futures 2018-2090: scenarios for building a more resilient forest sector.** World Futures Review. 10(2): 152-169. https://doi.org/10.1177/1946756718757751.

Bezold, C. 2009. **Aspirational futures.** Journal of Futures Studies. 13(4): 81-90. http://www.jfs.tku.edu.tw/13-4/AE06.pdf (accessed November 27, 2018).

Dreborg, K.H. 1996. **Essence of backcasting.** Futures. 28(9): 813-828. https://doi.org/10.1016/s0016-3287(96)00044-4.

Government Office for Science. 2017. **The futures toolkit: tools for futures thinking and foresight across UK government.** [N.p.]: 68-73. Available at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/674209/futures-toolkit-edition-1.pdf (accessed November 27, 2018).

Hines, A. 2011. **ConsumerShift: how changing values are reshaping the consumer landscape.** Tucson, AZ: No Limit Publishing.

Hines, A.; Bishop, P.C. 2013. **Framework foresight: exploring futures the Houston way.** Futures. 51: 31-49. https://doi.org/10.1016/j.futures.2013.05.002.

Hines, A.; Bengston, D.N.; Dockry, M.J.; Cowart, A. 2018. **Setting up a horizon scanning system: a U.S. federal agency example.** World Futures Review. 10(2): 136-151. https://doi.org/10.1177/1946756717749613.

Kok, K.; van Vliet, M.; Bärlund, I. [et al.]. 2011. **Combining participative backcasting and exploratory scenario development: experiences from the SCENES project.** Technological Forecasting and Social Change. 78(5): 835-851. https://doi.org/10.1016/j.techfore.2011.01.004.

Lovins, A. 1977. **Soft energy paths: toward a durable peace.** Cambridge, MA: Friends of the Earth/Ballinger Publishing.

Quist, J.; Thissen, W.; Vergragt, P. 2011. **The impact and spin-off of participatory backcasting: from vision to niche.** Technological Forecasting and Social Change. 78(5): 883-897. https://doi.org/10.1016/j.techfore.2011.01.011.

Robinson, J.B. 1982. **Energy backcasting: a proposed method of policy analysis.** Energy Policy. 10(4): 337-344. https://doi.org/10.1016/0301-4215(82)90048-9.

Robinson, J.B. 1990. **Futures under glass: a recipe for people who hate to predict.** Futures. 22(8): 820-842. https://doi.org/10.1016/0016-3287(90)90018-d.

Strong, R.; Ryan, J.; McDavid, D. [et al.]. 2007. **A new way to plan for the future.** In: Proceedings of the 40th Hawaii International Conference on System Sciences (HICSS'07). 10 p. IEEE Computer Society. https://www.computer.org/csdl/proceedings/hicss/2007/2755/00/27550230b.pdf (accessed November 27, 2018).