TECHNOLOGICAL FORESTS: ENGINEERING NATURE WITH TREE PLANTING ON THE GREAT PLAINS, 1870-1944

by

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For Wendy

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ABSTRACT

As Euro-American settlers moved onto the Great Plains in the 19th century they planted trees to try and reshape the landscape and influence society and the environment. The federal government, through land grant laws and its forestry bureau encouraged this tree planting. In 1902 the federal government established the first federal tree nursery and used seedlings produced there to plant a 30,000 acre forest in the sand hills of central Nebraska. After three decades of tree planting experience the U.S. Forest Service undertook the Prairie States Forestry Project, planting shelterbelts across the continent from Canada to Texas, as a response to the Dust Bowl and Great Depression. Over the course of the 20th century, as these forests grew they became naturalized, both as developing ecosystems and in the public perception as natural spaces for recreational activities. An envirotechnical analysis of this history shows the interactions of environment, culture, and technology; illustrates the historical use of organic technologies; and challenges the traditional categorization of natural and artificial.

PEOPLE AND TREES: CONSTRUCTING NATURE AND TECHNOLOGY

On April 16, 1902 President Theodore Roosevelt created two new federal forest reserves of just over two hundred thousand acres in the virtually treeless grassland of central Nebraska. On one of these, the Dismal River Reserve, foresters of the nascent U.S. Forest Service built the first federal tree nursery and used the seedlings they grew there to construct a thirty thousand acre forest. This forest, built in the middle of the Great Plains, stands today as one of the nation's most extraordinary National Forests and an example of environmental engineering with organic technology. This forest construction formalized previous private tree planting efforts and established the precedent and experience for federal foresters to plant shelterbelts across the continent during the 1930s as a technological fix for both environmental and social problems.

Roosevelt's proclamation of these forest reserves—the Dismal River Reserve in the sand hills of central Nebraska and the Niobrara Reserve to the north—was just the latest in a string of proclamations that would form much of the modern National Forest system in the United States. What made these particular forest "reserves" so unique was that they were treeless at the time they were created. A small group of passionate advocates had convinced Roosevelt that they could actually build a forest on these sandy grasslands. University of Nebraska botany professor Charles E. Bessey had campaigned for more than a decade for a prairie forestation project and enlisted federal forestry officials in the cause. The Dismal River Reserve would later be renamed in his honor and become the centerpiece of the Nebraska National Forest.[1] At the end of the 19th century, when the Forest Service was still the Division of Forestry, chief Bernhard E. Fernow had promoted tree planting on the prairies and commissioned the first scientific experimental plantation in Nebraska. Then Gifford Pinchot, the nation's first political forester and a gifted bureaucrat, used his influence with the President to make the yet to be forested reserves a reality. Unlike all the other early reserves, this land was set aside not for what it already was but rather for what it would become: a forest created by humans.

The first federal tree nursery, built on the Dismal River Reserve, subsequently produced millions of seedlings and continues to operate today. The nursery can be seen as a seedling factory for the production of individual organisms. When integrated into a planted forest in the surrounding sand hills, however, these discrete organisms eventually became a complex interacting system designed for human purposes. Moving from nursery to forest, managers tried to construct complexity out of rationalized components, a biological machine whose whole was greater than its parts. Yet in important ways the forest also built itself, becoming a system in which technology and ecology were seamlessly integrated.[2] Composed equally of human culture (labor, technology, science)

[1] In 1908 the Nebraska Reserves were renamed the Nebraksa National Forest. The Dismal River Reserve and the tree nursery there were named after Charles Bessey in 1915 although both were often still referred to by the name of the nearest town, Halsey. The Niobrara Reserve was renamed the Samuel R. McKelvie in 1971. Other areas in northwestern Nebraska, containing some native ponderosa pine forest, were later added to the Nebraska National Forest. This dissertation will focus on the forest planted on the original Dismal River Reserve.

[2] Throughout this dissertation I will use "ecology" and "ecological" to signify a set of conditions and interactions between organisms and inorganic materials and forces that, through their interactions, make up an ecosystem. These interactions are always part of an ongoing physical process. In the case of the Bessey Nursery and the Nebraska National Forest, foresters were trying to manipulate these materials and forces for the production of trees and the construction of forests.

and nature (soil, climate, plants, and animals), the product of this system was not merely timber but the forest as a whole, a self-perpetuating technological ecosystem. As a constructed system the purpose of this forest was in its operation; as it grew it produced ecological effects. Likewise, as they built it the foresters gained new ecological knowledge.

Figure 1 - Bessey Nursery in the Nebraska National Forest. Source: USFS

Building a nursery and planting seedlings in the sand, federal foresters hoped to demonstrate the practicality of environmental engineering and reforestation in a project that they hoped could be repeated wherever people wanted wood products and forest conditions. Constructing the forest to act as a technology for providing products and environmental and social services, foresters harnessed sunlight, soil, organisms, and ecological processes through human labor and machines. Each of these components, the natural and the cultural, did work towards the production of the system. Beyond its creation, this technological forest was also intended as an example of how a planted forest could be an organic production facility, in operation through its existence, manufacturing timber; providing climate control by affecting wind, water, and temperature; and attracting new settlers to a sparsely populated region. However, while it began as a technical solution to social problems, the forest quickly took on a life of its own as ecological processes shaped it and its meaning and purpose shifted over time. To foresters and the public, this "artificial" forest became "naturalized" as people flocked to enjoy what they considered to be a woodland nature experience and many new nonhuman species migrated to this new habitat.

Defining technology, like defining nature, can be a tricky thing to accomplish in a useful manner. For the purposes of this dissertation we can start by considering technology something that humans consciously develop, construct or build, and put into use for a particular purpose, although that purpose can change over time. In the broadest sense, technology is an extension of the human body constructed for the purpose of facilitating human intention in the world. (Although of course it is always accompanied by unintentional consequences as well.) Nature, on the other hand, will need to serve more functions as a term. It is the material state of the world as well as a perception and an ideological construction of human society. It provides physical resources and living conditions as well as being a marker of values and identity. As Angela Gugliotta writes, "the slippery category of the natural has long been central to human self-understanding."[3] The idea of nature has represented a symbolic positive moral value for society as well as a raw or primitive state of being requiring improvement by human civilization. It has

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[3] Angela Gugliotta, "Environmental History and the category of the Natural," in *Environmental History* 10 (January 2005), 37.

also been seen as an inherently pure place and condition that is degraded by human activity. Obviously these varied uses are often contradictory. Nevertheless, or more likely because of all this, nature and technology are essential to the experience and definition of humanity. In general, both technology and nature are best approached within the context of specific examples.[4]

The Bessey Nursery, Nebraska National Forest, and Great Plains shelterbelts provide excellent examples for this study. With the construction of nature as technology in these tree plantings, and the progression of that technology back into nature as they grew into forests, foresters found an intersection between high modernist motivations of control and a realization of the integration of people and nature.[5] They used their experience in Great Plains forestry to undertake a similar effort in planting the Kansas National Forest, to reforest other National Forests throughout the West, and in a federal program to plant a series of shelterbelts stretching from Canada to Texas in response to the Great Depression and the Dust Bowl. Because they were not bound by a normative view of pristine nature, they were able to understand the nature and technology embodied in the Nebraska National Forest as one and the same thing.

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[4] Clarence J. Glacken, *Traces on the Rhodian Shore: Nature and Culture in Western Thought from Ancient Times to the End of the Eighteenth Century* (Berkeley: University of California Press, 1967). David Arnold, *The Problem of Nature: Environmental Culture and European Expansion* (Oxford: Blackwell, 1996). For general technology history in the American context and environment see Ruth Schwartz Cowan, *A Social History of American Technology* (New York: Oxford University Press, 1997); Carroll Pursell, *The Machine in America: A Social History of Technology* 2nd edition (Baltimore: Johns Hopkins University Press, 2007).

[5] On high modernism see James C. Scott, *Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed* (New Haven: Yale University Press, 1998). On the application of high modernism to natural resource management see Paul Josephson, *Industrialized Nature: Brute Force Technology and the Transformation of the Natural World* (Washington D.C.: Island Press, 2002).

Although it may seem paradoxical, foresters learned more about nature when they managed it as a technological system rather than as a supposedly separate natural one. And in building a forest they offered future Americans a constructive way of interacting with the environment, putting organic pieces together and encouraging ecological connections with human intentions, but with a holistic, constructive purpose rather than an extractive, destructive one. This dissertation's analysis of these tree planting and forest building efforts thus offers an important addition to the existing interpretations of forest histories.

Forest Histories

It has been commonplace for Americans to perceive their interactions with the environment through a cost-benefit trade-off between resource development and environmental damage. Historians have also often adopted this point of view in their interpretation of the past. Previous forest histories have been largely harvest oriented and declensionist. Most have focused on the business and politics of forestry through the government forest agency and the timber industry with an emphasis on logging and management techniques related to timber harvest and conservation goals. Since the mid 19^{th} century there has been a basic dichotomy within the popular perception of forests and the meaning of forestry. Forests have been perceived as resources—amenable to manipulation and even requiring human management—but at the same time retaining other values only when left untouched by people as wild nature. Problems that the U.S. Forest Service had in administering a multiple-use policy in the mid-twentieth century reflect the consequence of this dichotomy. Under this model, two courses of action seemed possible: that forests and other "natural" landscapes under human management are shaped directly through logging or some other type of extractive process or that environmental damage is avoided by the exclusion of certain activities, natural forces (fire), or particular species (pests, predators, or people).

This dissertation will study some of the most intensively managed forests of all: those individually planted and tended by people. This planting activity has most often been carried out as reforestation following logging or fire in an existing forest. But as aforestation it has also occurred when previously unforested areas have been planted with trees. As both a physically and ideologically constructive activity, this form of tree planting can more easily be understood outside the traditional destruction or exclusion dichotomy. While some planting efforts have been for mitigation of damage, others have been purely constructive.

Some of the examples of this type of planting can be usefully examined as technologies, because they are created and operated by humans for specific purposes. As they grow, these engineered forests are manufacturing a product or producing a specific condition. They remain ecological, however, because they are subject to environmental forces, provide opportunities for other organisms besides humans, and are in fact living systems. Framing these planted forests as systems that are both environmental and technological, composed of individual organisms shaped by human intentions into interactive (and to some degree independent) systems, avoids the tendency of some scholarship on forest and environmental history to frame the subject in terms of wilderness versus artificial landscape. Although all environments are products of a similar ongoing interactive process, it is easier to dispose of this natural-artificial dichotomy through a study of forestry on the Great Plains. This is a history of forest construction rather than destruction. An inversion of the typical narrative of nature being turned into technology, this technology of tree planting was understood by people at the time as artifice being turned into nature.

The common theme in previous forest histories has been deforestation as an effect of human actions. While this has certainly occurred, the history of this process is not necessarily the best way to understand the past or plan for the future. An analytical approach that does not disconnect nature and technology or presuppose a destructive consequence will augment and balance this scholarship. Focusing on timber industry politics and economics, government agency management, and especially the social conflict between the two, histories of American forestry rarely give more than passing mention to tree planting efforts. Michael Williams, in *Americans and their Forests: A Historical Geography*, offers the most sweeping account of changes in American forests. In great detail, Williams describes the decline of the forest in the process of resource development through land clearing and logging. The forests he presents represent a vast bank of material resources that Americans drew from to build their new nation, transforming natural value into socioeconomic value. In the process enormous forests were greatly reduced; his emphasis is primarily on destruction. Admitting that the forest area of the United States has recovered significantly, after being reduced by almost half by the early 20th century, Williams only addresses this re-growth in his last chapter. He attributes this restoration to natural regeneration, the reversion of abandoned farmland to forest, and fire suppression policies. Conceding that "the area planted to trees and seeded artificially has gone on at a greater rate than has perhaps been appreciated," he still minimizes the total impact of reforestation and tree planting.[6] Williams' subsequent book on forest history, *Deforesting the Earth: From Prehistory to Global Crisis*, continues the theme of humans and their technologies as destroyers of forests, and thus nature, even more emphatically and on a global scale. Although grounded in specific historical and cultural contexts, this is a series of deforestation parables. Casting humanity as a force of natural destruction, he writes, "this is a story of how they changed or destroyed that legacy of the incomparable green mantle that clothes the earth."[7]

While Williams concentrates on forest changes, other historians have focused on the people effecting those changes. William Robbins describes the interactions among various groups within the government and private industry regarding forest policy. In his monograph, *American Forestry: A History of National, State, and Private Cooperation*, Robbins portrays a set of relationships intended to maximize the development of forest products. His emphasis on the industrial goals of forestry through the production of timber and wood fiber represents both the mainstream management ideology and the dominant historical interpretation of American forestry. Robbins presents reforestation as part of the political and industrial process of American forestry, yet he offers few

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[6] Michael Williams, *Americans and their Forests: A Historical Geography* (Cambridge: Cambridge University Press, 1989), 477. Williams' last chapter "The rebirth of the forest, 1933 and after," comprises 30 pages out of some 500 total.

[7] Michael Williams, *Deforesting the Earth: From Prehistory to Global Crisis* (Chicago: University of Chicago Press, 2002), xviii. For a similar approach outside of U.S. forests see Warren Dean, *With Broadax and Firebrand: The Destruction of the Brazilian Atlantic Forest* (Berkeley: University of California Press, 1997).

details of the methodology or environmental consequences. For example, he reports that early 20th century Forest Service scientists artificially propagated lodgepole pine seeds and performed other reforestation experiments. But these programs of propagation and tree planting were much larger and more influential than he implies.[8]

Examining the federal government's pursuit of scientific forestry within the context of the political system, two prominent historians of the U.S. Forest Service depict the agency from interpretive perspectives that differ in part because of the time periods they cover. Harold Steen recounts the birth and growth of the Forest Service as a government agency advocating for a forestry policy that mediated between industry and a national resource. He provides an institutional history with a Progressive ideology that reflected a publication date (1976) prior to the social and political conflicts that subsequently embroiled the Forest Service and forestry in general around issues of clearcutting, endangered species, and biodiversity. This uproar over forestry policy was, in part, a consequence of the inherent difficulty in facilitating both corporate and public interests; forests hold many values but sometimes those values are mutually exclusive.

Like Williams and Robbins, Steen refers to reforestation, even arguing, "nothing is more fundamental to forest conservation, for example, than reforestation following logging," yet he too fails to analyze the topic in any detail.[9] Steen's historical foresters are still acting upon rather than within nature; they manipulate and manage forests from the outside allocating access to different consumers. In contrast, in this dissertation the

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[8] William G. Robbins, *American Forestry: A History of National, State, and Private Cooperation* (Lincoln: University of Nebraska Press, 1985), 113.
[9] Harold K. Steen, *The U.S. Forest Service: A History*, (Seattle: University of Washington Press, 2004) Centennial Edition (first published 1976), 110.

foresters of the Bessey Nursery, the Dismal River forest, and the Prairie States Forestry Project are embedded in nature and extending that influence in American society through tree planting and their discourse of forest construction.

Offering a revised interpretation of Steen's characterization of the agency, Paul Hirt discerns a significant shift in Forest Service policy following World War II. He presents a U.S. Forest Service that badly mismanaged the nation's forests because of conflicting directives and a romantic vision backed by high modernist ideology. While the agency may have proclaimed multiple values for public lands during this period, he argues their motivation and funding still revolved around producing timber. Conceived as a conservator of the forest, the Forest Service became instead a facilitator of the timber industry. This new role still required reforestation efforts, but the public largely perceived reforestation work as part of a destructive process—a view that Hirt himself echoes. Production oriented forestry tended to turn "natural forest ecosystems into timber plantations." As a type of tree-farming this approach "preempted many other kinds of forest uses, or at least degraded the value of the forest for other purposes."[10] Other scholars have also traced the many components of the institutional and industrial history of American forests from the standpoint of timber harvest. Politics, technology, and capitalist forces of markets and labor have all been cast as playing a role in the

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[10] Paul Hirt, *A Conspiracy of Optimism: Management of the National Forests Since World War Two* (Lincoln: University of Nebraska Press, 1994), xxxiv. Public outrage over Forest Service policies was driven in part by clearcutting in the Monongahela National Forest in Virginia and the Bitterroot National Forest in Montana during the 1970s as well as aesthetic concerns over the hillside terracing involved reforestation in the Bitterroot. See Dale A. Burk, *The Clearcut Crisis: Controversy in the Bitterroots* (Great Falls, Mont.: Jursnick Printing, 1970).

destruction of the forest and creating a public backlash against logging and economics as the primary forest value.[11]

A forest policy with timber harvest as the main management tool turned out to be shortsighted and too simplistic for achieving any of the Forest Service's long term goals of sustainable harvest and artificial selection for a merchantable species. Describing one example of this policy, Nancy Langston offers one of the most insightful accounts of this failure to realize a sustainable forest management strategy. In *Forest Dreams Forest Nightmares: The Paradox of Old Growth in the Inland West*, she explains how foresters in eastern Oregon during the late 19th and early 20th centuries attempted to convert the forest from wasteful, "decadent" old growth to vigorous, efficient biomass producing young trees. These foresters tried to accomplish this reorganization of the forest in the Blue Mountains through clear-cutting and fire suppression, hoping to increase timber production and promote ponderosa pine growth. As Langston writes, "they assumed that human ingenuity could perfect nature without losing anything in the process." Ultimately, the Forest Service failed in its vision and in its understanding of this ecosystem. "Much of what went wrong in the Blue Mountain forests, and in land management across the nation," Langston argues, "came from the problems of trying to

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[11] See the various essays in Char Miller ed., *American Forests: Nature, Culture, and Politics* (Lawrence: University Press of Kansas, 1997); Samuel Hays, *The American People and the National Forests: The First Century of the U.S. Forest Service* (Pittsburg: University of Pittsburg Press, 2009); also by Samuel Hays, *Wars in the Woods: The Rise of Ecological Forestry in the United States* (Pittsburg: University of Pittsburg Press, 2006); Bill Devall, *Clearcut: The Tragedy of Industrial Forestry* (San Francisco: Sierra Club Books, 1994); Charles F. Wilkinson and H. Michael Anderson, *Land and Resource Planning in the National Forests* (Washington, D.C.: Island Press, 1987) discusses American forestry practice from a legislative point of view; on Canada and capitalism and technology and management see Richard Rajala, *Clearcutting the Pacific Rain Forest: Production, Science, and Regulation* (Vancouver: University of British Columbia Press, 1998); for a cultural geography perspective see Bruce Braun, *The Intemperate RainForest: Nature, Culture, and Power on Canada's West Coast* (Minneapolis: University of Minnesota Press, 2002).

simplify and control the bewildering complexity of the natural world." A system of cooperation rather than control would have been more fruitful. As Langston concludes, "Much as we try, we cannot substitute our version of nature for the version of nature out there. We can only play around with it a bit, tugging on this process, pushing a little at that other process, adding our own agents of mortality—loggers—to the agents of mortality that are always going to be out there: decay, insects, fire, and wind." The ecological influences, Langston shows, cannot be removed from the system.[12]

Formed over the course of a century, the thirty thousand-acre forest that grew from nursery seedlings in the Nebraska Sand Hills offers a striking example of how human efforts and ecological processes can combine. The foresters who planted it had the unique experience of building a new forest rather than managing an existing one. By approaching nature as a technology they created a new opportunity to gain ecological knowledge, consciously engage in an interactive relationship with the environment, and contribute to the biological complexity of their landscape. In contrast to foresters in other times and places, who operated on a timber harvest management model that called for the simplification of complex forests, managers of the Nebraska National Forest moved from standardization to complexity. Rather than removing old-growth in an effort to "normalize" forests, they tried to encourage diversity, and foster ecological processes, planting as many different species as they could successfully grow. While other tree planters in the 19th century, such as those in the acclimatization movement, were interested in propagating individual exotic species (Eucalyptus in California and

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[12] Nancy Langston, *Forest Dreams Forest Nightmares: The Paradox of Old Growth in the Inland West* (Seattle: University of Washington Press, 1995), 98, 156, 291.

Monterey pine in Australia, for example), federal foresters in Nebraska strove to build a system with many interactive components. Rather than a sterile tree plantation, they wanted forest conditions that would change the composition of the soil, affect the climate, provide multi-layered habitat, and promote natural regeneration. They started with individual trees but rather than working towards a simple marketplace commodity they intended to create a complex environmental experience—a new nature.[13]

Previous scholarly works focusing on timber harvest and management are essential to understanding forest history; however there are also instances of labor, technology, and ideology combining to create forests. Some foresters built forest ecosystems and used tree planting constructively to address environmental and social problems. They were ambitious, but they respected and came to understand the local environment by using trees as a technology. People can become agents of regeneration and environmental construction by stimulating ecological processes through things like tree planting. However this approach, as Langston points out, requires a recognition (and promotion) of complexity and a willingness to abandon the idea of human sovereignty. Carefully considered, small scale construction efforts might allow for a reforestation and restoration program informed with humility and respect for local conditions, a partnership between managers and nature rather than domination by human agency. While Langston's story of the Blue Mountains forests is one of failure, she nonetheless concludes that a sustainable relationship with nature is possible and certainly necessary.

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[13] On the effort to standardize forests and the ideology of *Normalbaum* (standardized trees) see Scott, *Seeing Like a State*. On the effects of applying this mindset to the American West see Nancy Langston, *Forest Dreams Forest Nightmares*. Ian Tyrrell, *True Gardens of the Gods: Californian-Australian Environmental Reform, 1860-1930* (Berkeley: University of California Press, 1999) discusses the acclimatization movement, which also included animals such as rabbits and camels in Australia.

This will require paying attention to the agency of ecological processes and developing a better vision of humanity's place in nature—a vision that begins with an understanding of past efforts.

People in Nature

Part of the purpose of environmental history is to explore the interconnections of culture and ecology as an underlying process influencing historical events. How do people perceive the world around them and attribute meaning to it? How do physical interactions and conceptual consequences influence human actions? That all the countless components of this interaction are constantly changing makes the history of these interconnections as intricate as life itself. That people are self-consciously considering the world around them and acting on these perceptions as realities adds another layer of complexity, which continues to shift in response to past events and contemporary ideology. Historians themselves, of course, are caught in the current of their own society and environment. They tend to understand the past through the issues of their present. This means that lately environmental historians have been trying to resituate humans, their ideologies and actions, within a more complex context—embedded within the environment and their own ideas of nature, rather than acting upon them objectively. Perhaps this trend is in response to the realization of the intricacies of ecology and the interdependence of humanity on the global ecology, and a diminution of the ideology of human exceptionalism through the use of technology (or at least the admission that technology can have negative consequences) growing out of the late 20th

century. The current problem of anthropocentric global climate change and its implications is just one example of this new context.

Environmental historians have been problematizing concepts that were once taken for granted, such as wilderness, human agency, and a range of seemingly deterministic historical forces like technology and science. Most have even abandoned the construct of a normative nature, a baseline, pristine environment that acts as a stage for human actions. This has been to some degree a recognition of past ideas and perceptions as well as an application of new theoretical ideas from the present. Americans early in their history were not really closer to nature than modern Americans, though they perhaps perceived themselves as such. There were two aspects to their relationship with nature, a physical reconstruction of the environment and an ideological construction of themselves. Americans were struggling to impose their cultural ideology onto the landscape. The historian David Nye examines the same process of deforestation that Michael Williams decries through the narratives of the axe as a technology of both destruction and construction in early America. As they cleared the forest with their axes, Nye argues, Americans were also building a new world and a new identity. William Cronon's *Changes in the Land: Indians, Colonists, and the Ecology of New England*, as one of the foundational works in environmental history, describes the shift from a Native American landscape to a Colonial agricultural landscape of "fields and fences." Both environments, Cronon argues, resulted from and reflected cultural goals; the shift "was as much an ecological revolution as a cultural one."[14]

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[14] David Nye, *America as Second Creation: Technologies and Narratives of New Beginnings* (Cambridge: MIT Press, 2003). In this nature-technology mythmaking the axe creates individual identity and destroys

Early Americans understood the interactions of culture and nature as reciprocal, with the most obvious connections occurring through the influence of the environment on human health and the accumulation of environmental knowledge through work in the physical world. Conevery Bolton Valencius, in *The Health of the Country: How American Settlers Understood Themselves and their Land*, describes a deep connection between environmental conditions and perceptions of human health for early Americans. The characteristics of the landscape had a physical influence on the characteristics of the body. Indeed, the land and the body were conflated in settlers' minds, as their bodies were part of nature and the land. From this point of view, efforts to shape the land, including draining wetlands, clearing forests, and instituting productive agriculture were as much about individual and collective health as economics and technology. Likewise, as settlers moved onto the Great Plains late in the 19th century, they planted trees to make that place more salubrious—to create a landscape that fostered physical and psychological health. Life on the plains was experienced through the body; trees seemed to make that affective experience better. In the 1930s the government used tree planting to engineer the environment in order to alleviate the obvious ailments of the environment

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the forest; the mill builds community but oppresses workers. William Cronon, *Changes in the Land: Indians, Colonists, and the Ecology of New England* (New York: Hill and Wang, 1983), 6. Other environmental histories that address the construction of the landscape in early America include Theodore Steinberg, *Nature Incorporated: Industrialization and the Waters of New England* (Cambridge: Cambridge University Press, 1991); Gordon G. Whitney, *From Costal Wilderness to Fruited Plain: A History of Environmental Change in Temperate North America* (Cambridge: Cambridge University Press, 1996); Carolyn Merchant, *Ecological Revolutions: Nature, Gender, and Science in New England* (Chapel Hill: University of North Carolina Press, 1989); and by including domestic animals in her analysis of landscape, Virginia DeJohn Anderson, *Creatures of Empire: How Domestic Animals Transformed Early America* (Oxford: Oxford University Press, 2004).

and American society. The health of the nation was intimately tied to the health of the countryside, so part of the solution was to repair the land with shelterbelts.[15]

People often moved from one place to another in search of health. Likewise, ideas of human health and bodies have been influential in the development of an environmental consciousness and ethic in American history and as a vehicle for environmental historians to study the past. As Linda Nash and other scholars have demonstrated, Rachel Carson's *Silent Spring* had a tremendous influence on American society by relating the effects of environmental pollution to the permeability of the human body and thus helped to stimulate the modern environmental movement. Scholars have also used bodies as points of interaction between culture and nature and seen bodies as sites of environmental history from ancient times to modern day America and in other nations around the world.[16]

In clearing the forest, planting and harvesting the fields, or homesteading on the Great Plains, Americans also knew their environment through their physical experience of it. In his influential article, "'Are You an Environmentalist or Do You Work for a Living?': Work and Nature," Richard White argues for the essential embeddedness of

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[15] Conevery Bolton Valencius, *The Health of the Country: How American Settlers Understood Themselves and Their Land* (New York: Basic Books, 2004). On government environmental efforts during the 1930s see Neil M. Maher, *Nature's New Deal: The Civilian Conservation Corps and the Roots of the American Environmental Movement* (New York: Oxford University Press, 2007); Sarah Phillips, *This Land, This Nation: Conservation, Rural America, and the New Deal* (New York: Cambridge University Press, 2007).

[16] The scholarship on health and bodies in environmental history is voluminous. Some of the most important include: Gregg Mitman, *Breathing Space: How Allergies Shape our Lives and Landscapes* (New Haven: Yale University Press, 2007); Linda Nash, *Inescapable Ecologies: A History of Environment, Disease, and Knowledge* (Berkeley: University of California Press, 2007); Nancy Langston, *Toxic Bodies: Hormone Disruptors and the Legacy of DES* (New Haven: Yale University Press, 2011); Brett Walker, *Toxic Archipelago: A History of Industrial Disease in Japan* (Seattle: University of Washington Press, 2011); see also the recent dissertation by E. Jerry Jessee, "Radiation Ecologies: Bombs, Bodies, and Environment During the Atmospheric Nuclear Weapons Testing Period, 1942-1965," Montana State University—Bozeman, Ph.D Dissertation (2013).

people in nature through their labor. Work has long been one of the principal modes of interaction between Americans and their environment. The act of working confers knowledge. With the success of nation building, beginning in the late 19th century—through settlement, natural resource development, and the rise of wage labor and marketplace consumption—outdoor recreation became popular as a way of simulating traditional work in order to maintain access to environmental knowledge through experience. In work and play, White writes, "we are acutely aware of our bodies. The labor of our bodies tells us the texture of snow and rock and dirt." In *The Organic Machine: The Remaking of the Columbia River*, White also describes the labor of early white explorers and more experienced Native Americans as they worked to overcome the power of the river and move upstream. Such physical efforts to overcome environmental obstacles led to a historical view in which humans are pitted against and must conquer nature, an idea that has more recently come to characterize the challenge of outdoor recreation experienced in whitewater rafting, mountain climbing, or hunting and fishing. Nature, then, is the original non-human place and survival there is the challenge. In this context acquiring knowledge of nature through experience is an existential activity. Its essentialness as an aspect of *human nature* is illustrated by the importance of recreation as a simulation of survival and at the same time, nature as the best place for relaxation and recuperation from the stress of an "artificial" modern life.[17]

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[17] Richard White, "'Are You an Environmentalist or do you Work for a Living?': Work and Nature," in William Cronon ed., *Uncommon Ground: Rethinking the Human Place in Nature* (New York: W. W. Norton & Co., 1995), 174; Richard White, *The Organic Machine: The Remaking of the Columbia River* (New York: Hill and Wang, 1995). Part of this historical process of replacing work in nature with recreation in nature involved the imposition of a sportsman's ethic in defining proper actions and conservation efforts. Some important environmental histories that look at this process and its consequences are Karl Jacoby, *Crimes Against Nature: Squatters, Poachers, Thieves, and the Hidden History of*

In addition to this physical interaction and influence of the environment, Americans have also looked to nature for ideological inspiration. Ideas of American exceptionalism arising from the environment and efforts to construct a unique American identity with nature are an important part of American environmental history. A celebration of the sublime at Niagara Falls and the Grand Canyon, along with the popularity of the Hudson River School artists signaled a growing affinity for nature in American society. David Nye examines the effect of the sublime in identity construction, expanding on the role of nature to include the cultural effect of technology. In *American Technological Sublime*, Nye suggests that nature and technology can be interchangeable forces in American society. Both were slightly overwhelming and yet inspirational, both indicated national greatness. The incredible material resources and physical challenges of the environment seemed to be matched by the ideological and technological potential of the United States as "Nature's Nation."[18]

Tree planting on the Great Plains in the 19th century was informed by these same environmental and social forces: an inspiring but challenging physical environment and a social program of nation building and expansion. It would take hard work, the application of technology, and a re-imagining of the place to settle the plains and successfully bring them into the body politic of the United Sates. Trees would make both the landscape and the society healthier. To this end, tree planting in Nebraska and

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American Conservation (Berkeley: University of California Press, 2001); Louis Warren, *The Hunter's Game: Poachers and Conservationists in Twentieth-Century America* (New Haven: Yale University Press, 1999); and Mark David Spence, *Dispossessing the Wilderness: Indian Removal and the Making of National Parks* (Oxford: Oxford University Press, 2000).

[18] David Nye, *American Technological Sublime* (Cambridge: MIT Press, 1994). Although it deals with a wide range of environmental topics and events within American history, John Opie, *Nature's Nation: An Environmental History of the United States* (Fort Worth: Harcourt Brace, 1998) captures the essence of this perception in its title.

Kansas was an environmental engineering effort to recreate a familiar social world by changing the physical environment. Tree planters learned about the land, its limitations and its possibilities, through the trial and effort experience of their work, and they participated in a grand national enterprise through negotiating the people's place in nature.

The desire to control all of the continent's natural resources and the idea of an inherent responsibility attached to the role of Nature's Nation led to an ideology of a collective Manifest Destiny. Americans seemed to think they were intended to infuse the whole continental landscape much as nature itself did. The settlement of the Great Plains simply continued the westward movement impulse, which had already led people to transgress the British Proclamation Line of 1763 and later to fill up California and the Oregon territory with missionaries, speculators, and farmers. Although the settlement of the plains marked the frontier at the end of its course and in the middle of the continent rather than the edge, the process was still one of natural resource acquisition and industrialization. Although it has not been understood as such in the popular imagination, the history of the American west, as many environmental historians point out, has been decidedly industrial.[19]

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[19] David Igler, *Industrial Cowboys: Miller & Lux and the Transformation of the Far West, 1850-1920* (Berkeley: University of California Press, 2005); Andrew Isenberg, *Mining California: An Ecological History* (New York: Hill and Wang, 2005); Andrew Isenberg, *The Destruction of the Bison: An Environmental History, 1750-1920* (New York: Cambridge University Press, 2000) ties bison and the nature of the west into the growing industrialization of the east; Deborah Fitzgerald, *Every Farm a Factory: The Industrial Ideal in American Agriculture* (New Haven: Yale University Press, 2003); Richard White, *The Organic Machine*, describes the industrialization of fishing and canning on the Columbia River but also uses metaphors of industrial production to describe the nature and the flow of energy through the river's ecosystem.

The rush for natural resources and the consequences of their extraction and processing figures prominently in environmental history. The standard narrative asserts that while these resources enriched the nation, the methods of accessing them damaged the environment. As with forest history, the initial interpretation has often focused on the destruction of nature by humans. Without denying negative consequences and the degradation of the environment, some scholars have offered a more complex analysis of this history. Historian Andrew Isenberg positions California as one of the earliest sites of industrialization in the American West, in *Mining California: An Ecological History*. Gold, water, timber, and grazing lands were all extracted and managed on an industrial scale resulting in serious environmental damage but also leading to the development of a corporate and technological infrastructure and eventually an environmental sensibility that earlier histories had failed to recognize. Like the foresters in Langston's Blue Mountains narrative, Californians learned ecological lessons from the consequences of their actions. Hydraulic mining for gold caused a cascade of negative effects downstream, flooding, water pollution, and deposits of crop suffocating slickens. As Isenberg points out, a dynamic nature refused to be ordered and controlled by technology as "ecological changes rippled through the interconnected environments." These interconnections between earth, water, people, plants, and fish became clearer to people at the time through this destruction, and some "nascent preservationists" contested this industrialization of the environment.[20]

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[20] Andrew Isenberg, *Mining California*, 16, 21. Other histories of mining in the West also exhibit this consequence of extraction resulting in pollution, with the pursuit of one environmental value impinging on other environmental values—copper and ranching in Montana and lead and human health in Idaho, for example. See Timothy J. LeCain, *Mass Destruction: The Men and Giant Mines that Wired America and*

Foresters on the Great Plains also learned about the environment from their actions. But they learned about ecology and interconnections by industrializing the ecological connections within the place itself. Operating the nursery as a tree factory and planting the seedlings into a system, they were harnessing organisms and processes and trying to establish connections, rather than trying to extract one component as a single value. Instead of applying a mechanical industrial process to the environment, they were industrializing nature in order to initiate a process. They expected that process and the new environment it created to provide them with goods and services.

Other environmental histories present the management of a natural resource as the industrialization of an environment and provide an exception to the Western myths of independence and individual opportunity. In *Industrial Cowboys: Miller & Lux and the Transformation of the Far West, 1850-1920*, David Igler describes large scale cattle ranching in California in the late 19th century as an effort by companies that "both shaped and were shaped by their physical surroundings." These cowboys were part of corporations that manipulated water, land, labor, and capital to transform the landscape into a production facility for grass and beef. Those who tended the grass and the cows were not free spirits, though, but wage laborers. The process was extractive, environmental engineering aimed to keep up production levels. The object of their ambition was exclusion and control as Henry Miller and Charles Lux attempted to monopolize the environmental conditions in particular places. Although they were trying to simplify this production system, they found that these "ecologies of industry and

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Scarred the Planet (New Brunswick: Rutgers University Press, 2009); Bradley Dean Snow, "Living with Lead: An Environmental History of Idaho's Coeur d'Alenes, 1885-2011," Montana State University—Bozeman, Ph.D Dissertation (2012).

nature" were beyond their full control. Despite their technological and managerial resources, "the natural environment still remained an active agent in the Far West's development."[21]

The Bessey Nursery was also a site of control, one where managers struggled with the agency of nature as they tried to manufacture tree seedlings as production units. From these separate trees a forest was constructed as an intricate system. Through the manipulation of materials, labor, and environment in the nursery, managers worked to rationalize the production of individual seedlings. However, in growing those seedlings into forests in the surrounding hills, they also created a new ecological landscape. This new ecosystem arose both by design and as an inadvertent consequence of their efforts, the product of a century-long process of nurturing complexity rather than imposing simplicity. Foresters still struggled with some undesired effects like insects and fire in this new human-engineered forest, but the interactions of ecology—the mechanism of nature's agency—was also an indispensable part of the processes.

In "The Agency of Nature or the Nature of Agency?" Linda Nash argues that environmental forces are still historical forces, even if they have no intentionality of their own.[22] Drawing on Bruno Latour and Actor Network Theory to point towards an "organism-in-its-environment" model, Nash suggests that historians can "overcome the dichotomy between evolution and history, biology and culture" by empowering various components of nature as interacting with and influencing human actions and human intentions. The history of tree planting on the Great Plains demonstrates that the role of

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[21] David Igler, *Industrial Cowboys*, 4, 10.
[22] Linda Nash, "The Agency of Nature or the Nature of Agency?" in *Environmental History* 10 (January 2005), 67.

nature goes even beyond an interactive context for human activity. Environment and ecology, as processes and organisms in action, participate in the creation of history. Foresters at the time harnessed these organisms and processes in the production of seedlings and the building of their forests. But this ecology also created its own reality within which foresters were bound. They had to react to the changing nature. The history of the Nebraska National Forest is one of both human and non-human actions.[23]

Paul Sutter also utilizes Actor Network Theory in order to "conceptualize and examine hybrid environments as fields of agency and power in which the human and nonhuman intermingle and together shape change over time." In discussing the efforts of entomologists as agents of empire participating in the construction of the Panama Canal, he recognizes both the scientists' constructed perception of nature as well as an objective material influence exerted by the ecology and organisms with which they worked, namely mosquitoes bearing yellow-fever and malaria. As a result, he explains, "we see environment intruding as a causal force." American scientists working in the Canal Zone "had to manage a series of environmental processes and entities so interlocked with human agency and action that they defied the dichotomies of tropical theorizing." In other words, nature refused to stay within its human conceived boundaries. The federal foresters planting trees on the Great Plains offers an important extension of Sutter's approach. Since the foresters deliberately sought to harness ecological processes to achieve their goals, they not only acknowledged the actions of nature, but counted on

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[23] On actor-network theory see Bruno Latour, *Reassembling the Social: An Introduction to Actor-Network Theory* (Oxford: Oxford University Press, 2005).

them. Foresters recognized the agency of nature in both the work that it did for them and in its resistance to their efforts.[24]

In tree nurseries, managers worked to stimulate seed germination and seedling growth, yet these were organic processes that they only partially controlled and gradually understood through trial and error and experimentation. In the field they wanted individual organisms to combine and interact and produce forest conditions. But the interactions involved in the constructed ecology of a planted forest were complex. As the trees grew, opportunistic organisms, inimical to the foresters' plans, took advantage of the changing ecosystem. People could not control the rain or snow or wind that shaped the development of the forest. Likewise, pine-tip moths, gophers, and deer also represented the agency of nature and helped construct the natural and social history of the forest. Foresters sought to control the moths and gophers and eventually the deer. Meanwhile, the public embraced the deer as an attribute that naturalized the planted forest. In a way this ecological agency contributed a wildness to the forest that added to the public perception that it was a *real* forest, a place where nature was beyond complete human dominance and control.

The push back of nature against human intention has been another theme within environmental history. Many scholars have pointed out the unforeseen consequences of human actions in the environment.[25] Mark Fiege, in *Irrigated Eden: The Making of an Agricultural Landscape in the American West*, explores the resistance of nature to human

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[24] Paul S. Sutter, "Nature's Agents or Agents of Empire? Entomological Workers and Environmental Change during the Construction of the Panama Canal," *Isis* 98, (2007), 729, 754.

[25] See Langston, *Forest Dreams*; also Nancy Langston, *Where Land and Water Meet: A Western Landscape Transformed* (Seattle: University of Washington Press, 2006); Edward Tenner, *Why Things Bite Back: Technology and the Revenge of Unintended Consequences* (New York: Vintage, 1997).

efforts in a more interactive way. He demonstrates how irrigation systems in the western United States resulted in hybrid landscapes as plants and animals took advantage of water management technologies and remained just beyond complete human control. Humans responded in turn by creating an irrigation system based more on feedback and interaction than imposition. The landscape that resulted was an "ambiguous entangling of artifice and nature." It was "a place made from earth, water, air, plants, animals, and artifacts," but also from the ideas and meanings assigned by people. The Nebraska National Forest and the prairie states shelterbelts are similar to Fiege's hybrid landscapes, but their history suggests a slightly deeper integration of humans and environment. Idaho's famous Russet Burbank potato, according to Fiege, was a product of the convergence of technology and nature. It "transformed sunlight, soil nutrients, and water into caloric energy." In a similar way, the Bessey Nursery combined organic materials through human labor and ecological activity to create individual tree seedlings. However, foresters then took those seedlings and incorporated them back into the landscape to begin the development of a new ecosystem, a forest where the process of the growing trees was the purpose. The idea of a hybrid landscape, seen through the Nebraska National Forest becomes more than the product of two separate forces in contention, acting back and forth upon each other. Rather than a consequence, the forest appears as an expression of a greater system within which humans and non-humans are components functioning together.[26]

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[26] Mark Fiege, *Irrigated Eden: The Making of an Agricultural Landscape in the American West* (Seattle: University of Washington Press, 1999), 6, 8, 205.

Although they do not usually fully conflate humans and nature, environmental historians have pointed out the ironies of the process of construction and counter-construction between the two. Jennifer Price, for example, in *Flight Maps: Adventures with Nature in Modern America,* uses the plastic pink flamingo to explore ideas and expressions of nature and artifice. She also describes the conflicted response of people to the troubling disjunction of authenticity and artificiality embodied in the consumption of nature at the American shopping mall. In The Nature Store, boundaries become unclear and people develop "deep suspicions" of what is "Real" and what is not as they purchase representations of nature. This meaning of nature, she implies, seems to depend on our separation from it.[27]

And yet this belief in separation is problematic. William Cronon famously exhorted environmental historians to look for nature across ideological boundaries, particularly finding the wild nature within the civil society through the city tree. In "The Trouble with Wilderness; or, Getting Back to the Wrong Nature," he uncovered the social construction of wilderness and explained it as a containing a central paradox that hindered a more accurate perception of the human place in nature and thus restricted the options for constructive human action. Although they both serve a purpose, he wrote, "the tree in the garden is in reality no less other, no less worthy of our wonder and respect, than the tree in the ancient forest." The point is to recognize that both trees and people share the same world. Cronon goes on to suggest that we "abandon the dualism

[27] Jennifer Price, *Flight Maps: Adventures with Nature in Modern America* (New York: Basic Books, 1999), 171.

that sees the tree in the garden as artificial . . . and the tree in the wilderness as natural" and in so doing discover ourselves "in a home that encompasses them both."[28]

American settlers and foresters of the federal government had in many ways already adopted this view during the nineteenth century as they planted trees in order to create a home in the Great Plains. They consciously built an artificial forest and then treated that forest as natural. They used nursery seedlings as technology in forest building and shelterbelt construction, and in doing so recognized the trees, people, animals, soil, and climate as part of a single system. This system encompassed nature and culture.

Since the days of Cronon's then-controversial "Trouble with Wilderness," most environmental historians have continued to move away from studies of pristine nature in favor of lived-in, interactive environments.[29] People interact with the world around them through technology. This means that nature is not only socially constructed in meaning, but wherever humans and the environment interact there is also a technological construction. The use of technology shapes human perception and produces physical consequences, both purposeful and unintentional. This dissertation seeks to join the perspectives of environmental history and the history of technology and examine tree

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[28] William Cronon, "The Trouble with Wilderness; or, Getting Back to the Wrong Nature," in *Uncommon Ground: Rethinking the Human Place in Nature* (New York: W. W. Norton, 1995), 88-89, 90.

[29] Some of the many environmental histories of lived in environments include: Martin V. Melosi, *The Sanitary City: Urban Infrastructure in America from Colonial Times to the Present* (Baltimore: Johns Hopkins University Press, 1999); William Cronon, *Nature's Metropolis: Chicago and the Great West* (New York: W. W. Norton, 1992) describes the effects of Chicago in drawing natural resources from its hinterlands; Mike Davis, *Ecology of Fear: Los Angeles and the Imagination of Disaster* (New York: Vintage Books, 1999) gives a socio-political ecology of Los Angeles; Matthew Klingle, *Emerald City: An Environmental History of Seattle* (Cambridge: Yale University Press, 2009).

planting on the plains as the planters themselves pursued it—as a system with no clear boundaries between the social, the technological, and the natural.

Nature and Technology

The Nebraska forest and shelterbelt trees transcend characterizations of artificial or natural and demonstrate that there is fundamentally no logically valid separation between technology and nature. While technology is an expression of human culture it is also shaped by the environment, and these interactions are reciprocal so that nature, culture, and technology are never independent of each other. People differentiate them for their own convenience, but really they are only different expressions of one elemental state of being. This essential holism necessarily has a force in human history, but historians generally study it by looking at interactions across the boundaries people have imposed. However, no matter where you position the lines, the categories always interact, suggesting the categories themselves were never truly discrete entities. The Nebraska National Forest at Halsey is in some ways clearly a human creation, but it is also an ecological or even technological creation.

The history of the construction of the Nebraska forest and the Great Plains shelterbelts provides a unique opportunity for examining some of the important themes that underlie our understanding of the environment and technology as forces that shape history. How have Americans perceived the environment and worked to shape it to reflect their own values? How have they understood themselves and defined their relationship with nature and technology? These influences involve both material forces and ideological ones; often people can not control the interactions between the two. Of course, over time, changing cultural context also shaped the way Americans constructed their ideas of nature and technology. For example, while European colonists and early American settlers saw technology as a tool for perfecting a raw, undesirably wild nature, many late 20th century environmentalists blamed technology for destroying a pristine, privileged nature.[30] While this characterization of technology is most common within American society at these two general time periods, there was always overlap and dissenting opinions. David Nye in *America as Second Creation: Technology and Narratives of New Beginnings*, describes this perception of technology in the environment and its role in constructing American identity through a series of foundation stories and counter narratives about particular technologies such as the axe and the frontiersman, the mill, the railroad.[31] This juxtaposition of triumph and progress with destruction and oppression belies any normative standard for technology as a social or environmental force. However, from both perspectives technology acted as an outside artificial force either improving or destroying nature. There is, perhaps, a more productive way to perceive technology and nature.

The people involved in Great Plains forestry made no such division for the trees they planted. In the Bessey tree nursery, the Dismal River forest, and the shelterbelts of

[30] For example see, Barry Commoner, *The Closing Circle: Nature, Man, and Technology* (New York: Alfred A. Knopf, 1971). On housing as technological destruction of environment see Adam Rome, *Bulldozer in the Countryside: Suburban Sprawl and the Rise of American Environmentalism* (Cambridge: Cambridge University Press, 2001); on early American views of nature and identity see Henry Nash Smith, *Virgin Land: The American West as Symbol and Myth* (Cambridge: Harvard University Press, 1950). Leo Marx, *The Machine in the Garden: Technology and the Pastoral Ideal in America* (Oxford: Oxford University Press, 1964) provides examples of early American critique of technology as a minority opposition to the technological enthusiasm of the time.
[31] Nye, *America as Second Creation*.

the Prairie States Forestry Project, the integration of nature, technology, and cultural ideology demonstrate that they imposed no inherent boundary between nature and human artifice. Farmers and foresters combined human ingenuity and labor with living organisms and ecological processes for environmental and social engineering. Their forests were one of their technologies. Therefore, a useful way to approach this historical episode is to apply an envirotechnical analysis that highlights the ways that nature, culture, and technology operate outside of their normally imposed categories.

Formalized into an analytical theory through the work of a special interest group, Envirotech, that drew members from the American Society for Environmental History and the Society for the History of Technology, scholars pursuing an envirotechnical analysis first attempted to explain the interconnections of culture and nature through the interactions of technology and environment. But more recent works have pointed out how the divisions between these categories can be blurred, with the engineering of organisms or the use of organisms specifically as technical tools.[32] The field now has even moved towards the point of denying any definitive difference between them, beyond the impositions of convention and perception (though of course these can be historical forces in their own right).[33] Furthering the trends of thinking about systems in the history

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[32] Susan R. Schrepfer and Philip Scranton, eds. *Industrializing Organisms: Introducing Evolutionary History* (New York: Routledge, 2004; For an early survey of the historiography of technology and environment leading into the development of this field see Jeffery K. Stine and Joel A. Tarr, "At the Intersection of Histories: Technology and the Environment," in *Technology and Culture* 39, no. 4 (October 1998).

[33] Timothy J. LeCain, *Mass Destruction: The Men and Giant Mines that Wired America and Scarred the Planet* (New Brunswick: Rutgers University Press, 2009); Sara B. Pritchard, "An Envirotechnical Disaster: Nature, Technology, and Politics at Fukushima," in *Environmental History* 17 (April 2012): 219-43; also Sara B. Pritchard, *Confluence: The Nature of Technology and the Remaking of the Rhone* (Cambridge: Harvard University Press, 2011); Martin Reuss and Stephen H. Cutcliffe, *The Illusory Boundary: Environment and Technology in History* (Charlottesville: University of Virginia Press, 2010).

of technology and of according some agency to ecological systems in environmental history, the implication of this perspective is that all systems are envirotechnical systems.[34]

Scholarship in the field of envirotech initially often focused either on examples of individual organisms or on very broad theoretical concepts. The edited volume, *Industrial Organisms: Introducing Evolutionary History,* offers essays describing the development and application of individual plants and animals as biotechnologies. Standardized dairy cows, diseased laboratory dogs, genetically engineered tree seedlings, and the socially constructed "chicken of tomorrow," are among the collection of organisms shaped by technology and society. Edmund Russell introduced the essays of this volume explaining that these organisms "were not machines, but they were biological artifacts shaped by humans to serve human ends. They were technology."[35] He has since published *Evolutionary History: Uniting History and Biology to Understand Life on Earth*, in which he characterizes human culture as an evolutionary force but also as a product of co-evolution with other organisms. Human actions, both intentional and unintentional, through breeding, hunting, environmental changes, and technology, have "shaped the evolution of other species" and this processes in turn has "shaped human history."[36]

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[34] On technological systems see Thomas Parke Hughes, *Networks of Power: Electrification in Western Society, 1880-1930* (Baltimore: Johns Hopkins University Press, 1983). On the complexity of systems as an inherent characteristic see Charles Perrow, *Normal Accidents: Living with High-Risk Technologies* (Princeton: Princeton University Press, 1999). Perrow's discussion of illegibility and tight coupling is especially applicable to ecology and envirotechnical systems.

[35] Schrepfer and Scranton, eds. *Industrializing Organisms*, 1; Edmund Russell's introduction to this collection is titled "The Garden in the Machine: Towards an Evolutionary History of Technology."

[36] Edmund Russell, *Evolutionary History: Uniting History and Biology to Understand Life on Earth* (Cambridge: Cambridge University Press, 2011), 4.

On a larger scale than individual organisms or species, Thomas P. Hughes, in *Human Built World: How to Think about Technology and Culture*, argues that human culture, through the application of technology, has turned the planet into an enormous "ecotechnological system." The human-built world that Hughes describes is a reconstruction or even a replacement of an original world. Technology, when used without careful consideration, imposes upon or destroys the natural environment. A similar but slightly more extreme position is suggested by Bill McKibben's problematic 1989 declaration of the "end of nature."[37] Certainly humans have an impact in the world, and a concern for the quality of the environment is essential, but to suppose that people can stop either the material process or the idea of nature borders on hubris.

According to Hughes, technology and environment collide as two separate forces. "Much of the planet," he writes, "consists of interacting natural and human-built systems, which together constitute ecotechnological systems." He suggests that when well managed, the combination of nature and technology can produce an ecotechnological system as if it were an engineering or architectural choice. "An Architect," Hughes argues, "taking into account natural forces, such as local climate, when designing a building is creating an ecotechnological system." However, cities where this concern with environmental integration is not pursued "are becoming simply human-built," places where people "use technology to overwhelm nature rather than interact with it and adapt to it."[38] Ultimately, this characterization reinforces the dichotomy of nature and culture, placing a normative positive value in unaltered nature and ascribing both the positive or

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[37] Thomas P. Hughes, *Human-Built World: How to Think about Technology and Culture* (Chicago: University of Chicago Press, 2004); Bill McKibben, *The End of Nature* (New York: Random House, 1989).
[38] Hughes, *Human-Built World*, 156-57.

negative outcome solely to human agency in designing the integration of technology and environment. It also tends to overemphasize human autonomy within the Earth's ecology. While people can choose whether to emphasize a particular environmental influence in their constructions or not, the fundamental integration of nature and culture through the mediums of environment and technology is ever-present.[39]

Between these two extremes of the individual technological organism and broad claims about the ecotechnological nature of the whole planet, lies much fertile ground for examining how the world of "first nature" (living organisms and ecological processes) and the world of human consciousness constructed through culture (collective ideology, values, and goals) are inextricably bound together in technology and landscape.[40] The best way of studying this condition is through exploring envirotechnical systems in action. Ann Greene gives an excellent example of this in *Horses at Work: Harnessing Power in Industrial America*. Horse power in 19th century America, she shows, was part of a great network of industrial production, technological innovation, economics, physical labor, and social identity. Clay McShane and Joel A. Tarr, in *The Horse in the City: Living Machines in the Nineteenth Century*, also describe horses as a ubiquitous component of the urban environment and social system. Horses powered most of the mechanisms of the 19th century world; they were an essential part of the physical structure and as a technology, integral to American culture. Ironically, as

[39] For an example of the integration of nature and technology in an ocean environment see Dolly Jorgensen, "An Oasis in a Watery Desert? Discourses on an Industrial Ecosystem in the Gulf of Mexico Rigs-to-Reefs Program," *History and Technology* 25 (2009).
[40] The term "first nature" to indicate environments and natural resources before they are accessed or developed by people (specifically Euro-American society) is used by many scholars such as William Cronon, *Nature's Metropolis: Chicago and the Great West* (New York: W. W. Norton, 1992), xix.

industrialization increased at the end of the 19th century and technological systems, especially the railroad, expanded and became more sophisticated, the need for horses as technology increased. More than simply individual organic machines, horses were intricately connected to larger systems and people's lives. Through their work they linked the mechanical, the economic, the social, and the natural together. Like working horses, forestry on the Plains and the shelterbelts of the PSFP provides a way to see the confluence of nature and culture. Farmers and foresters planted seedlings and created forests; the trees were the organic link between the people and the larger social values and environmental system.[41]

In a recent article titled "The Nature of Industrialization," Sara Pritchard and Thomas Zeller explain how industrialization increased the separation between producers and consumers, often obscuring the social and environmental costs of production, while simultaneously reinforcing the interconnectedness of humans and nature. Using examples of resource development and exploitation of coal, cotton, silver, bison, sugar, and water, Pritchard and Zeller argue that "industrialization was as natural as other large-scale transformations in human history," and that "industrialization in fact deepened the links between humans and nonhuman nature."[42] Natural resources, production processes, and environments of production and consumption were all envirotechnical artifacts and interactions. The importance of recognizing this interdependence of environmental

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[41] Ann Norton Greene, *Horses at Work: Harnessing Power in Industrial America* (Cambridge: Harvard University Press, 2008); Clay McShane and Joel A. Tarr, *The Horse in the City: Living Machines in the Nineteenth Century* (Baltimore: Johns Hopkins University Press, 2007).
[42] Sara B. Pritchard and Thomas Zeller, "The Nature of Industrialization," in Reuss and Cutcliffe, *The Illusory Boundary*, 69, 85. William Cronon makes a similar, though not explicitly envirotechnical, argument about the disconnection between consumers and the nature in production in *Nature's Metropolis*.

process and material and human culture and activity, whether it is in water management, silver mining, sugar production, or forest construction is to dispel the idea that humans can transcend their environment. In the relationships between humans and all the other aspects of nature, the environment cannot be reduced merely to the source of natural resources and the place where the consequences of utilizing those resources play out. Neither should the various resources and the environmental effects that arise from their use be considered as independent, isolated objects. It is invariably through the interactions and connections among all the components—perhaps even more than the independent qualities of the components themselves—that historians can develop deeper insights into the past and the consequences for the present or future.

It is in examining the interactions of all of the components of a place, event, or history, that an envirotechnical analysis is most useful. This view acknowledges the influence of physical materials, cultural ideas and perceptions, and the actions of humans and nonhumans as parts of a system in process. From an envirotechnical point of view, the interactions are critical. Often the qualities and effects of the particular components of the system cannot be kept within their own discrete boundaries as defined by people (either at the time or in retrospect), but instead interact across those boundaries with consequences that are inherently difficult to understand and often impossible to control. In utilizing trees as technology and attempting large-scale environmental engineering, foresters were expanding their own ideological and material boundaries of natural and artificial. By intentionally harnessing ecological processes to produce seedlings and forests, they learned through trial and error about the interconnections of the system they were building. Their efforts and their purposes thus perfectly illustrate an envirotechnical system in action, even as they struggled to maintain control of the nursery and the forest as sites of production and meaning.

Historian Timothy LeCain goes beyond the individual example and the simple declensionist cause and effect story of extraction and pollution to examine the envirotechnical interactions involved in copper mining, processing, and consumption. His book, *Mass Destruction: The Men and Giant Mines that Wired America and Scarred the Planet*, connects mining in Utah and Montana, ore processing in Anaconda, Montana, ranching in the nearby Deer Lodge Valley, and the exploding demand for copper from the late 19th into the 20th century. Copper wire, refrigerator coils, automobile radiators along with huge open pit mines, thick smelter smoke, toxic tailings, and poisoned livestock, illustrate an interactive system with no clear boundaries and demonstrate the need to connect acts of consumption with the environmental effects of production. Through the interactions of environment, technology, and society, the system he describes is bigger than a mine or a smelter or Montana ranches; it is the whole world, in as much as that world is a system bound together by copper. As LeCain argues, "it no longer makes sense to draw clear lines between technological and ecological systems."[43]

Even before the formal creation of envirotech as a field of study and an analytical method, as previously noted, historian Richard White had examined the Columbia River from this point of view. At once natural and technological, the river was a system within which energy flowed and humans and nonhumans worked to access that energy. In *The Organic Machine*, White describes the human efforts to rearrange the nature of the river

[43] LeCain, *Mass Destruction*, 10.

and apply mechanical technologies to extract energy in the form of salmon and electricity. Since before the arrival of Lewis and Clark and up into the present, people have used dip nets, fish weirs, steam boats, fish wheels and canneries, hydroelectric dams, and nuclear power plants in their interactions with the river and its ecosystem. At each stage the river changed, but it never lost its naturalness. As White points out, "The mechanical was not the antithesis of nature, but its realization in a new form." The form of the river and the organisms and machinery it contained might change, but energy still flowed through the system. This system was an ongoing construction, a negotiation between nature and culture. "The human and the natural, the mechanical and the organic, had merged so that the two could never be ultimately distinguished."[44] People never gained complete control over this river system. They discovered that in achieving one value they invariably lost another. Dams and wild salmon appeared to be mutually exclusive; hatchery salmon made a poor substitute. The system was more complicated than its managers might have liked. In the sand hills forest, too, managers struggled with complexity. On one hand they encouraged it to accomplish the transmutation of individual seedlings into holistic forest. But some components of the developing system, insects, gophers, and fire particularly, frustrated their desire for control. Foresters were trying to channel the energy within the system towards its own efficient construction, but like the Columbia as an organic machine, their technological forest retained a life of its own.

One of the most recent explicitly envirotechnical histories also focuses on the development of a river system. In *Confluence: The Nature of Technology and the*

[44] White, *Organic Machine*, 34, 108.

Remaking of the Rhône, Sara Pritchard presents the French river as multiple sets of envirotechnical systems. Systems in the plural, because at any one time there are different interacting components and subsystems, and plural also because over time the relationships between the components changed as different methodologies and technologies were employed with different values and goals. The river is understood as a whole, encompassing both material and discursive elements. The river at any given time is a result of the influence of ecology, environment, technology, culture, and history. Pritchard explains, "envirotechnical systems therefore encompass not only 'nature' and 'technology' but also all of the social, cultural, and political dimensions of 'technology.'" As with any application of an envirotechnical analysis, all of these forces can be perceived at work within the system but cannot be extracted or separated one from the other without diminishing the full understanding of the system. This perception of an envirotechnical system can be applied to a place, a process, or a historical event; rather than a categorization of the parts, it is seen through interactions that play out over time. In fact, an envirotechnical system might be best understood as a process in motion. "Envirotechnical systems are," as Pritchard claims, "inextricably embedded environments and technologies that *continually reshape* individual parts of the system and the whole." Like ecosystems, everything is constantly interacting with and influencing everything else, developing in place and over time.[45]

Pritchard differentiates presenting envirotechnical systems as an analytical category from thinking of it as a conscious construction of historical actors. Indeed, as they go about their business, most humans tend to focus on the separate components of a

[45] Pritchard, *Confluence*, 19, (italics mine).

system or event as it pertains to their own interest—typically what they think is most influential, within their control, or in danger of controlling them. Mostly then, an envirotechnical system has been a methodological framework for perception rather than a goal to pursue. However, envirotech may also offer a useful worldview to adopt in addressing current and future environmental and social problems, especially in as much as these problems are simultaneously social and environmental. Indeed, people in the past have occasionally proceeded from this point of view though. While they certainly did not describe their own goals and actions with the rhetoric of envirotech, foresters producing seedlings, building forests, and planting shelterbelts were consciously trying to construct complex systems we can describe as envirotechnical. They were manipulating multiple components without regard for their definitional boundaries. They were trying to achieve their goals through the interactions of these components. Of course, they were still bound by their own cultural context and influenced by their own values and goals. Nevertheless, the actions they took, the processes they used, and the forests they constructed provide a particularly clear view of envirotechnical systems in action as a process forming place and history.

By casting nature as an "organic machine," White implies the analytical perception that LeCain, Pritchard, and other Envirotech scholars have subsequently firmly adopted. LeCain argues that there are "no clear lines between technological and ecological systems" and that attempting to preserve those boundaries often has detrimental consequences. Pritchard suggests that we adopt "the idea of technology as natural" and "think about nature as technological."[46] What is the usefulness, then, of this envirotechnical approach? Certainly it can provide a less reductive view of history and allay some of the hubris of human agency by attributing more historical influence to the interactions within a complex system. Perhaps through this wider perspective on the past it also offers a more balanced world view for future decision making. At the very least, it seems to provide a more accurate perception and description of how the world actually works. However, as an analytical framework rather than a unified field for history, its value must be demonstrated on a case by case basis.

This dissertation will adopt an envirotechnical approach in considering the history of tree planting on the Great Plains from the late 19th century to the middle 20th century. As such, it builds on the legacy and interacts with scholarship of forest history, environmental history, history of technology, and the recent field of envirotech. It also engages with the science of ecology, specifically through the philosophy and practice of ecological restoration, and in this way offers a contemporary context within which this historical interpretation has practical relevance for current and future environmental and social issues.

Great Plains and Planted Forest

The forest construction in this narrative takes place on the Great Plains of the United States between the mid 19th century and the mid 20th century. This place and the environmental and social histories that have taken place there have inspired a wide range of scholarship. Briefly summarized, these works describe the history of the Plains as the

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[46] LeCain, *Mass Destruction*, 10; Pritchard, *Confluence*, 21-22.

American West and the Frontier, as a process of movement and development of resources and communities, as an interaction between environment and society, and as a location for conflicts between different social groups. As a place, its meaning shifted and changed over time for Americans and for American historians.

One of the most influential historical interpretations of the Great Plains was as a part of the frontier and the process of westward movement described by Frederick Jackson Turner in his famous Frontier Thesis, presented in 1893. In many ways mirroring the 19th century American ideology and romantic perception of the West as a place of opportunity and independence, Turner described the frontier experience as a continual re-constructing of American society through progressive stages, resulting in a process that promoted democracy and a particular American character. However, as subsequent scholars have well recognized, Turner's thesis was in some ways an academic version of Manifest Destiny, and it failed to account for many of the forces, interactions, and events in American history and even the West specifically.[47]

Although it was widely adopted and indeed almost reified in American historiography for a time, other scholars contributed amendments to this thesis. In 1931 Walter Prescott Webb offered a sweeping history of the Great Plains, the primary interpretive thrust of which was that the influence of the environment of the Plains

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[47] Frederick Jackson Turner, "The Significance of the Frontier in American History," was presented at a special meeting of the American Historical Association in 1893 at the World's Columbian Exposition in Chicago, Illinois then published in the *Proceedings of the State Historical Society of Wisconsin*. It is reprinted in many places including: Mary Ellen Jones, ed., *The American Frontier: Opposing Viewpoints* (San Diego, Greenhaven Press, 1994), 24-40. For a historiography of the American frontier and critique of the Turner Thesis see Kerwin Lee Klein, *Frontiers of the Historical Imagination: Narrating the Conquest of Native America, 1890-1990* (Berkeley: University of California Press, 1999); Kerwin Lee Klein, "Reclaiming the 'F' Word, or Being and Becoming Postmodern," in *Pacific Historical Review* 65 (May 1996): 179-216.

demanded the development of new technologies and a new American society. The story of the six-shooter, barbed wire, windmills, and the railroad, Webb argued, explained the history of the Plains. Certainly technologies were important—indeed trees planted by settlers and the federal government became technologies in this settlement history—but modern scholars now avoid the technological determinism evinced by Webb. Agricultural historian James C. Malin contributed to the historiography of the Great Plains by combining the science of ecology with human history. This University of Kansas professor perhaps presaged envirotechnical analysis by conflating human society and environmental processes to some degree and arguing for a holist view of history. He wrote, "Both history and ecology may be defined as the study of organisms in all their relations, living together, the differences between plant, animal, and human ecology or history being primarily a matter of emphasis." In challenging the Turner thesis, and specifically the closing of the frontier, as a valid interpretation of the history of the West, Malin suggested pursuing a history that embedded people in the environment with "a scientifically conceived ecological methodology applied to human history [that] would emphasize ecological competition of two or more cultures for dominance in given earth areas."[48]

Beginning in the 1980s, a new group of scholars, known as the New Western Historians, also recast western and frontier history away from an interpretation of frontier process to one of place. Historians such as Richard White, Patricia Limerick, William Cronon, and Donald Worster, tended to define the West, including the Great Plains, as a

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[48] Walter Prescott Webb, *The Great Plains* (Boston: Ginn, 1931); James C. Malin, *The Grassland of North America Prolegomena to its History* (Gloucester, Mass.: Peter Smith, 1967), 408, 410.

place with specific environmental characteristics (primarily aridity) and as a place of conflict. Conflict between different social and ethnic groups, conflict between individuals and the government, and even conflict between the environment and the American socio-economic system shaped their interpretations. In addition to adding race, class, and gender to the analysis of western history, they heavily emphasized the environment. For a period of time there was significant overlap in the fields and scholarship of environmental history and the history of the American West.[49]

One of these New Western Historians addressed the Great Plains specifically. Donald Worster, in his book *Dust Bowl: the Southern Plains in the 1930s*, portrays the history of the plains and the era of the great dust storms as a product of the conflict between American society and capitalism and the environmental conditions on the plains, particularly aridity and drought. While allowing for the significant influence of climatic cycles, Worster primarily attributes the Dust Bowl to human actions and an overarching social system. The Dust Bowl "was the inevitable outcome of a culture that deliberately, self-consciously, set itself that task of dominating and exploiting the land for all it was worth." The same underlying values and economic mechanisms that led to the Great Depression, he argues, also caused the Dust Bowl. While he does see environmental conditions and human society interacting in a system, people changing the environmental

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[49] Richard White, *It's Your Misfortune and None of My Own: A New History of the American West* (Norman: University of Oklahoma Press, 1991); Patricia Nelson Limerick, *The Legacy of Conquest: The Unbroken Past of the American West* (New York: W. W. Norton, 1987); William Cronon, *Nature's Metropolis*; Donald Worster, *Rivers of Empire: Water, Aridity, and the Growth of the American West* (New York: Pantheon, 1985).

status quo are the most important factor in this history. The consequences of industrial agriculture are "primarily the work of man, not nature."[50]

Other historians of the Great Plains have disagreed with Worster's interpretation. Geoff Cunfer expands the area from which he collects historical evidence (Worster had used Haskell County, Kansas and Cimarron County, Oklahoma as case studies) and presents this information through geographic information systems (GIS) mapping. Cunfer concludes that significant dust storms were more widespread, had frequently occurred on the plains, and were even a routine event. "They were the norm," Cunfer argues. He claims that drought was the primary cause and discounts the effects of plowing and intensive agriculture in creating the Dust Bowl. Furthermore, he describes the popular perception of Dust Bowl history as a type of propaganda. "One might view the persistence of the Dust Bowl story as a result, in part, of twentieth-century mass marketing," he suggests. Cunfer's explanation of the dynamics interacting in this event offers a kind of revision of the idea of technology and humans as the destroyers of nature. Neither greed nor the plow caused the great dust storms. "It appears," he concludes, "that dust storms are a normal part of southern ecology." To whatever degree this might be true, however, it does not lessen the impact of the Dust Bowl in American history.[51]

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[50] Worster, *Dust Bowl: The Southern Plains in the 1930s* (Oxford: Oxford University Press, 1979), 4, 13. See also chapter 12 "Dust follows the Plow" in Donald Worster, *Nature's Economy: A History of Ecological Ideas* (Cambridge: Cambridge University Press, 1977).

[51] Geoff Cunfer, "Scaling the Dust Bowl," in Anne Kelly Knowles, ed. *Placing History: How Maps, Spatial Data, and GIS are Changing Historical Scholarship* (New York: ESRI Press, 2008), 102, 110,118. See also Geoff Cunfer, *On the Great Plains: Agriculture and Environment* (College Station: Texas A&M University Press, 2005). On the Dust Bowl see R. Douglas Hurt, *The Dust Bowl: An Agricultural and Social History* (Chicago: Nelson-Hall, 1981); Brad D. Lookingbill, *Dust Bowl USA: Depression America and the Ecological Imagination, 1929-1941* (Athens, Ohio University Press, 2001); James N. Gregory, *American Exodus: The Dust Bowl Migration and Okie Culture in California* (Oxford: Oxford University Press, 1991); Sanora Babb, *On the Dirty Plate Trail: Remembering the Dust Bowl Refugee Camps* (Austin:

Regardless of the ultimate genesis of the dust storms, the Dust Bowl coupled with the Great Depression was certainly an unpleasant, even deadly experience for people on the Plains and a national emergency for American society in general. The Dust Bowl was an environmental and a social calamity. People expected the government to respond. Along with economic and social programs, many argued there needed to be an environmental engineering aspect to this response. The government had programs to remove land from production, to institute soil conservation methods, and to plant trees. The idea of using trees in shelterbelts as a method of reducing future problems—rather than just immediate amelioration—made sense because of the previous history of tree planting on the Plains. The first settlers and the federal government had become successful at using trees to shape the landscape. Windbreaks surviving from the late 19th and early 20th century plantings were well established and highly valued. The Forest Service now had the Bessey Nursery running at a high capacity, and the sand hill forest was gaining momentum. The Prairies States Forestry Project would be a technological application of the nursery seedlings and the foresters' knowledge.

There has been very little written on the Bessey Nursery, the Nebraska National Forest or the Prairie States Forestry Project. Apart from Forest Service publications and short popular articles in magazines like *National Wildlife,* only a few scholars have addressed this topic. Raymond Pool wrote one of the first histories of the Nebraska National Forest. Published in 1952 it gives a general account of the construction of the nursery and forest, particularly Charles Bessey's role in establishing the Reserves. Pool

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University of Texas Press, 2007); Caroline Henderson, *Letters from the Dust Bowl* (Norman: University of Oklahoma Press, 2003).

was a student of Bessey and a professor of botany at the University of Nebraska. A contemporary of the events he wrote about, Pool published "Fifty Years on the Nebraska National Forest" as part of the golden anniversary of the forest in 1952. His account presents good information through the story of the forest, but no real historical analysis.[52]

In 1977, Wilmon Droze published *Trees, Prairies, and People: A History of Tree Planting in the Plains States*. He briefly describes the creation of the Bessey Nursery, but the focus of the book is the Prairie States Forestry Project. Droze's emphasis is on the organizational structure of the Project and the political history surrounding its creation and operation. As an institutional history of a government agency project it is concerned with budgets and personnel; it discusses the accomplishments of the Project in tree planting but, beyond the nature of the topic itself, is not an environmental history.[53] Historian R. Douglas Hurt devotes a chapter to the Shelterbelt Project in his book, *The Dust Bowl: An Agricultural and Social History*. Largely a reiteration of Droze's federal agency narrative, it is offered as an unusual example among other mitigation efforts by the government along with contour plowing, cover crops, and livestock purchasing programs.[54]

More recently, agricultural historian Joel Orth has written about both the Nebraska National Forest and the Prairie States Forestry Project. "The Shelterbelt Project: Cooperative Conservation in 1930s America," describes tree planting during the Dust Bowl in the context of agricultural history and as part of the larger conservation

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[52] Raymond J. Pool, "Fifty Years on the Nebraska National Forest," in *Nebraska History* 34 (September 1953): 139-79.
[53] Wilmon H. Droze, *Trees, Prairies, and People: A History of Tree Planting in the Plains States* (Denton: Texas Woman's University, 1977).
[54] Hurt, *The Dust Bowl*.

movement. In another article, "Directing Nature's Creative Forces: Climate Change, Afforestation, and the Nebraska National Forest," Orth argues that "the early twentieth-century national forest movement on the Great Plains, as exemplified by the Nebraska National Forest, began as part of a deliberate program of wide-scale environmental modification or enhancement." Again, the trees are conservation tools and the effort is to shape the resources and characteristics of the landscape through environmental engineering. In his analysis, however, Orth does not see this effort or the results as altering the boundaries of natural and artificial. Foresters created a "hybridized landscape," he says. "The eventual forests were not Frankenstein monsters . . . but then neither could they be considered natural." Orth recognizes that people come to value the Nebraska forest for many uses, but he retains the perception of it as entirely a human construction, a social artifact.[55]

These scholarly treatments of Great Plains forestry can be built upon with a new envirotechnical approach to this history. They do not closely examine the technical aspects of the production process in the nursery or the role of ecology in the construction of the forest. In general, they offer either a triumphalist view of the human manipulation of nature or cast tree planting as an agricultural and conservation effort protecting social values in nature but not becoming nature. An analysis that gives more weight to the role of ecology, interacting with human intentions, technology, and labor, within a larger

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[55] Joel J. Orth, "The Shelterbelt Project: Cooperative Conservation in 1930s America," in *Agricultural History* 81, no.3 (Summer 2007): 333-57; Joel J. Orth, "Directing Nature's Creative Forces: Climate Change, Afforestation, and the Nebraska National Forest," in *Western Historical Quarterly* 42, (Summer 2011), 198, 215. On the Nebraska National Forest see also John P. Husmann, "'A Rare Garden Spot:' A History of the Nebraska National Forest, 1900-65," (master's thesis, University of Nebraska—Lincoln, 1998) for another interpretation from an agricultural point of view with many similarities to Henry Nash Smith's discussion of the "Garden of the World" ideology in *Virgin Land*.

system of forest creation and development can give a more complete picture of this history.

Planting Trees

The discourse of tree planting and forests forms another background from which to consider the meaning of the Bessey Nursery and the forests and shelterbelts planted from its seedlings. Why do people have such an attachment to trees? In building communities, many people invariably plant trees. In considering the environment people see trees as one of the most emblematic features of nature. In *Planting Nature: Trees and the Manipulation of Environmental Stewardship in America,* Shaul Cohen considers how these impulses and associations have been co-opted to justify irresponsible resource development and result in a false sense of environmentalism. Although he believes that "we should be planting trees," Cohen argues that the discourse of tree planting promoted by the timber industry and private organizations such as American Forests and the Arbor Day Foundation gives the illusion of environmental stewardship even as it preserved the status quo and avoided addressing increasing environmental problems. He argues that "trees offer a particularly powerful and intimate way to support or generate a hegemonic orientation toward nature and the environment." The problem with tree planting, he writes, is not that individuals, organizations, or corporations are absolved, but rather the "human arrogance and [the] sense of authority with respect to the environment" it creates "and the complacency this sense of authority fosters." These trees, he argues, are too often planted as a quick fix without any concern for the root problem.[56]

It is the discourse rather than the action Cohen criticizes. The hegemony he describes gets its power from the close connection people feel with trees. That mechanism results from a long tradition of humans viewing trees as the most visible symbol of nature and thus of environmental health. In the United States there has also been a long history of working to incorporate that nature into constructed human societies. The best communities, many American believed, included nature. Flowers, bushes, and trees were planted, not just for their aesthetics or as a sign of affluence, but as an essential quality of the proper human environment.

Historians have also studied this phenomenon in American society through the topic of horticulture. Philip Pauly, in *Fruits and Plains: The Horticultural Transformation of America*, describes how horticulturalists have shaped American history, explaining that 19th century horticulture was the equivalent of modern biotechnology. Like the foresters on the Plains, in developing new varieties, naturalizing exotic species, and planting landscapes, these planters were consciously participating in the ecological system. Cheryl Lyon-Jenness writes about the nursery business and the culture of planting trees and flowers in American history. In *For Shade and For Comfort: Democratizing Horticulture in the Nineteenth Century Midwest,* she explains how people used these plants to construct a social environment. Many Midwesterners "understood trees and flowers as a sign of traditional virtues and stable values, an

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[56] Shaul E. Cohen, *Planting Nature: Trees and the Manipulation of Environmental Stewardship in America* (Berkeley: University of California Press, 2004), 20, 22, 166.

antidote for the social ills and personal upheavals that accompanied rapid, undirected change." This cultural perception "imbued trees and flowers with a particular set of values that reflected their own vision of a proper society." The trees and flowers themselves carried out this social function, she argues, "without shedding their naturalness or their power as cultural symbols." Flowers around the house and trees planted along the road served as a "sociotechnic tool" within American society.[57]

As settlers move out onto the Great Plains, many saw their enterprise as creating a society and its proper environment from scratch. Trees were an important part of the world they wanted to construct. More than just ornamental, trees had a fundamental importance. Foresters, too, in building the sand hills forest, were doing more than just improving the landscape. They were engaged in an archetypal endeavor. At least Robert Pogue Harrison suggests this point of view through his wide-ranging work of literary criticism, *Forests: The Shadow of Civilization*. Tracing the role of forests in culture and the human imagination from the *Epic of Gilgamesh* to Thoreau's *Walden* to Frank Lloyd Wright's Fallingwater house, Harrison depicts forests as an essential force in the collective Western identity. In both their initial escape from the forest and their later return to it, humanity defines itself. With the more recent understanding of ecological interconnections, Harrison claims, "forests have come to assume a powerful symbolic status in the cultural imagination to the degree that they provide a compelling paradigm

[57] Philip J. Pauly, *Fruits and Plains: The Horticultural Transformation of America* (Cambridge: Harvard University Press, 2007); Cheryl Lyon-Jenness, *For Shade and For Comfort: Democratizing Horticulture in the Nineteenth-Century Midwest* (West Lafayette: Purdue University Press, 2004), xix.

for the notion of the earth as a single, complex, integrated ecosystem. . . . Forests have become metonymies for the earth as a whole."[58]

The construction and ongoing development of the Nebraska National Forest also reflects this idea. The forest embodied human intentions, but it also resulted from ecological imperatives. Foresters and laborers, animals and plants, the sun, soil, and rain all combined as separate elements that created a greater whole through their interactions. As parts of the same process they became unified in the forest.

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Like the separate trees planted into the Plains, the individual chapters of this dissertation each stand alone but they also join together to describe a bigger meaning. The history they recount is an interconnected affair of ideology, human actions, technology, ecology, and vision for the future through a common theme of tree planting. Each chapter describes a condition and a process within the greater envirotechnical system.

Chapter two, "Manifest Destiny and the Gospel of Tree Planting," follows 19th century settlers out onto the Great Plains. They have a vision and are scripting their own actions through the ideology of Manifest Destiny. Tree planting becomes an important part of fulfilling that vision and making the proper environment and society. The desire to plant trees and reshape the plains environment, while not greatly successful, gradually

[58] Robert Pogue Harrison, *Forests: The Shadow of Civilization* (Chicago: University of Chicago Press, 1992), 199.

brings the involvement of the federal government. In chapter three, “Building a Tree Factory,” the Forest Service, having experimented with tree planting and adopted an optimistic faith in their own power and agency, set out to build forests on the Plains. They construct the first federal tree nursery, and, utilizing ecological forces as the production process, operate it as a factory for producing millions of individual trees. Great effort is made to rationalize production in the face of ecological complexity. In chapter four, “Growing a Functional Forest,” foresters try to put this complexity to work by combining individual trees, planted in the surrounding grassland, into a functional system. The forest begins to develop the attributes of a functional forest as humans and non-human organisms seek out its nature. After decades of experimentation and trial and error, foresters gained knowledge, experience, and confidence in their environmental engineering abilities. Chapter five, “Engineering the Great Plains,” describes a grand project by the federal government to use tree planting as a technology to address the environmental and social problems of the Dust Bowl and Great Depression. A shelterbelt zone is established, running through the Plains states from Canada to Texas. Thousands of shelterbelts are planted and many develop into miniature forests. Finally, in chapter six, “Restoring an Imagined Nature,” the historic tree planting enterprise combines with the philosophy and practice of ecological restoration to offer a deeper historical context to the restoration movement and provide contemporary relevance to past tree planting and forest construction on the Great Plains.

The Bessey Nursery, the Nebraska National Forest, and the Prairie States Forestry Project serve as a clear example of envirotechnical systems. They present a historical narrative of tree planting and forest construction, and in connection with the history and practice of ecological restoration, may suggest a paradigm for understanding and informing human actions within the environment.

Seeing the Whole System

Placed within the context of the larger literature on forest history, environmental history, and envirotechnical analysis, several points become clear about this specific history of tree planting and forest construction. Key among these is the somewhat paradoxical realization that foresters learned more about trees and ecology from building a forest than from managing an existing one for timber harvest. Trees were harvested as individuals, but forests were constructed as systems. Through their work in the Bessey Nursery and the sand hills planting, foresters were conscious participants in local ecological process, a part of the system. To produce seedlings and build the forest, they harnessed ecological processes but the nursery and the forest also had a life of their own. Foresters could participate in but not fully control the system. Over time, the "artificial" forest became "natural." The system developed and many organisms and people took advantage of it. People value and interact with this forest as they do with any other national forest. The combination of culture, technology, environment, and ecological activity, in the one hundred year history of this forest provides a perfect picture of an envirotechnical system in action and demonstrates a useful way to think about other histories.

Although little known, the first government tree nursery and the sand hills forest were started with the beginning of federal forestry in the United States. The Nebraska forest grew up along with the new Forest Service, an idealistic agency run by Gifford Pinchot. A constructed forest made an ideal project in Pinchot's Progressive Era environmental program, which pursued conservation goals through scientific forestry. What could be more progressive than reclaiming "wasted land" and creating new resources for the future? What could be more modern and better serve as a grand scientific experiment than building a forest from scratch? In support of the settlement of the Great Plains, the government wanted to convert nonagricultural land there into forest, produce wood products such as lumber, fuel, and fence posts, and improve local living conditions through the influence of trees and a forest ecosystem. The project was an environmental engineering effort to construct a new landscape with a productive purpose. This landscape of "shifting sand" with "only a sparse covering of grass" seemed, at least to the foresters, to require improvement. In promoting Forest Reserves for the Plains, federal foresters argued that forestation offered "the only means of reclamation." Furthermore, the project would serve as "a practical demonstration of forest planting on the plains and would show the purpose of the government to aid in the development of that great, fertile country." The results would "enhance the value of the land in the plains" and even be applicable for environmental engineering in many other places as well.[59]

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[59] H. P. Baker, "Proposed Forest Reserves in the Sand Hills of Nebraska," winter 1901-1902, National Archives and Records Administration, Rocky Mountain Region (hereafter NARA), Record Group 95, Box 85, folder 390.

Known since 1895 as the “Tree Planter’s State,” Nebraska offered a place with the perfect combination of practical need and ideological sympathy for the creation of a planted forest. Settlers there had long been trying to grow their own trees. Immigrants to the state appreciated the ease with which they could break the sod, but they sorely missed the eastern woods many of them had left behind, especially when the piercing prairie winds blew. Stimulated by this tree planting sentiment and an interest in the ecological mechanisms of the environment, Arbor Day and the 1873 Timber Culture Act came out of Nebraska, and the state quickly became a center for the science of botany and agricultural innovation. Under the tutelage of Charles Bessey, Frederic Clements and Roscoe Pound established the “Nebraska School of Ecology.” They sought practical applications for agriculture in the emerging scientific study of the functions and relationships between organisms and the environment. Nebraskans had a special affinity for trees, and a history of pioneer spirit combined with an enthusiasm for scientific inquiry to inspire confidence in their ability to engineer a new nature in the sand hills.

Settlers began planting trees in the plains during the mid-nineteenth century and the construction of the Nebraska National Forest continued through the whole twentieth century. The long process of planting trees and growing forest bonded people to their environment and part of this history involved the cultural construction of the meaning of nature and people in this specific time and place. The Nebraska National Forest arose from the issues of American identity, westward expansion, settlement, land use, and natural resource management. The determination to control the environment, promote expansion, and, eventually, encounter “nature” shaped its meaning. A product of

Progressive Era positivism, the Nebraska National Forest later became the prototype for a New Deal response to the Dust Bowl and Depression. As a recreational spot, the Nebraska forest also attracted people from all over the state for picnicking, hiking, camping, and hunting. The forest reflected American faith in science and technology in the first half of the 20th century, and the importance of access to a certain type of nature experience in the second half. Similarly the shelterbelts, planted as organic technologies to fix specific problems, became important for habitat and recreation.

As organic technologies the value of these planted forests is in their inherent qualities as forests. The fact that they were built by people using ecological processes has important implications for an equivalency of technology and nature. Trees and forests have a significant value to humans. As we incorporate other people into our own sphere of concern, forming family, community, and society, we also need to recognize a similar relationship with the environment. Often, this is easy to do with trees and they become part of our lives. After three decades on the Great Plains, Willa Cather understood that environment. In her novel *My Ántonia*, Jim Burden explains the importance of trees in Nebraska when he says "Trees were so rare in that country and had to make such a hard fight to grow, that we used to feel anxious about them, and visit them as if they were persons."[60] On the Great Plains in the 19th century, the people and the trees had a lot in common.

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[60] Willa Cather, *My Ántonia* (New York: Alfred A. Knopf, 1918), 28.

MANIFEST DESTINY AND THE GOSPEL OF TREE PLANTING

> We urge the planting of trees from the standpoint of NECESSITY. We might urge it from the still HIGHER ground of HUMANITY. We may begin to plant for ourselves but we shall find that God is giving our work a wider range and grander significance than we ever imagined. We, it is true, may go to our rest beneath the shadow of trees which our own hands have planted, but others will arise to bless God for our work, and we shall live again in the grateful praise and thank-offerings of unborn generations.
> —Prof. E. Gale[1]

The effort by government foresters to build their own forest on the Great Plains from mass produced tree seedlings and their plan to use trees as an environmental engineering technology during the Dust Bowl grew out of a unique historical background and ideological context. The hand-planted Nebraska National Forest and the shelterbelts of the Prairie States Forestry Project were the products of a shared social vision by the federal forestry agency and advocates of Plains settlement. Tree planting on the Great Plains was not just an individual effort by independent settlers, but rather a collective project, a nationalistic enterprise, and eventually a government program. Moving west, claiming and reshaping the land, assembling new communities and expanding society, all were manifestations of a collective ideology and aspiration. Tree planting was only one component of this project, a practical task, but it also embodied the meaning of the whole. Trees symbolized the purpose inherent in westward movement and the doctrine of Manifest Destiny. Trees recreated a familiar landscape and proclaimed the stable, permanent presence of American society in the West. By planting trees Americans were putting down roots and building for future generations.

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[1] Kansas State Horticultural Society, *Seventh Annual Report on Kansas Forestry for 1886* (Topeka: Kansas Publishing House, 1887), 1.

Conceptions of the Land—Ideology, Environment, and Migration

Motivated by an ideology of divine entitlement and the hope of unbridled opportunity, Americans settling the Great Plains in the nineteenth century brought with them from the East a commitment to an established social structure and a particular world view. Where the environment did not match their expectations, they determined to re-engineer it to create a culturally familiar landscape and experience. They intended to shape the land in their image rather than allow the land to shape them.

As the epigraph by Professor Gale, president of the Kansas State Horticultural Society, suggests, the landscape they desired required trees. In the nineteenth century, Gale and others viewed planting trees on the plains as a deeply humanitarian effort. It was a noble enterprise, blessed by God, intended to benefit not only individual settlers but society as a whole and generations of future Americans. It was also a project endorsed by science. George Perkins Marsh, the American proto-ecologist, promoted tree planting. The creation of "artificial forests," he claimed, was "among the plainest dictates of self-interest and most obvious of the duties which this age owes to those that are to come after it."[2] Since its beginnings, American society had sought to perpetuate and expand itself, in time and space. By planting trees and building forests, settlers,

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[2] George Perkins Marsh, *The Earth as Modified by Human Action: A New Edition of Man and Nature* (New York: Scribner, Armstrong & Co., 1877), 393-93. Marsh has since been recognized as a prescient voice on the destructive ecological consequences of uncontrolled deforestation. His seminal book, first published in 1864, has been ranked in the conservation movement canon along side Aldo Leopold's *Sand County Almanac* and Rachael Carson's *Silent Spring* for its historical importance, even though it took some time to influence American society. See David Lowenthal, *George Perkins Marsh: Prophet of Conservation* (Seattle: University of Washington Press, 2000).

farmers, agents of industry and the federal government used living organisms as a technology for reproducing an existing social ideal in a new physical place.

In the first half of the nineteenth century, the Great Plains was a place Americans passed through on their way somewhere else. Between 1841 and 1859 some three hundred thousand people travelled up the Platte River valley, crossing the plains with no thought of stopping there.[3] Other lands, like Oregon and California, seemed more familiar and more promising. The plains were too dry and strangely forbidding in their openness, good perhaps only for Native Americans pushed out of the East. Euro-Americans tended to perceive the plains as a great treeless desert. When, later in the century, they finally did begin to settle there in large numbers they worked hard to re-engineer the place to better suit their cultural standards. One of the most remarkable ways they tried to do this was by planting trees. Farming offered a livelihood; building communities and governments provided social stability; but tree planting promised to change the climate and reshape the landscape—making it home. Before this environmental engineering effort and a re-imagination of this place, the plains seemed nothing but a great obstacle to American society.

Overland travelers on the Oregon and Mormon Trails followed the Platte River across the plains before crossing the Rocky Mountains or turning south to the Great Salt Lake. Emigrants on their way to lush Oregon valleys in the 1840s had no reason to linger in the dry grasslands as they raced to cross the mountains ahead of winter snows. The Mormons, after pausing in Winter Quarters just west of the Missouri River in 1846,

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[3] Elliot West, *The Way to the West: Essays on the Central Plains* (Albuquerque: University of New Mexico Press, 1995), 19.

pushed on along the north side of the Platte. They chose to settle around the Great Salt Lake, thinking distance and the inhospitable plains protected them from largely hostile American society. Three years later, eager travelers rushing across the continent to reach California saw nothing in the plains to compare with the tempting riches they expected to find in the gold fields. However, the traditional view of the Great Plains as a great American desert was misleading. Descriptions from the Zebulon Pike exploration of 1806-07 and Stephen Long's 1820 scientific expedition had fixed this mistaken idea in the American consciousness. Pike compared the plains to Africa's deserts, and Long called them a "Great Desert" which was "unfit for cultivation and of course uninhabitable by a people depending upon agriculture."[4] But, of course, various groups of Indian peoples had lived on the Plains for thousands of years.

In truth, the geology and the ecology of the Great Plains were the material factors that enabled nineteenth century Americans to travel across them. The open rolling terrain made overland travel with wagons possible and native grasses provided essential food for draft animals. Emigrants began their journeys west at the first sign of spring grass. Leaving Iowa and crossing the Missouri River, travelers soon left the waving tall-grass and moved into the mixed-grass prairie. There they had to hurry. Their window of time to cross the Great Plains opened only between the arrival of green grass and snowfall in the Rocky Mountains.

The Great Plains slope upward from the Mississippi River to the foot of the Rocky Mountains, from the low plains in the east to the high plains in the west. West of

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[4] Paul E. Cohen, *Mapping the West: America's Westward Movement 1524—1890* (New York: Rizzoli International Publications, 2002), 108-09; James P. Rhonda, *Beyond Lewis and Clark: The Army Explores the West* (Tacoma: Washington State Historical Society, 2003), 24.

the Missouri River aridity defined the grasslands as the rain shadow cast by the Rockies created gradients in the prairie from tall-grass to mixed grass to short grass. Boundaries shifted between these zones in response to the availability of moisture. Big bluestem (which can grow up to ten feet high), switch grass, and Indian grass of the tall-grass prairie shaded into the little bluestem, western wheatgrass, and needle-and-thread grass of the mixed grass plains. In the much drier high plains to the west, short grass species such as blue grama and buffalo grass predominated. Grass was the keystone of life on the plains. Some 140 different species of grass covered an area of 1 million square miles in a tapestry of intermingled patches.[5]

This huge expanse of grass fed immense herds of bison and supported large Indian pony herds, a newly adopted technology. Many Indian peoples had changed their culture, economy, and territory with the adoption of the horse, moving onto the Great Plains in larger numbers. With the horse, Indian people like the Cheyenne could follow the bison farther and live on the plains full time. Increased mobility allowed them to access more resources and live a richer life but only at the cost of large amounts of fuel for their horses. Historian Elliot West has perceptively described their nomadic horse culture as a seasonal cycle of "chasing grass." But a much more limited resource was just as essential to the survival of native people on the plains—trees. Timber tracts along the river bottoms, cottonwood and willow, provided fuel and winter forage. When white immigrants and settlers entered the Great Plains in large numbers, the human impact doubled as they drew heavily on the scarce timber resource and their livestock consumed

[5] Candace Savage, *Prairie: A Natural History* (Vancouver: Greystone Books, 2004).

and trampled the grass. The pressures of white society on the plains became permanent in the second half of the nineteenth century as transit shifted to settlement.[6]

While the earliest reports by Long and Pike disparaged the area, later accounts of the Plains generated great interest in the West and intentionally encouraged American expansionism. Reports from the expeditions of John C. Fremont did much to popularize and romanticize the westward routes. Fremont led five expeditions across the Great Plains between 1842 and 1853. Mapping and describing the West, climbing mountain tops to plant the American flag, and joining in the Bear Flag Revolt that took California from Mexico, he fired easterners' imaginations as "The Great Pathfinder." Fremont's wife, Jesse, refashioned his dictation and expedition notes into stirring prose for the general public. Generating popular interest in the west fit in nicely with the expansionist ideology promoted by her father, Senator Thomas Hart Benton. Benton was one of the most enthusiastic champions of the nineteenth century effort to encompass the entire North American continent within the cultural and political system of the United States, an idea known as Manifest Destiny. The underlying assumption of this ideology was not only that Americans had a divinely appointed responsibility to settle the continent, but also that the area subsumed by the United States would be transformed into productive landscapes. As Americans worked the newly settled land, the thinking went, the land would provide economic freedom and ensure political democracy.[7]

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[6] West, *The Way to the West*, 22. Elliot West believes that the resource consumption of native horse culture on the Great Plains was ultimately unsustainable. But the double impact of Native use of river bottom resources in the winter and white immigrant use in the summer very quickly depleted the timber and grass. See Elliot West, *The Contested Plains: Indians, Goldseekers, and the Rush to Colorado* (Lawrence: University Press of Kansas, 1998).

[7] Fremont was a highly ambitious, self-promoting and historically controversial adventurer in the American west. Though more cautious, he was in much the same vein as George A. Custer. There are many

Invoked as a national philosophy, Manifest Destiny embodied religious, racial, political, and commercial rationale for the expansion of the new American nation and the actions of its individual citizens. The idea of Manifest Destiny assured settlers and politicians that not only were they justified in their westward expansion—they were duty bound to it. Part nationalist enterprise and part divine mission, this ideology called Americans to embrace their supposed exceptionalism, to replace Indian and Mexican societies and people with their own, and to re-engineer the landscape. The raw potential of the land, through hard work and technology, would be made into a productive new social world. Americans saw themselves as giving a greater purpose to the wilderness. In the fulfillment of this social order, then, they were bound to reshape the environment to fit their goals and their values and even their aesthetic.[8]

The first significant movement to settle the central Great Plains by white settlers, besides the handful already inhabiting army forts and trading posts, followed the organization of two new territories under the 1854 Kansas–Nebraska Act. The impetus for this act lay in the desire to build a transcontinental railroad that would bind the country together, rather than any established local population seeking political status. Almost immediately, however, thousands of settlers poured into Kansas. In a sectional political compromise the legal status of Kansas as a slave or free state was left up to the settlers themselves. So in this new territory the volatile national issue of slavery's place in westward expansion played out in the local violence of "Bleeding Kansas."

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biographies of Fremont, see especially Allan Nevins, *Fremont: Pathmarker of the West* (Lincoln: University of Nebraska Press, 1992); Ferol Egan, *Fremont: Explorer for a Restless Nation* (Las Vegas: University of Nevada Press, 1985).

[8] On the ideology of Manifest Destiny and its socio-political influences see Anders Stephanson, *Manifest Destiny: American Expansion and the Empire of Right* (New York: Hill and Wang, 1996).

Southerners moved in, seeking to extend slavery into the west; but northern abolitionists came too, hoping to confine slavery to the South where it might eventually wither away. As both ideological populations grew, fighting superseded voting. In order to attract Free Soil supporters, organizations like the Emigrant Aid Company and the American Reform Tract and Book Society began to remodel the public image of the Great Plains, from a great desert to a prospective garden. Once there was a need to fill this land with people it had to be understood differently and presented to the American public in a new light.[9]

Travel guides and books now described the plains as fertile, beautiful, and full of advantages, promising that the region needed only the hard work of good people to create a civilization surpassing any other. "With a soil more fertile than human agriculture has yet tilled; with a climate balmy and healthful, such as no other land in other zones can claim," the 1856 *The Garden of the World; or, the Great West* concluded, "it does indeed present to the nations a land where the wildest dreamer on the future of our race may one day see actualized a destiny far outreaching in splendor his most gorgeous visions." In a sudden transformation from barren to bountiful, and with the promise of easy pickings in the far western gold fields rapidly fading into the reality of wage labor mining, the plains soon became the new frontier. They offered the new hope of individual freedom and opportunity. This fortuitous confluence of ideology and place would ensure the nation's future greatness. In the sweep of the prairie "over many fair and fenceless fields, greening in the rain and radiant sunshine," supporters of westward movement as a divine and patriotic project could see their faith embodied in the landscape. "In such scenes the

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[9] For a detailed account of the ideological, economic, and political forces behind "Bleeding Kansas" see Gunja SenGupta, *For God and Mammon: Evangelicals and Entrepreneurs, Masters and Slaves in Territorial Kansas, 1854-1860* (Athens: University of Georgia Press, 1996).

big heart of the American finds scope; he lets loose the spread eagles of the Fourth of July, and arrives at the absolute conviction that ours is a great country." Because of the new imagining of this place, American society became empowered, rather than confined, by the Great Plains.[10]

Settling the Land—Railroad Promotions of People and Trees

With the encouragement of political interests hoping to shape the ideological landscape of the new western territories, Americans flowed steadily onto the Great Plains. Kansas became a free state in 1861 with a population over one hundred thousand. Nebraska settled up more slowly, with some sectional controversy but little fighting. Its population in 1860 was less than thirty thousand. Nebraska finally achieved statehood, with Congress overriding a veto by President Andrew Johnson, in 1867. Once settlement started, hopeful people came in earnest. In 1874 the population of Kansas reached five hundred thousand and topped one and a half million by 1887. Nebraska trailed, but still numbered over a million citizens in 1890.[11]

Government programs such as preemption law, land auctions, veterans land bounties, and the Homestead Act helped farmers take up land in the plains. Under preemption, a settler could move onto unoccupied land and then purchase 160 acres for $1.25 an acre once it was surveyed. Passed in May 1862, at the outset of the Civil War with southern dissenters out of Congress, the Homestead Act was meant to fill up the

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[10] An Old Settler [C. W. Dana], *The Garden of the World; or, the Great West* (Boston: Wentworth & Co, 1856), 2,183.

[11] David M. Emmons, *Garden in the Grasslands: Boomer Literature of the Central Great Plains* (Lincoln: University of Nebraska Press, 1971), 32.

American West with small family owned farms worked with free labor. In the interest of Manifest Destiny and the idealized tradition of the yeoman farmer, this land grant program offered any American citizen, who was over twenty-one years old, 160 acres free if they worked it for five years and added certain improvements to the property. The promise of a homestead lured many Americans westward onto the plains, though relatively few succeeded in "proving up" and gaining free land.[12]

The Pacific Railroad Act, signed just over a month after the Homestead Act, was vastly more effective in transferring federal land into private ownership. To subsidize the construction of a transcontinental rail line, the government granted twenty square miles of land, in alternating sections adjoining the tracks, for every mile of track the railroad company built. The railroads became the real engines of Manifest Destiny—carrying settlers westward, connecting centers of commerce and sites of production and consumption, and selling land to the fortunate. To sell their land to a still skeptical public, railroad companies hired enthusiastic, and sometimes unscrupulous, promoters to praise the plains environment. Free excursion trains took newspaper editors on tours of railroad land developments with the expectation of favorable reports back home. The addition of a strong financial incentive and corporate organization to the ideological motivation of American expansionism made the settlement of the plains much more likely. Commercial advertising sold a new image of the Great Plains to American society. The one time Great American Desert had become "one of the most fertile and

[12] Less than half of filers 270 million acres was claimed by some 1.5 million homesteaders under the 1862 Homestead Act. About 60 percent of those who took out a claim failed to prove up. See National Park Service Homestead Monument, last modified 02/26/2013, http://www.nps.gov/home/historyculture/abouthomesteadactlaw.htm.

beautiful regions in America," according to an 1878 Union Pacific promotion, a place where the "smooth prairies are fast being transformed into happy homes and cultivated farms."[13] Once the perception of the place changed and the people arrived, work could begin on reconstructing the physical environment, making the dream a reality.

The railroads were careful to warn would-be settlers that building a home in the west was hard work but assured them that the steel roads would provide access to production materials and machinery as well as markets for their crops. Railroad literature also offered plenty of advice, especially on the need to plant trees. The Union Pacific told newcomers to Nebraska, "it should be the first care of the settler in this State to set apart a portion of his farm for the growing of trees." All the timber requirements of a farm, they advised, could be met by ten acres of cottonwood, hackberry, and black walnut. There were several options for fencing—sod, barbed-wire, or boards—but the best, according to the Union Pacific, was a planted hedge of Osage-orange. Fast growing and easy to plant, these hedges would "form a good wind break, furnish shade and shelter for stock, and give a picturesque appearance to the farm."[14]

Besides being land dealers, railroad companies had a vested interest in the success and permanence of communities as freight and travel customers. They realized that engineering the environment with trees would contribute to the stability of the new plains society. The Kansas Pacific Railroad published *Forest Tree Culture on Kansas Prairies* in 1879 to convince settlers "that a judicious and systematic propagation of forest trees in

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[13] Union Pacific Railroad Company, *Guide to the Union Pacific Railroad Lands: 12,000,000 acres: 3,000,000 acres in central and eastern Nebraska now for sale* (N.P.: Land Dept., Union Pacific Railroad Company, 1878), 2.
[14] Union Pacific Railroad Company, *Guide to the Union Pacific Railroad Lands*, 15-16.

Kansas, will result in an ameliorated climate, a more copious and regular rain-fall, a more equable temperature, greater beauty of landscape, and a chain of other substantial and permanent benefits to the farming community." This free, thirty page booklet argued for the creation of forests on the plains. Trees, it stated, "are the agents of protection against the howling storms of winter and the exhausting heat of summer. Each dweller on an open plain knows their value, and keenly feels the effects of their absence." Forests were an inextricable part of civilized society. According to the company, "no member of the community is so devoid of ordinary intelligence as not to feel the necessity of trees in contact with the abode of man. Where nature has omitted them, man must meet the defect by artificial means, and plant the trees he needs." To encourage this artificial production of forests, the Kansas Pacific offered the services of their forest culture agent, Maximilian G. Kern, and free copies of price lists and catalogues from leading wholesale nurseries. Further information on tree culture was available by correspondence. The company promised: "Especial efforts will be made to bring within the convenient reach of every farmer along the line of the Kansas Pacific Railway a cheap supply of seedling trees, most suitable to general cultivation in Central Kansas."[15]

Railroads not only promoted tree planting, they followed their own advice, planting thousands of acres. Huge consumers of timber, railroads needed wood for fuel, fencing, bridges, and most importantly cross ties on which to lay steel rails. In an 1884 government report on forestry, Franklin Hough estimated the total extent of railroad track in the United States at 112,000 miles. This track required an average of 2,640 ties per

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[15] Maximilian G. Kern, *Forest Tree Culture on Kansas Prairies* (Kansas City: Kansas Pacific Railway, 1879), 3, 32. Maximilian Kern was a landscape architect who designed the 1,300 acre Forest Park and Lafayette Park, both in St. Louis, Missouri.

mile. Furthermore, these ties had to be replaced at least every seven years as they decayed. Most often thought of as metal technologies—the iron horse and steel road—railroads, in fact, could not function without wood.[16]

Forest historian Michael Williams gives a startling example of overall wood use by railroad companies with one example just from the state of Ohio in 1870: 10,000 miles of wooden fencing; 10 million railroad ties; 16 miles worth of wooden bridges; 10 miles of trestles; 700,000 cords of wood fuel for locomotives. East of the Missouri, railroad companies could easily obtain lumber from local forests. Though even there some, like the Burlington and Missouri River Railroad and the St. Paul and Pacific, planted trees along their lines as windbreaks and snow fences. On the plains all wood products had to be imported, at increasing cost as the eastern forests diminished. Some companies started tree plantations on the plains to grow timber for the future. The Kansas City, Fort Scott, and Gulf Railway planted catalpa trees on more than 600 acres. These railroad plantations, however, were few and far between and were never carried out on a scale to meet demand. Williams points out that the aggregate of about 15,000 acres of trees they grew at about 48 sites would have provided, under optimal conditions, ten day's worth of ties at the 1910 rate of consumption. Despite their economic interest, railroads never became effective agents of aforestation. Nevertheless, they were still one of the greatest forces shaping the new plains landscape.[17]

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[16] F. B. Hough, "Report on Kinds and Quantity of Timber Used for Rail-Road Ties," *Report on Forestry Volume IV 1884* Nathaniel Eggleston ed. (Washington D.C.: GPO, 1884), 172. Hough's report on tie use was based on questionnaires returned by some 238 different railroad corporations.

[17] Michael Williams, *Americans and Their Forests: A Historical Geography* (Cambridge: Cambridge University Press, 1989), 346, 351.

Cities on the plains typically developed around the railroad lines, and by the late 1880s many had grown from frontier outposts into substantial centers of commerce and government. The Union Stock Yard opened in Omaha, Nebraska in 1884, making the city second only to Chicago in beef processing. Omaha even hosted a world's fair: the Trans-Mississippi Exposition of 1898. However, after the transition from territory to statehood the state capital was moved from Omaha to the new city of Lincoln. With the opening of a new capitol building in 1868 and the founding of the University of Nebraska the following year, Lincoln became the intellectual center of Nebraska and the central plains region. University of Nebraska botany professor Charles Bessey would become one of the strongest tree planting advocates outside of the federal forestry agency, lobbying for the construction of forests on the Great Plains as an environmental restoration effort. The university also established a department of forestry in the College of Agriculture in 1903, granting degrees in forestry and participating in the sand hill's tree planting that would build the Nebraska National Forest.

Cultural Construction—Planting Trees to Shape the Land

As Americans moved westward in greater numbers in the late nineteenth century they brought many technologies to help them transform the plains and prairies into a settled, productive landscape reflective of their culture. Like all technologies, theirs were integrations of human artifice and natural products or processes. Windmills harnessed energy out of the air in order to bring precious water up from deep wells. Wagons, plows, combine harvesters, and other large equipment were crucial for farming on the

Great Plains; all of these relied on the power of draft animals, without which no American farmer could succeed. Special breaking plows had to be developed to cut through the thick mat of roots that made up the prairie sod. Much less of an inconvenience to aspiring farmers than the thick forests in the east, this dense mass of roots could also become the building material for a first home. Sod houses, made from bricks of sod cut from the ground near the home site, were simply the product of centuries of sun, soil, and grass reshaped by human labor. Bricks of sod three feet wide were stacked up into walls and a roof, rearranging the natural environment into a technological shelter to protect a prairie family from the environment.

As a living technology, one of the most intriguing new combinations of nature and culture in this expanse of open grassland was the trees settlers planted. They planted trees for the physical and psychological reasons that still motivate people today: for the products of lumber, fence posts, firewood, and fruit; for more comfortable views that broke up the endless openness of the prairie landscape; and to ameliorate the climate by blocking the relentless winds and attracting moisture. These trees were an important technology that they used to make their farms more productive and more habitable.

Although the earliest plains travelers and the first settlers found adequate timber along the banks of rivers and creeks, this source of wood was soon exhausted. Alternatives like buffalo chips, barbed wire, and sod had to be found for fuel, fencing, and building materials. Also, being accustomed to eastern woodlands and more densely settled areas, the experience of the boundless, treeless space made many plains immigrants uncomfortable. Writing to her parents, in 1858, from her new home in

Kansas, Harriett Carr wistfully remembered the eastern landscape and society. “No spot on this Earth,” she told them, “seems so sweet and home like as your hills with their white villages clustered in their sheltered nooks. . . . The prairie is vast, magnificent and grand—but we miss the dear old trees, the gardens, the flowers and birds those pleasing and home like scenes which make the heart soft and happy.” Although she found the plains beautiful, it was not yet a proper home. For Carr, trees were an essential part of her old home. “Oh how I long for such a home,” she wrote, “for a little cot with the grand elms waving over it and the birds singing their joyous anthems amid the branches.”[18]

The weather was one of the most immediate physical experiences settlers struggled with in building a new home on the plains. Hot and dry in the summer and blizzards in the winter, the wind remained a constant and the empty rolling land offered no resistance to it. Instead, the wind shaped the landscape. Travelling westward through the Platte River Valley in 1866, Edward Nicholson described the land and the wind in his journal. On June 6th: “Traveled through a portion of the ‘Great American Desert’ and found the sand very deep.” As the wind blew, the “sand in some places formed like riffled snow drifts.” The wind blew from the west in the morning, shifted to the south and blew “very hard” in the afternoon, then in the evening it “raised to a small hurricane.” In an 1880 letter from Nebraska to her father, another settler, Eugenie Hathaway, wrote: “You may think you have blows [back] East, but I can tell you, you can’t hold a candle to the west. It is blowing hard today but nothing to what it did

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[18] Harriett Carr, quoted in Steven R. Kensella, *900 Miles from Nowhere: Voices from the Homestead Fronier* (St. Paul: Minnesota Historical Society, 2006), 90.

Saturday. . . . I don't know at what rate the wind blew but I'm pretty sure greased lightning could not begin to keep up. The dust was so thick that we couldn't see anything. You could hardly stand on your feet out doors."[19]

The lonely openness and turbulent climate made both trees a psychological and practical necessity for settlers. Many carried precious bundles of seedlings with them from their familiar wooded eastern landscape. One government inspector pointed out something new prairie farmers quickly understood from experience: "In no other part of the United States, perhaps, is the need for forest planting greater than on the northern prairies. Protection from wind and storm, and a sufficient supply of posts, poles, repair material, and fuel, are essential for the wellbeing of those who make the prairies their home."[20] At first individual farmers struggled to raise their own wild seeds or used seedlings from eastern nurseries. The federal government later offered technical assistance through agricultural bulletins and forestry advisors as well as political encouragement in land grant laws based on tree planting. Few private plantations succeeded, but new landowners were eager for help in reengineering the plains environment.

Authors writing about their lives on the plains remembered their desire for trees. Laura Ingalls Wilder, in describing her family's experience in Dakota Territory, likely expressed the hopes of all those trying to build new lives in the grasslands. "I wanted to see trees," her sister Carrie complained. "I don't blame her," said her mother. "I would

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[19] Edward Nicholson Journal, quoted in Kensella, *900 Miles from Nowhere*, 27; Sim Family Papers, quoted in Kensella, *900 Miles from Nowhere*, 128.
[20] James M. Fetherolf, "Forest Planting on the Northern Prairies," USDA, Forest Service, *Circular 145* (Washington D.C.: GPO, 1908), 5.

like to see some trees again myself. They would rest my eyes from all this prairie with not a tree. Not even a bush to be seen in any direction." Their father reassured them that soon there would be trees everywhere.

> "I'll be looking in all directions at once then," Ma smiled. "There's nothing more restful than shady groves in the summertime, and they'll break the wind too." "Don't worry," said Pa, "you're going to see plenty of trees all over this country. Likely they'll stop the wind and change the climate, too, just as you say."

The next day Laura's father brought home a wagonload of cottonwood seedlings he had dug from around the "Lone Tree" near Lake Henry. They planted them in a windbreak around their homesteader's shanty, carefully giving each one a precious pail full of water.[21]

Aridity was the most critical aspect of the plains climate for farmers. Once American agriculture pushed beyond the 98th meridian, access to reliable water sources became increasingly restricted. A plains farmer's most critical resource was rain. Being in the business of land sales, in addition to transportation, railroad companies were extremely concerned with the western climate, or at least its perception back east. Americans moved west in the hope of a better life; they wanted land that offered opportunity. Boosters, land companies, and railroads all encouraged the optimism that fed Americans' faith in their manifest destiny. The Kansas Pacific Railroad hired Richard Smith Elliott to raise trees and crops in western Kansas, to show potential settlers that the plains was not a desert and rains would come. Elliott had written a pamphlet, *Climate of the Plains*, in 1870 advocating plains agriculture. As the railroad's scientific expert he planted wheat, rye, barley, as well as oak, maple, elm, and other trees in three

[21] Laura Ingalls Wilder, *By the Shores of Silver Lake* (New York: Harper & Row, 1953), 270, 273-74.

agricultural experiment stations from 1870-1874. He also hosted tours for members of the press, who unfortunately usually remained unimpressed. Even as a promotional rather than a productive endeavor, these farms were not very successful. One newspaper man described Elliott as a "crack brained enthusiast" and his crops as "stunted and unpromising." The Santa Fe Railroad, over the next few years, was somewhat more successful at growing trees in the Kansas sand hills. By 1879 they had over ten thousand trees growing in various plots along their line, including cottonwoods, ash, maples, and black walnut. Their crowning achievement was the 1,000 twenty-two foot cottonwoods near Great Bend and the 2,000 twelve foot tall box elders just east of Dodge City.[22]

Despite his own lack of success, Elliott never lost faith in the power of trees to change the climate. Writing in 1873, he announced that his trials had proved that "grain and forage crops, forest trees and hedges may be grown on the Plains to the west line of Kansas, and probably to a considerable distance beyond, depending only on the rainfall." He believed the dryness of the plains climate had been over-estimated and rainfall could only increase. Where, in other lands, deforestation had caused desertification, here, with aforestation, the opposite process would occur. "The extension of settlements, . . . farm crops, and the growth of forest trees . . . are all agencies in amelioration of climate," he claimed. And even more enthusiastically: "All the acts of man must tend to improved conditions." Elliott cast settlers as the constructors of their own environments and urged them on; Americans should engineer the conditions they desired. "The individual will

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[22] James L. Forsythe, "Environmental Considerations in the Settlement of Ellis County, Kansas," *Agriculture in the Great Plains, 1876-1939*, ed. Thomas R. Wessel (Washington: The Agricultural History Society, 1977), 39-40; Craig Miner, *West of Wichita: Settling the High Plains of Kansas, 1865-1890* (Lawrence: University of Kansas Press, 1986), 42-43, 46.

not propose to wait for these changes," he pronounced, "but the multitude will move forward and produce them."[23]

In the most famous of all the rainmaking enterprises, Nebraskans Samuel Aughey, a University of Nebraska professor, and Charles Dana Wilber formulated the "Rain follows the Plow" hypothesis. According to their fanciful theory, both cultivation and closely planted groups of trees attracted rainfall. Reflecting the popular dogma of environmental engineering, many nineteenth century boosters and tree planting prophets widely advertised the pseudo-scientific idea that development increased rainfall to encourage settlement in the arid west. This resulted in many failed homesteads and (in counterpoint to the widespread faith in modernist control) a growing suspicion of grand scientific claims. Even after the idea was abandoned in the early twentieth century, a belief in some relationship between trees and moisture—whether in the atmosphere or the soil—persisted.[24]

The gospel of tree planting had many followers—settlers, scientists, boosters and businessmen, bureaucrats and politicians. In 1864, as part of the "Report of the Commissioner of the General Land Office" on the geology of Nebraska, Ferdinand Hayden wrote that, "the planting of ten or fifteen acres of forest-trees on each quarter-section will have the most important effect on the climate, equalizing and increasing the moisture and adding greatly to the fertility of the soil."[25] The Commissioner of the

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[23] R. S. Elliott, "The Plains," *Report of the State Board of Agriculture, 1873* (Topeka: State Printing Works, 1874), 256, 258.
[24] See Henry Nash Smith, "Rain Follows the Plow: The Notion of Increased Rainfall for the Great Plains, 1844-1880; and Emmons, *Garden in the Grasslands*, 138.
[25] Ferdinand V. Hayden, "The Geology of Nebraska," *Report of the Commissioner of the General Land Office*, 1867 159-60, quoted in Williams, *Americans and Their Forests*, 382.

General Land Office, Joseph S. Wilson, petitioned Congress in 1866 for forest planting on the Great Plains. "If one-third of the surface of the Great Plains were covered in forest," he wrote, "there is every reason to believe the climate would be greatly improved, the value of the whole area as a grazing country wonderfully enhanced, [and] the greater portion of the soil would be susceptible of a high degree of cultivation."[26] All of these early forest promoters specifically advocated planting trees as a way to engineer the environment for the benefit of local people and the country as a whole.

State government also strongly encouraged tree-planting programs on the plains. The Nebraska legislature passed a series of aforestation tax incentives beginning in 1861. One 1869 law gave a $100 tax exemption for five years for one or more acres of planted trees and in the 1870s counties were required to pay a $3.33 bounty for every three acres of windbreak a landowner planted. Former territorial governor, founding member of the Nebraska State Horticultural Society, and future Secretary of Agriculture, Julius Sterling Morton established Arbor Day in 1872 and on April 10 that year nearly one million trees were planted in the state.[27] In 1875 the Governor of Nebraska set aside the third Wednesday in April as an official tree planting day. April 22 became the legal holiday Arbor Day in 1885, honoring Morton's birthday. The state legislature recognized this tradition and the general enthusiasm for trees in 1895 by designating Nebraska the "Tree-Planter's State."

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[26] John H. Hatton, "A Review of Early Tree-Planting Activities in the Plains Region," in *Possibilities of Shelterbelt Planting in the Plains Region* (Washington D.C.: GPO, 1935), 51.
[27] Wilmon H. Droze, *Trees, Prairies, and People: A History of Tree Planting in the Plains States* (Denton, Texas: Texas Woman's University, 1977), 11-12.

A big event in Nebraska, Arbor Day was celebrated with planting competitions throughout the state and special programs at schools. Children planted trees, of course, but they also studied nature projects, sang patriotic songs, and recited Bible verses and poetry. One of the multitudes of selections suggested by the State Superintendent of Public Instruction for students to perform, a poem by R. H. Stoddard, reflects the general tone. "Summer or winter, day or night / The woods are ever a new delight; / They give us peace, and they make us strong, / Such wonderful balms to them belong." Then the last line recalled the wistful longing of the first plains settlers, "So, living or dying, I'll take mine ease / Under the trees, under the trees."[28] Arbor Day, though, was just one of the tree planting programs the state strongly promoted. Each year a semi-official "tree planting campaign" was organized with plantings planned throughout the state for schools, churches, hospitals, cemeteries, parks, and public institutions. This campaign continued well into the twentieth century and these trees represented a core social value. The Governor, Adam McMullen, instructed Nebraskans in 1928: "We should plant more trees in Nebraska for all the beneficial purposes. Trees add beauty, shelter, and an economic resource. They have an important place in the development and conservation of our civilization."[29]

Building a civilization and stretching it across the entire continent was nineteenth century America's national dream. Tree planting became one of the many facets of this great effort. In 1873, the year after Morton's first Arbor Day, another Nebraskan, U.S.

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[28] James E. Delzell, *Twenty-third Biennial Report of the State Superintendent of Public Instruction to the Governor of the State of Nebraska* (Lincoln: The Woodruff Press, 1914), 610.
[29] Conservation and Survey Division the University of Nebraska, *Tree Planting in Nebraska* (Lincoln, 1928), 3.

Senator Phineas Hitchcock, authored the Timber Culture Act. This federal act granted homesteaders 160 acres for planting a portion (first forty but later reduced to ten acres) in trees. The hope was "to encourage the growth of timber, not merely for the benefit of the soil, not merely for the value of the timber itself, but for its influence upon the climate."[30] The following year, in a bill offering minor adjustments to the Timber Culture Act, the Committee on the Public Lands praised the intent of the original law:

> No act of the last Congress was more generally welcomed in those sections of the country which it was intended especially to benefit than the act to encourage the growth of timber. . . . Public attention has been called to the subject of forest-culture, the influence of forests in mitigating the severity of the winter-season upon the prairies, in augmenting the quantity of rain, and in its general climatic and useful character.[31]

These trees were described by a Congressional Committee as a climate control technology facilitating the settlement of the plains. They also served as a governmental tool in managing one of the country's most important social enterprises during the nineteenth century—fulfilling manifest destiny. Offering free land in exchange for the planting of trees would draw people westward and set them to engineering the environment, recreating eastern society, and enriching the nation. The Timber Culture Act embodied the spirit and the goal of Manifest Destiny and reflected the belief in a special relationship between the United States and the nature that nurtured it. Fulfilling their divine mission, Americans would fill up the western lands and create a new landscape—a new nature and a new society—befitting a great nation. Hundreds of

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[30] U.S. Congress, *Congressional Globe*, 42nd Cong., 2nd sess., 10 June 1872, pt. 5, 4464.
[31] "Growth of Timber on Western Prairies," (February 5, 1874), Report No. 66, House of Represenatives, 43rd Congress, 1st Session.

thousands of people sought to expand the nation westward and gain a piece of it for themselves under this law, planting one tree at a time on their individual land claim.

In August 1885 Laura Ingalls married Almanzo Wilder and they moved into a house on his 160 acre tree claim in Dakota Territory. He had planted well over three thousand cottonwoods, elms, and maples and Laura thought "it would not be long before they sheltered and protected the little house from the summer's heat and the winter's cold and the winds that were always blowing!"[32] The couple realized they were part of a national movement of people and ideology. "These government experts have got it all planned," Almanzo told Laura, "They are going to cover these prairies with trees, all the way from Canada to Indian Territory. . . . If half these trees live, they'll seed the whole land and turn it into forest land, like the woods back East."[33] Like many people who came to make a new home on the plains, they were hoping to recreate a familiar world and planting trees was an essential part of the process.

Throughout the 1880s, the Kansas State Horticultural Society sent questionnaires out to all the counties in the state regarding tree planting activities for the year. Mirroring the optimism expressed by Laura and Almanzo Wilder, the overwhelming majority of the reports returned were positive. The state society asked about "the condition of artificial-planted forests" in each county, the varieties of trees planted and methods used, problems encountered with insects, climate, and soil types, and practical advice based on planting experience. The final question asked whether "the Western prairies can be made to produce forest trees sufficient to meet the wants and needs of settlers thereon?" Almost

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[32] Laura Ingalls Wilder, *The First Four Years* (New York: Harper & Row, 1971), 6, 15.
[33] Laura Ingalls Wilder, *These Happy Golden Years* (New York: Harper & Row, 1971), 171.

all the respondents said yes. Typically, they "most heartily believe[d]" and were "fully convinced" of future success in creating forests and wood products. Many wrote that, with proper planting the prairies would be "reclaimed" by forest trees; it was only a matter of time and effort. From Ness County, George Johnson wrote: "I certainly do believe that the Western prairies can and will be reclaimed, and will be made to respond to the efforts of settlers thereon, in the growth of forest trees. What one man can do, and has done, can be done by the many."[34]

Although each settler planted their own trees, their effort was ultimately seen as a collective one that benefited the whole society by making the land more habitable and filling up the empty plains with productive American citizens. Responding to the 1885 questionnaire, H. A. Stilles of Wabaunsee County, Kansas articulated the role of tree planting in reshaping the Plains and achieving the nation's manifest destiny.

> I have no doubt but that all our Western prairies may be made to produce all the necessary wood for fuel, fencing, and other purposes where needed on a farm; and as the tree-planter approaches, the desert line will rapidly recede, drouths will disappear, and fruitful fields and willing springs abound where now dearth and barrenness prevail. This is the work of the sturdy pioneer, through whose indomitable will and powerful arm the treeless plains will yet be reclaimed, and furnish happy homes to millions of our people.[35]

There was no small irony in the work of these sturdy pioneers planting forests. For the last century American pioneers had been steadily chopping down forests in their effort to fulfill their destiny. The new tale being told of nation's future was still a parable of

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[34] Kansas State Horticultural Society, *Sixth Annual Report on Kansas Forestry for 1885* (Topeka: Kansas Publishing House, 1886), 51, 89.
[35] Kansas State Horticultural Society, *Sixth Annual Report on Kansas Forestry for 1885*, 95.

American exceptionalism, but now the hero was planting trees instead of swinging an axe.

Federal Forestry—The Need for Experts and Planning

Finally, as they filled up the continent, towards the end of the nineteenth century, Americans were beginning to worry about the dangers of rapid natural resource destruction, particularly deforestation. Already, in 1864, George Perkins Marsh had warned of the dire consequences of deforestation. This concern did not question the utilitarian use of forests for timber, but rather the wasteful logging practices of the 19th century and the environmental consequences of deforestation, namely soil erosion, desertification, and destructions of watersheds that supplied large cities. Even in an era with a distaste for federal expenditure and the expansion of government bureaucracy, the need to address these concerns while still facilitating natural resource development, especially commercial logging, led to the establishment of a federal forestry agency that embodied an ideology of conservation.

In 1873 the members of the American Association for the Advancement of Science petitioned Congress to involve the federal government in the cultivation of timber and the preservation forests. Two years later, in 1875, the American Forestry Association formed with a meeting in Chicago that considered reforestation among other issues. Congress reluctantly became involved in national forest policy in 1876 by funding a forest survey, carried out and reported by Franklin B. Hough. He submitted a 650 page “Report on Forestry” in 1878 that included a large section on “Practical

Suggestions upon Tree-Planting." From this humble beginning a Division of Forestry was finally established in the Department of Agriculture in 1881. While the federal managing agency for forests was in Agriculture, the forests themselves, when designated by the President resided within the Department of the Interior. Although it would be some time before the foresters and their forests were united, the impetus for forest conservation and even the creation of new forests was begun.

After becoming Chief in 1898, Gifford Pinchot orchestrated the elevation of the Division to Bureau status as the US Forest Service and had the administration of federal forest reserve lands transferred from the Department of the Interior to his control in Agriculture in 1905. Out of a personal vision and his wealthy family's connections, Pinchot crafted a government program for the scientific management of forest resources. Through his influence, U.S. forestry science became a unique combination of government agency, university education (his family endowed the Yale School of Forestry), and private industry. Pinchot believed that expert training and government management would result in scientific forestry that produced a profitable, sustainable business and improved the environment. The Forest Service adopted this belief as its institutional ideology and sought ways to expand the nation's forests.[36]

A succession of federal forestry chiefs promoted tree planting as a way to build forests and even went so far as to cast it as a type of restoration and engineering project.

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[36] For the history of the founding and development of the agency, see Steen, *The U.S. Forest Service: A History*. For an autobiography of Pinchot, see Char Miller, *Gifford Pinchot and the Making of Modern Environmentalism* (Washington D.C.: Island Press, 2001). On Pinchot's melding of government administration with science and business, see Brian Balogh, "Scientific Forestry and the Roots of the Modern American State: Gifford Pinchot's Path to Progressive Reform," *Environmental History*, 7 no. 2 (April 2002), 198-225.

Forest historian Michael Williams reports that the first chief, Franklin B. Hough, "was convinced that the Plains had once been forested. Therefore [Hough] felt justified in fully subscribing to the idea that to reforest the Plains would restore them and make them fertile for agriculture." His successor, Nathaniel H. Egleston, doubted that forests could actually cause rain but nevertheless "concluded that one-fourth of the Plains should be planted to trees."[37] The third chief, Bernhard E. Fernow, was even more emphatic. "The fact that this area is not absolutely treeless," he reasoned, "goes far to support the proposition that it was not always forestless." Furthermore, he realized that the existing landscape of the prairies was both culturally and ecologically constructed, telling the Nebraska State Board of Agriculture that it was only the "fire of man" and the "tramp and browsing of the buffalos" that prevented the growth of forests. If humans conspired with nature to create the prairies and plains then they could also cooperate to build forests.[38]

What had been a desire to protect and beautify homesteads by planting a few trees into windbreaks and woodlots was becoming a grand vision of environmental engineering with constructed forests. And Fernow wanted ecologically sound forests. Healthy human-made forests, he believed, must mirror natural forests. "To establish forest conditions," he said, "must be the first aim of the planter. Forest conditions, as we find them in the natural forest, consist in the dense growth, mixed growth, undergrowth.

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[37] Williams, *Americans and Their Forests*, 385.

[38] Bernhard Fernow, "Forest Planting on the Plains," *Annual Report of the Nebraska State Board of Agriculture* (1891), 140. For a biography of Fernow see Andrew Denny Rodgers III, *Bernhard Eduard Fernow: A Story of North American Forestry* (Durham NC: Forest History Society, 1991).

By so much as any one of these conditions is deficient or lacking, by so much is the forest short of the ideal."[39]

Even so, human desires and human abilities remained paramount. Fernow saw no paradox in this combination of idealized natural conditions and human intervention. These constructed forests were meant to combine ecological functions with technical control to serve a social purpose. "The forest planter," Fernow reminded his audience, "may learn a lesson from Nature in recognizing these [forest] conditions as desirable ones and worthy of imitation; but we will also not forget that man is wiser than Nature; that he works with an object; that he must intelligently improve on Nature's methods to reach his end, which is the economical production of material or conditions."[40]

Creating these ideal conditions, however, was not easy. Self-proclaimed wise men could not simply ignore a fundamental ecological reality: it was very hard to grow trees on the Great Plains. The Timber Culture Act failed to achieve the foresting of the plains. It would eventually be repealed and remembered principally as an easy method for fraudulently procuring land. Leaving the task to individual initiative also proved impractical. Reforestation of the prairies, announced Fernow, "certainly does not appear to me an impossible undertaking," however, he felt it was "almost hopeless to expect it from the pigmy efforts of the pioneer settler, lost in this endless treelessness." Large-scale management of the environment for the construction of forest ecosystems required a marshaling of resources. This meant centralized control over production, including labor, location, process, and decision-making. Fernow envisioned it as a scientific project that

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[39] Fernow, "Forest Planting on the Plains," 140.
[40] Fernow, "Forest Planting on the Plains," 142.

would succeed through authoritarian efficiency and the application of expert knowledge, one that demanded the "commanding knowledge, means, and power" of the federal government.[41]

The similarity between this and other, larger enterprises described by the political scientist James C. Scott as high-modernist ideology is striking. Many of the Progressive Era reform efforts amounted to social engineering efforts reflecting a high-modernist motivation. In this case the social project also involved environmental engineering, the experts were scientific foresters, and the authority derived from the federal government. The impulse to reforest reflects the underlying motivation of high-modernists. "They began," Scott explains, "with a nearly limitless ambition to transform nature to suit man's purposes . . . . This belief that it was man's destiny to tame nature to suit his interests and preserve his safety is perhaps the keystone of high modernism."[42] High-modernist programs are typically standardized visions imposed from a distance. However, tree planting on the Plains was not simply top-down State intervention. Most farmers welcomed federal assistance. The contrast to high modernism in farm forestry and the construction of the Nebraska National Forest lies in the foresters' attention to the local nature of the projects. The features of the place directed their actions. As the Nebraska State Board of Agriculture's botanist reported: "In the East men cut away trees; here [we] must plant trees. In the East there were 'woodmen,' 'wood-choppers,' 'rail-splitters;' here we are to grow a race of 'tree-planters.'"[43] Local ecological forces and farmers'

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[41] Fernow, "Forest Planting on the Plains," 142.
[42] James C. Scott, *Seeing Like a State*, 94-95.
[43] Charles E. Bessey, "Report of the Botanist," *Annual Report of the Nebraska State Board of Agriculture* (1895), 228-29.

concerns shaped the development of the planted forests and scientific expert knowledge was tempered with practical working experience. Successful results required adapting methods and goals to local environmental conditions but everyone understood that foresting the plains would also take federal involvement.

Federal foresters might have viewed their work promoting tree planting on the plains as a scientific and moral mission, but they found their early efforts restricted to an advisory and experimental basis. So far as offering expert assistance to struggling plains farmers in the nineteenth century, all they could do was encourage private tree planting. Local environmental conditions created an opportunity for them to advise farmers on building forests. While the vast openness allowed immediate application of the plow, the plains environment was in many ways inhospitable to American settlers. The region was characterized by aridity and extremes of hot and cold temperatures. Perhaps an even more worrisome attribute was the incessant wind.

Planting Windbreaks—Using Trees as Technology

Through farm forestry on the plains the federal government recognized the settler's experience and proposed a solution. "Upon the prairies," wrote a government inspector, "the winds are almost as constant and regular as they are upon the sea." In the spring they carried welcome rains. But in the summer they blew hot, robbing moisture from the soil, while in winter cold winds often brought "the dreaded blizzard."[44] The winds bothered people, but they could kill crops and livestock. Bernhard Fernow, the chief of the Bureau of Forestry, described the plains experience: "To travel over them,

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[44] Fetherolf, "Forest Planting on the Northern Prairies," 7.

even for a day, will make you feel their greatest want—the want of trees. Wind swept every day, every hour, the comparative calm which even a single row of trees creates affords relief from the perpetual activity of the air."[45] Winds were a serious problem, Fernow suggested, and trees were the technological solution.

The plains conditions led federal foresters to offer their expertise to settlers whose lands were almost completely treeless. For protection from the wind, the Forest Service explained, "nothing serves the purpose better than a shelter of trees, and no other farm improvement will so well repay the money and time expended on it."[46] Fernow wanted the government to cooperate with prairie farmers in planting trees in shelterbelts as a public works project. On the plains, these windbreaks could be just as important as a well, a barn, or a house. Just as humans respond to the environment "by building a house around us, thus altering the temperature and moisture conditions of the atmosphere so inclosed [*sic*]," they could, Fernow asserted, "alter these conditions on a larger scale by such means as alternating forest areas and fields or by large bodies of forest."[47]

Successful tree planting could help stimulate the national goal of westward migration and offered the new government agency for scientific forestry a point of interaction with the American public. Establishing a special section within the Division of Forestry, supervised by an expert tree planter and assisted by "collaborators" throughout the country as experts on local conditions, federal foresters tried to help

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[45] Bernhard Fernow, "What is Forestry?" USDA, Forestry Division, *Bulletin 5* (Washington, D.C.: GPO, 1891), 31.
[46] Frank G. Miller, "Forest Planting in the North Platte and South Platte Valley," USDA, Forest Service, *Circular 109* (Washington, D.C.: GPO, 1907), 7.
[47] Bernhard Fernow, "Forest Influences," USDA, Forestry Division, *Bulletin 7* (Washington D.C.: GPO, 1893), 10.

landowners "attain the greatest usefulness and most permanent value" from their private tree plantations. Within the constraints of a very small budget, the forestry division attempted to "render practical and personal assistance to farmers and others by cooperating with them to establish forest plantations, woodlots, shelterbelts, and windbreaks." After an individual submitted an application for assistance, a forester would visit the property, study the ground, and then "make a working plan suited to its particular conditions."[48]

At this point federal foresters were still limited to offering technical advice and moral support. The Department of Agriculture published many bulletins and circulars promoting tree planting, describing the proper planting methods, and espousing the practical benefits of shelterbelts. In USDA Circular 22, "Practical Assistance to Tree Planters," issued in 1899, Gifford Pinchot argued that "as the farmers of the plains come to recognize more fully the great indirect as well as direct value of forest plantations, woodlots, shelterbelts, and windbreaks, scattered over the agricultural treeless regions, and undertake to grow them in greater numbers, even if individual plantations are small in extent, the total result will be of vast importance in the development of the West." Although the private citizens had to do the work, the Forestry Division stood ready through cooperative planning, "to aid farmers and other landowners in the treeless regions of the West, and wherever it is desirable to establish forest plantations."

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[48] Gifford Pinchot, "Practical Assistance to Tree Planters," *USDA Circular 22* (Washington D.C.: GPO, 1899).

Foresters would also collect and share information so everyone could learn from the successes and failures of others.[49]

In "Practical Tree Planting in Operation," the federal superintendent of tree planting, J. W. Toumey, described the success of one Kansas farmer's plantation. Joseph Lewis settled his land in 1880, laying out a 30 acre orchard and planting windbreaks around it. On the north side he planted a strip of cottonwood 320 feet wide. To the west he planted soft maple and black walnut, 240 feet wide. Cottonwood, red cedar, soft maple, Russian mulberry, and catalpa lined the southern side in a thinly planted 240 foot strip. The protection provided by these trees, Toumey claimed, helped make Lewis' farm "one of the most thrifty and profitable orchards in the State of Kansas." The cottonwoods grew the fastest, reaching 50 to 60 feet high in twenty years. The maple grew to 40 feet in this time and the walnut 25 to 35 feet. Although not all plantings could be as successful as this one, Toumey and the Forestry Division declared that, "not an acre of Western prairie land that has been transformed into forest should ever be allowed to revert." This was not simply a self-serving attitude but a genuine belief—by perhaps the most idealistic federal agency of the day—in the benefits of forest plantings.[50]

Landowners gained these benefits by reshaping, under the guidance of expert foresters, their surrounding environment into a technological landscape. Planted in rows according to vigorously researched scientific standards, these miniature farm forests were technological systems that could: provide windbreaks protecting homes, barns, crops, and livestock; lessen the evaporation of moisture; prevent soil erosion; eventually allow some

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[49] Pinchot, *Circular 22*.

[50] J.W. Toumey, "Practical Tree Planting in Operation," USDA, Division of Forestry, *Bulletin 27* (Washington, D.C.: GPO, 1900), 13-15.

harvesting of wood as fuel, fence posts, and building material; add aesthetic appeal to the landscape; and materially increase the value of the property. Foresters proposed specific designs for these planted technologies. They determined the appropriate species, spacing, and maintenance required once the system was established.

A wide variety of trees could be used, depending on local environmental conditions such as soil type and available moisture. Cottonwood, green ash, and catalpa were popular. Conifers worked very well in windbreaks but were slow growing, and during the nineteenth century their seedlings were difficult to produce in the plains states. A few exotic species showed promise, and some planters experimented with Austrian and Scotch pines and later Siberian elm.

Regardless of the species used, early Forest Service plans called for alternating two different trees within the rows of a windbreak. Trees were generally planted with four by four or four by six foot spacing. The goal of close spacing was to have the canopy close as quickly as possible, thereby creating shaded forest conditions under the trees. Until canopy closure occurred cultivation was required as yearly maintenance to "conserve the moisture content of the soil and to prevent the growth of weeds and grass."[51] Livestock had to be fenced out of the plantation and after a few years the trees could be thinned, producing firewood and fence posts. Foresters, as experts, sought to impose strict standards with planting plans; farmers, however, needed immediate practical effects to convince them to make the initial investment and effort. The foresters' goal was success in a scientific project; farmers were motivated more by economics.

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[51] Miller, "Forest Planting in the North Platte and South Platte Valleys," 14.

As with any technology, shelterbelts underwent a process of design, testing, and application. They were adapted to function more efficiently under various conditions. The Forest Service "conducted experiments to obtain a clear idea of the influences of windbreaks upon the atmospheric and soil conditions which affect the growth of plants." Then it was, "but a step to apply these general principles to local conditions and to determine the relative values of various species and of various arrangements of windbreaks with respect to local winds, and their positive value to certain crops." Although the Forest Service was interested in forestry on the Great Plains as a grand project, the emphasis here was clearly on the local—local conditions and individual farms. The motivation was modernist but the results in each case were unique. Each application of planted trees as technology had to be tailored specifically to the place it was needed. A windbreak benefited crops (and thus farmers) by reducing the mechanical force of the wind, lessening evaporation, decreasing "extremes of temperature both in the air and in the soil" by stagnating the air, and changing "the distribution of moisture in the air."[52]

The promises made for windbreaks were not just wishful rhetoric. The trees were effective technologies that had a measureable impact on farm production. In general, a good windbreak controlled the impact of the wind for an average distance of 20 times the height of the trees. A 25 miles per hour wind could be reduced to 5 miles per hour in the lee of the windbreak. This function also served as a snow trap in the winter when blowing snow dropped out on the leeward side of the trees. The ability to slow

[52] Carlos G. Bates, "Windbreaks: Their Influence and Value," USDA, Forest Service, *Bulletin 86* (Washington, D.C.: GPO, 1911), 8, 14.

evaporation depended on the density of the windbreak, but measured results ranged from ten to forty percent moisture savings. "A good windbreak 100 feet high and one-half mile long," reported forest scientist Carlos Bates, "will reduce by 32 per cent the evaporation from 73 acres, and thus decrease the possible loss of moisture from 56 inches to 39 inches, where the mean wind velocity is 10 miles per hour." The warming effect of shelterbelts during the summer growing season was also studied extensively. In just one example from a Nebraska farm, corn grown next to a 38 foot high mixed species windbreak illustrated the effectiveness of the trees. In late June the first 18 rows of corn closest to the windbreak averaged 4.5 feet in height, while the corn in the open averaged 2.5 feet. "At harvesting the weight of the corn at the point of greatest protection was about 18 bushels per acre greater than in the open," the report noted.[53] Thus this shelterbelt of trees was clearly offered as a technology for increasing farm production, making a persuasive argument to motivate profit minded farmers and reflecting the modernist cultural context of early twentieth century America. Applied science, in this case forestry, would increase production and raise living standards.

Growing forest trees on the plains in the nineteenth century, however, was much more difficult than raising crops. The first problem was obtaining reliable planting stock. Early settlers pulled seedlings from northern forests or planted cuttings of willow and cottonwood. When commercial nurseries began to make seedlings more widely available there were still serious issues with the quality of the stock and the difficulties inherent in shipping fragile seedlings. Once received, the little trees required careful handling and specific planting techniques—the seedlings needed to be kept moist, weather conditions

[53] Bates, "Windbreaks," 52, 65.

had to be just right during planting, the trees had to be placed in individual holes with their roots aligned properly, and time was of the essence. After they were in the ground farmers had to tend to the trees for several years, watering them if possible and cultivating the ground around them.

Successful plantations resulted only with the right combination of hard work and good luck. The government's role at this time was limited to offering encouragement, providing expert advice, and advertising the success stories. While some plantations thrived and farm forestry on the plains was proved possible, the lack of overwhelming success, under federal initiatives, can be seen in the 1891 repeal of the Timber Culture Act. Of the 290,278 Timber Culture filings, only 65,265 went to patent. The Act was more an embodiment of hope and ideology than a practical plan. It was useful to hold land to be purchased later, but it was often just too hard to raise the necessary trees and keep them alive long enough. Even those who made an honest effort to fulfill the law were generally disappointed. Almanzo and Laura Wilder carefully tended their trees for four years, watering and fertilizing them, pruning, and replacing those that died, only to have them all killed off one summer by drought and hot winds. They were forced, instead, to buy their land as a preemption claim.[54]

A Forest Experiment—To Replant the Plains

Frustrated by the necessity of relying on uncertain private planting efforts, federal foresters wanted to carry out their own forest plantings. In the search for an appropriate

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[54] Paul W. Gates, "Homesteading in the High Plains," in *Agriculture in the Great Plains, 1876-1936*, Thomas R. Wessel, ed., (Washington D.C.: The Agricultural History Society, 1977), 113; Wilder, *The First Four Years*, 122.

location for a large-scale federally sponsored forest planting experiment, government foresters looked to the Nebraska Sand Hills. Nebraska certainly offered a cultural climate supportive of tree planting and the sparsely populated rolling hills in the center of the state were not particularly suitable for crop agriculture. By successfully building a forest in this harsh environment the Forest Service could showcase planting techniques and justify similar projects all over the country. In a century-long nursery and tree planting effort they would eventually create a functional 30,000 acre forest there, the first division of the Nebraska National Forest. The government did not impose this plan unilaterally; there was an influential tree planting lobbyist in Nebraska, Charles Bessey, who drew them there.

Known eventually as “the father of the Nebraska National Forest,” Bessey was a vigorous promoter of reforesting the Sand Hills. Bessey came to the University of Nebraska in 1884 from the University of Iowa, where he had taught for fifteen years. In wire-rimmed spectacles and a pointed white beard, Bessey served as an intellectual father figure to a generation of scientists who came of age during the maturation of botany into ecology. From his position in Lincoln as professor of botany and by serving in an incredible number of professional and other organizational posts, he dramatically influenced American science and education. At various times Bessey served as dean of the college of literature, science, and the arts and acting chancellor of the University. He was president of the department of science of the National Education Association, of the Society for the Promotion of Agricultural Science, of the Microscopical Society, and also the Wild Flower Preservation Society, and vice president of the American Association.

Elected four times as secretary and vice-president of the Forestry Association of America, he also served as president of the Botanical Society of America in 1896 and president of the American Association for the Advancement of Science in 1911. Bessey edited the botanical section of the journal *The American Naturalist*, and in 1897 became botanical editor of *Science*. For many years he served as the official Botanist on the Nebraska State Board of Agriculture. In his official reports and personal connections through these organizations, Bessey constantly advanced the plains forestry cause.

As a founder of the so-called "new botany," he emphasized laboratory study and particularly championed the use of compound microscopes, research methods, and experimentation, over mere collection and identification. Bessey brought scientific rigor to botany, a field traditionally driven by amateur collectors. But he also built up an intimate connection, through voluminous correspondence, with all types of interested individual laypeople. He advised school teachers on curriculum, farmers on weed identification and treatment, and federal agencies on policies and programs. Through the Botanical Seminar at the University of Nebraska, his graduate students, particularly Roscoe Pound and Frederic E. Clements, surveyed the species and distribution of plants throughout the state. Considering the origins and movements of plants, their work eventually led to innovative theories in grassland ecology. Indeed, given this role it is somewhat ironic that Bessey was so influential in the transformation of grassland to forest.[55]

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[55] For more biographical detail on Charles Bessey, see Raymond J. Pool, "A Brief Sketch of the Life and Work of Charles Edwin Bessey," *American Journal of Botany* 2 (December 1915); Thomas R. Walsh, "The American Green of Charles Bessey," *Nebraska History* 53 (Spring 1972); Richard A. Overfield, "Charles E. Bessey: The Impact of the 'New' Botany on American Agriculture, 1880-11910," *Technology and*

Bessey tried to keep the developing emphasis on ecology grounded firmly in plant physiology, empirical knowledge gained through experimentation, and practical application of the results. He exemplified the combination of a high-modernist motivation with a focus on the local environment, happily sharing his expertise with other scientists, government officials, working farmers, and house-wives alike. In teaching his students and serving the public, his focus was on directing scientific knowledge towards solving specific problems in particular places and circumstances. He applied science to agriculture for the eradication of Russian thistle and other weeds and studied plant fungus and rusts. He worked closely with the U.S. Department of Agriculture, writing the experiment station section of the 1887 Hatch Act and later advising the stations. Under the Hatch Act the federal government gave states land grants to establish agricultural stations, usually connected with land grant colleges, that would study crops, soils, and special farming problems and techniques. These stations studied local conditions rather than developing and promoting general theories and universally standard practices. Through published reports and correspondence with federal officials, including Bernhard Fernow and Gifford Pinchot, Bessey influenced the Forestry Division, even becoming a paid "Collaborator" for $300 a year.[56]

Like Fernow and others, Bessey believed the plains had previously been forested. By gathering information from residents throughout the state and making his own

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Culture 16 (April 1975). On the establishment of grassland ecology, see Ronald C. Tobey, *Saving the Prairies: The Life Cycle of the Founding School of American Plant Ecology, 1895-1955* (Berkeley and Los Angeles: University of California Press, 1981). Charles Bessey's papers are reproduced on microfilm and catalogued in Joseph G. Svoboda and Patricia Churray, eds., *Guide and Index to the Microfilm Edition of the Charles E. Bessey Papers(1895-1915)* (Lincoln: University of Nebraska Press, 1984).

[56] Letter from Gifford Pinchot to Charles Bessey, August 26, 1899, Bessey Papers (herafter BP) roll 9.

investigations, Bessey confirmed his reforestation ideas: “A somewhat prolonged study of the Sand Hills has led me to the inquiry whether they have always been treeless.” He concluded, “it is reasonably probable that the Sand Hills were once wooded with the yellow pine.” Bessey traveled the state investigating this possibility and corresponded with people from all over the plains who offered him further evidence. He found trees growing in isolated canyons and discounted their distribution from wind or bird carried seed. He saw them as remnants of vanished forests. As there were both eastern and western trees in these scattered canyons, it seemed to Bessey that central Nebraska must have been a meeting place from which the forests had since retreated. In many letters, people reported finding logs and fragments of trees buried throughout the Sand Hills. Considering all this, Bessey firmly believed that “the central region was once wholly or in part covered with forests.” The subsequent course of action seemed obvious to him: “The question naturally comes to us whether it is possible to reforest this area. That it would be desirable to do so needs no argument.”[57]

As one of the most fervent missionaries of the gospel of tree planting, Bessey pushed the ideological and practical reasons for building new forests. For more than two decades, using his many official positions as a bully pulpit, he spread this message. “We have to preach the crusade of the filling up of the state with trees, and to do that we must plant trees, and plant trees, and plant trees. . . . Let us be true to the name we have

[57] Charles E. Bessey, “The Re-Foresting of the Sand Hills,” *Annual Report of the Nebraska State Board of Agriculture* (1894), 119; Bessey, “Were the Sand Hills of Nebraska Formerly Covered with Forests?” (1896), Walter B. Kiener Papers, Box 27, folder 4, Archives and Special Collections, University of Nebraska-Lincoln Libraries, (Hereafter ASCUN).

adopted of 'Tree-Planter's State.' Plant for shade; plant for protection; plant for beauty; plant for wood; and plant for the conservation of moisture."[58]

As Bessey's advocacy of tree planting was well known and respected, Fernow contacted him in February 1891 for help in creating an experimental plantation. "I should like to start an experiment there," Fernow wrote of the Sand Hills, "in planting *Pinus ponderosa*. I have a small amount of money that I could devote to such a purpose. I now would like to have your cooperation and suggestions."[59] Fernow sought land of the poorest soil quality so forest planting would not be seen as competing with agriculture or settlement opportunities. Bessey found a colleague at the university, entomology professor Lawrence Bruner, whose family owned a suitable piece of property in Holt County. Fernow provided the seedlings and strict instructions on handling and planting them. In March, through assistant-chief Nathaniel Egleston, he explained: "The work to be done would be to set aside and surround with a firebreak the area, which should be on the sand hill non-agricultural [land], and the planting of the trees. I propose no cultivation, nor plowing of the ground, except trenches. I would send you planting tools specially adapted to conifer planting, by hand and full instructions."[60] In April as the trees began to arrive, he advised, "I would not disturb the ground at all but plant with the spade, taking out a triangular cake of earth, set the plant and replace the earth immediately. That seems to me the proper plan, with a sand, apt to blow out."[61]

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[58] Charles E. Bessey, "Why Should We Plant Trees," *Annual Report of the State Horticultural Society* (1900), 117, 122.
[59] Bernhard E. Fernow to Charles E. Bessey, February 12, 1891, BP roll 4.
[60] Nathaniel H. Egleston to Lawrence E. Bruner, March 9, 1891, Archives and Special Collections, University of Nebraska-Lincoln Libraries (hereafter ASCUN).
[61] Bernhard E. Fernow to Lawrence E. Bruner, April 24, 1891, ASCUN.

The experiment included many species of trees. Wild Banksian pine (jack pine) and red pine seedlings were dug from the forest in Grantsburg, Wisconsin. Ponderosa pine, Austrian pine, Scotch pine, and other conifers as well as several types of deciduous tree seedlings were shipped from private nurseries in Michigan and Nebraska. The planting was carried out in four plats covering three acres with the trees planted every two to three feet in furrows three to four feet apart. As a test case, plat number four was plowed before planting "as for the planting of a crop of corn."[62] Predictably, all of the seedlings in this plat failed through soil loss, providing a simple lesson in the practical necessity of ecological complexity. While plants and grasses left around the planted trees took up precious moisture and could over grow the seedlings, soil plowed clear of vegetation was apt to blow quickly away. In this loose, dry sand a balance had to be struck between the soil fixing function and competitive nature of the native ground cover. Their planted forest would not succeed as a mono-cropped corn field. With the Bruner brothers continuing to replant the failed places, the other plats faired much better, especially the conifers in plat one. By November 1892 the plantation contained some nine thousand trees.[63]

Conclusion

As Euro-American settlers moved onto the Great Plains in the 19th century they were unaccustomed to the open, windswept environment and wanted to plant trees to make it more like the landscapes they were used to in the East. Trees were a familiar

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[62] Bernhard E. Fernow to Lawrence E. Bruner, April 20, 1891, ASCUN.
[63] Charles E. Bessey, "The Reforesting of the Sand Hills," *Annual Report of the Nebraska State Board of Agriculture 1893*, 95.

cultural marker, signifying qualities of comfort and suggesting social stability. Some people (mostly promoters and railroad agents) claimed trees would improve the climate. Settlers also worried about the lack of timber resources and hoped to provide for the future by planting woodlots. Farmers saw trees as technologies, much like sod houses and windmills, that could improve their land and make their lives better. They planted windbreaks around their homes and fields, though many of these plantings failed. The government sponsored tree planting. Local governments offered bounties and the federal government gave away land under the Timber Culture Act for successful tree growth. Federal foresters offered encouragement and advice, publishing how-to bulletins for settlers and farmers. More active involvement began when Bernhard Fernow funded a forest planting experiment in the Nebraska Sandhills. The private enterprise to settle and plant the plains had finally led to a more influential forestry agency within the government and this agency was about to embark on a large scale forest construction project.

Fernow ended the Bruner plantation work in February 1893, and summarized the experiment's success the following year. "I think we have satisfactorily demonstrated that the Banksian Pine is the tree for that region, and I believe also that close planting without cultivation is the proper method."[64] Their prototype of a technological forest had been successfully debuted. Tree planting on the Great Plains could now move into a new phase of government management and interstate connections. An ambitious leap still needed to be made. Building a full size, functioning forest rather than a farmstead woodlot or windbreak would require a tree factory for producing seedlings on an

[64] Bernhard E. Fernow to Hudson F. Bruner, November 7, 1894, ASCUN.

industrial scale, a concerted, long-term labor effort in planting trees, and the resources and management of the federal government. Fernow and his foresters were confident that they were equal to the task.

BUILDING A TREE FACTORY

> "The presence of trees on the hills that are now as bleak as anything that can well be imagined will beautify the country and in time supply the local demands for forest products"
>
> —Charles Scott[1]

In the first years of the twentieth century, the effort to construct forests on the Great Plains took a major leap forward as the federal government joined private tree planting efforts. Through the agency of the burgeoning Forest Service, the government built the first federal tree nursery in the Sand Hills of central Nebraska. This nursery was really a factory for producing tree seedlings that, like any factory, combined raw materials and human labor in a standardized process to manufacture a product. The local landscape, specially prepared, became the factory floor; workers, machinery, and the environment combined there in a system of production as regimented as any assembly line. This system used ecological interactions as a technological process to manufacture living organisms. Millions of tree seedlings rolled out of the nursery each year, mass-produced to serve as a construction technology themselves. Transplanted into the surrounding grassland, these little trees would grow up to form a brand new forest, a greater whole from the individual parts. Federal foresters firmly believed that they could accomplish this; the spirit of the Progressive Era, the evidence they found of previous trees and forests, and their faith in scientific forestry gave them the confidence to engineer a new environment.

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[1] C. A. Scott, "Foresting the Nebraska Sand-Hills," *Forestry and Irrigation* (September 1903), 454-457 manuscript copy from Walter B. Kiener Papers, Box 27, folder 10, ASCUN.

The Lay of the Land—Scouting a Forest Location

In March 1901, William Hall, the superintendent of the Section of Tree Planting within the Forestry Division, wrote to Charles Bessey announcing a reconnaissance expedition to promote tree planting on the Plains and inviting his suggestions. Hall planned a scientific investigation of timber growth in Nebraska by federal foresters in anticipation of establishing "extensive government plantations." Location was essential in this enterprise, as the chosen place needed to combine a unique set of characteristics. It must sustain the growth of trees where no forest already existed. The local and national population should support the project in that place, so it should not be suitable for some "higher purpose" such as agriculture, mining, or industry. The Sand Hills of Nebraska, Hall assured Bessey, were "to receive especial attention, as I believe timber can be made to grow there with more than ordinary success." Furthermore, aside from a few marginal homesteads and grazing opportunities, to American society, the area was the embodiment of a wasteland; building a forest there would be a progressive social project.[2]

The Sand Hills of Nebraska cover some twenty thousand square miles in the northwest third of the state. Similar to beach dunes in appearance, the hills consist of fine sand broken down from distant sandstone, transported eastward and piled up by the wind. Native vegetative growth has largely fixed the movement of the huge dunes especially since the suppression of fire allowed more substantial growth of grasses and shrubs. However, drastic disturbance of the vegetation results in "blow outs," where large

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[2] William L. Hall to Charles E. Bessey, March 29, 1901, BP roll 10.

amounts of soil are carried away by the wind. In the late nineteenth century the land was considered to have "no agricultural value whatever." Except where thin humus had accumulated in the valleys between the dunes, the soil is mostly silica and contains almost no organic matter.[3] Twenty-one inches of rain fall on average within a range of fourteen to thirty-five inches, mostly occurring in the late spring and early summer growing season. Moisture is quickly absorbed by the loose soil so there is little to no runoff. The rivers arising in the Sand Hills are spring fed. A few settlements were established in this area at the end of the nineteenth century, but the majority of the land remained under federal control.[4]

To those interested in establishing large forest plantations and promoting the expertise of scientific forestry, the Sand Hills seemed like an ideal place to start. Sparse population, rainfall inadequate for agriculture (but presumably sufficient to support trees once they were planted), and the perception of useless land transformed into valuable forest, set up ideal conditions for foresters to build faith in their science among Americans. Besides the practical lessons learned from the project, success here would leave no doubt that foresters could build forests wherever the American people wanted them. Federal forestry on the Plains would be just as much demonstration as experiment, with trees grown under these harsh conditions proving the viability of environmental engineering and forest construction.

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[3] Carlos G. Bates and Roy G. Pierce, "Forestation of the Sandhills of Nebraska and Kansas," *U.S. Forest Service Bulletin 121* (1913), 2-3.

[4] Charles E. Boldt, "Jack Pine Plantations in the Nebraska Sandhills," *Journal of Forestry* (February 1969), 96. For a history of the settlement of the Nebraska Sand Hills see, Charles Barron McIntosh, *The Nebraska Sand Hills: The Human Landscape* (Lincoln: University of Nebraska Press, 1996).

William Hall gathered his reconnaissance party in Kearney, Nebraska on July 1, 1901. Royal S. Kellogg, the party's leader, and Louis C. Miller, second in charge, both had almost a year's experience with the Forestry Division. The other five members, including Charles A. Scott who later became the first Nebraska National Forest Supervisor, were fresh out of college. Paid at a rate of $25 per month, Scott was one of the many Student Assistants Gifford Pinchot hired to fill out the staff of his agency. By the end of 1902 there were hundreds of Student Assistants working in what had become the Bureau of Forestry. Known later as the "Old Guard," Pinchot built the Forest Service around this educated, idealistic core group. Civil service exams, scientific collaboration, and a high degree of camaraderie ensured adequate qualifications and commitment to the new profession of forestry within the agency. These young foresters came from all over the country and many reflected the intense interest in forestry that existed in the treeless plains and prairie states. Scott had graduated from Kansas State Agricultural College and other members of the Nebraska expedition hailed from Kansas, Oklahoma, Iowa, and South Dakota.[5]

On July 6th, after stocking their two mule wagon with provisions and saddling their riding horses, the Nebraska Sand Hill Reconnaissance Survey Party set out from Kearney and headed, like so many hopeful Americans before them, westward along the Platte River. Instead of the independence and opportunity of a fresh homestead, these budding foresters sought evidence of tree growth and propitious planting sites. Like westering settlers though, they too were spreading American society and culture—by

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[5] Charles A. Scott, "The Early Days: The Dismal River & Niobrara Forest Reserves," USDA (June 2002), 1-2; Harold K. Steen, *The U.S. Forest Service: A History*, Centennial Edition (Seattle: University of Washington Press, 2004), 62.

building new American forests. Reaching the fork in the river, they continued up the North Platte to the Wyoming border. From there they traveled northward to Crawford, Nebraska before turning South and East and plunging into the heart of the Sand Hills, the real object of their mission. Roughly following along some 200 miles of the Burlington Northern's railroad track, the party explored the dunes and valleys of the central Sand Hills before meeting up with Hall again, three months after setting out, in Broken Bow, Nebraska. Outside of the Sand Hills, they found cottonwoods, willows, and ash growing along the water courses. More importantly, in the Northwest part of the state native ponderosa pine and red cedar rivaled the same species growing in any other forests. Scott measured ponderosa stumps two feet in diameter and counted 300 years worth of annual growth rings. Many of these trees grew in soil so barren that it seemed certain they could be propagated within the Sand Hills.[6]

With the reconnaissance survey completed, the party split up with some of the men, including Scott, Miller, and Hugh P. Baker, returning to Washington D.C. to work through the winter in the Bureau of Forestry office. They produced a report on the summer's expedition, wrote research papers on forestry topics, and did other Bureau work such as compiling timber volume tables. Scott went to church once or twice every Sunday and just as faithfully attended the weekly meetings of the Society of American Foresters at Gifford Pinchot's house. These meetings furthered the academic and professional quality of American forestry with presentations such as "Financial Problems in Forestry" by Henry S. Graves, reports on grazing in the Black Mesa Forest Reserve, and Scott's own paper, "Trees for Planting for the Production of [Railroad] Ties." At a

[6] Scott, "The Early Days," 4-5.

time when almost half of the Bureau's staff of 176 employees were Student Assistants, the Society provided education but, as Pinchot pointed out, was perhaps "even more important, in establishing a genuine respect for the profession of Forestry." A "spirit of comradeship" and the "free interchange of views," which often included interaction with prominent scientists from other fields related to Forestry, generated great excitement within the Bureau for the potential of American forestry. Pinchot believed that this experience welded the members of the Society into "the vital core of the Forest Service—vital in loyalty to all that the Service stood for and with the highest morale to be found anywhere under the Government of the United States."[7]

In this atmosphere of optimism, the report of the Nebraska survey, "Proposed Forest Reserves in the Sand Hills of Nebraska," announced that conditions were favorable for forest planting on the Plains and such planted forests "would be of great and lasting benefit not only to the immediate locality but to the entire Middle West." Historical changes in land use, particularly the exclusion of wildfire and the cultivation of exotic species, showed that the soil could support tree growth. Taking advantage of this, foresters could grow hundreds of thousands of acres of forest for the specific purposes of maximizing land use, producing timber and fuel, and improving regional climatic conditions.[8]

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[7] Charles A. Scott, "Diary 1902," CONS 166, Box 1, Denver Public Library; Gifford Pinchot, *Breaking New Ground*, Commemorative Edition (Washington D.C.: Island Press, 1998 originally published 1947), 150-51.

[8] H.P. Baker, "Proposed Forest Reserves in the Sand Hills of Nebraska" (Winter 1901-02), National Archives and Records Administration (herafter NARA), Rocky Mountain Region, RG 95, Box 85, folder 390, pgs. 8, 13.

Baker compared the loose sandy soil of the proposed Reserve area, between the Platte and the Niobrara Rivers, to the sand barrens of northern Michigan, Wisconsin, and Minnesota, which supported dense forests of conifers and broadleaf trees. While precipitation quickly drained into the soil, capillary action kept moisture near the surface even during times of drought. American settlers had little success farming these Nebraska sand dunes because a few years of plowing removed the ground cover of bunch grass and led to drifting sand and loss of moisture. However, the reduction of fire on the Plains that accompanied white settlement led to increased growth of wild plants. Sand cherry, wild rose, and redroot succeeded the sparse grasses on the hills while wild plum, choke cherry, and sumac grew thick in the valleys. This brush growth signaled to the survey party an eventual replacement of prairie grass with forest trees. "The increase of shrubbiness is general throughout the region," they reported, "and is a strong indication of a tendency to forest growth." Remnant clumps of ponderosa pine, red cedar, and hackberry, along with evidence of timber harvest by early settlers, suggested that in the past there had been "much more natural timber than at present." So, to some degree, foresters could believe that by planting trees they were encouraging a natural tendency and returning the landscape to a previous condition.[9]

The reconnaissance party had also visited the 1891 planting experiments on the Bruner property. Charles Bessey feared that those long neglected trees would have disappeared, but the survey party found the trees succeeding admirably, reaching from ten to nineteen feet high. They measured an average height growth for the previous year at 19 inches for Jack pine, 18 ½ inches for Scotch pine, and 9 to 15 inches for ponderosa.

[9] Baker, "Proposed Forest Reserves," 5-6.

Another government report, a decade later, described these same trees shifting in quality from artificial plantation to naturalized forest.

> The conditions of this miniature forest are entirely different from those in the surrounding hills, showing that the trees are permanently established. The grass has been killed out, the ground is covered with a light coat of needles, and, best of all, young seedlings of jack pine have appeared from time to time, from seed dropped by the planted trees. This is clear evidence of the adaptability of the species to the climate and soil of the region.[10]

This experimental planting indicated the possibilities of a general plains tree planting project. The Bureau of Forestry's institutional optimism now extended to its ability to grow entirely new forests. In his report on the Nebraska survey, Baker suggested the potential that early settlers had hoped for and future foresters embraced: "The trees which thrive in this location will grow on hundreds of thousands of acres in the sand hills where the conditions are precisely the same."[11]

Federal foresters were ambitious as well as optimistic. An extensive, well organized, scientific planting effort could now replace the haphazard individual plantings that had previously brought trees to the Plains. The government forests would be a "practical demonstration." They would establish scientific methods and stimulate more successful plantings by private individuals. Timber planting, Baker wrote, "would enhance the value of land in the plains." And once the proper methods were developed in Nebraska, they could be applied in other sandy areas such as along the Atlantic and Pacific coasts and the shores of the Great Lakes, where "little headway has as yet been made on account of the lack of extensive effort along systematic lines." A forest built in

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[10] Carlos G. Bates and Roy G. Pierce, "Forestation of the Sandhills of Nebraska and Kansas," *U.S. Forest Service Bulletin 121* (1913), 2-3.
[11] Baker, "Proposed Forest Reserves," 7.

the Sand Hills presaged new forests throughout the country. Federal forestry promised to bring the same organization and scientific methodology to the creation of forests that it used to manage existing forests. The Progressive Era rationality that inspired social engineering could now also reshape the physical environment.[12]

A Treeless Forest—Creating the Dismal River Reserve

With successful experiments completed, a positive report in hand, and a grand vision of forest creation, Pinchot began the task of getting the federal government to designate land in the Plains for aforestation by his agency. He solicited Charles Bessey and the Senators and Governor of Nebraska for letters to President Theodore Roosevelt promoting the enterprise. The Bureau of Forestry issued a lengthy press bulletin describing the Sand Hills survey and the evidence for the success of the project, announcing that everyone involved believed forests could be grown there from planted trees. The Nebraska Academy of Sciences petitioned the President and Congress to establish tree-planting reserves "large enough that plantations may be made upon so extensive [a] scale as to ensure the growth of successful forests." In January 1902, William Hall wrote to Bessey that "a forest tree planting reserve in the Sandhills of Nebraska is now almost within our grasp." The social and political questions were settled. The only obstacle remaining was a legal review of the issue by the Attorney General. Late nineteenth century Americans feared an impending timber famine and the President was authorized to set aside forested land to protect this valuable national resource. But could this authority be extended to land that contained no trees? Within

[12] Baker, "Proposed Forest Reserves," 12.

the spirit of Manifest Destiny, anything that extended the influence of American society across the continent seemed acceptable. Furthermore, at the height of the Progressive Era, support for tree planting and the conversion of wasted land to productive forest was strong and followed easily from an established policy of protecting existing forests.[13]

In 1891 Congress had passed a bill repealing the Timber Culture Act and amending various other land policies. The last paragraph of this nine page bill empowered the President, "from time to time," to set aside "any part of the public lands wholly or in part covered with timber or undergrowth" as forest reserves.[14] This obscure rider to a land bill became so important that the law President Benjamin Harrison signed is now known as the Forest Reserve Act. Harrison immediately set aside Yellowstone Forest Reserve, over a million acres surrounding the nation's first national park. In the next year, by Presidential proclamation, he created fifteen reserves totaling more than 13 million acres. His successor, Grover Cleveland, first added 5 million acres and then, with the Washington's Birthday Reserves in 1897, another 21 million acres. During his administration, from 1901 to 1909, Theodore Roosevelt tripled the size of the forest reserves to 150 million acres before Congress finally restricted the President's power to create them.[15]

An eager conservationist, Roosevelt responded favorably to the lobbying of Pinchot, Bessey, and other advocates of Plains forestry. On April 16, 1902 he set aside

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[13] Gifford Pinchot to Charles E. Bessey, January 28, 1902, BP roll 11; William L. Hall to Charles E. Bessey, January 12, 1902, BP roll 11.

[14] U.S. Statutes at Large, Vol. 26, Chap.561, pp. 1095-11-3. "An act to repeal timber-culture laws, and for other purposes." [H.R. 7254; Public Act No. 162], 1103.

[15] On the history of the creation of Forest Reserves see Harold K. Steen, *The U.S. Forest Service*; and Michael Williams, *Americans and their Forests*.

just over two hundred thousand acres in central Nebraska, creating the Dismal River and Niobrara Forest Reserves. Although there were already many federally protected forests throughout the country by this time, a complete lack of trees made these particular forest reserves unique. Pinchot and Bessey had convinced the President that forests could be built on the new reserves so Roosevelt set aside the land for what it would be made into rather than what it already was. Their first step was the construction of a tree nursery—a facility for the production of millions of individual tree seedlings that could later be combined to create a whole forest.

Dispatched from Washington D.C., Louis Miller and Charles Scott spent three months measuring tree growth on a Kansas plantation and surveying ponderosa pine in the Black Hills of South Dakota before arriving in Nebraska to work on the new forest reserves. After gathering their horses and equipment, stored in Kearney from the previous season, and meeting with some local ranchers, they set up a tent camp and began to survey the boundaries of the Dismal River Reserve on June 20, 1902. Two hundred miles west of the capital, Lincoln, and sixty miles north of North Platte, the new Reserve covered nearly 90,000 acres of sand hills between the Dismal River and the Middle Loup River. These rivers joined just east of the Reserve and eventually flowed into the Platte River. The Burlington Northern Railroad tracks ran along the far bank of the Middle Loup River to the north of the Reserve, with stations in the tiny towns of Halsey and Thedford about seventeen miles apart on the east and west of the Reserve. The other reserve Roosevelt created lay along the Niobrara River near the northern border of Nebraska. The Dismal River Reserve (sometimes called the Halsey Reserve after the nearby town) was developed first and remained the more important of the two planting projects.

Figure 2 - Surveying the Dismal River Reserve. Source: USFS

Scott selected an eighty acre nursery site on a level bench along the Middle Loup River about two miles from Halsey, with easy access to the rail line. More men arrived from the Bureau of Forestry and under Scott's direction they began to clear out the dense thickets of plum and choke cherry. To create a forest in this grassland they first had to build a facility to produce seedlings, a nursery in which to deliver the organic components of a new constructed environment. Like an expectant parent, Scott expressed his ambitions for the future forest. "The presence of trees on the hills that are now as bleak as anything that can well be imagined will beautify the country and in time supply the local demands for forest products."[16] This progressive vision of environmental engineering mirrored the new ideals of urban social reformers. Trees would bring beauty, order, and opportunity to the barren, sandy landscape.

The Factory—Building a Tree Nursery

The men fenced the "Nursery Eighty" with barbed wire, bounding the production site and protecting it from livestock and wildlife. Then, preparing a one-half acre plot, they "grubbed, plowed, harrowed, and raked . . . until the soil was free of roots" and ready to be seeded with trees. On this plot, they laid out twenty-one seed beds 7 feet wide by 136 feet long, each capable of producing twenty thousand seedlings. Lacking any local lumber, eight foot posts were shipped in from Virginia and set throughout the beds to support a slatted roof that would shade and protect the young seedlings. The final arrangement, according to Scott, "when completed resembled a huge chicken coop." Together, the prepared ground and the wooden framing made up the first factory floor with a potential production capacity of 420,000 trees.[17]

With the facilities ready, raw materials, in this case tree seeds, were now needed to start production. As William H. Mast, one the project's founding personnel, explained forests only grow on trees. "In order to start forests," he told the Nebraska Park and Forestry Association, "there must be seed or trees; we have neither. The question then that confronts us is to get trees or tree seeds from some other region and bring them

[16] C. A. Scott, "Foresting the Nebraska Sand-Hills," *Forestry and Irrigation* (September 1903), 454-457 manuscript copy from Walter B. Kiener Papers, Box 27, folder 10, ASCUN.
[17] Scott, "Foresting the Nebraska Sand-Hills."

here." In order to build a forest from scratch, importing seed to a nursery as a tree factory on the Reserve would solve the "question of securing seed and raising the seedling trees near where they are to form the forest." Forest construction had to begin with tree production.[18]

Figure 3 - Covered seedbeds, 1902. Source: USFS

For conifer trees, foresters had to gather cones and extract the seeds from the cones. There were "three methods of collecting cones—from felled trees, from standing trees, and from squirrel hoards." The *Saturday Evening Post* described this practice as

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[18] William H. Mast, "Whence Comes Our Seed and How We Grow Seedlings" (Read before the Nebraska Park and Forestry Association, York, Nebraska, June 14, 1904), NARA Rocky Mountain Region, RG95, box 20, folder 98.

"Robbing the Squirrels," although the foresters insisted that the squirrels laid up "quantities out of proportion to their need." Red squirrels being the most prolific collectors, some caches yielded twelve bushels of good cones, though two bushels was about average. The squirrels were apparently reluctant recruits in the foresters' tree planting enterprise. Collectors were advised "to have a pack horse along for immediate transportation, since if the cones are dug out and left on the ground for any length of time they will be carried away and cached again by the industrious animals."[19] By whatever means they were acquired, the cones required processing to release the seeds. This was generally done by heating and shaking the cones. Some tree species' cones readily released their seeds but others, like jack pine and lodgepole pine, normally held their scales tightly closed for several years waiting for the quick intense heat of a wildfire. Artificial drying houses and mechanical shakers mimicked the ecological processes that normally opened these cones.[20]

In the fall of 1902 four men were sent out to the Black Hills of South Dakota and the Pine Ridge area of northwestern Nebraska, and two more to the forests of Michigan and Minnesota to collect seed. Eighty-four pounds of yellow pine (ponderosa) seed came in from Crawford, Nebraska and another 80 pounds from Rochford, South Dakota. At Scott's Bluff, Nebraska they gathered 480 pounds of red cedar seed. With this and other collections, the total seed available for the first year's planting amounted to almost 1,000 pounds. In addition, 30,000 yellow pine seedlings were dug up near Nemo, South Dakota

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[19] William T. Cox, "Reforestation on the National Forests," *USDA Forest Service Bulletin 98*, (Washington D.C.: GPO, 1911), 17-18; "Robbing the Squirrels," *Saturday Evening Post*, January 20, 1912.
[20] George B. Sudworth, "The Forest Nursery: Collection of Tree Seeds and Propagation of Seedlings," *USDA Forest Service Bulletin 29* (Washington D.C.: GPO, 1900), 28.

and 70,000 Jack pine seedlings were collected in Minnesota. These seedlings were heeled in at the nursery site for planting the following spring. Transplanting wild seedlings was never very successful though; what they really wanted was to control the entire process from seed to tree and guarantee the quality of their own seedlings. Seed gathering became an annual event. Scott reported that 1903 “was a prolific seed year in certain parts of New Mexico and in the Jack pine regions of Michigan and Minnesota.” Accordingly, they “spared no energy to take advantage of this opportunity to collect a large quantity of seed.” Mast brought back over 2,000 pounds of seed, mostly yellow pine but also limber and pinion pine, red and white fir, and blue spruce, from Glorieta, New Mexico.[21]

With a good supply of seed secured, nursery operations began. Although some species, especially Jack pine and red cedar, were later broadcast sown, workers planted the first nursery beds, in November 1902, using homemade seed drills that created holes six inches apart. They placed seed into the holes at the rate of fifty to sixty per linear foot and raked over the soil. In this manner it took twenty-five and a half days to plant one acre, with a labor cost of $1.75 per day. As the seedlings grew the beds were periodically weeded and mulched with straw and the soil stirred after heavy rains. The nursery managers were building a factory system to manufacture seedlings on an industrial scale. Like any commercial industry, they kept meticulous account of costs and production. Cultivating and caring for the seedlings through the summer cost $120.75. With straw and labor for mulching at $43.75, the total cost was $164.50. After a year of growth the

[21] Charles A. Scott, “Annual Nursery and Planting Report, 1903,” Bessey Ranger District, Nebraska National Forest (hereafter BRD); Charles A. Scott, “Annual Nursery and Planting Report, 1904,” BRD, 3.

first output totaled 501,000 western yellow pines, 464,000 Jack pines, and 10,000 "various other sorts of pines and spruce seedlings." The production cost of these 975,000 seedlings ran "a trifle under" $0.70 per thousand. This included seed collection and planting, cultivation and mulching, clearing the ground, and one-tenth of the cost of building the shade frames (as this cost was amortized over ten years). Nursery bookkeeping records of materials, labor, and inventory mirrored any private factory operation concerned with profits.[22]

As foresters, nursery managers were also practicing science; their seedlings and their records were the products of experimentation. They intended the nursery to be a controlled environment. Foresters could manipulate the system's inputs by choosing seeds from different species or different sources of the same species. They could manage, to some degree at least, the environmental conditions in which the seeds grew—manipulating irrigation water, soil nutrients, and sun exposure. Foresters also worked very hard to exclude pests from the system by fighting insects, fungus, and diseases. Their goal was to increase the efficiency of the production process and improve the quality of the product. By controlling, as much as possible, all the aspects of the nursery system, they tried to maximize unit production, but they also wanted to learn what they could about how the system worked. They were, after all, building a tree factory that recreated the process by which wild forests reproduced. The seeds planted into nursery beds contained, in effect, a latent forest and foresters were developing a technological process to realize that forest. In doing so they produced both trees and knowledge.

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[22] Scott, "Annual Nursery and Planting Report, 1904," 6-8.

Federal foresters were not starting completely from scratch though. By the middle of the nineteenth century private commercial nurseries were well established in the Midwest, selling flowers, shrubs, evergreens, ornamental and fruit trees. Catalogue sales and the expansion of the railroad facilitated westward settlement and a growing nursery business. The Bloomington Nursery, in Illinois, shipped its plants by rail and advertised its products as "Western Trees for Western Planters." Demand was high and by 1872 the Bloomington Nursery planted six hundred acres and operated twelve greenhouses. Robert Douglas, in Waukegan, Illinois, specialized in propagating conifer seedlings. The Monroe Nursery, near Detroit, Michigan, offered over one million trees for sale to the public and supplied other nurseries and dealers at wholesale prices.[23]

Decades earlier, on the East Coast, horticulturists had imported foreign plants and trees, especially from Japan. Japanese conifers and Japanese creeper (later known as Boston ivy) were raised in nurseries and became common throughout the northeast. Charles S. Sargent, one of America's most prominent tree experts, proposed examining and experimenting with all the trees in the world and utilizing any of those that succeeded. For the western grasslands, Robert Douglas advocated planting any foreign forest trees that would prove more resilient on the prairies than indigenous American species. He particularly favored the European larch. The most important considerations, in selecting tree species, were success in propagation and transplanting and an efficacious environmental effect. Tree planting was big business in the prairie states of Iowa, Illinois, and Missouri, where farmers and homeowners planted both native and foreign

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[23] Cheryl Lyon-Jenness, *For Shade and Comfort: Democratizing Horticulture in the Nineteenth-Century Midwest* (West Lafayette, Indiana: Purdue University Press, 2004), 98-99, 102.

trees. *The Republic* magazine reported that Douglas shipped 15 million seedlings there each year in the early 1870s and estimated that the total nursery grown and forest gathered seedlings planted on the prairies equaled some 150 million annually. The magazine encouraged this effort and hoped government involvement would combine with private enterprise "to create a national enthusiasm that will soon dot our great prairies with artificial forests." *The Republic* held out high hopes for similar success on the dry plains west of the Missouri River as well and called for "a systematic plan for the extensive propagation of artificial forests" across the entire West.[24]

Building a forest in the arid Nebraska sand hills, however, was an entirely different proposition than planting trees in the moist, fertile Midwest. In the first field planting season at Halsey, in 1903, foresters planted the 30,000 western yellow pine and 70,000 jack pine seedlings they had pulled from wild forests the year before. They also sowed 10 acres of red cedar and 24 acres of pine and spruce. All of these plantings failed except about 35 percent of the jack pine. By comparison, the success of the first year's nursery crop grown from seed showed that to build a complete forest managers needed to start with seedlings artificially produced on site. Even these nursery seedlings, though, were always subject to injury by early frost, desiccating winds, excessive sunshine during the winter months known as "winter scalding," various diseases, and the depredations of insects, birds, and animals. Successful seedling production required methodical management and control.[25]

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[24] Philip J. Pauly, *Fruits and Plains: The Horticultural Transformation of America* (Cambridge: Harvard University Press, 2007), 86-87, 95; "Forest Culture," *The Republic* Vol. 3, no. 1, July 1874, 102-03.
[25] "Memorandum: Nursery and Planting Operations, Dismal River Forest Reserve, Halsey, Nebraska," 1905, BRD.

Production Line—A System to Manufacture Seedlings

The Bessey tree nursery was a production facility—a technological system made up of many components. The production site, which corresponded to a factory floor or assembly line, was the seedbeds with their shade frames, the larger transplanting fields, the greenhouses, equipment, and support infrastructure of storage sheds, offices, worker housing, and kitchen. The raw materials used in the manufacture of tree seedlings included seed, soil, water, fertilizer, chemicals, and mulch. Energy to power the process of production came from the sun, the labor of workers, the draft power of horses, and later the horsepower of tractors and trucks. The factory system put out millions of tree seedlings as the final product. These had to be handled during the process, then packaged and delivered once they were finished.

The production facility and the products themselves were at once nature and technology. The manufacturing system combined machinery and ecological processes to produce tree seedlings. The tree seedlings themselves, in turn, were intended to function as technology—as the individual components within a larger production of an engineered forest. The "widgets" manufactured in any factory can also be understood as just such an embodiment of nature and technology. Although it is perhaps easier to see the nature in a nursery tree seedling as a living organism, or the technology in a bolt or a ball bearing as part of a machine, they are each an inextricable integration of nature and human contrivance. Each designed, produced, and applied for a specific purpose.

As in any industry, expansion and innovation drove the nursery business. During the second year of operation, Charles Scott and the nursery staff built another half-acre of covered nursery beds and continued construction on the other facilities necessary for a tree factory. The headquarters building was completed allowing the foresters to move out of their tents. Thomas County agreed to construct a road from Halsey along the Chicago, Burlington, and Quincy Railroad right of way and build a bridge across the Middle Loup River to the nursery site, allowing much better access for delivering materials and shipping out seedlings. A telephone line was installed from the forest headquarters to the railroad depot two miles away in Halsey, connecting the nursery to the outside world. In March they established a weather station to record maximum and minimum temperatures and precipitation levels at the nursery. These readings became part of the annual reports and important for coordinating planting experiments. By digging a well and a one-acre-inch capacity reservoir, powered by a windmill and connected with pipes to the seed beds, they created a complete irrigation system.[26]

The aesthetics of the nursery were not neglected either. To improve the grounds drives were laid out and 190 ornamental shrubs and trees planted. One of the very first trees planted on the Dismal River Reserve was a balled and burlap wrapped two foot Colorado blue spruce, sent as a gift from the Hill Nursery in Dundee, Illinois. Scott and the three others working at the nursery at the time held an impromptu ceremony for the planting and named the tree in honor of Theodore Roosevelt.

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[26] Charles A. Scott, "A Short History of the Beginning of the Nebraska National Forest and Bessey Nursery," [no date], BRD, box 31, 4; "Memorandum: Nursery and Planting Operations;" Scott, "Annual Nursery and Planting Report, 1903," 2-3.

Figure 4 - Headquarters building. Source: USFS

When he returned in 1952 for the fiftieth anniversary celebration of the nursery, Scott was delighted to find that "Teddy" had grown into a beautiful specimen over forty feet tall. Visitors to the nursery in 1904, including such important officials as William Hall and Gifford Pinchot, several professors from the University of Nebraska, and ranchers from all over the state, were all impressed with the progress being made. Production, science, and demonstration were all part of the nursery's purpose. Scott reported that "the lively interest taken in this work by the people throughout the state goes far to bespeak the favorable light in which it is held." Of course, tree planting on the plains had already become a popular idea but a serious government project now encouraged high expectations.[27]

In 1904, more buildings were constructed to support the facility—an ice house, a coal shed, a tool shed, and a mess hall. Expanding the covered seed beds by an acre and a half increased the production capacity considerably. In 1905 an additional one and a half acres was prepared for growing hardwood seedlings. In these they planted honey locust, thornless locust, Kentucky coffee tree, elm, ash, Russian mulberry, Russian wild olive, hackberry, and soft maple. Over time, nursery workers continued to clear ground for more seed beds, removing grass and bushes and sifting out the roots. To raise production rates they needed to continue increasing the size of the factory floor. Eventually the seed beds, in five separate blocks, covered more than forty acres. In this factory these seed beds were the production line, built out of good clean soil.[28]

The soil at the Bessey Nursery was consistent fine sand. Many of the qualities that made it poor soil for farming were quite useful for nursery operations. It absorbed water quickly and was well drained, so moisture would be easily available to the roots but not stand long on the surface, damaging the young trees. The looseness of the sand allowed seedlings to be lifted easily from the beds, for transplanting or distribution, without damaging their roots. This sand however was extremely low in organic matter or nutrients for the seedlings. Nurserymen had to fertilize the soil extensively.

[27] Charles A. Scott, "The Colorado Blue Spruce," 1953, BRD, box 27; Scott, "Annual Nursery and Planting Report, 1904," 2.
[28] William H. Mast, "Annual Report of the Halsey Planting Station Nebraska National Forest, 1906," BRD, 17.

Beginning in 1906 the nursery began to experiment with different types of fertilizers. Chemical analysis of the soil by the University of Nebraska indicated that the potash level was higher than expected for such a sandy soil. They recommended that if any fertilizer was to be used at all it should be a mild phosphorus fertilizer and perhaps steamed bone. The German Kali Works, a company promoting and distributing commercial fertilizers, suggested a complete experiment using seven planting beds with various mixtures of potash, phosphoric acid, nitrogen, and lime. To support its rate of production, the Bessey Nursery needed soil amendments on an industrial scale. A soil consultant from Iowa State College recommended "an application of about 600 to 800 pounds of dried blood per acre or steamed bone at the rate of 200 pounds per acre." The nursery could obtain a good supply of blood and bone from the meat packer Swift & Company, in Omaha. "If well rotted barnyard manure was to be used," the consultant advised, "it should be applied at the rate of about 2 tons per acre at the time the beds are being made up for planting." The nursery set up 22 experimental seed beds of jack pine and ponderosa pine to test different combinations of these materials.[29]

Although the nutrients pre-existing in the sand hill soil supported the first few years of seedling production, the need for additional fertilizer soon became clear. Organic material in the soil was part of the ecological cycle that supported tree growth and it was an essential raw material that had to be fed into the system for seedling production. In 1908, forest supervisor William Mast reported that it was "apparent that the supply of plant food in the soil in some parts of the nursery is becoming exhausted

[29] Letter from S. Avery, University of Nebraska, Department of Chemistry to Halsey Forest Reserve, September 13, 1905, BRD, box 24; Office of German Kali Works to William H. Mast, April 18, 1906, BRD, box 24; "Concerning Fertilizer," BRD, box 24.

and it is believed that there is urgent need for the application of fertilizer in order to produce thrifty stock."[30] So beginning that year, empty seed beds were planted with cow peas or rye that was turned in during the summer as a green manure. The beds were covered with coarse manure in the fall to prevent soil blowing by the winter winds. Before replanting, workers gave seed beds a coating of 1 inch of well rotted manure spaded in, then "a small quantity of commercial fertilizer consisting of dried blood and bone meal was applied before the ground was smoothed with the rake." The nursery staff built a large 10' x 100' x 4' concrete pit and filled it with manure and water. Once they were a year old, seedlings received a treatment of liquid manure pumped from the bottom of the pit. This treatment had a significant positive effect on seedling growth.[31]

In the winter of 1911-12 the nursery acquired 80 tons of manure, which along with the 40 tons already on hand, was spread on all the vacant sections of the nursery. Block 1 received 24 tons in July and another 32 tons in September in preparation for seeding. Manure and fertilizer had become an essential material in the production process. The District Supervisor warned the nursery manager not to fail to collect more during the following winter. By the 1920s chemical fertilizers became popular and ammonium sulphate was spread or sprayed on all seed beds before planting.[32]

While soil and organic matter provided the foundation for the site of tree production, water was another input that had to be reliably delivered to the factory floor. The initial well, windmill, and reservoir were expanded and upgraded in 1907 into a more

[30] William H. Mast, "Annual Report on the Halsey Planting Station, Nebraska National Forest," 1908, BRD, 6.
[31] William H. Mast, "Annual Report on the Halsey Nursery, Nebraska National Forest," 1909, BRD, 16.
[32] Roy G. Pierce, "Annual Report of the Halsey Nursery, Nebraska National Forest,1911," BRD, 10.

flexible irrigation system with gasoline pumps and canvas hoses. This allowed further control over the water critical to production. Precipitation recorded at the nursery weather station averaged twenty two inches a year but around that average the annual rainfall could fluctuate widely. For nursery operations precipitation during the growing season, April through September, was most important. During the 1915 nursery season rainfall was eight inches above normal. Cooler than average temperatures also made it a very favorable growing season. But the following year, precipitation fell almost seven inches below the average and the temperature was higher than normal. A fifteen inch swing in precipitation levels from one year to the next belies the concept of an average rainfall level on the Plains and illustrates why it was so difficult for individual settlers to farm and successfully grow trees. Mechanical irrigation was essential in the nursery.[33]

While there was little nursery managers could do about the temperature beyond shading and mulching, they did not have to rely solely on the unpredictable rain. Irrigation, like fertilization, allowed them to manipulate another part of the ecology of production. The nursery used over six million gallons of water in 1916. Improvements to the irrigation system that year included a twelve inch flume line to Block III with plans to quickly replace most of the three inch pipe in the nursery with these flumes. One year and older seedlings and transplanted trees did well with flood irrigation, but freshly seeded beds and younger seedlings could wash out from this method. Through the late 1920s and early 1930s overhead sprinklers were installed for watering first year seedlings. Annual water use on the nursery would eventually reach as much as 26

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[33] Fred R. Johnson, "Annual Report Bessey Nursery, Nebraska National Forest, 1915," BRD, 38; Jay Higgins, "Annual Report Bessey Nursery, Nebraska National Forest, 1916," BRD, 43.

million gallons. By 1947, sprinklers and nine or eleven inch canvas hoses delivered water from the flumes to all the seed beds. Three reservoirs with a capacity of 250,000 gallons fed the flumes with water. Gasoline and electric pumps filled the reservoirs with well water. Water could also be pumped directly from the Middle Loup River to the seed beds, although this raised the problem of introducing contaminants into the production system. The river offered a plentiful supply of water but this water was part of the uncontrolled environment, not a pure component in a manufacturing system. Sand, suspended in the water, could clog flumes and hoses and "appreciable quantities of weed and grass seed" would be delivered to the seed beds with the river water, contributing to "the weed problem." So river water was used sparingly and well water much preferred for irrigation. Nursery managers wanted to grow only the seeds they planted.[34]

From the very beginning they seeded a variety of trees in the nursery beds. Jack pine, western yellow pine (ponderosa), lodgepole pine, piñon pine, limber pine, red cedar, red fir, white fir, Douglas fir, blue spruce, and more were planted during the first several years. The goal on the Reserve was to rationalize the production of seedlings in the nursery then use those seedlings to construct a forest. Like Charles Sargent and Robert Douglas, federal foresters were willing to try all kinds of trees to discover which species worked best in that environment. They planted exotic species like Scotch and Austrian pine with seed imported from the northern Alps, Austria, France, Finland, Sweden, Denmark, and Russia. Although their forest would be built almost exclusively with conifers, the Forest Service experimented with hardwoods and continued to grow them

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[34] Higgins, "Annual Report, 1916," 29-30; "Annual Nursery Report Bessey Nursery, Nebraska National Forest, Fiscal Year 1950," BRD, 4; John S. Maslock, "Watering Systems," [1947] from a binder containing compilation of reports by topic, BRD, box 27.

for distribution to the public. They also grew their own ornamental trees and shrubs for use on the nursery grounds.

The factory floor for the first stage of tree production was a series of seed beds laid out within the sections of a particular block of the nursery. The number of sections in a block and beds within a section changed as each season's planting was laid out. The number and layout of sections and beds reflected the ratio of species seeded that year. For example, in 1935 each of the five blocks had either five or six sections and anywhere from 60 to 102 seedbeds. The nursery that year had a total of 249 seed beds, each about four feet wide and two hundred feet long with two foot wide paths between the beds. In general, each year two-thirds of the total nursery area was in production and one-third was fallow and planted with a cover crop.[35]

Manufacturing—Ecology and Technology of Production

In preparation for seeding, the soil in each bed, having been treated with manure the year before and had a cover crop turned in, would be loosened and leveled. Nursery beds could be seeded in the fall or the spring. Seed was either broadcast sown or planted with a seed drill. When sowing, the soil was raked, the seed broadcast over the entire bed, then the soil was raked again. A seed drill was simply a device that laid or rolled across the bed imprinting a trough into the soil. A carefully measured amount of seed would be planted in the trough, covered over, and the soil packed down. Each row was drilled separately until the bed was finished. The nursery designed their own drills and

[35] A. W. Krofchek, "Bessey Nursery Tree Production," *The Bulletin—Rocky Mountain Region*, USFS, October 1935, BRD, box 27, 11.

utilized commercial ones like the "Planet Jr" (which is still in use today) that cut the trough and laid the seed. Seeds from different trees varied widely in size. For example yellow pine averages from 10,000 to 15,000 seeds per pound while lodgepole and jack pine have over 120,000 and red cedar up to 400,000 seeds per pound. Each species favored different planting conditions too, so managers experimented with many methods. Broadcast sowing was easiest, quickest, and therefore cheapest. But broadcast sown seedlings were often weaker and required more work later in thinning the seedlings as they came up in dense growth and needed more room for good development. The whole bed also generally showed more variability in the vigor and size of the plants than with drill planting. Also, broadcast sown beds had to be weeded by hand while the extra space between rows in a drilled bed allowed the use of tools for weeding and cultivating. At different times many species were broadcast sown in the nursery, but seed drill planting was preferred as it provided greater control over the process. In drill planting the leveling of the soil in the bed was more critical and covering the seeds to an appropriate, consistent depth was more difficult. One of the important equipment innovations at the Bessey Nursery was a soil spreader that could cover the drilled beds with an even layer of cleaned sand one-eighth to one-quarter inch thick.[36]

Once the seeds were covered and the soil firmed over, managers just had to wait for them to germinate. Each tree seed contains an embryonic plant that had begun to grow in the cone and then become dormant. The right combination of temperature, moisture, and oxygen is required to stimulate the seed to resume growing. It first sends

[36] William T. Cox, "Reforestation on the National Forests," (Washington D.C.: GPO, 1911), 24; George B. Sudworth, "The Forest Nursery: Collection of Tree Seeds and Propagation of Seedlings," (Washington D.C.: GPO, 1900), 42.

out a root, then an upward shoot. Each seed also contains enough stored energy to allow the shoot to reach the surface where it can begin to make its own food. Poor germination is often a result of seeds planted too deeply. However simply planting seeds into the soil is often not enough to stimulate germination. Many tree seeds have coatings that prevent the absorption of water or oxygen. Some seeds, from serotinous species, require especially high temperatures associated in the wild with forest fires before they germinate. All the effort of collecting seeds, constructing seedbeds, and carefully planting the seeds are wasted if the seeds are not brought out of dormancy at the right time. The first act in the manufacture of tree seedlings at the nursery was an ecological moment, the beginning of a life.

Nursery managers found several ways to mimic the environmental conditions that affected the ecological process of germination. Once they had collected, cleaned, and sorted a batch of tree seeds, they could mechanically manipulate the seeds to increase the success of germination. Two of the ways they did this were through scarification and stratification. Because tree seeds in the wild tend to lay on the forest floor for varying periods of time waiting for optimal environmental conditions, they often do not easily germinate in nursery beds just because someone plants them there. Many tree seeds have a coating that allows them to remain viable for years and protects them from damage. Some remain dormant and require a year or more of "after-ripening" in specific conditions before they will begin to grow. Scarification breaks the protective coating and allows the seed to more easily absorb water. In the wild this processing occurs as seeds pass through the digestive tracts of birds or animals, or are exposed to the heat of fire. In the nursery it is generally done by mechanical abrasion or by soaking the seeds in either warm water or a sulphuric acid solution. Stratification brings tree seeds out of dormancy quickly by combining pressure, temperature, moisture, and air flow to simulate a long period of time on a forest floor. The necessary environmental influence is reduced from years to months. Machines, temperature controlled storage buildings, and managed processing substitute for the organisms and conditions that make up the ecological interactions of germination.

Bessey Nursery managers developed equipment and procedures to speed up and increase the reliability of seed germination. Like the action of abrasive grit in a bird's crop, tumbling seeds in barrels lined with carbide paper helped remove the seed coating. Seeds were also soaked and screened. Juniper and red cedar seed was particularly hard to germinate so they received the most processing. In the technique in use by 1926, the berries were first soaked in water or a water and lye mixture. Then they were smashed to a pulp with a wooden board, scrubbed, and dried. Forcing the tiny seeds through a "common window screen" sized mesh screened the dried pulp. The seeds were soaked again in a solution of lye and water then rinsed and dried. This was basically an artificial process that mimicked consumption, digestion, and excretion of the seeds. Later nurserymen developed a "macerator" to replace hand pulping with machinery. Experimentation at Bessey led to an effective method of stratification for this cleaned seed. Moistened seed was mixed with twice the amount of wet sand in a box or layered one-quarter inch thick between one-half inch layers of wet sand and packed firm with a cement trowel. The box was buried in the ground and left over winter. Even greater success was achieved by 1950 with seed stratified in steel drums between layers of moist peat moss and kept in cold storage of 36 to 45 degrees Fahrenheit for three to five months. Refrigerated cold storage gave managers much more control over the process. They reported that, due to environmental fluctuations, “the ground stratification process [was] not deemed as reliable as controlled cold storage facilities.” Just like other manufacturers using the factory system, they sought success in standardization through mechanization and innovation. While seed germination was an organic, ecological process, the manipulation of the seeds and the environment to influence that process was one of the important technical aspects of the production of tree seedlings.[37]

Once they were sown in prepared beds, the seeds had sprouted, and the seedlings began to grow in the nursery, human workers had to tend them and try to shape them into the type of seedlings that would best succeed in forest planting. With the purpose of building a forest from the ground up in what foresters admitted were “rather difficult and unfavorable natural conditions,” it was “essential that the best possible class of planting stock” came out of the nursery. Nursery managers needed to produce vigorous plants, what they called thrifty stock. These were strong growing seedlings with good color, sturdy stems, and a well developed root system. A dense mass of side roots and rootlets was more important than a long tap root as these were responsible for taking up water from the soil right away when the seedlings were planted in the field. To encourage the

[37] Karl L. Janouch, “The Preparation of Seed,” 1926, BRD, box 27; W. B. Apgar, “Annual Report, Bessey Nursery, Nebraska National Forest, December 1 1929 to November 30, 1930,” BRD, 34-36; B. J. Abrams, “Treatment of Cedar Seed (J. virginiana)” 1942, BRD, box 27; John S. Maslock, “Treatment of Eastern Red Cedar Seed,” 1950, BRD, box 27.

proper development, root trimming was sometimes practiced as part of the production process in the nursery.[38]

Seedlings were also lifted from the seed beds after one or two years and transplanted into a new seed bed to grow for another year. The Bessey Nursery staff developed and improved specialized equipment for the transplanting operation. Different types of tree diggers were used which passed a pair of blades underneath the seedlings lifting them out of the soil. Horses or tractors pulled the digger (which looked something like a plow) forward with ropes or cables worked through a capstan mounted outside the seed bed. Transplant boards were also developed in which many seedlings were threaded into individual holes then the whole set of seedlings could be planted at once into a furrow. Seedlings were labeled according to how much time they spent in each seed bed. The most successful jack pine and yellow pine seedlings at Bessey were 2-1 seedlings—they spent two years in the first seed bed and one year in a transplant bed. The purpose of transplanting seedlings into a different bed for a season between the germinating bed and field planting was to produce better root development and stronger, hardier plants. Only thrifty seedlings, the target product of this tree factory, could withstand the handling, transplanting, and shipping of the manufacturing process, and environmental conditions in the field where they eventually ended up as a planted forest.

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[38] Jay Higgins, "Facts and Figures Regarding the Nebraska Planting Project," *The Bulletin—Rocky Mountain Region: Nebraska Forest Silver Anniversary Issue*, USFS, July 1927, ASCUN, Walter B. Kiener Papers, Box 53, folder 12, 29.

Expanding Control—Manipulating and Managing the System

In the fully developed factory system, workers in other industries might assemble a product piece by piece as it passed by on an assembly line.[39] To produce thrifty stock in the Bessey Nursery, however, workers tended to the seedlings and manipulated the environment of each location the seedling stopped at during the production process. Seed collection; seed processing and storage; sowing, growing and weeding in seedbeds; transplanting; packaging and shipping—each of these sites of production had technical requirements. Workers labored at every stage and human intentions guided the process, much of which was mechanized, but the trees did the actual growing. In this factory the product itself participated in the production. There was no separation between the technical process and the ecological process.

Seeds sprouted and seedlings grew, performing photosynthesis and taking up water and nutrients from the soil. Nursery workers watered the seedbeds, provided nutrients, thinned the seedlings, and weeded out the unwanted plants that grew there competing with the tree seedlings. It was a constant struggle to provide optimum growing conditions from year to year. Disagreeable weather impacted nursery operations in 1907. "On account of the dry spring weather," Scott reported, "the soil in the seedbeds was too dry to induce germination at the time of seeding. On May 3 a heavy snow fall

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[39] On industrialization and the factory system in America see David A. Hounshell, *From the American System to Mass Production: the Development of Manufacturing Technology in the United States* (Baltimore: Johns Hopkins University Press, 1984); Walter Licht, *Industrializing America: The Nineteenth Century* (Baltimore: Johns Hopkins University Press, 1995); Lindy Biggs, *The Rational Factory: Architecture, Technology and Work in America's Age of Mass Production* (Baltimore: Johns Hopkins University Press, 2002).

moistened the ground sufficiently to germinate the seed but the cold weather that followed retarded all vegetation and up until the present time (June 1) there has not been enough warm weather to induce a good thrifty growth and not over 10 per cent of the seedlings that should appear are yet above ground."[40] With the gasoline pump and irrigation ditches installed later that year and further improvements to the irrigation system over time, especially the installation of overhead sprinklers, the nursery's reliance on capricious precipitation diminished. Burlap coverings for the seed beds also helped retain warmth and protect the beds, improving germination.

The following year, ironically, there were good, frequent rains and only a small amount of irrigating was required. Instead, wind was the big problem. "Terrific windstorms," on April 23, 24, and 25, 1908, killed some 30,000 transplanted Scotch pine seedlings and damaged many more so that "their possibilities for thrifty growth were very considerably reduced."[41] Plans were made to protect future transplants with a light mulch of hay or straw. Too much mulch, though, could damage the seedlings by blocking out sunlight. Problems and solutions shifted from year to year. Control was difficult to achieve. Winter mulch that protected seedlings from dangerous winds and cold temperatures one year could smash them the next under the weight of especially heavy snow melt. Even as they tried to manage all the variables of the production process, unpredictable environmental conditions caused nurserymen much frustration. Forest supervisor William Mast complained in his 1909 report: "on account of dry atmosphere, the effect of which is much intensified by the frequent strong winds, and because of the

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[40] Charles A. Scott, "Annual Report on the Halsey Planting Station, Dismal River National Forest, Fiscal Year 1907," BRD, 4-5.
[41] Mast, "Annual Report, 1908," 17.

necessity of giving the coniferous seeds only a very light covering it becomes a difficult proposition to furnish favorable conditions for germination and maintain them until all the seeds have come up."[42] That April a severe windstorm had blown all the freshly sown seed out of three of his seed beds. Because the tree factory relied on ecological forces in the manufacturing process, it was firmly embedded in the local environment and thus subject to the vagaries of those forces. Physical improvements to the nursery could mitigate the impact but never remove the need for ecological interactions. This factory could never be placeless.

By trying to provide ideal conditions for the production of trees, the nursery also promoted the growth of other, unwanted plants. These had to be pulled out by hand. Some of the most labor intensive work in the nursery involved removing weeds from the seed beds. As the trees grew so did the weeds. Weed seed came in on the wind; it was in the manure, the straw and hay mulch, and the irrigation water from the river. Nursery workers inadvertently spread weed seed everywhere as they tended the tree seedlings. The tree factory was constantly manufacturing an unwanted product. It was as if a bicycle factory was forced to also build tricycles that it then could not sell. Worse than just a by-product or waste material, these opportunistic plants used up valuable resources, threatened the success of tree seedlings, and vexed the management. Weeds were "most troublesome" in 1917 and "because of the shortage of labor it was difficult to control them." Controlling the ecological interconnections of the tree factory confronted managers with the dilemma of maximizing the growth of one plant while trying to eliminate the growth of another. A special cultivating tool was developed at the Bessey

[42] Mast, "Annual Report 1909," 18.

Nursery that loosened the soil and made the work more efficient, but weeds remained a perennial problem especially in the transplant beds. In 1921 “the weeds were worse than ever before.” In 1924, they were “quite troublesome” and there were not enough workers to deal with them. “Weeds made a much more rapid progress than did the weed pullers,” the nursery manager reported, “as a result the nursery was very weedy until about the latter part of July.” Weeding operations in 1926 caused considerable damage to seedlings as the “tremendous weed growth” resulted in a heavy matted root system and many trees were pulled out with the weeds.[43]

Nursery managers, like factory millwrights, had to be problem solvers. Weather and weeds, though troublesome, were common, straightforward challenges. Another, more insidious problem struck each year. “Damping off,” a fungus that attacked the roots during warm, moist weather, caused sudden wilting and death in young seedlings. Thousands could be killed in a single day. It was a persistent problem and in the early years of the nursery damping off destroyed a significant portion of each season’s production. The first seedlings grown in 1903 were struck by it; the jack pine and yellow pine suffered considerable losses. Often up to 60 percent of the newly germinated seedlings in a bed succumbed. In 1911 damping off killed 99 percent of the trees in some seed beds and the nursery as a whole lost half of its seedlings. All nurseries struggled with this problem and there were no treatments only preventative measures. Excessive moisture in the soil had to be avoided during the first few weeks of growth. This was a

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[43] Jay Higgins, “Annual Nursery Report, Bessey Nursery, Nebraska National Forest, 1917,” BRD, 11; Jay Higgins, “Annual Nursery Report, Bessey Nursery, Nebraska National Forest, 1921,” BRD, 9; Karl L. Janouch, “Annual Nursery Report, Bessey Nursery, Nebraska National Forest, 1924,” BRD, 6, 10; William C. Buckner, “Annual Nursery Report, Bessey Nursery, Nebraska National Forest, 1926,” BRD, 6.

difficult proposition because newly seeded beds required a certain amount of water to stimulate germination in the first place. Some nursery manuals suggested sprinkling a layer of warm dry sand over the beds. But at Bessey the seed beds were already almost pure sand and managers found no benefit in adding more on top. Nursery managers had to balance protecting new tree sprouts with mulch and burlap while allowing sufficient airflow and regulating soil moisture after germination. Unpredictable weather could still spoil their best efforts with sudden rain and a rising temperature. A philosophy of efficient factory production could certainly not condone a loss of 50 percent of the product each year. From this point of view, damping off was one of the nursery's biggest problems.[44]

Correspondence between the forest supervisor and a University of Michigan professor who had recently visited nurseries in Europe revealed the prevalence of the problem there as well. Beyond adjusting nursery conditions to produce the healthiest possible seedlings in the hope of increasing survival rates when damping off struck, nurseries in Europe reported no effective remedies. Staff at the Bessey Nursery experimented with different treatments including treating the soil with formalin, covering seedlings with mulches, and spraying different mixtures of copper sulphate. In a cooperative project with the Bureau of Plant Industry, Carl P. Hartley of the Bureau's Office of Forest Pathology conducted experiments at the nursery that eventually led to some success in preventing damping off by spraying the beds with ammonium sulphate right before the seeds were sown. A mobile barrel sprayer was developed and the

[44] Sudworth, "Forest Nursery," 49; Scott, "Annual Nursery and Planting Report, 1904," 7; Pierce, "Annual Report of the Halsey Nursery, 1911," 12-13.

application of a dilute solution of sulphuric acid became standard practice for new seed beds each season.[45]

Figure 5 - Mobile sprayer, 1908. Source: USFS

They found, coincidentally, that this acid treatment also suppressed weeds and caused a more synchronized germination of seed in each bed, although concentration adjustments and careful watering were necessary to prevent acid injury to the seedlings. In the 1912 seed beds they discovered a "remarkable difference in the height of the acid treated seedlings as compared to the non-treated." The treated seedlings ranged from one to two inches bigger. Also the reduction of weeds in treated beds was so great that the savings in labor costs for weeding was greater than the cost of spraying the sulphuric

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[45] Roy G. Pierce, "Annual Report on the Halsey Nursery Nebraska National Forest, 1910," BRD, 10-11; Pierce, "Annual Report, 1911," 12-13.

acid. The forest supervisor was delighted, reporting: "the acid treatment for jack and Norway pine produces the sturdiest, most uniform and undoubtedly the heaviest stand at a final cost not exceeding, and probably less than the non-treated beds." This represented a great advancement in nursery science and more importantly increased (and more reliable) production. As in any factory, experimentation and innovation concentrated on production problems while operating costs and product quality provided measures of success.[46]

Bugs in the System—Opportunistic Organisms Limiting Production

With the damping off fungus danger reduced, though not eliminated, there were still plenty of other "bugs" to be worked out of the production line. Responding to the new idealized environment the nursery created, other unwanted organisms threatened seedling production. Pine tip moths, hawk moth larvae, and grey blister beetles infested the young trees. While other manufacturing facilities experienced mechanical glitches, this tree factory suffered from organic attacks. Birds and rodents ate newly sown seeds. Rabbits and deer ate seedlings. An epidemic of white grubs, the larval stage of June beetles, killed some twenty percent of the western yellow pine transplants in 1930 and damaged the jack and Norway pine as well by eating the roots. Lamenting the damage done to the output of the nursery and recognizing the living nature of their product, managers referred to the problems of weather, disease, and parasitic organisms in their

[46] H. Earl French, "Annual Report Halsey Nursery, Nebraska National Forest, 1912," BRD, 8, 28. While sulphuric acid sprayed on the bare soil of seed beds before germination greatly reduced the weeds there, it could not be used in the transplant beds where weeds remained a significant problem.

annual reports under the heading of "Injuries." These pests were injuring the individual trees and the organic whole of the nursery. Great efforts were made to combat them.

Beginning in 1907, nursery workers coated all the seed sown with red lead to discourage birds and rodents from eating it. When rabbits ate several thousand Scotch pine seedlings to within an inch of the ground, Scott decided, "the shotgun remedy liberally applied will probably prove the most effective method of preventing further depredations."[47] Beetles killed several hundred black and honey locusts in 1910 and the nursery staff fought back by spraying Paris green (an infamous early 19th century dye that became useful as an insecticide due to its toxic copper arsenite content). As the local deer population grew through the 1930s and began eagerly browsing the seedlings, some two miles of deer fencing was installed to protect the nursery. This proved ineffective though, as the deer simply jumped the cattle guards or swam across the river north of the nursery. A night guard was employed to chase off the deer, the cattle guards widened, the fencing extended, but the conflict with the deer continued. The white grub outbreak so worried managers that they commenced a poisoning campaign, applying crude arsenic to the transplant beds at the rate of 80 pounds per acre. This seemed to have no effect on the grubs so they set up experimental plots to test crude arsenic, calcium arsenate, and sugar of lead at the rate of 100, 200, 400, and 500 pounds per acre. None of these proved very effective. A four year project, begun in 1932, then tested the use of basic lead arsenic against white grubs in experimental plots at the rates of 500, 1000, and 1,500 pounds per acre. The final conclusion of the experimenters was that lead arsenic was very detrimental to tree growth and should not be applied for the prevention of white

[47] Scott, "Annual Report, 1907," 11.

grubs. The severity of the grub infestation, meanwhile, seemed to have passed with the end of the June beetle's three year life cycle. The soil of the test plots had to be stripped to a depth of twelve inches and replaced with new soil.[48]

The difficulties of environmental conditions—the geology, the weather, the flora and fauna—of central Nebraska were more important to the Bessey tree nursery than they would have been to any other industrial factory. While other factories could substantially exclude the external environment, managers at the Bessey Nursery had to use it to manufacture a living product. The nursery was not just located in a generic place and they could not simply erect enormous buildings or warehouses to contain their facilities and protect their assembly lines and finished products. The nursery was embedded in the landscape; the environmental conditions were an intimate component of the manufacturing process and exposure to the elements a necessary condition. The manufacturing process harnessed the sun, rain, soil, and even the trees' own biology. These components could be manipulated but not fully controlled. The interaction of the environmental and biotic components was the mechanism that produced living trees but this interaction provided opportunities for other organisms as well. The machinery of tree manufacturing was the ecology of tree life and this ecology included fungi, grubs, birds, rabbits, and deer. In creating tree life it was impossible to exclude all other life.[49]

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[48] Pierce, "Annual Report, 1910," 11-12; Philip L. Heaton, "Bessey Nursery, Nebraska National Forest, Annual Nursery Report, January 1, 1937 to December 31, 1937," BRD, 55; Philip L. Heaton, "Bessey Nursery, Nebraska National Forest, Annual Nursery Report, January 1, 1936 to December 31, 1936," BRD, 39-40.

[49] Even though the later construction of automated greenhouses that provided water and nutrients mechanically to produce seedlings in individual containers substantially increased the level of control, this lack of complete control still holds true.

Factory Workers—Labor Management for Tree Production

While trying, as best they could, to manage the ecology of tree production, the people in charge of the Bessey Nursery attempted to rationalize the human and mechanical components of their system in the same ways as other industrial manufacturers. Along with application of inorganic power sources (falling water, fire, electricity) and the mechanization of production processes that took place in the industrial revolution came a new regime of "scientific management" of labor, aimed at making workers more efficient. Frederick Winslow Taylor codified this management style in 1911 when he published *Principles of Scientific Management*. Popularly known as Taylorism, this scientific management of labor utilized stopwatch measured time and motion studies and work station organization to rationalize and control the movements factory workers used in their jobs. The goal was efficiency and the idea fit perfectly with Progressive Era modernist ideology, sparking quite a fad. Taylorism suggested a proper way to perform any labor task from factory work to housekeeping. Factory workers themselves, though, often resented the further loss of control of their labor and sometimes resisted through purposeful slow-downs, known as soldiering. Part of the division in American society arising from industrialization included a new class of managers responsible for supervising labor and implementing scientific management.[50]

Labor regimes at the Bessey Nursery ranged from the planning and supervision of trained foresters, to the delicate tasks done by semi-skilled nursery workers, to general

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[50] On the history of Taylorism see H. G. J. Aiken, *Scientific Management in Action: Taylorism at Watertown Arsenal, 1908-1915* (Princeton: Princeton University Press, 1985); R. Kanigel, *The One Best Way: Frederick Winslow Taylor and the Enigma of Efficiency* (New York: Viking, 1989).

labor of temporary workers who planted trees, dug new seed beds, and pulled weeds. There was a staff of permanent Forest Service employees and a seasonal force of local and migrant laborers. Nursery managers and forest rangers supervised daily operations submitting reports and receiving directions from the Forest Supervisor and District Supervisor. The hierarchy and bureaucratic organization of the Forest Service provided a clear structure for management of the nursery. Similar to the situation in other industries, a relationship existed between management and labor where one side valued production capacity and quality while the other was more concerned with wages and working conditions. In this case, however, management had a long term plan driven by an ideology bordering on a manifest destiny. The institutional identity and idealism of the Forest Service infused the purpose and operation of the nursery. A special Forest Service publication in 1927, reprinting a newspaper description, offered a perfect example of their determination. There were, they admitted, many obstacles to overcome. "But like the attack of the American troops on the German lines in the Argonne forest, the attack of forest scientists upon the sand hills never halted. Each year saw more thousands of baby trees started in the nursery. Each year saw more hundreds of acres set out to evergreens."[51] Unfortunately, in this campaign they were forced to rely on a separate, usually transient group of wage laborers who did not share their vision of the nursery or the Forest Service's mission. A situation that caused managers from the Forest Service much frustration.

Each year from thirty to fifty men were hired to work in the nursery and plant trees in the hills. The number and quality of laborers fluctuated widely from year to year

[51] *The Bulletin, 1927*, 20.

and within the course of each year's work. The Forest Service men worried their mission was at the mercy of the workers they were forced to hire. Forest Supervisor Roy Pierce admitted, "the labor problem controls the output of the Nursery." While they preferred to hire local men and spring planting sometimes offered seasonal employment to nearby ranchers, this workforce often proved insufficient or nonexistent. Advertising in newspapers, post offices, and employment agencies, managers usually had to take anyone they could get for each year's nursery work and field planting. "Several tramps have been hired during [planting] season, and with only one exception, these men have not proved worth keeping," Pierce complained in his 1910 report. "In the future it would be better not to hire the habitual hobo. Hire and fire should go pretty closely together with temporary laborers."[52]

The 1912 spring season began on April 2 with a crew of eleven men in the nursery which increased to thirty-seven by April 10. A parsimonious federal budget compounded the poor employee outlook when on May 8 all but seven men were discharged "because of the small balance remaining in the appropriation," although a few more were added on in July. Nursery managers desperately wanted a reliable workforce that returned each year. What they got instead was "a green bunch of men, many irresponsible and young, who had to be instructed in everything, and then watched continually." In 1912 as in most years, the nursery found it "necessary to retain the services of a number of men who were of no account." Many of the men who began work each spring did not last through the season. The reasons so few stayed on or returned the following year, "the more or less shifting nature of the sand hill population,

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[52] Pierce, "Annual Report, 1910," 13.

the small wages paid, the temporary character of the work, and the small chance of advancement," were all beyond the control of the nursery manager. The "better class of laborers" went into railroading or farming.[53]

The nursery tried various schemes to attract good employees and keep them working through the entire season. Many workers came in on the rail line; their transportation costs could be worked off by remaining at the nursery at least thirty days. A significant bonus was added on top of the daily wage to those that stayed the whole season and performed satisfactory work. Workers earned $1.28 per day plus room and board and a 24 cent per day bonus. Still, many quit to take up farm work in the early fall. The nursery foreman found it "extremely difficult to replace them with anything but vagrants or hoboes which can be secured from the labor agencies in cities."[54] Besides the quality of labor, it was often impossible to get enough workers. Frequently boys were hired to help weed the transplant beds, but they required much more supervision and most did a poor job. One year, "three local boys, about 11 years old, were hired to weed seed beds but they became homesick and lasted only one day."[55] A more serious illness struck in 1916. Measles broke out in camp at the beginning of the season and then on April 13 there were two cases of small pox. The afflicted men were isolated, the camp was fumigated and everyone vaccinated and quarantined. There were no more cases but the episode interfered with the season's work. "The poorer class of men took advantage of the quarantine and would shirk or lay off from work on any little pretext, 'sore arm' being the prevalent excuse." Clearly the "soldiering" carried on in other industries, as

[53] French, "Annual Report, 1912," 37-38.
[54] Higgins, "Annual Report, 1916," 5; Johnson, "Annual Report, 1915," 29-30.
[55] Jay Higgins, "Annual Nursery Report, Bessey Nursery, Nebraska National Forest, 1919," BRD, 20.

workers sought to control their own labor and resist the factory system, occurred in the tree factory as well.[56]

Nursery managers, in turn, struggled to control their workers and maximize the efficiency of their operations. Like the efforts at scientific management in other factories, nursery managers sought efficiency through machinery and tried to standardize the work expectations. "The Bessey Nursery cultivators again proved their superior efficiency," the nursery supervisor reported in 1924. "Cost of weeding is cut down considerably by use of the cultivator, if used before the weeds become too large." The same report recorded a labor time-motion study. "It took 5 man-days to cultivate and weed Section 10, Block III, when the weeds were plentiful but not large. The second weeding took 29 man-days, because all weeds were too large for the use of cultivators. The third weeding and cultivation took 8 man-days and the fourth 7 man-days, making a total of 49 man-days for the season." If better labor management had resulted in the use of the cultivators for the second weeding, according to the supervisor, a savings of 12 man-days could have been realized at a reduced operating cost of $289.00 for that section. Because weeding involved the greatest expenditure for labor each year, it offered one of the best areas for increasing efficiency. Another study in the same report examined the work of a group of ten boys hired at $30.00 per month and board to weed transplant beds. It recorded the age of the laborer, wage per hour in cents, quality of work, number of trees pulled with weeds, area weeded in two hours, and the labor cost per square foot including a half-cent charge per tree pulled. The most efficient of these boys cost 16 cents per square foot and the least efficient $1.10 per foot. "It all goes to

[56] Higgins, "Annual Report, 1916," 32-33.

show," the supervisor reported, "that not too much care can be exercised in selecting labor." Furthermore, as all factory managers realized, greater control over labor equaled greater efficiencies in production.[57]

Labor control at Bessey was hard to achieve though, because even the simplest tasks required skill acquired through experience and worker turnover was high. As nursery managers continuously complained, even when good workers could be found their "shiftless nature" kept them from staying long. "It is most discouraging to attempt to do efficient work with the kind of labor had this year," wrote one manager.[58] As the decade of the 1920s wore on though the labor outlook got considerably better. In 1927, "labor was plentiful" and of a high quality, with none of the problems of the past. The sudden surplus of workers enabled the foreman to hire the best. Most were locals from within 200 miles of the nursery. The following year, labor "was sufficient at all times to warrant good progress." Nursery work paid $1.50 plus room and board and a 50 cent per day bonus.[59]

In 1929, for the first time, the Forest Supervisor mentioned the possibility of hiring women for nursery work. He believed they would be useful for some tasks such as threading the transplant boards. A lack of facilities for housing women workers, however, prevented him from "giving this class of labor a trial." A large pool of workers was available into the 1930s due to the high unemployment of the Great Depression, though turnover at the nursery remained high. Then, from 1934 to 1942 the Civilian

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[57] Janouch, "Annual Report, 1924," 11-13.
[58] Karl L. Janouch, "Annual Nursery Report, Bessey Nursery, Nebraska National Forest, 1925," BRD, 18.
[59] William C. Buckner, "Annual Nursery Report, Bessey Nursery, Nebraska National Forest, 1927," BRD, 21.

Conservation Corps provided almost all of the labor for the nursery and the field planting. Although they initially required training and close supervision, the CCC became an ideal labor force. Besides nursery work and tree planting, they built roads, buildings, and a very popular swimming pool for the public visiting the forest. Established by President Franklin Delano Roosevelt as one of many federal programs in response to the Great Depression, the CCC was a good example of how the circumstances of the Great Depression did not restrict production at the nursery or even the expansion of its operations. The labor outlook improved. Substantial additions were made in the Bessey Ranger District's infrastructure.[60]

Modernization—Improving the Production Line

Annual appropriations increased each year through the 1930s funding a modernization effort that included investments in machinery and efficiency. The nursery experimented with new techniques to increase the control of water use in irrigation, to test the use of chemicals in treating weeds, and to try to standardize the seedlings by producing a uniform height growth. Managers carried out further time studies to apply a mechanical advantage in weeding. Horse teams were given up in favor of tractors for plowing and pulling nursery equipment. In 1930 an ambitious new nursery manager, W. B. Apgar, requested a "Celectrac '20' tractor" and "a new Ford Model AA truck with platform body . . . equipped with a large, powerful spotlight." To equip an experimental

[60] William C. Buckner, "Annual Nursery Report, Bessey Nursery, Nebraska National Forest, December 1, 1928 to December 1, 1929," BRD, 43. On the history of the CCC and their conservation work see Neil Maher, *Nature's New Deal: The Civilian Conservation Corps and the Roots of the America Environmental Movement* (Oxford: Oxford University Press, 2008).

laboratory in the new administration building, he requested "a microscope, soil-testing apparatus, thermometers, scales, electric oven, and other small items." Four new buildings were also needed, he explained: a new mess-house, an open-sided shed, an implement shed, and a garage for seven cars and two tractors. The irrigation pumps should all be operated by electricity, he suggested, and the operating calendar switched from the nursery year to the calendar year, all in the quest for increased efficiency. At this time the nursery was producing just over 2 million seedlings per year but with these improvements, Apgar reported, it would be equipped to increase production output to 4.5 million trees.[61]

Conclusion

Before they could build a forest in the plains, foresters needed a facility for producing seedlings. The Bessey Nursery was a tree factory. It had a production line constructed of carefully constructed beds producing rows of seedlings. Mechanical irrigation systems increased production. Managers developed specialized tools and techniques to increase efficiency and expand their control. Labor had to be managed as well and Tayloristic practices, complete with time-motion studies, were instituted. Just like any factory, control over the process and the workers was crucial to success. In this factory though, nature was a more obvious component of the production system. The soil, the climate, the nature of seeds and seedlings were all part of the manufacturing process. Nature also intervened and impeded the efficiency of production. Workers weeded seed beds to remove unwanted plants that were produced along with the

[61] Apgar, "Annual Report, 1930," 38-39, 58-60.

seedlings. Managers struggled to control insects and fungus and disease. As in other factories, innovation was important and the nursery managers used science and technology to increase the output. With experimentation and experience the Bessey Nursery became very productive.

Over time the process for manufacturing trees was rationalized and modernized. The nursery, like many other American business enterprises in the first quarter of the twentieth century, prospered. Its workers packaged and shipped their product all over the West. Private organizations and National Forests in ten western states ordered trees from the Bessey Nursery and reforested their land with seedlings made on the Great Plains. The bulk of the nursery output, though, went out into the grassy hillsides that surrounded the tree factory. Planted in the sand, the trees grew up in the landscape and into an ecosystem. Factory seedlings eventually became a National Forest.

GROWING A FUNCTIONAL FOREST

I am the Forest Nebraska,
As fresh and as green as it sounds;
For 'though not the forest primeval,
I'm prime and no evil abounds.

I am a living example,
Of what a few persons can do,
When they have the vision and daring
And courage to make dreams come true.[1]

—Silas

A forest is more than just a collection of trees. It is an ongoing process. A functional forest is a set of relationships—many organisms interacting together within and as creators of a matrix of climate, soil, moisture, and nutrients.[2] The sun, soil, precipitation, and nutrients form the context and the conditions for these interactions. But the various organisms themselves, their behavior, their actions, their bodies help create the physical connections that make up a forest. The trees provide food and shelter for other organisms; they fall and decay to add soil to the forest floor. But some connections are even more intimate. Underground, tree roots join with microorganisms, mycorrhizal fungi, sometimes even sharing each other's cells, in a mutually beneficial relationship that allows trees to prosper even in barren soil by providing carbohydrates for the fungi in exchange for phosphorus or nitrogen. Meanwhile, on the trunks and in

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[1] From LoCoed Silas, "Welcome to the Nebraska," NARA, Denver, RG95, box 20, folder 98, a poem written in honor of the silver anniversary of the Nebraska National Forest in 1927.

[2] In using the term "functional forest" I am referring to an ecosystem characterized by trees that has developed sufficient interconnections of ecological process and gained some degree of self-sufficiency or momentum. This characterization is in contrast to human-managed environments that require constant maintenance such as agricultural fields or most commercial tree plantations. Of course this is not to suggest that any forest will persist forever or be immune to disturbance or change.

the forest canopy mosses, lichens, and epiphytes, plants drawing their moisture directly from the air, grow out of the trees. The lines between one organism and another can be blurred and any one is invariably dependent on the others. The environment, the physical structure, and the process of life all combine in a forest as if it were a single giant entity.

A functioning forest is a system, and like a technological system, there are flows of energy and individual components carrying out specific actions. There are many levels of interaction. The individual components—the organisms—are often dependent on each other within these levels and between the levels. However, despite their similarities, a forest is an ecological system that is far more complex than the most complicated mechanical system ever created by humans. But the foresters planting trees on the Dismal River Forest Reserve in 1903 were setting out to create a functional forest. Over time these relationships formed and the factory-made technological trees became part of an ecological system. Foresters built the framework and managed some of the connections, but environmental conditions and the interactions of organisms brought the forest to life.

Beyond the ecological connections, a forest is also a place with certain qualities recognized and valued by people through experience and use. The average American may not be able to offer a scientific definition of a forest, but they certainly know one when they see it. A socially constructed place as well as an ecological one, a forest, with its trees, holds cultural values for American society. People use forests for many purposes. Literally, a physical manifestation of nature, people go to the forest to experience Nature. They often feel that they are going *back* to the Nature they have lost in their everyday lives. Hiking, camping, hunting and fishing connect them to a primeval world. Uninhibited children and especially enthusiastic nature lovers, like John Muir, climb up into the trees to get even closer.[3] In the forest people can see and feel ecological forces and believe that they are a part of the environment. Trees are one of the most potent symbols of Nature, of the wild and even of life itself.

Sometimes though, trees simply provide wonderful shade for a picnic. In the burning summer of an open plains afternoon in Nebraska this might be the most appreciated quality of all. In fact, the wordless highway sign for a picnic area in Nebraska is a picture of a large spreading tree. A square green sign with a single giant tree and an arrow makes a fitting symbol of the importance of planting trees on the Great Plains. The tree becomes a place. It is something to head for, a sanctuary from the sky and the sun and the road. Even in the mundane function of traffic directions the meaning of trees and forests is apparent.

At the end of the 19th century, in the spirit of Manifest Destiny backed by the hubris of Progressive Era high modernism, on the Great Plains where something so culturally important as trees were missing, it made perfect sense to build a forest.

Factory Output—Trees for a Future Forest

This forest began with individual trees. As a tree factory, the Bessey Nursery was a resounding success. Nursery managers had become experts at producing tree seedlings. Reaching record numbers in 1941, the Bessey Nursery contained some 11 million

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[3] See John Muir, "A Wind-Storm in the Forest," in *The Mountains of California*, for the story of how he rode for hours in a wind storm in the top of a 100 foot Douglas spruce.

seedlings. That year the Bessey Nursery produced 8,605,000 1-0 seedlings, 2,239,000 2-0 seedlings, and 3,219,000 transplants with a total value of $31,140. Two years later, with the loss of CCC labor in 1942, production declined drastically as World War II monopolized government resources and priorities. However, output increased again after the war. Operations continue to the present and today the nursery annually produces five million seedlings of forty different species on forty-six acres as well as two crops of container seedlings each year in two automated greenhouses. The nursery also serves as the Forest Service Rocky Mountain Region Seed Bank, storing seed to preserve the genetic diversity of forests throughout the West in the event of fire or disease.[4]

From the very beginning the nursery served other national forests by supplying seed and seedlings for reforestation. In 1905 it sent fifty thousand western yellow pine and red fir to the Black Hills Forest Reserve. The same species were also sent to the Pike's Peak Forest Reserve in Colorado. Every year thereafter tree seedlings were shipped to national forests throughout the west. In 1906 Charles Scott went to Kansas to establish the Garden City Forest Reserve and Nursery. Fifty thousand seedlings were shipped there from Nebraska and an effort was made to begin another hand-planted forest in the Kansas sand hills about fifty miles west of Dodge City. Established in 1908 the Garden City Nursery was intended to replicate the operations at the Forest Service's first nursery in Nebraska, although they would focus on hardwoods in Kansas rather than conifers. Some 300,000 acres along the south side of the Arkansas River were optimistically designated as the Kansas National Forest. Work in the nursery and field

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[4] "Capacity and Production and Value Trees in Bessey Nursery 1904 to 1959," BRD; "Charles E. Bessey Nursery, A Full Service Nursery," USDA Forest Service pamphlet, n.d.

planting continued until 1915 when the project and the National Forest were abolished, a failure mainly due to consecutive years of drought.[5]

Tree seedlings from the Bessey Nursery were also available to other organizations and private individuals. Shipments went out to Wyoming, for the Reclamation Service, and to the Helena Improvement Society in Montana. Others went to Oklahoma and Colorado. In 1907 the nursery made some sixty separate shipments of seedlings and seed. The Bessey Nursery provided seedlings for sale and at cost through the State Extension Service and directly to farmers for improving their land. Trees were distributed under State and federal programs as well. A 1911 appropriation to the Kincaid Act of 1904 (an amendment to the Homestead Act that increased land claims up to 640 acres in the Nebraska Sand Hills) encouraged settlers to improve their land with trees. In the first year nearly 45,000 trees were provided to some 494 applicants. Eventually, two-and-a-half million seedlings were distributed free of charge to Kinkaid settlers.[6] By 1952 farmers in Nebraska had received 15 million hardwoods and 12 million conifers through the Clarke-McNary Act of 1924. Along with provisions for forest protection and forest fire prevention, this act used funds from timber harvests for reforestation and many of the seedlings came from the Bessey Nursery. In a cooperative

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[5] Charles A. Scott, "Report of Work on Dismal River Forest Reserve, 1905," 4, BRD; William H. Mast, "Report of Nursery Work and Field Planting on the Dismal River Forest Reserve, 1906," 3, 6, BRD. On the Garden City Nursery and the Kansas National Forest see Willis Conner Sorensen, "The Kansas National Forest, 1905-1915," *Kansas Historical Quarterly*, vol. XXXV (winter 1969).

[6] Tree seedlings were distributed for free from the nursery to homesteaders and private landowners of the 6th Congressional District of Nebraska under the Kincaid Act from 1912 until 1927. Scott, *The Early Days*, 42; H. Earl French, "Results of Tree Distribution Under the Kinaid Act, 1911," NARA, Denver, RG95, box 20, folder 98.

effort through the Extension Service of the University of Nebraska, many of these trees were also planted into private windbreaks, shelterbelts, and farm woodlots.[7]

The nursery also provided trees for the national shelterbelt planting of the Prairie States Forestry Project, run by the Forest Service during the Great Depression. Seedlings from Bessey as well as other local nurseries were used to engineer the environment in response to the Dust Bowl and provide employment through tree planting. Despite all these other uses and recipients, however, the nursery's founding purpose and main effort was always directed at producing trees for planting in the surrounding hills and building the Nebraska National Forest.

Forest Dreams—Planting the First Trees

Charles Bessey's dream of a reforested Sand Hills was adopted and put into action by Bernhard Fernow and Gifford Pinchot. The trees, planted by laborers under the supervision of federal foresters like Charles Scott and William Mast, would grow to be enjoyed by generations of Nebraskans. But the forest, like all forests, grew slowly. The first plantings failed and ultimately the forested area of the Bessey Ranger District only ever amounted to some thirty thousand acres. Nevertheless, apart from the extent of the forest itself, the effort of constructing the forest was important. Foresters learned very different lessons from planting a new forest than they did from managing or harvesting an

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[7] Scott, "Annual Report on the Halsey Planting Station Dismal River National Forest Fiscal Year 1907," 15-16, BRD; USDA Forest Service, "Nebraska National Forest," (September 1952), 17; Raymond J. Pool, "Fifty Years on the Nebraska National Forest," *Nebraska History*, XXXIV, (September, 1953), 173-174.

existing one.[8] In planting the Dismal River forest they discovered which species could succeed in what conditions. They learned the importance of seed provenance—where a seed came from was essential to where it could grow. They saw the influence of soil, climate, slope, elevation, and facing exposure on tree growth. Their forest was not just trees; other organisms helped or hindered their work. Because they were building rather than harvesting a forest, they saw the ecological interconnections much more clearly and quickly.

Once the forest was growing, a variety of other organisms responded opportunistically to the new environmental conditions and forest managers had to deal with a changing ecological complexity. Later, by introducing new species, they added to that complexity themselves, like building a living jigsaw puzzle. Through work and attention they became intimately involved in an evolving environment that was initially of their own making but increasingly beyond their full control. The tight rationality of the nursery factory could not be maintained in the field, as it became a forest. The puzzle was arranging itself and creating new pieces even as they worked on it. From the planted rows of individual trees, the forest took on a greater life of its own.

The first field planting on the Dismal River Reserve was undertaken in the spring of 1903. There were no nursery seedlings yet available so they planted wild seedlings collected from other forests. In the spring of 1902, on the way to beginning the first work at Halsey, Louis Miller and Charles Scott stopped off in the Black Hills of South Dakota

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[8] See Langston, *Forest Dreams, Forest Nightmares* for an example of foresters attempting to manage an old growth forest in eastern Oregon through timber harvests in order to maximize merchantable species like ponderosa pine. In their failure to shape the forest they wanted through logging, these foresters learned hard lessons about succession and ecosystem functions.

and conducted a survey of tree reproduction and availability of seedlings for transplanting in Nebraska. Their report described deforestation from logging to provide timbers for the mines in Lead and Deadwood. Miller also commented on the succession of forest trees after fire, explaining that aspen quickly filled in the burned over areas and significant quantities of pine (a much more desirable species) could not grow until the aspen had matured and died out. However, they were able to locate suitable stocks of Bull pine (ponderosa) to dig for beginning the Dismal River Reserve planting and recommended artificial seeding experiments for several areas in the Black Hills.[9]

The first field planting at the Dismal River Reserve, in the spring of 1903, showed that building a forest would not be a simple task. They began the forest on May 6. A cool cloudy day following over an inch of rain the night before, "the conditions were perfect for tree planting." With five men planting seedlings into individual holes about four feet apart and three boys dropping trees for them, they put in 16,000 seedlings that first day. Scott declared it, "not a bad day's work for the beginning" of what became "the largest man-made forest in the plains." This first planting season lasted nine days, until May 14.[10]

The foresters planted 30,000 western yellow pines pulled in the Black Hills, 70,000 jack pines from the forests of Minnesota, and several thousand each of cottonwood and willow cuttings. Also, 10 acres were sown with red cedar and 24 acres with pine and spruce seed. While the foresters were confident in their mission, initial

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[9] L. C. Miller, "A Report on the Transplantation Bull Pine Seedlings in the Black Hills Forest Reserve," (1902), BRD, 4.

[10] USDA Forest Service, "The Bulletin, Rocky Mountain Region: The Nebraska National Forest," Vol 8, no. 10 (October, 1935), 3.

Figure 6 - First forest planting, 1903. Source: USFS

expectations were low. A memorandum from the new reserve reported that "the use of forest grown seedlings has rarely been successful, and it could scarcely be considered so in the sandhills where soil conditions are more unfavorable than in many forested regions." The yellow pine failed completely, as did the cedar, pine, and spruce seed. The jack pine seedlings fared better, with up to fifty percent surviving. Two years later, some trees measured 20 inches in height and the average was 11 inches. Their average growth in 1905 was 6.5 inches. Within four years the best of these reached three to four feet. As no special care was given to the trees once they were planted, this growth was described as "extremely remarkable and exceed[ing] that made by the trees in their native soil in

Minnesota." Despite all the losses, optimism prevailed. "The success attained through this experiment fully warrants the continuation of forest planting on land which is of little value for grazing and of no value for agriculture." Despite the enthusiasm, social and commercial priorities still bounded the place.[11]

For field planting, wild seedlings were unreliable at best. Ironically, to build a functional forest from scratch foresters needed to start with artificially produced seedlings. The next year, 1904, about 300,000 trees that had been produced in the Halsey nursery were planted on 350 acres. Although they had hoped to begin earlier, dry windy conditions that spring postponed the field planting until the end of April. With this late start, the men took to the hills on April 26 and planted western yellow pine and piñon pine until May 27 when the favorable conditions ended with the soil too dry and the air too hot. Shallow furrows of about four inches depth were cut into the soil eight feet apart with a plow. The men then used spades to plant the seedlings into the furrows at six foot intervals. The foresters wanted to cut down on the competition of the existing grass and lay a straight line for the planters but minimize the amount of sandy soil exposed to the wind. They started with the most favorable locations for planting, the north and east slopes, but they also made sure to plant in the bottoms and other slopes and exposures too.[12]

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[11] William H. Mast, "Report of Nursery Work and Field Planting on the Dismal River Forest Reserve, 1906"; "Memorandum: Nursery and Planting Operations, Dismal River Forest Reserve, Halsey, Nebraska," (1906), 3-4.

[12] Charles A. Scott, "Notes Covering the Climatic Conditions, and the Conditions of the Nursery Stock on the Dismal River Forest Reserve for the Years 1903 and 1904 Until September 1st," BRD, 6-7; Charles A. Scott to William L. Hall, [Annual Report 1904], BRD, 8.

They wanted to give the seedlings the best chance to succeed but they were also experimenting to learn what could be accomplished. As a type of experimental control they planted some of the yellow pine in a seed bed under a lattice roofing, to try and provide the most favorable conditions possible. Careful records were kept of all the plantings including, numbers and species of seedlings, planting location and conditions, and source of the original seed. As scientists, they not only produced records; they also analyzed their efforts and results, presenting papers and publishing articles related to the tree planting project. Articles appeared in *Forest and Irrigation*, *Twentieth Century Farmer*, *Nebraska Farmer*, and *Nebraska Teacher*. In 1903, in the course of nursery work, field planting, and outside consultation many reports were submitted to the Bureau of Forestry including "Jack Pine in the Sand Hills," "Colorado Seed Crop 1903," "Collecting Lodgepole Pine Seed," "Seed Collecting in New Mexico," and "Forest Planting on Ranches in the Sand Hills, Superintended by Frank G. Miller, in Spring of 1904," among others. As scientific foresters, they were not only building a forest, they were collecting and distributing knowledge. In a search for a successful, repeatable method, the ambition of the project was for many forests, not just one.[13]

The seedlings planted in the hills in 1904 were the first products of the nursery operation. Although they did not receive any additional care after planting (there was none of the tending, watering, weeding, and spraying that took place in the nursery), they were carefully observed and evaluated. Each day's planting was recorded and later in the season counts were made of the surviving seedlings and their condition described. For example, of the 936 ponderosa pine seedlings planted on April 27, ninety percent were

[13] Scott, "Notes Covering Climatic Conditions," 11; Scott, "Annual Report, 1904," 1-2.

still living on June 11. Other plantings were not so successful. One thousand seedlings were planted in one plot on April 30; only 274 remained on July 21. There were many variables influencing these survival rates: the quality of the seedling stock; where the original seed came from; the weather conditions on the day of planting and the care with which they were planted; and most obviously, the location in which they were planted. South facing slopes, receiving the most sun and heat (and therefore having the driest soil), were the least favorable. Six plots were planted on south slopes in 1904 with an average survival rate of 24.4 percent. In the worst plot only 70 seedlings lived out of 1,000 planted. However, a place with a concentration of the best variables was not necessarily the best location for growing trees. In the valleys between the steep hillsides the conditions were most favorable—optimal moisture, shade, and protection from the wind. But that increased the competition from native grasses, which usually crowded out the seedlings. First season survival rates in the valleys averaged only 51.9 percent.[14]

So right from the start foresters were beginning to see the environmental influences of location, climate, and competition on their nascent forest. This influence would become clearer over time. But more immediately, foresters attributed planting losses to two main causes: the failure simply to survive the transplantation process and the filling in of the furrows and burying of the seedlings by windblown sand. While the shock of transplantation was quickly fatal or not, the windblown sand and environmental influences persisted, "especially in the exposed situations." The seedlings that survived transplanting made little growth in the first field season. "The stems . . . increased a trifle in length and diameter but not so much as it was hope[d] that they would." Often the

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[14] Scott, "Notes Covering Climatic Conditions," 9-11.

seedlings lost most of their leaves. In the trial planting under the latticed roof, the ponderosa seedlings grew "very little in height and diameter," but they did grow a new crop of leaves. By September 1 they had a survival rate of 80.5 percent. Managed conditions improved their chances, but the foresters worried that they would still have to be replanted into the fields, incurring further losses.[15]

Nevertheless, the value of a seedling's growth in the field the first year was in the development of the root system and the results of this experiment would lead to the increasing use of two year old seedlings (2-0) and previously transplanted seedlings (1-1 or 2-1) in field planting. Transplanted seedlings were much sturdier and had a larger proportion of short roots. These were essential in taking up moisture after field planting and establishing the tree in that new place. This value was pointed out in 1906 when the Reserve supervisor wrote: "Carefully conducted experiments have shown that it is not policy to plant one-year-old seedlings. To meet with the best success, seedlings should be 2 years old when planted, as trees of this age and size are little injured by the sand or drought." To provide enough two year old seedlings and transplants the nursery capacity had to be increased significantly.[16]

In April and May of 1905, 396,100 seedlings were planted on 342 acres in the hills of the Dismal River Reserve. Of these, 274,700 were ponderosa pine raised in the nursery and this year, for the first time, over 80,000 two year old seedlings were available for field planting. The remainder of the trees planted were jack pine—wild seedlings gathered from Minnesota by Forest Service men and from Wisconsin by the Evergreen

[15] Scott, "Notes Covering Climatic Conditions," 11.
[16] "Memorandum," (1906), 5.

Nursery Company.[17] In 1906 they planted over 319,000 seedlings and introduced some new species. The previous season small experimental plots of Norway pine, red fir, white fir, and Colorado blue spruce had been tried and now they set out some 20,000 red and white firs into the hills. The following year they set out over 20,000 Scotch pine on north and east slopes covering 20 acres. Then, over the next couple years they increased the Scotch pine (with seed imported from Europe) and introduced Norway pine, red pine, Austrian pine (shipped in from nurseries in both Iowa and Prussia), Douglas fir, blue spruce, and red cedar. This was both a search for the most successful species and an effort to diversify their forest. In 1906 they also tried out fall planting, setting 7,000 jack pine and ponderosa in September and October in the southwest corner of the "nursery eighty," on north facing slopes. Significant rainfall before and after the planting seemed to suggest this would be a successful effort.[18]

The institutional optimism of the U.S. Forest Service was crucial at this stage of the forest building project. Although the nursery operations were expanding and becoming quite successful by now, the field planting still struggled. Forest Supervisor, Charles Scott, complained: "The tree planting that has been done on this reserve . . . has not resulted successfully from a tree-planting standpoint." Although the handful of ponderosa pine and about 20 percent of the jack pine from the original 1903 plantings that still survived were beginning to put on substantial growth, the bulk of the of the 1904

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[17] Charles A. Scott to E. A. Sterling, (1905), BRD, 2-3; Charles A. Scott and William H. Mast, Report on Field Planting and Nursery Conditions on the Dismal River Forest Reserve, Halsey, Nebraska," (1905) BRD, 4.

[18] Charles A. Scott, "Progress Report on the Halsey Planting Station, Dismal River National Forest," (1906), BRD, 6, 11; Scott, "Annual Report, 1907," 18-19; Roy G. Pierce, "Annual Report on the Halsey Nursery, Nebraska National Forest," (1910), BRD, 5-6, 33.

seedlings did not survive their second year in the field. Scott reported that fewer than 5 percent remained. Even in their failures though, the foresters were learning valuable lessons: about creating hardy seedlings with better root systems through transplanting in the nursery; how to handle seedlings carefully in the planting operations, especially protecting the roots; and the best way to prepare the planting sites to retain moisture and reduce competition. Even though a majority of the new trees were dying, the foresters believed they were making progress. As Scott wrote, "the results of the work of these years will, however, aid us materially in planning the future work." They continued to anticipate success and planned to keep expanding their efforts. Scott called for larger appropriations, increased nursery production, and expanded field work. His goal was to increase field planting to 1,000 acres each year.[19]

Nurturing the Forest—Giving Seedlings the Best Start

The most immediate variable for the success of the forest was the quality of the seedlings planted. The nursery was making great strides in producing "thrifty" seedlings at ever increasing quantities. But it was not just the quality of the seedlings as they left the nursery that mattered. The condition of the seedlings as they went into the ground in the hills was equally important. Nursery managers had developed special techniques for packing and shipping seedlings across the country. Bundled in wet burlap or moss and packed in vented crates they travelled by wagon and rail and generally arrived in excellent condition. When the nursery received seedlings from other places they took great care to heel them into the ground for a time before planting and often put them into

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[19] Scott and Mast, "Report," (1905), 1-3; "Memorandum," (1906), 7.

transplant beds for a whole season to invigorate and acclimatize them. The short trip from the nursery into the surrounding hills was just as delicate an operation as an interstate shipment. At first the nursery managers sent wagon loads of seedlings out to the planting camp each day where the field crew would soak the roots in buckets of water before planting them into the ground. It was important that the roots not dry out, causing the trees to wither once planted. But after several seasons of planting the foresters found it was better to keep as much of the nursery soil clinging to the roots as possible, rather than washing it all off by soaking the seedlings in water. The workers were also admonished not to shake off the roots before planting. The fine soil from the nursery beds was bound to the seedlings' tiny rootlets, which were essential in taking up moisture and establishing the trees quickly in the field, removing the soil tended to remove these rootlets.[20]

Digging up the seedlings from the nursery and replanting them in the hills had a traumatic effect on the plants. Each tree had to re-establish itself in a new place, get a grip on the ground with its roots, begin to draw up moisture and nutrients, and withstand the sudden competition of the surrounding wild vegetation. To maximize the production process, seedlings had been cared for all their lives—watered, fertilized, shaded from the sun, protected from the competition of weeds, transplanted to invigorate their roots. Now they were abandoned to the wild where they suddenly had to fend for themselves. The first necessity was to begin to take in moisture; they had no time to grow new rootlets. The foresters realized this. "It requires some time after planting for the roots to take hold

[20] Roy G. Pierce, "Annual Planting Report, 1911," BRD, 1-2; Carlos G. Bates and Roy G. Pierce, "Forestation of the Sandhills of Nebraska and Kansas," *U.S. Forest Service Bulletin 121*, (1913), 10.

of the soil in such a way as to draw moisture from it. There is continual transpiration from the needles and the moisture which goes out from these must be supplied from that taken by uninjured rootlets, and from the absorption through the cortex of other roots, until new roots can be formed."[21] The survival of the whole tree depended on the immediate functionality of its roots.

"Owing to the dry atmosphere extreme care must always be exercised to protect, both the roots and tops of the trees from the time they are removed from the soil until they have been reset and become established," the forest supervisor wrote. But this was not just a connection between the seedling's roots and the soil. There was a relationship to the whole environment that the tree had to encompass. The weather conditions during and immediately after planting greatly affected the tree. The windy Nebraska sandhills were a dry, unforgiving place for a pampered nursery tree. "Transpiration is so much greater on a windy day than on a calm day that often times many plants that would survive . . . are so reduced in vitality that although they may live for some time they are unable to withstand the summer drouth." Seedlings that had thrived for two or three years in nursery beds were still surprisingly fragile when replanted in the field. Planted into an arid grassland, these seedlings were being thrust into a running ecosystem and they were immediately subject to its environmental demands.[22]

The weather, of course, was a constant influence on the trees throughout the year. As noted before the wind dried out seedlings or buried them in blowing sand. On July 17, 1908 and again on July 12, 1911 hail storms tore up the bark on some seedlings and

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[21] William H. Mast, "Annual Report on the Halsey Planting Station, Nebraska National Forest, 1908," BRD, 20.
[22] Mast, "Annual Report 1908," 20.

"did considerable damage by shearing the leaves off of the west side of the new growth and destroying the terminal buds." Heavy frost could also kill the terminal bud of a seedling, which was responsible for the tree's upward growth. A lower branch becoming the new leader could replace the dead terminal bud but this took more time and could be hindered by frosts in successive years. Severe snow storms in April 1911 killed many of the jack pine seedlings planted the year before and even broke many of the leaders on the five year old jack pines. On other trees limbs were frozen back six inches by the severe cold. Winter storms could be just as deadly as summer winds and when the damage was done, each season seemed worse than the last. In April 1913 the worst blizzard in thirty years stopped planting work and covered the hills with snow as the temperature dropped to minus 16 degrees Fahrenheit. And this was just one event in a bad year: "taken as a whole," the supervisor reported, "the past season is believed to be the most severe season on field planted stock since planting was started at this place in 1903." Despite the heavy losses and considering the "extremely unfavorable weather conditions," he still hoped for a high percentage of survival among the 1913 planting.[23]

Surprisingly, the weather could also be good. The 1915 season experienced the highest rainfall in the history of the forest planting, 35 inches compared to an average of 23 inches during the previous twelve years. The rain was well distributed throughout the year with more than half of the excess precipitation occurring during the growing season. This rain was welcome and important, as the most critical component of field planting success. The foresters considered the 1915 season "very favorable to field planted

[23] Mast, "Annual Report 1908," 19; Roy G. Pierce, "Annual Report on the Halsey Nursery, Nebraska National Forest, 1911," BRD, 33; Pierce, "Annual Planting Report 1911," 27; "Annual Planting Report, Nebraska National Forest, 1913," BRD, 3.

stock," especially since 1914 had surpassed even 1913 as "the driest and most severe summer on record at Halsey." Dry conditions returned the following year, however, with only 16 inches of precipitation during all of 1916. A new record low, the drought cut into the planting work. When the rains came was as important as how much moisture accumulated. This year "there was practically no precipitation during the entire planting season, and the ground became so dry shortly after beginning operations that it was impossible to plant south slopes." The year before, persistent drought had shut down the Garden City Nursery and Kansas National Forest. But the project at Halsey operated on a larger scale with a founding precedent so it had a stronger commitment from the Forest Service and more intrinsic momentum. Although they worried and complained about the weather, foresters continued to plant trees in the Sand Hills; the Nebraska National Forest would be built.[24]

Foresters knew that "it [was] soil moisture conditions which practically control the fate of trees planted on the Nebraska Forest."[25] However, for the nursery seedlings, planted into the wild sand hills, the key to survival was not just how much rain and snow fell each year but the struggle to absorb that moisture before it was taken by all the surrounding vegetation. The grasses in the Nebraska Sand Hills were well established and adapted to the local conditions and climate variations. They were preexisting components in an already operating system. To grow into mature trees and develop into a successful forest the planted seedlings had to overcome intense competition from the native grasses. These grasses grew dense in the valleys between the dunes, making "the

[24] Theodore Krueger, "Annual Planting Report 1915," BRD, 6-7; Jay Higgins, "Annual Planting Report 1916," BRD, 3.
[25] Fred R. Johnson, "Annual Planting Report 1914," BRD, 5.

grassy bottoms . . . as difficult to plant successfully as the south slopes." To grow into a forest, the seedlings had to incorporate themselves into the system and then reshape the system. This attempt at artificial succession was not a simple task. The 1911 Planting Report admitted, "competition is so keen in the bottoms that many of the trees succumb to it."[26]

While earlier advocates of tree planting had blamed grazing bison and anthropogenic fires for the lack of trees on the plains, the sparse and sporadic rainfall and the difficulty in competing for that moisture really limited the spread of trees and the succession of forest from grassland. Once they began building their own forest there, foresters realized this and tried to give their trees every advantage. The nursery was a factory with the single purpose of producing the hardiest seedlings possible. While the foresters could not reproduce out in the hills the control they established in the nursery, they did try to protect the trees in their forest from injuries and fire. And in planting the seedlings, they worked to give them the best possible start. From the first year of field planting they experimented with different planting methods, searching for the most successful (and cost effective) technique. The first trees were planted into holes dug individually with a spade. Intense debate and experimentation developed over the next few years focusing on the type of hole to use: slit, square, or cone.

The slit method was the cheapest and the quickest method, not inconsiderable advantages for a government agency. The worker simply inserted a spade into the soil and moved it back and forth to create an opening into which the seedling was slipped. The rapidity of this method, though, often led to the seedlings being poorly set and the

[26] Pierce, "Annual Planting Report 1911," 7-8.

accumulation of failed seedlings resulted in a higher eventual cost. Failed spots had to be replanted in subsequent years. While there were lots of ecological reasons for seedlings not to take, bad planting practices represented unacceptably inefficient work. Although there were always the typical budgetary tensions between the local ranger district and the regional and national headquarters, the construction of the forest was a long term goal that no one was willing to sacrifice for seasonal fiscal savings.

In the square hole method one worker dug a row of one foot deep holes and another worker followed along placing seedlings and filling in the soil around them. It may have been adopted despite the extra cost if it had been more effective; however, this was slower work and eventually proved to not provide significantly better results. The problem was in placing each seedling's roots at the proper depth and spread out in the hole so they could immediately begin to supply moisture to the tree. Without an increase in seedling survival there was no point in the extra time and expense.

The cone method of planting used a square hole with a small mound of dirt replaced in the bottom. The seedlings roots were then arranged over this cone, keeping the roots separated and giving them access to more soil space. While the immediate success rate was much higher this method was very slow and thus expensive on a per tree basis. The greater cost made this method impractical except in the most important small scale plantings. Extensive studies were carried out comparing each method. In the fall of 1909, 70 percent of the cone planted, 36 percent of the square hole planted, and 42 percent of the slit planted seedlings survived as "thrifty" trees. By the fall of 1911, 40 percent of the cone, 15 percent of the square hole, and 33 percent of the slit plantings were left, with the cone hole seedlings averaging about an inch more in growth. The foresters pointed out though that whatever the advantages, none of these methods fully protected "the trees from ultimately succumbing to the competition with native vegetation."[27]

Machines and Men—Technology and Labor of Tree Planting

The importance of finding the best method of planting revolved around giving each seedling the best advantage over the problems of moisture and competition while taking into consideration cost and efficiency. Unsurprisingly, foresters found the best compromise for these requirements by designing a new technology—the trencher. The trencher method was simply a mechanical form of the slit method. First a breaking plow or sidehill plow turned over a shallow furrow. Then the trencher plow cut a small trench, 8 to 10 inches deep and one to two inches wide at the top, inside the furrow. The trees were planted at intervals in the trench and the slit closed and soil firmed by the planter's feet. The advantage of the square hole and cone methods over the slit method was in clearing a small area for each seedling and reducing the immediate competition. The trencher method accomplished this by turning over a furrow and thus clearing the grass from one whole side of each row of seedlings, but without disturbing the soil so much that it would blow away or bury the seedlings in the wind. The planting method related directly to competition for moisture. "The dry spells" of 1911, supervisor Roy Pierce reported, "killed more trees planted by the square hole and cone method, than by the

[27] Bates and Pierce, "Forestation of the Sandhills," 15.

trencher method." These other methods allowed "competition from four sides . . . when moisture is lacking. At this time, the grasses which have more extensive root systems obtain the moisture."[28] So the environment and biology of the system helped shape the way the foresters planted their trees; they worked to mitigate the influence of the organisms that were already there.

Trencher planting, however, was also by far the most efficient method. Planting experiments during 1910 and 1911 showed that about 215 trees per day per man could be planted using the cone method, 500 trees per day by the square hole method, and about 1,000 trees per day by the trencher method. This combination of efficacy and efficiency made trencher planting the preferred method for planting the nursery seedlings in the hills and expanding the sand hill forest. Mechanization of the planting process resulted in ever increasing acreage planted each season. In 1913, trees were set on 311 acres. Almost one million trees were planted in 1914 on 597 acres and over one million on 659 acres in 1916. Work on the forest slowed down during U.S. involvement in World War I, but increased again in 1922 to almost 800 acres. The scale of the effort kept increasing; in 1935 over 1,000 acres were planted using five side-hill plows and five trenchers. Three mules pulled each plow and each trencher had a four horse team. Five four-man planting crews followed the trenchers, planting the seedlings and closing the trench. Three Forest Service rangers supervised the whole operation.[29]

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[28] Pierce, "Annual Planting Report 1911," 11.
[29] "Annual Planting Report 1913," 1; Johnson, "Annual Planting Report 1914," 2; Higgins, "Annual Planting Report 1916," 1; John A. Lubbe, "Annual Planting Report Bessey and Niobrara Divisions, Nebraska National Forest, 1922," BRD, 1; U.S. Forest Service, "Nebraska National Forest," *The Bulletin, Rocky Mountain Region*, (October, 1935), BRD, Box 27, 10.

Figure 7 - Horse plowing and trencher operation. Source: USFS

In 1937 tractors and a newly built trencher machine were used as well as horse teams drawing plows and trenchers. Built at the Forest Service Equipment Laboratory in Portland, Oregon, the machine was a two wheeled vehicle that attached to a tractor draw bar. It had two plow blades and a trencher tool and the wheels were adjustable for the slope of a hillside in order to keep the trencher blade horizontal. One tractor would pull two of the plow-trencher machines, replacing the labor of fourteen horses. In fact the tractors were meant to supplant horses in 1937 but trouble with the draw bar arrangement required the continued use of horses. By the end of the season the tractor equipment and the horse drawn equipment had produced about the same mileage of trenching. But tractors were sure to eventually replace the horses as a way to increase control over the planting process.

The Forest Service never kept very many of its own horses at the Bessey District preferring to contract from local farmers for draft power during the planting season although this was often unsatisfactory for various reasons. The quality of horses varied widely and farmers often tried to slow the work to spare their horses or left to work on their own land. In 1915, "most of the teams hired were in poor condition, or the owners left for various reasons." The Forest Service wanted their operations to improve local conditions, both physical and social, but this was often an impediment to their production goals.

> While it was desired to give the small settlers surrounding the Forest an opportunity to earn a living, the 1915 season has demonstrated that they are not entirely satisfactory and reliable. Their teams are mostly in poor condition on account of lack of feed, and they will take them off without a moment's notice at the time they have been fed up enough to do a few day's work on their own farms.[30]

The Forest Service implemented a stricter seven point contract to regulate the hired teams, but this source of draft labor was an ongoing problem.

Switching to tractors would relieve the foresters from unreliable labor and uncertain contracts from year to year, giving the foresters more control. Tractors would also standardize the process. Once the breakdown issues were resolved planting quality and efficiency were expected to go up. The forest supervisor described their experience in 1937: "the quality of the trench made by horse units and tractor drawn units favored the tractor units by a large margin." Unlike the horse drawn trenchers, the tractors "maintained a uniform depth of trench and it was always in the center of the plowed furrow." The planting equipment continued to be upgraded and improved. By 1942 the

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[30] Krueger, "Annual Planting Report 1915," 8-9.

tractors and planting machines were credited for increasing the number of trees planted per man-hour and improving the quality of the planting.[31]

Figure 8 - Tractor trenching, 1940. Source: USFS

Both the mechanization of planting and the supervision of labor were aspects of Taylorism being applied to the construction of the forest. Foresters were shaping a new ecosystem with industrial management. Like the rationalization of the nursery, they were applying modernist rationale and scientific methods although rather than individual production units they were trying to create an organic whole, a self sustaining system. But until the individual trees achieved the collective momentum and stability of an actual forest the seedlings and the whole project was quite fragile. Careful management was necessary until the forest could reach a state of ecosystem functionality. Later ecologists

[31] "Tractor Planting," Box 27, BRD; Carr, L.H., "Annual Planting Report Nebraska National Forest 1937," BRD, 2.

described this state as dynamic equilibrium, an idea that replaced the previous model of strict ecological succession towards a climax ecosystem.[32]

As in the nursery operations, labor was something the foresters in the field worked hard to control and even design as part of the correct planting method. However, just like the troubles with the contracted horse teams, the quality and control of labor foundered on the limited availability of workers. In 1912, "owing to the congestion of work, and to a smaller force of men than was needed to do all of the work that was to be done, it was necessary to retain the services of a number of men who were of no account." The problem was perennial: "it will be a much more serious problem in 1913," the supervisor complained, "with twice the amount of work to do." In 1915, "with few exceptions the laborers . . . were a very poor lot of men, making the problem of supervision exceedingly difficult. There were too many of the 'one quit, all quit' type of men which resulted in a continuous coming and going of men." Obviously the hired workers, having their own legitimate personal and family concerns, did not share the great vision and optimism of the Forest Service. They worked for their wage. In 1915 this was $1.30 per day plus board, with a bonus of 20 cents per day if they stayed through the last day of the season. Most did not. Labor, like the weather and the local ecology, was essential in the forest building process but impossible to fully control.[33]

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[32] On developing ideas of succession see Robert McIntosh, *The Background of Ecology: Concept and Theory*, (Cambridge: Cambridge University Press, 1986); Sharon Kingsland, *The Evolution of American Ecology, 1890-2000*, (Baltimore: Johns Hopkins University Press, 2008); and Donald Worster, *Nature's Economy: A History of Ecological Ideas*, (Cambridge: Cambridge University Press, 1994).

[33] H. Earl French, "Annual Report, Halsey Nursery, Nebraska National Forest 1912," BRD, 38; Krueger, "Annual Planting Report 1915," 18-19.

Figure 9 - Tree planter, 1922. Source: USFS

The foresters, though, realized the importance of good labor in the planting process for the success of the forest and did their best to script this work. The 1915 planting crew consisted of forty five men, including a Forest Assistant, four crew bosses, teamsters and plowmen, a cook and cook's helper, and twenty four planters. The workers lived in a tent camp in the hills and trees, water, and meals were freighted out from the nursery. The men had breakfast at 6:30 a.m. then left camp for the planting site at 7:00 a.m., taking enough seedlings for a half day's work. They stopped work at 11:45, returning to the camp for lunch. Resuming work at 1:30 they continued planting until 5:00 p.m. The Forest Assistant was in charge of the planting camp, ordering trees from the nursery and issuing instructions to the crew bosses. While the Forest Assistant was formally educated in forestry and the crew bosses were often district rangers, men with previous experience, or advanced forestry students from the University of Nebraska, the men actually planting the trees were ad-hoc temporary workers. New men almost always formed these crews from year to year and there was often high turn over throughout the planting season.[34]

Early on, in 1906, Supervisor William Mast had recommended that the emphasis be placed on proper planting techniques. "After the men were accustomed to planting the trees well," he said, "greater speed was gradually developed."[35] The success of the forest relied on the work of the temporary laborers. The foresters needed to "train each man to do first class work." Without this direction and close supervision during the planting, he wrote, "the ordinary man will destroy more trees than the cost of his wages."[36]

The Forest Service tried to standardize the labor and the planting process. Forest supervisors kept a strict accounting of hours and cost of labor. Tayloristic scientific management flourished in the forest and supervision was considered critical to the success of the forest. The foresters and forestry students from the University of Nebraska who supervised the workers received strict written instructions. They were warned to check for teamsters reducing the trench depth to rest their horses. Planters had to be watched to be sure they handled the seedlings properly as they had a tendency to knock dirt out of the roots to lessen the weight. "Do not allow the planters to whip the roots or to stand at the box and 'thread' or separate the trees one at a time," instructed forest supervisor Jay Higgins. "This makes it easier to take a tree from the basket, but exposes the roots to the drying sun and wind and is dangerous for the life of the tree." The roots of the seedlings had to be set precisely in the holes, not laid at an angle or curving

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[34] Krueger, "Planting Report 1915," 13-15.
[35] Mast, "Report of Nursery Work and Field Planting, 1906," 9.
[36] William H. Mast, "Annual Report on the Halsey Nursery, Nebraska National Forest 1909," BRD, 14.

upwards. “There is a tendency on the part of some planters to allow the tips of a few roots to remain above the surface,” Higgins wrote. “When so planted the trees will probably die.” Like a production line, the pace of work mattered as well as the quality. “The work should be pushed as much as possible and an effort made to plant as many trees as possible each day . . . . [However] it is not felt that it is good policy to inform the crews of the number of trees planted each day, as this is likely to arouse a rivalry to beat the other crew’s record at the expense of sacrificing the care of planting.” Planters were a means to an end within the Forest Service’s institutional vision. Less participant and more tool in the forest’s creation, the ideal laborer should perform much like the improved trencher, efficiency and efficacy in worker and machine.[37]

Forest Ecology—Learning to Make the System Work

The system foresters were building combined culture and environment, so in addition to labor problems foresters also had to contend with ecological issues. Foresters managed nature as well as labor (with similar incomplete success). While they intended to harness components of the environment such as the sun, rain, and soil to do much of the work of producing the forest, environmental factors also imposed limitations and shaped the outcome of the forest. Like soldiering workers or tired draft horses, different components of the local environment had an impact on the process beyond the control of foresters.

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[37] Jay Higgins, “Instructions for the Guidance of Foremen in Charge of Planting Crews,” (June 1917), BRD, Box 24.

Responding to this environmental construction of their technological forest, managers became more familiar with the ecology of the system. They kept careful records of the source of their seeds and exactly where the resulting seedlings were planted. Because they were planting rather than harvesting, one of the first things they learned was the importance of provenance and site—the conditions of the place from which the tree seeds came and the conditions of the place the where the seedlings were planted. The highly localized conditions of these places had a significant influence on tree seed genetics and seedling growth. "Since the success or failure of forestation or reforestation projects depend to a large degree on the adaptability of the species to its new environment," wrote one nursery specialist, "it is very important that tree seeds are collected from local sources of a traceable origin or from localities having very similar climate and altitude."[38] Writing in the Forest Service news letter for the Rocky Mountain Region in July 1927, forest supervisor Jay Higgins announced that evidence from the Nebraska planting suggested that "locally-grown seed or that grown under climatic conditions most closely approaching those of Nebraska will produce the most desirable and suitable planting stock."[39]

The bulk of the seedlings planted in the Bessey Ranger District in the first decades were grown from seed collected in New Mexico, Colorado, the Black Hills of South Dakota, and the Pine Ridge area in northern Nebraska. But the nursery also imported and propagated seed from all over the world. As their own forest matured foresters collected seed from these trees. The trees planted in the Nebraska Forest

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[38] M.K. Meines, "The Purpose of this Nursery," n.d., BRD, Box 31, 1.
[39] USDA Forest Service, "the Bulletin, Rocky Mountain District, Nebraska Forest Silver Anniversary Issue," (July 1927), 25.

seemed to adapt to local conditions. Higgins reported that Scotch pine seedlings grown from seed gathered from trees growing near the nursery "were twice the size of seedlings grown from seed obtained from Sweden." Yellow pine seed collected from the planted forest also produced seedlings that were "noticeably larger and sturdier" than seed from the Black Hills. The foresters also noticed a regional variation in European sources of Austrian and Scotch pine, attributing better form and growth to the northern strain over the southern one. Southern varieties were scraggly and more susceptible to winter kill. The northern ones were "hardier, more thrifty, and by nature better adapted for planting in the sandhills." However the most successful Austrian pine seedlings came from seed collected from the windbreak of the Agricultural College orchard in Lincoln, a very local source.[40]

Forester Carlos Bates also wrote in 1927 about a project he began in 1909 to do "an intensive study of the ecological factors affecting the success of planting" in the sand hills forest. In comparing yellow pine (ponderosa) grown from seed collected in New Mexico growing side by side with yellow pine from the Black Hills and the Pine Ridge area of northern Nebraska, Bates noticed an increased vigor and even suggested a slight resistance to the tip moth in the trees with a more local seed source. "The New Mexico trees have been a feast for the tip-moth and have attained a height of only four to five feet, while the local stock, though not escaping injury, has grown twice as tall and presents a relatively sound appearance." Recording the browsing patterns of deer during the winter of 1926 that showed a definite preference to the yellow pine of Black Hills origin over adjacent plantations of other sources, he argued that there was a chemical

[40] "The Bulletin, 1927," 25-27.

difference in different forms of the same species, which went "far beyond any theory as to their slight 'adaptation' to different climatic conditions."[41] The differences, though not immediately visible, were fundamental and developed through interaction with the local environment.

> The yellow pine of Colorado or New Mexico or Montana is *not* the yellow pine of Nebraska, practically speaking, although the taxonomists may give them all the same name. Possibly the great diversity in adaptation and behavior of the various forms of yellow pine is unique. I have the feeling that this species may be comparatively young and plastic. But we know that its natural range, in the borderland between savannah and mountain forest, subjects it to a great variety of climatic conditions, to each of which it seems to have adapted its habit in some peculiar way.[42]

Paying such close attention to the source of their seed and its environment led foresters to be more conscious of the highly localized conditions in their own forest. Through their planting operations, Nebraska foresters began to recognize a geography of microclimates. As a Forest Service publication noted, "as early as 1909, an effort was made to work out a site-species relationship based largely on topographic features or exposures."[43] They identified four general sites—ridges, north slopes, south slopes, and bottoms—and discovered where to plant different trees. Jack pine could succeed on ridges and steep loose south slopes where other species could not. Western yellow pine did well on moderate south slopes and northern exposures. Scotch and Austrian pine and red cedar required sheltered north slopes. The ridge tops had very loose sandy soil and high wind exposure, resulting in the lightest vegetation growth. North slopes, with less sun exposure, were cool and moist and carried a heavy cover of grass and shrubs. The

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[41] C.G. Bates, "A Vision of the Future Nebraska Forest," *Journal of Forestry*, Vol. 25, no. 8, (December 1927), 1036-37.
[42] Bates, "A Vision of the Future Nebraska Forest," 1034-35.
[43] USDA Forest Service, "Nebraska National Forest," (September 1952), 11.

northern exposures had a gentler slope than the southern, presented the least difficulty in planting, and most tree species could be successful there. The southern slopes were not only steeper, but also much warmer, drier, and sparsely vegetated. Jack pine did well there because its growing season began earlier than other species so it could take advantage of the moisture from the deeper snow drifts and earlier melt off. The bottoms and valleys had the heaviest soil and accumulated moisture from the slopes resulting in thick vegetation. Decomposition of this vegetation over time helped develop the most fertile soil in the forest, but competition from the great variety of grasses and shrubs there tended to crowd out planted tree seedlings. As a quick growing species, jack pine had the best chance of succeeding in the valleys.[44]

Figure 10 - Rows of jack pine, 1911. Source: USFS

[44] "The Bulletin, 1927," 29; "Forest Types," BRD, Box 27, 1.

Wildlife—Managing Forest Populations

Microclimates resulting from the combinations of geography and weather were not the only force shaping the composition of the developing forest. Interactions between competing organisms had an effect as well. While ecologists Frederick Clements and Victor Shelford first stressed the importance of animal-plant relationships within a biome as an ecological principle in their 1939 text *BioEcology*, Nebraska foresters already understood this clearly from practical experience. As foresters adjusted their planting efforts to the environmental conditions, other organisms began to take advantage of the new landscape they created. Although they were much more tolerant of ecological diversity in the field than in the nursery, forest managers nonetheless characterized some of these opportunistic organisms as pests. Caught in the dilemma of trying to construct a complex interactive ecosystem and at the same time protect its main component, the trees, from the other components that treated the trees as a resource, foresters had to carefully manage the system until it could become robust and self-sustaining.[45]

Some of the pests that damaged the planted trees included birds, grasshoppers, gophers, rabbits, and porcupines. Even when the forest was just getting started in 1906, birds "seriously injured" a large number of trees by picking off the terminal bud and slowing the annual growth of the seedlings. Gophers were a menace. Described as "attacking" the young trees, they ate the roots until they became too tough at about seven years old. The gophers dug burrows two to three feet deep under the ground and up to

[45] Frederic Edward Clements and Victor Ernest Shelford, *BioEcology* (New York: J. Wiley & Sons, 1939); on the history of the science of ecology see Greg Mitman, *The State of Nature: Ecology, Community, and American Social Thought, 1900-1950* (Chicago: University of Chicago Press, 1992); Worster, *Nature's Economy*; McIntosh, *The Background of Ecology*; and Kingsland, *The Evolution American Ecology*.

half a mile long, sometimes killing ten to fifteen trees in a row. The Forest Service put out strychnine poisoned grain and sweet potato bait. In 1919 they estimated that half the gopher population on the forest were killed. The next year's campaign was even more effective when poisoning was followed up with trapping, culling an estimated 90% of the population. Still, in 1921 the trapping program caught 1138 gophers and 929 more the following year, all on forest land previously poisoned. The gophers remained a persistent part of the growing forest ecosystem, prospering as they had in the grassland environment. No matter how many foresters removed more showed up the following year, drawn as much by the buffet of fresh and tender young tree roots as by any poison-laced bait. Rabbits posed a similar problem, eating the tops of the seedlings, although they could be more easily dispatched with shotguns if not poisoned.[46]

Other "pests" that threatened the forest could be much smaller and more sporadic but just as damaging. Grasshoppers, for instance, swarmed the forest in 1929 through 1933, "completely wiping out several hundred acres and severely injuring other areas" as well as badly damaging domestic crops throughout the state. Voracious feeders, they took the needles off the young trees and ate the bark off the stems, girdling seedlings less than an inch in diameter. Scotch pine seemed particularly appetizing as even vigorous seedlings up to three inches tall were "completely eaten: needles, bark, wood and all."[47] Other insect threats included pitch moths, cone moths, pine needle moths, bark beetles, and scale insects. The Nebraska foresters regularly consulted with the federal Bureau of

[46] Mast, "Report of Nursery Work and Field Planting on the Dismal River Forest Reserve, 1906," 9; Albert M. Day, "Special Report: Pocket Gopher Control on the Nebraska National Forest, 1918-1922," BRD, USDA box; "Trapping Gophers on the Nebraska Forest," NARA, Denver, RG95, box 20, folder 98.
[47] "Grasshoppers," (1933) BRD, Box 27.

Entomology, which assured them that it would continue to "make a special study of insect enemies of forest reproduction and forestry nursery stock."[48]

Figure 11 - Seedlings eaten by gophers. Source: USFS

The biggest insect enemy of all in the Nebraska forest was the pine tip moth. Pine tip moths became a serious problem in the plantations in 1909, although they were believed to have come in on the first batches of wild seedlings from the Black Hills or Michigan. The insect was common there and in many other locations, like New England and the Southern states, but usually caused few problems. Occasionally, it became epidemic, as on Nantucket Island in 1876, but even these occurrences were sporadic. In the new Nebraska forest, however, the moth flourished. Feeding on the trees' terminal

[48] A. B. Hopkins to F. W. Bealey, April 29, 1905, BRD, Box 24.

buds, the larvae of the pine tip moth severely stunted tree growth and even killed trees from repeated attacks. Efforts to solve the problem led to some insightful ecological rumination. As to why the moths were so much more destructive in the Nebraska plantations than other forests, scientists concluded: "Presumably it is due to the fact that some of the environmental factors that hold the pest in check in the native pine forests are lacking in the Nebraska environment." Foresters were thinking of these organisms and conditions in terms of interacting system components. They began a study of the life cycle and effects of the pine tip moth in cooperation with the Bureau of Entomology in 1924. They expected to discover more about "the ecology and control of the tip moth."[49]

In contrast to the poisoning of birds and gophers and the shot gunning of rabbits, foresters took a more systems-oriented approach to the pine tip moth. The moths could not be so easily eliminated. Scientific studies pointed out the ecological complexity of the problem and foresters tried to address it through the ecological connections within the forest as a system. The question was why were pine tip moths held in check in other forests but not in the Nebraska forest? They had not simply evaded their predators by invading a new environment. Nebraska foresters collected tips of infested pine trees and raised the moth larvae in the laboratory. They discovered some sixteen different species of parasites associated with the pine tip moths. These parasites had migrated with the moths or had attacked them after they arrived, seizing a new opportunity in the same way the moths had invaded the freshly planted trees. This problem helped the foresters to see many levels interacting in the forest system. A 1927 scientific report announced, "in

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[49] Samuel A. Graham and Lynn G. Baumhofer, "The Pine Tip Moth in the Nebraska National Forest," reprinted from *Journal of Agricultural Research*, vol. 35, no. 4, (Washington D.C., August 15, 1927), 324-25.

addition to the parasitic insects that are present in the plantations, there are other agencies that tend to reduce the tip-moth numbers." Ants, spiders, and a species of predacious beetle were known to eat them. "Arboreal birds," it stated, "are finding their way into the plantations, and some of them are doubtless finding in the tip moth a source of food." The newly planted forest created opportunities for a range of different organisms: moths, parasites, beetles, and birds. As the forest grew the ecological complexity of the area increased or at least developed in new ways.[50]

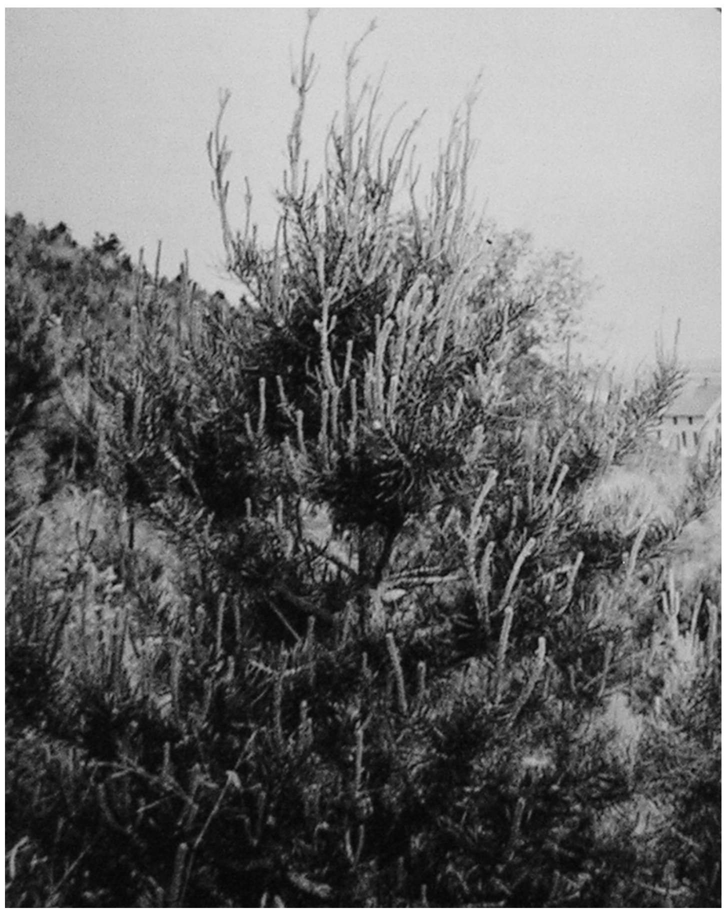

Figure 12 - Tree damaged by pine tip moths. Source: USFS

[50] Graham and Baumhofer, "The Pine Tip Moth in the Nebraska National Forest," 331-32.

Optimistically, foresters and entomologists hoped that by adding to that ecological complexity themselves they could reduce the damage to the trees. They introduced additional moth parasites from Virginia and Nantucket Island in 1925. Within four years, *Campoplex frustranae*, an ichneumon fly (really a type of wasp) from Virginia "had spread naturally over the entire planted area, and even into the then isolated Camp 4 plantings." Adult *Campoplex* laid their eggs in the pine tip moth larvae, which were consumed by the *Campoplex* larvae when they hatched. The effort was largely successful. "Three years after its introduction there was a noticeable decrease in tip moth infestation . . . and by the next year a parasitism of approximately 83 per cent had been reached." After this, the trees made a marked recovery and began to put on good growth. The moths did not disappear, but they became a regulated component of the new forest's ecosystem.[51]

As the new forest grew and developed into a functioning ecosystem, many species flourished. One animal species, mule deer, made an interesting transition from rare species to nuisance animal to valuable public resource. The forest and the management philosophy that came along with it provided both a new physical habitat and a protective social environment for the deer population. Interviewing local ranchers in 1902, before the forest was begun, Charles Scott learned that only two or three deer were thought to still survive in the area. However, as the forest grew so did the deer population. To protect the forest wildlife, and especially the deer, the state legislature made the Bessey Division a game and bird reservation in 1921. Local settlers tended to shoot all the deer

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[51] Lynn G. Baumhofer, "Pine Tip Moths," (1930) *Silvical Report for the Nebraska National Forest*, BRD, Box 27.

outside of the reservation, so the forest became a refuge. Supervisor Higgins observed that "the does seem to appreciate the protection afforded by the plantations by rearing their fawn in the trees." More and more were seen each year and a substantial herd developed in the forest. They became something of a novelty and visitors came to see the deer as much as the trees. The forest supervisor reported in 1941: "the deer herd continues to be one of the major attractions at the forest. Numerous small groups are conducted through the forest throughout the year. It is estimated that 2,000 people are shown the deer and informed about them on show-me trips." The great interest in the deer represented the multiple values, social and ecological, developing in place as a forest rather than just a sterile tree plantation.[52]

The deer population on the Bessey Ranger District eventually reached eight hundred and became quite a nuisance. In spite of a "deer-proof" fence constructed around the nursery, they began to damage seedlings and over browse trees in the forest. Using the planted trees as a food source, especially when heavy winter snow covered the ground, the deer high-lined the larger trees, eating up as far as they could reach, and hedged smaller ones, eating from the top down. Forest Service personnel recommended the development of a game management plan. An ecological study was initiated in 1944 and the following year the state legislature authorized a hunt for December 1 through 21 to remove between 300 to 400 deer. Five hundred permits were issued and hunters from all over the state (76 of Nebraska's 93 counties) harvested 361 deer. A wide variety of information was collected from the hunters and the deer they shot. This moment in the

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[52] Jay Higgins, "Annual Fish and Game Report, 1923," (November 16, 1923), 1, BRD, Box 24; V.J. Dayharsh, "Nebraska National Forest Wild Life Report, 1941," 4, BRD, Box 24.

forest's history clearly illustrates how ecosystem development, scientific studies, recreational activity, and wildlife management all interconnected in the Nebraska forest. The hand-planted forest, like all the other "natural" national forests embodied ecological diversity and multiple social values.[53]

There were other examples of management for species diversity and recreational opportunity as well. Upland game bird hunting became a popular activity in the forest and surrounding grasslands. Foresters managed populations of quail, chukar, grouse, and prairie chickens and introduced turkeys and ring-necked pheasants. Forest supervisor Higgins believed that the growth of the planted trees benefited the game birds, reporting that they "have been seen at various times out in the planted areas well back from the river valley," where they would ordinarily be found in the prairie. "The quail," he wrote, "will probably be the better off because of the trees." In addition to the native population, several coveys of quail were hatched at the nursery and turned out into the woods. Besides importing foreign Scotch and Austrian pine, the foresters introduced other exotic species to the forest. In 1920 Chinese ring-neck pheasants, a rooster and three hens, purchased from the State Game Department were released. Then in 1923, the supervisor's wife raised three settings of thirteen pheasant eggs each under her Rhode Island Red chickens. After several weeks on a "high class diet of custard, hard-boiled eggs, and buttermilk," they were allowed to fly off and settled along the valley near the nursery. Turkeys were also released on the reserve but they caused considerable damage in the nursery where they ate the sowed tree seed and delighted in "promenading down

[53] Levi Mohler, John H. Wampole, and Edson Fichter, "Mule Deer in Nebraska National Forest," *The Journal of Wildlife Management*, Vol. 15, no. 2 (April 1951), 135-137, 155.

the middle of the seed beds and occasionally scratching out a hole and dusting themselves." Foresters found it was difficult to have both diversity and orderliness. Everything pursued its own advantage and they wanted to ensure their priorities.[54]

As with wildlife management practice all over the country during the early twentieth century, predators and furbearers were hunted and trapped heavily on the Nebraska forest. Every effort was made to exterminate coyotes, with local ranchers trapping more than a hundred each winter. The coyotes, however, (like the gophers) managed to maintain a steady population every year. Other furbearers trapped in the Nebraska National Forest included muskrat, skunk, raccoon, beaver, weasel, and badger. The Nebraska forest managers often suggested that weasels and badgers should be protected because of their value in killing rodents and gophers, which damaged the tree seedlings. Obviously, a philosophical conflict was highlighted here between traditional perceptions of predators as bad and a growing appreciation for ecological complexity and connections that their experience in the new forest was fostering[55]

Ecosystem Management—Forest Conditions and Public Attraction

With the implementation of wildlife management, the concern over complicated ecological interactions, the introduction of exotic species, and the ambition to provide multiple values in their forest, the Nebraska foresters had moved from being simple tree planters to being ecosystem managers. In fact they were embedded, through their actions

[54] Higgins, "Fish and Game Report, 1923," 3-4; Arthur L. Nelson, "Annual Nursery Report, Bessey Nursery, Nebraska National Forest, December 1, 1928 to December 1, 1929," BRD, Box 24, 18.
[55] Jay Higgins, "Annual Fish and Game Report, 1921," BRD, Box 24, 4; C.L. Van Giesen, "Five-Year Game Report, Nebraska National Forest," (November 7, 1934), BRD, Box 24, 4.

and their ideologies, in the forest ecosystem itself. The forest had become a living artifact of the combination of nature and culture—trees; animals; soil; sun and rain; human labor; applied technology; and a social vision. Evidence in 1932 of natural regeneration, with over 100 "naturally reproduced" trees along the south side of the oldest planting sites, suggested the system was becoming self-sustaining. The individual nursery seedlings were becoming an integrated forest. Just five years earlier, Carlos G. Bates, of the U.S. Forest Service, in "A Vision of the Future Nebraska Forest," predicted the results. In addition to the practical economic benefits, the Nebraska forest would be "an oasis of flourishing pines in a desert of Nebraska sand hills; a restful spot to which thousands are already turning; a sanctuary which in a few years has become the home of countless songbirds and game-fowl, and a retreat as well for the few remaining deer of the state." The forest, as a place and a purpose, was complex.[56]

As it grew, the forest changed the environment in some of the ways early tree planting advocates had predicted, slowing wind movement and reducing evaporation. Using the weather station established on the reserve in 1918, around which the forest had grown, and another built in 1930 on an open site, scientists collected daily measurements of precipitation, wind, air and soil temperature, and evaporation. Using this data, a scientific study published in 1942 revealed that the air temperature was lower within the forest and the soil temperature was warmer in winter and cooler in summer than in the open sand hills. Within the forest "the average wind movement was only 28 percent of that in the open, and the wind movement continuously decreased with the development of

[56] A.L. Nelson, "Natural Reproduction," (1932), BRD, Box 27; Bates, "A Vision of the Future Nebraska Forest,", 1037.

the stand," while the yearly evaporation rate was only 58 percent of that in the open grassland. The new forest was not just individual seedlings growing into individual large trees; it was an evolving ecological system—a new environment.[57]

Figure 13 - Bessey Ranger District, Nebraska National Forest. Source: USFS

As it grew, the forest developed as a new habitat for many organisms. A 1965 study on the biogeographic extension of animal species into the Sandhills forest reported "profound changes in the ecological relations of the region." As with the diversification of local flora through the human agency of planting of trees, "the animal communities have likewise been enriched—intentionally as well as inadvertently—by exotic animal

[57] C. H. Niederhof and R. Stahelin, "Climatic Conditions Within and Adjacent to a Forest Plantation in the Nebraska Sandhills," *Journal of Forestry* 40 (March 1942), 244-248.

forms." Many of these species "existing, and even flourishing . . . in the Halsey National Forest ecosystem [were] definitely new to the area and state." Some sixty new species migrated to the forest through "fortuitous importation" or extensions of previously documented ranges." One example, the Virginia opossum, "probably influenced by the availability of forest cover," arrived from the East and established a population. According to the study, the changing distributional pattern and hybridization of bird species in the area gave "additional evidence for the fact that human activity and tree planting in the Halsey forest area have contributed to the breaking down of zoogeographic barriers and effected faunal mixing."[58]

Producing a new micro-climate beneath its canopy, attracting new organisms and providing habitat, reproducing itself, the forest had become an operating system. An article in the journal *American Forests* announced: "Seedlings now spring up unassisted, indicating that man has succeeded in establishing a true forest in only half a century, on a site where sand dunes once tried to discourage the tough prairie grasses."[59] Built from factory-made seedlings, the forest had begun to take on a wild life of its own.

People came to the forest too, attracted by the landscape's new nature. As it developed into an interactive ecosystem, the forest experience became the point. Its purpose had shifted from the production of timber resources on treeless plains to the construction of a unique place—a place with an inherent social value. As consumers of the system's new value, people came for an experience of nature: to walk in the woods, picnic, camp, and hunt. There was an open hunting season for deer, antelope, wild

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[58] Raymond E. Henzlik, "Biogeographic Extensions into a Coniferous Forest Plantation in the Nebraska Sandhills," *American Midland Naturalist* 74 (July 1965), 89, 91.
[59] Homer Fine, "Nebraska's Man-Made Oasis," *American Forests* 58 (September 1952), 13.

turkeys, prairie grouse, and rabbits. The Bessey Ranger District built a permanent 4-H camp and also hosted Boy Scouts, Future Farmers of America, and church groups. The people of Nebraska were very proud of their hand-planted forest. They held big annual picnics and official celebrations for the twenty-fifth, fiftieth, and one hundredth anniversaries of the forest. Charles Scott, the forest's first supervisor, returned to speak for the fiftieth anniversary. Programs for the celebration were printed on paper made from trees harvested from the forest. On weekends and holidays, especially, thousands of people came to swim in the pool built by the CCC and climb the Scott Lookout Tower to get a panoramic view of the whole forest. In 1965 over 133,000 visitors were recorded at the Bessey District. People came to this forest in the Sand Hills of central Nebraska from 32 states and 6 foreign countries.[60]

From a practical point of view, the founders of the Nebraska National Forest intended to produce timber products for local markets. But they also had a more holistic purpose. Bessey wanted to restore a previous landscape. Fernow emphasized the need for ecological complexity. Others hoped to influence the local climate. Much more than growing trees for lumber or paper, they all dreamed of building a whole, intact and functioning forest—a forest that the people of Nebraska could enjoy. Carlos Bates wrote in the *Journal of Forestry* that federal forestry was about more than economic values. In a larger sense, it should be "gauged by the social and economic benefits to the whole people, and when the social value is apparent, a return in dollars and cents is rarely to be

[60] USDA Forest Service, "1965 Review Central Plains Forestry Office, Nebraska National Forest, Oglala National Grasslands, Cooperative Forestry in Nebraska and Kansas, Pine Ridge Job Corps Conservation Center," NARA, Denver, RG 95, Box 20, folder 99, 3.

questioned."[61] In a publication celebrating the fifty years of forest construction, the Forest Service continued to emphasize the social value of the forest.

> To the ordinary citizen the educational and inspirational values of this area surpass the economic. It is a place where the forester, the botanist, the ecologist, the biologist, the agronomist, the ornithologist, and scientists in many lines, as well as the practical businessman and farmer, can study the effects of the establishment of a forest in a virtually treeless region and observe the changes in vegetation, bird, and animal life. And that is why an ever-increasing number of people visit the Forest for a days picnic and for the inspiration and education it provides. The Nebraska Forest is an economic, aesthetic, recreational and inspirational asset to the citizens of Nebraska and adjacent states.[62]

Any forest holds many values. It is a physical place that provides habitat and resources for plants, animals, birds, insects, and people. It is a cultural construct that embodies ideas of nature and provides spiritual, psychological, and recreational opportunities. A functional forest is more than just a group of trees. It is an ongoing process, a living system; the whole is more than the sum of its parts. Although it began as hand planted seedlings, produced in a factory, incongruous in the middle of rolling grassland, the Nebraska National Forest developed all the attributes of a functional forest. And, perhaps it holds an even greater meaning. A 1975 article in the wilderness-promoting magazine *National Wildlife* described this engineered forest with enthusiasm: "millions of conifers stretch out on every side, transforming this area of west-central Nebraska into an ecological crossroads, where prairie goldenrod and the ponderosa pine grow side by side" and "a wealth of wildlife prospers within the diverse habitats of forest and prairie."[63]

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[61] Bates, "A Vision of the Future Nebraska Forest," 1038.
[62] USDA Forest Service, "Nebraska National Forest," (September 1952), 25.
[63] Dennis Farney, "In the Sea of Grass a Forest Grows," *National Wildlife* 13 (December/January 1975), 18.

Figure 14 - Dense forest cover. Source: USFS

Conclusion

With seedlings successfully flowing out of the nursery production line, foresters set to work planting the surrounding hills and building the forest for which the Reserve had been created. There were many difficulties. There were definite reasons (beyond the effects of fire and bison) why trees did not already grow thickly on the Plains. Competition from well established grasses and a severe climate limited the germination and growth of wild trees there. Foresters had to overcome these limitations to build their forest. Strong, hardy seedlings were required, but the nursery was able to produce those. Effective planting techniques and technologies had to be developed to help the seedlings succeed. The trencher planting method, and sheer persistence in planting, helped achieve this. Once the seedlings started to grow in the field there was little foresters could do to manage them. The control established in the nursery did not transfer to the hillsides. But as the little trees grew up and developed some momentum and a certain critical mass, they began to take on the characteristics of a forest. This forest attracted other organisms, which found habitat and resources among the trees. Some of these, according to the foresters, were pests and damaged the trees they had so carefully planted. Other opportunistic organisms, like deer, were more welcome. They seemed to indicate the growing ecological interactions and marked the development of the forest as a system. In fostering this growing system—dealing with the competition and climate, fighting off the pests, and offering the deer as a product of the forest—foresters learned many lessons about the workings of the ecosystem. As it developed the forest also attracted people, who came there for an experience of nature. The forest became valuable to the public.

This forest is a hybrid landscape, a constructed nature. It is an ecological and cultural crossroads where people and their efforts are integrated with the environment of the place and the process of life there. The Nebraska National Forest is at once an ecological system, a technological system, and part of a social system. The realization of this integration has implications for all of humanity's ideas and efforts and all of the places we go. Federal foresters who had worked on the Nebraska forest understood this and took an approach that integrated ecology and technology in applying forestry during the 1930s to the environmental and social problems of the Dust Bowl and the Great Depression. Building more forests, they thought, could help engineer a better Plains environment and embed American society in the landscape in a more sustainable relationship.

ENGINEERING THE GREAT PLAINS ENVIRONMENT

> While the planting of trees will not change climatic conditions as a whole, it will alleviate or modify many unfavorable features of existing conditions.
>
> From a human standpoint, shelterbelt planting, by adding beauty to the landscape, breaking up the monotony of the Plains, and satisfying the craving for growing trees in a treeless region, has an immeasurable value in happiness and contentment.
>
> —Raphael Zon[1]

As a result of their history of managing and building forests, most agents of the U.S. Forest Service accepted the idea that their forests integrated natural, cultural, and technological forces. They also had reinforced their intention of building forests, as technologies, to do work on their behalf. It was clear that planted forests did more than just bring timber products to the treeless plains. The success of the Bessey Nursery and the Nebraska National Forest suggested the possibility of an environmental engineering approach to a wider range of ecological and social problems. Their experience in Nebraska gave the Forest Service Leaders the confidence to undertake an enormous technological planting project at the height of the Great Depression; from 1934 to 1942 the service planted a shelterbelt system of trees that spanned the continent from Canada to Texas in response to the environmental problems of the Dust Bowl and the social problems of the Great Depression.

Initially envisioned by President Franklin Delano Roosevelt as an enormous block planting, then as a set of contiguous belts, the Prairie States Forestry Project (PSFP)

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[1] Raphael Zon, "What the Study Discloses," *Possibilities of Shelterbelt Planting in the Plains Region*, Washington D.C.: GPO, 1935, 7, 8.

ultimately planted nearly 19,000 miles of disconnected shelterbelts on more than 30,000 separate farms.[2] The (possibly apocryphal) story behind Roosevelt's idea is that during his first presidential campaign, in the late summer of 1932, his train was stalled just outside of Butte, Montana, where logging and smelter emissions had severely damaged the forests and vegetation of the surrounding hills. Roosevelt wondered about the possibility of planting trees as an environmental restoration technique.[3] Once in office, he had the opportunity to test this approach as a palliative for the symptoms of the Dust Bowl—drought, wind, and shifting soil in the Plains, which seemed to have once again become the Great American Desert. It would also serve as a work relief program for unemployed Depression victims. Roosevelt turned to the Forest Service, through the current chief Robert Y. Stuart, and found it receptive to his general idea, but experienced enough in tree planting to recommend specific suggestions.

Technological Trees—The Shelterbelt Idea

As was shown in chapter two, federal foresters had been working since the late nineteenth century in cooperation with farmers on the plains to plant shelterbelts. Part of the purpose of the establishment of the Dismal River Forest Reserve was to carry out environmental engineering experiments through tree planting. In the report recommending the Reserve, Hugh Baker had described Plains conditions which,

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[2] E.N. Munns and Joseph H. Stoeckeler, "How are the Great Plains Shelterbelts?" *Journal of Forestry* 44, no. 4 (April 1946), 256. Initially known as the Shelterbelt Project, the name was changed to the Prairie States Forestry Project in 1936.

[3] This story is mentioned in several places, for example, in 1946: Munns and Stoeckeler, "How are the Great Plains Shelterbelts," 237. William Droze, in *Trees, Prairies, and People: A History of Tree Planting in the Plains States*, (Denton: Texas Woman's College, 1977), 50, 62, attributes it to *New York Herald* columnist Robert S. Allen.

amplified by drought thirty years later, were at the heart of the Dust Bowl experience. "In summer the sun shines upon the scantily covered sandy surface, which with the high radiatory [*sic*] action of the earth, heats to great intensity the atmosphere near the ground and generates hot winds which rush away damaging all forms of vegetable life." Planting trees, he was sure, would improve the environment. "The effect of the forest purely as a windbreak would be decidedly beneficial. The scourge of the sand hills is the wind. It sweeps over them almost incessantly. Even in small bodies trees are efficient local windbreaks, and if grown over the area contemplated in the reserves they would favorably affect the wind over a large part of western Nebraska."[4] The newly-built forest was now well established in Nebraska and the foresters were ready to move out of the sand hills and into the larger Great Plains area. In the 1930s, the land and the people there certainly seemed to need trees more than ever.

Stuart assigned silviculturist Edward N. Munns to begin research on the larger Shelterbelt plan. Munns enlisted the aid of Raphael Zon, Director of the Forest Service Lake States Experiment Station and the station's head silviculturist Carlos Bates. These two men had extensive experience with tree planting on the plains. Bates had been studying the effects of shelterbelts for decades. Block planting, one giant shelterbelt, was ruled out as technically impossible given the environmental conditions of the area, particularly soil composition. The idea of long, continuous strips of trees within the shelterbelt zone was abandoned as well, for similar reasons. Instead individual shelterbelts would be planted separately throughout the zone. Ideally these would each be at least 100 yards wide and extend for one mile in an east to west orientation. Bates

[4] Baker, "Proposed Forest Reserves in the Sand Hills of Nebraska," 11.

and others who had been working on shelterbelts knew the effects were strictly local. While the plantings in the shelterbelt zone would stretch from the Canadian border to Texas, the project would have to aim for an accumulation of localized benefits rather than an unrealistic single application with a continental effect. Zon, Bates, and others at the Lake States Experiment Station submitted a "Plan for Immediate Drought Relief." They claimed that with modifications Roosevelt's original idea would be both "feasible and desirable" and in their scientific opinion "of enormous immediate and permanent benefit to the section of the Great Plains Region which is now suffering most acutely from the direct and secondary effects of prolonged drought."[5]

Bates, a staunch proponent of the benefits of shelterbelts, foresaw great possibilities. While the trees would certainly not change the climate on a large scale or prevent future droughts, he wrote, "the effect upon all forms of life is going to be far from insignificant." Technical expertise would bring great social benefits. "If the project can be made successful, as it is believed it can with the utmost care and proper technical guidance, such an effort will have a spiritual effect far greater than any physical effect which can be measured."[6] This is the faith that infused all the Forest Service tree planting efforts, first in the Nebraska Sandhills and now in the Shelterbelt Project: that forests improve people's lives physically and spiritually. And the Forest Service believed it could successfully build those forests.

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[5] Quoted in Droze, 76.
[6] Memorandum from Bates to Raphael Zon, May 29, 1934, quoted in Droze, 74.

Trees on the Ground—Placing the Shelterbelt Zone

Roosevelt was convinced. He established the Shelterbelt Project by executive order on July 11, 1934. Paul Roberts, who was born in Nebraska and had graduated with a degree in forestry from the University of Nebraska in 1915, became Administrative Director with authority over the fieldwork and the overall project. Zon became Technical Director, responsible for planting standards, tree species, and shelterbelt specifications. Bates supervised all of the project's experimental work carried out at the Lake States Station. The field headquarters for the project was established in Lincoln, Nebraska and individual state headquarters set up in all of the other states the shelterbelt zone would pass through—North Dakota, South Dakota, Kansas, Oklahoma, and Texas. Charles Scott, the original supervisor of the Dismal River forest who had since gone into the private nursery business, was recruited and placed in charge of the Kansas operations. In the fall of 1934 the Forest Service started gathering seed for beginning the nurseries that would be established in each state and began to produce a comprehensive report that would direct the future work of the project.

Published in 1935, *Possibilities of Shelterbelt Planting in the Plains Region* described the environmental and social problems facing the nation on the Great Plains and offered a scientific and philosophical rationale for addressing these problems with tree planting. It gave geographical, vegetative, climatic, and soil studies of the shelterbelt zone. A survey of relevant past scientific studies and the history of tree planting on the Plains were included along with comparative examples of shelterbelt plantings in Canada, Denmark, Hungary, and Russia. Reviewing the report for the journal *Ecology*, University of Oklahoma professor Paul Sears described the work as "a remarkable example of applied ecology."[7]

The proposed shelterbelt zone encompassed 114,700 square miles of land and was mapped out as 100 mile wide and 1,150 mile long strip following the transition area between the tall-grass prairie and the short-grass plains, running generally along the 99th meridian but jogging eastward in South Dakota and westward in southern Nebraska and northern Kansas. The zone's western boundary roughly followed the annual precipitation line of 16 inches in the north and 22 inches in the south. Within the zone individual shelterbelts were ecologically constrained mainly by soil characteristics. Each shelterbelt would be an individual planting. Zon explained, "there can be no continuous parallel forest strips, but each planting must be adapted to the soil conditions of the individual farm or farms which it is to protect, and must be oriented according to the damaging winds prevailing in each locality." He emphasized that the trees were not a "cure-all" but should be one component of "a much broader program of water conservation, soil-erosion control, terracing, strip cropping, and other measures." Nevertheless, the project was a grand plan; it would be ongoing and expanding in size and effort. Zon suggested that the project be understood as "a regional forestry enterprise" with the Great Plains "organized as a distinct forest region." As an application of technology, a land management directive, and a new perception of the plains through forestry, this project

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[7] Paul Sears, "The Great American Shelter-Belt," *Ecology* 17, no. 4. (October 1936), 684.

was the perfect successor of the Nebraska National Forest and a revitalization of the ideology of Manifest Destiny through tree planting.[8]

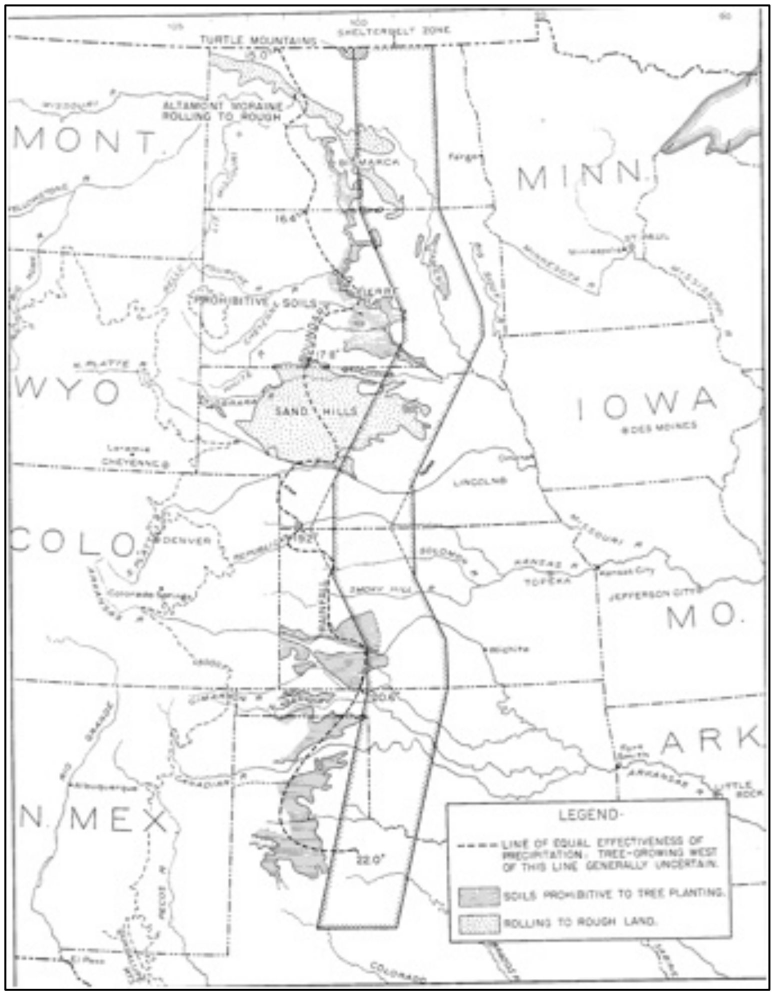

Figure 15 - Shelterbelt Zone. Source: USFS

An ambitious environmental engineering effort, the project was government intervention on a grand scale. Similar to other progressive State programs described by political scientist James C. Scott, in the PSFP a distant centralized authority applied its

[8] Raphael Zon, "What the Study Discloses," *Possibilities of Shelterbelt Planting in the Plains Region* (Washington D.C.: GPO, 1935) 5, 9-10.

power and expertise in an attempt to improve the environment and society.[9] Scott explained his diverse international examples of authoritarian State planning as a type of social imperialism that often fail because they do not include "the necessary role of local knowledge and know-how."[10] In this case, however, the Shelterbelt Project was shaped by considerable pressure from local conditions and local people. The physical conditions of the environment inspired an intervention and set practical boundaries on the effort. Many farmers invited government involvement, much as private scientists had encouraged federal forestry in 1873. These locals were not the unwilling victims of imposed government planning; in fact, they welcomed these tree plantings as improvements to their farms. Defending the project in the *Journal of Forestry* in 1934, Clayton Watkins wrote, "these tree belts will be made to fit the community through which they run rather than attempting to make the community fit the tree belt."[11]

Although the plan was conceived and subsidized on a national scale, the plantings were carried out in specific local places and adapted accordingly. Plains settlers and farmers had long tried to plant trees on their land, the federal government simply brought money and expertise that locals could not muster. Although the work and the effects were local, the benefits were intended for all Americans. Raphael Zon, the Technical Director of the PSFP, explained that while "the Plains shelterbelt project represents a national effort applied to the amelioration of regional conditions," the "benefits accruing

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[9] James C. Scott, *Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed* (New Haven: Yale University Press, 1998) describes strictly regimented German forestry, utopian city planning in Brazil, and Soviet Collectivization as authoritarian impositions of what he calls high-modernist ideology.
[10] Scott, *Seeing Like a State*, 6.
[11] Clayton Watkins, "Individual Letters Received on Shelterbelt Project," *Journal of Forestry*, 32, no. 8, (November 1934), 972.

to an interstate region that contributes vitally to the national economy accrue in like measure to the welfare of the Nation collectively."[12] The problems of the Depression and the Dust Bowl were environmental and social, local and nationwide, individual and collective. One of the solutions, embodied in the PSFP, combined nature and technology, local workers and federal power to remediate the Plains landscape by planting trees.

Technological Trees—Engineering Society on the Plains

Federal foresters saw shelterbelts as technical tools. They had long understood planted trees as organic technologies; in 1911 a Forest Service Bulletin written by Carlos Bates had championed shelterbelts as a technology for increasing farm production.[13] Later, considering the issue of home heating on the plains, Bates claimed that it was better to approach the problem "not from the standpoint of the architecture or heating engineer but from that of modifying the environment." Using an organic technological fix could integrate rather than attempt to isolate people from their environment. Through extensive experiments, Bates found that a well placed shelterbelt could reduce a farmer's winter heating bill by about 25 percent.[14] Raphael Zon encouraged tree planting as a farming technology. "Shelterbelts," he wrote, "should help to stabilize this agriculture and leave it less at the mercy of the elements." They could "make living conditions more comfortable and add much needed variety to the monotonous prairie landscape." He

[12] Raphael Zon, "Prospective Effects of the Tree-Planting Program," *Possibilities of Shelterbelt Planting in the Plains Region*, Washington D.C.: GPO, 1935, 33.
[13] Carlos G. Bates, "Windbreaks: Their Influence and Value," USDA, Forest Service, *Bulletin 86*, (Washington D.C.: GPO, 1911).
[14] Carlos G. Bates, "Shelterbelt Influences: The Value of Shelterbelts in House-Heating," *Journal of Forestry*, 43, no. 3, (March 1945), 176-77.

anticipated that "the social benefits from windbreaks [would] be as great as the physical," providing for plains farmers "the amenities of a higher cultural life."[15] Shelterbelts could help recreate the treed landscape, productive economy, and sophisticated society of the East.

The PSFP planted shelterbelts to produce certain environmental and social conditions. These trees were nature as technology for "stabilizing the productiveness of the land, and making one of the most important agricultural regions of the Nation a better, more desirable place to live."[16] For locals, shelterbelts offered the personal benefit of improved yields and better living conditions. For foresters and the federal government they addressed national environmental and social issues—drought, dust, agricultural efficiency, and economic depression.

The Chief of the Forest Service in 1935, Ferdinand Silcox, suggested that tree planting on the Plains provided more than just the improvement of physical conditions. "A larger and more vital value . . . and one that cannot be expressed in physical terms or realized by those who have not experienced life in the prairie-plains region," he wrote in *Possibilities of Shelterbelt Planting*, "is the reinforcement of the people's morale that comes with shade from sun glare, shelter from the ever-prevailing winds, the improved appearance of the countryside, a greater pride in ownership, and a real increase in value of the farmstead—all culminating in a general sense of being at home on the land." This was important because by the 1930s the sense of the Great Plains as a hospitable home

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[15] Raphael Zon, "Shelterbelts—Futile Dream or Workable Plan," *Science*, 81, no. 2104, (April 26, 1935), 392, 394.
[16] USDA Forest Service, Prairie States Forestry Project, *Trees that Temper the Western Winds* (Washington D.C.: GPO, 1938), 14.

for Americans was in serious doubt. In fact, Silcox described the situation there as "a national calamity as a result of the severe climatic and economic conditions . . . brought home to the country as a whole by great dust storms, nature's own manifestation of land disorders."[17] When called on by President Roosevelt, the U.S. Forest Service was ready to work at fixing this broken land and restoring social stability.

A particular set of historical circumstances set the stage for this government effort at environmental engineering. As immigrants from the east became settlers and farmers on the Great Plains in the 19th century pursuit of Manifest Destiny, they planted more than trees. Wheat, corn, oats, alfalfa, subsistence crops became cash crops that would fund a new western agricultural economy and incorporate the Plains into the American nation. The immigrants impacted the prairie environment almost immediately. Elliot West describes the destruction of grass and timber resources associated with the overland travel to Oregon, California, Utah, and Colorado.[18] When the Plains became a site of white settlement rather than just transit, people began to rearrange the land even more drastically. Sod cutting plows took up centuries' worth of grass growth to provide building materials for homes and barns and to gain access to the rich soil for farming. Other technologies, barbed wire fencing, railroads for transporting agricultural and consumer products, tractors and ever more powerful mechanical harvesters, helped entrench this new society into the Plains landscape and seemed to promise environmental

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[17] F. A. Silcox, "The Problem," *Possibilities of Shelterbelt Planting in the Plains Region* (Washington D.C.: GPO, 1935), 1.

[18] Elliot West, *The Contested Plains: Indians, Goldseekers, and the Rush to Colorado* (Lawrence: University Press of Kansas, 1998); see also his essay "Land" in Elliot West, *The Way to the West: Essays on the Central Plains* (Albuquerque: University of New Mexico Press, 1995). West also argues that, as a result of adopting a new horse-based culture, perhaps the Native American use of grass and timber resources was unsustainable.

and economic security and even prosperity.[19] Wells and windmill pumps gave settlers access to the most critical resource on the Plains—water. However, before the late 20th century these wells provided only enough water for a household and some livestock. Agriculture, particularly the large-scale commercial agriculture that grew from 19th century bonanza farms, still relied on capricious rains.[20]

Ideologies of Manifest Destiny and opportunity, along with a healthy dose of advertising and boosterism, enticed more and more people onto the Plains in the optimistic pursuit of the American Dream. They worked hard to establish a productive society. Favorable environmental conditions and historical events brought boom times to Plains agriculture. Monocropping of wheat and corn, the development of mechanical farm equipment like combine harvesters, and the ever increasing railroad system (bringing farming materials in and taking produce out of the Plains) made farming profitable. Even if there was a growing tendency towards land consolidation and bonanza farming by corporate owners, there still seemed to be abundant opportunity. Drought in the 1890s might have put a damper on the enthusiasm for Great Plains settlement and agriculture but by the second decade of the twentieth century the boom was on again. Positive precipitation and a heavy demand for wheat generated by World War I drove up prices and the chance for profit. Utilizing gasoline powered tractors, farmers plowed and planted more land than ever and businesses and private citizens got into wheat farming on the Plains as an investment. Between 1899 and 1929 the number

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[19] Walter Prescott Webb, in *The Great Plains* (Boston: Ginn, 1931) argues that the conditions of the plains environment drove setters to develop many of these technologies in order to prosper there.

[20] See Deborah Fitzgerald, *Every Farm a Factory: The Industrial Ideal in American Agriculture* (New Haven: Yale University Press, 2003) for an analysis of the development of commercial farming on the Great Plains, particularly the reliance on technology and an industrial ideology of agricultural production.

of acres harvested on the Plains had almost doubled from 54 million acres to 103 million.[21]

Unfortunately the marvelous alignment of climate and markets could not last; they both failed spectacularly accompanied by clouds of dust appropriate to the size of the bust. The great crash came in 1929 but even before that stores of wheat sat unsold, rotting in silos and railroad sidings as the markets failed farmers first. Overproduction forced the value out of the crops, and then drought, as a sort of ironic environmental corrective, took the productive capacity out of the land. There had been dust storms before, in 1855, 1879, 1880, 1881, 1894, and 1895 but the combination of increased plowing and severe drought in the 1930s resulted in storms that, according to historian Donald Worster, were completely different in "frequency and scale." These dust storms, he says, were "of such violence that they made the drought only a secondary problem . . . of such destructive force that they left the region reeling in confusion and fear." The land literally moved, with millions of tons of earth blowing away in each storm. The Department of Agriculture reported, "half of the Great Plains—some 500,000 square miles—had been seriously damaged by erosion." The people moved too, some 300,000 fleeing to California between 1935 and 1939 and more than 3 million in all leaving the Plains over the course of the decade. Manifest Destiny immigration now mirrored by Dust Bowl exodus.[22]

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[21] Carolyn Merchant, *Columbia Guide to Environmental History* (New York: Columbia University Press, 2002), 97. Besides wheat the other large scale commodity crop harvested on the Plains was cotton.

[22] Donald Worster, *Nature's Economy: A History of Ecological Ideas* (Cambridge: Cambridge University Press, 1977), 221, 223, 225; Donald Worster, *Dust Bowl: The Southern Plains in the 1930s* (Oxford: Oxford University Press, 1979), 12, 49. See also Geoff Cunfer, "Scaling the Dust Bowl," *Placing History: How Maps, Spatial Data, and GIS are Changing Historical Scholarship*, edited by Anne Kelly Knowles, (Redlands, Ca: ESRI Press, 2008), 111. There is an ongoing academic debate regarding whether human

The dust from the plains blew eastward; sometimes falling heavily on cities where people, like the plains farmers, found the ground had shifted under them too. The Great Depression was a financial disaster and, for American society, an existential calamity. A combination of factors caused the economic depression: market speculation and overvaluation of stocks; overproduction of goods and insufficient purchasing power among the middle and lower classes; and an international financial house of cards built on German reparation debts and American loans to Europe following WWI. The consequences of the Depression though were more than economic: general fear and uncertainty about the future; disillusionment with the financial system and banking; and a loss of faith in the traditional promise of opportunity in America that hard work (and proper morals) led to success. Unemployment became the central experience of the Depression. By the time Roosevelt took office as President in 1933 the number of unemployed in the nation's workforce was reaching 25 percent. In a whirlwind of legislation during his first 100 days he tried to find pragmatic approaches to address the many problems—the need to stabilize the banking system, lower agricultural production while providing relief for farmers, regulating the stock market, and protecting home owners from foreclosure. Most importantly, Roosevelt tried to put people to work. The Public Works Administration provided jobs building schools, hospitals, courthouses, bridges, and dams (most notably Boulder Dam on the Colorado River). The Works Progress Administration employed millions of people and in the Civilian Conservation

activity and capitalist ideology (as argued by Worster and others) or drought and environmental conditions (as argued by Cunfer and others) is the principle agent of the Dust Bowl. For my examination of tree planting as a contemporary environmental engineering response, the resulting conditions are more important than the ultimate causation.

Corps some 2.5 million young men aged 18 to 24 did construction and conservation work in National Parks and National Forests around the country.[23]

In July 1934, President Roosevelt announced the shelterbelt project as one of his many initiatives in response to the dust storms, failing agriculture, and unemployment affecting the United States and the Plains in particular. In preparation for the public announcement, forestry officials had written a memorandum describing the purpose of the project that is worth quoting at some length. The goal of the project, according to foresters, was:

> The amelioration of the local effects and manifestations of unfavorable climatic elements and it is absurd for anyone to say that man cannot accomplish this on a considerable scale, just as he accomplishes it on a small scale when he builds himself a shelter. . . . If merely the surface velocity of the wind over a wide territory can be broken and decreased in the slightest degree, soil will be held in place, the moisture of soil will be conserved, havens of shelter will be created for man, beast, and bird, and much future suffering and property loss will be averted. Meanwhile, a harassed people will be given new courage and a pittance on which to subsist, without recourse to charity and loss of self-respect.[24]

Planted as a technology, these trees were intended to perform both environmental and social engineering. The shelterbelts would repair a damaged environment, prevent future problems of drought and wind, and improve the lives of humans and animals. The trees even promised to infuse a new spirit of courage and self-respect into a beleaguered people. Technological optimism and trust in a government sponsored approach

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[23] On the New Deal see Jason Scott Smith, *Building New Deal Liberalism: The Political Economy of Public Works, 1933-1956* (Cambridge: Cambridge University Press, 2006). On the role of the Civilian Conservation Corps in the New Deal conservation work see Neil M. Maher, *Nature's New Deal: The Civilian Conservation Corps and the Roots of the American Environmental Movement* (Oxford: Oxford University Press, 2004).

[24] Carlos G. Bates, Harold R. Scholz, and Joseph H. Stoeckeler to Raphael Zon, May 28, 1934, quoted in Droze, *Trees, Prairies, and People*, 73.

characterized the New Deal Forest Service just as institutional confidence had bolstered Pinchot's Progressive Era agency.

The head of the PSFP, Paul Roberts, purposefully characterized the shelterbelts as technology. One of a whole series of technologies developed to help people live on the Great Plains, the planted trees were intended to solve specific problems.

> Just as the windmill to raise water to the surface, and barbed wire, first to protect crop lands and later to enclose pastures, were a part of man's adaptation to Plains conditions, and just as crop agriculture has had to be adjusted through development of special techniques and special strains and varieties of farm crops; so forestry can and should be adapted and used as an essential economic betterment to protect crops, livestock, and man himself from the effects of prevailing high winds; to conserve soil moisture in a region of deficient precipitation; to provide fuel, posts and other wood products in a region where they are largely lacking; and as a social benefit to add to the beauty of man's surroundings and to his general comfort and happiness.[25]

Trees had been planted on the Plains before the adoption of windmills and barbed wire but the scale and careful design of the planting now represented an innovation in their application as a technology. The problems were more serious so the technology had to be bigger and more widespread, its adoption promoted by the government.

Doubt and Defense—The Scientific Reputation of Forestry

Restoring the drought stricken landscape and the economically ravaged population of the Plains, however, was a tall order for any technological fix and not all professional foresters were as positive and enthusiastic as those associated with the

[25] Paul Roberts, *Plains Forester* 3, no. 1 (January 1938), 1. The *Plains Forester* was an internal newsletter of the PSFP published from 1936 to 1942 and distributed to all the permanent employees of the project. It contained project news, information sharing on techniques and tools, and social announcements.

project. While promoters saw tree planting as a viable technological solution offered by scientific experts, opponents feared that failure and a too close association with a specious nineteenth century "Rain follows the Plow" mentality would undermine the foresters' credibility and public acceptance of forestry as a legitimate science.[26]

This debate took place between foresters within the federal agency and in the private sector, within the social context of whether science was best carried out in the public sphere of government bureaucracy, by the universities as "enclaves of pure research," or through the activity of private industry. For scientists, if not the general public, there was some tension between theoretical knowledge and applied science. Biological science, particularly, struggled to achieve the perception of rigor attached to the physical sciences, like physics or chemistry. In agriculture this tension was acute. As Nathan and Ida Reingold point out, "agriculture seemed to the leading scientific figures of this era" to have "too much of the utilitarian and not enough of the abstruse." The American public, however, was "conditioned to conceive of science solving all problems and inclining to a faith in big projects."[27] Backed by ideological optimism and previous planting experience, the Forest Service presented the PSFP as a big solution for a big problem. But there were doubters. Even though Pinchot had purposefully forged unique connections in American forestry between government, universities, and industry, some

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[26] Nineteenth century boosters had widely advertised the pseudo-scientific idea that rain follows the plow to encourage settlement in the arid west, claiming that increased population and agricultural activity would change the climate. This resulted in many failed homesteads and a widespread suspicion of grand scientific claims. See Henry Nash Smith, "Rain Follows the Plow: The Notion of Increased Rainfall for the Great Plains, 1844-1880," *The Huntington Library Quarterly*, 10, no. 2, (February 1947): 169-193.
[27] Nathan and Ida H. Reingold, *Science in America: A Documentary History 1900-1939* (Chicago: University of Chicago Press, 1981), 5-6, 127-128.

forestry scientists were leery. At stake in this case was the still fragile expert status of foresters.

In a *Journal of Forestry* editorial, H. H. Chapman, Yale professor of forestry and president of the Society of American Foresters, wrote a scathing critique of the shelterbelt idea as it was first proposed and publicized with an emphasis on block plantings or contiguous belts. "Foresters," he wrote, "have been and still are regarded by many engineers and scientists as falling short of professional status." He was concerned that forestry be perceived as a modern science. He continued:

> Just as real progress has perhaps for the first time been recorded in convincing other professions of the soundness and technical honesty of our findings . . . there comes this sudden front page publicity, reviving all the old misguided notions of forests and climate. Thinking foresters cannot but regret the form that this has taken or the interpretations placed by the public upon such official statements as 'man can ameliorate the effects of the weather on a large scale, just as he can around his home."[28]

A flurry of letters followed, arguing both sides of the issue. Many foresters were agreed that the project was too fanciful and would damage the reputation of forestry as a scientific and professional enterprise. Professor Fay G. Clarke, from the School of Forestry at the University of Montana, was concerned that failure would "shake the public confidence in our professional integrity." He lamented further: "For some thirty years the lumbermen have thought of the professional foresters as a lot of rattle-brained theorists, and we are just now beginning to disabuse them of this opinion and to secure their confidence. And now, are we going to lose the ground we have thus gained by sponsoring, or perhaps I should say condoning, a project of this magnitude that most of

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[28] H.H. Chapman, "Editorial: The Shelterbelt Tree Planting Project," *Journal of Forestry* 32, no. 8, (November 1934), 801.

us feel is doomed to failure?"[29] Obviously, insecurity and an obligation to private enterprise existed within forestry in a way it did not in most other sciences.[30]

Chapman had solicited the criticism with a questionnaire sent to scientists and professional foresters. The issue was framed in a decidedly negative light and the results of the survey were printed in the *Journal of Forestry* as a summary of the various complaints about the project. The accompanying letter began: "The announcement of the President's western tree planting program about a month ago, has, by reason of its scope, the publicity it has received, and the very serious questions raised as to its probable success, caused widespread apprehension among foresters both within and without the region affected." Chapman thought that, "quiescent acceptance of this project without questioning either its technical soundness or its administrative efficiency might damage the reputation of foresters and forestry for decades."[31] Positive comments were not reported in the summary compiled by Chapman but could be found within the text of many of the published individual responses.

A clear division existed between foresters in the private sector or university positions and those currently in the Forest Service. Carlos Bates replied, "I want you to know that I protest most vehemently against the publication of Chapman's editorial." Bates questioned the specific expertise and the local knowledge, of the "cross-section" of professional foresters surveyed. "One would like to know just how such a cross-section

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[29] F. G. Clark, in "Digest of Opinions Received on the Shelterbelt Project," *Journal of Forestry* 32, no. 8, (November 1934), 952-53.
[30] Examples of the science and practice of forestry as beholden to private interests ranges from Gifford Pinchot's tour of the West to solicit support for his new government agency at the beginning of the 20th century to the virtual subservience of the Forest Service to the timber industry after WWII through production quotas and funding mandates as described by Paul Hirt in *A Conspiracy of Optimism*.
[31] H. H. Chapman, "Digest of Opinions Received on the Shelterbelt Project," *Journal of Forestry* 32, no. 8, (November 1934), 953.

was obtained, and to what extent those who know anything, first hand, about the conditions have been consulted. . . . I do not consider the opinion of the greater number of eastern foresters on this subject as of very much value."[32] In a lengthy letter of response, Clay Watkins, from the College of Agriculture in Lincoln, described the long history of tree planting in Nebraska. He described the PSFP as "not a fantastic dream but a sound practical program." The effort was simply an expansion of the environmental transformation begun by early settlers who carried cuttings and seedlings in their covered wagons. Appealing to a pioneering spirit, which had perhaps become relevant again in the face of the environmental and social problems of the 1930s, he praised these first tree planters for "their faith in the future of Nebraska. In times like these," he continued, "we need a little more of the old-time faith and spirit which together developed the moral fibre [*sic*] that characterized those who pioneered this state."[33] As ever, the psychological effects of community and hope and a cultural investment in the landscape were as important as the physical consequences of tree planting.

Respondents who had been associated with forestry on the plains, and especially the Bessey Nursery and Nebraska National Forest supported the project while foresters from other parts of the country were generally skeptical. However, even Chapman, had to concede that trees could be grown on the plains, "provided the entire operation is guided from first to last by the highest technical skill in selecting site, species, seed

[32] C. G. Bates, "Individual Letters Received on Shelterbelt Project," *Journal of Forestry* 32, no. 8, (November 1934), 957.
[33] Clayton W. Watkins, "Individual Letters Received on Shelterbelt Project," *Journal of Forestry* 32, no. 8, (November 1934), 969-72.

sources, [and] planting methods."[34] This was the expertise that the Forest Service had been developing at the Bessey Ranger District for three decades. Many federal foresters had begun their careers in the sandhill forest, moved up in the agency, and were now shaping policy for this new planting project. They were optimistic; after all they had already built a whole forest in Nebraska. It was, perhaps, a combination of this practical experience from earlier efforts and the vigorous debate within the field of forestry as a science that prevented the PSFP from becoming another failed example of high modernism. These two factors adapted an overly ambitious idea into a workable plan fitted to local conditions and locals' demands.

The opponents' concern was over feasibility rather than whether the shelterbelts were desirable. Even if they doubted the grand plan, virtually everyone acknowledged the benefits of trees on the plains. Chapman admitted that once trees were established, the localities were "made better places for human beings to live in."[35] Other commentators looked for the project to bring more stability to plains agriculture. "The greatest significance of our own shelterbelt project, it seems to me," wrote one in *The New Republic*, "is the evidence it gives of a turn towards a more settled, civilized way of life. Greater than any economic advantage will be the protection afforded human beings and beasts against the crazy, pounding prairie winds of winter, and against the summer sun." A properly constructed society on the Plains required a technological approach to the environment and a stable moral order—planted trees were always meant to root people to the Plains. "When you begin to have shelter belts, terraced fields, artificial

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[34] Chapman, "Editorial," 802.
[35] Chapman, 802.

water holes, you are approaching an agriculture that is fundamentally conservative, where pleasantness of life and a traditional, decent use of the land are beginning to be more important than snatching a quick fortune and moving to Southern California."[36] The impetus to modify the environment and make life better on the Plains by planting trees, brought from the East by 19th century settlers, carried even more force in the context of the Dust Bowl and Great Depression.

Seed Money—Getting the Project Started

Planted as a technology, the trees' environmental effect served a social purpose. Shelterbelt project foresters pointed to their practical experience and suggested flexibility in adapting to local conditions and landowners' concerns. They had the support of the President and the momentum created by New Deal experimentation in social engineering through government programs. Roosevelt paid particular attention to the enterprise as a pet project. An enthusiastic forester himself, he had, since 1912, planted trees on his own land in New York State and purchased adjacent properties to reforest. By 1945 he had planted more than half a million trees on his Hyde Park estate.[37]

With confident directors and Presidential backing the Shelterbelt Project proceeded, albeit with various adaptations during its course. Very quickly it shifted from the initial idea of block planting or contiguous belts to smaller discrete belts within a shelterbelt zone. Over time, more changes were made in the project's goals and methods. Historian Wilmon Droze, in *Trees, Prairies, and People: A History of Tree Planting in*

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[36] Jonathan Mitchell, "Shelterbelt Realities," *The New Republic*, (August 29, 1934), 71.
[37] John F. Sears, "Grassroots Democracy: FDR and the Land," *FDR and the Environment*, ed. Henry L. Henderson and David B. Woolner, (New York: Palgrave, 2005), 9-10.

the Plains States, describes the eight year program as a series of negotiations regarding funding and political agendas. Gaining Congressional approval and funding for the project was an ongoing battle in the first years. There was a fair amount of opposition to the project in Congress, particularly from Representatives whose states or districts were not in the planting zone. Although the Forest Service idealistically claimed the effort would ultimately benefit the whole nation. Congressmen looked for more immediate and direct advantages for their constituents. An initial budget of $75 million was proposed for the entire project. In his executive order establishing the Shelterbelt Project, Roosevelt allocated $15 million from the Emergency Appropriations Act of 1934. Much of this money was earmarked for purchasing or leasing land from farmers for the shelterbelt locations and for constructing local nurseries in the shelterbelt zone. The Comptroller, John R. McCarl, however refused to release the money because the Emergency Appropriations funds were intended only for financing immediate relief work. Eventually $1 million was secured to begin the work. Plans to fund the project from the Agricultural Adjustment Administration fell through when the Supreme Court ruled that agency unconstitutional in January 1936. Later that year Congress even voted to finance the dismantling of the Shelterbelt Project. Roosevelt was able to keep the project in operation through 1942, though, with small annual allocations from the Works Progress Administration budget. From this point on the Shelterbelt Program became officially known as the Prairie States Forestry Project (PSFP).[38]

The outcome of this funding struggle meant that the government would not own or even control the land on which the shelterbelts were built. Farmers would enter into

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[38] Droze, *Trees, Prairies, and People*, 100-102, 130.

cooperative agreements with the Forest Service and be responsible for maintenance of the belts once they were constructed. Thus the efficacy of the shelterbelts and the long-term success of the project rested on the uncertain effort of individual farmers rather than the scientific management of idealistic federal foresters. The Forest Service would provide the tree seedlings, draw up a specific plan for each location, and oversee the planting of the belts. Farmers would be responsible for protecting the trees from livestock and cultivating the ground in the shelterbelt, turning over the soil between the rows of trees to reduce competition from prairie grass and weeds, an operation crucial to the successful growth of the belt. However, because the government did not control the land, farmers could also, if they chose, remove rows or even whole belts after they had been planted. So, lack of political support and secure funding led to a significant loss of control in the management of shelterbelts as they developed. The new name of the program suggested the grand foresting enterprise the Forest Service had always wanted to carry out on the Plains, but really the planted shelterbelts were more separate individual entities than ever. Success of the plantings would vary widely, some would prosper but others would disappear. The best ones might develop forest conditions within the belt and provide the benefits foresters promised, but the collective accomplishment of the project would not fulfill the hopes of early tree planters and forest builders.

Instead of a regimented, expert managed program of plains forestry, the shelterbelt project amounted to a more intensive example of the cooperative arrangement the federal Forestry Division had fostered with settlers in the 19th century when they tried to promote tree planting on the Plains. The difference now was that the Forest Service could provide the trees and did the planting but the trees then became the property and responsibility of the landowner. Agricultural historian Joel Orth interprets the history of the PSFP as a set of compromises necessary to facilitate "cooperative conservation" in a democratic state. With the goal of conserving the natural resources of the Great Plains, namely fixing the shifting, blowing soil in place, landowners and farmers entered into a cooperative effort with the government in which the idealism and technical specifications of the Forest Service were shaped by negotiated compromise. According to Orth, expert status was subjugated to democratic participation. "Negotiated boundaries between scientific practice, economics, farmer experience, and an ever-changing natural world became integral to the project's continuance." Despite foresters' desire to stick to strict technical standards, "farmer pressure continued to shift administrative and silvicultural ideals." Orth offers the example of Julius Hansen, a farmer in Kearney County, Nebraska, who plowed under young trees, reducing his fourteen-row shelterbelt to six rows. Thus, statist planning and high modernism were mitigated by the democratic agency of a private citizen.[39]

Technical Standards—The Social Construction of Shelterbelts

The PSFP certainly existed within and was subject to the socio-political forces of a democratic, capitalist American culture. However, there are other ways of analyzing these shelterbelts that help point out the interconnections between humans and the environment. The design, development, and construction of shelterbelts by foresters and

[39] Joel Orth, "The Shelterbelt Project: Cooperative Conservation in 1930s America," *Agricultural History* 81, no. 3 (Summer, 2007), 343-44.

their adoption as a farm improvement by farmers can also be understood as the application of a technology. Shelterbelts were a technological fix for the Dust Bowl and Depression problems. The history of the PSFP reflects many of the common themes in the development and deployment of any technology.

The adaptations that were implemented by foresters or instigated by farmers and landowners can also be seen as the process of the social construction of technology.[40] Shelterbelts, in practice, reflected the requirements of end users; their design changed as a practical social necessity rather than adhering to the optimal physical parameters determined through research and experimentation. In other words, foresters were forced to compromise the design of their technology (individual shelterbelts) with the demands of those who would have to live with them. As Orth points out, "when Forest Service personnel began translating plans into trees they confronted a host of political, social, and environmental troubles." In response, "they continually shifted the technical guidelines to account for social, economic, bureaucratic, and natural factors."[41] This process is an example of what historians of technology characterize as the development of a technology under the collective pressures and demands of users—social construction. It also illustrates the influence of the local environment on a technological system, even as this technology itself was meant to reshape the environment—an envirotechnical relationship.

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[40] On the social construction of technology see Wiebe Bijker, Thomas Hughes, and Trevor Pinch, eds. *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology* (Cambridge: MIT Press, 1987); David E. Nye, *Technology Matters: Questions to Live With* (Cambridge: MIT Press, 2006).

[41] Orth, "The Shelterbelt Project," 334.

Foresters, with the luxury of an eager first round of farmers volunteering their land, began planting shelterbelts of ten rows of trees about 140 feet wide and up to one mile long. Ideally, the trees were planted close together in the rows to achieve forest conditions within the plantations more quickly. As the trees grew and the canopy closed overhead the shelterbelt no longer needed the required cultivation and maintenance as the weeds were shaded out and the trees became well established in a kind of ecological momentum. A standardized procedure, though, was impossible to maintain in the project. All of the foresters' technical plans were subject to various influences. "Farmer attitudes, soil conditions, site factors, farm equipment, the Plains economic situation, moisture content of the soil, and the necessity of responding to changing directives from Washington," as Droze points out, shaped the outcome of every planting. Like all technological and ecological systems, each shelterbelt was contingent on many factors.[42]

Spacing between the trees, spacing between the rows, and even the number of rows in a belt were soon influenced by farmers' demands. For at least the first three or four years, until the canopy closed, farmers had to cultivate the ground between the rows with a harrow or plow. Farmers often preferred belts with an odd number of rows so they could begin and end their cultivating on the same end of the shelterbelt. Foresters adapted their plans accordingly. There was also a degree of technological accommodation as foresters reluctantly widened the distance between the rows of trees to better fit the standard size of cultivating equipment. Although they wanted wider rows, farmers were usually loath to sacrifice more cropland to the shelterbelt, so they then pushed for fewer rows in a belt. Shelterbelts planted in the first two years were often up

[42] Droze, *Trees, Prairies, and People*, 101, 138.

to 165 feet wide; by 1937 the standard width was about 100 feet. These belts could have as few as seven or even five rows instead of the standard ten. Planting plans, Orth observes, started with “a silvicultural ideal but soon became a hybrid of technical and social needs.”[43]

The species composition within a shelterbelt was also subject to the social construction of technology. Foresters preferred multiple species belts with fast growing, tall trees in the center rows and slower growing, bushy conifers in the outer rows. A “hipped roof design” that peaked at the center offered the most protection as it channeled the wind up and over the shelterbelt. The correct density was also important. The belt did not need to be impenetrable; a thick filter was more effective than a solid barrier. But gaps and holes in the belt defeated its purpose. Hardwoods grew quickly and were popular with foresters and farmers alike, giving the impression of rapid progress. Conifers provided the best coverage, especially on the outside of the belt, but they were slow-growing and more difficult to successfully transplant. Cottonwoods were often used instead of more effective species because they were easily obtained and grew tall quickly. However, they were not long-lived and when they died they left large holes in the shelterbelt. Foresters relied on cottonwood more than they knew they should and they also pushed for wider shelterbelts (which hid failed plantings in the belt better) as they tried to achieve some technological momentum for their project. The impression of success helped convince farmers and legislators of the project’s efficacy and made further applications of the technology more likely. If measured by continued usage, these

[43] Orth, “The Shelterbelt Project,” 342, 344.

socially responsive versions of shelterbelts constituted a more successful technology even though they sacrificed some of the technically optimal characteristics.

Ecological Standards—The Environmental Construction of Shelterbelts

In addition to social influences, local environmental conditions—or what might be termed a form of environmental construction—shaped shelterbelt technology and construction. As many of the early critics had argued, not all areas within the shelterbelt zone were conducive to tree growth. Variations in soil type limited planting opportunities and definitely prevented any contiguous shelterbelts running the length of the zone as first proposed. Project managers commissioned soil surveys to produce maps of suitable planting sites. Ten thousand plots from throughout the shelterbelt zone were examined and soil samples taken. Soil types and characteristics were mapped out and correlated with their suitability for tree growth in general and specifically for particular species of trees. Droze points out that these highly detailed soil maps "determined to a substantial degree the overall plan for planting the prairie-plains."[44] The best soil produced the best shelterbelts. In this case one of the most important soil characteristics was texture. Sandy soil, rather than finely textured clay or silt, had a better ability to absorb moisture to a depth where it was accessible to tree roots. During the soil survey, crews excavated and examined the roots of 126 trees of various species and in different soil types. Each of these root systems was drawn out on a graph. This enabled scientists to examine the relationships between different tree species and soil types and then to

[44] Droze, *Trees, Prairies, and People*, 133.

make planting recommendations for specific locations throughout the zone. For example, the Valentine soils, found largely in North Dakota, were suitable for a wide range of trees including willow, cottonwood, hackberry, Russian-olive, American elm, choke cherry, and ponderosa pine. Epping soils in northwest Nebraska, however, were often on steep slopes and absorbed moisture too slowly. They were unsuited to tree planting except perhaps for hardy, drought-resistant species like red cedar.[45]

While soil type had a very fine scale influence on planting locations, the broader ecosystem interactions of the area had a strong influence on the size and shape of the shelterbelt zone as a whole. Frank Hayes, a senior soil scientist with the Bureau of Chemistry and Soils, wrote a report on the climate and geography of the shelterbelt zone included in *Possibilities of Shelterbelt Planting in the Plains Region*. He described the shelterbelt zone as "an administrative area whose bounds are defined by an economic and social objective." However, because of scientific studies like his, this zone was shifted and adjusted based on the local environmental conditions. "Soil, climate, topography, ground water, vegetative growth," and other factors played an important role in determining where trees could be grown and so where the zone would be placed as foresters searched for "a satisfactory working balance between needs and possibilities." The environment forced changes in the original plans, as the zone was "extended, contracted, deflected, or straightened as conditions seemed to dictate, so that the present outlines differ materially from the tentative pattern with which the study began."[46] While

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[45] F. A. Hayes, "Soil and Forest Relationships of the Shelter Belt Zone," *Possibilities of Shelterbelt Planting in the Plains Region*, (Washington D.C.: GPO, 1935), 111, 133, 139.
[46] F. A. Hayes, "The Shelterbelt Zone: A Brief Geographical Description," *Possibilities of Shelterbelt Planting in the Plains Region*, (Washington D.C.: GPO, 1935), 11.

foresters were trying to reengineer the environment, they still recognized the need to work within the ecological possibilities. It is a testament to the experience and ecological understanding gained from past tree planting and forest building efforts that they recognized the environmental limitations and were willing accept them.

In another example of environmental construction, locally produced seedlings always provided the most successful tree growth. Realizing this and building on the experience gained at the Bessey Nursery, project managers established local nurseries throughout the shelterbelt planting zone. At the height of the project the Forest Service operated thirteen of its own nurseries and leased seven more from private owners. The planting policy was to use nursery stock "grown from seed collected locally." This was important because, as federal foresters at the time pointed out, even within the same species, "over a period of many generations trees, like other organisms, develop characteristics which fit them for the particular environment in which they grow and may unfit them for another type of environment."[47] Adaptations to a locality affected a tree's "growth rate, yield, form, longevity, susceptibility to insect and disease attack . . . [and] ability to reproduce naturally."[48] Benefiting in large measure from advances developed at the Bessey Nursery in seed collection and germination techniques of scarification and temperature manipulation, local nurseries in the shelterbelt project became very

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[47] USDA, Prairie States Forestry Project, *Tree Planting on the Prairie States Forestry Project*, (Washington D.C.: GPO, 1938), 3; also on the differences, particularly regional, between different varieties of a given species see, Franz Fankhauser, "Concerning the Significance of the Seed Source of our Forest Trees," *Journal of Forestry* 29, no. 5 (May 1931): 652-660.

[48] Harold Engstrom and Joseph Stoeckeler, "Nursery Practice for Trees and Shrubs Suitable for Planting on the Prairie-Plains," USDA, (Washington D.C.: GPO, 1940), 8.

successful seedling producers. In 1939 alone the 13 nurseries of the PSFP produced a record 60.5 million seedlings.[49]

Forest Conditions—The Value of Organic Technology

In 1942, with many government agencies shifting their resources towards the war effort, the PSFP ended and shelterbelt responsibilities transferred to the Soil Conservation Service with planting continuing on a much smaller scale.[50] During its eight years of operation the PSFP planted some 220 million trees in 30,223 separate shelterbelts. A survey of 1,079 of these shelterbelts, carried out in 1944 and published in the *Journal of Forestry*, declared the project a success with 78 percent of the belts rated as good or better. Only 10 percent of the belts surveyed were rated as unsatisfactory. The survey collected information on the age of the planting, the appearance of the belt, the soil conditions, water table, and types of damage done to the belt. Measurements were taken in each row of height, diameter, crown spread, individual tree survival, vigor, crown class, and closure of the canopy. Canopy closure was one of the most important objectives in the development of a shelterbelt. Usually achieved between five and ten years after planting, it marked the stage when the farmer could stop cultivating between the rows of trees. Adequate cultivation during the early years of growth was the single most important factor in the success of the shelterbelt. Once the belts had reached maturity questions of proper maintenance—particularly trimming and cutting out trees,

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[49] Droze, *Trees, Prairies, and People*, 153.
[50] The Soil Conservation Service had been doing a small amount of shelterbelt planting all along.

fostering the growth of one species over another, or even whether to promote conifers or hardwoods—became the subjects of further studies for plains foresters.[51]

Canopy closure was also important because it fostered "the formation of true forest conditions" within the shelterbelt. As the crown closed overhead weeds and grasses were shaded out underneath and the composition of the soil began to change with the build up of leaves and branches. In 19 percent of the belts they examined the foresters found a buildup of leaf mulch up to an inch thick. The trees of the belt were beginning to perform ecosystem functions. "The soil in such cases," the foresters reported, "was all that a forest soil should be, a marked contrast to the hard sun-baked soils of the adjacent fields and pastures."[52] Following the same process that had occurred in the Nebraska National Forest, many of these shelterbelts, planted by hand, were becoming miniature forests.

In contrast to the doubt and division exhibited in the *Journal of Forestry* at the announcement of the project, this report on the development of the shelterbelts ten years later boldly claimed that the project's accomplishments included: "landscape improvement, control of wind erosion, snow traps along highways, protection of farmsteads, gardens, orchards, and feedlots, providing a haven for game and song birds, furnishing wild fruit for preserves, providing fence posts and small poles for use on the farm, and bringing new districts into the soil conservation program." Again, besides the practical consequences of the shelterbelts farmers and foresters pointed out more esoteric benefits. The miniature forests improved the landscape, adding color and contrast,

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[51] Munns and Stoeckeler, "How are the Great Plains Shelterbelts?" 239, 257.
[52] Munns and Stoeckeler, "How are the Great Plains Shelterbelts?" 240.

beautifying farms. The survey report suggested a social mechanism too, relevant to the shift that had taken place on the Plains from Manifest Destiny immigration to agricultural speculation to Dust Bowl exodus. Shelterbelts "give the community an appearance of permanence—something solidly and deeply rooted in the soil. They dispel some of the fly-by-night aspect which has come to be associated with prairie carpetbaggers who settle down for a few years to gamble on the hope of two good wheat crops in succession and then promptly pick up and depart."[53]

As the report pointed out, these shelterbelts were multipurpose technologies and not only people benefited from them. The PSFP shelterbelts served many non-human users and these other users benefited farmers. The Forest Service declared shelterbelts one of the "least expensive of the improvements which a prairie farmer can put upon his land" because, in addition to providing fuel and posts and acting as windbreaks, they provided "cover for game birds and birds that eat crop destroying insects" and were "valuable for recreation."[54] The belts were "veritable havens for upland game birds, particularly pheasants and doves, and for numerous insectivorous song birds." Hawks and owls were commonly associated with the shelterbelts. Deer and squirrels migrated to the planted shelterbelts from woodland areas along streams. This influx of wildlife to the agricultural environment was welcome. Although, some farmers complained that coyotes also denned among the trees preying on their chickens and turkeys.[55]

In 1935, Raphael Zon foresaw that "alternation of forest strips with cultivated fields combines ideal conditions for the conservation and propagation of upland game

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[53] Munns and Stoeckeler, "How are the Great Plains Shelterbelts?" 257.
[54] USDA, *Tree Planting on the Prairie States Forestry Project*, 2.
[55] Munns and Stoeckeler, "How are the Great Plains Shelterbelts?" 253.

birds, which may bring the farmer some cash return if properly handled."[56] Ten years later, the Forest Service survey of the PSFP shelterbelts reported, "pheasant hunting in the shelterbelts was being successfully advertised as the lure to attract Chicago nimrods to the Plains."[57] These values were being recognized at the same time as the growing interest and government involvement in wildlife management, particularly for migratory birds and waterfowl.[58] In the later twentieth century habitat services for wildlife (along with the resulting recreational opportunities) became one of the explicit purposes for shelterbelt construction and management. Stephen Capel of the Kansas Fish and Game Commission declared in 1988 that, "the large, multi-row shelterbelts of the dust bowl era (1930-1940) have become outstanding wildlife habitats. They are of sufficient size and plant diversity to provide full life requirements for some wildlife species and a substantial portion of the cover requirements for many others." Social ideas regarding the purpose of the shelterbelts as a technology continued to shape their construction. Capel suggested including a row of tall deciduous trees such as bur oak, black walnut, or eastern cottonwood. "Some of these species," he admitted, "may not be the species of choice purely from a windbreak design standpoint because they may overtop the conifers, but

[56] Zon, "Shelterbelts," 394.
[57] Munns and Stoeckeler, "How are the Great Plains Shelterbelts?" 253.
[58] The Migratory Bird Hunting Stamp Act, passed in 1934, provided revenue for the government to acquire valuable wetlands. While the initial focus of the federal wildlife agency was on waterfowl habitat, upland game bird management would soon follow at the state and federal level along with the increasing popularity of sport hunting. On the history of wetlands and waterfowl refuge management see, Robert M. Wilson, *Seeking Refuge: Birds and Landscapes of the Pacific Flyway* (Seattle: University of Washington Press, 2010).

they offer better wildlife benefits, especially in providing winter food. Generally the benefits are worth the trade-off."[59]

As its trees grew, a successful shelterbelt developed the characteristics of a miniature forest: leafy much on the ground, shaded canopy overhead, and cover and food resources for wildlife. Beginning in the 1970s and continuing to the present, ecologists began to study shelterbelts specifically as wildlife habitat. The older shelterbelts, particularly, "contained regenerating woody vegetation and were wide enough . . . to begin to mimic conditions of eastern deciduous forest tracts."[60] These shelterbelts were described in one study as "man-made islands" within intensively farmed landscapes that were "extremely valuable to a variety of bird species during migration and as nesting areas." The older shelterbelts resembled "natural" woodland habitat, being "characterized by larger trees, denser woody understory, more woody debris (tree stumps, fallen logs) and junk, and sparse forbs." In considering ways to provide habitat and encourage species diversity within intensively managed agricultural areas, the study's author suggested, "the presence of farmstead shelterbelts, combined with field windbreaks, riparian habitats, and woody fencerows would perhaps be an alternative land-use priority."[61] Constructed as a farming technology, shelterbelts did more than improve conditions for crops, livestock, and people, or attach people to the landscape and create a stable society. They also incorporated human society into the local ecological

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[59] Stephen W. Capel, "Design of Windbreaks for Wildlife in the Great Plains of North America," *Agriculture, Ecosystems, and Environment* 22/23, (1988), 338-39.
[60] Richard L. Schroeder, Ted T. Cable, and Sandra L. Haire, "Wildlife Species Richness in Shelterbelts: Test of a Habitat Model," *Wildlife Society Bulletin* 20, no. 3, (Autumn 1992), 271.
[61] Richard H. Yahner, "Small Mammals in Farmstead Shelterbelts: Habitat Correlates of Seasonal Abundance and Community Structure," *The Journal of Wildlife Management* 47, no. 1, (January 1983), 74,76, 82.

system, resulting in more organic diversity than existed in agriculture practiced without this technology.

Although designed for farmers, the PSFP shelterbelts actually had many different users. At least 108 species of birds and 28 species of mammals utilized these technological forests for forage, breeding sites, travel corridors, and protection from predators and weather. Wildlife biologists concluded that “shelterbelts have helped maintain or extend the ranges of several small mammal and bird species.” Ultimately, farmers benefitted from sharing their technology with these other users. Birds and predatory insects living in the shelterbelts may have helped reduce agricultural pests. One late twentieth century study suggested, “birds consume about 145 kg of insects per kilometer of shelterbelt each year.”[62]

Foresters knew the shelterbelts became habitat for birds that could provide biological control of insects. “Cover as afforded by shelterbelt plantings does much to justify its maintenance by harboring some of the most important groups of insect enemies, beneficial birds,” reported Carroll Orendorff of the U.S. Biological Survey in the March 1938 issue of *Plains Forester*. This was not just coincidental occurrence but resulted directly from the planting and the effectiveness of the birds might even exceed other pesticide technologies.

> In fact, brown thrasher, catbird, kingbird, goldfinch, many warblers, the quail, and a number of other beautiful and attractive birds are ordinarily found in this type of cover, but generally not where it is absent. Unlike man-made agencies of control, birds continue their activities throughout the seasons, and they work in and through crops where men cannot go. Scores of instances are known in which birds have suppressed local

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[62] R. J. Johnson and M. M. Beck, “Influences of Shelterbelts on Wildlife Management and Biology,” *Agriculture, Ecosystems, and Environment* 22/23, (1988), 301, 326.

> outbreaks of insect pests, and while their work in insect control is not always so spectacular, it is a steady aid that should always be encouraged.

So in addition to all the other benefits of shelterbelts, Orendorff argued, "the affording of an improved environment for all wildlife should be an additional incentive for the establishment of prospective windbreaks."[63]

This is a good example of how the complexity of interactions in an organic technological system produced more benefits than an inert technology such as a wall or snow fence. Foresters recognized this potential and early settlers and farmers on the plains were also seeking some esoteric benefits from their planted trees—shade, aesthetics, animal habitat—unavailable to them from a less organic solution.

Increasing the complexity and biological diversity of a landscape, developing organic technologies and integrating human activities into an ecosystem, rather than attempting to impose control through simplification and monolithic technology can result in a more efficacious relationship between humans and the environment. Many government officials, foresters, and farmers during the 1930s blamed heavily-mechanized, commodity-crop, industrial agriculture for making the landscape vulnerable to changing environmental conditions, like drought. Many of these same people then looked to an organic technology, trees planted into shelterbelts, as a solution and the basis for a more stable environment and society.

Writing in 1944, the prominent ecologist Victor Shelford claimed that western European settlers on the Great Plains were psychologically predisposed and physiologically adapted to a deciduous forest environment. His article, "Deciduous

[63] Carroll F. Orendorff, *Plains Forester* 3, no. 3 (March 1938), 8.

Forest Man and the Grassland Fauna," in the journal *Science*, summarized the standard declension story of overgrazing and over plowing—"the plow turned more and more land wrong side up each year"—and characterized the shelterbelt planting and the earlier timber claim plantings as a collective cultural reaction to the original environment and conditions resulting from their destruction of it. The shelterbelts were part of the common idea that "the planting of trees is a remedy for all sorts of ills." His article argued for the expansion of this environmental engineering impulse from tree planting to include the reintroduction of many animal species that had been diminished or extirpated from the Plains. Predators like foxes, coyotes, and badgers (although there was still too much cultural prejudice to include wolves) could be fostered as biological controls on rodents. Also, some burrowing rodents could be understood as beneficial in loosening and aerating the soil. Shelford's proposal was to increase the stability of agriculture and Plains society by increasing the complexity of the ecosystem. Trees, then, would be just one of many organisms which could act as a technology integrating human activities and values with ecological mechanisms.[64]

Trees and People—The Meaning of Shelterbelts on the Plains

Trees are an archetypal force in American society. "Western civilization literally cleared its space in the midst of forest," writes Robert Pogue Harrison in *Forests: The*

[64] V. E. Shelford, "Deciduous Forest Man and the Grassland Fauna," *Science* 100, no. 2590, (August 18, 1944), 138, 140; V. E. Shelford, "Deciduous Forest Man and the Grassland Fauna II," *Science* 100, no. 2591, (August 25, 1944), 161-162.

Shadow of Civilization.[65] This space, as a cultural clearing, was also figurative. With the development of collective values, goals, and ideology people set themselves apart from forests, in opposition to nature. They needed trees, as symbols of wildness, to define their own identity by contrast. Forests, Harrison claims, were a point of reference, a boundary surrounding civilization that served a psychological purpose; forests allowed people to idealize themselves and their institutions. This desire can be seen in the American settlement of the Great Plains, as individual landowners sought the familiar comfort of trees in a boundless landscape. Boosters, railroads, and federal and state governments promoted the idea of tree planting. It was a cultural activity and a civic duty. Trees helped make a strange and harsh landscape into a home; planting them on the Plains was part of the civilizing process of Manifest Destiny.

But people need trees for practical reasons too; they were material resources as well as environmental attributes. People used trees where they found them and planted them wherever they did not already grow. As settlers moved out on to the Great Plains they brought their forests with them. Assistance from Forest Service experts and government programs made this effort possible. Local demand and the expansion of scientific forestry, in this case, favored government involvement. Individuals cooperated with the government in many tree planting efforts with many goals. As Victor Shelford pointed out, they believed planting trees could be the solution for lots of problems. Homestead planting, timber claims, and the Shelterbelt Project were all intended to help

[65] Robert Pogue Harrison, *Forests: The Shadow of Civilization* (Chicago: University of Chicago Press, 1992), ix.

individuals and American society get a grip on the Plains landscape—to fill up the land and then to hold the soil and hold the people in place.

In the open, windswept grassland, trees had a practical and a psychological purpose. Shelterbelts marked boundaries and offered protection. They represented an exercise of cultural will by settlers in a new environment and, in the 1930s, a nation responding to a social disaster. As a response to the Dust Bowl and Great Depression, shelterbelts offered a unique technological fix embodying a collective American ideology, a modernist belief that they could control nature and society with science and technology. Shelterbelts were an organized intervention meant to repair a damaged landscape and a broken people by conserving soil and moisture, offering employment, and boosting morale. American settlers had always used technology to impose their will on the world around them; the shelterbelts of Great Plains farm forestry provided living trees as one of those technologies.

Conclusion

Farmers and foresters planted trees on the plains to mitigate environmental and social conditions in the belief that these organisms best created the values they desired in the landscape. Over time, with scientific study and government involvement, this tree planting effort became more successful. At first, private landowners struggled alone to grow trees on their farms. Then, federal nursery managers developed and applied various technologies—irrigation systems, nursery equipment, mechanical tree planters, automated greenhouses, fertilizers and pesticides—to manufacture millions of seedlings.

They used nature as technology, harnessing sunlight, soil organisms, and ecological processes through human labor and machines to create a production facility. Success at the Bessey Nursery and Nebraska National Forest then gave foresters the confidence to undertake a continent-spanning planting program using trees as an environmental engineering technology. Responding to the problems of the Dust Bowl and the Great Depression, the U.S. Forest Service built 19,000 miles worth of shelterbelts across the center of the continent as a technological fix. The Prairie States Forestry Project reflected many aspects of high modernist ideology, but it was also modified, like all technologies, by local conditions and social pressures. Soil, landscape, and climate affected the distribution of the shelterbelts. Farmers' demands shaped each individual shelterbelt, influencing the species of trees as well as the number and spacing of rows.

Shelterbelts were technological and ecological systems designed and built by humans, but they were also shaped and used by non-human nature. As organic technologies shelterbelts had significance beyond just being wind-stopping walls, and farmers and foresters recognized and valued this. Shelterbelts that developed forest characteristics served as habitat and offered recreational activities for people. When planting shelterbelts the Forest Service made no distinction between nature and artifice, realizing that the best solution lay in treating them both as one. They believed the environment and people's daily lives could be improved by using tree planting as constructive interaction within an ecosystem.

Thinking about this history from an envirotechnical point of view provides a better perception of the intricate set of connections involved and suggests more elaborate opportunities for future action. The history of these forest building and tree planting enterprises offers insight on the importance of addressing environmental and social problems with a more intrinsic and holistic approach. Solutions which work towards integrating human values and goals with ecological process—using organic technologies, encouraging community involvement, maintaining respect for local conditions, and fostering complexity—can result in a wider range of benefits and a healthier relationship between humans and the environment. Such an approach is now being fostered by the scientific field and public activity of ecological restoration. As a kind of applied version of an envirotechnical perspective, ecological restoration seeks to involve people in their environment in a constructive effort to repair past damage, restore ecological functionality, and promote integrity between humans and nature.

RESTORING AN IMAGINED NATURE

> "We believe that where forests once grew, forests can certainly be made to grow again."
>
> —Charles Scott[1]

> "Inventionist ecology . . . maintains that it is both possible and desirable not only to conserve natural resources, preserve natural ecosystems, and restore natural landscapes, but also, when the occasion warrants and the knowledge is sufficient, to *create* new ecosystems, new landscapes, perhaps even new species."
>
> —Frederick Turner[2]

Throughout the history of the United States, critics from George Perkins Marsh to 20th century radical environmentalists have justifiably complained about forestry practices. Clear-cutting specifically and deforestation in general have seemed to define American society's historical relationship with the environment.[3] Along the way it has become commonplace to think of technology as the mechanism for this environmental destruction. At the same time, however, some people have been more positive. Carlos Bates recognized the constructive possibilities in American forestry. In 1927, describing the future of the hand-planted Nebraska National Forest, Bates envisioned forestry and reforestation connecting people with the environment. "Let us think what it means to the mundane life of the average citizen," he wrote, "to be able to point to an area once logged

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[1] C. A. Scott, "Foresting the Nebraska Sand-Hills," *Forestry and Irrigation* (September 1903), 454-457 manuscript copy from Walter B. Kiener Papers, Box 27, folder 10, ASCUN.
[2] Frederick Turner, "The Invented Landscape," in *Beyond Preservation: Restoring and Inventing Landscapes*, eds. A. Dwight Baldwin Jr., Judith DeLuce, and Carl Pletsch (Minneapolis: University of Minnesota Press, 1994), 36, emphasis in original.
[3] This characterization is not only applied to forestry. Mass destruction mining, industrial pollution, and commodity agriculture on the Great Plains have all contributed to the perception of a declensionist narrative for the environmental history of the United States. Of course, very real examples of these things have also driven the environmental movement that has long been at the heart of American environmental history.

and devastated by fire, saying to himself: 'This is no longer land laid waste by man's extravagance; it is fulfilling its highest purpose. . . . I help plant it; I help protect it; I have a life interest in it. It is mine to love and cherish.'"[4] Bates and many of those foresters involved in the Bessey Nursery, the Dismal River forest, and the Prairie States Forestry Project saw forestry as a constructive, participatory activity. In the 21st century, ecological restoration promotes the same sentiment. Its supporters claim "restoration experiences demand that people participate in the creation of nature. By way of actively tending nature, restorationists develop respect and concern for the environment as well as a vested interest in its future—a deeper meaning."[5]

Environmental historians have long realized that people and nature are inextricably intertwined. Many have questioned the usefulness of categorizing specific landscapes solely in terms of degrees of degradation from the pristine or of characterizing humans only as destroyers of nature. Indeed, it is becoming increasingly accepted that there is no separation between people and nature; that, while culture and technology are human creations they are also merely manipulations of a material environment. Nature is a matrix of which humans are an integral component. In promoting ecological restoration, the philosopher-poet Frederick Turner maintains "the formula 'a sustainable relationship between human beings and Nature' is profoundly misleading." He argues, "there is no 'between' the human and the natural, unless there can be a special relationship, not between one thing and another, but between the most characteristic and

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[4] C. G. Bates, "A Vision of the Future Nebraska Forest," in *Journal of Forestry* 25 (December 1, 1927), 1030.

[5] R. Bruce Hull and David P. Robertson, "Which Nature?" in *Restoring Nature: Perspectives from the Social Sciences and Humanities*, eds. Paul H. Gobster and R. Bruce Hull (Washington D.C.: Island Press, 2000), 300.

quintessential part of a whole, and the whole of which it is a privileged part."[6] Much of the real environmental damage that has driven a declensionist environmental history and motivated the modern environmental movement comes perhaps from the too-easy cultural perception that humans act upon rather than from within nature.

Technology, in this separatist view, becomes one of the markers of difference and the primary means to create the separation of humans and nature. The history of technology has generally cast technology as an exceptional rather than an essentialist force within human society and especially within nature. Over time, however, analyses of technology have shifted from technology as a "black box," to technology as cultural artifact shaped by social interactions to technology as interconnected systems, both mechanical and social. More recently an envirotechnical analysis has included ecosystems along with mechanical and social systems in the study of technology and environmental history. The writer Langdon Winner, realizing that technology could be influenced by value choices, urged people to actively attend to the development and application of technology and avoid "technological somnambulism."[7] In a similar way envirotechnical analysis strives to recognize and then advertise how technology, culture, and nature are all inherently incorporated in any particular situation or event. From this more intricate perception, better value judgments and decisions can be made. The

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[6] Frederick Turner, "The Invented Landscape," in *Beyond Preservation: Restoring and Inventing Landscapes*, ed. A. Dwight Baldwin Jr., Judith De Luce, and Carl Pletsch (Minneapolis: University of Minnesota Press, 1994), 46.

[7] Langdon Winner, *The Whale and the Reactor: A Search for Limits in an Age of High Technology* (Chicago: University of Chicago Press, 1986), 5. While he discounted the idea of technological determinism (that the trajectory and effects of technology are inevitable) he believed that people have failed to make conscious, critical decisions about technology. Instead people have fallen into the ideology that technological development equals progress, with the consequence that technology shaped society rather than society shaping technology.

ramifications of this idea include a clearer understanding of the past and, like the ecological restorationist model suggests, a more integrative basis for future actions.

By design and by mistake, human actions shape nature; but, for all their innovations, people can never escape nature. They must, instead, find a healthy, functional role within the greater system.[8] The landscapes in which people live will always be, like the Nebraska forest, a product of technological, social, and ecological construction. Ecological restoration, as a philosophy and an activity, offers one positive way to consciously pursue this integration.

This is not such a new idea. Over a century ago foresters collaborated with nature when they built a forest in the sandy grasslands of Nebraska, even if they could not completely overcome their cultural bias against fire or their desire to protect their work from pests. They built this forest and the later shelterbelts on the Great Plains as technologies with a purpose. They also built them to prove that they could create a forest environment. During the construction of the forest, as they helped hand-planted factory seedlings develop into a viable ecosystem, they learned about nature from a new perspective. Harnessing the ecological interactions for their own ends, they successfully integrated social goals, technological control, and natural processes. By pursuing the complexity promoted by Charles Bessey, Bernhard Fernow, and the other ideological founders of the forest and builders of the shelterbelts, they realized the holistic influence of a forest ecosystem.

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[8] For a discussion of this point of view see Emma Marris, *Rambunctious Garden: Saving Nature in a Post-Wild World* (New York: Bloomsbury, 2011).

Forest Fire—The Natural Enemy of an Artificial Forest

In the Nebraska Sand Hills by the middle of the 20th century the individually planted seedlings had grown up into trees and these trees had grown together into a forest with intricate biological and social connections. What had once seemed so obviously an artificial construction had, over time, become naturalized—naturalized through the ecological connections that developed and naturalized in the public mind because the place now looked like, acted like, and served all the uses of a forest ecosystem. The Forest Service promoted it as "a place where the forester, the botanist, the ecologist, the biologist . . . can study the effects of the establishment of a forest in a virtually treeless region and observe the changes in vegetation, bird, and animal life." People visited the forest "for the inspiration and education it provides." Embodying the same values as other national forests, "the Nebraska Forest," they declared, "is an economic, aesthetic, recreational and inspirational asset to the citizens of Nebraska and adjacent states."[9] Although the history of the creation of the forest made it somewhat of a novelty, it was just one of the many forests in the national forest system. Hundreds of thousands of people visited it each year for the same reasons they visited any of the other forests in the system. They came there seeking an experience in nature.

On May 5, 1965 the forest at the Bessey Ranger District experienced a natural event common to most forests sooner or later. At 11:30 that Wednesday morning lightning struck about 11 miles south of the District office and started a grass fire that quickly spread to the forest. Known as the Plum Creek Fire, the *Omaha World-Herald*

[9] USDA Forest Service, "Nebraska National Forest," (September 1952), 25.

newspaper described the scene, "50 mile-an-hour winds, compounded by gale-like thermal gusts" swept the fire "through the world's largest man-made forest. Stately jack pine that had stood for over half a century exploded like roman candles."[10] Only in such a tree-deprived area as the Sand Hills could jack pine be described as stately. Nevertheless, the fire was a traumatic experience for the foresters and the community. Hundreds of local volunteers came out to help fight the fire over the next two days. Despite their help and the best efforts of Forest Service personnel, including fire crews from Wyoming, Colorado, and South Dakota and three aircraft dropping fire retardant, about nine thousand acres of timber, almost one-third of the forest and part of the 4-H camp burned. The Forest Service estimated about one and a half million trees were killed.

The Dismal River Forest had caught fire before. In March 1910 a fire burned 341 acres, killing thousands of young trees. This was the same year as the "Big Blowup" when fires that summer burned some 3 million acres in Washington, Idaho, and Montana leading the Forest Service to develop its "out by 10 am" policy. All forest fires were supposed to be put out or brought under control by 10 am the day after they were discovered. Motivated by a conservation mindset and reacting to the loss of life and timber value, the agency attempted to exclude fire from the national forests. So in 1965, when the Plum Creek Fire hit the Nebraska forest, fire was the forester's enemy even if the trees it threatened had not been hand planted and represented half a century of work. By now, though, the forest was more established, both in the hills and within the local

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[10] Tom Allen, "Nature Gradually Erasing Scars of Halsey Forest Fire," *Omaha-World Herald*, May 4, 1971.

community. It had developed historical and natural value. Beyond just the larger size of the Plum Creek Fire, the loss seemed much greater than in 1910. A mature forest had burned, not just some planted trees.

There was an immediate public outcry. The Governor of Nebraska, Frank Morrison, inspected the damage and declared it "one of the worst tragedies in the state's history." As he pointed out, in Nebraska "trees are at a premium."[11] The *Omaha World-Herald* wrote: "Many Nebraskans must have been touched by a deep sense of tragedy when they read or heard that the Halsey Forest was on fire." The paper gave some early history of the planting of the forest, praising Charles Bessey and Theodore Roosevelt for their vision. It seems that most residents of the state did not know the full story of the forest but valued it simply for its conditions as a natural forest. "Halsey Forest is a prized possession of all Nebraskans, and they will hope that steps will be taken to restore its burned-over area as fast as Nature and the hands of man will permit."[12] The paper and the people of Nebraska were demanding reforestation of the environment. A hand-planted forest had become more valuable than the original native grassland; everyone wanted the constructed nature restored.

The fire was out by Friday May 7 and fire fighters packed up to return to their home states. Already, the newspaper assured its readers, "Replanting at Halsey [was] Ready to Start." Though it would "take years to replenish the once-verdant hills," the District Ranger announced they would "start planting trees Saturday morning at 8."[13] (Fortunately, this forest had its own seedling nursery.) Over a million and a half trees

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[11] "Morrison Shocked by Fire's Damage," *Lincoln Star*, May 7, 1965.
[12] "Tragedy in the Forest," *Omaha World-Herald*, May 7, 1965.
[13] John Lee, "Bessey Nursery Seedlings Planned for 4-H Camp Area," *Lincoln Star*, May 8, 1965.

were dead but what was not lost from the half century of work was the knowledge that a forest could be built there and the science and know-how to do it. By Wednesday May 12, only a week after the fire had started, the Secretary of Agriculture, Orville Freeman, had assured the Governor of Nebraska that the federal government would "restore the 16,000 acres of National Forest and Grassland swept by fire last week." According to Freeman, "the Nebraska National Forest is the greatest man-made forest in this country." Begun as a research project, he said, now people had come to count on the forest for recreation. "Because people appreciate this National Forest and find it useful, we intend to restore it as quickly as possible, using our latest scientific know-how." With the forest users in mind, they would start with fast-growing hardwoods planted around the 4-H camp, which would be rebuilt. These trees would "provide the recreation environment the young people have come to count on at their camp."[14]

While trees can burn and die, forests as a whole generally survive forest fires. In 1912 foresters noticed some regeneration that had occurred after the fire of 1910 with jack pine resprouting from the root stock. While seedlings from the same planting that survived the fire had reached two feet in height, the sprouts from the burned trees were already 18 inches tall.[15] The forest recovered from the 1965 Plum Creek fire too, with natural regeneration and more seedling planting, though the human effort was most effective and greatly appreciated. "Nature, with the help of man," wrote the *Omaha World-Herald* in 1971, "is finally winning its battle to erase the ugly scars of the state's

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[14] USDA Forest Service, "A New Look at the Objectives for the Sandhills Zone of the Nebraska National Forest Following the Plum Creek Fire—1965," NARA Record Group 95, Box 38, folder 137.

[15] Fred Johnson, "Sprouting Ability of Jack Pine," (November 14, 1912), NARA, Record Group 95, Box 20, folder 98.

worst forest fire." The fire had made a "wasteland" out of the forest. "Where once the wind sang soft lullabies amid the pines, there was silence among the blackened skeletons. No bird chirped. The once abundant wildlife died or fled." But only six years later, millions of trees had been planted again and "the seedlings are three to four feet high. The birds and wildlife are back."[16] No one seemed to recognize any irony in the process that had led from the construction of an artificial forest in the native grassland environment, to the naturalization of that forest through ecological changes and cultural perception, to the destruction of that forest by the natural occurrence of lightning strike fire, to the reconstruction of that preferred environment—the natural forest—by more human labor planting more factory seedlings. They were unselfconsciously restoring the nature of the artificial forest. Their ability to do so, their work, their perception of the finished product, and the values that drove them were as much a part of the forest as the soil, the roots and leaves, and sun and rain. The forest was truly an envirotechnical system.

The same issues of artificiality, naturalness, labor, values, and perception underlie the contemporary philosophy and practice of ecological restoration. However, as with the American cultural and intellectual understanding of people and nature in the environment, a consensus on what is natural and what is artificial, precisely what to restore in a landscape, and how to understand the effort has been elusive. In demanding the restoration of the nature of this plains forest, Nebraskans were making a value choice of trees and forest over grassland. Their constructed forest had replaced part of the

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[16] Tom Allen, "Nature Gradually Erasing Scars of Halsey Forest Fire," *Omaha-World Herald*, May 4, 1971.

prairie ecosystem. Perhaps, though, if the Nebraska forest had been more successful and spread over a larger area of the Great Plains it would have become a target for contemporary prairie restoration. In the case of forest construction or ecological restoration, human values are built into the landscape, whether that is forest trees or prairie plant communities.

Restoration History—Creating New Values

Ecological restoration has a long history, although the practice and the science of the field were only formalized in the late 20th century. In a general sense, any historical effort to repair environmental damage has a connection to ecological restoration, although recently the subject has become more carefully defined to suggest the fundamental goal of recreating a landscape with historical integrity and ecological functionality.[17] In his comparative international history of ecological restoration, Marcus Hall recognizes restoration activities taking place in Italy in the 1870s. Under the authority of the provincial and national governments, foresters began planting trees in the hillsides around the village of Vinadio in the Stura Valley. Oaks, chestnuts, and other

[17] There is a great deal of literature within the field of ecological restoration defining its terms and goals and debating its meaning. Some of the important works include: William R. Jordan III and George Lubick, *Making Nature Whole: A History of Ecological Restoration* (Washington D.C.: Island Press, 2011); Andre F. Clewell and James Aronson, *Ecological Restoration: Principles, Values, and Structure of an Emerging Profession* (Washington D.C.: Island Press, 2007); William Jordan III, *The Sunflower Forest: Ecological Restoration and the New Communion with Nature* (Berkeley: University of California Press, 2003); Eric Higgs, *Nature by Design: People, Natural Process, and Ecological Restoration* (Cambridge: MIT Press, 2003); Robert Elliot, *Faking Nature: The Ethics of Environmental Restoration* (New York: Routledge, 1997); Paul H. Gobster and R. Bruce Hull, eds. *Restoring Nature: Perspectives from the Social Sciences and Humanities* (Washington D.C.: Island Press, 2000); A. Dwight Baldwin Jr., Judith De Luce, and Carl Pletsch, eds. *Beyond Preservation: Restoring and Inventing Landscapes* (Minneapolis: University of Minnesota Press, 1994). On the practice of restoration see Dave Egan and Evelyn A. Howell, eds. *The Historical Ecology Handbook: A Restorationists Guide to Reference Ecosystems* (Washington D.C.: Island Press, 2005).

species were planted to try and stabilize the land and mitigate deforestation and overgrazing. Along with this "century-long planting effort" non-organic technologies like rock walls and check dams were also used to try and control the alpine runoff, flooding, and erosion.[18]

In the United States, Hall attributes the beginning of a restorationist ethic to the 1864 publication of *Man and Nature: or, Physical Geography as Modified by Human Action*. In this landmark book, George Perkins Marsh not only warned of the consequences of deforestation and environmental damage, he also urged environmental restoration. Hall points out that this marked a shift in the perception of environmental damage from something that was primarily a natural process to something that was a consequence of human agency. "By placing people at the center of blame for degredation," he writes, "Marsh was also placing them at the center of responsibility for carrying out restoration." From an envirotechnical perspective, it is not too much, then, to characterize Marsh's ideas as a product of an emerging new realization that humans were part and parcel of the greater envirotechnological system. The potential existed for positive as well as negative results. The interaction worked in both directions and as Hall claims, "after *Man and Nature* (1864), threats to the land were not just a degenerating nature, but also a degenerating culture." With this warning from Marsh and his appeal for restorative action, nature and culture could now be recognized as interactive and even interdependent.[19]

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[18] Marcus Hall, *Earth Repair: A Transatlantic History of Environmental Restoration* (Charlottesville: University of Virginia Press, 2005), 65-67.
[19] Hall, *Earth Repair*, 7,13.

Although Marsh's work was widely-read and influential, little action was taken in implementing his restorationist ideas. In the early part of the 20th century efforts were made that can be directly linked to the future ecological restoration movement. In 1920 at Vassar College, botany professor Edith Roberts began a field project with her students to reintroduce native plant species into a four acre plot on the campus near the Fonteynkill Creek. They cleared out non-native species and planted local specimens. Eventually known as the Dutchess County Botanical Garden, the area operated as an outdoor laboratory in which they re-established 28 of the county's 30 plant associations including 93 percent of some 2,000 native species. With the rapid early 20th century growth of the science of ecology, especially ideas of plant communities, more interest was developing in native plants and previous landscapes. This trend was a reversal of the earlier enthusiasm for exotic species commercial nurseries had promoted. At Carleton College in Northfield, Massachusetts, a botany professor and the college groundskeeper began an arboretum in 1926 by planting native trees and shrubs. The Carleton College Cowling Arboretum has since grown to 880 acres and includes examples of native ecosystems like upland forest, floodplain forest, prairie, oak savannah, and wetlands habitats. Other attempts around the same time, though, less successful, had similar goals. The Holden Arboretum near Cleveland, begun in 1930, attempted to construct a more complete ecosystem by including specific small birds and mammals.[20]

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[20] Jordan and Lubick, *Making Nature Whole*, 65-69. On the development of plant ecology science see Sharon E. Kingsland, *The Evolution of American Ecology, 1890-2000* (Baltimore: Johns Hopkins University Press, 2005); Joel E. Hagen, *An Entangled Bank: The Origins of Ecosystem Ecology* (New Brunswick: Rutgers University Press, 1992); Ronald C. Tobey, *Saving the Prairies: The Life Cycle of the Founding School of American Plant Ecology, 1895-1955* (Berkeley: University of California Press, 1981); and Worster, *Nature's Economy*.

The most famous early example, and what William Jordan calls "an origin myth" for ecological restoration, begins with the establishment of the University of Wisconsin—Madison Arboretum. Aldo Leopold, a former U.S. Forest Service forester who pioneered modern game management before accepting a professorship in the topic at Wisconsin, dedicated the Madison Arboretum in 1934, "to reconstruct . . . a sample of original Wisconsin—a sample of what Dane County looked like when our ancestors arrived here during the 1840s." Thus Leopold became the founding figurehead of the later restoration movement, with his principle of keeping all the pieces when tinkering with the landscape and a preference for a pre-Euro-American settler landscape. Part of the grounds were turned into the Curtis Prairie, using CCC labor to tear out existing plants and trees and replant historic species. To promote the tall-grass prairie species and inhibit succession of shrubs and trees, managers began to use fire as a restoration technology. Unlike the situation in the Nebraska National Forest, where it was seen as a deadly enemy, fire became a common tool of prairie management. Besides stimulating the growth of native fire-adapted prairie plants, this burning suppressed the growth of trees. Following an era of national concern over deforestation and timber shortages, a new (albeit very small scale) environmental value had taken hold: the appreciation of a native landscape for its own sake, for its historical sake, apart from any resources it produced. The goal of reestablishing historic organisms would eventually shift to the modern ecological restoration goal of restoring function. Ecology had developed as a science and was now being adopted as a landscape value.[21]

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[21] Jordan and Lubic, *Making Nature Whole*, 77. For biographical information on Aldo Leopold see Susan Flader, *Thinking Like a Mountain: Aldo Leopold and the Evolution of an Ecological Attitude Toward Deer,*

Ecological Engineering—Constructing Form and Function

This was a new idea, to purposely create a landscape for values beyond an aesthetic or a productive purpose. This was environmental engineering but with a new motivation, fostering representative organisms and ecosystem functionality. The Society for Ecological Restoration defines ecological engineering as the "manipulation of natural materials, living organisms and the physical–chemical environment to achieve specific human goals and solve technical problems." People have always been environmental engineers to some degree. Certainly agriculture and gardening shape the environment and utilize ecological processes, but the motivation and the goal in that case is the end product—a subsistence or commodity crop, a presentation of landscape as artwork. The effort is to replace the original process and physical structure with a new one controlled by human purpose. Urban construction too is environmental engineering but the overwhelming (though never complete) consequence there is the removal of ecological process. Through *ecological* engineering though, a fundamental difference in ecological restoration and in the construction of forests is the cooperative nature of the enterprise, shaped by human intentions but embodying a different set of values. Writing for the Society for Ecological Restoration, Andre Clewell and James Aaronson explain that while the purpose of restoration is "ecosystem improvement, it is ultimately conducted to fulfill people's values. These include ecological values, socioeconomic values, and

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Wolves and Forest (Columbia: University of Missouri Press, 1974); Curt D. Meine, *Aldo Leopold: His Life and Work* (Madison: University of Wisconsin Press, 2010). For Leopold's own discussion of an ecological value of land see Aldo Leopold, "The Land Ethic," in *A Sand County Almanac with Essays from Round River* (New York: Ballantine, 1966).

personal values." In achieving these values the ecological process, self-sustaining ecosystem interaction, is itself an essential part of the goal.[22]

Constructing and maintaining a forest requires establishing a self-sustaining ecological process. Multiple organisms and complex environmental interactions create something more than just a collection of trees. In building the Nebraska forest and the Great Plains shelterbelts, American foresters were trying to create much more than standing timber. However, they were certainly not the first to try building a forest ecosystem. Beginning in 1850 the British planted trees on Ascension, a small tropical volcanic island on the mid-Atlantic ridge about halfway between Africa and South America. Charles Darwin had visited the island in July 1836, during his voyage on the *HMS Beagle* and reported, "the Island is entirely destitute of trees." Joseph Hooker also visited Ascension in 1847. Afterwards, Darwin apparently convinced him to have the Royal Navy begin planting trees on the island with the help of Kew Gardens. The intention was to use the growth of the trees to change the environment of the island, increasing and capturing rainfall and developing deeper soils. Several times a year trees and plants were sent to the island and by the 1920s there was a "good and hearty" growth. Today the island's summit, Green Mountain, is covered with forest and one ecologist has suggested it as a model method for terraforming Mars, engineering by ecological process. For a more earthly purpose he proposes, "This system provides ecosystem services, such

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[22] Clewell and Aronson, *Ecological Restoration*, 134, 170.

as carbon sequestration, and illustrates the possible role of man-made ecosystems in the mitigation of global warming."[23]

The Nebraska Sand Hills were not Mars, but may have seemed the next thing to it for the foresters in 1902. Trees planted on the hills were expected to reconstruct that environment. As Charles Scott said in beginning the planting, forests would make hills that were "as bleak as anything that can well be imagined," beautiful and productive.[24] Charles Bessey, in 1892, had also contrasted the beauty of future forests he was promoting with the "waste and desolation of the quarry, the coal pit, and the mining camp." Two years later he again raised the ambitious plan of planting trees in the Sand Hills. "If we could place across the central portion of the state a belt of forest land from fifty to one hundred miles wide, and one hundred and fifty to two hundred miles long, the beneficial influence upon the state would be almost incalculable."[25]

Not only would the new landscape be better, but many advocates of the forest believed it would also represent the restoration of a previous environment. As was shown earlier, Bessey argued that the Sand Hills had been forested in the past. After "a somewhat prolonged study of the flora of the Sand Hills," including expeditions of his own and correspondence with people around the region, he concluded that "the central region was once wholly or in part covered with forests." Trees, often western and eastern

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[23] Patrick Armstrong, *Darwin's Other Islands* (London: Continuum, 2004), 229; David M. Wilkinson, "The Parable of Green Mountain: Ascension Island, Ecosystem Construction and Ecological Fitting," in *Journal of Biogeography* 31 (2004): 1-4. See also BBC News article Howard Falcon-Lang, "Charles Darwin's Ecological Experiment on Ascension Isle," (September 1, 2010), http://www.bbc.co.uk/news/science-environment-11137903.

[24] Scott, "Foresting the Nebraska Sand-Hills," *Forestry and Irrigation* (September 1903), 454-457 manuscript copy from Walter B. Kiener Papers, Box 27, folder 10, ASCUN.

[25] Charles E. Bessey, Annual Report of the Nebraska State Board of Agriculture," (1892); Charles Bessey, "Annual Report of the Nebraska State Board of Agriculture," (1894), 119.

varieties, growing side by side in isolated canyons, suggested the state had been once been a middle ground for a larger forest. Remnants of yellow pine, logs and stumps, were discovered throughout the Sand Hills and they still grew to the north at Pine Ridge and along the canyons of the Niobrara River and its tributaries as far east as Holt County.[26] Speaking to the Nebraska Board of Agriculture in 1891, Bernhard Fernow, Chief of the Forestry Division, said he did not believe aridity alone accounted for the treeless condition of the Plains. He put forward "the proposition that it was not always forestless." This forest would yet exist, he claimed, "if the fires of man with the tramp and browsing of the buffalos had not prevented it; or, since the scattered tree growth found on this area suggests that forest growth once existed, it would exist now if fires had not destroyed much of it, thus disturbing the conditions which were favorable to the conservation of the scanty moisture." This part of the plains was treeless he reiterated, as a result of "reforestation being prevented by continued fires and countless hordes of buffalo." The persistence of these reforestation arguments paid off; President Theodore Roosevelt gave them the grassland to turn back into forests.[27]

Once they had the Reserves, they set to work. Scott announced, "it is our purpose to improve the general conditions of the country by establishing forests on these reserves." Echoing Bessey and Fernow he confirmed, "we believe that where forests once grew, forests can certainly be made to grow again." With the nursery in production and the seedlings planted in the hills, the foresters building the Dismal River forest were doing ecological engineering. They were using organisms and ecological processes to

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[26] Charles Bessey, "Were the Sand Hills of Nebraska Formerly Covered with Forests?" (1896), ASCUN, Walter B. Kiener Papers, Box 27, folder 4.
[27] B. E. Fernow, "Annual Report of the Nebraska State Board of Agriculture," 140.

reshape the environment in order to instill social values. Scott "hoped that the results of this work [would] be of great value to the people of the entire state." They were creating a new landscape and learning forest building techniques and forestry science at the same time.[28]

The claim that the Sand Hills had been previously forested made a convenient justification for promoters who wanted to construct human values into the landscape there. However, they were also sincere in trying to mesh environmental improvement with social improvement. The young foresters who did the work were very idealistic, like the new agency they worked for. In building and operating the nursery and the forest, they utilized techniques and pursued values and goals similar to those of contemporary ecological restoration. They developed and improved equipment and methods in nursery practice, producing vigorous seedlings on a large scale. Over the decades they improved planting techniques to ensure the survival and success of those seedlings in the field. Like Valencius' farmers seeking health in the land, the explorers and fishermen on the Columbia River, and the volunteers doing ecological restoration in the future, they knew the land—its organisms and its functions—through their labor. They wanted to create a functional system and as "forest conditions" developed the system became self-sustaining. They believed their work would improve the environment and that enhanced environment would have a beneficial effect on society. The products of the forest, constructed as a system, would include natural resources and services that would tend to stabilize society on the plains. One of these services would be to foster a significant relationship between people and the environment. Over the years

[28] Scott, "Foresting the Nebraska Sand-Hills."

those who built the forest certainly became deeply connected to it, but so did the thousands of visitors who came to experience nature. Like the future practitioners of ecological restoration, their ultimate goal was to create a meaningful landscape that combined ecological and social functionality.

In planting trees on the Great Plains settlers and foresters were constructing human values into the landscape, creating a new environment. But then, of course, all human actions do that to some degree. The trick is to do so carefully, with forethought, and supporting multiple values. The construction of the envirotechnical system that became the Nebraska National Forest provides a unique perspective on the practice and values of modern ecological restoration, which itself might inform a wide range of actions that impact the environment. As an example that predates the standard beginning of restoration science and practice, this constructed forest and the ideology behind it can be useful in considering restoration philosophy.

While the argument is not being presented here that Great Plains tree planting was the equivalent in all respects to modern ecological restoration, a worthwhile comparison can be made. What is the difference between repairing a damaged environment and creating an entirely new one? Both use a similar method of effecting environmental change with ecological process—ecological engineering using organic technologies. Both set a goal of self-sustaining landscapes, a functional ecological system. Both attempt to embody social values into this system, whether those are historical values in a reconstructed condition or future values achieved through an improved environment. In each case fostering a more explicit human position in nature, through reconstruction work and the effects of the completed system as a product and process, is an important goal.

Recognizing the similarities between environmental histories a century apart, it seems that applying an envrirotechnical analysis to Great Plains tree planting and other historical events might stimulate a more holistic perception of contemporary situations and suggest more complex approaches to environmental issues. In other words, our problems and solutions are not necessarily more complicated than those of the past. However, we can perhaps perceive and understand the past more easily than the present. Indicative of this situation, while the methods and goals of forest construction and modern restoration may be similar, there seems to be much more contention and concern over the meaning of contemporary ecological restoration.

Restoration Philosophy—Debating the Meaning of Nature

Within the field of ecological restoration a great deal of attention has been paid to the definition of the practice and goals and the meaning of the activity and the outcome. Founded in 1987, the Society for Ecological Restoration is the principal organization for the field. A non-profit organization with members from more than 60 countries, the Society includes, by its own estimation, "scientists, planners, administrators, consultants, indigenous peoples, landscape architects, teachers, artists, engineers, natural resource managers, farmers/growers, community leaders, and volunteers." It is an organization pursuing grass-roots involvement in the environment that promotes restoration projects and publishes scholarship on the topic. "Ecological restoration," in the Society's official definition, "is the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed."[29]

The *SER International Primer on Ecological Restoration* gives a fuller explanation of the purpose. "Ecological restoration is an intentional activity that initiates or accelerates the recover of an ecosystem with respect to its health, integrity, and sustainability." Frequently, as one might expect, the damage and destruction has resulted from human actions. But restoration also aims to mitigate natural destruction too. "In some cases, these impacts to ecosystems have been caused or aggravated by natural agencies such as wildfire, floods, storms, or volcanic eruption, to the point at which the ecosystem cannot recover its predisturbance state or its historic developmental trajectory." This intervention to mitigate what ecologists might, in a less value laden way, describe as ecological disturbance, indicates a much more inclusive role for the actions of restorationists. While the goal is to return the system to some baseline state of structure and functionality, it seems that the agency of the destruction is less important than the value of the preexisting condition. The restorationists are not just making restitution for human actions—they propose to serve as a kind of system maintanence crew, repairing the damage from within. Clearly the values they see embodied in the environment can be more important than the source of the disturbance.[30]

From an environmental perspective this activity is about fostering diversity and restoring the ecological system. But there is also an intention of human incorporation.

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[29] Society for Ecological Restoration. https://www.ser.org/about (accessed March 3, 2013); Clewell and Aronson, *Ecological Restoration*, 7.

[30] Society for Ecological Restoration, *The SER International Primer on Ecological Restoration* (2004), https://www.ser.org/resources/resources-detail-view/ser-international-primer-on-ecological-restoration#3 (accessed March 3, 2013).

Andre Clewell, a prominent restoration practitioner and former president of the Society for Ecological Restoration and James Aronson, head of the Restoration Ecology group at the Center of Functional and Evolutionary Ecology in Montpellier, France, and curator of restoration ecology at the Missouri Botanical Garden, argue for anthropocentric values as another benefit of restoration activities. "From a socioeconomic perspective," they write, "ecological restoration recovers flows of natural goods and services of economic consequence that functional ecosystems provide to society. From the perspective of personal and cultural values, ecological restoration renews our relationship with nature in the realms of aesthetics, personal fulfillment, and shared experience and meaning."[31]

In other words, fostering diversity in form and complexity in function within an environment, of which people are a participating part, benefits humanity. This appears to represent the intentional (re)construction of an envirotechnical system. Placing people in the system is an important accomplishment of ecological restoration, especially as they are not relegated to conducting repairs from the outside. Clewell and Aronson explain that "a cultural ecosystem can be self-sustaining only insofar as traditional cultural practices are counted among the normal ecosystem functions. In other words, humans belong to ecosystems and participate in ecosystem processes." Although there still exists some bias for traditional cultures as apposed to contemporary society within the restoration movement, the implication that this applies to all societies cannot be avoided. Participating in restoration activity itself reveals and reinforces the connections between people and the system. As Eric Higgs points out, "the act of pulling weeds, planting, configuring a stream bank to match historical characteristics, participating in a prescribed

[31] Clewell and Aronson, *Ecological Restoration*, 7.

fire that returns an old process to the land helps develop a ferocious dedication to place. By investing labor one becomes part of that place." People (and environmental historians in particular) have long recognized that their acts of destruction involve them in the history of environments. But as restoration ecology has come to recognize—and as the foresters building the Bessey Nursery, Sand Hills forest, and Great Plains shelterbelts demonstrate—people can participate in ecosystems in positive ways as well.[32]

The intention of creating a functional ecosystem that included human activities, using organisms and ecological processes as tools, and ascribing value to the ability to construct and participate in such systems, are all sensibilities embraced by ecological restoration that were also embodied in the history of tree planting projects on the Great Plains. The benefits derived by people as a value of participating in restoration and a consequence of enhanced ecosystem services is a fairly new rationale within the ecological restoration movement. It emerged only after a period of criticism and argument over the definition of nature and the question of whether natural conditions can be recovered once lost. Many thinkers in the field, like most environmental historians before them, have shifted away from arguing over categorization and semantics towards promoting the benefits of restoration in practice rather than definition. The value of incorporating humans into the environment, and perceiving them as part of an envirotechnical system, is probably more important in the long run than preserving some dogmatic interpretation of the authenticity of nature. Including humans helps people recognize their reliance on the functionality (and other values) of the system.

[32] Clewell and Aronson, *Ecological Restoration*, 8; Higgs, *Nature by Design*, 1-2.

As an academic discipline and a practical science, ecological restoration has often been particularly contemplative and engaged in philosophical debate. The shift towards the value of the activity, described above, was in part a consequence of dissension in the field. Like the foresters who worried about loss of prestige in the science of forestry and so protested the Shelterbelt Project, or Bill McKibben who pronounced the end of nature, some philosophers and pundits have been concerned with the loss of nature as a normative category as a result of restoration activity and ideology. Since 1982, with Robert Elliot's article "Faking Nature," fierce arguments have raged over the equivalency of restored and wild nature. In an era of environmentalist concern about justifications that would permit environmental destruction, ecological restoration seemed to promote a problematic premise. Elliot worried that restoration, "assumes that environments that have been despoiled, degraded, or destroyed can in fact be rehabilitated or restored." More important than the physical structure, he was concerned that "it assumes that the values associated with the original, natural environment can likewise be restored." The comparison Elliot and other critics made was of original, authentic art and forgery. The value, they argued was in the first creation. "Faked nature was less valuable than original nature." A copy, no matter how good was never the real thing.[33]

"Wild nature has intrinsic value," Elliot claimed.[34] Many would agree; but as a foundation for an environmental ethic in the real world, this exclusive attitude seems only

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[33] Robert Elliot, "Faking Nature," in *Inquiry* 25, (1983); Robert Elliot, *Faking Nature*, vii. See also the debate carried on through the various publications of William Jordan III and Eric Katz, such as Jordan, *The Sunflower Forest*; Eric Katz, "The Problem of Ecological Restoration," in *Environmental Ethics* 18 (1996). Katz, Jordan, and other authors are collected in *Environmental Restoration: Ethics, Theory, and Practice*, ed. William Throop (New York: Humanity Books, 2000).

[34] Elliot, *Faking Nature*, 1.

to support a preservationist position, a policy of exclusion and inaction. While this position has had and continues to have relevance and importance, it has also been shown as insufficient by some environmentalists and environmental historians, including William Cronon's influential analysis of "The Trouble with Wilderness." Nevertheless, like Elliot, Eric Katz feared the consequences resulting from human hubris and defended the idea of nature. Humans and their creations were outside this nature. "Once a system has been created, designed, or managed by human technology and science," he wrote, "it is no longer a natural system—it is now an artifact, a product of human intention and design." There was, he argued, "a fundamental ontological difference" between "natural entities and human artifacts."[35]

This position, though, seems not to take into account the processes of ecology and the effect of time. Historical places and structures, abandoned cabins or ancient cities, become naturalized over time as they decay back into the land and people forget about them.[36] Environments too, however they were generated, tend to become naturalized by time in the popular consciousness—the Nebraska National Forest has to a large degree. Also, presumably over time ecological succession reshapes the landscape and organisms of an area and the process reclaims the environment. Can nature come back? Just think of jungle overtaking ancient ruins in Central America. If the cultural material is recycled and reformed through ecological and geological process, is its nature returned?[37]

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[35] Eric Katz, "Another Look at Restoration: Technology and Artificial Nature," in Gobster and Hull, *Restoring Nature*, 38.
[36] See Tim Edensor, *Industrial Ruins: Space, Aesthetics and Materiality* (New York: Berg, 2005).
[37] See Alan Weisman, *The World Without Us* (New York: St Martin, 2007).

Ecological restoration is sometimes posited in this way, as jump-starting an ecological process. Once the process becomes self-sustaining the restoration has been successful and the environment rebuilds itself. In a sense, this was exactly what Plains foresters were after—forest conditions that would perpetuate and cause changes in the environment, engineering with an ecological process that was self-generating. Some restorationists have cast ecological restoration as a type of gardening through which people are connected to a sense of nature by their labor. A degree of ecological autonomy probably needs to be a component of the system as the end product, yet, people should still be part of the system. One drawback of ecological restoration as a proactive envirotechnical world view might be that it seems to be only applicable to uninhabited environments. Clewell and Aronson, however, propose the idea of "socioeconomic ecosystems." This approach allows for careful management of a range of landscapes with varying degrees of wildness and management. "The key of this approach," they say, "is to stop seeing people as somehow outside ecosystems but rather as part and parcel of nature and therefore of ecosystems. This leads to the notion of local management of the ecosystems on which we depend from the inside out." A vision of the lived-in world as interconnecting envirotechnical systems with different conditions and qualities, each embodying relevant values, could replace the dichotomy of natural and artificial.[38]

Inventing Ecologies—Beyond Restoration Ecology

More recent restoration scholarship has mirrored even more closely the thinking of some environmental and envirotechnical historians. Summing up a collection of

[38] Clewell and Aronson, *Ecological Restoration*, 50.

essays contesting the meaning of restoration ecology, R. Bruce Hull and David Robertson thought everyone could agree that "restoration blurs the distinction between culture and nature." Furthermore, paralleling the trend in environmental history away from exceptionalizing pristine wilderness, they claim, "the act of restoration instills respect in us for the land. It builds into our culture an appreciation and respect not just for nature, but for our relationship with nature, and not just for wild nature but for all forms of nature from parks to parking lots."[39] Matthias Gross, in *Inventing Nature: Ecological Restoration by Public Experiments*, suggests that new environmentalists will begin "creating new natures: excavating buried marshes, or importing new animals, cutting down unwanted woods, and breaching dams, and actually designing and creating whole landscapes." Elliot and Katz, and if they were here Muir and even Pinchot, would perhaps be horrified at this prospect. Or, maybe this is just the landscape construction people have been doing all along, simply with different motivating values. Gross is all for pushing past the limitations on restoration of the concept of natural. Now, he claims, "the restorationists' concept of *designing artificial nature* renders obsolete the radical distinction between the human made and natural and thus raises complex questions about traditional understandings about the relationship between society and nature." The future of ecological restoration according to Gross, is not in the tradition of Aldo Leopold, but instead lies in "Ecological Inventionism" an idea he traces to the mid 1990s and

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[39] R. Bruce Hull and David P. Robertson, "Which Nature?" in ed. Gobster and Hull, *Restoring Nature*, 301.

philosopher-poet Frederick Turner, whose work *Genesis, an Epic Poem* describes the terraforming of Mars.[40]

So while early restorationists had pushed back against critics, explaining that restoration strove not for control but participation an improvement of environmental conditions and ecological function and a connection between people and ecosystems formed through involvement, latter day restorationists demanded even more human immersion in the process. Frederick Turner conceived of an "inventionist ecology," as a supplement to traditional conservationism, that would "when the occasion warrants and the knowledge is sufficient . . . *create* new ecosystems, new landscapes, perhaps even new species." Turner arrives at some of the same conclusions that underlie envirotechnical analysis, although he preserves a good measure of human exceptionalism. "We humans," he writes, "are both part of nature, and superior to and more valuable than any other part; at the same time we are essentially dependent on the rest of nature, and the loss of any of its unique and beautiful forms is an absolute loss to us."[41] In a similar way, an envirotechnical point of view is now increasingly likely to reject the duality of humanity and nature, but still recognize differentials of influence in any particular situation, issue, or event. In studying history, each specific case, examined separately and in comparison with others, will reveal different relationships amongst the parts of the whole system (and humans are often not the most powerful force). This point of view and a restorationist ethic, applied beyond just restoration projects, could usefully influence future human environmental interactions.

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[40] Matthias Gross, *Inventing Nature: Ecological Restoration by Public Experiments* (New York: Lexington Books, 2004), 1, emphasis in original.
[41] Frederick Turner, "The Invented Landscape," 36, 45, emphasis in original.

In 2004, Matthias Gross explained that for "restoration and inventionist ecologists, the idea of simply preserving nature is as outdated as the struggle against nature that led to the pillage and exploitation of nature. Now they are also creating new natures."[42] The founders of the Nebraska National Forest, planting trees by the Dismal River one hundred years earlier, would certainly have empathized with this argument. They often framed their efforts as improving the land by restoring an earlier environmental condition and believed implicitly in their moral authority and ability to shape nature. But they also learned to adapt their efforts to the local environment. They worked hard to build their forest and their experience offers an early example of tree planting as environmental engineering and provides a deeper historical context for the current restoration movement.

Eric Katz, William Jordan, and Frederick Turner are among many scholars who have debated the philosophical meanings of ecological restoration. Katz claims that after restoration an environment is no longer natural but at best a hybrid artifactual system; Jordan focuses on the process of restoration as creating community with nature; and Turner pushes past mere restoration to promote an "inventionist ecology." Each of these perspectives has antecedents in the construction of the Dismal River Forest Reserve. Both the Dismal River Forest and ecological restoration are about constructing environments and making value choices, whether those are for past ecologies or future ones. Both rely on the scientific knowledge and technological abilities of humans. In building a forest from scratch in the Nebraska grasslands, federal foresters developed important knowledge, innovative tools and techniques, and practical experience. Any

[42] Gross, *Inventing Nature*, 1.

attempt at effective restoration requires working with ecological processes over long periods of time—the Dismal River Forest has been building and growing for more than one hundred years. As a project that incorporated human intentions and actions with ecological process it provides a history that can help inform our own perception of our place in the environment and by comparison suggests the modern practice of environmental restoration as a paradigm for current issues.

Conclusion

In the soft, sandy plains of Nebraska, well over a century ago, idealistic young men began a forest. They were building nature and they were building with nature. It was a working relationship. Their forest was not as grand and magnificent as the Sequoia forest in California's Kings Canyon or the 17 million acre Tongass National Forest in Alaska, but it has, over time, become valuable and meaningful. They built the way people always do, with labor and technology, but also by enlisting ecological forces as part of that technology. So the importance of their work is not just the end product, the forest, but also the process with which they built it. The forest was a system but the process was a system too, one that incorporated nature and culture just as the final forest incorporates nature and culture.

National Wildlife described the Nebraska National Forest as an ecological crossroads. It was certainly at the center of a web of connections, both material and cultural. Settlers coming to the Plains desired trees. They brought them along, and shipped them in later, planting trees in windbreaks, farm yards, and timber claims. As part of the process of national expansion and as part of their personal experience, they wanted to recreate a familiar landscape and society that included trees. Railroad companies and the federal government used the potential of trees to draw settlers westward. The promise of tree planting was an improved environment and a successful society. Communities would prosper as their trees grew, the nation would prosper as its communities expanded. But it was hard to get trees to grow in the dry grassland. Federal foresters tried to help, offering encouragement and expert advice. Progressive, scientific forestry was about more than harvesting or managing timber resources. It was also about growing forests.

Filled with idealistic ambition, foresters at the turn of the 20th century wanted to build their own forest. They intended to learn the scientific skill of how to do it, and then use this ability to put forests wherever society wanted them. To build a forest they first had to produce individual trees. Seedlings could be planted together and perhaps nurtured into a real forest but each seedling had to be made separately. Clearing land for seedbeds, importing seeds from around the country and the world, and developing the machinery and process of production, they built a seedling factory. The first federal tree nursery, this operation had all the characteristics of industrial manufacturing. As part of the production process, the nursery relied on ecological mechanisms: sunlight, nutrients, soil, and water as power sources and raw materials and germination, photosynthesis, and growth as building mechanisms. Because even this simplified environment was still an ecosystem, nursery managers could not establish as much control as they wished. Nevertheless, developing machines and techniques, they implemented all of the components of the factory system, such as standardization of product and process, mechanization, management of labor, mass production and consumption. They achieved economies of scale, pushed for innovation and expansion, and packaged and shipped their product. They manufactured millions of seedlings.

If trees were a prominent American symbol of nature, then this nursery was a factory producing nature. But the real quality of nature is in the interactions of organisms and their environment. Foresters expanded their work regime from the nursery into the field, planting 30,000 acres. In doing this they were building a system, not for producing a product, but for creating a quality. They wanted to produce "forest conditions." While they understood this through certain characteristics like canopy closure and soil build-up, the foresters knew these conditions came from ecological interactions and connections. These conditions and connections developed over time, though foresters were occasionally dismayed with some of the interactions. As an ecosystem, the forest was much harder to control than the nursery. Predators, disease, and fire were actually part of the growing nature of the system. Because of all their work, the foresters still had a lot of value invested in the trees as individuals so it took a long time for them to feel secure in the momentum of the whole forest as a system. The users of this system, though, soon adopted it as a forest. The birds and animals and people who inhabited it and became part of the system helped to make it a real forest.

Although foresters had harnessed ecological processes and used human labor to produce the trees and planted them together in the surrounding hills, the interactions of the trees with other organisms and the environment was what gave the forest a life of its own. In building this system and starting these interactions foresters learned about many of the inconspicuous qualities and requirements of trees and forests. The surprisingly strong influence of microclimates and facing exposures, the importance of seed provenance, the demands of competition among organisms and resistance to forces like weather and fire that threatened the trees' existence but ultimately made the forest as a system more rigorous, were all important lessons that went along with the technical knowledge they developed in building the forest. They learned about the nature of forests by constructing one, and then they used that knowledge and experience to apply trees as a technology for environmental and social problems in other places.

Some of the first trees planted on the Great Plains were in windbreaks and the Forest Service took its work seriously in building shelterbelts there in the 1930s. Trees, as a symbol of nature, also served well as technology. The shelterbelts were carefully designed to specific standards intending to fit them to the conditions of their location and purpose. However, like all technologies many forces shaped each shelterbelt including political and economic considerations, the demands of their users, and changing social values. Though small, these technological forests developed forest conditions and natural values for habitat and recreation. As organic technologies these shelterbelts served many more purposes that an inert construction could. They represent a history of tree planting enthusiasm, the development of practical environmental knowledge, and the value of perceiving nature and culture in the same object and purpose.

Americans eagerly planted trees on the Great Plains. Federal foresters built a thirty thousand acre forest and thousands of shelterbelts there. In each of these technological forests, trees, soil, animals and plants, as well as people, their ideas and technologies were all part of the same system, all constructing that system, the environment, and history, through their interactions. This is a small, simple conclusion to reach but perhaps it has profound implications. Perhaps there is no irony in an organic technology, or in a technological forest becoming naturalized, or in ecological restoration seeking to restore natural values with ideology and technology. Perhaps this is just an example of the underlying reality. In that case, this narrative of tree planting and constructed forests as envirotechnical systems offers a more comprehensive method of understanding the past and the hope of a more resilient environmental future.

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